Prosthetic
Best Practice Guidelines

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Creating life's turning points, together

Contents

Acknowledgements

These guidelines have been produced over many years by a team of specialist clinicians working in NHS prosthetic rehabilitation centres in the UK. In addition to those who have searched, reviewed and formulated the guidelines, many clinicians around the country have contributed to the process of professional consensus. We would like to acknowledge and thank all those who have contributed to this project, whether as members of the various groups, as directors of Steeper, or by your contribution to the professional consensus surveys. The encouragement and support is appreciated.

The organisation and editing of the guidelines has been carried out by Vicky Jarvis and Tim Verrall.

Vicky is the clinical and quality lead for Steeper Group, and a prosthetist with many years experience. She was a member of and later led the prosthetics Best Practice Group, whose focus have been the development of evidence-based prescription guidelines and clinical governance protocols. Vicky has completed a postgraduate diploma in Health Research at Leeds University, and maintains an active interest in research and development in the field.

Tim trained as a prosthetist with Steeper at Roehampton in 1974, and has worked at Manchester and Liverpool prosthetic centres. He headed up the Steeper Best Practice Group for five years, contributing his considerable experience in both upper and lower extremity prosthetics to the guidelines. With patience and dedication he drew together all the evidence and hard work of the group to form this comprehensive guide to prescribing every aspect of modern prosthesis.

Our thanks also go to former members of the Best Practice Group (BPG) who have contributed ideas, material and valuable time to make the guidelines what they are today:

Tony Miller – Prosthetist, Mags Miller – Orthotist, and Debbie Franklin – Prosthetist, Derby, who, along with several other prosthetists, formed the Best Practice Working Party (BPWP) and set the ball rolling.

Julie Kirby – Prosthetist, Liverpool, who headed up the BPWP for a time and to all the Best Practice co-ordinators from each of the Steeper centres at which they worked.

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Foreword

These guidelines are intended to help you, the clinician, to provide the best possible prescription for your patients. They will give you the information you need to evaluate the prescriptive options available to you, as well as providing clinical evidence to support the decisions you make. They may also be used to best advise your patients of the advantages and disadvantages of their treatment, thus meeting the requirements of patient consent. Great care has been taken to ensure these guidelines provide high quality clinical evidence which can be used with confidence as a guide to current best practice.

Each guideline has been developed from a critical appraisal of available literature[1] and a consenus of clinical opinion derived from an adaptation of the Delphi technique[2] primarily from prosthetists within Steeper, as well as rehabilitation consultants and other members of rehabilitation teams across the UK.

To simplify use the guidelines are categorised according to level of amputation. For each level there are guidelines covering choice of socket prescription, casting method and prosthetic hardware. The hardware guidelines are generic and no specific products have been evaluated as this is not the remit of these guidelines.

The guidelines are in the form of a table of indications and contraindications highlighting the patients most likely to benefit or not from the particular prescription expressed in the guideline statement. Although this statement declares that ‘any patient’ should be provided with a particular prescription ‘when some or all the indications are observed and ideally none of the contraindications exhibited,’ it must be understood that few patients will fit exactly into these statements. Indeed some patients may be appropriate for more than one prescription. It is up to the prescribing clinician to use this evidence base alongside their clinical evaluation of the patient’s presenting condition, their aims, and their lifestyle to formulate an optimum prescription.

1. Originally, all literature searched was carried out using the RECAL bibliographic search engine of the National Centre for Prosthetics and Orthotics based at the University of Strathclyde. The search terms used and exclusion criteria are explained in the introduction and also in the Central Reference File held by Steeper Best Practice Group. Since 2007 RECAL has not been updated and subsequent literature searches have been undertaken using a range of databases including Medline, CINNAHL and Embase.

2. The Delphi technique is an internationally recognised method for obtaining unbiased consensus of opinion. The method of obtaining this consensus is explained in the introduction and Central Reference File for these guidelines.

Introduction

Scope and Purpose

These guidelines aim to address the clinical question:

'What is best evidence-based practice for the prescription of socket type, the choice of casting method, and the generic hardware for patients with a lower extremity amputation?'

These guidelines aim to:

- Guide and support clinicians in the decision-making process when prescribing prostheses.
- Facilitate prescription of the most appropriate prosthesis for each patient, thereby aiding the patient to reach their maximum functional potential.
- Aid the implementation of current best evidence-based practice.
- Reduce large national variations in prescription.
- Produce recommendations which can be easily audited.

These guidelines do not aim to dictate which method or prescription must be used overall, but rather to offer guidance to the clinician by highlighting indications and contraindications for a variety of practices which are all considered to be good practice.

The objectives of these guidelines are:

- To identify and critically appraise all relevant published articles.
- To gain consensus of professional opinion for each guideline statement using the Delphi technique.
- To produce recommendations based upon the general consensus of professional opinion and best available current evidence.
- To produce recommendations through guideline statements in three key areas:
    - Prescription of socket type
    - Casting method
    - Prescription of generic hardware
- To produce a tool for audit purposes.

AGREE Instrument

The Appraisal of Guidelines Research and Evaluation (AGREE) instrument published by the AGREE collaboration in September 2001 provides a framework for assessing the quality of clinical practice guidelines. It is used throughout the NHS by guideline developers and policy makers to ensure rigorous guideline production and appraisal.

Clinical practice guidelines are "systematically developed statements to assist practitioner and patient decisions about appropriate health care for specific clinical circumstances."[1] Their purpose is "to make explicit recommendations with a definite intent to influence what clinicians do."[2]

The criteria contained within the AGREE instrument have been developed through discussions between researchers from several countries and reflect the current state of knowledge in the field. This introduction provides evidence of how the Best Practice Guidelines meet these criteria.

These guidelines address all levels of lower extremity amputation, whether unilateral or bilateral. The target patient population for each guideline is defined within each guideline statement, for example:

'Quadrilateral sockets should be prescribed for any patient with a transfemoral amputation, when some or all of the indications are observed, whilst ideally none of the contraindications are exhibited.'

The guideline then highlights the most appropriate patients within that patient population, by defining indications and contraindications for that socket type, casting method or generic hardware. These guidelines do not address patients with congenital anomalies or upper extremity absences.

Stakeholder Involvement

These guidelines were originally compiled and used by clinicians within Steeper Group, a private company providing prosthetic and orthotic services to the NHS. The main compilers have been a group of clinicians with a special interest in the field of evidence-based practice, who then drew on the wider community of clinicians to gain consensus of opinion alongside the best available research evidence. The guidelines have been widely used and expanded significantly over the years.

Development and Production of Prescription Guidelines

The process of developing a guideline is important to ensure an unbiased representation of the consensus of clinical opinion and current best available evidence. For these guidelines, an adapted form of the Delphi Technique[3] was used to gain consensus of professional opinion together with literature reviews for each topic.

Literature Search/Review

RECAL was a specialist search engine for the National Centre for Prosthetics and Orthotics. It was based at the University of Strathclyde and contained references from many prosthetic and specialist rehabilitation journals worldwide. In 2007 this service was disbanded although the original database with abstracts is still available online in the form of Recal Legacy, though it is no longer updated.

The preferred search engine is now PUBMED (or MEDLINE where available) with Athens, NHS Evidence, CINNAHL and Embase also searched. Abstracts are screened and papers thought to be of use are sourced through the NHS or university libraries. Search terms are recorded in the central reference copy of that guideline. References were also obtained from the clinical consensus process described on page 9.

References where a hard copy was not available or which were not in English were automatically excluded. Furthermore any references which were deemed to be irrelevant to the guideline after appraisal by members of the Steeper Best Practice Group (BPG) were also excluded.

All of the remaining references were critically appraised by two members of the BPG and their conclusions recorded on a review form. They were classified using the CASP[4] system to give the type of study undertaken within the types listed on the following page. Methodological quality was assessed to ensure only papers which attempted to reduce confounders or bias were considered relevant. Any indications or contraindications arising from the results of the papers were recorded. For a new guideline these results are compiled into preliminary prescription criteria to form the first phase of the consensus procedure described on page 9. In the case of updates to existing guidelines the references were added to the guideline, using italics to denote that they are only from the literature review and not consensus.

Definitions of Study Types

Qualitative research

The collecting of people's experiences which are then collated and analysed in largely non-statistical ways. Examples include diaries, structured and non-structured interviews.

Quantitative research

The gathering of observations measured and analysed in a numerical, scientific way, carried out to provide statistical evidence to support an existing hypothesis. Examples of quantitative research include:

Case studies or series - A descriptive study of the characteristics/clinical findings seen in one (study) or several (series) patients who have the same condition or disease. It is a study method that can lead to increased understanding of one context and the processes at work. It is scientifically weak, but can be a good starting point for further research. Routine surveillance programs can use accumulating case reports or series to suggest the emergence of new disease or epidemics.

Cross-sectional study – A descriptive study that looks at exposure and disease status simultaneously at one point or period of time, e.g. frequency of disease, risk factors or other characteristics at that time. Strength of evidence is low as it can only show an association between factors. The scale and scope may vary; it can be used to assess prevalence – the overall proportion of the population who have the disease or incidence – or the number of new cases over a defined time. It can also be analytical when comparing more than one sample or exposure variables that do not change over time. For example: a study of silicone suspension liner wearers at a particular time to monitor the prevalence of blisters within that population.

Case control study – An analytical study in which subjects are selected on the basis of presence of disease or condition and compared to a control group who do not have the disease of interest. The groups are compared retrospectively for evidence of an exposure or characteristic of interest. For example: a study of the prevalence of blisters in people with a silicone suspension liner compared to patients not using a silicone suspension liner of that type.

Cohort – An observational analytical investigation where subjects are classified on the basis of presence or absence of exposure to a suspected risk factor for a disease. They are followed up over time to determine the development of disease. This is compared to the unexposed control group. The design can be prospective – subjects have been exposed but the disease has not yet occurred, or retrospective – the investigation starts after both exposure and disease has already occurred. For example: a study of a group of dysvascular patients over five years, recording the level of second amputation in those patients who smoke compared to those who don't smoke.

Randomised Control Trial (RCT) – An intervention or experimental study where subjects are randomly allocated to one of two (or sometimes more) groups. For example, patients experiencing phantom pain are randomly provided either a Relax Night Care sock or a placebo sock then followed up to record frequency and intensity of phantom pain at night. One group receives the experimental treatment or intervention, the other group is the control and receives a placebo or standard treatment. Effectiveness is measured by comparing outcomes in the groups. Intervention studies are considered to be the most scientifically robust as the process of randomising achieves, on average, control of all the other factors that may affect outcomes.

This type of study is often quoted as the gold standard for research; however a poorly designed RCT has little or no value and would be less scientifically robust than a well designed cohort or case control study.

Professional Consensus

The nature and history of prosthetics mean that research can be scarce and often of poor methodological quality, therefore a necessary source of evidence has to be consensus of clinical professional opinion. This is obtained using an adaptation of the Delphi Technique.[3] This process is illustrated in **Fig. 1** on page 10.

Phase One: Literature review

The results of a literature review completed as described above are compiled into a list of preliminary prescription criteria. See below for more details on critical appraisal.

Phase Two: Establishing prescription criteria

The preliminary prescription criteria are sent to all Steeper prosthetists and the multidisciplinary teams in each branch with a request to comment on the given criteria, and to suggest any other factors that would affect their prescription practise or any research they are aware of. All responses are anonymous and are collated and edited to a standard wording to form initial guideline statements.

Phase Three: Obtaining professional consensus

These guideline statements are compiled into a questionnaire and returned to all Steeper prosthetists and the multidisciplinary teams in each branches with a request to indicate their level of agreement with each statement. The available responses are 'Strongly Agree', 'Agree', 'Disagree', 'Strongly Disagree' or 'No Experience' with each statement. Any responses outside these categories are disregarded. Again all returns are anonymous and the branch of origin or profession is not recorded. There is also opportunity to add any further criteria that may affect the prescription. This phase can be repeated to include these criteria if necessary.

Phase Four: Production of guideline

The final guideline is produced using the consensus of agreement to indicate the importance of each criterion. Each indication/contraindication statement has four levels of agreement: Strongly Agree (SA), Agree (A), Disagree (DA) and Strongly Disagree (SDA).

On return of the phase 2 questionnaires, the agreement (SA + A) for each indication and contraindication is to be calculated as a percentage of the total number of responses (SA + A + SDA + DA), thus excluding the 'No Experience' responses.

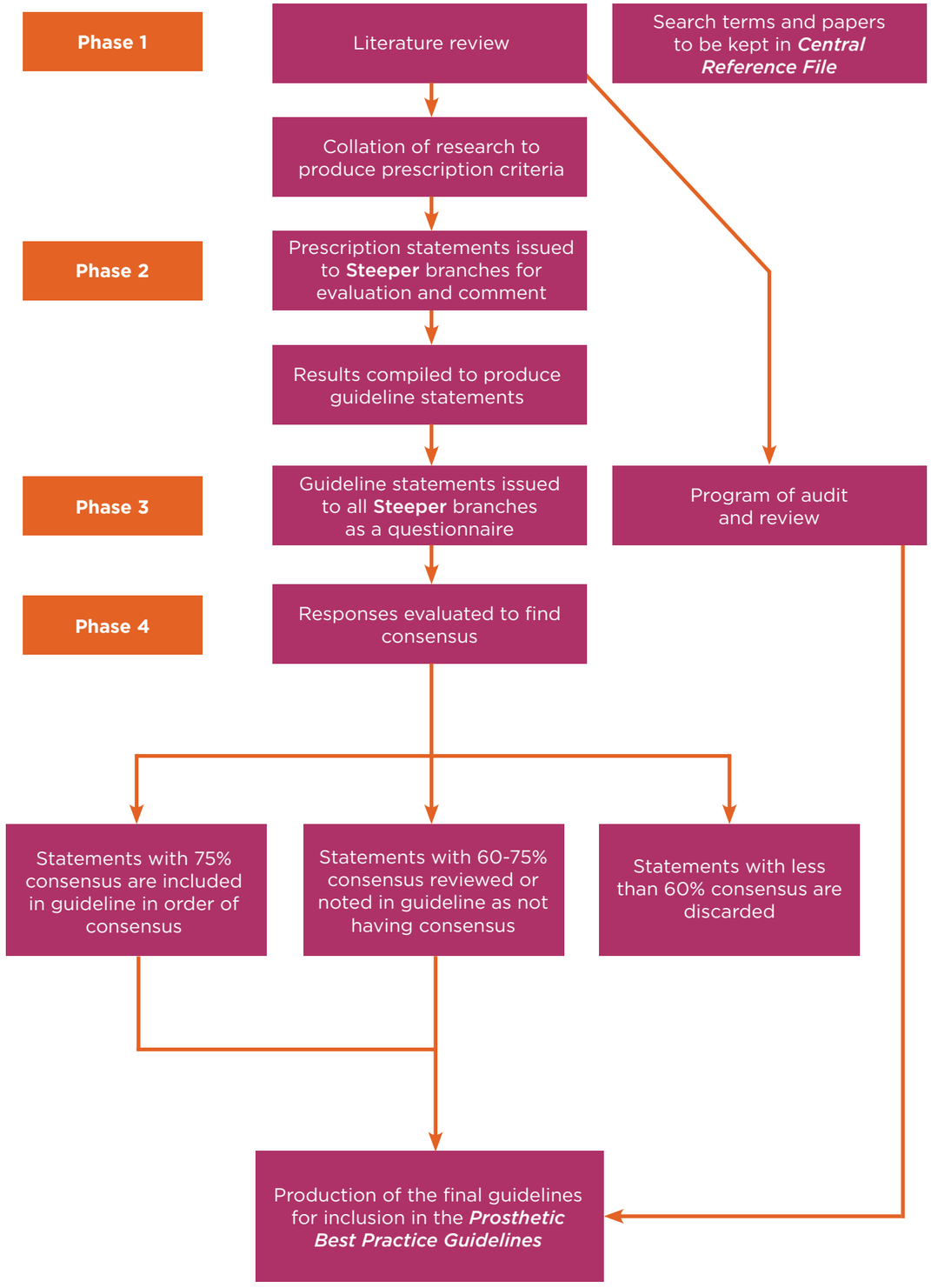
Consensus is defined as a "general agreement of a substantial majority", this is reached when >75% of responses agree or strongly agree.

A figure of <60% is defined as no consensus and the indication/contraindication is rejected. For figures between 60% and 75%, the BPG review the particular indication or contraindication to decide if there is either sufficient evidence to suggest it should be included, a need to reword it for clarification and resubmit it, or a need to exclude it.

The strength of agreement or disagreement is accounted for when each indication or contraindication that has consensus is scored using the following method to weight the amount of agreement: (SA*2) + (A*1) – (DA*1) – (SDA*2). This score is used to determine the order in which the criteria appear in the guideline.

At regular intervals, the Steeper BPG will review each guideline to search for new literature and audit prescription criteria. If a revision of the guideline is indicated the process will be restarted at phase two.

Fig. 1 Method for Producing a Prescription Guideline



The Format and Presentation of the Guidelines

These guidelines have been developed with the aim of making them as user friendly as possible. The format of the guidelines should help clinicians determine the available options for each amputation level and easily decide which casting method, socket type or generic hardware is most appropriate.

The published guidelines will consist of:

1. The ***Prosthetic Best Practice Guidelines*** containing; a brief introduction, contents page, all guidelines and overview pages. This has been published as a book and is available as a PDF on the Steeper Group website.

2. The ***Introduction***; a quick reference guide to how the guidelines have been put together and how best to use them.

3. The ***contents page*** listing all the available guidelines for the socket types, casting methods and generic hardware for each amputation level. After identifying each option relevant to their patient it is then up to the clinician to decide which method is most appropriate.

4. The ***guidelines*** contain a *Guideline Statement*, with *Definitions* to ensure clarity, followed by a table of *Indications and Contraindications*, with definitions, notes and explanations of any terms or expressions used.

Where professional consensus and/or references are contradictory or unclear, explanations are provided. The recommendations made by the indications and contraindications are intended to be clear and concise to enable comparisons between the guidelines to be made easily.

Each chapter ends with a table of *references*, in which the APA style of referencing is used. The reference details will include the author(s) name, publishing year, article/study title, journal name, volume, issue (if applicable), and page number(s).

References that support a specific indication/contraindication are linked to that indication / contraindication in the guideline, by a superscript number.

Overview pages are included to provide additional information which, though it may not be exhaustive, can help in the application of the guidelines.

There is also a ***Central Reference File*** containing all details of literature searches including hard copies of references used; details of professional consensus surveys and all material relating to development of the guidelines. This will be held centrally and be available for examination on request.

The Application of the Guidelines

These guidelines have been produced for the benefit of those who are responsible for determining the most appropriate socket type, casting method and generic hardware for a particular patient with a lower extremity amputation. This is most often the responsibility of the prosthetist and rehabilitation consultant, but may also include the physiotherapist, occupational therapist and other members of the multidisciplinary team, and should always include the patient themselves.

The guidelines can be a useful tool by which the clinician can reason through the various options available. Indications and contraindications can be compared to find the most appropriate way of making progress with the patient's prosthetic rehabilitation according to current best practice guidelines.

It should also be a useful tool for the multidisciplinary team, providing the team with greater assurance that the proposed course of action is best practice according to the evidence and professional consensus, and not just a preference of the clinician involved. The contraindications observed may also provide the team with a clearer idea of what issues need to be considered prior to prosthetic provision or the application of a particular technique.

They can also be used to work through the various options with the patient as part of the process of gaining their consent for a particular course of action, or to explain why an alternative approach is inappropriate. The guidelines are not intended to restrict clinicians from attempting to make progress with the rehabilitation of the patient, or to remove their freedom to make decisions regarding their patient's care. Rather it is to provide a framework of evidence to support and advise them as to what others in the profession believe to be the most appropriate application of the many different prosthetic approaches available, and to warn of any potential pitfalls.

The Best Practice Guidelines are the property of Steeper. They are clinically independent with no affiliation or bias towards any manufacturer or supplier of prosthetic products.

References - Introduction

1. LOHR K N, FIELD M J, (1992). A provisional instrument for assessing clinical practice guidelines. In: *Guidelines for Clinical practice. From development to use.* Washington D.C.: National Press.

2. HAYWARD R S A, et al., (1995). Users guides to the Medical Literature VIII. How to use Clinical Practice Guidelines A. Are the recommendations valid? *JAMA*, Vol. 274(7), p570-574.

3. VAN DER LINDE, et al., (2005). Use of the Delphi Technique for developing national clinical guidelines for prescription of lower limb prostheses. *JRRD*, Vol. 42(5), p693-703.

4. CASP, (1999). Critical Appraisal Skills Program / The Health Care libraries Unit.

Partial Foot Prostheses Guidelines

Prescription Guideline Title	Ref Number
Silicone partial foot for Chopart	PF P SSS 01
Silicone partial foot for Lisfranc	PF P SSS 02
Silicone partial foot for transmetatarsal	PF P SSS 03

Partial foot prostheses

Amputation Type

- Toe disarticulations
- Transmetatarsal amputations
- Ray amputations
- Lisfranc disarticulations
- Midtarsal amputations. Generally referred to as Chopart disarticulations

Prosthetic Treatment

These amputations are most often treated by the provision of bespoke insoles, used in either standard or bespoke footwear. In the case of multiple or significant toe amputations, a carbon graphite sole may also be used to provide better function at toe off. Removal of the first or fifth ray rarely requires more than an insole in an appropriate shoe. Removal of the central, or more than one ray is not recommended.

- Silicone prosthesis
- *Leather lacing prosthesis*
- AFO with toe filler
- *Insole with toe filler*
- *Socket with sole plate*

Casting Method

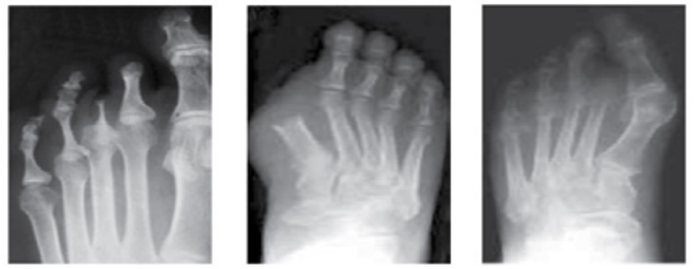
- *Compression box*
- *Hand casting*
- *Alginate casting*
- *CAD / CAM*

Materials

The materials used are dependant on the type of prosthesis that is chosen.

The guidelines shown in italics have yet to be produced.

Toe amputation

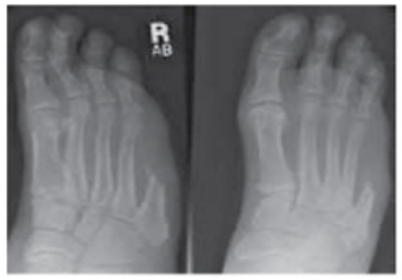


(Hallux valgus deformity after removal of second toe)

Toe amputation involves removal of one or more toes through phalanges, interphalangeal joints or metatarsophalangeal joints. Metatarsal head pressure can become more prominent, and fixation of the long extensor tendon to the dorsal joint capsule aids in elevation of the metatarsal head.[1] The standard technique is to prepare a plantar soft tissue flap, consisting of the thick plantar skin, which enables weight-bearing.

Disarticulation of the second toe may result in hallux valgus deformity because the great toe tends to migrate towards the third toe to fill in the gap.[2] Amputation of the great toe or even of all five toes usually does not impair walking ability. Prosthetic toes can be fitted for cosmetic restoration, although it may be difficult for these to remain in place. If function is impaired or hallux valgus develops, this can be treated by similar methods to non-amputated feet.

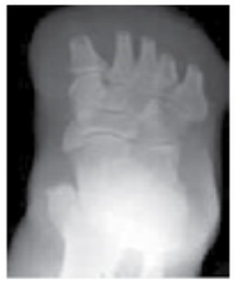
Ray amputation



Ray amputation involves the excision of the toe and a variable portion of its metatarsal. The bone should be bevelled on the plantar aspect to avoid an area of high pressure during latter stance phase. In regard to the first (medial) ray, the metatarsal shaft should be left as long as possible to aid in effective elevation of the medial arch by a custom-molded insole.[2] Single amputations of rays two, three, or four will only moderately affect the width of the forefoot. Resection is best carried out through the proximal metaphysis just distal to the intersection of the base of the involved ray with those of the adjacent metatarsals, leaving the tarsometatarsal joints intact.[2] For a fifth metatarsal amputation, the shaft should be transected obliquely with an inferolateral-facing facet, leaving the uninvolved half to three-quarters of the shaft to preserve forefoot width and retain the insertion of the peroneus brevis.[2]

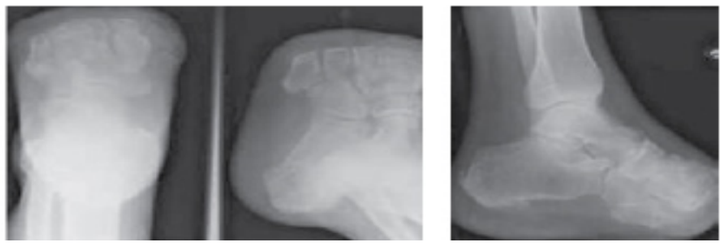
Prosthetic solutions for this amputation level can include cosmetic restoration using a silicone toe – this may need to be secured to the foot around the forefoot and does not usually affect function. If function is compromised, orthotic insoles with a simple toe filler and medial and/or transverse arch support can be used. Shoe adaptations are sometimes required to improve function.

Transmetatarsal amputation



Transmetatarsal amputation involves the excision through the epiphysis of the metatarsals. The tendons of the flexor and extensor muscles are sutured to each other or if possible, fixed to the bone. It is important to avoid an equinus position.[3] Patients with these amputations can usually walk without a prosthesis however base of support is decreased which results in balance that is less than normal and reduced push off power. A tightly fitting silicone prosthesis can provide cosmetic restoration, protect the distal end and provide transmetatarsal support. A rigid sole plate may be necessary to improve roll over and push off.

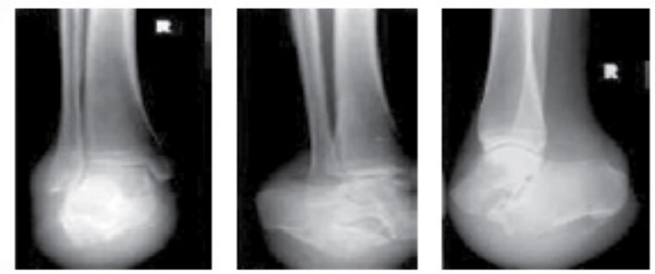
Transmetatarsal (Lisfranc) disarticulation



First described by Lisfranc in 1815,[2] Lisfranc disarticulation involves the incision of the foot at the tarsometatarsal joint, with the sole being preserved to make the flap. Approximately 50% of the original supporting area is remaining but a major loss of the forefoot length. Equinovarus is a common postoperative problem. This has been overcome quite adequately with the reinsertion of the extensor tendons and the peroneal tendons at a more proximal site.[4]

Some surgeons perform an Achilles tendon lengthening[1,2,3,4] when they think that an equinovarus is probable. The lost surface area must be restored to improve balance, push off and avoiding an equinus position. A tightly fitting silicone prosthesis can provide cosmetic restoration, protect the distal end and provide transmetatarsal and medial arch support. A rigid sole plate may be necessary to improve roll over and push off.

Midtarsal (Chopart) disarticulation



This disarticulation is through the talonavicular and calcaneocuboid joints. Chopart disarticulation removes the forefoot and midfoot, saving talus and calcaneus. At the time of disarticulation, all ankle dorsiflexors are divided. Without restoration of dorsiflexor function and weakening of the plantar flexors, severe equinus deformity from myostatic contracture of the unopposed triceps surae is inevitable. Active dorsiflexion can be restored to this extremely short residual foot by attachment of the anterior tibial tendon to the talus, either through a drill hole in the talar head or with sutures or staples to a groove in the distal aspect of the head.[1,2,3,4]

A subcutaneous Achilles tenotomy can be carried out to prevent equinus deformity. The ankle and subtalar movement between residual limb and socket create the biggest challenge for Chopart. The movement results in friction and the possibility of skin breakdown and sores. This can be neutralised with a good grip of the socket around the heel. A surgical alternative to avoiding movement inside the socket is an arthrodesis of the foot joint and between talus and calcaneus.[2,3] This results in a stable residual limb that can tolerate end-bearing and a slight shortening which will simplify prosthetic fitting.[3]

The advantages with Chopart disarticulation are a longer lever arm for balancing forces (compared to a higher level amputation) and an area for weight distribution. With preservation of full leg length and a stable heel pad, the Chopart patient can walk with direct end bearing for short distances without a prosthesis, although this short residuum has no inherent rollover function.

A tightly fitting silicone prosthesis can provide cosmetic restoration, protect the distal end and provide trans-metatarsal and medial arch support. A rigid sole plate may be necessary to improve roll over and push off. Depending on the shortening of the limb and condition of the residuum this level is sometimes treated prosthetically as a Symes amputation – see chapter three.

