South Tees Hospitals NHS
NHS Foundation Trust

Prosthetic Rehabilitation

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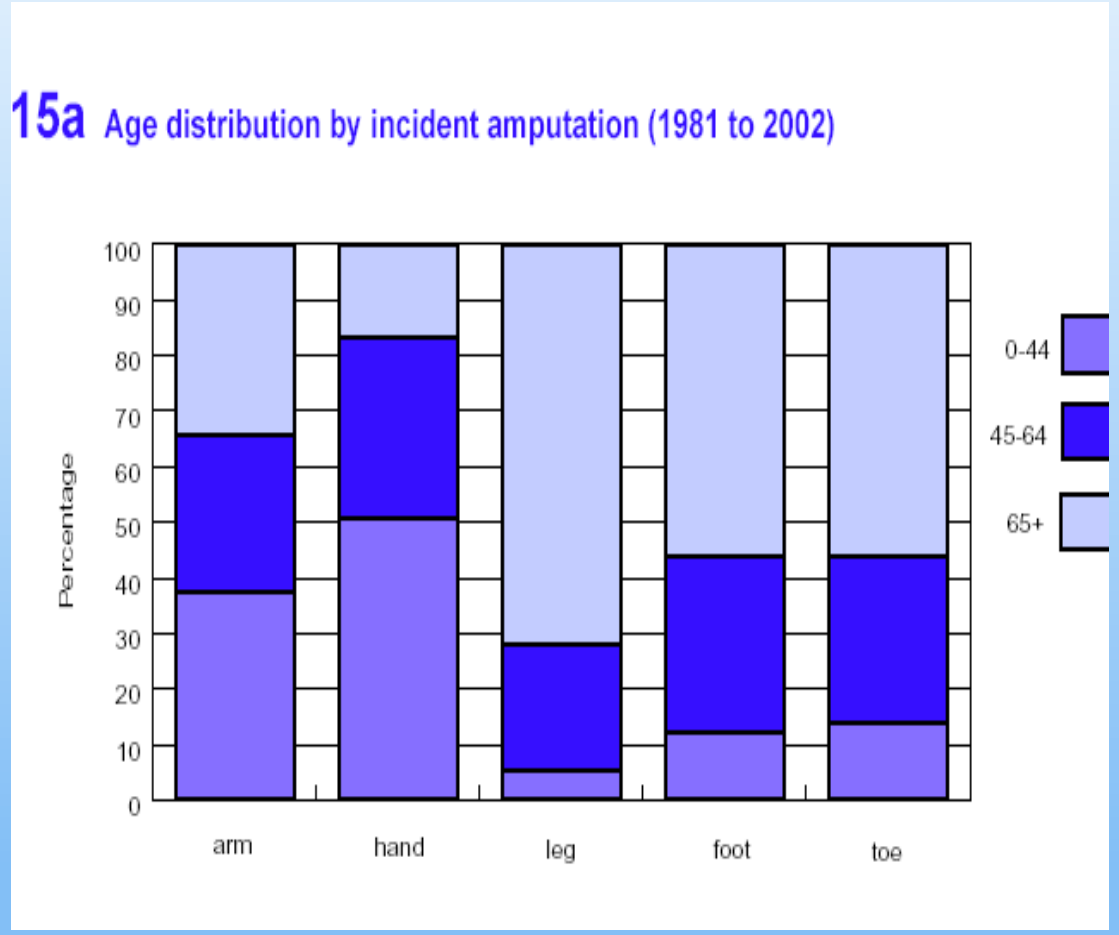
Cleveland Disablement Services Centre
The James Cook University Hospital

Cleveland DSC

- Serves large geographical area
- 1000 + limb users
- Based at JCUH
- Regional Vascular Unit
- Trauma Centre
- Many other specialties

Amputation

- **Amputation** is the removal of a limb by trauma, medical illness, or surgery.
- As a surgical measure, it is used to control pain or a disease process in the affected limb, such as malignancy or gangrene.
- In some cases, it is carried out on individuals as a preventative surgery for such problems. (Wikipedia)
- If elective – pre-amputation consultation service



Referrals to Cleveland DSC

- Age range prenatal to 100 years old (+)
- Congenital limb absence
- Primary post amputation patients
- Upper and lower limb loss
- Pre-amputation counselling and education
- Transfers in to service
- 2nd opinions
- NASDAB stats opposite

Prosthetics and Prosthetic Rehabilitation

- A prosthesis is an artificial device designed to emulate where possible a missing body part like a limb.
- Prosthetic rehabilitation is the clinical practice to use prostheses and appliances to restore function in people with limb loss following amputations or congenital limb deficiencies.

