Post-operative Management following Orthopaedic Surgery for Common Knee Surgeries:

“Evidence-based & Clinically Designed Rehabilitation Leads to Better Outcomes”

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CONTENT

MODULE 1 Lecture: Introduction of common knee pathologies/injuries, associated orthopaedic surgery and post-operative rehabilitation/management.

Practical Break: use of NMES in orthopaedic knee rehabilitation.

MODULE 2 Lecture/Practical: Initial post-operative review and patient education.

MODULE 3 Practical: Progressive, knee-based mobility, flexibility and strength home exercise rehabilitation.

MODULE 4 Lecture: Complications of orthopaedic knee surgery.

MODULE 5 Lecture/Practical: Functional aids and gait assessment in the post-operative care of orthopaedic knee surgery patients.

MODULE 6 Lecture: Hydrotherapy for orthopaedic knee surgery.

MODULE 7 Lecture/Practical: Pre- and post-operative imaging and clinical assessment for orthopaedic knee surgery.

APPENDICES
1. Common Subjective and Objective Tools to Assess the Knee
2. Knee Injury and Osteoarthritis Outcome Score (KOOS)
3. Knee Pain Scale Questionnaire (KPS)
4. Short Form Health Survey (SF36)
5. Berg Balance Scale (BBS)
6. Fullerton Advanced Balance Scale (FABS)
7. Radiological Assessment of the Knee: Definition of Terms
Module 1

Introduction of common knee pathologies/injuries, associated orthopaedic surgery and post-operative management.
Overview

- Common Knee Surgeries
  - Ligament Reconstruction
  - Meniscus Pathology
  - Articular Cartilage Pathology
  - Tibio-femoral Re-alignment
  - Patello-femoral Re-alignment
  - Joint Replacement

- Anatomy
- Biomechanics
- Injury Mechanism
- Injury Assessment
- Surgery
- Post-operative Care

Anterior Cruciate Ligament (ACL)

- Posterior femur to anterior tibia
- Two bundles (Girgis 1975)
  - anteromedial (tight in flex/ext)
  - posterolateral (tight in ext)
- Functions;
  - screws home tibia (ER) on femur in knee extension
  - prevents anterior tibial translation
  - prevents hyperext, varus & valgus
  - minimizes rotation

ACL Injuries

- Non-contact - 70% (Moeller 1997)
  - planting & cutting – fast deceleration, with or without pivoting (rotational force)
  - straight knee landing - jump & land in full knee extension
  - one step stop landing - with hyperextended knee (ACL stretched beyond limit)

- Contact - 30% (Amhein 1997)
  - posterior blow causes ant tibial translation
  - lateral blow causes rotational tibial force

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ACL Injuries

-Signs & Symptoms-

- Restricted ROM & Effusion
- Joint tenderness
  - lateral joint
  - medial joint (meniscus?)
- +ve anterior drawer
- Imaging
  - X-ray (ligament avulsion fracture)
  - MRI
    - bone bruise (LFC), >80% (Beynnon, 2005)
    - may slow rehabilitation progression
    - associated soft tissue injuries

Imaging

- X-ray (ligament avulsion fracture)
- MRI
  - bone bruise (LFC), >80% (Beynnon, 2005)
  - may slow rehabilitation progression
  - associated soft tissue injuries

ACL Injuries

-Surgical Treatment-

- Surgical Reconstruction
  - Autografts
    - Patella Tendon
    - Hamstring Tendon
    - LARS/Hybrid
  - Dependent on;
    - Age
    - Degree of instability
    - Associated abnormalities
    - Return to sport
    - Occupation

Surgical ACL Management

-Patella vs Hamstring Tendon-

Hamstring Tendon
- accelerated early patient recovery
- healing of tendon graft may be delayed & weaker (Dovinog, 2005)
- ↑ laxity (Freedman, 2003; Feller, 2003; Bizzini, 2006)
- potential for development of hamstring scar tissue formation

Patella Tendon
- more ‘physiological’ (bone-tendon-bone)
- most common choice of the professional athlete (Bartlett, 2001)
- donor morbidity – patella tendinopathy & AKP (Aglietti, 2004; Matsumoto, 2006)
- patella baja (‘low-riding’ patella, tight infrapatellar soft tissues)
- no difference in stability, ROM, thigh atrophy & symptoms at 2-3yrs
  (Corry, 1999; Eriksson, 2001)
LARS - Ligament Augmentation & Reconstruction Surgery

- Stability ↓ Morbidity
- Faster Recovery

Lars Ligament ↓

Hamstring Graft ↓

Patella (BTB) Graft ↓

Stability ↑ Morbidity

Slower Recovery

ACL Reconstruction - Advances in ACL Management

- Advances in surgical techniques
  - open arthroscopy: arthroscopic
- Better graft fixation techniques
- ↑ understanding of graft strength
- Post-operative Rehabilitation
  - accelerated rehabilitation
    - Shelbourne, 1990; Howell, 1996; Beynnon, 2005
  - complete immobilization: protected mobilization
  - return to sport (12mo - 6-9mo)

ACL Reconstruction - Post-operative Rehabilitation

- Phase 0 – Prehabilitation
- Phase 1 – 0-2wks post-surgery
- Phase 2 – 2-12wks post-surgery
- Phase 3 – 3-6mo post-surgery
- Phase 4 – 6-12mo post-surgery

ACL Reconstruction - Phase 0: Prehabilitation

- Eliminate/minimize swelling
- Restore ROM
- Maintain gait quality, muscle strength & activation
- Patient education
- Time from injury to surgery is debateable?
  - post-operative arthrofibrosis is ↓ by postponing surgery until near full motion has been achieved (Shelbourne, 1991; 1995)
  - patients with good pre-op ROM, leg control, mental state & ↓ swelling, have improved recovery, regardless of time to surgery (Shelbourne, 1995)
  - recently: comparable knee ROM with either early or delayed ACL surgical reconstruction (Bottini, 2008)

ACL Reconstruction - Graft Regeneration

Scaffold
- strongest in 1st wk
- tendon dies over 8wks
- only scaffold remains
- re-establishment of blood supply (12-15mths)

Ligament Ingrowth
- movement stimulates revascularization & fibroblastic changes
- controlled exercises & normalized gait patterns direct correct orientation of newly laid down collagen
ACL Reconstruction -Phase 1: 0-2wks-

- PWB > FWB
  - 'NWB' vs 'WW' as tolerated: similar clinical & functional outcomes (Tyler, 1998; Jorgensen, 2000)
- Restore ROM (0-100°)
  - early motion; pain & adverse changes in articular cartilage, while preventing scar tissue formation (Buckwalter, 1995)
- Eliminate swelling
  - cryotherapy (Konrath, 1996)
  - remedial massage
- Patella Mobilisation
- Bracing???