References - Partial foot overview

1. WILLIAM WAGNER F, (1992). Partial-Foot Amputations: Surgical Procedures. *Atlas of Limb Prosthetics: Surgical, Prosthetic and Rehabilitation Principles*. 2nd ed. Rosemont, IL: American Academy of Orthopaedic Surgeons.

2. BOWKE J H, (2007). Partial Foot Amputations and Disarticulations: Surgical Aspects. *Journal of Prosthetics and Orthotics,* Vol. 19(3S), p62-76.

3. SÖDERBERG B, et al., (2001). Partial Foot Amputations. *Guidelines to Prosthetic and Surgical Techniques*. 13th ed. Swedish Orthopaedic Association's public.

4. CHAIRMAN E L, (2000). Amputation of the Foot. In: HETHERINGTON V. J. (ed), *Textbook of Hallux Valgus and Forefoot Surgery*. Cleveland. p471-480.

Silicone partial foot for Chopart

Prescription Guideline - PF P SSS 01

Guideline Statement

A silicone partial foot prosthesis should be prescribed for any patient with a Chopart (midtarsal) amputation, when some or all of the indications are observed, whilst ideally none of the contraindications are exhibited.

Definitions

- Silicone partial foot prosthesis is a slip on, self-suspending prosthesis made almost entirely of silicone, providing a restoration of the forefoot shape.

Indications	Contradications
Patient prefers cosmetic appearance[1,2,4]	Primary patient with oedematous residual limb[1]
Psychological benefits with improved body image	Activity level above moderate walking, requiring good forefoot action[1]
Stable ankle joint[1]	Ankle joint requires functional support[1]
Healed residual limb[3]	Unhealed residual limb[1,3]
Good personal hygiene	Poor personal hygiene
	Excessive perspiration
	Bulbous residual limb
	Large residual limb
	Inappropriate footwear*[4]
	Allergic reaction to material used

*Inappropriate footwear – may best be defined as that which has too high a heel, such that the plantar-flexed position of the residuum creates loads on it that cannot be comfortably maintained, or has heels that are so narrow that medial/lateral stability is compromised, or which has so little containment that it cannot safely be kept in place on the prosthesis. At this level of amputation it is preferable if the shoe provides some support or retention above the level of the prosthesis to help retain it on the residuum.

Silicone can be an excellent material with which to provide protection for delicate areas of tissue, especially if a softer patch is included in the lay-up of the prosthesis. But it can also cause perspiration and this may lead to a softening of the tissue, increasing the problem. Care needs to be taken therefore to determine the cause and nature of such a problem before proceeding.

Exceptions

- Those patients who are deemed medically unfit, unwilling, or because of their current lifestyle or circumstances, unsuitable for the provision of a prosthesis.
- Poor cognitive ability and compromised hand function may, in some cases, be contraindications for prosthetic rehabilitation. The multidisciplinary team (MDT) must assess whether the patient has the level of ability required with or without a carer, to use the prosthesis being prescribed, correctly, safely and consistently before proceeding.
- Where an alternative approach is seen to be more suitable according to the indications/ contraindications of its guideline.

Silicone partial foot for Lisfranc

Prescription Guideline - PF P SSS 02

Guideline Statement

A silicone partial foot prosthesis should be prescribed for any patient with a Lisfranc amputation, when some or all of the indications are observed, whilst ideally none of the contraindications are exhibited.

Definitions

- Silicone partial foot prosthesis is a slip on, self-suspending prosthesis made almost entirely of silicone, providing a restoration of the forefoot shape.

Indications	Contradications
Patient prefers cosmetic appearance[1,2,4]	Primary patient with oedematous residual limb[1]
Psychological benefits with improved body image	Activity level above moderate walking, requiring good forefoot action[1]
Stable ankle joint[1]	Ankle joint requires functional support[1]
Healed residual limb[3]	Unhealed residual limb[1,3]
Good personal hygiene	Poor personal hygiene
	Excessive perspiration
	Bulbous residual limb
	Large residual limb
	Inappropriate footwear*[4]
	Allergic reaction to material used

*Inappropriate footwear – may best be defined as that which has too high a heel, such that the plantar-flexed position of the residuum creates loads on it that cannot be comfortably maintained, or has heels that are so narrow that medial/lateral stability is compromised, or which has so little containment that it cannot safely be kept in place on the prosthesis. At this level of amputation it is preferable if the shoe provides some support or retention above the level of the prosthesis to help retain it on the residuum.

Silicone can be an excellent material with which to provide protection for delicate areas of tissue, especially if a softer patch is included in the lay-up of the prosthesis. But it can also cause perspiration and this may lead to a softening of the tissue, increasing the problem. Care needs to be taken therefore to determine the cause and nature of such a problem before proceeding.

Exceptions

- Those patients who are deemed medically unfit, unwilling, or because of their current lifestyle or circumstances, unsuitable for the provision of a prosthesis.
- Poor cognitive ability and compromised hand function may, in some cases, be contraindications for prosthetic rehabilitation. The multidisciplinary team (MDT) must assess whether the patient has the level of ability required with or without a carer, to use the prosthesis being prescribed, correctly, safely and consistently before proceeding.
- Where an alternative approach is seen to be more suitable according to the indications/ contraindications of its guideline.

Silicone partial foot for trans-metatarsal

Prescription Guideline - PF P SSS 03

Guideline Statement

A silicone partial foot prosthesis should be prescribed for any patient with a Chopart (midtarsal) amputation, when some or all of the indications are observed, whilst ideally none of the contraindications are exhibited.

Definitions

- Silicone partial foot prosthesis is a slip on, self-suspending prosthesis made almost entirely of silicone, providing a restoration of the forefoot shape.

Indications	Contradications
Patient prefers cosmetic appearance[1,2,4]	Primary patient with oedematous residual limb[1]
Psychological benefits with improved body image	Activity level above moderate walking, requiring good forefoot action[1]
Healed residual limb[3]	Unhealed residual limb[1,3]
Good manual dexterity[4]	Impaired hand function[4]
Stable ankle joint[1]	Unstable ankle joint that requires support[1]
Good personal hygiene	Poor personal hygiene
	Excessive perspiration
	Bulbous residual limb
	Large residual limb
	Inappropriate footwear*[4]
	Allergic reaction to material used

*Inappropriate footwear – may best be defined as that which has too high a heel, such that the plantar-flexed position of the residuum creates loads on it that cannot be comfortably maintained, or has heels that are so narrow that medial/lateral stability is compromised, or which has so little containment that it cannot safely be kept in place on the prosthesis. At this level of amputation it is preferable if the shoe provides some support or retention above the level of the prosthesis to help retain it on the residuum.

Silicone can be an excellent material with which to provide protection for delicate areas of tissue, especially if a softer patch is included in the lay-up of the prosthesis. But it can also cause perspiration and this may lead to a softening of the tissue, increasing the problem. Care needs to be taken therefore to determine the cause and nature of such a problem before proceeding.

Exceptions

- Those patients who are deemed medically unfit, unwilling, or because of their current lifestyle or circumstances, unsuitable for the provision of a prosthesis.
- Poor cognitive ability and compromised hand function may, in some cases, be contraindications for prosthetic rehabilitation. The multidisciplinary team (MDT) must assess whether the patient has the level of ability required with or without a carer, to use the prosthesis being prescribed, correctly, safely and consistently before proceeding.
- Where an alternative approach is seen to be more suitable according to the indications/ contraindications of its guideline.

References - Partial foot prescription guidelines

1. LANGE L R, CPO (1992). The Lange Silicone Partial Foot Prosthesis. *JPO,* 4(1), p.56.

2. KULKARNI J, CURRAN B, EBDON-PARRY M, HARRISON D, (1995). Total Contact Silicone Partial Foot Prostheses for Partial Foot Amputations. *The Foot,* Vol. 5, p32-35.

3. WIGNEY W A, (1965). A Prosthesis to restore balance and prevent Pressure Ulcers after Partial Amputation of the Foot. *The Medical Journal of Australia,* (June), p20-25.

4. GLEDHILL S A, (2003). Experiences with Silicone Partial Foot Prostheses. *Orthopädia-Technik Quarterly*, English 3rd ed., p6-7.

Ankle Disarticulation Guidelines

Prescription Guideline Title	Ref Number
Symes socket with differential liner	AD P SYM 01
Symes sockets with medial trap	AD P SYM 02
Symes sockets with posterior trap	AD P SYM 03

Ankle disarticulation prostheses

Amputation Type

Symes amputation	Pirogoff amputation	Boyds amputation

Prosthetic Treatment

Symes with differential liner	Dependent on the patient's quality of amputation, consideration needs to be given as to whether the socket types, indications, and contraindications, are going to be the same for these amputation types as for the Symes.
Symes with medial trap	
Symes with posterior trap	
Symes with silicone self-suspending socket	
Symes with gel self-suspending socket	

Casting Method

Hand casting	
CAD / CAM	

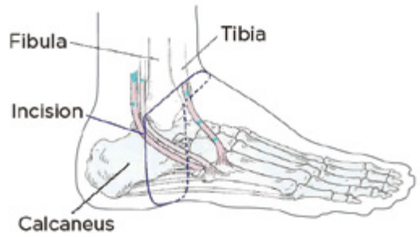
Materials

The usual material choice for these prostheses is resin laminate.

The guidelines shown in italics have yet to be produced.

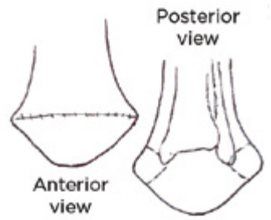
Symes amputation

Fig. 1



For many years now the standard ankle disarticulation has been that described by Syme in 1843 as a "disarticulation through the ankle joint with preservation of the heel flap to permit weight-bearing at the end of the residual limb".

The amputation involves an incision as shown in fig. 1 - the disarticulation of the talus from the ankle joint and the shelling out of the calcaneus from the heel pad.

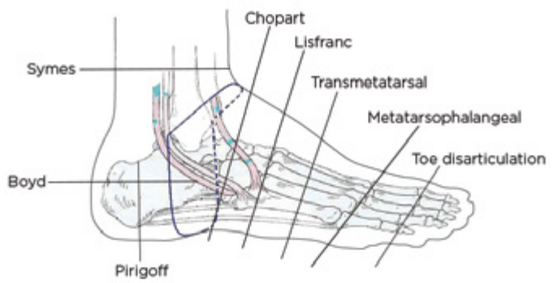


At this stage the calcaneus and the forefoot are removed. Syme recommended the removal of the articular surface of the tibia, but unless there is some other reason for doing so, most surgeons think this unnecessary.

The heel pad, once centered under the leg, is held by suturing the plantar fascia to the anterior tibial cortex through drill holes. Since the main reason for failure of this type of amputation is the migration of the heel pad, it must always be supported until the patient is able to wear a prosthesis. The end result should be a functional endbearing residual limb, with sufficient ground clearance to allow the use of a dynamic prosthetic foot. It should also enable ambulation without a prosthesis, though if this becomes too frequent it can cause the heel pad to move.

This method is also frequently used where a congenital deformity of the foot has occurred, possibly with some other associated absence. This allows the opportunity for the provision of a functional prosthesis, but bearing no resemblance to those covered by these guidelines.

Pirogoff and Boyds amputations



These amputation methods both rely on the successful fusion of a calcaneotibial arthrodesis. In both cases the talus is removed and the end of the tibia is cut to expose the cancellous bone.

Pirogoff makes a vertical section of the calcaneus and, disposing of the anterior portion, securely fixes the remainder with the heel pad to the end of the tibia. Boyd makes a transverse section of the calcaneus, just distal to the peroneal tubercle and similarly fixes the remainder to the end of the tibia.

Both should result in an end-bearing residual limb more suited to ambulation without a prosthesis, but the minimal ground clearance makes the provision of a functional prosthesis very difficult.

Symes sockets with differential liner

Prescription Guideline - AD P SYM 01

Guideline Statement

Sockets with a differential liner should be prescribed for any patient with a Symes amputation, when some or all of the indications are observed, whilst ideally none of the contraindications are exhibited.

Definitions

- Differential liner – a foam liner built up and split medially to allow donning over residual limb and easy donning of the outer socket over that.

Indications	Contradications
All children	Volume of residuum fluctuates
Stable volume of the residual limb	Compromised hand function
Well defined shape to the residual limb	Patients requiring good cosmetic shape, but with a bulbous distal end of the residual limb
Patient is heavy, or uses the prosthesis for high impact activities, or carries heavy loads, such that a trap would compromise the socket strength[1]	Sensitive distal end of the residual limb, such that pushing into the liner would cause pain or discomfort
	Where patient preference requires very secure suspension with minimal pistoning
	Prostheses which have components that require to be accessed through a trap/aperture

Exceptions

- Those patients who are deemed medically unfit, unwilling, or because of their current lifestyle or circumstances, unsuitable for the provision of a prosthesis.
- Poor cognitive ability and compromised hand function may, in some cases, be contraindications for prosthetic rehabilitation. The MDT must assess whether the patient has the level of ability required with or without a carer, to use the prosthesis being prescribed, correctly, safely and consistently before proceeding.
- Where an alternative approach is seen to be more suitable according to the indications/ contraindications of its guideline.

Symes socket with medial trap

Prescription Guideline - AD P SYM 02

Guideline Statement

Sockets with a medial trap should be prescribed for any patient with a Symes amputation, when some or all of the indications are observed, whilst ideally none of the contraindications are exhibited.

Definitions

- Medial trap – the socket has a medial aperture to allow donning, with a cover fastened over it to provide suspension and contain the residuum.

Indications	Contradications
Bulbous distal end of residual limb	Poor manual dexterity
Positive suspension – provided a suitably bulbous distal to the residual limb	Little or no bulbous shape to the distal end of the residuum – parallel or conical in shape
Ease of donning – medial aperture best position to accommodate residual limb	Straps to hold medial trap cosmetically unacceptable[1]
Where an aperture is required at an area of the socket where least forces act	Size of the medial aperture compromises the structural integrity of the socket

Exceptions

- Those patients who are deemed medically unfit, unwilling, or because of their current lifestyle or circumstances, unsuitable for the provision of a prosthesis.
- Poor cognitive ability and compromised hand function may, in some cases, be contraindications for prosthetic rehabilitation. The MDT must assess whether the patient has the level of ability required with or without a carer, to use the prosthesis being prescribed, correctly, safely and consistently before proceeding.
- Where an alternative approach is seen to be more suitable according to the indications/ contraindications of its guideline.

Symes socket with posterior trap

Prescription Guideline - AD P SYM 03

Guideline Statement

Sockets with a posterior trap should be prescribed for any patient with a Symes amputation, when some or all of the indications are observed, whilst ideally none of the contraindications are exhibited.

Definitions

- Posterior trap – the socket has a posterior aperture to allow donning, with a cover fastened over it to provide suspension and contain the residuum.

Indications	Contradications
Highly defined calcaneus	Extreme medial condyle shape
Where differential “push fit” liner too bulky cosmetically	Scarring over posterior aspect
Scarring over medial aspect	Prominent Achilles tendon – irritation at calcaneal trim line
	Upper limb weakness/absence

Exceptions

- Those patients who are deemed medically unfit, unwilling, or because of their current lifestyle or circumstances, unsuitable for the provision of a prosthesis.
- Poor cognitive ability and compromised hand function may, in some cases, be contraindications for prosthetic rehabilitation. The MDT must assess whether the patient has the level of ability required with or without a carer, to use the prosthesis being prescribed, correctly, safely and consistently before proceeding.
- Where an alternative approach is seen to be more suitable according to the indications/ contraindications of its guideline.

References - Ankle disarticulation prescription guidelines

1. MEYER L C, BAILEY H L, FRIDDLE D, (1970). An improved prosthesis for fitting the ankle-disarticulation amputee. Vol. 9(6), p11-15.

Prescription Guideline Title	Ref Number
Patella tendon-bearing (PTB) sockets	TT P PTB 01
PTB with supracondylar suspension	TT P PTB 02
PTB with suprapatella suspension	TT P PTB 03
PTB with elastic suspension sleeve	TT P PTB 04
PTB with cuff strap	TT P PTB 05
PTB with corset and side steels	TT P PTB 06

Casting Guideline Title	Ref Number
Wrap technique for PTB hand casting	TT C PTB 01
Anterior slab technique for PTB hand casting	TT C PTB 02

Prescription Guideline Title	Ref Number
Transtibial silicone self-suspending sockets	TT P SSS 01

Casting Guideline Title	Ref Number
Transtibial silicone self-suspending sockets Icecast®	TT C SSS 01
Transtibial silicone self-suspending sockets hand casting	TT C SSS 02

Prescription Guideline Title	Ref Number
Transtibial gel self-suspending sockets	TT P GEL 01

Casting Guideline Title	Ref Number
Transtibial gel self-suspending sockets hand casting	TT C GEL 01
Transtibial gel self-suspending sockets resin bandage casting	TT C GEL 02

Transtibial sockets

Amputation Type

There are no specific amputation types for this level that would significantly affect the choice of socket type

Socket Type

PTB	Silicone self-suspension socket	Gel self-suspension socket
Supracondylar	Silicone self-suspending sockets for the purpose of these guidelines, are considered to be any 2mm thick, silicone liners or roll on silicone sockets.	For the purposes of these guidelines the gel socket can be defined as any thicker, softer silicone, urethane or polymer liner, worn inside a total contact socket.
Suprapatella		
Elastic sleeve suspension		
Cuff strap		
Corset & side steels	*ICEX*	

Casting Method

Anterior slab technique	Icecast®	Hand casting (plaster)
Wrap technique	Hand casting	Hand casting (resin)
CAD/CAM		

Materials

Polypropylene	Acrylic laminate

The guidelines shown in italics have yet to be produced.

The patella tendon-bearing socket overview

As with numerous things in prosthetics, the principle behind the patella tendon-bearing (PTB) socket, when it was first introduced around 1959, has been revised and the subsequent socket shape changed many times, that trying to produce a definition that all clinicians will agree with is almost impossible. This attempt has been based on what little literature there is, coupled with input from a number of experienced prosthetists.

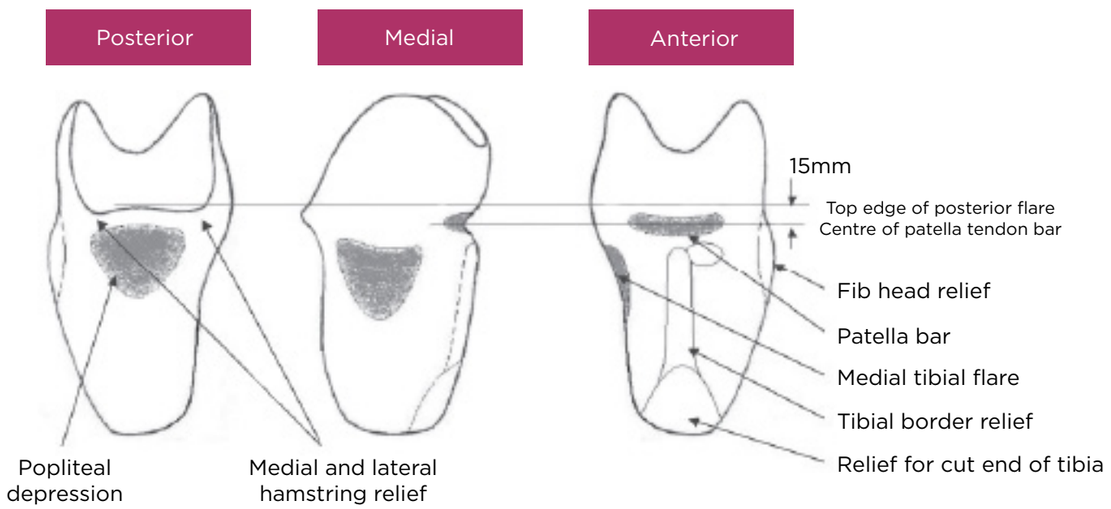
Most of the available literature starts by stating that the PTB is a total contact socket. It then goes on to define the specific weight-bearing areas and the areas that are unsuitable for weight-bearing, namely the fibula head, the anterior border and tuberosity of the tibia, and the cut ends of both the tibia and fibula. These need to be given a certain amount of relief when rectifying the positive cast, dependant on the quality of the tissue cover and their prominence.

Excessive allowances will obviously compromise the original intention of total surface contact and failure to provide contact distally can lead to distal congestion in the residuum. As the name suggests, it is intended that the main weight-bearing area is the patella tendon and to this end a patella bar is produced in the socket. The effectiveness of this has often been questioned, but in order to achieve it the cast needs to be taken in about 50 degrees of flexion and the bar shaped to produce an upward force on the tendon, with the anterior wall of the socket extending to encapsulate about a third of the patella.

To maintain the patella tendon on the patella bar the posterior wall must apply a force anteriorly in the popliteal region with the proximal edge, approximately 15mm higher than the centre of the patella bar, flared to provide comfortable knee flexion and trimmed to avoid pressure on the hamstrings. Some weight-bearing can be incorporated in the medial wall by means of the tibial flare and paratibial pressure can be applied to help prevent rotation.

The proximal edges of the medial and lateral walls normally extend to about the level of the adductor tubercle of the femur. This also helps prevent rotation as well as containing the soft tissues, and may help some mediolateral stability. They may, however, be trimmed lower if the suspension system chosen requires or allows it.

PTB sockets are most often produced with a polyethylene foam liner (Pelite), but it is possible to use hard sockets without liners, provided the shape of the residuum allows it to be donned. Some patients prefer this style of socket, but the foam liners do allow some opportunities to adjust the fit and accommodate changes in residual limb volume.



Patella tendon-bearing (PTB) sockets

Prescription Guideline - TT P PTB 01

Guideline Statement

Patella tendon-bearing sockets should be prescribed for any patient with a transtibial amputation, when some or all of the indications are observed, whilst ideally none of the contraindications are exhibited.

Definitions

- PTB – please see the information on the patella tendon-bearing overview.

Indications	Contradications
A residual limb able to tolerate localised pressures on the patella tendon, paratibial and popliteal fossa areas	Excessively grafted or scarred residual limbs, or limbs which are vulnerable to frequent breakdown
A residual limb able to tolerate full weight-bearing[1]	Intolerance to full weight-bearing through the residual limb[2]
A requirement for rotational stability	Adherent scar tissue
Dysvascular amputee	

Exceptions

- Those patients who are deemed medically unfit, unwilling, or because of their current lifestyle or circumstances, unsuitable for the provision of a prosthesis.
- Poor cognitive ability and compromised hand function may, in some cases, be contraindications for prosthetic rehabilitation. The MDT must assess whether the patient has the level of ability required with or without a carer, to use the prosthesis being prescribed, correctly, safely and consistently before proceeding.
- Where an alternative approach is seen to be more suitable according to the indications/ contraindications of its guideline.

PTB with supracondylar suspension

Prescription Guideline - TT P PTB 02

Guideline Statement

Patella tendon-bearing sockets with supracondylar suspension should be prescribed for any patient with a transtibial amputation, when some or all of the indications are observed, whilst ideally none of the contraindications are exhibited.

Definitions

- Supracondylar – the suspension is integral to the socket. The medial and lateral walls of the socket extend proximally to include the area above the condyles of the femur. The socket grips in this area to provide the suspension by means of a bony lock.

Indications	Contradications
Ease donning and doffing (quick)*[3]	Poor bone definition i.e. obese thigh
Medio-lateral stability required[1]	May be difficult to don and doff i.e. if large discrepancy between supracondylar and epicondylar areas*[1]
Prevention of knee hyperextension	Hyperextension of knee
Preference based on patient experience	Medially sited femoral bypass graft
Eliminates need for auxiliary attachments	Excessive scar tissue
Short or medium residual limb**[1]	Low pressure tolerance
Less restrictive to circulation than certain other suspension systems	Painful knee joint or low pressure tolerance (contributing factors: arthritis, osteoporosis)
Improved suspension***[3]	Volume fluctuation
Ease of adjustment	Poor cosmesis*[3]
Improved cosmesis*	Limits knee range of motion (in flexion)[1]

*These are comparative issues, both may apply, dependant on the alternatives.
**Short residual limb – cut end of the tibia barely longer than the distal border of the fibula head.
***Improved suspension – a marked improvement in the reduction of piston action or secure attachment of the prosthesis to the residual limb compared with other methods of suspension.

Exceptions

- Those patients who are deemed medically unfit, unwilling, or because of their current lifestyle or circumstances, unsuitable for the provision of a prosthesis.
- Poor cognitive ability and compromised hand function may, in some cases, be contraindications for prosthetic rehabilitation. The MDT must assess whether the patient has the level of ability required with or without a carer, to use the prosthesis being prescribed, correctly, safely and consistently before proceeding.
- Where an alternative approach is seen to be more suitable according to the indications/ contraindications of its guideline.

PTB with suprapatella suspension

Prescription Guideline - TT P PTB 03

Guideline Statement

Patella tendon-bearing sockets with suprapatella-supracondylar suspension should be prescribed for any patient with a transtibial amputation, when some or all of the indications are observed, whilst ideally none of the contraindications are exhibited.

Definitions

- Suprapatella-supracondylar - the suspension is integral to the socket. The medial, lateral and anterior walls of the socket extend proximally to include the area above the condyles of the femur and the patella, the socket grips in this area to provide the suspension by means of a bony lock.

Indications	Contradications
Short residual limb*[1,3,4]	Poorly defined skeletal anatomy
Medio-lateral stability required[1,3,4,5]	Volume fluctuation
Prevention of knee hyperextension	Reduced tolerance to pressure
Well-defined skeletal anatomy	Knee joint pain
Improve suspension[3]	Work or leisure activities
Athletic or other sporting activities	Patient concern about cosmetic appearance[3,4]
Good rotational stability[3]	

*Short residual limb – distal end of tibia barely longer than distal border of the fibula head.

Exceptions

- Those patients who are deemed medically unfit, unwilling, or because of their current lifestyle or circumstances, unsuitable for the provision of a prosthesis.
- Poor cognitive ability and compromised hand function may, in some cases, be contraindications for prosthetic rehabilitation. The MDT must assess whether the patient has the level of ability required with or without a carer, to use the prosthesis being prescribed, correctly, safely and consistently before proceeding.
- Where an alternative approach is seen to be more suitable according to the indications/ contraindications of its guideline.

PTB with elastic suspension sleeve

Prescription Guideline - TT P PTB 04

Guideline Statement

Patella tendon-bearing sockets with elastic suspension sleeves should be prescribed for any patient with a transtibial amputation, when some or all of the indications are observed, whilst ideally none of the contraindications are exhibited.

Definitions

- PTB – please see the information on the patella tendon-bearing overview.
- Elastic suspension sleeve - a tubular sleeve that is fitted on the top part of the socket and then rolled or pulled over the knee to mid-thigh level. Many sleeves are available, from simple cotton/Lycra, neoprene, silicone, and gel, with varied thicknesses and properties, all with the aim of aiding suspension of the prosthesis.

Indications	Contradications
Improved control of prosthesis	Patients who require positive suspension (sleeve may elongate)
Poor muscle tone	Excessive perspiration[1,6,7]
Better cosmetic effect – hides trimlines[1,6]	Allergic reactions[1]
Increased security	May constrict circulation[6]
Comfort when sitting	Poor hygiene
Secondary suspension	Patients with tapered thigh (may roll down)
Large thigh	Patients who kneel (poor wear rate)[6]
Can aid in waterproofing prosthesis if a silicone suspension sleeve is used	Impaired hand function creates problems donning the sleeve
Long residual limb[1]	Patients who require unrestricted knee movement[6]
Good muscular control[1]	

Exceptions

- Those patients who are deemed medically unfit, unwilling, or because of their current lifestyle or circumstances, unsuitable for the provision of a prosthesis.
- Poor cognitive ability and compromised hand function may, in some cases, be contraindications for prosthetic rehabilitation. The MDT must assess whether the patient has the level of ability required with or without a carer, to use the prosthesis being prescribed, correctly, safely and consistently before proceeding.
- Where an alternative approach is seen to be more suitable according to the indications/ contraindications of its guideline.

PTB with cuff strap

Prescription Guideline - TT P PTB 05

Guideline Statement

Patella tendon-bearing sockets with cuff strap suspension should be prescribed for any patient with a transtibial amputation, when some or all of the indications are observed, whilst ideally none of the contraindications are exhibited.

Definitions

- Cuff strap – a simple circumferential strap, generally in leather, that fastens above the femoral condyles and is attached to the socket with two side straps.