A young man with bilateral amputations illustrating the differences between a transfemoral socket and a hip disarticulation socket.

Our service - NHS England - commissioners

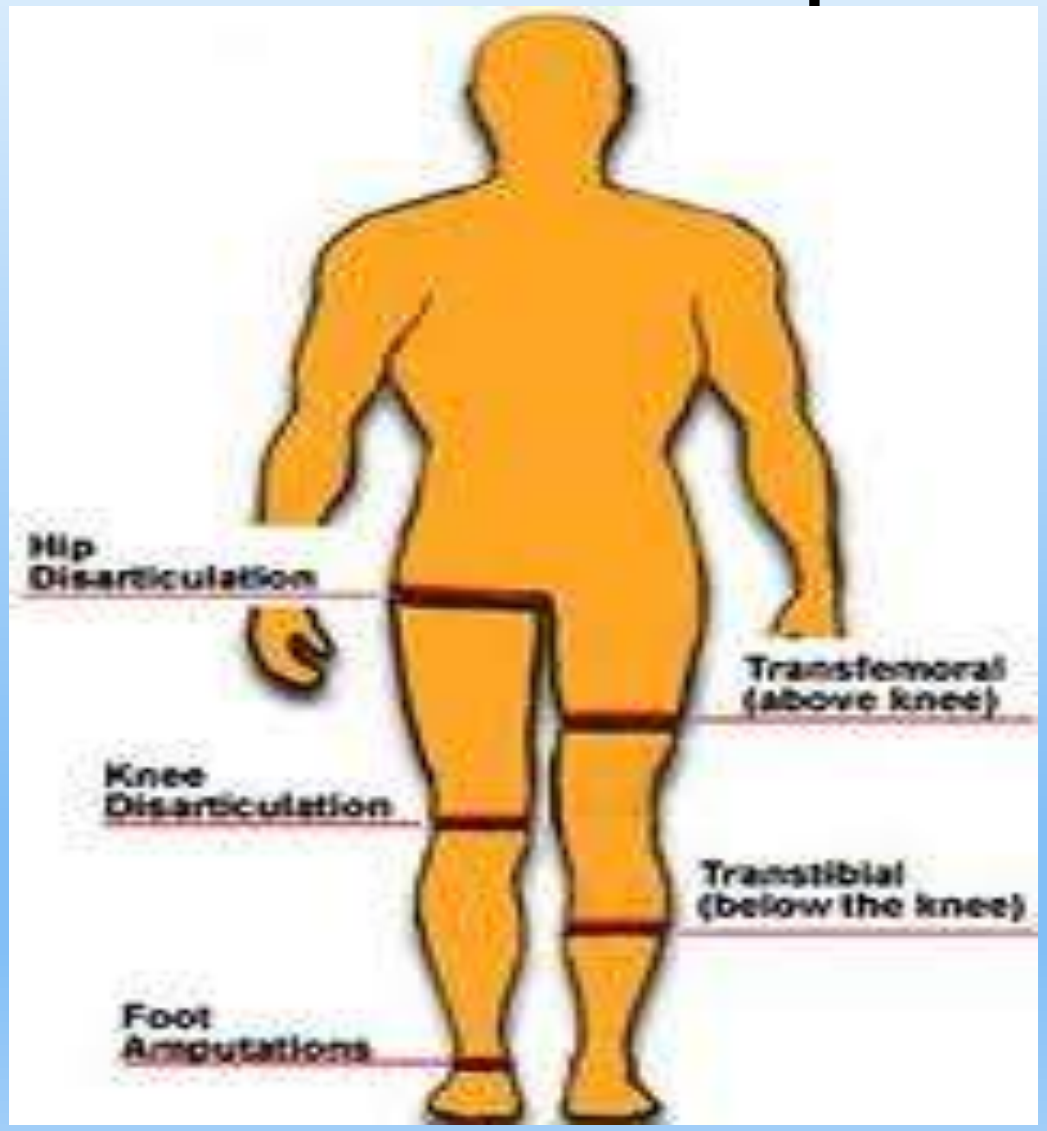
- ‘The rehabilitation and re-ablement of all patients is provided by a specialised Multi-Disciplinary Team (MDT) which should be consultant led.’

