Basic Prosthetic Knee Rehabilitation
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Scope

Up to SIGAM Level D

ie walks ≥ 50m on level ground in good weather with *walking aids*.

K level 1-2, possibly lower 3.

- K1 = indoor, single cadence
- K2 = limited outdoor, single cadence
- K3 = Active walker, variable cadence
- K4 = Very active, high impact sport
Scope
Manufacturer’s activity guidance

*Ottobock*: Mobis 1-4, activity + weight

*Ossur*: Low/Mod/High, impact + activity

*Endolite* and *Medi*: K levels
Plan for session  2.00 – 3.00pm

1. Classification of prosthetic knees for physiotherapists

2. Review of knee function during normal and amputee gait

3. Gait training: key points

4. Practical demonstration

5. Questions and discussion
Classification of prosthetic knees for physiotherapists: stance control

Stance vs Swing

Stability/safety

Responsiveness
Stance control

Locked

- SAKL

Free

- HOKL

Single axis
- Weight activated
- Posterior alignment
- Hydraulic
- Microprocessor
- Polycentric
- 4 bar
- Geometric locking
Knee locked
Semiautomatic Knee Lock (SAKL)

- Low activity K1-2
- Light weight
- Need stance stability
- Walk: knee locked
- Sit to stand: knee unlocked

Examples
- Medi OFMO
- Ossur locking knee
- Endolite Compact SAKL
Knee Free: Single-axis
Weight activated stance stability

STANCE control

• Alignment
• Weight activated braking mechanism
  – Any part of foot
  – 0-30° knee flexion
• Release: off-load or load toe (varies)

SWING control

• Pneumatic /spring assist / friction depending on knee and patient requirements
Knee Free: Single-axis
Weight activated stance stability

Prescription
• Activity K1 – 3
• Can accommodate
  – Hip flexion contracture
  – Short residuum
  – Weak residuum

Examples
– Medi OP4 (3, toe load)
– Blatchford ESK (1-3, toe load)
  or Phoenix (1-2, off load)
– Ottobock 3R93 (1-2, off load)
Knee Free: Single-axis Alignment only stance stability

STANCE control: alignment
- GRF critical to knee stability
- Hip must extend early stance
- Posterior placement of the knee joint.
- Release: hip flexion/toe load/off load

SWING control
- Pneumatic
Knee Free: Single-axis Alignment only stance stability

Prescription
• Activity K3-4
• Variable walking speed, minimal stance stability
• Require:
  – Full hip extension
  – Good hip strength

Example: Ottobock 3R95
Free knee: polycentric 4 bar

- 4 pivot points
- Instantaneous centre of rotation (ICR) changes with knee flexion

**STANCE control**

- Alignment (inherently stable)
- ↑ prox and post ICR > stability
- ↑ prox, ↑ ease release

**SWING control**

- Various – pneumatic/ hydraulic/ friction +/- ext assist
- Shortens mid swing
Free knee: polycentric
4 bar: stable, single cadence

Prescription

- Activity K1 – 3
- Can accommodate
  - Short residuum
  - Weak residuum
- May need full hip extension

Examples

- Ossur Balance Knee (low, ext assist)
- Medi OFM1(K1-2, friction)
- Ottobock 3R78 (M2-3, ext assist)
Free knee: polycentric
4 bar: responsive (cadence and release stance stability)

Prescription
• Activity K1 – 3
• May require good voluntary control

Examples
• Endolite 4 bar with PSPC (1-3, pneumatic)
• Medi OP5 (3, pneumatic)
• Ottobock 3R106 (2-3, pneumatic)
Free knee: polycentric responsive (cadence and release stance stability)

Example: Ottobock 3R60

Prescription
• Activity M2–3
• Hydraulic control swing
• Stance flex (SF)
Free knee: polycentric
Geometric locking

- Multibar (linkages)
- Instantaneous centre of rotation (ICR) changes with knee flexion

STANCE control
- Geometric lock in extension
- +/- 0-15° stance flex (SF)
- Release: load toe - effortless

SWING control
- Various – pneumatic/ hydraulic/ friction +/- ext assist
- Shortens mid swing
Free knee: polycentric
Geometric locking

Prescription

• Activity K1 – 3
• Require full hip extension
• Can accommodate any length and weak residuum

Examples

• Ossur Total knee
  – 1900: low, single cadence, no SF
  – 2000: moderate to high, cadence responsive, SF
  – 2100, moderate to extreme, cadence responsive, SF

• Medi
  – OHP3SF: K3, cadence responsive, SF
HOKL (free knees with optional lock)

Prescription: patients who may need locked knee for specific activity or who may want to have knee locked at times

Examples
Medi: OFM2, OFM1 (K1-2)
Ossur: Balance knee (low)
Endolite: ESK + MKL (K1-3)
Ottobock: 3R93 (M1-2)

Divers and Scott 2006
## Contents

Review of normal gait

Implications for gait training

Prosthetic knee issues

### Points for Gait Training

| Patient must learn full weight transference with maximum lateral shift of the pelvis. |

| Patient will require good ipsilateral gluteus medius strength to control pelvic stability. It is crucial that gluteus medius is strengthened to function well isometrically, concentrically and eccentrically. This work should be started as soon as possible. |

| Re-educate hip extension and anterior pelvic shift with upright posture and normal lumbar lordosis. Ensure patient understands how his/her prosthetic knee is stable e.g. weight activated lock, geometric lock for full weight bearing and how to augment knee stability by generating a hip extension moment if required. |

### Task II: Single Limb Support/progression *Midstance (MS)*

#### Objective:

- Begins stance limb support i.e. full weight bearing requiring maximum stability
- Forward trunk and stance limb progression
- Raise body – increase clearance for swing of contralateral leg.