Indications	Contradications
Secure flexible suspension required[3]	Cuff strap cosmetically unacceptable[3]
Preference based on patient experience	Scarring/grafting at site of cuff strap
Adjustable - accommodates residual limb knee[1]	Patient requires medio-lateral support
Primary patient: oedematous or changing limb volume	Patients who have ill defined contours in residual supracondylar area
Other suspensions not suitable	Short residual limb
Positive suspension when sitting[3]	Poor eyesight
	May constrict circulation[3]
	Needs a degree of strength/dexterity[3]
	Some inherent pistoning[3]

Exceptions

- Those patients who are deemed medically unfit, unwilling, or because of their current lifestyle or circumstances, unsuitable for the provision of a prosthesis.
- Poor cognitive ability and compromised hand function may, in some cases, be contraindications for prosthetic rehabilitation. The MDT must assess whether the patient has the level of ability required with or without a carer, to use the prosthesis being prescribed, correctly, safely and consistently before proceeding.
- Where an alternative approach is seen to be more suitable according to the indications/ contraindications of its guideline.

PTB with corset and side steels

Prescription Guideline - TT P PTB 06

Guideline Statement

Patella tendon-bearing sockets with corset and side steels should be prescribed for any patient with a transtibial amputation, when some or all of the indications are observed, whilst ideally none of the contraindications are exhibited.

Definitions

- A standard PTB limb and modular components with the addition of side steels, knee joints and a thigh corset. The knee joint is usually single axis and set posterior and higher than the anatomical knee joint. When fitting to a PTB socket with intimate contact the corset must be loose enough to allow movement when sitting. The corset may be soft or hard depending on the function needed, e.g. weight-bearing or suspension only. Additional suspension in the form of a shoulder strap or belt may be necessary depending on the patient's anatomy.

Indications	Contradications
Greater knee stability required i.e. for medio-lateral instability of the knee[1,2,4,8,9]	Good thigh musculature
Poor thigh musculature	Good weight-bearing residual limb
Unable to fully bear weight on residual limb[9]	Stable knee
Short residual limb[1,2]	Cosmetic appearance unacceptable[8]
Wounds or skin abnormality on the residual limb[1,2,8]	Compromised hand function making donning difficult
Heavy user of prosthesis	Prosthesis can be heavy[1,8]
Patients with recurvatum	Unable to load bear through the thigh or ischium
Instability of contra lateral limb[8]	Less comfort in wear[8]
Patients who require an interim prosthesis[8]	Reduced proprioceptive input[8]
Flexion contracture in the knee[8]	Paresis of proximal leg muscles i.e. hip muscles (for which prosthesis is too heavy to use)[8]
Patients who require very positive suspension[9]	Abnormal residual limb shape[8]

Exceptions

- Those patients who are deemed medically unfit, unwilling, or because of their current lifestyle or circumstances, unsuitable for the provision of a prosthesis.
- Poor cognitive ability and compromised hand function may, in some cases, be contraindications for prosthetic rehabilitation. The MDT must assess whether the patient has the level of ability required with or without a carer, to use the prosthesis being prescribed, correctly, safely and consistently before proceeding.
- Where an alternative approach is seen to be more suitable according to the indications/ contraindications of its guideline.

Wrap technique for PTB

Hand Casting Guideline - TT C PTB 01

Guideline Statement

Patella tendon-bearing sockets should be hand cast using the wrap technique for any patient with a transtibial amputation, when some or all of the indications are observed, whilst ideally none of the contraidications are exhibited.

Definitions

- The wrap technique for casting for patella tendon-bearing sockets can be taken to include any style of casting where the residual limb is wrapped with plaster bandage and palpated to define the bony or soft areas previously marked.

Indications	Contradications
Tissue can be manipulated as required[10]	Uncovered open wounds
Weight-bearing areas on the residual limb can be preloaded[10,11]	Allergy to plaster bandage
A good representation of the patients residual limb can be achieved[10]	
Problem areas on the residual limb can be identified and palpated[10,11]	
Patient preference	
Control of the orientation of line of progression[1]	

Exceptions

- Those patients who are deemed medically unfit, unwilling, or because of their current lifestyle or circumstances, unsuitable for the provision of a prosthesis.
- Poor cognitive ability and compromised hand function may, in some cases, be contraindications for prosthetic rehabilitation. The MDT must assess whether the patient has the level of ability required with or without a carer, to use the prosthesis being prescribed, correctly, safely and consistently before proceeding.
- Where an alternative approach is seen to be more suitable according to the indications/ contraindications of its guideline.

Anterior slab technique for PTB

Hand Casting Guideline - TT C PTB 02

Guideline Statement

Patella tendon-bearing sockets should be hand cast using the anterior slab technique for any patient with a transtibial amputation, when some or all of the indications are observed, whilst ideally none of the contraindications are exhibited.

Definitions

- The anterior slab technique for casting for patella tendon-bearing sockets, involves the application of an anterior plaster slab to define the patella tendon, tibial crest and the cut end of the tibia. When set, this is then wrap cast to capture the residual limb volume.

Indications	Contradications
Suitable for patients who need increased definition of the patella tendon and tibial crest[12]	
Residual limbs with excessive soft tissue in the posterior half (as this technique minimises M-L distortion)[12]	

Exceptions

- Those patients who are deemed medically unfit, unwilling, or because of their current lifestyle or circumstances, unsuitable for the provision of a prosthesis.
- Poor cognitive ability and compromised hand function may, in some cases, be contraindications for prosthetic rehabilitation. The MDT must assess whether the patient has the level of ability required with or without a carer, to use the prosthesis being prescribed, correctly, safely and consistently before proceeding.
- Where an alternative approach is seen to be more suitable according to the indications/ contraindications of its guideline.

Prescription Guideline - TT P SSS 01

Guideline Statement

Silicone self-suspending sockets should be prescribed for any patient with a transtibial amputation, when some or all of the indications are observed, whilst ideally none of the contraindications are exhibited.

Definitions

- Silicone self-suspending sockets for the purpose of this guideline, are considered to be any 2mm thick, silicone liners or roll on silicone sockets, using shuttlelock and pin, lanyard or suction valve suspension systems.

Indications	Contradications
Positive suspension[13,14,15,16,17]	Allergic reaction to liner[13,16]
Reduced shear forces[13,15,16]	Poor personal hygiene[13,15]
Minimal socket pistoning[13,15]	Distal end of residual limb is hypersensitive[13]
Grafted or scarred skin[15]	Invaginated scarring (unless steps are taken to care for the condition of the scar tissue)[13]
Short residual limb	Ulceration/unhealed scars*[15]
Patient has an active lifestyle[16,17]	Excessive distal redundancy (though can be accommodated in Pelite liner over the silicone liner)
Soft tissue stabilisation required	Adherent distal scarring[13]
Good cosmesis (no auxiliary suspension)[13,16,17]	Lack of space for prescribed hardware
Problems encountered with other forms of suspension[15]	Residual limb shapes that cannot be accommodated within a liner
Poor sensation – sock causing skin breakdown	Patient suffers persistent sweating problems [13,16,17]
Patient preference	Difficulty in donning/doffing[16,17]
Comfort[16]	
Volume control[13]	
Hygienic interface (easy to clean)[17]	

*Some work has been done by Össur that would indicate that Iceross® liners can be used to enhance the healing process.

Exceptions

- Those patients who are deemed medically unfit, unwilling, or because of their current lifestyle or circumstances, unsuitable for the provision of a prosthesis.
- Poor cognitive ability and compromised hand function may, in some cases, be contraindications for prosthetic rehabilitation. The MDT must assess whether the patient has the level of ability required with or without a carer, to use the prosthesis being prescribed, correctly, safely and consistently before proceeding.
- Where an alternative approach is seen to be more suitable according to the indications/ contraindications of its guideline.

Transtibial silicone self-suspending sockets

Icecast® Guideline - TT C SSS 02

Guideline Statement

Silicone self-suspending sockets should be cast using Icecast® for any patient with a transtibial amputation, when some or all of the indications are observed, whilst ideally none of the contraindications are exhibited.

Definitions

- Icecast is a pressure casting method using the patented Össur equipment to obtain a positive plaster cast.

Indications	Contradications
Excessive flaccid tissue	Transtibial residual limbs greater or equal to size 32 liner
Measurable distal elongation and pressure applied[18]	Previous intolerance of pressure casting technique
Residual limb tolerant to even distribution of pressure	Children/patients whose residual limb is too small for casting equipment
	Patients wearing silicone liners which have no matrix, allowing elongation under pressure
	If specific modification of the plaster cast is required during casting
	Particular residual limbs which give no definition under pressure
	Silicone socket manufacturer expressly advises against the use of Icecast

Exceptions

- Those patients who are deemed medically unfit, unwilling, or because of their current lifestyle or circumstances, unsuitable for the provision of a prosthesis.
- Poor cognitive ability and compromised hand function may, in some cases, be contraindications for prosthetic rehabilitation. The MDT must assess whether the patient has the level of ability required with or without a carer, to use the prosthesis being prescribed, correctly, safely and consistently before proceeding.
- Where an alternative approach is seen to be more suitable according to the indications/ contraindications of its guideline.

Transtibial silicone self-suspending sockets

Hand Casting Guideline - TT P SSS 03

Guideline Statement

Silicone self-suspending sockets should be hand cast for any patient with a transtibial amputation, when some or all of the indications are observed, whilst ideally none of the contraindications are exhibited.

Definitions

- Hand casting is defined as the wrapping of the residuum with plaster bandage, palpating so as to displace any surplus material posteriorly. See casting instructions provided by liner manufacturers.

Indications	Contradications
Greater control* of loading areas**[19]	Excessive flaccid tissue
Accommodate flexion contractures	Consistency of modification*** of the positive cast is required
Patient preference based on previous experience	Where exact measurement of distal elongation and pressure applied is required

*Control – able to define contours of residual limb.
**Loading areas – option to provide varying degrees of surface pressure.
***Modification – the alteration to volume and shape of the positive cast.

Exceptions

- Those patients who are deemed medically unfit, unwilling, or because of their current lifestyle or circumstances, unsuitable for the provision of a prosthesis.
- Poor cognitive ability and compromised hand function may, in some cases, be contraindications for prosthetic rehabilitation. The MDT must assess whether the patient has the level of ability required with or without a carer, to use the prosthesis being prescribed, correctly, safely and consistently before proceeding.
- Where an alternative approach is seen to be more suitable according to the indications/ contraindications of its guideline.

Transtibial gel self-suspending sockets

Prescription Guideline - TT P GEL 01

Guideline Statement

Gel sockets should be prescribed for any patient with a transtibial amputation, when some or all of the indications are observed, whilst ideally none of the contraindications are exhibited.

Definitions

- For the purposes of this guideline the gel socket can be defined as any thicker, softer silicone, urethane or polymer liner, worn inside a total contact socket. Suspension may be by means of a lanyard, shuttlelock and pin, elastic suspension sleeve or a sleeve with a suction socket valve. These different suspension methods require consideration before prescriptions as they each have different indications and contradications.

Indications	Contradications
Bony residual limb	Allergic reaction to liner
Sensitive residual limb requiring reduced friction and shear	Excessive distal redundancy (when using lock and pin)
Grafted or scarred tissue that requires protection[20]	Lack of space for prescribed hardware, especially when using a shuttlelock and pin
Positive suspension, especially with suction valve and sleeve[20]	Invaginated scarring (unless steps are taken to care for the condition of the scar tissue)
Problems with other forms of suspension	Unhealed scars or ulceration
Patient prefers the cosmesis	Poor personal hygiene
Patient preference based on experience	Hypersensitive distal end of residual limb[20]
Comfort[1]	Persistent perspiration[20]
Adherent scars*	Adherent scars*

*This appears as an indication and a contraindication, gel sockets may cause problems with adherent scars, but evidence suggests that these are less than with other socket types.

Exceptions

- Those patients who are deemed medically unfit, unwilling, or because of their current lifestyle or circumstances, unsuitable for the provision of a prosthesis.
- Poor cognitive ability and compromised hand function may, in some cases, be contraindications for prosthetic rehabilitation. The MDT must assess whether the patient has the level of ability required with or without a carer, to use the prosthesis being prescribed, correctly, safely and consistently before proceeding.
- Where an alternative approach is seen to be more suitable according to the indications/ contraindications of its guideline.

Socket Hand Casting Guideline - TT C GEL 01

Guideline Statement

Gel self-suspending sockets should be hand cast for any patient with a transtibial amputation, when some or all of the indications are observed, whilst ideally none of the contraindications are exhibited.

Definitions

- Hand casting is defined as the wrapping of the residuum with plaster bandage, palpating so as to displace any surplus material posteriorly (as when hand casting transtibial Iceross type sockets using the Össur technique).

Indications	Contradications
Problem areas on the residual limb that need to be identified and palpated when casting	Where a diagnostic socket fitting is recommended and patient may find the additional visit problematic**
Soft tissue can be manipulated as required	
Patient preference based on experience	
Liner manufacturer recommends method*	

*Please refer to the liner manufacturer's instructions for details of their recommended method, especially with regard to the rectification of the positive.
**Recommended practice is to produce a diagnostic socket from the cast and then to proceed to the production of the definitive socket.

Note: Attempts have been made to use Icecast or suction when casting for gel sockets, but the results have been inconsistent.

Exceptions

- Those patients who are deemed medically unfit, unwilling, or because of their current lifestyle or circumstances, unsuitable for the provision of a prosthesis.
- Poor cognitive ability and compromised hand function may, in some cases, be contraindications for prosthetic rehabilitation. The MDT must assess whether the patient has the level of ability required with or without a carer, to use the prosthesis being prescribed, correctly, safely and consistently before proceeding.
- Where an alternative approach is seen to be more suitable according to the indications/ contraindications of its guideline.

Resin Bandage Casting Guideline - TT C GEL 02

Guideline Statement

Gel self-suspending sockets should be cast using resin bandage for any patient with a transtibial amputation, when some or all of the indications are observed, whilst ideally none of the contraindications are exhibited.

Definitions

- Casting with a resin bandage is defined as the tight wrapping of the residual limb with a resin bandage, or casting tape (such as Dynacast P), without palpating. It was originally offered as a casting method specific to the Silipos Explorer liner.

Indications	Contradications
Where a diagnostic socket fitting is recommended and patient may find the additional visit problematic*	Technique not recommended by the specific liner manufacturer

*Recommended practice is to trim the finished cast and use it as a diagnostic socket, drilling a number of holes to allow the degree of contact to be observed. Any allowances required could either be made on the subsequent positive plaster cast, or by means of silicone pads applied prior to casting. This is a clean casting method, producing a rigid negative that obviates the need for an additional diagnostic socket and associated fitting.

Exceptions

- Those patients who are deemed medically unfit, unwilling, or because of their current lifestyle or circumstances, unsuitable for the provision of a prosthesis.
- Poor cognitive ability and compromised hand function may, in some cases, be contraindications for prosthetic rehabilitation. The MDT must assess whether the patient has the level of ability required with or without a carer, to use the prosthesis being prescribed, correctly, safely and consistently before proceeding.
- Where an alternative approach is seen to be more suitable according to the indications/ contraindications of its guideline.

References- Transtibial prescription and casting guidelines

1. EDWARDS M L, (2000). Below knee prosthetic socket designs and suspension systems. *Phys Med Rehabil Clin N Am*, Vol. 11(3), p585-593.

2. PANTON H J, (1975). Considerations for joints and corset. *Amputee Clinics,* Vol. 7(3), p1-3,6-7.

3. LYTTLE D, (1987). Suspension of the below-knee prosthesis: comparison of supracondylar cuff and brim. *J Assoc Child Prosthet Orthot*, Vol. 22, p79-80.

4. RUBIN G, NITSCHKE R O, GARDNER H F, (1970). The supracondylar-suprapatellar PTB prosthesis. *Bull Prosthet Res,* Vol. 10(14), p102-106.

5. MARSCHALL K, NITSCHKE R, (1966). The P.T.S. Prosthesis. *Orthop Prosthet Appl J.*, Vol. 20, pp.123-126.

6. HAIDAR A, HARRISON R, EWINS D, (2001). Patellar tendon-bearing socket with suction sleeve suspension (PTB S4). *BAPOMAG,* Vol. 1, p27-28.

7. LEGRO M, REIBAER G, AGUILA M, et al., (1999). Issues of importance reported by persons with lower limb amputations and prostheses. *JRRD,* Vol. 36(3).

8. BAARS E C T, (2002). Is a conventional type trans-tibial prosthesis really that conventional? *O&P World,* Vol. 5(2), p34-36.

9. VITALI M, ROBINSON K, ANDREWS B, HARRIS E, REDHEAD R, (1986). Amputations and prostheses. 2nd ed. Bailliere Tindall, p145–148.

10. WILSON L A, LYQUIST E, (1968). Plaster bandage wrap cast: procedure for the below knee stump. *Prosthetics Int. Journal*, p3-7.

11. FAJAL G, (1968). Stump casting for the PTS below knee prosthesis. *Prosthetics Int. journal,* Vol. 3(4/5), p22-24.

12. FILLAUER C, (1971). A Patellar Tendon-Bearing Socket with a Detachable Medial Brim. *Orthotics and Prosthetics,* Vol. 25(4), p26-34.

13. LAKE C, SUPAN T J, (1997). The Incidence of Dermatological Problems in the Silicone Suspension Sleeve User. *J Prosthetics Orthotics,* Vol. 9, p97-106.

14. NARITA H, YOKOGUSHI K, SHII S, (1997). Suspension Effect and Dynamic Evaluation of the Total Surface Bearing (TSB) Trans-tibial Prosthesis: A Comparison with the Patellar Tendon-Bearing (PTB) Trans-tibial Prosthesis. *J Prosthetics Orthotics*, Vol. 21, p175–178.

15. MCCURDIE T, HANSPAL R, NIEVEEN R, (1997). A Consensus View: a Questionnaire Survey of the ICEROSS. *United Kingdom Prosthetics and Orthotics International,* Vol. 21, p124–128.

16. DATTA D, VAIDYA S K, HOWITT J, (1996). Outcome of Fitting an ICEROSS Prosthesis: Views of Trans-tibial Amputees. *Prosthet Orthot Int,* Vol. 20, p111– 15.

17. CLUITMANS J, GEBOERS M, DECKERS J, (1994). Experiences with Respect to the ICEROSS System for Trans-tibial Prostheses. *Prosthet Orthot Int,* Vol. 18, p78–83.

18. CARLSON T, (1997). Applications of Silicone Sockets. *BACPAR Newsletter,* Vol. 6, 10.

19. LILJA M, JOHANSSON S, OBERG T, (1999). Relaxed versus activated stump muscles during casting for trans-tibial prostheses. *Prosthet Orthot Int*, Vol. 23, p13-20.

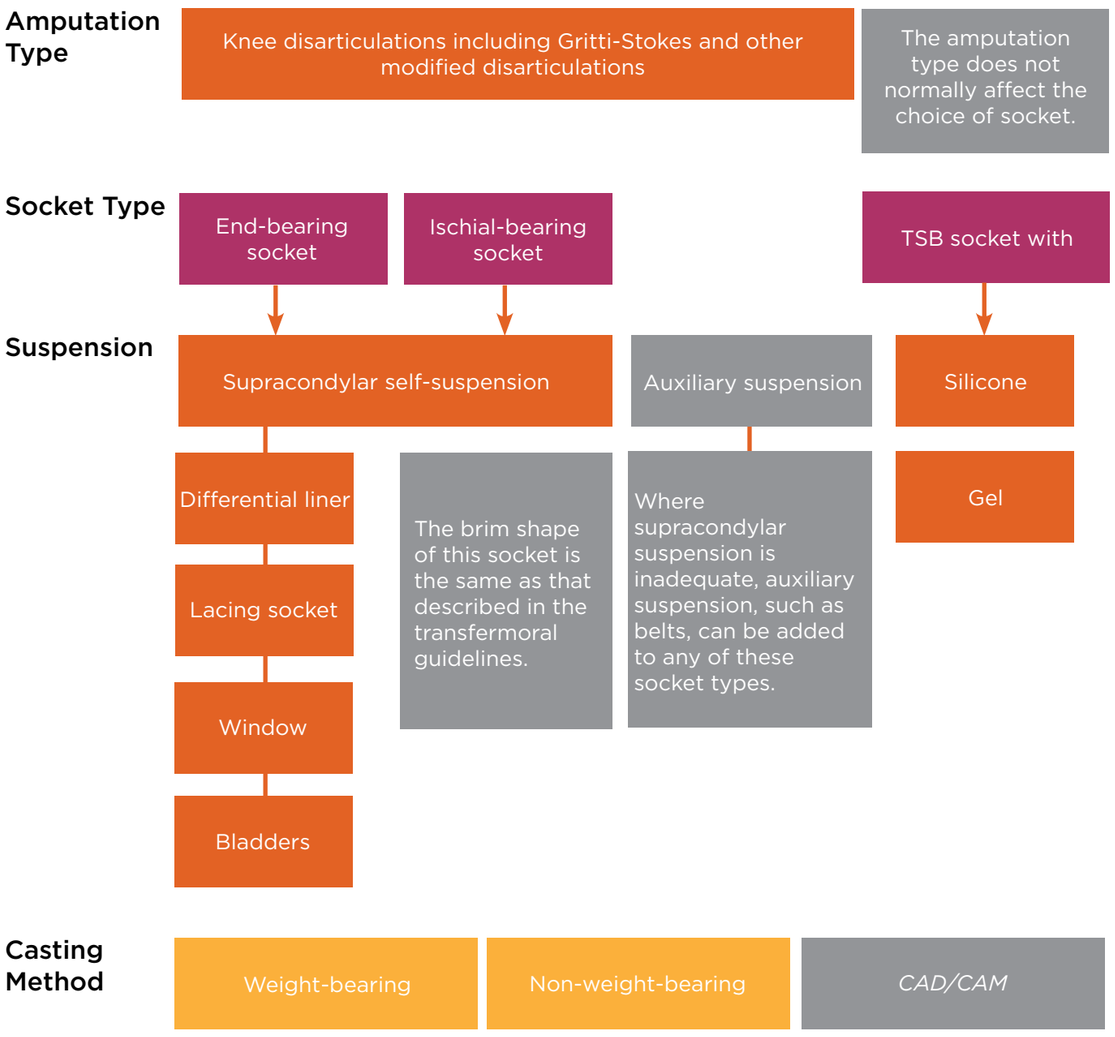
20. HATFIELD A G, MORRISON J D, (2001). Polyurethane gel liner usage in the Oxford Prosthetic Service. *Prosthet Orthot Int,* Vol. 25, p41-46.

Knee Disarticulation Guidelines

Prescription Guideline Title	Ref Number
Knee disarticulation end-bearing socket	KD P EB 01
Knee disarticulation ischial-bearing socket	KD P IB 01
Knee disarticulation self-suspending socket with liner	KD P SS 01
Knee disarticulation self-suspending socket with medial trap	KD P SS 02
Knee disarticulation self-suspending socket with lacing	KD P SS 03
Knee disarticulation self-suspending socket with bladders	KD P SS 04
Knee disarticulation total surface-bearing socket with silicone liner	KD P TSB 01
Knee disarticulation total surface-bearing socket with gel liner	KD P TSB 02

Casting Guideline Title	Ref Number
Knee disarticulation weight-bearing hand casting	KD C WB 01
Knee disarticulation non-weight-bearing hand casting	KD C NWB 02

Knee disarticulation sockets



The guidelines shown in italics have yet to be produced.

Knee disarticulation overview

Disarticulation of the knee is a comparatively rare and rather controversial choice of amputation in Britain, although it is more widely used elsewhere. It has definite surgical and rehabilitation benefits, but these are often contradicted by the prosthetic disadvantages. The choice of prosthetic knees is limited and the prosthesis may have a poor cosmetic appearance due to the bulky distal end of the socket and distal displacement of the prosthetic knee centre.

This means this amputation level is most frequently used when the amputee is considered to be inappropriate for prosthetic rehabilitation or for children, where it is preferable to preserve the growth plate. This allows the residual limb to grow naturally without the need for revision surgery at regular intervals in the child's life. Normally the residual limb does not grow to its full length thus overcoming the prosthetic disadvantages once adulthood has been reached.

Benefits of a knee disarticulation

- A quick and simple procedure with reduced trauma and risk of infection. It has a reduced recovery time and is the preferred level for an emergency lifesaving operation.
- Increased length of lever arm and intact muscle groups allow greater strength and control of the limb and a reduced risk of hip contractures. In rehabilitation, non-limb wearers benefit from the longer lever arm for sitting balance and transfers. It has also been shown that amputees with a knee disarticulation walk further and use their prosthesis more often than their transfemoral counterparts.
- The ability to weight-bear through the residual limb increases the comfort of the limb compared with an ischial-bearing socket.
- The retention of the condyles allows for the socket to be self-suspending thus removing the need for auxiliary suspension. The retention of the condyles also aids rotational stability of the socket.

Types of knee disarticulation

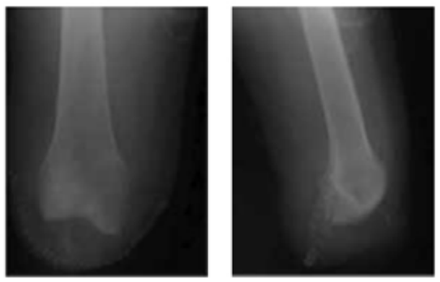
There are three commonly used variations of the knee disarticulation amputation:

1. Standard knee disarticulation
2. Adapted knee disarticulation
3. Gritti-Stokes amputation

Standard knee disarticulation

This is the only true disarticulation as no bone is cut.

The surgeon removes the joint capsule and sews the quadriceps muscles to the hamstrings at the attachment of the tendon. The most frequent cause of failure of this amputation is poor wound healing as a result of ishaemia, in which case a transfemoral revision is required.



Adapted knee disarticulation

This was developed to counter some of the criticisms of the knee disarticulation. The femoral condyles are removed and the distal surface of the femur cut flat. The muscle groups are then attached as above. This improves the cosmetic appearance by reducing the bulk of the distal residuum whilst maintaining a long lever arm and minimising muscle imbalance. However, the advantages of distal weight-bearing and self-suspension may be lost as result of the condyles being removed.

The Gritti-Stokes amputation

This is named after the surgeons who described this amputation technique and is the most controversial of the methods. In this case the femur is cut just above the level of the condyles. The patella is then reshaped and attached to the cut femur to reproduce the distal weight-bearing surface. This shortens the residual limb and reduces the distal bulk with the intention of overcoming the prosthetic objections to this level. However the removal of the condyles loses the benefits of suspension and rotational stability. Also experience suggests the uneven muscle pull between the flexors and extensors may cause the patella to become detached anteriorly resulting in a very sensitive and non-weight-bearing distal end of the residual limb. Despite more recent surgical techniques that angle the cut end of the femur to try and overcome this, it remains a strongly disliked amputation method among many prosthetists.

Reading list - Knee disarticulation

1. BACHE A, (2002). The Gritti-Stokes amputation: a summary. *ISPO UK Newsletter,* Winter Vol., p29-31.

2. CULL D L, et al., (2001). A reappraisal of a modified through-knee amputation in patients with peripheral vascular disease. *Am J Surg,* Vol. 182(1), p44-48.

3. FABER D C, FIELDING P, (2001). Gritti-Stokes (through-knee) Amputation: should it be reintroduced? *Southern Med Journal,* Vol. 94(10), p997-1001.

4. HAGBERG E, BERLIN O K, RENSTROM P, (1992). Function after through-knee compared with below-knee and above-knee amputation. *Prosthet Orthot Int,* Vol. 16, p68-173.

5. GARD S A, CHILDRESS D S, UELLENDAHL J E, (1996). The influence of four bar linkage knees on prosthetic swing phase floor clearance. *JPO,* Vol. 8(2), p34.

6. HUGHES J, (1983). Biomechanics of the through-knee prosthesis. *Prosthet Orthot Int*, Vol. 7, p96-99.

7. LODER R T, HERRING J A, (1987). Disarticulation of the knee in children. *J Bone Joint Surg Am*, Vol. 69(8), p1155-1160.

8. LYQUIST E, (1983). Casting the through-knee stump. *Prosthet Orthot Int*, Vol. 7, p104-106.

9. MAJESKI J, (2004). Modified Supracondylar amputation of the femur. *Am Surg*, Vol. 70(3), p265-267.*

10. NELLIS N, VAN DE WATER J M, (2002). Through-the-knee amputation: an improved technique. *Am Surg,* Vol. 68, p466-469.

11. NELSON V S, et al., (2006). Limb deficiency and prosthetic management 1. Decision making in prosthetic prescription and management. *Arch Phys Med Rehabil,* Vol. 87(Suppl 1), S3-S9.

12. OTTER N, et al., (1999). An open socket technique for through-knee amputations in relation to skin problems of the stump: an explorative study. *Clin Rehabil*, Vol. 13, p34-43.

13. PINZUR M S, BOWKER J H, (1999). Knee disarticulation. *Clin Orthop,* Vol. 361, p23-28.

14. RADCLIFFE CW (1994) Four-bar linkage prosthetic knee mechanisms: kinematics, alignment and prescription criteria. *Prosthet Orthot Int*, Vol. 18, p159-173.