ACL Reconstruction -Phase 1: 0-2wks-

Knee Bracing (rehabilitation)

- Debateable (short- vs long-term outcomes?)
- Short term
  - ↓ pain, swelling & prevalence of hemarthrosis (Brändsson, 2001)
- Long term
  - no differences in joint laxity, activity level, ROM, strength, pain & functional performance at 1 & 2 yrs post-op (McDevitt, 2004; Birmingham, 2008)
  - not necessary following ACL recon (Wright, 2008)
- May be beneficial for partial ACL tears?
  - biomechanical reinforcement (Bayley, 1992; 1997)
  - proprioceptive enhancement (Cook, 1999)

ACL Reconstruction -Phase 1: 0-2wks-

Restoring ROM (0-100°)

- flexion: CPM, active heel slides (with assistance), rower slides
- extension: passive extension, prone leg hangs

Hydrotherapy (ROM, gait retraining)

ACL Reconstruction -Phase 1: 0-2wks-

Lower limb strengthening

- Isometric quads/VMO activation (20° flexion)
  - ACL under tension at full extension
  - Neuromuscular electrical stimulation
    - ↑ gait normality & extensor strength post-ACL
    - (Snyder-Mackler, 1991; 1995)
  - Prone knee flexion
  - Supported calf raises (bilateral) & ankle ROM
  - Hip abd/add/ext

ACL Reconstruction -Phase 2: 2-12wks-

- No swelling
- Restore ROM
  - full knee extension
  - flexion (0-130°)

Lower limb strengthening

- bridging activities
- hip abd/add/ext/flex
- terminal knee extension (wgt)
- introduce leg curls, leg press (double/single)
- functional activities (partial squats, lunges, step ups/downs; bike)
- ↑ emphasis on good quality eccentric activities

Hydrotherapy (introduce functional activities)

ACL Reconstruction -Phase 2: 2-12wks-

Lower limb stretching

- gastroc, soleus, hamstrings, quads, gluts, ITB
Balance & control exercises
- wobble boards, mini-tramp, hydro pool etc.

ACL Reconstruction - Phase 2: 2-12wks-

ACL Reconstruction - Phase 3: 3-6mo-
- Restore full ROM (flexion & extension)
- Restore full strength/power
  - ↑ reps, weights & difficulty
- Return to "restricted" sport-specific drills
  - Trampoline work (ie. jogging)
  - Jogging, running

ACL Reconstruction - Phase 4: 6-12mo-
- Return to sport
  - Specific strength, power & agility

ACL Rehabilitation - Research: "the old" -

1. Accelerated rehabilitation detrimental?
   - ↑ rate of AP displacement (Aglietti, 1995; Bynum, 1995)
   - may need early protection of co-existent pathology
     - 71-85% of patients who sustain an acute ACL rupture,
       also sustain bone bruises/lesions (Rossen, 1991; Graf, 1993)

2. OKC exercises detrimental?
   - ↑ AP displacement (Beynnon, 1996; Heijne, 2007)
   - directly stresses ACL graft (Henning, 1985; Bynum, 1995)

ACL Rehabilitation - Research: "the current" -

1. Accelerated rehabilitation favoured
   (Shaw, 2002; Risberg, 2004; Beynnon, 2005)

2. Bracing: not required, immobilization detrimental
   (Byeun, 2005; Morrin, 2005; Harilainen, 2006)

3. Immediate ROM & WB: safe, ↓ AKP, facilitates better cartilage nutrition & collagen reorganization
   (Shaw, 2002; Risberg, 2004; Beynnon, 2005)

4. OKC quad exercises: safe, no laxity differences & ↑ effective than CKC in restoring quad strength
   (Bynnon, 2005; Tagesson, 2005; 2007; Trees, 2006)

ACL Rehabilitation - Key Considerations-

The primary goal of all ACL rehab is to initiate knee motion as early as possible to prevent atrophy & arthrofibrosis (Finsal, 1991)

However, rehabilitation should not:
- ↑ swelling & inflammation
  - soft tissues react negatively to being over-stressed
  - may ↓ scar tissue formation, quad atrophy & ↓ ROM
- jeopardize the integrity of graft fixation sites or place the limb in ranges known to ↓ excessive ACL tension (Grunski, 2008)
- foster muscle fatigue
  - ↑ knee joint instability (Skinner, 1986)
  - jeopardize healing of the new graft (Kissel, 2001)

OKC & CKC must be used appropriately (Fitzgerald, 1997)

OKC
- Quads 'neutral angle' = 60-75° (Sawhney, 1990)
- OKC quads = 60° = anterior tibial shear
- OKC quads = 75° = posterior tibial shear

CKC
- Axial compression ↓ joint stability & ↓ displacement (Markolf, 1981)

Need for individualized, evaluation-based rehabilitation
Posterior Cruciate Ligament (PCL)

- Anterior femur to posterior tibia
- Primary knee stabiliser
- 2x thicker/stronger than ACL
- Two thick bands
- Anterolateral (tightens in flex)
- Posteromedial (tightens in ext)
- Functions
  - Prevents posterior tibial translation
  - Prevents excessive flexion, extension & hyperextension

PCL Injuries

Signs & Symptoms
- poorly defined pain (generally posterior)
- minimal swelling (extrasynovial structure)
- +ve posterior drawer test
- Imaging
  - X-ray (ligament avulsion fracture)
  - MRI (tear severity, additional damage to posterolateral structures, cartilage/bone)

PCL Injuries

Surgical Treatment
- 60% ruptures result in additional posterolateral disruption (Hames, 1998)
- 52% ruptures have associated chondral damage (Hamada, 2000)
- 83% incidence of bone bruising after acute ruptures (Mar, 2004)

Surgical Reconstruction (posterolateral damage, ↑ rotatory instability)

PCL Reconstruction

- Post-operative Rehabilitation
  - Phase 0 – Prehabilitation
  - Phase 1 – 0-2wks post-surgery
  - Phase 2 – 2-12wks post-surgery
  - Phase 3 – 3-6mo post-surgery
  - Phase 4 – 6-12mo post-surgery

PCL Reconstruction

- Phase 0: Prehabilitation
  - Eliminate/minimize swelling
  - Restore ROM
  - Maintain gait quality, muscle strength & activation
  - Patient education
  - Post-operative treatment - slow & deliberate rehabilitation (Fanelli, 2008)
PCL Reconstruction
-Phase 1: 0-2wks-
- NWB
- Knee brace (locked in extension, 3-6wks)
- Eliminate swelling
  - cryotherapy & remedial massage
- Patella Mobilisation
- Restore 'Passive' ROM (0-30°)
  - early motion; pain & adverse changes in articular cartilage, while preventing scar tissue formation (Buckwalter, 1995)
- NO hamstring activation

PCL Reconstruction
-Phase 2: 2-12wks-
- NWB (6wks) > PWB (7-10wks) > FWB (10wks+)
  - wk7 (25%), wk8 (50%), wk9 (75%), wk10 (FWB)
- No swelling
- Restore ROM (as of wk6)
  - full knee extension/flexion
Lower limb strengthening
- No OKC or active hamstring strengthening
- 2-4 wks: SLR, hip abd/add/ext/flex
  - activities in full knee ext
- 4-8 wks: calf raises (wk 8), CKC quads
- 8-12 wks: cycling (↑ seat), TLE (↓ wgt)

PCL Reconstruction
-Phase 3: 3-6mo-
- Restore full ROM (flexion & extension)
- Restore full strength/power
  - ↑ reps, weights & difficulty
  - no active hamstrings for 6mo
- Return to 'restricted' sport-specific drills
  - Trampoline work (ie. jogging)
  - jogging, running
-Phase 4: 6-12mo-
- Return to sport
  - Specific strength, power & agility

PCL Reconstruction
-Phase 1: 0-2wks-
- Hydrotherapy
  - Passive ROM & gait retraining
Lower limb strengthening
- Isometric quads/VMO activation
- Neuromuscular electrical stimulation

PCL Reconstruction
-Phase 2: 2-12wks-
- Lower limb stretching
  - gastroc, soleus, hamstrings, quads, gluts, ITB
Hydrotherapy (ROM, gait, functional & balance tasks)
Balance & proprioception exercises
  - wobble boards, mini-tramp, hydro pool etc.