- ‘The needs of patients of all age groups are addressed including physical, psychological, social, emotional and spiritual with the emphasis on individual outcomes, independence and prevention keeping patients dexterous, mobile and safe.’

Main levels of amputation

- Transtibial
- Transfemoral
- Knee Disarticulation
- Symes Amputation
- Partial Foot
- Digits

Lower Limb Levels of Amputation



Types of amputation

- Myoplasty – agonists are sutured to antagonists to cover the end of the bone
- Myodesis – Muscle attached to end of bone
- Simple flap – poor, as bone poorly covered
- Guillotine – straight through bone


3M™ Wound Measuring Guide

The ideal stump - residuum

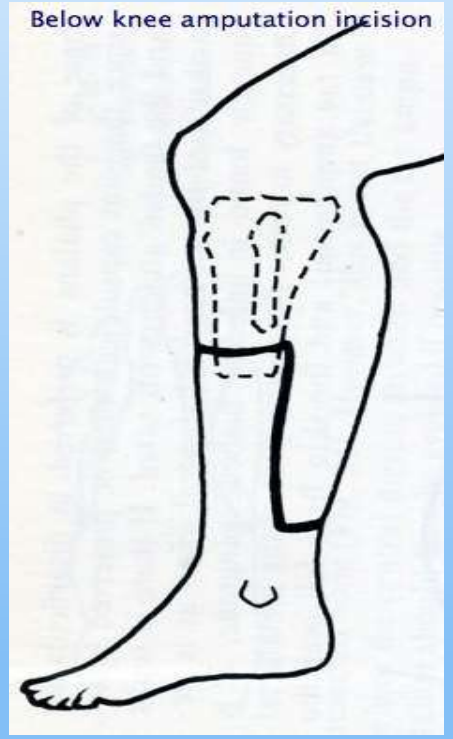
- Ideal length and shape, bone end well covered with muscles
- Non adherent incision scar
- Muscular with good muscle power
- Absence of neuroma
- Free from infection-osteomyelitis
- Full and free movements at the joints above
- No fixed deformity
- Sensate

Not always that easy to achieve…….