15. SIEV-NER I, et al., (2000). Why knee disarticulation (through-knee-amputation) is appropriate for non-ambulatory patients. *Disabil Rehabil,* Vol. 22, p862-864.

16. TANNER A, (1998). Management of the paediatric knee-disarticulation. *BAPO Mag*, Vol. 2, p20-21.

17. TINGLEFF H, JENSEN L, (2002). A newly developed socket design for a knee disarticulation amputee who is an active athlete. *Prosthet Orthot Int*, Vol. 26, p72-75.

18. LEONARD J A, (1994). Lower limb prosthetic sockets. P*hys Med Rehabil: State Art Rev,* Vol. 8, p129-145.

Casting theory

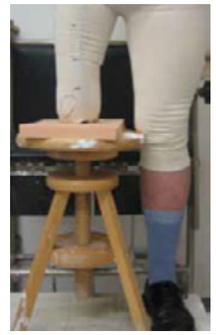
When taking the impression of all forms of knee disarticulation amputation usually the two goals are self-suspension and end-bearing. There are two primary approaches to taking the plaster of paris cast impression for knee disarticulation sockets as outlined in the guidelines:

- Weight-bearing cast – Originally described by Lyquist.[1] Uses a foam pad distally to allow weight-bearing whilst casting.
- Non-weight-bearing – Described by Botta and Baumgartner.[2] Suitable for patients unable to stand for a weight-bearing cast. Stresses meticulous moulding of femoral condyles

Casting procedure for weight-bearing cast [1,3,4]

Before casting, circumferential measurements of the residual limb should be taken – beginning 5cm proximal to the distal surface and continuing proximally at 5cm intervals to a level approximately 5cm below the ischial tuberosity. These measurements may serve as a guide during rectification.

Fig. 1 Use of a weight-bearing platform with plastazote pad



- A cast sock is worn suspended over the shoulder. Mark the positions of the patella (if present), the adductor tubercle (on the lateral posterior femoral condyle) especially if prominent or painful and the intercondylar notch. To capture the bony contours of the distal femoral condyles, an adjustable stand with a soft end pad is used to support approximately half the patient's body weight. Adjust the height of the platform until the pelvis is horizontal and instruct the patient on weight-bearing to ensure equal loading between the platform and the sound side (Fig. 1).
- An anterior cutting strip may be needed as the contouring over the medial condyle could make cast removal difficult.
- Remove the platform and wrap plaster bandage around the residual limb. Slabs may be used to cover the distal end. Extend proximally to a level a little below the ischial tuberosity. With larger patients it may be necessary to do the cast in two parts. Reposition the residual limb on the platform, ensuring that flexion/extension and adduction/abduction are as desired.

Fig. 2 Contour the medial supracondyle area, with a flat counter pressure laterally

- The area above the medial condyle should be contoured to provide suspension, with a counter pressure over the lateral area (Fig. 2). The posterior section at this level can also be flattened slightly to form a triangular shape in the supracondylar area that will help prevent rotational movement of the socket on the residual limb.
- Proximally the cast should be flattened slightly posteriorly and in the Scarpa's triangle area to provide sitting comfort and allow proper function of the adductor longus and rectus femoris.

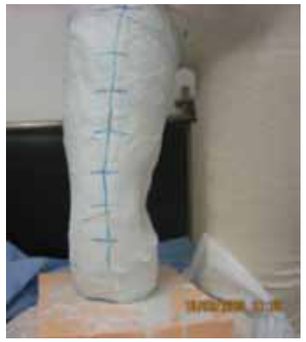


Fig. 3 Showing the medial and lateral shaping plus the position of the cutting strip

- Mark the position of the cutting strip before removing the cast (Fig. 3).
- Rectification should define the supracondylar contours necessary for suspension and reduce the proximal thigh region to provide stability during stance phase.

Cast procedure for non-weight-bearing casts[2]

Using this casting method it is important to pay particular attention to the anatomy of the distal end of the residual limb to enable the femoral condyles to transmit full weight on to the prosthesis.

- The cast is taken with the patient lying supine on his/her back and holding the residual limb in a position of about 70 degrees of flexion.
- A tubigrip sock sewn to the correct shape is donned. Ideally the negative mould should be produced using elastic plaster bandages to allow even pre-compression of the soft tissues, although ordinary bandages may be used.
- Pre-cut strips of plaster bandage - the first is applied in a sagital direction to cover the intracondylar notch, with other strips applied to cover the patella (if present) and condyles, continuing proximally as necessary, finishing with circular plaster bandage to cover the entire residual limb.
- The negative is now moulded with two hands, one gently modelling the intracondylar notch while the other provides a snug fit of the plaster cast just proximally to the femoral condyles and the proximal end of the patella.
- The proximal trim of the socket should extend to just below the ischial tuberosity. This provides control of lateral and torque forces. Rectification should not be needed.

References - Knee disarticulation casting & rectification techniques

1. LYQUIST E, (1983). Casting the through-knee stump. *Prosthet Orthot Int*, Vol. 7, p104-106.

2. BOTTA P, BAUMGARTNER R, (1983). Socket design and manufacturing technique for through-knee stumps. *Prosthet Orthot Int,* Vol. 7, p100-103.

3. MICHEAL J W, (1992). Knee Disarticulation: Prosthetic Management. *Atlas of Limb Prosthetics: Surgical, Prosthetic, and Rehabilitation Principles.* Chapter 19B.

4. STARK G, (2004). Overview of Knee Disarticulation. *JPO,* Vol. 16, p130-137. Retrieved from www.oandp.org/jpo/library/2004_04_130.asp

Prescription Guideline - KD P EB 01

Guideline Statement

End-bearing sockets should be prescribed for any patient with a form of knee disarticulation amputation, when some or all of the indications are observed, whilst ideally none of the contraindications are exhibited.

Definitions

- Form of knee disarticulation – see overview.
- End-bearing socket – this is a socket designed to take the majority of the patient's weight through the distal end of the femur (or patella if present). The socket extends proximally to provide supporting surfaces and a degree of weight-bearing will be through the thigh tissues. The socket finishes a little below the ischium level and often incorporates a flexible outer laminate top section.

Indications	Contradications
A residual limb able to tolerate distal weight-bearing[1]	Intolerance to full distal weight-bearing e.g. excessive scarring or grafting distally
Where lower and/or flexible socket trim lines are required or preferred, e.g. to increase sitting comfort	

Note: Partial end-bearing combined with partial ischial-bearing can be considered as an option, however this will reduce the biomechanical advantages of end-bearing and can compromise alignment.

Exceptions

- Those patients who are deemed medically unfit, unwilling, or because of their current lifestyle or circumstances, unsuitable for the provision of a prosthesis.
- Poor cognitive ability and compromised hand function may, in some cases, be contraindications for prosthetic rehabilitation. The MDT must assess whether the patient has the level of ability required with or without a carer, to use the prosthesis being prescribed, correctly, safely and consistently before proceeding.
- Where an alternative approach is seen to be more suitable according to the indications/ contraindications of its guideline.

Knee disarticulation ischial-bearing socket

Prescription Guideline - KD P IB 01

Guideline Statement

Ischial-bearing sockets should be prescribed for any patient with a form of knee disarticulation amputation, when some or all of the indications are observed, whilst ideally none of the contraindications are exhibited.

Definitions

- Form of knee disarticulation – see overview.
- Ischial-bearing socket – this is a socket designed to take the majority of a patient's weight through the ischial tuberosity with support and some weight through the thigh, but little or no contact distally.

Indications	Contradications
A residual limb unable to tolerate weight-bearing on the distal end e.g. painful scarring, mobile/painful patella[1]	Intolerance to full ischial bearing e.g. excessive scarring or grafting over the ischial tuberosity
A residual limb able to tolerate ischial weight-bearing	Where the patient is unable to tolerate high and/or rigid socket trims e.g. when sitting or for cosmetic reasons

Note: Partial end-bearing combined with partial ischial-bearing can be considered as an option, however this will reduce the biomechanical advantages of end-bearing and can compromise alignment.

Exceptions

- Those patients who are deemed medically unfit, unwilling, or because of their current lifestyle or circumstances, unsuitable for the provision of a prosthesis.
- Poor cognitive ability and compromised hand function may, in some cases, be contraindications for prosthetic rehabilitation. The MDT must assess whether the patient has the level of ability required with or without a carer, to use the prosthesis being prescribed, correctly, safely and consistently before proceeding.
- Where an alternative approach is seen to be more suitable according to the indications/ contraindications of its guideline.

Knee disarticulation self-suspending socket with liner

Prescription Guideline - KD P SS 01

Guideline Statement

Self-suspending sockets with a differential liner should be prescribed for any patient with a form of knee disarticulation amputation, when some or all of the indications are observed, whilst ideally none of the contraindications are exhibited.

Definitions

- Form of knee disarticulation – see overview.
- Self-suspending socket with differential liner – a flexible liner manufactured in foam or flexible plastic that conforms to the anatomical shape of the femoral condyles on the residual limb to provide suspension. The outside of the liner is built up to allow insertion into the rigid support of the main socket. The inner socket can be split to aid donning.

Indications	Contradications
A residual limb with well defined condyles	Patients who would have difficulty separating the inner liner from socket
Patients who do not require or prefer not to use auxiliary suspension	Inability to tolerate supracondylar pressure
Where extra protection over bony anatomy is required[1]	Where cosmesis is an important factor and minimum overall socket thickness is required[1]
Where adjustment to fit may be required[2]	Where the condyles are poorly defined or have been surgically removed
	A residual limb with excessive soft tissue
	Where the patient cannot tolerate excess heat from an enclosed socket

Exceptions

- Those patients who are deemed medically unfit, unwilling, or because of their current lifestyle or circumstances, unsuitable for the provision of a prosthesis.
- Poor cognitive ability and compromised hand function may, in some cases, be contraindications for prosthetic rehabilitation. The MDT must assess whether the patient has the level of ability required with or without a carer, to use the prosthesis being prescribed, correctly, safely and consistently before proceeding.
- Where an alternative approach is seen to be more suitable according to the indications/ contraindications of its guideline.

Knee disarticulation self-suspending socket with medial trap

Prescription Guideline - KD P SS 02

Guideline Statement

Self-suspending sockets with medial traps should be prescribed for any patient with a form of knee disarticulation amputation, when some or all of the indications are observed, whilst ideally none of the contraindications are exhibited.

Definitions

- Form of knee disarticulation – see overview.
- Self-suspending socket with a medial* trap - (this may be referred to as a window socket). The rigid outer of the socket has a window cut out on the medial* side at supracondylar level, that aids donning and doffing. A trap is then secured in place using straps. The trap provides suspension. It may or may not have a Pelite or other liner incorporated into the whole, or just the distal end of the socket.

*Whilst a trap positioned medially is common, the trap may be located elsewhere for structural or build requirements e.g. use of side steels.

Indications	Contradications
A residual limb with well defined condyles[1]	A patient who has large thighs where the straps and fastenings may rub on the contralateral limb
Where easy donning and doffing are required	Where adjustments to overall fit are likely (especially when no liner present)
Where a slim cosmesis is required (especially where no liner is used)[1]	Where the patient is concerned about the cosmetic effects of the straps
Where small volume changes may need to be accommodated at supracondylar level in order to retain suspension[1]	Where a structurally strong socket is required (as a socket with a fenestration is structurally weaker than a similar socket without a fenestration)

Exceptions

- Those patients who are deemed medically unfit, unwilling, or because of their current lifestyle or circumstances, unsuitable for the provision of a prosthesis.
- Poor cognitive ability and compromised hand function may, in some cases, be contraindications for prosthetic rehabilitation. The MDT must assess whether the patient has the level of ability required with or without a carer, to use the prosthesis being prescribed, correctly, safely and consistently before proceeding.
- Where an alternative approach is seen to be more suitable according to the indications/ contraindications of its guideline.

Knee disarticulation self-suspending socket with lacing

Prescription Guideline - KD P SS 03

Guideline Statement

Self-suspending sockets with lacing should be prescribed for any patient with a form of knee disarticulation amputation, when some or all of the indications are observed, whilst ideally none of the contraindications are exhibited.

Definitions

- Form of knee disarticulation – see overview.
- Self-suspending sockets with lacing – sockets made from either leather or composite materials split the length of the socket anteriorly then secured in place by lacing. Modern techniques allow it to be used with modular components, but it is more commonly used with conventional limbs.

Indications	Contradications
Patients requiring a socket with a good range of adjustment[1] e.g. volume or weight fluctuation	Where the patient dislikes the appearance of the lacing[1]
Where a socket material with breathable properties is required	Poor manual dexterity/strength*
	Poor patient hygiene
	Where the patient cannot apply/determine the appropriate pressure when tightening the lacing
	Where a quick manufacture time is required
	Where the condyles are poorly defined or have been surgically removed

*Lacing could be replaced with velcro cross straps or lanyard systems such as the RevoFit™ in cases of poor hand function.

Exceptions

- Those patients who are deemed medically unfit, unwilling, or because of their current lifestyle or circumstances, unsuitable for the provision of a prosthesis.
- Poor cognitive ability and compromised hand function may, in some cases, be contraindications for prosthetic rehabilitation. The MDT must assess whether the patient has the level of ability required with or without a carer, to use the prosthesis being prescribed, correctly, safely and consistently before proceeding.
- Where an alternative approach is seen to be more suitable according to the indications/ contraindications of its guideline.

Knee disarticulation self-suspending socket with bladders

Prescription Guideline - KD P SS 04

Guideline Statement

Self-suspending sockets with bladders should be prescribed for any patient with a form of knee disarticulation amputation, when some or all of the indications are observed, whilst ideally none of the contraindications are exhibited.

Definitions

- Form of knee disarticulation – see overview.
- Self-suspending sockets with bladders – pneumatic pads or silicone bladders are incorporated between layers of laminate in the socket. The patient inflates these to the required pressure after donning to provide suspension.

Indications	Contradications
Patients who require good localised suspension over the condyles[1]	Where the patient cannot apply/determine/ administer the appropriate supracondylar pressure
Patients who require good control of supracondylar pressure	Volume fluctuation that cannot be accommodated by inflating the pads[1]
Residual limbs with minor volume changes	Poor hand function
Patients who require self-suspension with easy donning	Where a quick manufacture time is required[1]

Exceptions

- Those patients who are deemed medically unfit, unwilling, or because of their current lifestyle or circumstances, unsuitable for the provision of a prosthesis.
- Poor cognitive ability and compromised hand function may, in some cases, be contraindications for prosthetic rehabilitation. The MDT must assess whether the patient has the level of ability required with or without a carer, to use the prosthesis being prescribed, correctly, safely and consistently before proceeding.
- Where an alternative approach is seen to be more suitable according to the indications/ contraindications of its guideline.

Knee disarticulation TSB socket with silicone liner

Prescription Guideline - KD P TSB 01

Guideline Statement

Total surface-bearing (TSB) sockets with silicone liner should be prescribed for any patient with a form of knee disarticulation amputation, when some or all of the indications are observed, whilst ideally none of the contraindications are exhibited.

Definitions

- Form of knee disarticulation – see overview.
- TSB socket with silicone liner - a total contact socket that incorporates a silicone interface. Suspension can be provided by a pin, lanyard or suction with a hypobaric seal. A pin is not recommended because of space considerations.[2] Where the choice of suspension affects the guideline, this will be noted.
- Silicone liners – generally have a stabilising matrix and are available in various durometers. They protect the skin from shear forces and can provide suspension.

Indications	Contradications
Where abundant scar tissue is present	Where the patient cannot tolerate silicone e.g. an allergy, invaginated scarring etc[1]
Where the patient would benefit from a protective liner between the residual limb and outer socket, whilst keeping socket thickness to a minimum[1]	Where poor hand function prevents donning e.g. especially for liners with a hypobaric sealing membrane[1]
Fleshy or muscular residual limb with little bony definition	Where minimum build height is required (when using pin and lock suspension)
Where a positive lock (suspension) is required that is independent of volume changes e.g. with a pin or lanyard	A residual limb with prominent condyles
Where minimum build height is required (hypobaric sealing membrane only)	Patients who suffer from persistent sweating
Where specific weight-bearing cannot be tolerated	Where the patient would benefit from full end-bearing through the femur, e.g. in children to encourage normal bony growth
An insensate residual limb	Poor personal hygiene[1]

Exceptions

- Those patients who are deemed medically unfit, unwilling, or because of their current lifestyle or circumstances, unsuitable for the provision of a prosthesis.
- Poor cognitive ability and compromised hand function may, in some cases, be contraindications for prosthetic rehabilitation. The MDT must assess whether the patient has the level of ability required with or without a carer, to use the prosthesis being prescribed, correctly, safely and consistently before proceeding.
- Where an alternative approach is seen to be more suitable according to the indications/ contraindications of its guideline.

Knee disarticulation TSB socket with gel liner

Prescription Guideline - KD P TSB 02

Guideline Statement

Total surface-bearing sockets with gel liners should be prescribed for any patient with a form of knee disarticulation amputation, when some or all of the indications are observed, whilst ideally none of the contraindications are exhibited.

Definitions

- Form of knee disarticulation – see overview.
- TSB socket with gel liner – a total contact socket that incorporates a gel interface. Suspension can be provided by the self-suspending shape of the knee disarticulation residual limb.
- Flexible gel liners – generally urethane or polymer gels that are thick and soft with flow properties, providing cushioning for the residual limb. They do not normally contain a matrix and therefore are not recommended for use with a pin or lanyard as this can distend the liner and distal tissues, as well as adding to the build height.
- An air expulsion valve can be used distally.[1]

Indications	Contradications
Excessive scarring/grafting of skin	Where poor hand function prevents donning
An insensate residual limb	Poor personal hygiene
Where specific weight-bearing cannot be tolerated	Where patients cannot tolerate a gel liner e.g. allergies or heat problems
Where minimum build height is required	Where the patient would benefit from full end-bearing through the femur[1] e.g. in children to encourage normal bony growth
Fleshy or muscular residual limb with little bony definition	Patient suffers from persistent sweating
	Where patient requires good rotational control

Exceptions

- Those patients who are deemed medically unfit, unwilling, or because of their current lifestyle or circumstances, unsuitable for the provision of a prosthesis.
- Poor cognitive ability and compromised hand function may, in some cases, be contraindications for prosthetic rehabilitation. The MDT must assess whether the patient has the level of ability required with or without a carer, to use the prosthesis being prescribed, correctly, safely and consistently before proceeding.
- Where an alternative approach is seen to be more suitable according to the indications/ contraindications of its guideline.

Knee disarticulation weight-bearing

Hand Casting Guideline - KD C WB 01

Guideline Statement

All forms of knee disarticulation amputation should be hand cast using the weight-bearing technique for any patient with a form of knee disarticulation amputation, when some or all of the indications are observed, whilst ideally none of the contraindications are exhibited.

Definitions

- Form of knee disarticulation – see overview.
- Weight-bearing hand casting – see knee disarticulation casting page.

Indications	Contradications
Patients who would benefit from distal contouring that weight-bearing produces	Patients who cannot tolerate distal end-bearing e.g. painful bursa distally
Patients who are able to tolerate distal weight-bearing	Patients who may find it difficult to stand for casting e.g. comorbidities, bilateral amputations[4]
To provide correct weight-bearing alignment of the residual limb on the end-bearing pad during casting	
Patients who are able to stand in an upright position during casting[3]	
To allow the patient to control the amount of weight taken distally*	

*Some patients may need or prefer to partial end-bear and partially ischial-bear, although this loses some of the benefits of end-bearing – see main guidelines for socket shapes.

Exceptions

- Those patients who are deemed medically unfit, unwilling, or because of their current lifestyle or circumstances, unsuitable for the provision of a prosthesis.
- Poor cognitive ability and compromised hand function may, in some cases, be contraindications for prosthetic rehabilitation. The MDT must assess whether the patient has the level of ability required with or without a carer, to use the prosthesis being prescribed, correctly, safely and consistently before proceeding.
- Where an alternative approach is seen to be more suitable according to the indications/ contraindications of its guideline.

Knee disarticulation non-weight-bearing

Hand Casting Guideline - KD C NWB 01

Guideline Statement

All forms of knee disarticulation amputation should be hand cast using the non-weight-bearing technique for any patient with a form of knee disarticulation amputation, when some or all of the indications are observed, whilst ideally none of the contraindications are exhibited.

Definitions

- Form of knee disarticulation – see overview.
- Weight-bearing hand casting – see knee disarticulation casting page.

Indications	Contradications
Patients who may find it difficult to stand for casting e.g. comorbidities, bilateral amputations[4]	Patients who would benefit from weight-bearing during casting[4]
Patients who would benefit from the definition achieved by hand moulding of the distal end of the residuum[4]	
Patients who require comfort and safety during casting[5]	

Exceptions

- Those patients who are deemed medically unfit, unwilling, or because of their current lifestyle or circumstances, unsuitable for the provision of a prosthesis.
- Poor cognitive ability and compromised hand function may, in some cases, be contraindications for prosthetic rehabilitation. The MDT must assess whether the patient has the level of ability required with or without a carer, to use the prosthesis being prescribed, correctly, safely and consistently before proceeding.
- Where an alternative approach is seen to be more suitable according to the indications/ contraindications of its guideline.

References - Knee disarticulation prescription and casting guidelines

1 STARK G, (2004). Overview of Knee Disarticulation. *JPO*, Vol. 16, p130-137.

2 BOTTA P, BAUMGARTNER R, (1983). Socket design and manufacturing technique for through-knee stumps. *Prosthet Orthot Int*, Vol. 7, p100-103.

3 LYQUIST E, (1983). Casting the through-knee stump. *Prosthet Orthot Int*, Vol. 7, p104-106.

4 MICHEAL J W, (1992). Knee Disarticulation: Prosthetic Management. *Atlas of Limb Prosthetics: Surgical, Prosthetic, and Rehabilitation Principles,* Chapter 19B.

5 BOTTA P, BAUMGARTNER R, (1983). Socket design and manufacturing technique for through-knee stumps. *Prosthet Orthot Int,* Vol. 7, p100-103.

Transfemoral Guidelines

Prescription Guideline Title	Ref Number
Quadrilateral sockets	TF P QUS 01

Casting Guideline Title	Ref Number
Quadrilateral socket hand casting	TF C QUS 01
Quadrilateral socket brim casting	TF C QUS 01

Prescription Guideline Title	Ref Number
Ischial containment sockets	TF P ICS 01

Casting Guideline Title	Ref Number
Ischial containment socket hand casting	TF C ICS 01
Ischial containment socket jig casting	TF C ICS 02

Prescription Guideline Title	Ref Number
Transfemoral suction sockets	TF P SUC 01
Transfemoral soft elastic suspension belts	TF P SUS 01
Transfemoral silicone self-suspending sockets	TF P SSS 01

Casting Guideline Title	Ref Number
Transfemoral silicone self-suspending socket hand casting	TF C SSS 01

Transfemoral sockets

Amputation Type

There are no specific amputation types for this level that would significantly affect the choice of socket type.

Socket Type

- Quadrilateral
- Ischial containment

Suspension

- Suction
- Auxillary suspension

Casting Method

- Quadrilateral hand casting
- ICE hand casting
- Quadrilateral brim casting
- Casting jigs
- *CAD/CAM*

Materials

- *Polypropylene*
- *Laminates*

Applicable to both the thinner silicone liners and the thicker gel liners. The choice of distal connection, including the unique seal-in liner, have little effect on the overall guideline, but where they do is mentioned, or is obvious from the manufacturer's own guidelines.

The guidelines shown in italics have yet to be produced.

The quadrilateral socket overview

The traditional quadrilateral socket has a narrow anterior to posterior dimension **(A)** compared to the medial to lateral dimension **(B)** - see Fig 1. The anterior wall of the socket is ideally 5-7cm higher than the posterior wall to retain the residuum, and combined with the narrow anterior to posterior dimension, helps keep the ischial tuberosity on the ischial seating area of the posterior brim, but may need to be reduced to provide comfort when sitting. The ischial seating should normally be parallel to the ground.

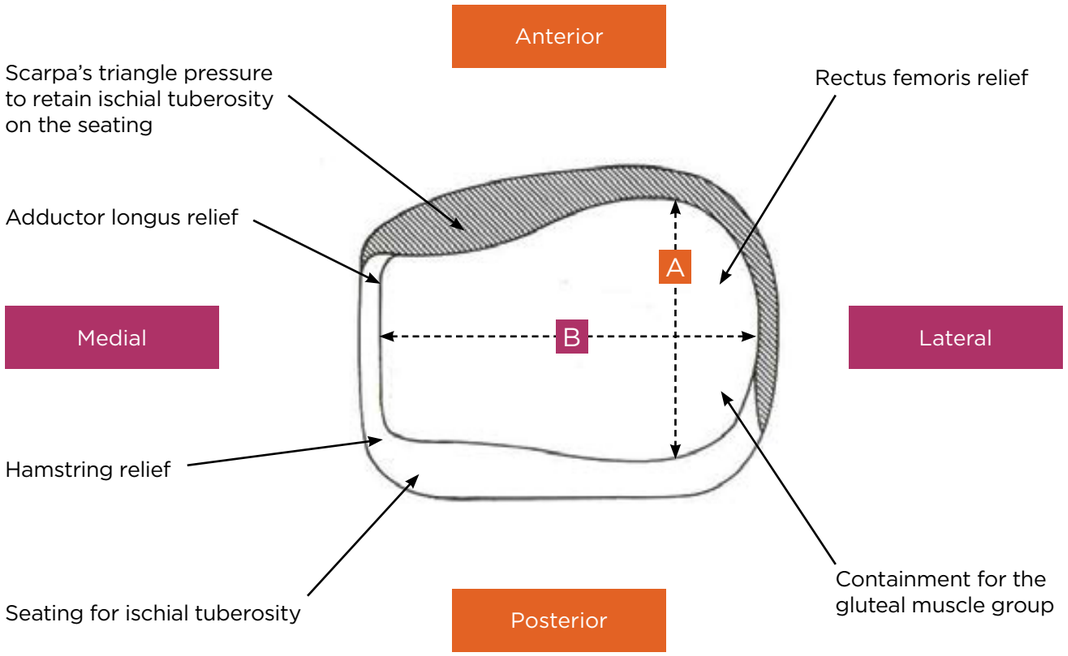
The corner between the anterior and medial walls of the socket is shaped to provide relief for the adductor tendon when it comes into action in the stance phase; the proximal edge of the medial wall is kept low enough to prevent painful contact with the ischial ramus.

The lateral wall of the socket, whilst it should be kept as high as possible in order to spread the lateral forces over as large an area as possible, is generally lower than with other types of socket. This combined with the wider medial to lateral dimension can allow a lack of mediolateral stabilising force, but since this lower lateral wall makes it very suitable for use with a rigid pelvic band suspension, this problem is then negated.

The diagram below gives some idea of the socket shape at brim level, but soft tissue or highly toned muscular tissue would change the shape of the residuum and subsequently the shape of the socket would need to change to accommodate the differences.

The above are the principles that underpin the design of the preformed brims developed by Hosmer and others, for assisting prosthetists in casting and measuring patients for this type of socket.

Fig. 1



Prescription Guideline - TF P QUS 01

Guideline Statement

Quadrilateral sockets should be prescribed for any patient with a transfemoral amputation, when some or all of the indications are observed, whilst ideally none of the contraindications are exhibited.

Definitions

- Quadrilateral socket – as defined by the overview.

Indications	Contradications
Patients who have long residual limbs and therefore more intact adductor musculature[1,2]	Patients who have prominent hamstrings which the standard quadrilateral shape may impinge upon
Patient preference, based on previous experience[2,3]	Intolerance to pressure on the ischial tuberosity[4]
Patients whose residual limb has good muscle tone[2]	The need to avoid excess pressure on the neuro-vascular bundle (Scarpa's triangle)[4]
Those patients who require a rigid pelvic band for suspension	Patients who have a short residual limb[5]
Less active/geriatric patients[2]	Patients who have soft residual limb muscle tone
	Patients who have weak adductor musculature
	Patients who require very positive M/L femoral stabilisation within the socket[4,6]
	Patients who require more rotational stability than soft tissue stabilisation alone will allow e.g. no bony lock to control rotation[2]
	Patients with low back pain, or a low pain threshold in the groin or tuberosity area*

*Studies have shown that quad sockets can cause pain in these areas due to M/L socket width and shear forces at the gluteus medius.[7]

Exceptions

- Those patients who are deemed medically unfit, unwilling, or because of their current lifestyle or circumstances, unsuitable for the provision of a prosthesis.
- Poor cognitive ability and compromised hand function may, in some cases, be contraindications for prosthetic rehabilitation. The MDT must assess whether the patient has the level of ability required with or without a carer, to use the prosthesis being prescribed, correctly, safely and consistently before proceeding.
- Where an alternative approach is seen to be more suitable according to the indications/ contraindications of its guideline.