Medial Collateral Ligament (MCL)
- Functions (support medial knee)
- Tight in extension, only anterior portion tight in flexion
- MFC to MTC (has attachment in medial meniscus)
MCL Injuries

- Valgus force (a "blow" to the outer leg)
- 90% knee ligament injuries are ACL, MCL, or combined (Miyasaka, 1991)

MCL Treatment

- Isolated I/II/III MCL ruptures can be treated conservatively (Baker, 2004; Miller, 2003)
- ACL & Grade III MCL treatment debateable
  - Surgical repair of both ligaments (Anderson, 1992)
  - Surgical MCL, conservative ACL (Frolich, 1998; Shirakura, 2000)
  - Surgical ACL, conservative MCL (Millet, 2004; Halinen, 2006)
  - Combined conservative treatment (Joki, 1984)

Post-op Management

Isolated MCL

- Initial RICE, ↓ pain & swelling
- NWB 2wks, then WB as tolerated
- Brace options:
  - hinge brace, 30-90° (Phisitkul, 2006)
  - unloader brace (protect from valgus stress)

Combined ACL/MCL

- delayed WB, hinged brace
- ROM initiated 3wks (Edson, 2006)

Menisci

- fibrocartilaginous ‘wedges’
- ↑ congruence & contact area of T/F joint;
  - assist in joint stability/lubrication
  - shock absorbers
  - proprioceptive feedback?
- Lateral meniscus: covers LTC, oval shaped, thicker, shorter, mobile
- Medial meniscus: covers MTC, C-shaped, larger & thinner, ↓ mobile, provides attachment for MCL

Meniscal Injuries

- ↑ shear stress generated in knee flexion/compression, combined with femoral rotation (DeHaven, 1997)
- Medial meniscus ↑ injury prone (Pyne, 2002)
- ↓ mobility (attachment to MCL & joint capsule)
Meniscal Injuries - Signs & Symptoms -

- Dependent on tear severity

Signs & Symptoms
- Tenderness on palpation (joint line, 45-90°)
- Joint effusion
- Restricted ROM
- Pain (location dependent)
- Clicking, catching &/or locking, +ve McMurray’s

Meniscal Injuries - Treatment -

Conservative
- Meniscectomy
- Meniscus repair

Surgical
- Need to preserve as much as possible
- Outer 1/3 has blood supply (↑healing)

Meniscal Imaging

Meniscectomy

Meniscus Repair

Meniscectomy - Rehabilitation -

- Eliminate swelling
  - cryotherapy & elevation
  - remedial massage
- Early restoration of ROM
  - Immediate cycle ergometry improves early outcome (Kellin, 2009)
  - Early motion; pain & adverse changes in articular cartilage, while preventing scar tissue formation (Buckwalter, 1995)
- WB as tolerated
- Patella Mobilisation
Meniscus Repair -Rehabilitation-

- Dependent on repair type/location
  - peripheral vs central repairs
  - radial tears prone to disruption
  - adjunct procedures?
- Avoidance of impact, OKC & rotational activities (4-8 wks)
- WB avoidance/restriction imperative
  - Peripheral: TT for 1-2wks, FWB by 4wks
  - Central: TT for 2wks, 50% for 4-6wks, FWB by 7-8wks

Meniscus Repair -Rehabilitation 0-4 wks-

- Eliminate swelling
  - cryotherapy, elevation, remedial massage
- Early restoration of ROM
  - early motion ↓ pain & adverse changes in articular cartilage, while preventing scar tissue formation (Buckwalter, 1995)
- Hinge brace (2wks locked in extension, 90° 4-6wks)
- Patella Mobilisation, circulatory exercises
- Hydrotherapy
- Strength
  - isometric quads, SLR exercises
  - peripheral: initiate WB & CKC exercises (squats, calf raises)

Meniscus Repair -Rehabilitation 4-8 wks-

- Introduce weighted OKC exercises (avoid TLE)
- Introduce modified CKC exercises
  - partial squats, calf raises etc.
- Full restoration of ROM
- Wean off brace 6-8 wks
- Caution: hyperextension with anterior repairs, deep flexion with posterior repairs

Meniscus Repair -Rehabilitation 8-12 wks-

- Introduce cycling
- Progress functional & proprioceptive exercises (activity specific)
- Introduce lateral & rotational exercises

-Return to Sport (6-12mo)-

- Running 5-6 months (Hekkmann, 2006)
  - based on pain & strength profile
- Initial programming
  - walk-run-walk
  - initiated & progressed from ¼ normal run speed
  - straight line only, progress to lateral/cross-cut

Articular Cartilage

- Covers bones in moveable joints, ↑ SA & load support
- Unique biomechanical & biochemical qualities enable near frictionless movement
- Limited repair capacity
  - No nerve & blood supply
  - Derives nutrients from synovial fluid (mainly) & bone plate

Articular Cartilage Injuries

Common causes
- sports or work related trauma
- joint instability (ie. ACL)
- meniscal deficiency
- mal-aligned joint – deformity (varus/valgus)
- obesity
- genetic pre-disposition / biologic
Articular Cartilage Injuries

Areas of Damage
- WB femoral condyles (LFC & MFC)
- WB tibial plateau
- patella & trochlea

Signs & Symptoms
- joint pain
- swelling
- crepitus
- ‘catching’ in the knee

Articular Cartilage Repair - Treatments -

Conservative
- Pharmaceutical
- Exercise & wt management

Surgical
- Debridement
- Focal Resurfacing (HemiCAP®)
- Osteochondral graft / mosaicplasty
- Microfracture
- MACI (matrix-induced autologous chondrocyte implantation)

Debridement

Focal Resurfacing

Mosaicplasty

Microfracture
Matrix-induced Autologous Chondrocyte Implantation

Cartilage ‘regeneration’ technique (not ‘repair’)

**Step 1**
- cartilage cells harvested and multiplied
- cells seeded on synthetic collagen membrane

**Step 2**
- defect is cleaned
- seeded membrane cover is cut to size
- membrane cover is glued into place

MACI – Open Arthrotomy
Rehabilitation following Cartilage Repair

- Maturation Process

Diagrammatic View

MRI View

Arthroscopic View

Rehabilitation following Cartilage Repair

- Maturation Process
- Knee Biomechanics

Rehabilitation following Cartilage Repair

- Maturation Process
- Knee Biomechanics
- Adjunct Surgical Procedures
- Patient Individuality
- Evidence-Based?
Rehabilitation Elements of Cartilage Repair

1. Motion
   - improve matrix production & cell differentiation (Farr 2011; Salter 1980)
   - improve proteoglycan/collagen organisation (Reinhold 2006; O’Driscoll 1986)

2. Strengthening
   - with caution if activity loads implant site (Nho, 2010)
   - strength exercises must accommodate maturation process

3. WB
   - following cartilage repair, WB surface demonstrates organized hyaline cartilage, non-WB demonstrates fibrocartilage (Peterson 2002)

Post-operative Loading

Mechanical Environment
(Fitzgerald, 2004; Torzilli, 1997)

Dynamic/ cyclic loading
(Gouch, 2001; Elder, 2000; Buchmann, 1999)

Static compression/ immobilization
(Fitzgerald, 2004; Regan, 2000; Grumbles, 1995)

ANABOLIC

CATABOLIC

Cartilage Repair Rehabilitation

• PWB & controlled exercise
  (Gillogly, 1998; Hambley, 2000; Robertson, 2004)

• How is WB achieved?