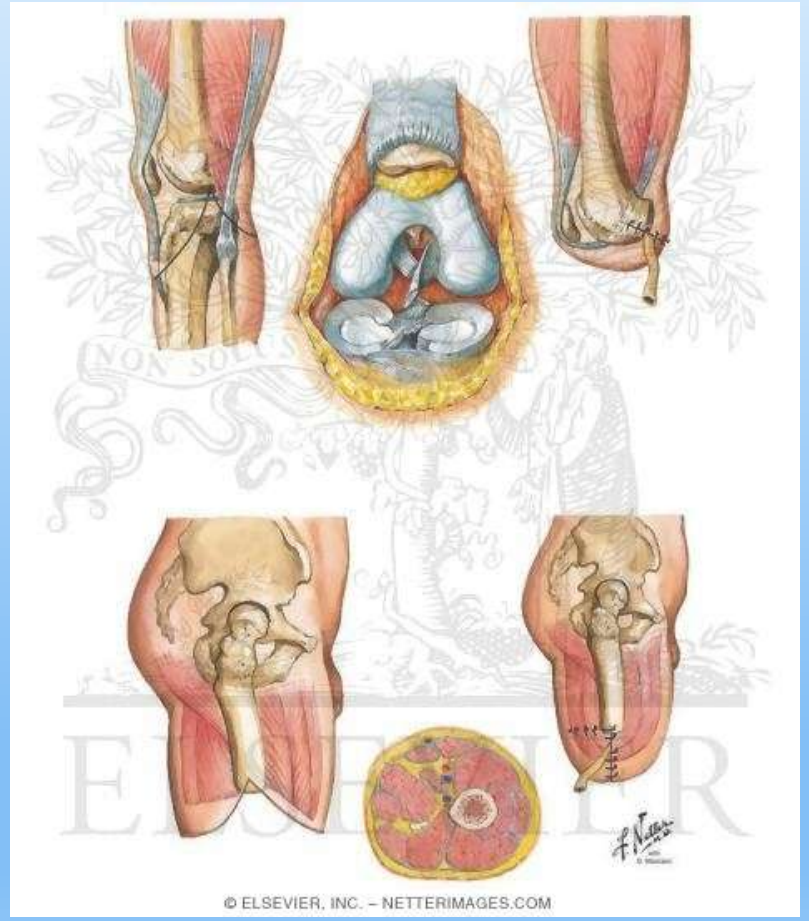
Lower limb amputation

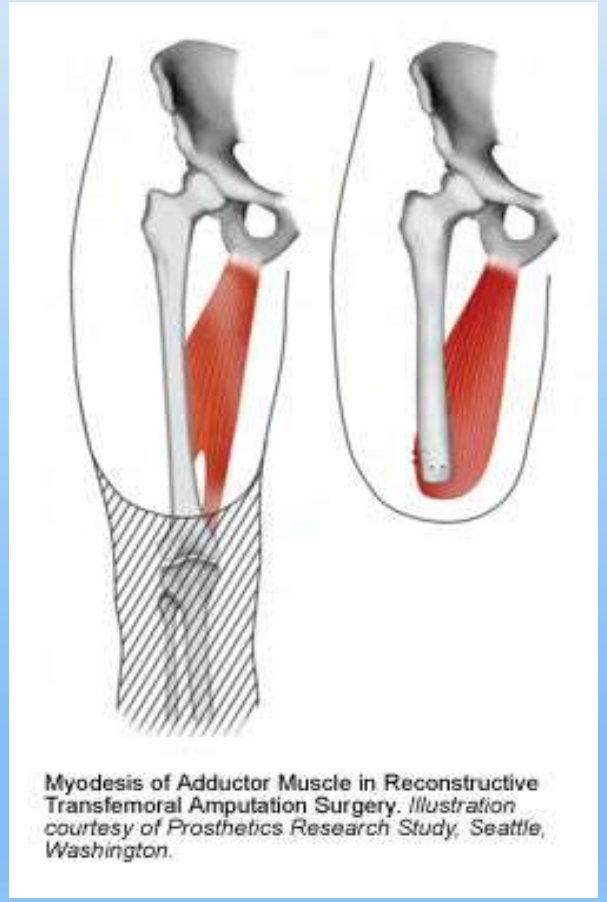
- Cylindrical to conical shape
- Beveled bone ends
- Well covered kick point
- TTA – fibula shorter than tibia
- Myoplasty / osteomyodesis if possible

Transtibial Amputation



Transfemoral





Myodesis of Adductor Muscle in Reconstructive Transfemoral Amputation Surgery. *Illustration courtesy of Prosthetics Research Study, Seattle, Washington.*

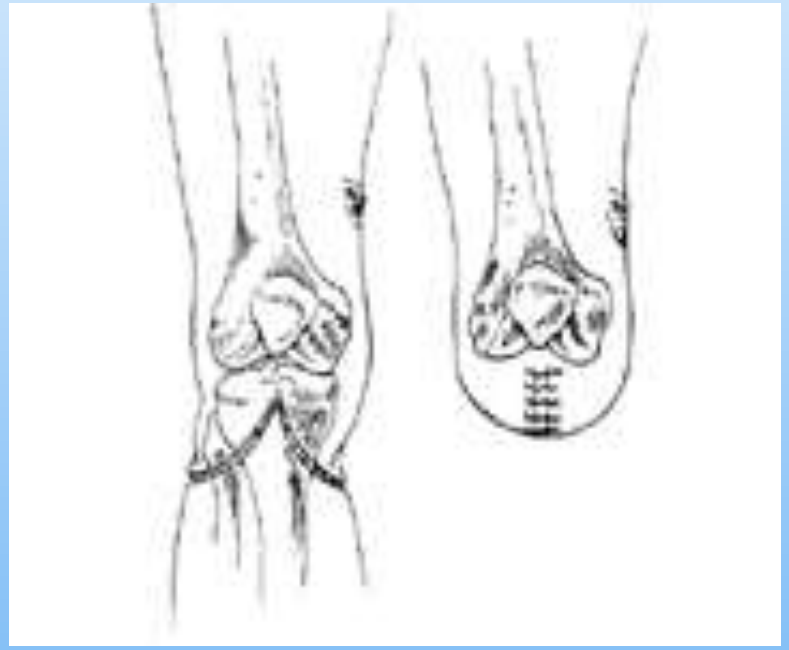
Symes Amputation

- James Symes
- Difficult to Fit
- Bulbous End
- Shaved Bone, Healing
- Scar Tissue
- Low profile
- End bearing