Hand Casting Guideline - TF C QUS 01

Guideline Statement

Quadrilateral sockets should be hand cast for any patient with a transfemoral amputation, when some or all of the indications are observed, whilst ideally none of the contraindications are exhibited.

Definitions

- Quadrilateral socket – as defined by the overview.

Indications	Contradications
Scars or grafted tissue which must be accommodated by modifying the quadrilateral shape	Patients who are unable to stand without the assistance of a casting jig for the required time period needed for casting
The patient does not fit comfortably into any jig or brim	
Patient preference based upon previous experience	

Exceptions

- Those patients who are deemed medically unfit, unwilling, or because of their current lifestyle or circumstances, unsuitable for the provision of a prosthesis.
- Poor cognitive ability and compromised hand function may, in some cases, be contraindications for prosthetic rehabilitation. The MDT must assess whether the patient has the level of ability required with or without a carer, to use the prosthesis being prescribed, correctly, safely and consistently before proceeding.
- Where an alternative approach is seen to be more suitable according to the indications/ contraindications of its guideline.

1 2 3 4 5 6 7 8 9 10

Brim Casting Guideline - TF C QUS 02

Guideline Statement

Quadrilateral sockets should be cast using a brim for any patient with a transfemoral amputation, when some or all of the indications are observed, whilst ideally none of the contraindications are exhibited.

Definitions

- Quadrilateral socket – as defined by the overview.
- A “brim” takes the form of the proximal section of a quadrilateral socket. Made of plastic or metal and available in a range of sizes, these can be applied to the patient, checked for fit and, with some types, adjusted whilst on the patient. They are then either held on to the patient by means of a shoulder strap, or they may have some form of jig which will allow the patient to weight-bear on the brim. The distal section is then wrapped with plaster.

Indications	Contradications
Less time consuming casting procedure therefore possibly less stressful for weak patients	Residual limb is too short for the brim
Patients who would benefit from support of a casting jig during casting	The patient’s residual limb does not fit comfortably into any available brim
Patient preference based upon previous experience	Patients with residual limbs <4 ¾” (12cm) medio-laterally[9]
Minimal patient contact required when casting i.e. for religious reasons	Patients with residual limbs >8” (20.3cm) medio-laterally[9]
Where the quad shape is indicated but difficulties arise defining the quad shape by hand[8]	Residual limbs where significant oedema is present[9]
To aid casting for a quadrilateral socket for patients with a transfemoral amputation who require to be cast lying on a bed[9]	
To aid in the production of the quadrilateral shape when applying an immediate postoperative rigid dressing[10]	
Where consistency in socket shape is required when casting[11]	

Exceptions

- Those patients who are deemed medically unfit, unwilling, or because of their current lifestyle or circumstances, unsuitable for the provision of a prosthesis.
- Poor cognitive ability and compromised hand function may, in some cases, be contraindications for prosthetic rehabilitation. The MDT must assess whether the patient has the level of ability required with or without a carer, to use the prosthesis being prescribed, correctly, safely and consistently before proceeding.
- Where an alternative approach is seen to be more suitable according to the indications/ contraindications of its guideline.

Prescription Guideline - TF P ICS 01

Guideline Statement

Ischial containment sockets should be prescribed for any patient with a transfemoral amputation, when some or all of the indications are observed, whilst ideally none of the contraindications are exhibited.

Definitions

- Ischial containment sockets may be defined as any transfemoral socket which contains the ischium within the socket supporting the ischium and ramus medially, whilst holding the femur in a position of natural adduction by way of lateral support along the length of the femur.

Indications	Contradications
Intolerance to ischial weight-bearing[4]	Patients who require a rigid pelvic band
Short residual limb[1,2,3,5,12]	Low activity patients
Patient preference based on previous experience	Patients with an abnormally shaped pelvis [7]
Previous problems with rotational control of the socket on the residual limb	Patients who would find the cosmetic appearance of the ischial containment socket unsatisfactory [13]
Desired improvement of proximal socket edge cosmesis[13]	Patients who are unwilling or unable to devote the necessary time and effort for the required fitting stage
High activity patient[1,2]	
A history of discomfort over cut end of femur	
Patients who require positive M/L stabilisation of the femur[4]	
Patients who require reduced pressure at the Scarpa's triangle area[4]	
Patients who have fleshy residual limbs [1,2,3,12]	
Patients who are wearing a quadrilateral socket who require improved comfort when sitting[13]	
Patients who are wearing a quadrilateral socket who show significant lumbar lordosis at heel off [13]	
Patients who are wearing a quadrilateral socket who require improved M/L stability at mid-stance[12, 13]	
Patients who are wearing a quadrilateral socket who require reduced energy expenditure [14,15]	
Patients wearing suction sockets[2]	
Patients who have groin and low back pain (a study has shown IC sockets to reduce pain in these areas) [7]	
Patients who require socket pressure to be distributed over as large an area as possible (e.g. for those with an insensate residual limb)[15,16]	

Exceptions - see exceptions on page 69.

Hand Casting Guideline - TF C ICS 01

Guideline Statement

Ischial containment sockets should be hand cast for any patient with a transfemoral amputation, when some or all of the indications are observed, whilst ideally none of the contraindications are exhibited.

Definitions

- Ischial containment sockets may be defined as any transfemoral socket which contains the ischium within the socket supporting the ischium and ramus medially, whilst holding the femur in a position of natural adduction by way of lateral support along the length of the femur.

Indications	Contradications
Patients who do not fit comfortably into any available jig or brim	Patients who are not able to stand unaided without the assistance of a jig for the duration of casting

Note: Hand casting for ischial containment sockets may require more than one prosthetist and a longer appointment slot. Additionally, the ischial containment casting technique is of a more intimate nature, therefore it is very important that informed consent is gained from the patient before proceeding.

Exceptions

- Those patients who are deemed medically unfit, unwilling, or because of their current lifestyle or circumstances, unsuitable for the provision of a prosthesis.
- Poor cognitive ability and compromised hand function may, in some cases, be contraindications for prosthetic rehabilitation. The MDT must assess whether the patient has the level of ability required with or without a carer, to use the prosthesis being prescribed, correctly, safely and consistently before proceeding.
- Where an alternative approach is seen to be more suitable according to the indications/ contraindications of its guideline.

Ischial containment socket

Jig Casting Guideline - TF C ICS 02

Guideline Statement

Ischial containment sockets should be cast using a casting jig for any patient with a transfemoral amputation, when some or all of the indications are observed, whilst ideally none of the contraindications are exhibited.

Definitions

- Ischial containment sockets may be defined as any transfemoral socket which contains the ischium within the socket supporting the ischium and ramus medially, whilst holding the femur in a position of natural adduction by way of lateral support along the length of the femur.
- An ischial containment casting jig is a piece of equipment, the intention of which is to define the critical aspects of the socket shape on the patient during casting (as shown in images on the following page).

Indications	Contradications
Patient preference based upon previous experience	Patient does not fit comfortably into the jig or brim
The patient is unable to stand unassisted for the duration of casting	Patients who have short residual limbs
Patients who have medium to long residual limbs	Patients who have fleshy residual limbs
Patient's residual limb has good muscle tone	Hip flexion contracture present

Exceptions

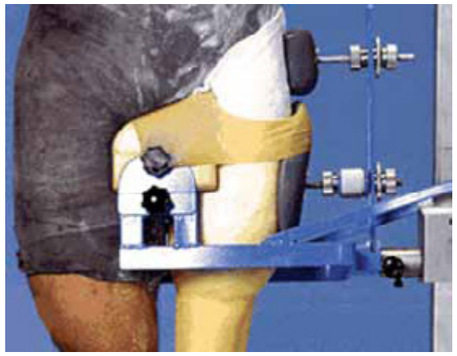
- Those patients who are deemed medically unfit, unwilling, or because of their current lifestyle or circumstances, unsuitable for the provision of a prosthesis.
- Poor cognitive ability and compromised hand function may, in some cases, be contraindications for prosthetic rehabilitation. The MDT must assess whether the patient has the level of ability required with or without a carer, to use the prosthesis being prescribed, correctly, safely and consistently before proceeding.
- Where an alternative approach is seen to be more suitable according to the indications/ contraindications of its guideline.

Casting jig examples

Blatchford Casting Jig

Images courtesy of Blatchford.

Otto Bock Sit-Cast System



Images courtesy of Otto Bock

Transfemoral suction socket

Prescription Guideline - TF P SUC 01

Guideline Statement

Suction sockets should be prescribed for any patient with a transfemoral amputation, when some or all of the indications are observed, whilst ideally none of the contraindications are exhibited.

Definitions

- Transfemoral suction sockets suspended by slight negative 'residual limb-socket' pressure, combined with muscle contraction. No auxiliary attachments are usually required and the residual limb is in direct contact with the socket, and may otherwise be in any style appropriate to the patient's needs.

Indications	Contradications
Improved cosmesis is required[1]	Residual limb volume fluctuation[1,18,19]
Stable residual limb volume[1]	Impaired hand strength for donning
Good residual limb muscle tone[17,18,19]	Poor residual limb/hip muscle control*[19,23,24]
Elimination of auxiliary attachments required[5,18,20,21]	Poor personal hygiene[20]
Full range of hip motion required[1,17, 20,21,22]	Very short, <3" (7.5cm) residual limb[21,22,24,25]
Improved comfort[20]	Conical shaped residual limb[22]
Less interference with clothing[20]	Bulbous residual limb
Very positive suspension is required[5,20,22]	Very long residual limb[21,22,24,25]
Patients who have contralateral limb impairment[20]	Patients with poor balance[1,26]
Patients who participate in athletic activities[23]	Invaginated/adherent scaring at the socket edge[6,18,21,22,23,24]
Medium-length residual limb[1,18]	Compromised vascularity/dysvascular*[21,22,25,27]
A residual limb free of complications[1,18]	Insufficient flesh cover
Patients who prefer not to wear a residual limb sock[18,21]	Previous distal congestion[28,29]
Patients who require improved control and proprioception from the prosthesis[21]	Patients who cannot tolerate a high anterior socket wall[30]
Primary patients (greater success is seen if this is the first transfemoral socket fitted)[21]	Patients who are unwilling or unable to devote the necessary time and effort for the required fitting stages[20,21,22,24,25,30]
Hygienic residual limb-socket interface is required[21]	Excessive scarring/graft sites[25,30]
	Excessive redundant soft tissue[22,30]
	Excessive hip flexion contracture[18,24]
	Patients who have active osteomyelitis[18,20,21,22]
	Residual limbs which cannot tolerate more than 1½ psi of negative pressure for 1½ minutes[20]
	Sharp bone spurs[18,20,21,25]
	Residual limbs with ulceration, cysts or abscesses present[21,22]
	Residual limbs with drainage sinuses present[22]
	Residual limbs where infection is present[22,25]
	Dermatological residual limb complications[18,19,21,22,25]
	Excessive perspiration causing skin problems[19,21,22]
	Associated injuries to the pelvis or hip joint[18]
	Capillary fragility[18,21]
	Large neuromas[18]
	Residual limbs which cannot tolerate up to 4 psi for a second at a time[18]
	Muscles which are not strong enough to contract sufficiently to maintain suspension during the swing phase[18,21]
	Excessive oedema[21]
	Hypertrophic scarring or deep fissures[1]
	Scar tissue which has poor elasticity[1]
	Compromised heart conditions[1]
	Residual limbs which cannot tolerate the tissue stress (i.e. shear forces) when donning[26]

Note: Suction sockets generally require greater dexterity, effort and balance for donning and doffing than alternative methods of suspension[1.6] *Literature has also been found which contradicts this statement.

Exceptions

- Those patients who are deemed medically unfit, unwilling, or because of their current lifestyle or circumstances, unsuitable for the provision of a prosthesis.
- Poor cognitive ability and compromised hand function may, in some cases, be contraindications for prosthetic rehabilitation. The MDT must assess whether the patient has the level of ability required with or without a carer, to use the prosthesis being prescribed, correctly, safely and consistently before proceeding.
- Where an alternative approach is seen to be more suitable according to the indications/ contraindications of its guideline.

Transfemoral soft elastic suspension belts

Prescription Guideline - TF H SUS 01

Guideline Statement

Soft elastic suspension belts should be prescribed for any patient using a transfemoral prosthesis when some or all of the indications are observed, whilst ideally none of the contraindications are exhibited.

Definitions

- Soft elastic suspension belt – a fabric suspension belt which fits circumferentially onto the socket and around the users pelvis. Also known as Total Elastic Suspension (TES) belt.

Indications	Contradications
Where an additional method of suspension is required with a self-suspending socket*	Hip joint instability
Where a method of suspension is required that is not affected or compromised by volume fluctuation of both the residuum and trunk	Allergic reaction to material
Where a simple method of suspension is required	Where the belt is used as the sole method of suspension for patients who require positive rotational control of the socket
Patient preference	Poor upper body strength making donning difficult
Comfort required when sitting	Poor hip muscle power
Where the prosthesis is intended for cosmetic/transfer use only**	Patients who cannot tolerate the heat generated when wearing neoprene
Where cosmesis under clothes is an issue	Abdominal pathology for example colostomy
	Patients with a short residual limb***

*Self-suspending – where suspension is inherent in the socket design i.e. suspension over the femoral condyles, suspension from tight fit of socket and pull through or suspension from a ratchet pin, hypobaric valve or lanyard.
** It has been identified that there are wide variations with regard to how cosmetic prostheses are manufactured. Some may utilize a soft suspension belt to secure the cosmetic prosthesis in place whilst others may attach the prosthesis to the wheelchair. The above indication refers to the former.
***Although the contraindication 'patients with a short residual limb' did not reach the consensus level of 75% agreement, it did gain 73% agreement and so the best practice group members felt that this high level of agreement should be recognised.

Exceptions

- Those patients who are deemed medically unfit, unwilling, or because of their current lifestyle or circumstances, unsuitable for the provision of a prosthesis
- Poor cognitive ability and compromised hand function may, in some cases, be contraindications for prosthetic rehabilitation. The MDT must assess whether the patient has the level of ability required with or without a carer, to use the prosthesis being prescribed, correctly, safely and consistently before proceeding.
- Where an alternative approach is seen to be more suitable according to the indications/ contraindications of its guideline.

Transfemoral silicone self-suspending socket

Prescription Guideline - TF P SSS 01

Guideline Statement

Silicone self-suspending sockets should be prescribed for any patient with a transfemoral amputation, when some or all of the indications are observed, whilst ideally none of the contraindications are exhibited.

Definitions

- Silicone self-suspending sockets for the purpose of this guideline, are considered to be any 2mm thick, silicone liners or roll on silicone sockets, using shuttlelock and pin, lanyard or suction valve suspension systems.

Indications	Contradications
Positive suspension	Heavy scarring of residual limb
Patients who do not like secondary suspension aids like TES belts[31,32,33,34]	Allergic reaction to liner[34]
Patient would benefit from a total contact socket[1, 35]	Patients who cannot adapt to a different socket shape
Mild volume fluctuation, able to add/remove socks if necessary*	Patient who cannot cope with extra weight to the prosthesis
Moderate to high activity patients**	Low activity patients**
Improved proprioception	Ulceration/unhealed scars***
Patient ability to don liner effectively and consistency for pin alignment	Poor hip muscular control
Strong musculature	Lack of space for prescribed hardware[1]
Reduced friction and shear forces on residual limb[34,35]	Poor hygiene[34,35]
Low activity patients	Excessive distal sensitivity[34]
	Volume fluctuations of residual limb[35]
	Persistent perspiration

*Patient needs a good understanding of socks and volume management.
**Journals say otherwise.
***Some work has been done by Össur that would indicate that Iceross liners can be used to enhance the healing process.

Exceptions

- Those patients who are deemed medically unfit, unwilling, or because of their current lifestyle or circumstances, unsuitable for the provision of a prosthesis.
- Poor cognitive ability and compromised hand function may, in some cases, be contraindications for prosthetic rehabilitation. The MDT must assess whether the patient has the level of ability required with or without a carer, to use the prosthesis being prescribed, correctly, safely and consistently before proceeding.
- Where an alternative approach is seen to be more suitable according to the indications/ contraindications of its guideline.

Transfemoral silicone self-suspending socket

Socket Hand Casting Guideline - TF H SUS 01

Guideline Statement

Silicone self-suspending sockets should be hand cast for any patient with a transfemoral amputation, when some or all of the indications are observed, whilst ideally none of the contraindications are exhibited.

Definitions

- Hand casting is defined as the wrapping of the residuum with plaster bandage, palpating so as to identify underlying anatomy and shape to desired design. See casting instructions provided by liner manufacturers.
- Silicone self-suspending sockets for the purpose of this guideline, are considered to be any 2mm thick, silicone liners or roll on silicone sockets, using shuttlelock and pin, lanyard or suction valve suspension systems.

Indications	Contradications
Casting method recommended by the manufacturers	The patient is unable to stand long enough for the cast to be taken*[36]

Note: It has been presumed that the hand-casting technique being considered here is that taught by Össur.

*It is possible, if the patient has difficulty standing for the length of time required by this technique, to cast using a quadrilateral brim with a supporting jig. The resultant socket will not have the characteristic shape achieved when using the Össur method, but has been found to be reasonably satisfactory.

Exceptions

- Those patients who are deemed medically unfit, unwilling, or because of their current lifestyle or circumstances, unsuitable for the provision of a prosthesis.
- Poor cognitive ability and compromised hand function may, in some cases, be contraindications for prosthetic rehabilitation. The MDT must assess whether the patient has the level of ability required with or without a carer, to use the prosthesis being prescribed, correctly, safely and consistently before proceeding.
- Where an alternative approach is seen to be more suitable according to the indications/ contraindications of its guideline.

References - Transfemoral prescription and casting guidelines

1. KAPP S L, (2000). Trans-femoral socket design and suspension options. *Phys Med Rehabil Clin North Am*, Vol. 11, p569-583p

2. SCHUCH C M, PRITHAM C H, (1999). Current trans-femoral sockets. *Clin Orthop*, Vol. 361, p48-54.

3. STAROS A, RUBIN G, (1991). Prescription considerations in modern above-knee prosthetics. *Phys Med Rehabil Clin North Am*, Vol. 2, p311-324.

4. OTTO J, (2001). Trans-femoral sockets: the shape of things to come. *O&P Business News*, Vol. 10(9), p24-38.

5. LEONARD J A, (1994). Lower limb prosthetic sockets. *Phys Med Rehabil: State Art Rev*, Vol. 8, p129-145.

6. ERIKSON U, JAMES U, (1973). Roentgenological study of certain stump-socket relationships in above-knee amputees with special regard to tissue proportions, socket fit and attachment stability. *Upsala J Med Sci*, Vol. 78, p203-214.

7. VISSER-MEILYJMA, et al., (1992). Experiences of above-knee amputees with an NMLsocket in comparison with a quadrilateral socket. *J Rehabil Sci*, Vol. 5, p22-25.

8. FOORT J, (1986). Innovation in prosthetics and orthotics. *Prosthet Orthot Int*, Vol. 10, p61-71.

9. FOORT J, (1963). Adjustable-brim fitting of the total-contact above knee socket. In: *Biomechanics Laboratory*. San Francisco, Berkley: University of California, p22.

10. CURRELL IJ, (1969) A prefabricated brim for the above-knee immediate postsurgical rigid dressing. *Artificial Limbs*, Vol. 13(2), p74-78.

11. TOSBERG W A, (1964). The New York University flexible above-knee casting brim. *Prostheses Braces Tech Aids*, Vol. 13, p3-4.

12. FLANDRY F, et al, (1989). The effect of (the) CAT-CAM above-knee prosthesis on functional rehabilitation. *Clin Orthop Relat Res,* Feb Vol. 239, p249-262.

13. HACHISUKA K, et al., (1999). Subjective evaluations and objective measurements of the ischial-ramal containment prosthesis. *J UOEH*, Jun Vol. 1;21(2), p107-18.

14. GAILEY RS, et al., (1993). The CATCAM socket and quadrilateral socket: a comparison of energy cost during ambulation. *Prosthe Orthot Int*, Vol. 17, p95-100.

15. SHIN J C, et al., (2000). Prosthetic ambulation in a paraplegic patient with a transfemoral amputation and radial nerve palsy. *Yonsei Med J*, Vol. 41, p512-516.

16. HERMAN T, et al., (1995). Prosthetic fitting and ambulation in a paraplegic patient with an above-knee amputation. *Arch Phys Med Rehabil*, Vol. 76, p290-293.

17. CONDE-SALAZAR L, et al., (1988). Allergic contact dermatitis from a suction socket prosthesis. *Contact Dermatitis*, Vol. 19, p305-306.

18. CANTY T J, (1949). Suction socket for above knee prosthesis. *United States Naval Med Bull*, Vol. 49, p216-233.

19. THORNDIKE A, (1955). End results in suction socket prosthesis for above-knee amputees. *Am J Surg*, Vol. 89, p919-923.*

20. EBERHART H D, MCKENNON J C, (1954). Suction-socket suspension of the above knee prosthesis. In: KLOPSTEG P E, WILSON P D, *Human limbs and their substitutes*. New York: Hafner, p653-675.

21. THORNDIKE A, (1949). Suction socket prosthesis for above-knee amputees: interim report of Veterans Administration experimental program. *Am J Surg*, Vol. 78, p603-613.

22. HADDAN C C, THOMAS A, (1954). Status of the above-knee suction socket in the United States. *Artificial Limbs*, Vol. 1(2), p29-39.

23. BECHTOL C O, (1954). The principles of prosthetic prescription. In: KLOPSTEG P E, WILSON P D, *Human limbs and their substitutes*. New York: Hafner, p159-165.

24. KELHAM RDL, et al., (1957). Sockets, suspension and control of the above-knee limb for ideal stumps. *Artificial limbs in the rehabilitation of the disabled*, p56-78, 175-176.

25. MAZET R, et al., (1951). Analysis of one hundred and twenty-four suction socket wearers followed from six to fifty-five months. J *Bone Joint Surg,* Vol. 33(A), p618-627.

26. LAYTON H, (1998). A vacuum donning procedure for transfemoral suction socket suspension prostheses. *Prosthet Orthot Int*, Vol. 10, p21-24.

27. THOMPSON RG, et al., (1965). Above-the knee amputations and prosthetics. *J Bone Joint Surg*, Vol. 47(A), p619-630.

28. BADELL A, et al., (1994). Kaposilike Acroangiodermatitis induced by a suction socket. *Br J Dermatol*, Vol. 131, p915-917.

29. KOLDE G, et al., (1989). Kaposi-like acroangiodermatitis in an above-knee amputation stump. *Br J Dermatol*, Vol. 120, p575-580.

30. WILDER M J, (1966). The “Partial” suction socket. *ICIB*, Vol. 5(6), p1-3.

31. JAIN A S, STEWART C P U (1993). The Use of the Shuttle Lock System for Problem Transfemoral Suspension. *Prosthe Orthot Int*. Vol. 23, p256-257.

32. TRIEB K, et al., (1998). Silicone Soft Socket System: its Effect on the Rehabilitation of Geriatric Patients with Transfemoral Amputations. *Arch Phys Med Rehabilitation*, Vol. 80, p522-525.

33. HEIM M, et al, (1997). Silicone Suspension of External Prostheses. *J Bone Joint Surg (BR)*, Vol. 79(B), p638-40.

34. LAKE C, SUPAN T J, (1997). The Incidence of Dermatological Problems in the Silicone Suspension Sleeve User. J *Prosthetics Orthotics,* Vol. 9, p97 - 106.

35. HABERMAN L J, et al. Silicone–Only Suspension (SOS) for the Above-Knee Amputee. *Journal of Prosthetics and Orthotics*, Vol. 4(2), p76-85.

36. Össur transfemoral casting course literature.

Hip Disarticulation and Hemipelvectomy Guidelines

Prescription Guideline Title	Ref Number
Hip disarticulation ischial-bearing sockets	HD P IBS 01
Hip disarticulation ischial containment sockets	HD P ICS 01
Hemipelvectomy volume-bearing sockets	HD P VBS 01
Hip disarticulation and hemipelvectomy silicone sockets	HD P SSS 01

Casting Guideline Title	Ref Number
Hip disarticulation and hemipelvectomy hand casting	HD C HDP 01
Hip disarticulation and hemipelvectomy jig with wedges casting	HD C HDP 02
Hip disarticulation and hemipelvectomy suspension casting	HD C HDP 03

Hip disarticulation and hemipelvectomy sockets

Amputation Type	Hip disarticulation	Hemipelvectomy
Socket Type	Total contact, with weight-bearing through ischial tuberosity	Total contact, with weight-bearing through volume
	Total contact, with weight-bearing through ischial tub. with containment	*Total contact, with weight-bearing through the rib cage*
	Silicone socket (using either of above socket types)	*Total contact, with weight-bearing through contralateral ischial tub.*
Casting Method	*Casting method specific to ischial containment*	Hand casting using a jig with wedges
	CAD/CAM	Hand casting using a suspension sling
		Hand casting without a jig
Materials	Silicone & laminate construction	*Resin laminates*
		Leather & laminate construction

The guidelines shown in italics have yet to be produced.

Prescription Guideline - TF P IBS 01

Guideline Statement

An ischial-bearing socket should be prescribed for any patient with a hip disarticulation amputation, when some or all of the indications are observed, whilst ideally none of the contraindications are exhibited.

Definitions

- Ischial-bearing – where the ischial tuberosity and the volume of the residuum contained within the socket are the means of weight-bearing through the prosthesis.

Indications	Contradications
Good tissue covering of the ischial tuberosity area	Patient cannot tolerate ischial weight-bearing e.g. scarring or pain in ischial area[2]
No scarring or pain in the ischial tuberosity area	Unable to tolerate pressure on the abdomen
Patient prefers cosmetic appearance (improved body symmetry)	Patient requires greater stability e.g. ischial containment required
Volume fluctuations of the residual limb*[1,2]	Unable to tolerate high socket walls
Unable to tolerate ischial containment	Unhealed fractures or dislocation of pelvis

*Volume fluctuations and obesity[1,2] were considered by some clinicians to be contraindications, but consensus was not achieved.

Exceptions

- Those patients who are deemed medically unfit, unwilling, or because of their current lifestyle or circumstances, unsuitable for the provision of a prosthesis.
- Poor cognitive ability and compromised hand function may, in some cases, be contraindications for prosthetic rehabilitation. The MDT must assess whether the patient has the level of ability required with or without a carer, to use the prosthesis being prescribed, correctly, safely and consistently before proceeding.
- Where an alternative approach is seen to be more suitable according to the indications/ contraindications of its guideline.

Hip disarticulation ischial containment socket

Prescription Guideline - HD P ICS 01

Guideline Statement

An ischial containment socket should be prescribed for any patient with a hip disarticulation amputation, when some or all of the indications are observed, whilst ideally none of the contraindications are exhibited.

Definitions

- Ischial containment – where the socket contains the ischium and supports the ischium and ramus medially.

Indications	Contradications
Stable volume	Unstable volume
Patient requires improved stability of socket – providing better control of the prosthesis[3,4,5]	Children – since it may restrict their pelvic development
Patient prefers cosmetic appearance as the socket can be reduced in size, whilst still retaining adequate stability and suspension	Invasive casting technique unacceptable to patient
Improved suspension[3]	
Improved comfort[4]	

Exceptions

- Those patients who are deemed medically unfit, unwilling, or because of their current lifestyle or circumstances, unsuitable for the provision of a prosthesis.
- Poor cognitive ability and compromised hand function may, in some cases, be contraindications for prosthetic rehabilitation. The MDT must assess whether the patient has the level of ability required with or without a carer, to use the prosthesis being prescribed, correctly, safely and consistently before proceeding.
- Where an alternative approach is seen to be more suitable according to the indications/ contraindications of its guideline.

Hemipelvectomy volume-bearing socket

Prescription Guideline - HD P VBS 01

Guideline Statement

A volume-bearing socket should be prescribed for any patient with a hemipelvectomy amputation, when some or all of the indications are observed, whilst ideally none of the contraindications are exhibited.

Definitions

- Volume-bearing - where the volume of the residuum is contained within the socket. This forms the means of weight-bearing through the prostheses.

Indications	Contradications
Good tissue covering	Patient has a hernia that would not benefit from containment
Stable internal anatomy	Residual limb intolerant to pressure
Residual limb requires tissue support	Painful or adherent scarring
Inability to weight-bear on skeletal areas e.g. contralateral ischium or rib cage	Unhealed or damaged internal organs[2]
Patient has a hernia that would benefit from support	Pregnancy
	Unstable residual limb volume
	Diaphramatic weakness or hernia[2]
	Abdominal weakness[2]

Exceptions

- Those patients who are deemed medically unfit, unwilling, or because of their current lifestyle or circumstances, unsuitable for the provision of a prosthesis.
- Poor cognitive ability and compromised hand function may, in some cases, be contraindications for prosthetic rehabilitation. The MDT must assess whether the patient has the level of ability required with or without a carer, to use the prosthesis being prescribed, correctly, safely and consistently before proceeding.
- Where an alternative approach is seen to be more suitable according to the indications/ contraindications of its guideline.