Modifying patient gait

Standard bathroom scales
(Gray, 1998; Hambley, 2000; Ebert 2008)

Phase 1 (Wk 1)

• Circulation & isometric activities, passive knee flexion exercises, cryotherapy

• CPM:
  - improve matrix production & aid cell differentiation (Farr 2011; Salter 1980)
  - improves proteoglycan & collagen re-organization (Reinhold 2006; O’Driscoll 1986)

• Crutch & WB education, knee brace fitting

Phase 2 (Wk 2-3)

• Commencement of out-patient rehabilitation
  - Introduction of active knee flexion, NMES, straight leg activities
  - Introduction of soft tissue & patella mobilisation, remedial massage & hydrotherapy

Phase 1-4 (0-12 wks)

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<td>Unloader Brace (deg)</td>
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Phase 3 (Wk 4-6)
- Progress strength-based activities
- Introduce WB & flexibility exercises, recumbent cycling

Phase 4 (Wk 7-12)
- Commence proprioception activities
- Introduction of functional hydro exercises

Phase 5 (3-6 mo)
- Progress to more demanding CKC exercises, rowing ergometry/elliptical trainers

Phase 6-7 (6-12 mo)
- Increasing difficulty/functionality
- Introduce ↑ WB activities

Return to Sport?

TF Malignment
- Neutral alignment
  - Axis - mid femoral head to mid ankle
  - 60-70% BW transmitted through medial compartment (Andriacchi, 1994)
- Varus knee: axis passes medially, ↑ load
- Valgus knee: axis passes laterally

Open Wedge High Tibial Osteotomy (OW HTO)

Advantages
- simple
- automatically tightens lax MCL
- avoids tibiofibular & peroneal nerves

Disadvantages
- limb lengthening
- donor site morbidity
- delayed union/non-union?
Closing Wedge
High Tibial Osteotomy (CW HTO)

Advantages
- ↑ healing rate
- lower complication rate

Disadvantages
- limb shortening
- LCL laxity
- ↑ Q angle

HTO -Rehabilitation-

0-2 wks
- Immediate RICE
- Immediate ROM (heel slides, CPM), circulation & patella mobilization (Noyes, 2006)
- Brace (full ext): 6 wks
  - Removed for exercises, CPM, hydro only
  - ROM 0-90

2-4 wks
- ROM 0-120+
- SLR activities

HTO -Rehabilitation-

4-6 wks
- Progress SL exercises, introduce stationary bike
- ROM 0-135+
- Brace (unlocked for ambulation, off for sleeping)
- Introduce CKC WB tasks (calf raises)

6-12 wks
- X-ray (radiographic evidence of healing)
  - Introduction of OKC WB tasks (leg press, modified squats, steps)
  - Introduction OKC hamstrings (7-8 wks)
  - Balance/pro proprioception (9-12 wks)

3-12 mo
- Progress OKC and CKC activities, progression to return to activity
- Return to running 6mo+

HTO -Rehabilitation-

Weight Bearing (WB)

- Traditionally – Conservative!
- Importance of early repair
- Altered angulation/rotation will affect limb alignment
- Open Wedge: concerns of force capabilities of fixation (Brinkman, 2008)

- Current
  - New implants offer superior stability
  - Early stability & bone healing improved via “gap filling” (Brinkman, 2010)

Current Research
- FWB at 2wks, no complications (Takeuchi, 2009)
- Immediate FWB provided comparable pain & motion at osteotomy site, earlier return of knee function (Brinkman, 2010)

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Primary Factors:
- Trochlea dysplasia (shallow groove)
- Extensor mechanism malalignment
- Patella height
- Patella tilt
- Quad congruence/Q angle
- TT position

Secondary Factors:
- genu valgum, genu recurvatum, femoral anteversion, ligamentous laxity, sex

Surgery - PF Malalignment -
Lateral Retinacular Release
- arthroscopic surgery
- tight structures cut/released or lengthened (patella slides more centrally between femoral condyles)

Tibial Tubercle Transfer
↑ lateral TT = ↑ Q angle

TTT - Post-op Rehabilitation -
Wks 1-2
- Straight knee brace at all times
- No SLR— assistance with lifting of leg
- TT WB
- Commence gentle quad isometrics (wk 2)
- SL abd/add, hip extensors strengthening
- ROM 0-30/60 deg
- CPM (60 deg MAX)
- Deep water hydrotherapy

TTT - Post-op Rehabilitation -
Wks 3-4
- Hinged Knee Brace
- progress ROM to 90+ deg
- Isometric quad/co-contractions with VM focus
- NMES, co-contractions, spider kills etc.
- Machine based hip strengthening (no flexion)
- PWB 20-70% of BW (with brace)
**TTT - Post-op Rehabilitation - Wks 5-6**

- Progress to near full ROM
- Progress to full WB (with brace)
- SLR?
- Functional exercises in pool

**Wk 6+**

- X-Ray by surgeon to ensure bony integration
- Progress quad & associated exercise to improve strength & PFJ biomechanics
- Functional Exercises

**Osteoarthritis**

- Degeneration of articular cartilage
- Signs & Symptoms
  - Pain & stiffness
  - Swelling & inflammation
  - Poor mobility
  - Joint deformity
- Imaging (x-ray)
  - Unequal joint space narrowing
  - Osteophytes & sub chondral cysts

**OA Treatments**

- Patient education
  - Crutches, brace, orthotics
- Manage associated diseases
  - Diabetes, gout etc.
- Pharmacological
  - Analgesics (paracetamol)
  - Glucosamine & chondroitin
  - NSAID’s & Cox 2 inhibitors
  - Intra-articular corticosteroids
  - Viscosupplementation
- Exercise
- Surgery

**Surgical Treatment**

- Unicompartmental
  - Medial/Lateral
  - Patellofemoral
  - Unicondylar knee replacement
  - Tricompartmental
  - Tibial Osteotomy
  - Trochleoplasty
  - Total knee replacement

**Unicondylar Knee Replacement**

- Total Knee Replacement
- Trochleoplasty

**VIDEO – UKR**
**Post-operative Rehabilitation - In-patient -**

- ROM Slides
- Passive knee extension
- Static Quads
- SLR
- TLE
- Discharge
  - 90° flexion?
  - proficient SLR?

**Post-operative Rehabilitation - CPM -**

- In-patient: recent research suggests negative influence
- Out-patient: outcomes suggest not required
  (Beaupre’, 2001; Lenssen, 2008; Bruun-Olsen, 2009)
- Our experience?