Through Knee Amputation

Advantages:

- Simple, quick
- End bearing
- Good sitting balance
- Good level of amputation for children
- More challenging prosthetically



Disadvantages:

- Flap necrosis
- Synovial leak
- Low knee centre
- Wide & bulky prosthesis

The residuum changes……..

- With time generally shape becomes more conical TFA / TTA
- Shrinkage occurs, muscle tone changes, ageing
- More profiled as soft tissues mature / wastage of redundant muscles
- Changes also associated with weight gain or loss, fluid fluctuations, diurnal, pregnancy, menstrual cycle, dialysis, CF…..
- Pathology advancing – PVD, neuropathy, inflammation of joint or soft tissues, infection…..
- Skin and tissue problems, neuromas, folliculitis, bursae, ulceration…
- Socket associated problems etc, etc
- May need recasts, changes of prescription

Advice for patients

- Takes more energy to walk – physical and mental, psychological
- Probably will be less functional
- More at risk of slips trips and falls, use of walking aids
- Skin care and inspection essential - sweating
- Good hygiene essential, self and prosthesis
- Reduced range of movement at joint within socket
- Stump will change with time
- Lavatory more difficult for TFAs
- **Can never replace lost limb**

Suitability for prosthetic rehabilitation?

- Grieve et al (1996) showed that following amputation patients experienced lower levels of function compared to “normals”. Greive AC and Lankhorst GJ (1996) Functional outcome of lower limb amputees: a prospective descriptive study in a general hospital. Prosthet Orthot Int, 20, 79-87
- Life expectancy of a vascular amputee is short and in the elderly is associated with a considerable morbidity and deterioration of functional and residential status.
- Amputees with extensive co-morbidity are less likely to walk especially those with associated musculo-skeletal impairment e.g. rheumatoid arthritis.
- Amputee and Prosthetic Rehabilitation – BSRM Standards and Guidelines 2003. (many refs)

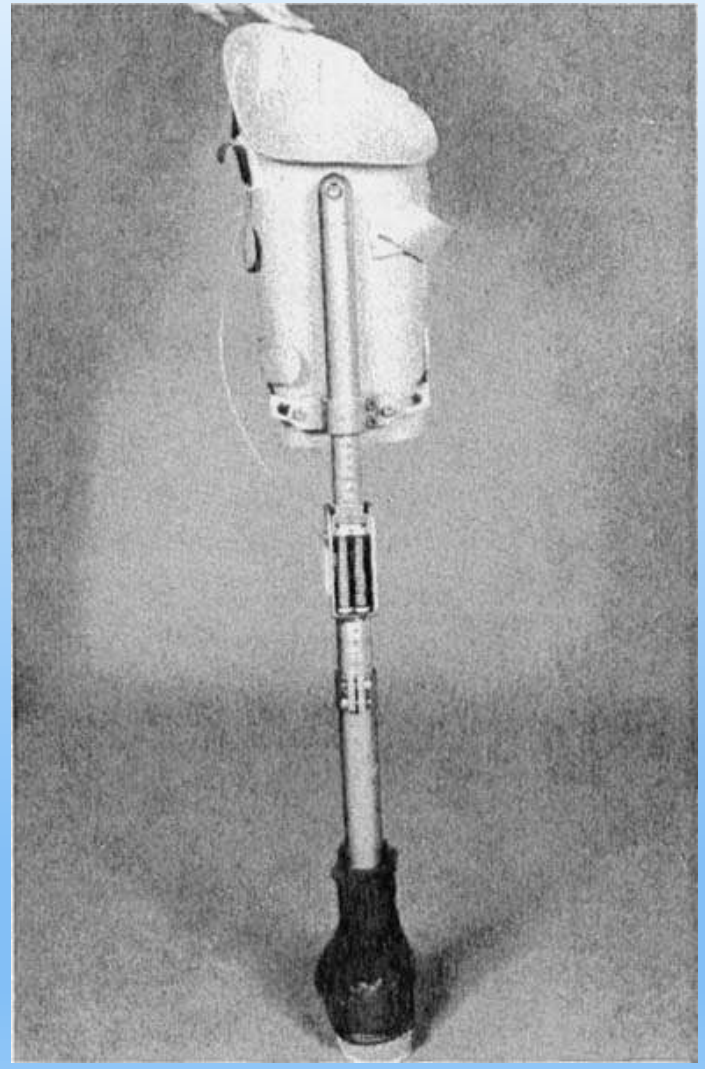
- The ability to perform activities of daily living (ADL) tasks is the most important predictor for well being and quality of life.
- Patients who are confused or have cognitive impairment are unlikely to benefit from a prosthesis.
- Other factors that are significantly related to less prosthetic use are age, female gender, (possession of wheelchair), level of physical disability, poor compliance and self perception and the amputee's dissatisfaction'
- Amputee and Prosthetic Rehabilitation – BSRM Standards and Guidelines 2003. (many refs)
- Trauma patients – success dependent on other injuries and comorbidities
- Level(s) of amputation – transfemoral or higher, transhumeral or higher / multiple amputations - increased energy consumption with prosthesis, decreased function