Prescription Guideline - HD P SSS 01

Guideline Statement

A silicone socket should be prescribed for any patient with a hip disarticulation or hemipelvectomy amputation, when some or all of the indications are observed, whilst ideally none of the contraindications are exhibited.

Definitions

- Silicone socket – A socket in which the containment and suspension are provided by a silicone material that encapsulates the structural element of the required limb system.

Indications	Contradications
Increased comfort[5,6,7,8]	Fluctuation in residual limb volume
Good suspension (worn next to skin)[6]	Excessive perspiration[6]
Patient prefers cosmetic appearance[7]	Patient cannot manage extra weight of silicone [6,7]
Hygiene	Patient likely to require alterations to socket[6]
Increased freedom of movement[6,7]	
Less effort when walking[7]	

Exceptions

- Those patients who are deemed medically unfit, unwilling, or because of their current lifestyle or circumstances, unsuitable for the provision of a prosthesis.
- Poor cognitive ability and compromised hand function may, in some cases, be contraindications for prosthetic rehabilitation. The MDT must assess whether the patient has the level of ability required with or without a carer, to use the prosthesis being prescribed, correctly, safely and consistently before proceeding.
- Where an alternative approach is seen to be more suitable according to the indications/ contraindications of its guideline.

Hand Casting Guideline - HD C HDP 01

Guideline Statement

Hip disarticulation and hemipelvectomy sockets should be cast using a hand casting technique for any patient with a hip disarticulation or hemipelvectomy amputation, when some or all of the indications are observed, whilst ideally none of the contraindications are exhibited.

Definitions

- Hand casting – casting without the aid of any form of jig with blocks, or sling suspension.

Indications	Contradications
Patient with little soft tissue, whether muscular or skeletal in build	Soft tissue that requires supporting within the socket
Patient does not fit into the jig (e.g. child or large adult)	Limb system requires the use of a jig and wedges to achieve a specific hip angle
	Patient needs support during casting

Exceptions

- Those patients who are deemed medically unfit, unwilling, or because of their current lifestyle or circumstances, unsuitable for the provision of a prosthesis.
- Poor cognitive ability and compromised hand function may, in some cases, be contraindications for prosthetic rehabilitation. The MDT must assess whether the patient has the level of ability required with or without a carer, to use the prosthesis being prescribed, correctly, safely and consistently before proceeding.
- Where an alternative approach is seen to be more suitable according to the indications/ contraindications of its guideline.

Hip disarticulation and hemipelvectomy jig with wedges

Casting Guideline - HD C HDP 02

Guideline Statement

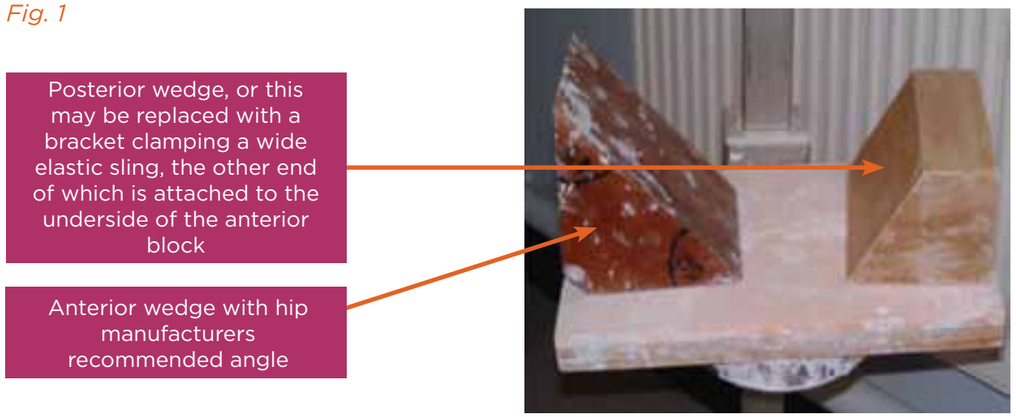
Hip disarticulation and hemipelvectomy sockets should be cast using a jig with wedges for any patient with a hip disarticulation or hemipelvectomy amputation, when some or all of the indications are observed, whilst ideally none of the contraindications are exhibited.

Definitions

- Jig with wedges – a weight-bearing platform on which the patient sits, that allows the positioning of anterior and/or posterior angled blocks, the anterior block being at the angle recommended by the hip joint manufacturer (Fig. 1). Sometimes the posterior wedge may be replaced with a wide elastic sling section.

Indications	Contradications
Need to position hip joint, (component supplier recommendation)[1]	Soft or excessive abdominal tissue[1]
Patients with good muscle tone[1]	
Need to provide relief for ischial tuberosity	
Less effort when walking[7]	

Fig. 1



Exceptions

- Those patients who are deemed medically unfit, unwilling, or because of their current lifestyle or circumstances, unsuitable for the provision of a prosthesis.
- Poor cognitive ability and compromised hand function may, in some cases, be contraindications for prosthetic rehabilitation. The MDT must assess whether the patient has the level of ability required with or without a carer, to use the prosthesis being prescribed, correctly, safely and consistently before proceeding.
- Where an alternative approach is seen to be more suitable according to the indications/ contraindications of its guideline.

Hip disarticulation and hemipelvectomy suspension

Casting Guideline - HD C HDP 03

Guideline Statement

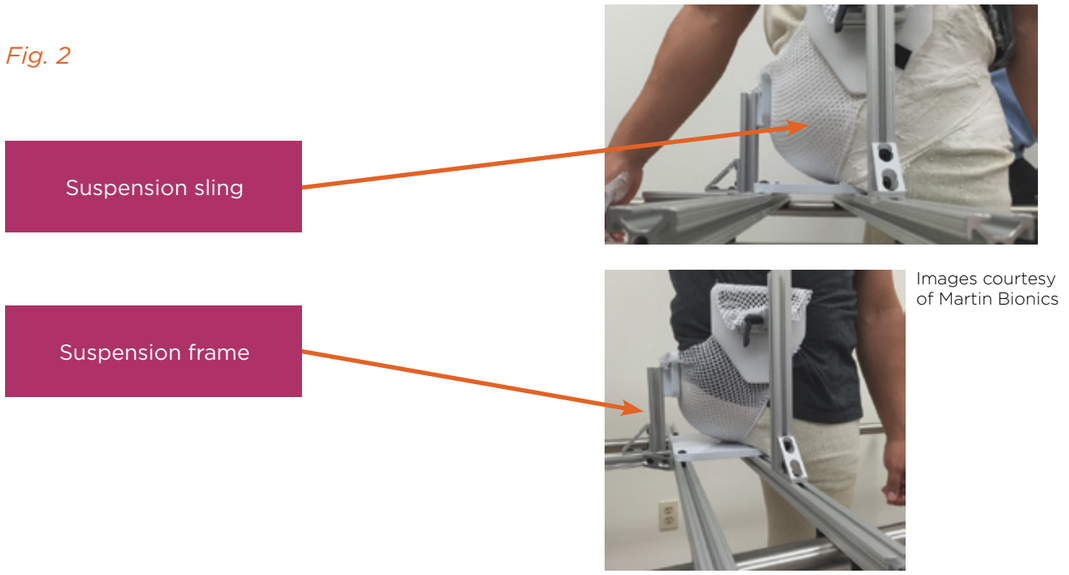
A suspension casting technique should be used for any patient with a hip disarticulation or hemipelvectomy amputation, when some or all of the indications are observed, whilst ideally none of the contraindications are exhibited.

Definitions

- Suspension casting technique – a method of casting that supports the patient's residual limb in a sling, from a hoist or a frame (Fig. 2).

Indications	Contradications
Patient requires volumetric loading e.g. hemipelvectomy amputee[7,9]	Limb system requires hip joint position to be defined during casting[1]
Soft or excessive abdominal tissue[1,7]	

Fig. 2



Images courtesy of Martin Bionics

Exceptions

- Those patients who are deemed medically unfit, unwilling, or because of their current lifestyle or circumstances, unsuitable for the provision of a prosthesis.
- Poor cognitive ability and compromised hand function may, in some cases, be contraindications for prosthetic rehabilitation. The MDT must assess whether the patient has the level of ability required with or without a carer, to use the prosthesis being prescribed, correctly, safely and consistently before proceeding.
- Where an alternative approach is seen to be more suitable according to the indications/ contraindications of its guideline.

References - Hip disarticulation and hemipelvectomy prescription and casting guidelines

1. STARK G, (2001). Overview of Hip Disarticulation Prostheses. *JPO*, Vol. 13(2), p50.

2. VITALI M, ROBINSON K P, ANDREWS B G, HARRIS E E, REDHEAD R G, (1986). Hindquarter Amputations and Prostheses. *Amputations and Prostheses*, 2nd ed., p179-190.

3. SABOLICH J, GUTH T, (1988). The CAT-CAM-H.D. *A New Design for Hip Disarticulation Patients, Clinical Prosthetics and Orthotics*, Vol. 12(3), p119-122.

4. LITTIG D H, LUNDT J E, (1988). The UCLA Anatomical Hip Disarticulation Prosthesis. *Clinical Prosthetics and Orthotics*, Vol. 12(3), p114-118.

5. TAYLOR S, (2004). A Casting Technique For An Ischial Containment Socket For A Hip Disarticulation Amputee Using The Otto Bock Casting Jig. *BAPO Mag*, Spring ed., p18-20.

6. VAN DE WAARDE T, (1984). Ottawa Experience with Hip Disarticulation Prosthesis. *Orthotics and Prosthetics*, Vol. 38(1), p29-35.

7. VAN DE WAARDE T, MICHAEL J W, (1992). Hip Disarticulation and Hemipelvectomy Prosthetic Management. *Atlas of Limb Prosthetics,* 2nd ed., p539-552.

8. MADDEN M, (1986). The Flexible Socket System as Applied to the Hip Disarticulation Amputee. *Orthotics and Prosthetics*, Vol. 39(4), p44-47.

9. HAMPTON F, (1964). A Hemipelvectomy Prosthesis. *Artificial Limbs*, Vol. 8(1), p3-27.

Hardware Guidelines

Feet

Prescription Guideline Title	Ref Number
Solid Ankle Cushion Heel Feet (SACH)	HW P FEE 01
Uniaxial feet	HW P FEE 02
Multiaxial feet	HW P FEE 03
Energy storing feet	HW P FEE 04
Patient adjustable feet	HW P FEE 05

Knees

Prescription Guideline Title	Ref Number
Monocentric knees	HW P KNE 01
Polycentric knees	HW P KNE 02
Semi-Automatic Knee Locks (SAKL)	HW P KNE 03
Hand Operated Knee Locks (HOKL)	HW P KNE 04
Weight-activated stance control units	HW P KNE 05
Mechanical constant friction units	HW P KNE 06
Extension bias assist deviced	HW P KNE 07
Pneumatic swing control units	HW P KNE 08
Hydraulic swing control units	HW P KNE 09
Hydraulic swing and stance control units	HW P KNE 10
Microprocessor control units	HW P KNE 11

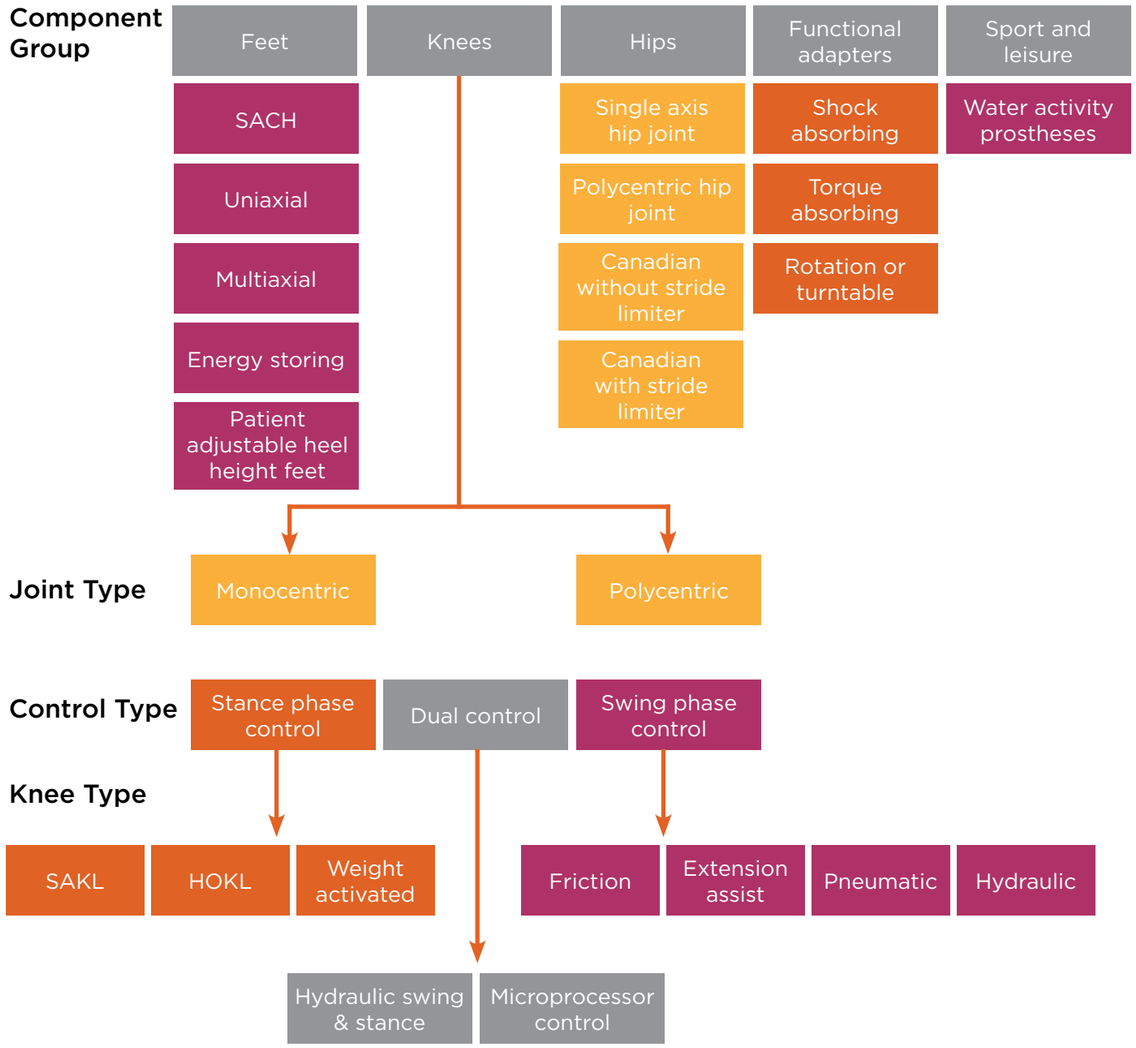
Functional Adapters

Prescription Guideline Title	Ref Number
Shock absorber	HW P ADA 01
Torque absorber	HW P ADA 02
Rotation or turntable adapter	HW P ADA 03

Sport and Leisure

Prescription Guideline Title	Ref Number
Water activity prosthesis	HW PWAP 01

Generic Prosthetic Hardware



In the overview for generic prosthetic hardware there are just five categories of feet listed. In order to accommodate the variety of prosthetic feet currently available in each category, it has been necessary to apply fairly broad definitions to them. What follows is an attempt to define each of those categories as well as possible and to leave you to consider for yourself which category a particular product may best fit into. Many feet boast several features and, as a result, are appropriate to more than one category, but the illustrated examples are clearly appropriate to the category. They have been selected for that reason alone and are not being promoted by these guidelines above any other product.

SACH

Solid Ankle Cushion Heel feet have been in existence for some considerable time and their full name almost defines them, though most are often abbreviated to the word SACH.

The term ‘Solid Ankle’ simply means that there is no movement in any plane at the ankle itself, hence any function of the foot is contained within the structure of the foot, as it is designed to allow progression from heel strike to toe off.

The most obvious of these is the ‘Cushion Heel’ which absorbs the forces at heel strike by deformation of the material from which the heel is made. Some feet have an adjustment screw in the heel which has the effect of making the heel cushion firmer or softer.

The material of the forefoot is generally reinforced internally to provide sufficient support to progress the patient from mid-stance towards toe off, with a toe break of softer material at the end of the internal reinforcement that allows smooth progression to the toe off itself.

In some cases the material from which the reinforcement is made is such as to provide some energy retention and the term ‘Dynamic Sach’ is used to describe them. Due to their simple construction SACH feet are fairly lightweight, robust and inexpensive.

Uniaxial

The principle of the uniaxial foot predates the SACH foot by many years. Originally they were made of wood with a single pivot at the ankle, allowing dorsiflexion and plantar flexion controlled by a rubber heel and forefoot bumpers, with a toe break containing another rubber bumper. By adjusting the size or firmness of the bumpers the characteristics of the foot could be adjusted to suit the individual.

There are several modern versions of the uniaxial foot and all take advantage of this adjustability of function, with the benefit of better materials from which to produce the bumpers and pivot bearings.

These feet often incorporate other features such as a replaceable cosmetic foot shell, flexible pivot bushes which allow some inversion and eversion, a full length forefoot keel providing a measure of energy retention and return, and an adjustment at the heel strike bumper which allows a subtle increase or decrease in the firmness of the action.

The uniaxial foot provides the benefit of adjustability within a reasonably lightweight, simple and durable construction.

Multiaxial

As the name implies, these feet provide dorsiflexion, plantar flexion, inversion and eversion. The aim of this is to provide a foot action which is compliant enough to accommodate uneven surfaces, whilst still providing the support and control required. In the simplest examples this is provided by an ankle unit with two rubber components which can be exchanged for softer or firmer options, dependant on the needs of the individual.

The product illustrated incorporates a replaceable foot shell and a full length, two-part forefoot keel, assisting inversion and eversion of the forefoot on uneven terrain. Also there are three different bumpers and two sets of pivot bushes, all of which can be changed to accommodate the needs of the user.

Energy storing

Feet of this type are normally produced from a carbon fibre composite, since it is a material which can return over 90% of the energy absorbed[1] by bending it and is also a very light material.

This type of foot was originally highly priced and aimed at the needs of the high-activity patient. Often under pressure from the users themselves, many early versions of these feet were over prescribed, being fitted to inappropriate patients, or with the spring strength set too high.

Even when correctly prescribed these products were not always very forgiving on uneven ground. However, over the years new designs have been introduced which aim to meet the needs of the less active individuals, and also to provide better compliance on uneven surfaces, without reducing the effectiveness of the energy retention and return.

As a consequence there are now a large number of options available, aimed at meeting the needs of patients over a wide range of activity levels, with prices becoming increasingly more competitive.

Patient adjustable

The ability for patients to adjust their prosthetic feet has been in demand, with the most popular being adjustable heel height.

Modern styles of footwear for men and women have produced the problem that changing footwear creates a change of prosthetic alignment, which at best may be a little uncomfortable and at worse, unwearable or dangerous.

Very few of the devices tried have been ideal and durability has often been an issue. The actual function of the foot is sometimes compromised by extreme changes in heel height and the function of both the adjustment and the feet themselves is sometimes a compromise.

More recent attempts have been better and new products, from patient adjustable ankles for use on a variety of feet, to new feet with better compliance and energy retention, and even units with electronically-controlled systems of adjustment seem to be appearing more regularly.

Prescription Guideline - HW P FEE 01

Guideline Statement

A SACH foot should be prescribed for any patient with a lower limb amputation, when some or all of the indications are observed, whilst ideally none of the contraindications are exhibited.

Definitions

- SACH foot – see overview.
- Lower limb amputation – ankle disarticulation and higher levels of amputation, or where there is a congenital shortening allowing space for a prosthetic foot.

Indications	Contradications
Patients who would benefit from a low maintenance durable foot	Patients who require energy return (high activity patients)
Patients who are expected to be indoor walkers, SIGAM C or below[1]	Patients who require a greater range of movement at the ankle joint (e.g. walking on uneven terrain)[2]
For use with a water activity limb	Patients who want to walk at varying and fast speeds[2]
Patients who require a lightweight foot	Patients who cannot tolerate the decreased stride length of a SACH foot[2]
Patients who would benefit from shock absorption properties of the foot when walking at lower speeds[1]	Patients with a weak or compromised contralateral limb (a SACH foot results in greater transfer of weight to and increased stance time on the sound side)[2,3]

Exceptions

- Those patients who are deemed medically unfit, unwilling, or because of their current lifestyle or circumstances, unsuitable for the provision of a prosthesis.
- Poor cognitive ability and compromised hand function may, in some cases, be contraindications for prosthetic rehabilitation. The MDT must assess whether the patient has the level of ability required with or without a carer, to use the prosthesis being prescribed, correctly, safely and consistently before proceeding.
- Where an alternative approach is seen to be more suitable according to the indications/ contraindications of its guideline.

Prescription Guideline - HW P FEE 02

Guideline Statement

A uniaxial foot should be prescribed for any patient with a lower limb amputation, when some or all of the indications are observed, whilst ideally none of the contraindications are exhibited.

Definitions

- Uniaxial foot – see overview.
- Lower limb amputation – ankle disarticulation and higher levels of amputation, or where there is a congenital shortening allowing space for a prosthetic foot.

Indications	Contradications
Patients who require stability during stance (provided by the foot moving to plantargrade quickly)	High activity patients (SIGAM E–F)
Patients who would benefit from plantar or dorsiflexion resistance being set to their specific need	Patients who would find regular maintenance inconvenient
Patients requiring M-L stability at ankle during stance phase (e.g. hip disarticulation)	Where the space available is insufficient to allow the use of a foot with a uniaxial mechanism
	Patients who require the main characteristic of the foot to be its lightness[5]

Exceptions

- Those patients who are deemed medically unfit, unwilling, or because of their current lifestyle or circumstances, unsuitable for the provision of a prosthesis.
- Poor cognitive ability and compromised hand function may, in some cases, be contraindications for prosthetic rehabilitation. The MDT must assess whether the patient has the level of ability required with or without a carer, to use the prosthesis being prescribed, correctly, safely and consistently before proceeding.
- Where an alternative approach is seen to be more suitable according to the indications/ contraindications of its guideline.

Prescription Guideline - HW P FEE 03

Guideline Statement

A multiaxial foot should be prescribed for any patient with a lower limb amputation, when some or all of the indications are observed, whilst ideally none of the contraindications are exhibited.

Definitions

- Multiaxial foot – see overview.
- Lower limb amputation – ankle disarticulation and higher levels of amputation, or where there is a congenital shortening allowing space for a prosthetic foot.

Indications	Contradications
Patients who regularly walk on uneven terrain[1,4,5]	Patients who require no ankle movement for maximum return with an energy storing foot
Patients who participate in outdoor activities where multiaxial movement at the ankle is a benefit e.g. golf[4]	Patients who would find regular maintenance inconvenient
Patients with moderate to higher activity (SIGAM D-F)[1,4]	Patients who require the main characteristic of the foot to be its lightness
Patients who prefer the gait symmetry provided by the multiaxial movement[1,5]	High activity patients who require energy absorption and return at heel strike, as opposed to early plantar flexion
Patients who require stability during stance (provided by the foot moving to the plantigrade position quickly)	Where the space available is insufficient to allow the use of a foot with a multiaxial mechanism

Exceptions

- Those patients who are deemed medically unfit, unwilling, or because of their current lifestyle or circumstances, unsuitable for the provision of a prosthesis.
- Poor cognitive ability and compromised hand function may, in some cases, be contraindications for prosthetic rehabilitation. The MDT must assess whether the patient has the level of ability required with or without a carer, to use the prosthesis being prescribed, correctly, safely and consistently before proceeding.
- Where an alternative approach is seen to be more suitable according to the indications/ contraindications of its guideline.

Prescription Guideline - HW P FEE 04

Guideline Statement

An energy storing foot should be prescribed for any patient with a lower limb amputation, when some or all of the indications are observed, whilst ideally none of the contraindications are exhibited.

Definitions

- Energy storing foot – see overview. There are many different types of energy storing feet, each with different properties. This guideline is an overview of all the different types. Characteristics of each individual foot should be taken into account when prescribing.
- Lower limb amputation – ankle disarticulation and higher levels of amputation, or where there is a congenital shortening allowing space for a prosthetic foot.

Indications	Contradications
Patients with higher activity (SIGAM E and above)	Lower activity patients (SIGAM C and below)[9]
Patients who benefit from reduced energy expenditure on walking (more significant at higher walking speeds)[6]	Patients who cannot tolerate extra forces on residual limb generated by full length toe lever[9]
Patients who would benefit from shock absorption properties of the foot[3]	Patients who do not like cosmetic appearance of foot
Active patients with transfemoral amputations who would benefit from longer stride length and lower energy expenditure[2,7,8]	Patients who are only able to walk at slow walking speeds
Patients who benefit from durability of foot (reduced lifetime cost)	
Patients who benefit from stride length symmetry[6]	
Patients who regularly walk long distances	

Exceptions

- Those patients who are deemed medically unfit, unwilling, or because of their current lifestyle or circumstances, unsuitable for the provision of a prosthesis.
- Poor cognitive ability and compromised hand function may, in some cases, be contraindications for prosthetic rehabilitation. The MDT must assess whether the patient has the level of ability required with or without a carer, to use the prosthesis being prescribed, correctly, safely and consistently before proceeding.
- Where an alternative approach is seen to be more suitable according to the indications/ contraindications of its guideline.

Prescription Guideline - HW P FEE 05

Guideline Statement

A patient adjustable heel height foot should be prescribed for any patient with a lower limb amputation, when some or all of the indications are observed, whilst ideally none of the contraindications are exhibited.

Definitions

- Patient adjustable heel height foot – see overview.
- Lower limb amputation – ankle disarticulation and higher levels of amputation, or where there is a congenital shortening allowing space for a prosthetic foot.

Indications	Contradications
Patients who require the ability to adjust the alignment of the foot to accommodate different shoe heel heights	Patients who are unable to satisfactorily align the foot in a safe position for walking
Patients who regularly walk barefoot; the ability to adjust the foot avoids knee hyperextension or abnormal forefoot contact[10]	Patients who require a lightweight foot
Activities that require a different foot angle to walking (e.g. horse riding, skiing)	

Exceptions

- Those patients who are deemed medically unfit, unwilling, or because of their current lifestyle or circumstances, unsuitable for the provision of a prosthesis.
- Poor cognitive ability and compromised hand function may, in some cases, be contraindications for prosthetic rehabilitation. The MDT must assess whether the patient has the level of ability required with or without a carer, to use the prosthesis being prescribed, correctly, safely and consistently before proceeding.
- Where an alternative approach is seen to be more suitable according to the indications/ contraindications of its guideline.

References - Prosthetic feet prescription guidelines

1. HUANG, (2000). Gait analysis and energy consumption of below-knee amputees wearing three different prosthetic feet. *Gait and Posture,* Vol. 12, p162-168.

2. POWERS, et al., (1994). Influence of prosthetic foot design on sound limb loading in adults with unilateral below-knee amputations. *Arch Phys Med Rehabil*, Vol. 75, p825-829.

3. LEHMANN, et al., (1993). Comprehensive analysis of energy storing prosthetic feet: flex foot and seattle foot versus standard SACH foot. *Arch Phys Med Rehabil*, Vol. 74, p1225-1231.

4. ROMO, (1999). Specialised prostheses for activities. *Clinical orth and related research*, Vol. 361, p63-70.

5. MARINAKIS, (2004). Interlimb symmetry of traumatic unilateral trans-tibial amputees wearing two different prosthetic feet in the early rehabilitation stage. *JRRD*, Vol. 41(4), p581-590.

6. HSU. Physiological comparisons of physically active persons with trans-tibial amputation using static and dynamic prostheses versus persons with nonpathological gait during multiple speed walking. *JPO*, Vol. 12(2), p60-67.

7. MACFARLANE, et al., (1997). Mechanical Gait Analysis of Transfemoral Amputees: SACH foot versus the Flex-foot. *JPO*, Vol. 9(4), p144-151.

8. MACFARLANE, et al., (1997). Transfemoral amputee physiological requirements: comparisons between SACH foot walking and flex-foot walking. *JPO*, Vol. 9(4), p138- 143.

9. TORBURN, et al., (1995). Energy expenditure during ambulation in dysvascular and traumatic below knee amputees: A comparison of five prosthetic feet. *JRRD*, Vol. 32(2), p111-119.

10. HAN, et al., (2003). Gait patterns of trans-tibial amputee patients walking indoors barefoot. *Am J Phys Med Rehabil*, Vol. 82(2), p96-100.

Prosthetic knee joints overview

There are many different types of prosthetic knee joint available, but they can all be categorised by the way in which the joint can be flexed and extended. They are either monocentric, moving around a single axis, and/or polycentric, where there are several axes of movement.