**Post-operative Rehabilitation - General Aims -**

- Decrease swelling (RICE)
- Increase knee flex ROM to 110°+
- Ensure full extension
- Restore strength (esp. quads)
- Gait retraining
- Improve function in ADL

**Post-operative Rehabilitation - Wks 1-3 - Knee ROM -**

- Passive/active Extension
  - no resting with pillow/support under knee
  - promotes FPD
- Flexion ROM
  - active assisted exercise
  - should feel stretch – No pain
  - patient controls stretch intensity
  - long holds/stretch better than short duration

---

**TKR**

**Advantages**
- Minimally invasive
- Shorter recovery time
- ↑ knee ROM than TKR
- Retain cruciates (gait/kinematics)

**Disadvantages**
- ↑ revision rate than TKR
- Lateral overload?

**UKR**

**Advantages**
- Minimally invasive
- Shorter recovery time
- ↑ knee ROM than TKR
- Retain cruciates (gait/kinematics)

**Disadvantages**
- ↑ revision rate than TKR
- Lateral overload?
Post-operative Rehabilitation
Wks 1-3
• Quad Strength most affected
  • neuromuscular inhibition & prior disuse
• Joint able to tolerate ↑ load
  • considerable soft tissue pain (surgery)
• No leg extensions with ↑ load
  • ↑ TF & PFJ loads
• Hamstring & gastroc strength important
• Hip abduction/rotation strength
  • maintain good knee alignment

Post-operative Rehabilitation
Wks 4-6
• Critical period for ↑ ROM
• Proprioception & Gait Retraining

Post-operative Rehabilitation
Wks 4-6
• Progress knee & hip strength
• Loss of cruciates (quads & hams important)
• CKC recommended
• Hip abductors & external rotators

Post-operative Rehabilitation
Hydrotherapy
• ROM & Flexibility
• Strength & Function
• Proprioception
• Gait Retraining

Patient Satisfaction
• Pain relief: 72-86%
  • Function: 70-84%
• Primary reasons for dis-satisfaction
  • Expectations
  • Post-op complication
  • Pre-op pain at rest
  • Joint stiffness & gait abnormalities

(Bourne, 2009)
Module 2

Initial post-operative review & patient education.
Initial Post-operative Patient Review

1. Accumulate as much information as possible (patient, referral, hospital discharge letter, surgeons rooms if necessary)
   i. Surgery
   ii. Patient history (demographics, injury and surgery history)

2. Wound review
   i. Patient wound education (what is a good wound?)
   ii. Introduction of hydrotherapy

3. Oedema control
   i. RICE
   ii. Cryotherapy and tubi-grip/TED’s stocking
   iii. Role of remedial massage/lymphatic drainage

4. Assessment and progression of knee effusion

5. Assessment of knee ROM
   i. Dependent on surgery & post-operative timeline
   ii. Correct assessment of knee ROM (flexion and extension)

6. Brace fitting (if required)
   i. Types of braces (RS, hinge, unloader)
   ii. Initial settings and progression of brace ROM
   iii. Proper fitting, adjustment and alignment

7. Crutch education
   i. Correct height and adjustments
   ii. Types of crutches (axillary, forearm) – discussed later
   iii. Correct ambulation techniques (ie. stairs, bathroom etc.) – discussed later
   iv. Teaching of proficient WB ambulation
8. Analgesia

i. Why is pain control important?

ii. Poor pain controllers?

iii. Types

   - **Simple**: paracetamol (panadol)
     - safe without side effects
     - should be taking regularly in ‘anticipation’ of pain

   - **NSAIDs**: Ibuprofen (Neurofen), Diclofenac (Voltaren), Celecoxib (Celebrex: COX2?)
     - inhibit cycloxygenase: COX 1 & 2 (COX-1 protect stomach lining, COX-2 are produced with joint damage/inflammation)
     - side effects including stomach bleeding (be aware of reflux & stomach discomfort)

   - **Opioids**
     - short-acting (Endone/Oxycodone) or slow-release (Oxycontin)
     - side effects common including drowsiness, nausea, constipation
     - should not be driving

   - **Other**
     - Tramadol (Tramol): somewhere between paracetamol and oxycodone (short & long acting variations), for be used for excessive night pain
     - Sleeping tablets (Temazepam): condition dependent
     - Antibiotics

9. Review of early home exercises (dependent on surgery)
Module 3

Progression of knee based exercise rehabilitation program.
Knee Home-based Exercise Progressions - Practical

1. Strength & Neuromuscular Control
   - Isometrics
   - Straight leg
   - Multi-joint
   - Functional

2. Knee ROM & Flexibility
   - Mobilisation
   - Assisted
   - Active-assisted
   - Active ROM
   - Specific & general flexibility

3. Hydrotherapy (Module 6)
   - Gait
   - Balance & proprioception
   - Joint specific
     - ROM
     - Strength
   - Functional
### Hollywood Functional Rehabilitation Clinic