Guidance for provision

- Compliance with physiotherapy pre-prosthetic preparation
- Success with early walking aid trial (if appropriate / possible)
- Compression hose tolerated (if appropriate / possible)
- Non sensitive stump – esp. load bearing areas, traction of tissues
- Wheelchair independent and safe
- No / minimal flexion contractures
- Pre-amputation mobility and function indicative
- Post amputation function and recovery
- Ability to stand and balance on remaining leg esp. TFA / TKA / THA

PPAMaid and Femurett

- Pneumatic
- Post
- Amputation
- Mobility
- Aid
- Assessment tools +



NHS England – Commissioners of Prosthetics service

- Four factors determine whether NHS England commissions a service as a prescribed specialised service. These are:
- The number of individuals who require the service; 55 – 60,000 in UK
- The cost of providing the service or facility;
- The number of people able to provide the service or facility (34 centres in England)
- The financial implications for Clinical Commissioning Groups (CCGs) if they were required to arrange for provision of the service or facility themselves.

Payment for service

- Working on Tariffs – for years…….
- Currently following like for like – Block contract
- This service specification also honours the Cross Government guarantee to our Armed Forces, Veterans and their Families, as set out with the **Murrison Report – A Better Deal for Military Amputees** and so relates to the provision of enhanced prosthetic services to Veterans. 9 designated centres (£6.7m) Other centres £1m. Central fund for individual applications.
- This should also offer a benefit to all NHS patients with limb loss in the wider NHS - £100,000 for Cleveland for equipment etc.

Care pathways

NHS England – Prosthetic Specialised Services for people of all ages with limb loss

- Primary patients - new patients with limb loss / revision / reconstruction surgery – regular review (MOM pathway!)
- 0-18 year old limb loss – regular review 3x per annum
- Established patients with limb loss using prostheses – review by consultant every 18m-2years (NHS England)
- Prosthetics – annual review and maintenance check (Medical Devices regulation and safety 2015)

Prosthetic Manufacture

- Otto Bock Healthcare – specialise in design and development of prosthetics, orthotics and materials
- Founded by Herr Otto Bock following WW1 in 1919.
- Sponsors of the Paralympic Games since 1988.
- Prosthetics manufactured on site at JCUH, componentry from Germany
- Early prosthetics exoskeletal, later endoskeletal modular

What we Do-

- Assessment- Weight, height, other conditions, limb condition, Walking trial, does the pt want a prosthesis?
- Cast- volume capture of residual limb, rectification of cast
- Manufacture- Sockets are custom fabricated on site, polyprop or glass fibre impregnated resins
- Fitting- trial of the socket on the pt adjusting height fit and function
- Maintaining prosthesis

The residuum changes……

- With time generally shape becomes more conical TFA / TTA
- Shrinkage occurs, muscle tone changes, ageing, healing
- Changes also associated with weight gain or loss, fluid fluctuations, diurnal, pregnancy, menstrual cycle, dialysis, CF…..
- Pathology advancing – PVD, neuropathy, inflammation of joint or soft tissues, infection…..
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Volume Capture for Bespoke Socket

- Plaster wrap cast
- 3d Scanning
- Measurements for electronic test socket.