These categories can then be subdivided into the various methods of controlling the knee, both in the stance phase (when the patient's weight is loaded through the knee), and the swing phase (when the knee is unloaded and free swinging). There are some knees which incorporate the control of both the stance and swing phase within one system, which we have categorised as dual control. These include the microprocessor controlled knee units.

Monocentric knee joints

A monocentric, or single axis knee, flexes and extends freely around a single pivot. At its simplest it is a low maintenance, lightweight knee, with stance phase stability achieved by positioning the knee unit with respect to the weight line and by means of the patient's own muscular control.

The knee is stable when the ground reaction force (GRF) - the line through which the patient's body weight appears to act at any given point in the stance phase - passes anterior to the knee centre. More complex single axis knee units have added stance phase and swing phase control.

Polycentric knee joints

A polycentric knee joint mimics the anatomical knee joint by having more than one axis. Most polycentric knee joints have four points of rotation connected by links or bars, and are also known as four-bar knees. The instantaneous centre of rotation (ICR) of the knee changes its position as the knee flexion angle increases or decreases, thus simulating the anatomic axis of motion more closely.

The instantaneous centre of rotation (ICR) of a polycentric knee is the point around which the knee appears to be bending at any given point in time, and is located at the intersection of a line defined by the anterior articulations and a line defined by the posterior articulations.[1]

The more anterior the ground reaction force is, with reference to the ICF, the greater the knee extension moment developed in early stance and the more stable the prosthesis becomes. As the stance phase progresses, the ICF moves anterior to the GRF and the resulting flexion moment makes knee flexion easier during late stance.[1]

As well as enhanced stance phase stability and easier flexion at late stance, the geometry of a polycentric knee causes the prosthetic shin to shorten as knee flexion increases and this enhances toe clearance at mid swing phase.[2]

Polycentric knees also benefit patients with a knee disarticulation or long transfemoral residual limbs, since they are constructed such that when flexed they are extremely compact, resulting in a more cosmetic appearance when sitting. Generally, they also have a large degree of flexion and these two things combine to allow a patient to kneel more easily.

Semi-automatic knee lock (SAKL)

This is a knee unit which incorporates a spring loaded locking device. This device automatically locks with a distinctive click when the knee is in full extension, thus preventing flexion in both the stance and swing phases of the gait. The patient can manually unlock the knee by operating a lever attached to the outside of the socket in order to sit down.

This knee mechanism provides maximum stability in stance. The semi-automatic knee lock design is usually lightweight, but the resulting locked knee gait compromises toe clearance in swing phase. Therefore the prosthesis is often made slightly shorter than the sound side limb to compensate for this.[3]

Manual or hand operated knee lock (HOKL)

Fitted to a free knee mechanism, this device allows the patient to lock the knee manually, giving them the option of walking with the knee locked or unlocked.

For example, the patient might use the free knee indoors, or on smooth surfaces, but use the knee locked on irregular or uneven ground. The free knee element of such units usually offers only simple swing and stance control.

Weight-activated braking

This method of achieving knee stability during stance phase involves a braking mechanism that is activated when weight is applied through the knee to prevent the knee unit from buckling. As load is applied to the prosthesis, friction in the brake increases such that the knee will lock when the patient's body weight is on the prosthesis, thereby preventing knee flexion. The degree of friction is adjustable to the body weight of the particular patient. The free knee element of the HOKL unit shown above is weight activated.

Geometric locking design

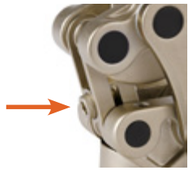
Some polycentric knees include a geometric locking design which engages at initial heel strike if the knee is fully extended and the ground reaction force is posterior to the knee centre.

This is not just the geometric stability that is normally associated with polycentric units, but is a positive change in the geometry which completely prevents knee flexion, until it disengages when the knee is in full extension and the vertical load through the foot falls anterior to the knee axis, just prior to toe off.

Mechanical constant friction

This is usually a very simple device that applies pressure against the knee pivot and provides some damping of the swing phase motion. The friction can be adjusted to enable the patient to walk reasonably well, but since it gives uniform resistance throughout the gait cycle, it will only allow one fixed cadence (walking speed). If the cadence increases, heel rise will become excessive and thus prolong the swing phase, but with increased terminal impact. Extension bias assist devices are commonly added to these units to limit heel rise (see next section).

The unit shown has a friction adjustment that simply pinches the bottom pivot and an internal extension assist spring.



Extension bias assist devices

Extension bias assist devices help advance the limb during early swing phase and limit heel rise. Two basic types of extension bias devices are used: internal and external. An internal unit is often a compression spring built into the knee mechanism, whilst the external device may be no more than an elastic pick up strap attached to the anterior section of the socket and to the shin.

Pneumatic knee units

As the name would suggest, pneumatic control cylinders use air to achieve the desired swing phase control characteristics. These characteristics are achieved by controlling the air movement in a cylinder from one side of a piston to the other through adjustable valves. When the knee flexes the piston is pushed down into the cylinder, compressing the air and creating a partial vacuum above it.

The pressure difference creates resistance to knee flexion, which is controlled by the rate of flow through the flexion valve. Knee extension is similarly controlled by the rate of air flow through the extension valve as the piston moves up the cylinder. Pneumatic knees are fairly cadence responsive, but because air is compressible, they can be overpowered by more active users. They tend to be lighter and less expensive in comparison with hydraulic units.

Hydraulic knee unit

Hydraulic knee units function in a similar way to pneumatic ones, but use a fluid instead of air. When the knee flexes a rod moves a piston down the cylinder and forces hydraulic fluid through an adjustable flexion valve from below the piston, into the cylinder above the piston.

The reverse applies as the piston moves upwards during extension, forcing the fluid through the extension valve. The degree of resistance can be controlled by adjusting the flexion and extension valves and is dependent on the rate of movement of the piston, the resistance increasing with increased speed of walking and decreasing as the walking speed slows. Therefore hydraulic fluid control tends to be more responsive to changes in walking speed than pneumatic control, but may be more susceptible to significant changes in temperature.

Dual control knees

Hydraulic swing and stance control

These knee units provide both stance and swing phase control from one hydraulic cylinder. This incorporates a stance control piston on one end of the piston rod and swing phase control unit at the other end of the piston rod, such that the piston rod is dual purpose.

Image courtesy of Össur

The swing control piston forces fluid through the upper passages and valves of the cylinder, to function in a similar way to the hydraulic knee control in swing phase. The lower stance control piston operates in the lower chamber of the cylinder. Fluid in the lower chamber can only flow through the stance control piston valve, which closes to a preset position at heel strike, reducing the rate of flow and preventing sudden flexion of the knee. This gradually yielding stance resistance is designed to assist in walking down slopes and descending stairs leg over leg. The patient also has the option to shut the stance yield altogether, in order to prevent flexion, or remove both stance and swing resistance for selected activities. Hans Mauch developed the first clinically effective stance and swing control hydraulic knee in the 1950s.[1]

Microprocessor control knee unit

The microprocessor control knee is a more recent development that uses built-in electronic sensors to collect real-time data and thereby, control stance and swing phase. The Endolite Intelligent Knee was one of the first microprocessor controlled pneumatic knee units. This uses a single built-in sensor to detect when the knee was in full extension and adjusts a pneumatic swing control cylinder accordingly.[1] In use, a built-in computer chip adjusts the pneumatic resistance of the cylinder, optimising the swing phase characteristics to allow a broad range of gait speeds from very slow to very fast.[1]

The prosthetist is able to specify several different optimal adjustments during dynamic alignment that the computer chip later selects and applies according to the pace of ambulation the user chooses.[1] A more advanced type of computer-controlled prosthetic knee and shin system is the C-leg from Ottobock. It incorporates an on-board microprocessor, hydraulics, pneumatics, and servo motors.[3] A microprocessor controls the single axis knee with hydraulic stance and swing phase control as well as the automatic servo adjustment of the hydraulic resistance valves. This design is unique in that it uses multiple sensors that are integrated into the prosthetic shin structure to gather and calculate biomechanical data such as the amount of vertical loading, the sagittal plane ankle moment, and the position, direction, and angular acceleration of the knee joint.[1]

This data is sampled 50 times per second, allowing the computer to readjust the knee accordingly.[1,3] Electronic sensors in the C-leg collect real time data, which is then sent to the hydraulic damper to control stance and swing phase movements.[4] On the negative side, microprocessor controlled knee units are expensive, add weight and require regular charging and maintenance.

Endolite Orion 3 Knee

Image courtesy of Blatchfords

Ottobock C-leg

Image courtesy of Ottobock

Ossur RHEO 3 Knee

Image courtesy of Össur

Freedom Plié® 3

References - Prosthetic knee joints overview

1. MICHAEL J, (1999). Modern Prosthetic knee mechanisms. *Clinical Orthopaedic and related research*, Vol. 361, p39-47.

2. HUANG M, LEVY C, WEBSTER J, (2001). Acquired limb deficiencies.3. Prosthetic components, Prescription, and indications. *Arch phys med rehabil*, Vol. 82, p17-24.

3. LUCARDI M, NIELSON C, (2000). Orthotics and Prosthetics in rehabilitation. *Transfemoral Prosthetics*, p495-498.

4. Transfemoral prosthetics (Above-knee prosthetics), National Centre for training and education in prosthetics and orthotics, knee mechanisms, p9-29.

Prescription Guideline - HW P KNE 01

Guideline Statement

A monocentric knee unit should be prescribed for any patient requiring a prosthetic knee joint when some or all of the indications are observed, whilst ideally none of the contraindications are exhibited.

Definitions

- Monocentric knee unit – see overview.
- Lower limb amputation – transfemoral and higher levels of amputation, or where there is a congenital shortening allowing space for a prosthetic knee.

Indications	Contradications
Patients who would benefit from a light-weight knee (will depend on the swing or stance controls)[1]	Patients with long residual limbs
Small/petite adults or children who require small and lightweight knee (will depend on the swing or stance controls)[2]	Patients who have difficulty in clearing ground in swing phase

Exceptions

- Those patients who are deemed medically unfit, unwilling, or because of their current lifestyle or circumstances, unsuitable for the provision of a prosthesis.
- Poor cognitive ability and compromised hand function may, in some cases, be contraindications for prosthetic rehabilitation. The MDT must assess whether the patient has the level of ability required with or without a carer, to use the prosthesis being prescribed correctly, safely and consistently before proceeding.
- Where an alternative approach is seen to be more suitable according to the indications/ contraindications of its guideline.

Prescription Guideline - HW P KNE 02

Guideline Statement

A polycentric knee unit should be prescribed for any patient requiring a prosthetic knee joint when some or all of the indications are observed, whilst ideally none of the contraindications are exhibited.

Definitions

- Polycentric knee unit – see overview.
- Lower limb amputation – transfemoral and higher levels of amputation, or where there is a congenital shortening allowing space for a prosthetic knee.

Indications	Contradications
Patients who prefer cosmetic appearance of low profile knee when sitting (knee disarticulation, long transfemoral)[1,2,3]	Patients who require knee stability when knee is not in full extension
Patients who would benefit from stance stability of geometric locking design[1,2,3]	Patients who cannot initiate or control knee flexion in late stance
Patients who require limb shortening to aid toe clearance at mid swing[1,2,4]	Patients with poor control of limb during gait affecting ability to stabilise knee
Patients who would benefit from initiation of knee flexion during late stance[1,2]	
Patients who prefer the more anatomically correct gait of a polycentric knee	
Patients who require durability and reliability (stability minimally affected by wear on knee)	

Exceptions

- Those patients who are deemed medically unfit, unwilling, or because of their current lifestyle or circumstances, unsuitable for the provision of a prosthesis.
- Poor cognitive ability and compromised hand function may, in some cases, be contraindications for prosthetic rehabilitation. The MDT must assess whether the patient has the level of ability required with or without a carer, to use the prosthesis being prescribed correctly, safely and consistently before proceeding.
- Where an alternative approach is seen to be more suitable according to the indications/ contraindications of its guideline.

Semi-Automatic Knee Locks (SAKL)

Prescription Guideline - HW P KNE 03

Guideline Statement

Semi-automatic knee locks should be prescribed for any patient requiring a prosthetic knee joint when some or all of the indications are observed, whilst ideally none of the contraindications are exhibited.

Definitions

- Semi-Automatic Knee Lock (SAKL) - a type of prosthetic knee joint that automatically locks on extension of the knee and must be manually unlocked by the patient.

Indications	Contradications
Patients with poor stability (safety issue)	Patients who are unable to reliably lock/unlock the knee e.g. cognitive impairment
Patients with weak musculature on amputated side[2]	
Patients who have low predicted mobility [5,6]	
Patients with weak musculature on contralateral side	
Patient preference[6]	
Older (geriatric) patients, as it enables a higher walking velocity with lower effort [5]	
Patients with low patient confidence	
Patients with large hip flexion contracture >30 degrees	
Patients where a lightweight prosthesis is required	

Note: Whilst consensus was not reached, concern regarding the ability of the patient to operate the thigh release if their hand function is poor was expressed and needs to be taken into consideration.

Exceptions

- Those patients who are deemed medically unfit, unwilling, or because of their current lifestyle or circumstances, unsuitable for the provision of a prosthesis.
- Poor cognitive ability and compromised hand function may, in some cases, be contraindications for prosthetic rehabilitation. The MDT must assess whether the patient has the level of ability required with or without a carer, to use the prosthesis being prescribed correctly, safely and consistently before proceeding.
- Where an alternative approach is seen to be more suitable according to the indications/ contraindications of its guideline.

Hand Operated Knee Locks (HOKL)

Prescription Guideline - HW P KNE 04

Guideline Statement

Hand operated knee locks should be prescribed for any patient requiring a prosthetic knee joint when some or all of the indications are observed, whilst ideally none of the contraindications are exhibited.

Definitions

- Hand Operated Knee Lock (HOKL) - any prosthetic knee joint that has the option of being a locked knee or a free knee through manual operation by the patient.

Indications	Contradications
Patients requiring the option of maximum stability on occasions e.g. uneven ground, changing medical condition[2]	Patients with low cognitive ability who are unable to determine when it is appropriate to lock and unlock the knee safely
Geriatric patients who may occasionally require to use a locked knee to reduce effort[5] or increase walking speed[5,6]	Patients who are unable to reliably operate a HOKL for example patients with short term memory loss
Patients in the early stages of rehab where predicted final mobility level exceeds current ability, for example free knee use is predicted, but not initially achievable due to other complications	Patients above SIGAM E since they should benefit from swing phase control not available in knees with a HOKL
Patient preference	Poor muscle control

Note: Whilst consensus was not reached, concern regarding the ability of the patient to operate the thigh release if their hand function is poor was expressed and needs to be taken into consideration.

Exceptions

- Those patients who are deemed medically unfit, unwilling, or because of their current lifestyle or circumstances, unsuitable for the provision of a prosthesis.
- Poor cognitive ability and compromised hand function may, in some cases, be contraindications for prosthetic rehabilitation. The MDT must assess whether the patient has the level of ability required with or without a carer, to use the prosthesis being prescribed correctly, safely and consistently before proceeding.
- Where an alternative approach is seen to be more suitable according to the indications/ contraindications of its guideline.

Weight-activated stance units

Prescription Guideline - HW P KNE 05

Guideline Statement

A weight-activated braking stance control unit should be prescribed for any patient requiring a prosthetic knee joint when some or all of the indications are observed, whilst ideally none of the contraindications are exhibited.

Definitions

- Weight-activated braking stance control unit – see overview.
- Lower limb amputation – transfemoral and higher levels of amputation, or where there is a congenital shortening allowing space for a prosthetic knee.

Indications	Contradications
Patients who are capable of walking with free knee but require enhanced stability[1,2]	Patients who require initiation of flexion in late stance [2]
Patients who prefer the reassurance of stance phase stability	More active patients* (SIGAM E-F)[2]
Patients with weak hip musculature	Patients who would find regular attendance for maintenance inconvenient
Patients with medium activity level (SIGAM D–E)	
Patients with a short residual limb	

*This will often depend on patient preference.

Exceptions

- Those patients who are deemed medically unfit, unwilling, or because of their current lifestyle or circumstances, unsuitable for the provision of a prosthesis.
- Poor cognitive ability and compromised hand function may, in some cases, be contraindications for prosthetic rehabilitation. The MDT must assess whether the patient has the level of ability required with or without a carer, to use the prosthesis being prescribed correctly, safely and consistently before proceeding.
- Where an alternative approach is seen to be more suitable according to the indications/ contraindications of its guideline

Mechanical constant friction units

Prescription Guideline - HW P KNE 06

Guideline Statement

A mechanical constant friction swing-control unit should be prescribed for any patient requiring a prosthetic knee joint when some or all of the indications are observed, whilst ideally none of the contraindications are exhibited.

Definitions

- Mechanical constant friction knee unit – see overview.
- Lower limb amputation – transfemoral and higher levels of amputation, or where there is a congenital shortening allowing space for a prosthetic knee.

Indications	Contradications
Low to moderate activity level (SIGAM B-E)	Patients who require cadence responsiveness [1,2,7]
Patients who require a lightweight knee[1]	Patient who is unable to control prosthetic knee stability[1]
Patients who require a durable knee[1]	Patients who do not like the terminal impact of knee (certain knee types)
Patients requiring the ability to self adjust swing of knee (only certain knee types)	

Exceptions

- Those patients who are deemed medically unfit, unwilling, or because of their current lifestyle or circumstances, unsuitable for the provision of a prosthesis.
- Poor cognitive ability and compromised hand function may, in some cases, be contraindications for prosthetic rehabilitation. The MDT must assess whether the patient has the level of ability required with or without a carer, to use the prosthesis being prescribed correctly, safely and consistently before proceeding.
- Where an alternative approach is seen to be more suitable according to the indications/ contraindications of its guideline.

Extension bias assist devices

Prescription Guideline - HW P KNE 07

Guideline Statement

Extension bias assist devices should be prescribed for any patient requiring a prosthetic knee joint when some or all of the indications are observed, whilst ideally none of the contraindications are exhibited.

Definitions

- An extension bias assist device – see overview.
- Lower limb amputation – transfemoral and higher levels of amputation, or where there is a congenital shortening allowing space for a prosthetic knee.

Indications	Contradications
Patients who prefer sense of stability gained from strong extension (terminal impact)	Patients with high activity level (SIGAM E and above)
Patients with short residual limbs or weak hip flexors	Patients who require variable cadences*
Patients who require a low maintenance and durable knee	

*Where the extension assist is the sole or main swing phase control.

Exceptions

- Those patients who are deemed medically unfit, unwilling, or because of their current lifestyle or circumstances, unsuitable for the provision of a prosthesis.
- Poor cognitive ability and compromised hand function may, in some cases, be contraindications for prosthetic rehabilitation. The MDT must assess whether the patient has the level of ability required with or without a carer, to use the prosthesis being prescribed correctly, safely and consistently before proceeding.
- Where an alternative approach is seen to be more suitable according to the indications/ contraindications of its guideline.

Pneumatic swing control units

Prescription Guideline - HW P KNE 08

Guideline Statement

A pneumatic swing phase control unit should be prescribed for any patient requiring a prosthetic knee joint when some or all of the indications are observed, whilst ideally none of the contraindications are exhibited.

Definitions

- Pneumatic swing control unit – see overview.
- Lower limb amputation – transfemoral and higher levels of amputation, or where there is a congenital shortening allowing space for a prosthetic knee.

Indications	Contradications
Patients who benefit from preset cadence of knee*[1]	Patients who overpower the knee unit[1,2]
Slow to moderate cadence walkers*[2]	
Patients who need lighter knee than hydraulic*[1]	
Patients who are exposed to extremes of temperature in their work or leisure	

*These are general guidelines that may not apply to all knees in this category.

Exceptions

- Those patients who are deemed medically unfit, unwilling, or because of their current lifestyle or circumstances, unsuitable for the provision of a prosthesis.
- Poor cognitive ability and compromised hand function may, in some cases, be contraindications for prosthetic rehabilitation. The MDT must assess whether the patient has the level of ability required with or without a carer, to use the prosthesis being prescribed correctly, safely and consistently before proceeding.
- Where an alternative approach is seen to be more suitable according to the indications/ contraindications of its guideline.

Hydraulic swing control units

Prescription Guideline - HW P KNE 09

Guideline Statement

Hydraulic swing control units should be prescribed for any patient requiring a prosthetic knee joint when some or all of the indications are observed, whilst ideally none of the contraindications are exhibited.

Definitions

- A hydraulic swing control unit – see overview.
- Lower limb amputation – transfemoral and higher levels of amputation, or where there is a congenital shortening allowing space for a prosthetic knee.

Indications	Contradications
More vigorous walker[1,2]	Patients who require a lightweight knee[1,2]
Patients who walk at rapid or varied cadences[1,2]	Patients who are exposed to extremes of temperature in their work or leisure[2]
Patients who would benefit from smooth swing phase[2]	
Patients who wish to run	

Exceptions

- Those patients who are deemed medically unfit, unwilling, or because of their current lifestyle or circumstances, unsuitable for the provision of a prosthesis.
- Poor cognitive ability and compromised hand function may, in some cases, be contraindications for prosthetic rehabilitation. The MDT must assess whether the patient has the level of ability required with or without a carer, to use the prosthesis being prescribed correctly, safely and consistently before proceeding.
- Where an alternative approach is seen to be more suitable according to the indications/ contraindications of its guideline.

Hydraulic swing and stance control units

Prescription Guideline - HW P KNE 10

Guideline Statement

Hydraulic swing and stance control units should be prescribed for any patient requiring a prosthetic knee joint when some or all of the indications are observed, whilst ideally none of the contraindications are exhibited.

Definitions

- A hydraulic swing and stance control unit – see overview.
- Lower limb amputation – transfemoral and higher levels of amputation, or where there is a congenital shortening allowing space for a prosthetic knee.

Indications	Contradications
Patients who benefit from yield function (e.g. going down stairs/slopes)[2]	Patients who require a lightweight knee[1,2,8]
Active amputees (SIGAM E-F)[1,2]	Patients who are exposed to extremes of temperature in their work or leisure[2]
Patients who would benefit from switching off stance control for some activities (e.g. cycling)	Patients who need a low profile build option to maintain a good cosmetic appearance
Patients with bilateral limb loss that would benefit from yield for moving from standing to sitting[2]	
Patients who require variable cadence[1]	
Patients who participate in sports and outdoor activities[2]	
Patients who require stance stability offered by the yield function[2]	
Patients who would benefit from ability to lock knee for some activities[2]	

Exceptions

- Those patients who are deemed medically unfit, unwilling, or because of their current lifestyle or circumstances, unsuitable for the provision of a prosthesis.
- Poor cognitive ability and compromised hand function may, in some cases, be contraindications for prosthetic rehabilitation. The MDT must assess whether the patient has the level of ability required with or without a carer, to use the prosthesis being prescribed correctly, safely and consistently before proceeding.
- Where an alternative approach is seen to be more suitable according to the indications/ contraindications of its guideline.

Microprocessor control knee units

Prescription Guideline - HW P KNE 11

Guideline Statement

A microprocessor control knee unit should be prescribed for any patient requiring a prosthetic knee joint when some or all of the indications are observed, whilst ideally none of the contraindications are exhibited.

Definitions

- Microprocessor control knee unit – see overview.
- Lower limb amputation – transfemoral and higher levels of amputation, or where there is a congenital shortening allowing space for a prosthetic knee.

Indications	Contradications
Patients who walk at rapid and varied cadences[9,10]	Patients who may be exposed to water**
Patients who would benefit from good gait symmetry at various cadences[1,2,9,11,12,13,14,15]	Patients who usually walk at one speed[9,11,12]
Patients who would benefit from reduced energy consumption in walking[1,2,12,14]	Inability to regularly charge batteries
Patients who would benefit from stumble recovery[16]	Patients who require a lightweight prostheses
Patients who would benefit from enhanced stability on uneven ground[2,10,11,13,15,17]	Patients who may be exposed to high magnetic fields
Patients who prefer confidence of extra stability[2,16]	Patients who would find regular maintenance inconvenient
Bilateral amputee who is capable of walking[18]	Patients with limited mobility[11] (SIGAM grades A-C)
Patients who regularly walk in more demanding environments (hills, slopes, stairs)[10,14,17]	
High-activity patients (SIGAM grades E-F)*[11]	

*This is the recommended range, however individual patient goals must be considered, for example patients who wish to run would not necessarily benefit from microprocessor control.
** Water resistant MPK's now available.

Exceptions

- Those patients who are deemed medically unfit, unwilling, or because of their current lifestyle or circumstances, unsuitable for the provision of a prosthesis.
- Poor cognitive ability and compromised hand function may, in some cases, be contraindications for prosthetic rehabilitation. The MDT must assess whether the patient has the level of ability required with or without a carer, to use the prosthesis being prescribed correctly, safely and consistently before proceeding.
- Where an alternative approach is seen to be more suitable according to the indications/ contraindications of its guideline.

References - Prosthetic knee prescription guidelines

1. HUANG M E, et al., (2001). Acquired Limb Deficiencies. 3. Prosthetic Components, Prescriptions, and Indications. *Arch Phys Med Rehabil*. Vol. 82(1), p17-24.

2. MICHAEL J W, (1999). Modern Prosthetic Knee Mechanisms. *Clin Orth and Rel Res,* Vol. 361, p39-47.

3. VRIES J.de, (1995). Conventional 4-bar linkage knee mechanisms: A strength-weakness analysis. *J Rehabil Res Dev,* Vol. 32(1), p36-42.

4. SAPIN E, et al., (2008). Functional gait analysis of transfemoral amputees using two different single axis prosthetic knees with hydraulic swingphase control: Kinematic and kinetic comparison of two prosthetic knees. *Prosthet Orthot Int*, Vol 32(2), p201-218.

5. ISAKOV E, SUSAK Z, BECKER E, (1985). Energy Expenditure and Cardiac Response in Above Knee Amputees While Using Prostheses with open and Locked Knee Mechanisms. *Scand J Rehab Med*, Vol. 12(3), p365–374.

6. DEVLIN, et al., (2002). Patient preference and Gait Efficiency in a Geriatric Population with Transfemoral Amputation using a Free Swinging versus a Locked Prosthetic Knee Joint. *Arch Phys Med Rehabil*, Vol. 83, p246-249.

7. BOONSTRA A M, et al., (1996). Gait Analysis of Transfemoral Amputee Patients using Prostheses with Two Different Knee joints. *Arch Phys Med Rehabil.* Vol. 77, p515-520.

8. WHITESIDES T E, et al., (1985). Mauch S.N.S. Hydraulic Knee Units in Above-knee Amputees A Long-term Follow-up Study. *Clin Orth and Rel Res*, Vol. 194, p264-268.

9. SEGAL A D, et al., (2006). Kinematic and kinetic comparisons of transfemoral amputee gait using C-leg and Mauch SNS prosthetic knees. *J Rehabil Res Dev*, Vol. 43(7), p857-870.

10. KAHLE J T, et al., (2008). Comparison of nonmicroprocessor knee mechanism versus C-Leg on Prosthesis Evaluation Questionnaire, stumbles, falls, walking tests, stair descent, and knee preference. *J Rehabil Res Dev*, Vol. 45(1), p1-14.

11. KAUFMAN K R, et al., (2007). Gait and balance of transfemoral amputees using passive mechanical and microprocessor controlled prosthetic knees. *Gait & Posture*, Vol. 26, p489-493.

12. JOHANSSON J L, et al., (2005). A Clinical Comparison of Variable Damping and Mechanically Passive Prosthetic Knee Devices. *Am J Phys Med Rehabil*, Vol. 84(8), p1-13.

13. SEYMORE R, et al., (2007). Comparison between the C-leg® microprocessor-controlled prosthetic knee and nonmicroprocessor control prosthetic knees: A preliminary study of energy expenditure, obstacle course performance, and quality of life survey. *Prosthet Orthot Int*, Vol 31(1), p51-61.

14. DATTA D, HOWITT J, (1998). Conventional versus microchip controlled pneumatic swing phase control for transfemoral amputees: User's verdict. *Prosthet Orthot Int*, Vol. 22(2), p129-135.

15. KAUFMAN K R, et al., (2008). Energy Expenditure and Activity of Transfemoral Amputees Using Mechanical and Microprocessor-Controlled Prosthetic Knees. *Arch Phys Med Rehabil*, Vol. 89, p1380-1385.

16. HAFNER B J, et al., (2007). Evaluation of Function, Performance, and Preference as Transfemoral Amputees Transition From Mechanical to Microprocessor Control of the Prosthetic Knee. *Arch Phys Med Rehabil*. Vol, 88, p207-217.

17. ORENDURFF M S, et al., (2006). Gait efficiency using the C-Leg. *J Rehabil Res Dev*, Vol 43(2), p239-246.

18. PERRY J, et al., (2004). Energy Expenditure and Gait Characteristics of a Bilateral Amputee Walking with C-Leg Prostheses Compared With Stubby and Conventional Articulating Prostheses. *Arch Phys Med Rehabil*, Vol. 85, p1711-1717.