**KNEE PROGRAM - STRENGTH**

<table>
<thead>
<tr>
<th>Action</th>
<th>Sets:</th>
<th>Reps:</th>
<th>Details</th>
</tr>
</thead>
</table>
| **Isometric Quads** | | | - Whilst focusing on the quadriceps musculature, actively contract thigh musculature.  
- To accentuate vastus medialis, the foot may be externally rotated to 45°.  
- The use of neuromuscular electrical stimulation can be used to facilitate activation, particularly in the vastus medialis (placed over the VM muscle belly).  
- Hold for 5-10 seconds, then release. |
| **Co-contractions** | | | - Initiate hamstrings contraction, focusing on pushing heel into bed.  
- Subsequently, actively contract quadriceps.  
- Focus on maintaining both hamstring and quadricep contraction together.  
- Hold for 2 seconds, then release. |
| **Calf Press (Theraband)** | | | - Wrap the theraband (red, green or blue) around the ball of the foot, holding the ends in your hands.  
- With the leg straight, use the resistance provided by the band to actively plantar-flex (push toes out) the foot.  
- Dorsi-flex the foot (pull toes back) with control, under the load provided by the band, back to the start position. |
| **Thigh Abduction (Theraband)** | | | - Lie on your back.  
- Bend both knees and place your feet flat on the bed.  
- Wrap the theraband around your knees, and open your knees against the band resistance.  
- Hold the contraction for 3-10 seconds, and then return to start position slowly. |
| **Pillow Squeeze** | | | - In a seated or supine position, bend the knees to 90°, or what can be achieved.  
- Place a pillow between your knees.  
- Squeeze knees together as firm as comfortable, holding for 5-15 seconds. |
<table>
<thead>
<tr>
<th>Exercise</th>
<th>Sets: _____ Reps: _____ Wgt: _____</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Straight Leg Raise (SLR)</strong></td>
<td><img src="image1.png" alt="Image" /></td>
</tr>
<tr>
<td>- Bend knee of the non-affected side to flatten and support lumbar spine.</td>
<td></td>
</tr>
<tr>
<td>- Lock knee of the affected leg out straight and lift the leg to a height parallel to the bent knee.</td>
<td></td>
</tr>
<tr>
<td>- Lower the leg until it touches the bed, then lift again, ensuring the knee remains straight.</td>
<td></td>
</tr>
<tr>
<td><strong>45° Straight Leg Raises</strong></td>
<td><img src="image2.png" alt="Image" /></td>
</tr>
<tr>
<td>- Bend knee of the non-affected side to flatten and support lumbar spine.</td>
<td></td>
</tr>
<tr>
<td>- Lock knee of the affected side, and externally rotate the thigh by turning the toes outward to 45°.</td>
<td></td>
</tr>
<tr>
<td>- Lift leg to a height just below the opposite bent knee.</td>
<td></td>
</tr>
<tr>
<td>- Lower the leg under control.</td>
<td></td>
</tr>
<tr>
<td><strong>Hip Abduction</strong></td>
<td><img src="image3.png" alt="Image" /></td>
</tr>
<tr>
<td>- Lie on the non-affected side.</td>
<td></td>
</tr>
<tr>
<td>- Ensure the upper body is facing slightly downward.</td>
<td></td>
</tr>
<tr>
<td>- Whilst maintaining a straight leg, squeeze the gluteal musculature and slowly abduct (lift) the affected leg as far as comfortably possible.</td>
<td></td>
</tr>
<tr>
<td>- Lower the leg with control, ensuring the pelvis is stable throughout.</td>
<td></td>
</tr>
<tr>
<td><strong>Hip Adduction</strong></td>
<td><img src="image4.png" alt="Image" /></td>
</tr>
<tr>
<td>- Lie on the affected side.</td>
<td></td>
</tr>
<tr>
<td>- Bend the non-affected leg, and place it over and in front of affected leg, resting it on a large roller/pillow.</td>
<td></td>
</tr>
<tr>
<td>- With the affected leg straight, and toes pulled back, lift the thigh vertically.</td>
<td></td>
</tr>
<tr>
<td>- Hold at the top for 1-2 seconds, and then lower slowly.</td>
<td></td>
</tr>
<tr>
<td><strong>Hip Extension (Straight Leg)</strong></td>
<td><img src="image5.png" alt="Image" /></td>
</tr>
<tr>
<td>- Lie on your stomach.</td>
<td></td>
</tr>
<tr>
<td>- Whilst keeping the affected leg straight, lift it from the bed, holding the position for 2 seconds, then lower.</td>
<td></td>
</tr>
<tr>
<td>- Focus on maintaining knee extension, and avoiding rotation through the pelvis.</td>
<td></td>
</tr>
<tr>
<td><strong>Hip Extension (Bent Knee)</strong></td>
<td><img src="image6.png" alt="Image" /></td>
</tr>
<tr>
<td>- Lie on your stomach.</td>
<td></td>
</tr>
<tr>
<td>- Bend the knee of the affected leg to 90°.</td>
<td></td>
</tr>
<tr>
<td>- Lift the affected leg from the bed, pushing the foot toward the roof, holding the position for 2 seconds, and lowering slowly.</td>
<td></td>
</tr>
<tr>
<td>- Focus on maintaining knee position, and avoiding rotation through the pelvis.</td>
<td></td>
</tr>
<tr>
<td>Exercise</td>
<td>Sets: _____ Reps: _____ Wgt: _____</td>
</tr>
<tr>
<td>--------------------------------------</td>
<td>--------------------------------------</td>
</tr>
<tr>
<td><strong>Hip Abduction – Fig 4</strong></td>
<td>➢ Lie on the non-affected side.</td>
</tr>
<tr>
<td></td>
<td>➢ Slide the affected (top) leg up the non-affected (bottom) leg, bending the knee.</td>
</tr>
<tr>
<td></td>
<td>➢ Ensure the upper body is facing slightly downward.</td>
</tr>
<tr>
<td></td>
<td>➢ Keeping the foot of the top leg in contact with the bottom, squeeze the gluteal muscle and raise the knee as far as possible.</td>
</tr>
<tr>
<td></td>
<td>➢ Ensure the pelvis is stabilized throughout.</td>
</tr>
<tr>
<td><strong>Terminal Leg Extension (TLE)</strong></td>
<td>➢ Place a rolled up pillow under your knee (1).</td>
</tr>
<tr>
<td></td>
<td>➢ Push down into the towel and lift your heel off the bed until your leg is straight (2).</td>
</tr>
<tr>
<td></td>
<td>➢ Feel the inner quadriceps muscle to ensure a good quality contraction.</td>
</tr>
<tr>
<td></td>
<td>➢ Hold for 2-5 seconds, then lower slowly.</td>
</tr>
<tr>
<td></td>
<td>➢ The use of neuromuscular electrical stimulation can be used to facilitate activation, particularly in the vastus medialis (placed over the VM muscle belly) (3).</td>
</tr>
<tr>
<td><strong>Standing (or prone) Leg Flexion</strong></td>
<td>➢ Stand holding on to a chair for support.</td>
</tr>
<tr>
<td></td>
<td>➢ Slowly bend the heel of your affected knee up behind you toward your buttocks.</td>
</tr>
<tr>
<td></td>
<td>➢ Ensure the pelvis remains stable throughout.</td>
</tr>
<tr>
<td></td>
<td>➢ Hold for 2 seconds and lower.</td>
</tr>
<tr>
<td><strong>Seated Leg Extension (SLE)</strong></td>
<td>➢ Sit on a chair or fitball (for additional stability work) (1).</td>
</tr>
<tr>
<td></td>
<td>➢ Whilst ensuring good posture and pelvic stability, initially lift the foot off the ground (2).</td>
</tr>
<tr>
<td></td>
<td>➢ Then slowly extend (straighten) the affected knee until your leg is straight (3).</td>
</tr>
<tr>
<td></td>
<td>➢ Feel the inner quadriceps muscle to ensure a good quality contraction.</td>
</tr>
<tr>
<td></td>
<td>➢ Hold for 2-5 seconds, then lower slowly.</td>
</tr>
</tbody>
</table>
### Bridging

**Sets:** _____  **Reps:** _____

- Lie on your back with the knees bent to 90° and the feet flat on the floor, with arms resting by the sides (1).
- Lift the pelvis and trunk from the floor, until the trunk and thighs are aligned (2).
- Emphasis should be placed on good pelvic activation, control and spinal segmental movement.
- Hold the position for 3-10 seconds, breathing normally.
- Slowly lower the trunk and pelvis to the floor.
- Increase difficulty by placing arms on chest, or introducing an additional SLR, taking the BW through a single leg (3).

### Ball Bridging

**Sets:** _____  **Reps:** _____

1. Lie on your back, and place the heels on the top of the theraball (1).
2. With an exhalation, lift the pelvis and trunk from the floor (2).
3. Hold the position for 3 seconds, breathing normally.
4. Slowly lower the trunk and pelvis to the floor.
5. Increase difficulty by:
   - placing arms on chest (decrease stability).
   - incorporating straight leg raises from the bridge position (3).
   - incorporating ball rolls (hamstrings) from the bridge position (4).

### Spider Kills

**Hold:** _____  **Reps:** ______ or ______ mins

- Sit on a stable chair with knee bent at 70-90°.
- Press your heel into the floor to initially contract the quadriceps musculature.
- Use your fingers to feel for the quadriceps contraction, particularly through vastus medialis.
- From this position, slowly turn the toes out whilst holding quadriceps contraction and heel pressure.

### IRQ (Theraband)

**Sets:** _____  **Reps:** _____  **Wgt:** _____

- Stand facing the wall, one foot forward of the other, with the affected leg behind the non-affected leg.
- Ensure the affected knee is bent and the tubing/band is secured around the affected leg, above the knee.
- Allow the band to act as resistance, and gently push the knee back straight, taking the heel to the ground.
- Hold the position for 2 seconds.
- Slowly return to the starting position.
<table>
<thead>
<tr>
<th><strong>Exercise</strong></th>
<th><strong>Sets:</strong> _____ <strong>Reps:</strong> _____</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Heel Raises</strong></td>
<td><img src="image1" alt="Image" /> <img src="image2" alt="Image" /> <img src="image3" alt="Image" /></td>
</tr>
</tbody>
</table>
| ➢ Stand with both feet on edge of step, with the heels hanging off the edge (1).  
➢ Keeping the body erect, rise onto the forefeet (2).  
➢ Then slowly drop heels below level of step.  
➢ Repeat.  
➢ Use single leg for increased load (3). |
| **Deadlifts** | ![Image](image4) ![Image](image5) ![Image](image6) ![Image](image7) |
| ➢ Initially stand with feet shoulder width apart, and slight flexion (bend) in both knees.  
➢ Whilst maintaining a straight back, slowly lower your trunk toward the ground, maintain a straight back – the flexion should be generated from the waist/hips.  
➢ From the lowered position, squeeze through the hamstrings and gluteals and return.  
➢ Hold in front of the body for increased demand. |
| **Balance** | ![Image](image8) ![Image](image9) ![Image](image10) ![Image](image11) |
| ➢ Initially stand on a piece of foam or a pillow/cushion, on both feet and hip width apart.  
➢ Try to maintain your balance on the unstable surface, by keeping both feet parallel with the ground (1).  
➢ The balance activity can be made harder by:  
 ➢ decrease support base or close the eyes (2)  
 ➢ using one leg only, eyes open (3)  
 ➢ using one leg only, eyes closed (4). |
| **Balance** | ![Image](image12) ![Image](image13) ![Image](image14) ![Image](image15) |
| ➢ Stand on a duradisc (1) or wobble board (2), on both feet and hip width apart.  
➢ Try to maintain your balance on the unstable surface, keeping both feet parallel with the ground (1).  
➢ The balance activity can be made harder by:  
 ➢ closing the eyes  
 ➢ decreasing the support base (feet closer)  
 ➢ using one leg only (3 & 4). |
| **Wall (Ball) Squats** | ![Image](image16) ![Image](image17) ![Image](image18) |
| ➢ Stand with the back against a solid wall or fitball.  
➢ Place the heels about a thighs length from the ball/wall.  
➢ Place a ball/folded pillow between the knees and maintain a ‘squeeze’ (1).  
➢ Slowly lower the trunk until the knees are bent through a 60° range, progressing further as tolerated (2).  
➢ For variation, tie a theraband firmly around thighs and maintain a firm squeeze out against the band during the squat to engage gluteals (feet remain over feet). |
Wall (Ball) Lunges