#### Second Rocker:

- **Ankle**
  - Pelvis: Maximum lateral shift resulting in a hip adductor moment controlled by eccentric contraction of ipsilateral gluteus medius *(see above diagram)*
  - **Hip:** Extension
  - **Knee:** Extension to - 5°
  - **Ankle:** Dorsiflexion
  - **GRF:** Initially through the hip and posterior to the knee, giving a knee flexion moment, then anterior to the knee and ankle giving a knee extension movement.
  - **Muscles:** Quadriceps and soleus early MS then just soleus once GRF moves anterior to the knee.

#### Mid Stance

- Requires maximum knee stability which can be provided prosthetically in several ways:
  - Alignment
  - Knee mechanics e.g. Geometric lock, weight activated lock and augmented as necessary by active hip extension.
Goal of gait training is to achieve:

- Safety
- Function
- ‘Energy efficient gait based on normal physiological walking patterns.’ Broom head et al 2003
Checklist

- Hip flexion +/- abd accommodated
- On properly
- Fitting properly: correct socks
- Length correct
- Suspension holding
Normal Gait Perry 2002
3 Tasks, 8 phases

Weight Acceptance
- Initial Contact
- Loading Response

Single limb support
- Mid stance
- Terminal stance

Limb advancement
- Preswing
- Initial, Mid and Terminal swing
Normal Gait requires normal movement and control pelvis

5 degrees of movement in each plane as it yields to body weight in stance and follows the advancing limb in swing  Perry 1992

Shift: ant and lat
Rotation: ant /post
Tilt: ant /post
Obliquity
Task 1: Weight Acceptance

Initial Contact

Objective: positioning limb for stance
- Pelvis: ant rot
- Knee: extended
- GRF ant to knee
- Pros knee issues: none
Gait Training: initial contact

• Knee extended
• Soft heel contact
• Equal stride length
• Active ipsilat hip extension
• Arm swing! (ipsilat arm behind)
Task 1: Weight Acceptance

Objectives
- Optimum weight acceptance
- Shock absorption
- Weight bearing stability

1st Rocker: calcaneum

Pelvis: ant/lat shift

Knee: flexing to 18°

GRF: Ant. to hip and post. to knee

Pros knee issues: ? Knee flexion (SF)
Gait training: Loading Response

• No Pros LR knee flex: extend hip
• Pros LR knee flex (SF): teach ‘bounce’
• Glut max firing: hip extending, ant pelvic shift
Task 2: Single Limb Support  

*Midstance*

- **Objectives:**
  - max. WB stability
  - Raise body - \( \uparrow \) clearance for swing
- **2\textsuperscript{nd} Rocker:** Ankle
- Pelvis: max lat shift
- *Knee:* Extension to \(- 5^\circ\)
- *GRF:* Initially through hip and posterior to knee then ant to knee
- Pros knee issues: ?how stable
Gait training

- Full weight bearing (avoid elbow crutches)
- Trust! (patient understands knee)
- Ant pelvic shift and hip ext (normal lordosis)
- Posture and body position+++
Gait training: midstance

Max lat pelvic shift
(good ipsilat glut med strength to control hip add moment)
Foot position
Task 2: Single Limb Support  

**Terminal Stance**  

**Objectives:**
- Begin knee flexion for swing
- Single limb support

- **3rd Rocker:** forefoot
- **Pelvis:** post rot
- **Knee:** Extension to flexion (just begins)
- **GRF:** ant to knee moving just posterior to knee and hip
- **Pros knee issues:** allows knee flexion under load
Gait training: terminal stance

- Full weight bearing
- Anterior pelvic shift with hip extension
- Weight onto forefoot
Task 3: Swing limb advancement

Preswing

- **Objective**: Position limb for swing
- **4th Rocker**: Toes
- **Pelvis**: ↑ post rot, obliquity, ↓ lat shift
- **Knee**: Passive flexion to 40°
- **GRF**: behind the knee and hip
- **Pros knee issues**: ?flex under load, ?how stance stability released
Gait training: preswing

Free knee

- Hip must get ahead of knee
- WT onto toes
- Prosthetic knee destabilised
- 40° passive knee flex
- Pelvic obliquity
Gait training: preswing

Locked knee

• Must initiate swing with hip hitching
• Correct forward trunk lean/ ‘pulling along bars’
Task 3: Swing limb advancement

Initial Swing

Mid Swing

Terminal Swing

Objectives: Advance limb, clearance, controlled acceleration and deceleration
Pelvis: > obliquity gradually reducing then increasing, increasing ant rot
Knee: flexes to 60° then begins extending at MSw to full knee extension at TSw
Pros knee issues: ?cadence responsive, ?shortens
Gait training: swing

- Dissociated hip flexion
- Early hip extension to control step lengths
- Target practise
- Clearance
- Resist pelvis to strengthen ant rotation
Gait training tools

- Parallel bars
- Line
- Mirror
- SPACE
- Camera / Silicone coach
- Treadmill
- Ramp
- Stairs
Gait training: Swing phase
Reciprocal arm movement
5. Practical demonstration
Take home 😊

5 point pre-walking check
• Residuum: appearance, hip extension ROM (+ strength)
• Don correctly
• Good fit (correct socks, comfortable)
• Correct length
• Suspension holding

Key gait training knee questions
• Locked or free
• If free: -
  – ?stance flexion
  – ?stance control
  – ?release for stance
  – ?cadence responsive

*If in doubt speak with your prosthetist*


Any questions?
Thank you for your attention.
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