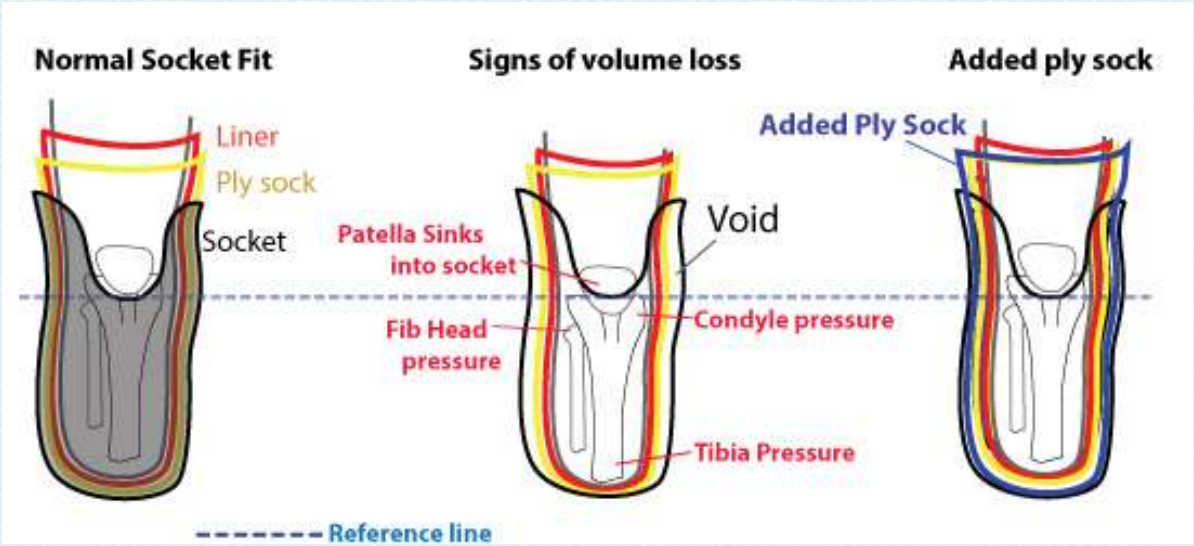
- Rectification of positive model.
- Relief of pressure over bony prominences.
- Loading pressure tolerant areas.

The Prosthetic Socket

- The basis of all prosthetics – a well fitted socket
- Transmission of forces in weight bearing, needs good suspension
- Two main types- Specific Weight Bearing or Total surface /global loading

Patella Tendon Bearing Socket

Total Surface Bearing Socket



Suspension Systems

- Silicone Suspension

- Elevated Vacuum

Socket and interface design and materials

- Flexible sockets with carbon fibre support structure

Prescription Guidelines

- Primary transtibial
- Guidance for the provision of transfemoral prosthesis
- Primary transfemoral
- Established transtibial
- Established transfemoral
- Water activity limb
- Second limb

Prescription Guidelines in prosthetics – TT primary

A code	Primary patients					
K code	0	1	1 or 2	2	3	3 or 4
SIGAM code	A	B	C	D	E	F
Limb type	Cosmetic wheelchair limb	TT generic system chosen for cost effectiveness, reliability and performance taking account of person's weight and activity level				
Socket	Simple interface	Polypropylene or laminate socket. Pelite liner				
Suspension	Sleeve	Cuff/ supracondylar suspension. Sleeve suspension				
Interface materials	Suspension difficulties consider liner	Normally stump socks. For residua which are skin grafted, bony, short or appropriately dressed wounds consider gel, silicone, polyurethane liners or inserts. For suspension difficulties consider liner				
Feet	Lightweight SACH	SACH/ multiaxial			Dynamic SACH or multiaxial	
Additional component		Not normally considered for primary patient				