Sets: ____ Reps: ____

- Lean against a fitball, with a foot about a thighs length from the ball, and the other tucked under the ball (1).
- Using the ball as support and keeping the back straight, lower the trunk until the front thigh is flexed through 60-90° (2), also bending the back knee.
- Tighten the thigh muscles as you return to the start.
- Neuromuscular electrical stimulation can be used to facilitate activation, particularly vastus medialis (3).

Unstable Squats

Sets: ____ Reps: ____

- Stand on an unstable surface (foam/pillow) with the feet shoulder width apart and even body weight through both legs.
- Slowly lower the trunk until the knees are bent through a 60° range, progressing further as tolerated (1).
- Ensure the knees remain in line with the feet, and do not progress any further forward than the toes.
- Progress difficulty by squatting on more unstable surfaces (ie. bosu ball) (2 & 3).

Unstable Lunges

Sets: ____ Reps: ____

- Stand in a lunge position, with the front (or back) foot on an unstable surface (foam/pillow) (1).
- Whilst keeping the back straight, slowly lower the trunk until the front knee is flexed through 60-90°, also allowing the back knee to bend.
- Tighten the thigh as you return to the starting position.
- Progress difficulty by lunging with both feet on unstable surfaces (2), or incorporating a change in front foot (3) or back foot (4) height.

Side Ball Lunges

Sets: ____ Reps: ____

- Stand side on to a solid wall, leaning on a fitball with the most distant foot about a thighs length from the ball (1), and the knee of the nearest foot slightly bent.
- Whilst keeping the back straight and not allowing the pelvis to rotate or sink, slowly lower the trunk until the distant knee is flexed through 30-90° (2).
- Tighten the thigh as you return to the starting position.
- Progress difficulty by moving support leg further away.

Decline Squats

Sets: ____ Reps: ____

- Stand on a decline surface with the feet shoulder width apart and even body weight through both legs (1).
- Slowly lower the trunk until the knees are bent through a 60° range (2), progressing further as tolerated (3).
- Ensure the knees remain in line with the feet, and do not progress too far in front of the toes.
- A decline squat will place a higher degree of load through the quadriceps and kneecap.
<table>
<thead>
<tr>
<th>Exercise</th>
<th>Sets: _____ Reps: _____</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Lateral ‘Drop-downs’</strong></td>
<td><img src="image1" alt="Image" /> <img src="image2" alt="Image" /></td>
</tr>
<tr>
<td>➢ Stand with the affected leg on a solid box/step, with the unaffected side hanging off the edge (a rail or stick can be used for support on the unaffected side (1).)</td>
<td></td>
</tr>
<tr>
<td>➢ Initially, lift the pelvis on the unaffected side, by contracting the musculature above the hip (this will ensure a level pelvis throughout the exercise).</td>
<td></td>
</tr>
<tr>
<td>➢ Slowly lower the trunk until the knee of the affected (weight bearing) side is bent through a 30° range (2), progressing further as tolerated.</td>
<td></td>
</tr>
<tr>
<td>➢ Ensure the pelvis remains levels, and the knee remains in line with the foot, not moving too far forward in front of the toes.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Lateral ‘Step-ups’</strong></th>
<th><img src="image3" alt="Image" /> <img src="image4" alt="Image" /> <img src="image5" alt="Image" /></th>
</tr>
</thead>
<tbody>
<tr>
<td>➢ Initially stand perpendicular to a step (step height = 10-15 cm) with the affected side closest to the step).</td>
<td></td>
</tr>
<tr>
<td>➢ Proceed to step up side-ways (1), ensuring the knee always remains on a line between the hip and foot (2).</td>
<td></td>
</tr>
<tr>
<td>➢ Emphasis should be placed on maintaining balance, correct upright posture, abdominal bracing, good knee alignment and pelvic/gluteal control.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Forward ‘Step-ups’</strong></th>
<th><img src="image6" alt="Image" /> <img src="image7" alt="Image" /> <img src="image8" alt="Image" /></th>
</tr>
</thead>
<tbody>
<tr>
<td>➢ Initially stand facing a step (step height = 10-15 cm).</td>
<td></td>
</tr>
<tr>
<td>➢ Proceed to step up straight ahead with the affected leg (1), ensuring the knee always remains on a line between the hip and foot (2).</td>
<td></td>
</tr>
<tr>
<td>➢ Emphasis should be placed on maintaining balance, correct upright posture, abdominal bracing, good knee alignment and pelvic/gluteal control.</td>
<td></td>
</tr>
<tr>
<td>➢ Neuromuscular electrical stimulation can be used to facilitate activation, particularly vastus medialis (3).</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Lateral ‘Step-downs’</strong></th>
<th><img src="image9" alt="Image" /> <img src="image10" alt="Image" /> <img src="image11" alt="Image" /> <img src="image12" alt="Image" /></th>
</tr>
</thead>
<tbody>
<tr>
<td>➢ Initially stand on a step (step height = 10-15 cm).</td>
<td></td>
</tr>
<tr>
<td>➢ Proceed to step down straight ahead with the unaffected leg (1), ensuring the knee always remains on a line between the hip and foot (2) – a rail or other support may be required to ensure good control.</td>
<td></td>
</tr>
<tr>
<td>➢ Emphasis should be placed on maintaining balance, correct upright posture, abdominal bracing, good knee alignment and pelvic/gluteal control.</td>
<td></td>
</tr>
<tr>
<td>➢ Neuromuscular electrical stimulation can be used to facilitate activation, particularly vastus medialis (4).</td>
<td></td>
</tr>
<tr>
<td>Exercise</td>
<td>Time:</td>
</tr>
<tr>
<td>---------------------</td>
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</tbody>
</table>
| Recumbent Bike      | _____ | _____| _____ | ➢ Sit on the modified cycle with the feet in the foot straps and the arms on the arm rests.  
➢ Perform a cycling motion with the legs, maintaining an appropriate speed.  
➢ Many recumbent bikes offer a more comfortable posture, and the ability to cycle at a reduced knee flexion and load. |
| Upright Bike        | _____ | _____| _____ | ➢ Sit on the stationary cycle with the feet in the foot straps and the arms on the arm rests.  
➢ Perform a cycling motion with the legs, maintaining an appropriate speed. |
| Row Ergometer       | _____ | SR:  | _____ | ➢ Sit on the rowing ergometer, with both feet fixed.  
➢ Actively slide the body forward until both knees reach a comfortable range, ensuring the back remains straight and both knees and feet remain in a straight line.  
➢ Pull the handle into your chest, whilst concurrently extending your knees, pushing out against the foot platform.  
➢ Inhale as you return to the start position. |
## Continuous Passive Motion (CPM)