There are three main types of functional adapter that can be used when producing a prosthesis:

Shock absorber

As well as allowing torsional rotation, these units are intended to provide shock absorption at heel strike, by means of a sprung telescopic element. The rotational force of the spring and the force required to compress the unit can generally be adjusted independently in many designs, by swapping the compression spring or rotational rubbers.

The unit illustrated can be set up with different lateral and medial rotational forces. This may, for example, allow a greater lateral rotation force to be chosen to prevent excessive rotation at toe off, but provide a lesser rotational resistance appropriate to the patient's golf swing.

Most available units combine both shock and torque absorbers, such as the Fillauer Durashock

Image courtesy of Fillauer

Torque absorbers

Torque absorbers are generally designed to take the place of a standard tube clamp adapter and allow rotation in both directions against a resistance, which will return the unit to the neutral position once the rotational force is removed.

The force exerted by the resistance is sometimes adjustable. They may be installed to reduce the effects of rotational forces on the residual limb or on other components in the build, or to allow the rotation required for a specific activity, such as golf. To this end they are sometimes included as an integral part of a prosthetic foot.

Rotation/turntable adapter

A rotation adapter or turntables are designed to allow the patient to rotate one element of their prosthesis against another. By depressing the button on the side of the unit, rotation can be achieved, but the unit automatically locks again when rotated back to the original position. Since they are often installed above the knee joint, they are generally designed to add as little as possible to the build height. If positioned between the prosthetic knee and the socket, the rotation of the knee, shin and foot section enables the user to lift the foot onto the other knee when sitting, perhaps for the purpose of changing footwear, or when repositioning a patient adjustable foot, or simply to sit cross-legged.

It can also be useful where the patient needs to tuck the shin and foot out of the way when driving, or working in confined spaces. If positioned below the knee, in a transfemoral or transtibial prosthesis, the foot can then be rotated, thereby making kneeling easier.

Guideline - HW P ADA 01

Guideline Statement

A shock absorber should be prescribed for any patient with a lower limb amputation, when some or all of the indications are observed, whilst ideally none of the contraindications are exhibited.

Definitions

- Shock absorber – see overview.
- Lower limb amputation – ankle disarticulation and higher levels of amputation, or where there is a congenital shortening allowing space for a prosthetic foot.

Indications	Contradications
Patients who regularly have to dismount from a height e.g. horse rider, lorry driver	Patients who could not manage extra weight of the component
Patients who regularly participate in high impact activities e.g. basketball, tennis[1,2,3]	Insufficient build length for component
Patients who would benefit from reduced interface pressures and shear forces[4,5]	Where the shock absorption counteracts the action of other components such as an energy storing foot [2]
Patient preference for greater comfort	
Patients who regularly walk long distances	

Exceptions

- Those patients who are deemed medically unfit, unwilling, or because of their current lifestyle or circumstances, unsuitable for the provision of a prosthesis.
- Poor cognitive ability and compromised hand function may, in some cases, be contraindications for prosthetic rehabilitation. The MDT must assess whether the patient has the level of ability required with or without a carer, to use the prosthesis being prescribed, correctly, safely and consistently before proceeding.
- Where an alternative approach is seen to be more suitable according to the indications/ contraindications of its guideline.

Torque absorber

Prescription Guideline - HW P ADA 02

Guideline Statement

A torque absorber should be prescribed for any patient with a lower limb amputation, when some or all of the indications are observed, whilst ideally none of the contraindications are exhibited.

Definitions

- Torque absorber – see overview.
- Lower limb amputation – ankle disarticulation and higher levels of amputation, or where there is a congenital shortening allowing space for a prosthetic foot.

Indications	Contradications
Patients who regularly participate in activities which require torsional movement (e.g. golf)[6]	Patients who could not manage extra weight of the component
Patients who require prosthetic replacement of hip rotation (e.g. hip disarticulation, hemipelvectomy or congenital hip deficiency)	Insufficient build length for component
Where rotational shear forces at the socket interface may cause discomfort or tissue breakdown	Where the rotational movement has a detrimental effect on the patient's functional ability (e.g. lateral deflection at end of stance phase or feeling of instability or loss of control in gait)
	The desired cosmetic cover would be damaged by or would prevent rotation (decision will also involve patient preference)

Exceptions

- Those patients who are deemed medically unfit, unwilling, or because of their current lifestyle or circumstances, unsuitable for the provision of a prosthesis.
- Poor cognitive ability and compromised hand function may, in some cases, be contraindications for prosthetic rehabilitation. The MDT must assess whether the patient has the level of ability required with or without a carer, to use the prosthesis being prescribed, correctly, safely and consistently before proceeding.
- Where an alternative approach is seen to be more suitable according to the indications/ contraindications of its guideline.

Rotation/turntable adapter

Prescription Guideline - HW P ADA 03

Guideline Statement

A rotation or turntable adapter should be prescribed for any patient with a lower limb amputation, when some or all of the indications are observed, whilst ideally none of the contraindications are exhibited.

Definitions

- Rotation or turntable adapter – see overview.
- Lower limb amputation – ankle disarticulation and higher levels of amputation, or where there is a congenital shortening allowing space for a prosthetic foot.

Indications	Contradications
Transfemoral patients who require rotation for a regular activity (e.g. sitting cross-legged, driving, praying, donning shoes)*	Poor cognitive ability – unable to operate component safely and effectively
Patients who require regular kneeling (e.g. gardening, praying) and benefit from the foot being rotated**	Poor manual dexterity – unable to operate component safely and effectively
	Patients who could not manage with extra weight of component
	Insufficient build length for component
	The desired cosmetic cover would be damaged by or would prevent rotation

*With the device fitted proximal to the knee joint.
**With the device fitted distal to the knee joint or in transtibial use.

Note: Otto Bock does not recommend distal fitting of their rotation adapter and therefore, in this case, a risk assessment would be needed

Exceptions

- Those patients who are deemed medically unfit, unwilling, or because of their current lifestyle or circumstances, unsuitable for the provision of a prosthesis.
- Poor cognitive ability and compromised hand function may, in some cases, be contraindications for prosthetic rehabilitation. The MDT must assess whether the patient has the level of ability required with or without a carer, to use the prosthesis being prescribed, correctly, safely and consistently before proceeding.
- Where an alternative approach is seen to be more suitable according to the indications/ contraindications of its guideline.

References - Functional adapters prescription guidelines

1. GARD S A, et al., (2003). The effect of a shock absorbing pylon on the gait of persons with unilateral trans-tibial amputation. *J Rehabil Res Dev*, Vol. 40(2), p109-24.

2. GRAHAM L A, et al., (2000). Case study: Combined shock absorbing shin and dynamic response. *Prosthet Orthot Int,* Vol. 25(3), p246.

3. HSU M J, et al., (1999). Physiological measurements of walking and running in people with trans-tibial amputations with 3 different prostheses. *J Orthop Sports Phys Ther*, Vol. 29(9), p526-533.

4. ROSS J, et al., (2004). Study of telescopic pylon on lower limb amputees. *Leipzig Compendium*.

5. BUCKLEY J G, et al., (2002). Oxygen consumption during ambulation: comparison of using a prosthesis fitted with and without a tele-torsion device. *Arch Phys Med Rehabil*, Vol. 83, p.576-581.

6. ROGERS J P, et al., (2004). The effect of prosthetic torsional stiffness on the golf swing kinematics of a left and a right sided trans-tibial amputee. *Prosthet Orthot Int*, Vol. 28(2), p.121-131.

Water activity prosthesis overview

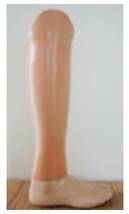
Water activity limbs are designed to be worn in wet environments, with the exact design varying according to need.

Endoskeletal

By combining waterproof structural components with waterproof feet, and knees where required, can provide a limb for use in water, but also one which will allow a satisfactory and safe gait for most of the users other activities. These can be made to be more cosmetic using a clip on cover.

Image courtesy of LegWorks

Exoskeletal



A common form of water activity limb is a conventional style limb with a hollowed out shin and water inlets, in an attempt to reduce buoyancy for those who wish to paddle or swim. This is combined with a SACH or dynamic SACH foot. Otto Bock also produces two knee options that can be built into a transfemoral prosthesis in a similar fashion.

LA ankle™

This is a specific component available for water sports which unlocks from a plantigrade position (foot at 90 degrees to shin) to allow plantar flexion (toes pointing down) - a suitable position for use with a flipper. This works well with the Trulife Seattle Lightfoot, since it can be bolted directly to the keel, lowering the position of the ankle pivot, thereby making the fully plantar flexed foot more natural in appearance and functionally more effective.

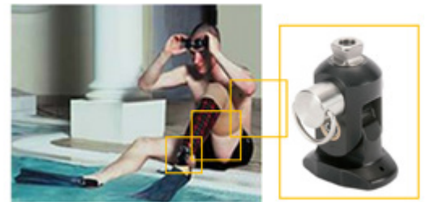


Image courtesy of Ortho Europe

Freedom Innovations Freestyle swim foot

This foot and ankle combination is designed for use with a flipper, but is also a fairly dynamic, energy storing foot that allows the wearer to go from swimming to active walking, without the need to change their prosthesis.

Process and procedures for prescription of a water activity limb[1]

1. A referral may come either from the patient/user or a member of the multidisciplinary team who has identified the need.
2. A consultation should be arranged with appropriate members of the multi-disciplinary team.
3. The need and indications should be discussed including an explanation of the limiting factors.
4. The present day-to-day prosthesis should be viewed to see if slight modification may serve the specific purposes.
5. A model of the water activity limb, if available, should be demonstrated to show its mechanics and limitations.
6. The specific indications should be documented if a water activity limb is prescribed.
7. Ensure follow-up to identify use and maintenance regime for prosthesis if necessary.

Alternatives – limb/cast covers

If a water activity limb is not suitable, there are clear cast/prosthesis covers for adults (Fig. 1) or Sealskinz socks for children (Fig. 2), from Limbo products or other online retailers.

Fig. 1

Image courtesy of Thesis Technology

Fig. 2

Image courtesy of Sealskinz®

Prescription Guideline - HW P WAP 01

Guideline Statement

A water activity prosthesis should be prescribed for any patient with a lower limb amputation, when some or all of the indications are observed, whilst ideally none of the contraindications are exhibited.

Definitions

- Water activity prosthesis – see overview.
- Lower limb amputation – ankle disarticulation and higher levels of amputation, or where there is a congenital shortening allowing space for a prosthetic foot.

Indications	Contradications
Occupational reasons where a waterproof limb is essential or reduces health and safety risk[1]	
Specific water activity sport or leisure which necessitates the use of a water activity limb[1]	
Where risk analysis identifies that due to an associated medical or physical condition, participation in an activity or leisure pastime presents a health and safety risk as a major issue and a water activity limb can significantly reduce these risks[1]	
Social reasons where health and safety risk is a significant issue[1]	
Where other measures to address disability or handicap are impossible or impractical, e.g. where adaptation like fitting appropriate sitting shower facility is inadvisable[1]	
Social reasons for leisure and psychological well-being[1]	

Exceptions

- Those patients who are deemed medically unfit, unwilling, or because of their current lifestyle or circumstances, unsuitable for the provision of a prosthesis
- Poor cognitive ability and compromised hand function may, in some cases, be contraindications for prosthetic rehabilitation. The MDT must assess whether the patient has the level of ability required with or without a carer, to use the prosthesis being prescribed, correctly, safely and consistently before proceeding.
- Where an alternative approach is seen to be more suitable according to the indications/contraindications of its guideline.

References - Water activity limb prescription guidelines

1. HANSPAL, et al., (2006). Water activity limbs. *Prosthetics and Orthotics International*, Vol. 26, p218-225.

Index

Glossary

Abduction
Movement away from the midline of the body.

Acrylic Resin
Thermosetting resin used in fabrication of an acrylice laminate prosthetic socket.

Adapter
Device used to connect a prosthetic socket to the components of the prosthesis.

Adduction
Movement toward the midline of the body.

Adductor longus tendon
The origin of this tendon is located high in the front of the groin. It functions with the muscles here to adduct the thigh.

Alignment
Attaching and assembling prosthetic components in order for them to align with the body in a correct position.

Ambulation
The act of walking.

Amputation
The loss of a body extremity by surgery or trauma.

Ankle block
Connector between prosthetic foot and shin.

Anterior
On the front side of the subject.

Anterolateral
A position on the front and outside of the specific subject.

Anteromedial
A position on the front and inside of the specific subject.

Articulation
The point at which two bones make contact.

Atrophy
Muscle shrinkage due to lack of use.

Bench Alignment
Initial alignment of prosthetic components before fitting to the individual.

Bespoke
Custom-made.

Bilateral amputation
Amputation of both left and right limbs (upper or lower).

Build-up
Area where plater/other material is used to relieve an impingement or prominence.

Bulbous residual limb
Refers to the residual limb being larger in circumference at the end than at the top.

CAD/CAM
Computer Aided Design, Computer Aided Manufacture.

CAD/CAM mill
Machine that carves to a specific shape.

CAD/CAM scanner
Laser scanner used to electronically capture the measurements and shape of specific body parts.

Calcaneocuboid
Relating to the calcaneus and the cuboid bones in the foot and ankle.

Carbon fibre
Material used for structural reinforcement in laminated sockets or in manufacture of prosthetic parts. This material is very strong, though can be brittle and therefore needs mixing with other materials for strength.

Cast/negative model
Plaster shell removed from the residual limb.

Cast/positive model
Plaster or foam model of a specific subject.

Cast rectification
Functional changing of the shape of a cast to apply pressure in tolerant areas and relieve sensitive areas.

Casting procedure
Technique of getting a 3-dimensional body impression using plaster of paris.

Check socket
A socket made of clear plastic used to evaluate the fit of the socket design to the residual limb. This material is brittle, therefore cannot be used in the definitive limb unless well enforced.

Circumduction
During gait the affected limb will swing outward and then back in through the swing phase.

Circumference
Measurement around a specific part of the body.

Clam shell design
When two pieces of material come together to support a specific body structure.

Component
General term to describe prosthetic parts which make up a prosthesis.

Condyle
Rounded part of the bone normally located at the joint.

Congestion
Where tightness or constriction of the upper part of the residual limb causes the accumulation of excessive blood or tissue fluid in the distal end of the residuum.

Conical residual limb
Refers to the residual limb being smaller in circumference at the end than at the top.

Contracture
Tissue shortening that causes a loss of normal joint range, for example the knee joint cannot be fully straightened. This is often seen after amputation surgery due to shortening of muscles or tightness following prolonged sitting.

Contralateral
The unaffected limb or side of the body.

Congenital
Occuring at or before birth.

Coronal plane
Perspective of looking from the front (observes abduction/adduction).

Cosmetic cover
Soft or flexible cover used to protect the prosthesis as well as make the prosthesis look more realistic.

Cuff
Used in prosthetics to provide a circular strap enclosure of the thigh.

Cylindrical residual limb
Refers to the residual limb being similar in circumference at the end and at the top.

Disarticulation
An amputation through a joint.

Distal
A relative term used to describe the point on a limb which is farther away from the body in relation to another part of that limb.

Doffing a prosthesis
Taking off a prosthesis.

Donning a prosthesis
Putting on a prosthesis.

Donning aid
Tool used to help put on something.

Dorsal
The back side of.

Dorsiflexion
Lifting of the toes/ankle toward the ceiling.

Durometer
Term used to describe how soft or hard materials are.

Dysvascular Amputee
An individual with the loss of a limb secondary to circulatory impairment.

Early Walking Aid
A temporary artificial limb that is fitted soon after surgery; this adjustable prosthesis is worn as the residual limb and is healing for early walking practice at physiotherapy sessions.

Endoskeletal design
A prosthetic limb that is constructed using a tube or pylon as the support structure; this allows for the easy adjustment and exchange of components. An endoskeletal system can be covered with cosmetic foam that is shaped to match the sound side limb.

Energy return
A spring-like feeling of return from a specific type of foot.

Epiphysis
The expanded end of a long bone at the articulation. During the period of growth the epiphysis is either entirely cartilaginous or is separated from the shaft by a cartilaginous disk.

Equinovarus
A foot deformity in which the heel is turned inward and the foot is plantar flexed.

Equinus
A toe down position of the foot, in which the forefoot is lower than the heel.

Exoskeletal design
A prosthetic limb made without a pylon or easily interchangeable components; finished as a hard outer with no internal components.

Extension
A straightening of the joint.

Extension assist
Prosthetic knee joints which have a mechanism to help extend the knee.

Extension moment
Force (torque) causing extension (straightening of joints).

Fabrication
Process of creating an end product.

Femoral condyle
The bulbous part of the lower end of the femur that attaches to the knee joint.

Fibula
The small support bone that runs along the outside of the leg just below the knee.

Fibular head
The prominent bone on the outside of the leg just below the knee.

Flexion
Bending of a joint, such as the knee or the elbow, which decreases the angle between the two parts.

Follicitus
Inflammation of the hair follicles which may lead to deeper abscesses; often caused by bacteria.

Framed socket
A rigid material encompassing a flexible plastic inner portion to a prosthetic socket.

Gait
Walking.

Gait analysis
The study and evaluation of how a person walks.

Gait deviation
Undesired movements during walking.

Gait pattern
Specific trait of how a specific individual walks.

Gait training
Usually consists of several sessions on learning how to walk with a prosthesis with your physiotherapist.

Gluteal muscles
Muscles of the buttocks that are largely responsible for extending the thigh.

Hamstrings
The thigh muscles that run behind the knee to control the knee bending.

Hallux valgus deformity
The migration of the great toe over towards the direction of the 2nd toe.

Heel off/heel rise
Part of stance phase when the heel comes off the ground when walking.

Heel strike
Part of stance phace when the heel contacts the ground when walking.

Hemicorporectomy
Amputation that removes the lower part of the body at the waist.

Hemipelvectomy
Amputation of one leg together with removal of the half of the pelvis on the same side of the body.

Hip disarticulation
Ampuation of the entire leg through the hip joint.

Hip dysplasia
When the hip becomes dislocated.

Hygiene
Term used to describe how well a person cleans themselves or their prosthesis.

Hyperextension
Beyond the normal range of extension.

Initial swing
Part of swing phase when the leg begins to swing forward during walking.

Insenate
Lack of feeling or sensation in a part of the body.

Insole
Orthosis that is placed inside the shoe for the foot to stand on; provides support or cushioning.

Instability
Specific part of body that has poor control or insufficient support.

Interface
The material that is used between the prosthesis and the skin.

Ischial containment (socket)
A transfemoral (above knee) prosthetic socket design that incorporates part of the ischium of the pelvis to increase stability during gait.

Ischial seat/shelf/support
The part of a prosthetic socket that supports the ischial tuberosity.

Ischial tuberosity
Bony landmark at posterier aspect of ischium of the pelvis, the bone may be felt when sitting.

Ischial weight-bearing
Weight transfer at the ischium (in a prosthetic socket).

Ischium
The bone of the pelvis on which you sit.

I.S.N.Y.
Icelandic-Scandinavian Socket design modified by New York University.

Keel
Inner component of prosthetic feet.

Knee sleeve
A soft material stretched over a transtibial (below knee) prosthetic socket and up onto the thigh that supports the knee joint and helps the leg stay on.

Laminate
Fabrication technique that uses resin reinforced with fibers to make a custom prosthetic socket.

Lateral
An anatomical term to describe something which is toward the outside, away from centre.

Leather
Cured animal hide.

Leg lenth discrepancy
When one leg is longer than the other.

Lever arm
Term used in prosthetics to describe length of residual limb. The longer the lever arm, the more leverage and stability.

Limb
Arms or legs; extremeties.

Liner - silicone/gel
A thin layer of soft material that covers the residual limb to provide padding and suspension and often with a locking system to connect the liner to the prosthesis.

LISFRANC amputation
Amputation through the tarsometatarsal joint; through the middle of the foot.

Longitudinal
In a lengthwise direction.

Lordosis
Posterior curvature of the spine.

Lower leg
Part of the leg below the knee joint.

Medial
Towards the centre line, middle.

Medial Tibial Plateau
Located just on the inside of the lower leg below the knee.

Metaphysis
The growing portion of a bone.

Metatarsal heads
Located at the ball of the foot as the distal end of the metatarsals.

Metatarsus
Collective term for the five bones in the middle of the foot, located between the tarsals and the phalanges.

Mid-patella tendon
The soft tendon located just under the knee cap.

Mid-stance
When the foot is flat on the floor during walking.

Mid-swing
When the foot is off the floor and in the middle of swing during walking.

Modification
Process of manipulating plaster or foam into a desired shape.

Myostatic contracture
Permanent shortening.

Negative pressure
A type of pressure that occurs when air is trapped inside a socket and causes a suction.

Neuroma
The regrowth of cut nerves to form a sensitive bundle of nerves that sometimes occurs after an amputation.

Nylon sheath
Type of fine nylon sock that can be used directly against the skin to cut down on friction or wick away sweat when wearing a prosthesis.

Oblique
At a slanting angle; not horizontal or vertical.

Oedema
An abnormal accumulation of fluid beneath the skin or in one or more cavities of the body.

Open-end socket
Prosthetic socket with an open distal end.

Osteo
Pertaining to bone.

Parallel bars
Stationary bars that are used as a walking aide for balance when learning to walk with a prosthesis.

Passive motion
Prostheses controlled by an outside force.

Patella
Another word used to describe the knee cap.

Patellar-tendon
Soft tendon located just below the knee cap.

Pe-Lite foam
Type of foam material sometimes used in a prosthesis, this is a trade name and many different varieties of the same function exist.

Perineum
The groin area that is located between the legs.

Peripheral Vascular Disease
Disease in the peripheral blood vessels, mostly arteries.

Peroneal muscle
Two muscles located on the outside of the leg below the knee to the ankle. These muscles assist to raise the foot during walking.

Phalanges
The bones of the toes.

Phantom Pain
Pain felt in the portion of the limb which has been removed.

Pistoning
Undesirable up-and-down motion of the residual limb in a prosthetic socket that may cause rubbing and blisters.

Plantar
Toward the sole; occuring on the sole of the foot.

Plantar flexion
Movement of the foot at the ankle joint directed toward the ground.

Plumb line
Vertical reference line.

Polyester
A chemical resin that is used in fabrication of prostheses.

Polyethylene
A flexible type of plastic that is used in prosthetics.

Polypropylene
A more rigid type of plastic used in the fabrication of prostheses.

Popliteal
Pertaining to the area behind the knee sometimes called the knee pit. The concave shallow depression located here is called the popliteal fossa.

Posterior
Toward the back of the subject.

Posterolateral
A position on the back and outside of the specific subject.

Posteromedial
A position on the back and inside of the specific subject.

Prescription
A plan of care written by a physician or other health care professional.

Pronation
The pronated foot is one in which the arch tends to collapse. As the foot strikes the ground the arch flattens somewhat in order to absorb shock, and to assist in balance during mid-stance; this is called pronation.

Prone
Laying face downward.

Proprioception
The sense of the relative position of parts of the body; knowing the location of joints in space without using sight.

Prosthesis
Artificial medical device used to replace a missing limb or body part such as artifical limbs, hands, fingers, feet or toes.

Prosthetic components
The parts that make up the artificial limb. For example, foot, ankle, socket, tube etc.

Prosthetics
Science and practice of evaluating, measuring, designing, fabricating, assembling, fitting, adjusting, or servicing prostheses.

Prosthetic residual limb sock
A sock knitted to fit the shape of the residual limb worn inside the socket. The sock reduces the friction between the residual limb and the socket, absorbs sweat and can be used to replace lost volume in the socket due to shrinking of the residual limb.

Prosthetic technician
Person trained to fabricate, repair and maintain prostheses under the supervision of a prosthetist.

Prosthetist
A health care profession who is skilled in making and fitting artifical parts (prostheses) for the human body.

Prosthetist/Orthotist
A health care professional who is dual-qualified in both prosthetics and orthotics.

Proximal
A relative term used to describe the point on a limb which is closest to the midline of the body.

Patellar tendon-bearing prosthesis
A prosthesis designed for weight-bearing at the patella tendon.

Push off
The last part of stance phase when the foot comes off the ground.

Plantigrade
Used to describe the foot and ankle in a 90° neutral position.

Range of motion
Term used to measure the amount of movement there is in a joint/extremity.

Rectus femoris
One of the four quadriceps mucscles located on the front of the thigh.

Rehabilitation team
Group of allied health care professionals, specialising in rehabilitation who serves the needs if a patient, that frequently includes; physician, surgeon, prosthetist, orthotist, physiotherapist, occupational therapist, social worker and counsellor.

Residual
The remaining part.

Residual limb
Terms used to describe the remaining limb after an amputation.

Residual limb care
Care and hygiene of the residual limb.

Residual limb/Residuum
Remaining portion of the limb after amputation.

Resin
A chemical liquid that is used in fabrication of prostheses.

Revision surgery
Surgical modification of the residual limb.

Rocker bottom sole
A modification on the sole of a shoe that removes material on the toe and the heel of the sole. Allows for a quicker rollover as well as distributes pressure through the stance phase.

Rotator
Prosthetic component that provides rotation.

SACH foot
Solid Ankle Cushion Heel foot.

Sagittal plane
Pertaining to the side of; observes flexion and extension.

Shock absorber
Component used on a prosthesis that reduces vertical impact forces.

Shrinkage
Term used to describe when an extremity or residual limb loses muscle mass or volume.

Shrinker sock
Type of compression garment used to reduce the oedema in a residual limb.

Shuttle lock
Locking mechanism used in a prosthesis to keep the liner locked in the socket to suspend the prosthesis.

Silesian belt
Strap that wraps around the waist to suspend the prosthesis.

Silicone
Chemical material with rubber-like mechanical properties.

Silicone liner
Liner with suspension or soft tissue replacement properties.

Silicone suspension sleeve
A silicone sheath that stretches over a transtibial (below knee) prosthetic socket and up onto the thigh that supports the knee joint and helps the leg stay on.

Socket
Prosthetic “container” for the residual limb.

Sound-side leg
Non-amputated side/limb.

Stance
Act of standing.

Stance phase
Phase of walking while the foot is in contact with the ground.

Static alignment
Initial alignment of prosthetic components before fitting to the individual.

Suction socket
Prosthetic socket with suspension supported by vacuum, using a one-way valve in the socket and either the skin, a silicone liner or an airtight sleeve to maintain the vacuum.

Supination
The supinated foot is one in which the arch is high. As the foot is in contact with the floor after mid-stance towards push off the foot supinates to create a firm base from which to push off.

Supine
Laying face upwards.

Supracondylar
Above the condyles.

Suspension
The way in which the prosthesis is held onto the residual limb.

Suspension sleeve
A tubular knee sleeve used for suspension. Also used to keep air from getting into the socket in suction suspension.

Swing phase
The phase of walking when the foot is not in contact with the ground.

Swing phase control
Mechanism used in a prosthesis that controls the swing of the knee joint by increasing or decreasing the speed.

Symes amputation
An amputation level that is performed through the ankle joint.

Talonavicular
Pertaining to the talus and the navicular bones.

Talus
The bone on which the lower leg articulates at the ankle.

Tarsal
One of the seven bones of the ankle.

Tarsometatarsal
Pertaining to the tarsus and the metatarsus.

Tarsus
A collective term for the seven bones which make up the ankle, including the talus, calcaneus, navicular, cuboid, medial cuniform, intermediate cuniform and lateral cuniform.

Terminal swing
The part of walking at the end of swing phase when the foot is just about to contact the floor.

Tibia
Bone located on the front of the leg below the knee. Also known as shin bone.

Tibial condyle
Top wide part of the tibia.

Tibial crest
Front edge of the tibia (shin) bone.

Tibial tuberosity
Prominent front edge of the tibia located at the proximal end of the bone, just below the knee.

Total contact socket
Socket providing equal surface contact all over.

Transfemoral
A type of amputation that occurs above the knee.

Transtibial
A type of amputation that occurs below the knee.

Triceps surae
The muscle of the calf made up of two muscles combined, the gastrocnemius and the soleus muscles.

Unilateral
One-sided.

Upper extremity
Arm.

Valve
Device to control release of air in an AK socket to facilitate suction.

Vaulting
Undesirable gait deviation when walking with a prosthesis. To walk up into the toes on the sound side in order to contact ground through swing phase on the prosthetic side.

Volume fluctuation
When oedema in the leg causes swelling or shrinkage within the residual limb.

Volume loss
The reduction of oedema or atrophy of muscle throughout residual limb after an amputation.

Walking aid
A tool used to support a person when walking.

Weight-activated safety knee
A type of prosthetic knee that brakes when weight is applied through it.

Weight-bearing
Term used to tell an individal to transfer weight to a specific leg.

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