Prescription Guidelines for Established Adults with transfemoral amputation

A code	A0L (A1L Cosmetic)	A1L	A2L	A3L		A4L
SIGAM Grade	A	B	C	D	E	F
Limb type	Cosmetic wheelchair limb		Trans-Femoral generic system chosen for cost effectiveness, reliability and performance.			
Socket	Simple interface		Total contact/open ended thermoplastic/laminated socket +/- flexible liner Metal socket			
Suspension	Silicone suspension Elastic sleeve		RPB +-Shoulder Brace Soft Suspension +/- Expulsion Valve/Sleeve		Suction Soft suspension +/- expulsion valve/sleeve Silicone/PU liner	
Interface materials			For residua that are bony or have skin grafts consider gel, silicone, polyurethane liners / interfaces. Consider interface liners for suspension difficulties			
Knees			SAKL[1] [1]semi automatic knee lock	SAKL Stabilised Knee +/-MKL & Pneumatic SPC[2]	Low to moderate cadence stabilised knee +- Pneumatic SPC	
					Moderate to high cadence Single axis knee with hydraulic swing +/- stance control Stabilised knee with pneumatic SPC Stabilised knee microprocessor SPC Microprocessor swing/stance control	
				Long residuum Polycentric knee with mechanical SPC [2]swing phase control	Long residuum Low to moderate cadence Polycentric knee with mechanical SPC	
					Long residuum Moderate to high cadence Polycentric knee with hydraulic SPC	
Feet	Lightweight SACH[3] Foot shell only [3]solid ankle cushion heel		SACH Multiaxial	Dynamic SACH Dynamic multiaxial	Dynamic multiaxial High performance energy return foot	
Additional components					**Shock pylon Torque absorber Combined shock pylon and torque absorber**	**Components under Grade 'F', plus provision of specialist or high activity non standard prescription components appropriate for high impact/stress**

Upper Limb Prosthesis

Cosmetic Prosthesis-

•Most common prescription. Designed to look good but generally non functional.

•Silicone or PVC cosmetic gloves matched by skin tone and hand size.

Functional Prosthesis

•Body Powered- using a harness on contralateral shoulder to power terminal device

•Myo Electric- motors which re-act to muscle signals to power terminal devices ie hands.

Advances in Prosthetics

- Socket and interface design and materials – e.g. carbon fibre, polymers
- Silicone in prosthetics for comfort and cosmesis
- Microprocessor knee Policy approval – Kenevo, C leg, Genium
- Hydraulic ankles – Triton smart ankle, Meridium. Powered ankles.
- Sports prosthetics – approved for children 0-18, Blades, lots of upper limb tools, water activity legs, diving legs
- Osseointegration
- Transplantation

Microprocessor Knees – Kenevo, C leg, Genium

	X3	Genium	C-Leg 4	Kenevo
Stance control	Intuitive and deliberate stance option	Intuitive and deliberate stance option	Intuitive or automatic stance	Locked or intuitive stance
Real-time swing control	√	√	√	√
Stumble recovery feature	√	√	√	√
Optimized Physiological Gait	√	√		
Walk-to-run feature	√	√		
Dedicated running mode	√			

Microprocessor for safety and high activity

- Kenevo

- Genium X3

Hydraulic and powered ankles – Smart Triton and Meridium

Custom silicone in prosthetics

Sports prosthetics – Blades, lots of upper limb tools, water activity legs, diving legs

Evidence based?

- **Advances in Technology: Evidence Base for Clinical Use**
- It is generally accepted that the evidence base for prosthetics services is limited due to low numbers of participants and difficulties with conducting randomised controlled trials.
- Rehabilitation; BACPAR Guidelines, BSRM guidelines, NHS EBP, OT guidelines, Prosthetic Best Practice Guidelines (Steeper's).
- Cochrane and other systematic reviews

In summary….

- Transtibial – 14-15cm length, 18cm if bulky residuum
- Transfemoral – 10cm from distal end of femur
- Well bevelled bone – No prominences
- Knee Disarticulation – For paediatrics and non limb wearers
- Well covered bone end
- Non adherent tissue/scar if possible
- Good conical or cylindrical shape as we cannot manipulate the tissue!
- No dog ears!

Thankyou all for listening.