<table>
<thead>
<tr>
<th>Time: _____</th>
<th>Maximum Range: ____</th>
</tr>
</thead>
<tbody>
<tr>
<td>➢ The Continuous Passive Motion (CPM) machine is designed to passively flex and extend the affected knee within a desired range dependent on the surgery and post-operative time-point, or as per specific instructions given by the orthopaedic specialist</td>
<td></td>
</tr>
</tbody>
</table>

## Passive Knee Extension

<table>
<thead>
<tr>
<th>Time: _____</th>
</tr>
</thead>
<tbody>
<tr>
<td>➢ Place a rolled up towel or pillow under the ankle, or place the foot on a chair or coffee table.</td>
</tr>
<tr>
<td>➢ Relax your leg, and allow your knee to straighten.</td>
</tr>
<tr>
<td>➢ Repeat as often as possible.</td>
</tr>
<tr>
<td>➢ A light weight may be placed over the thigh for increased pressure.</td>
</tr>
</tbody>
</table>

## Ankle Pumps

<table>
<thead>
<tr>
<th>Sets: _____</th>
<th>Reps: _____</th>
</tr>
</thead>
<tbody>
<tr>
<td>➢ Actively dorsi- (pull toes back) and plantar-flex (push toes out) both feet in an alternating fashion.</td>
<td></td>
</tr>
<tr>
<td>➢ This will ensure joint swelling is minimized, activating the fluid pump.</td>
<td></td>
</tr>
</tbody>
</table>

## Active Assisted Knee ROM

<table>
<thead>
<tr>
<th>Sets: _____</th>
<th>Reps: _____</th>
</tr>
</thead>
<tbody>
<tr>
<td>➢ Whilst sitting or lying on a bed or floor, loop a towel around your foot.</td>
<td></td>
</tr>
<tr>
<td>➢ Initially slide your heel towards your bottom, then pull with the towel until you feel a stretch in the knee.</td>
<td></td>
</tr>
</tbody>
</table>

## Active Knee ROM

<table>
<thead>
<tr>
<th>Sets: _____</th>
<th>Reps: _____</th>
</tr>
</thead>
<tbody>
<tr>
<td>➢ Whilst sitting or lying on a bed or floor, place a sock or tie a plastic bag on the foot of the affected limb.</td>
<td></td>
</tr>
<tr>
<td>➢ Actively slide your heel towards your bottom, then pushing the foot back out, extending the knee.</td>
<td></td>
</tr>
<tr>
<td><strong>Patella Mobilisation</strong></td>
<td>Sets: _____ Reps: _____</td>
</tr>
<tr>
<td>--------------------------</td>
<td>---------------------------</td>
</tr>
<tr>
<td>1.</td>
<td>➢ Using the thumb and forefinger, locate the medial and lateral borders of the patella.</td>
</tr>
<tr>
<td>2.</td>
<td>➢ Ensuring the quadriceps muscle is relaxed, and the knee fully extended, carefully move the patella side-to-side (1 &amp; 2), holding for 10 seconds medially.</td>
</tr>
<tr>
<td>3.</td>
<td>➢ Repeat this process proximal and distal (3 &amp; 4) to the body.</td>
</tr>
<tr>
<td>4.</td>
<td>➢ Ensure the quadriceps muscle is relaxed, and the knee fully extended, carefully move the patella side-to-side.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Ball Rolls</strong></th>
<th>Sets: _____ Reps: _____</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>➢ Lie on your back with the feet on a fitball and legs initially straight.</td>
</tr>
<tr>
<td></td>
<td>➢ Pull the ball back toward the buttocks, dragging the ball with the heels.</td>
</tr>
<tr>
<td></td>
<td>➢ Keep within a painfree range of motion.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Passive ROM (Rower)</strong></th>
<th>Sets: _____ Reps: _____</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>➢ Sit on the rowing ergometer, with both feet fixed to the foot rests, or flat on the ground.</td>
</tr>
<tr>
<td></td>
<td>➢ Actively slide the body forward until both knees reach a comfortable range, ensuring the back remains straight and both knees and feet remain in a straight line.</td>
</tr>
<tr>
<td></td>
<td>➢ Use your body weight to gently push further forward, bending the knees further, though maintain a pain free range of motion.</td>
</tr>
<tr>
<td></td>
<td>➢ Return to the start position, and repeat.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Hamstring Stretch</strong></th>
<th>Sets: _____ Hold (sec): _____ Per Day: _____</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>➢ Sitting on the side of the bed with your affected leg out straight.</td>
</tr>
<tr>
<td></td>
<td>➢ Whilst keeping the leg and back straight, and the toes pulled back toward the body, bend forward at the hips until the stretch is felt down the back of the knee/thigh.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Quadriceps Stretch</strong></th>
<th>Sets: _____ Hold (sec): _____ Per Day: _____</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>➢ Initially stand holding the back of a chair for balance.</td>
</tr>
<tr>
<td></td>
<td>➢ Place the foot of your affected leg on a chair or stool behind you (the height of which will depend on the degree of bend the knee can withstand).</td>
</tr>
<tr>
<td></td>
<td>➢ Stand up tall, and push hips forward until a further stretch is felt in the front of the thigh.</td>
</tr>
<tr>
<td></td>
<td>➢ Bend the supporting leg to further increase the stretch.</td>
</tr>
</tbody>
</table>
Gastroc/Soleus Stretch (Band) | Sets: _____ Hold (sec): _____ Per Day: _____
--- | --- | ---
1. Using a strap, belt or band around the forefoot, and with the knee initially straight, gently pull back the forefoot to stretch the calf (gastrocnemius) musculature (1).
2. This should also be repeated with a bent knee, to stretch the achilles/soleus (2).

Soleus Stretch (Bent Knee) | Sets: _____ Hold (sec): _____ Per Day: _____
--- | --- | ---
1. In a standing position, with the leg of the affected side behind and knee bent, gently move the body forward to feel a stretch in the Achilles/soleus region (1).
2. The heel should not leave the ground.
3. This stretch can also be achieved with the heel of the affected side hanging over a step (knee bent), using the body weight to gently ease into the stretch (2).

Calf Stretch (Straight Leg) | Sets: _____ Hold (sec): _____ Per Day: _____
--- | --- | ---
1. In a standing position, with the leg of the affected side behind and knee straight, gently move the body forward to feel a stretch in the calf/knee region (1).
2. The heel should not leave the ground.
3. This stretch can also be achieved with the heel of the affected side hanging over a step (knee straight), using the body weight to gently ease into the stretch (2).

Gluteal/Lumbar Stretch | Sets: _____ Hold (sec): _____ Per Day: _____
--- | --- | ---
1. Begin lying on your back, with one leg straight and the other bent to 90° in the hip and knee.
2. Use the opposite arm to the bent knee to gently pull the leg across the body as far as you comfortably can, ensuring the shoulders remain flat and do not lift off the surface.
**ITB/Hip Stretch**

Sets: _____ Hold (sec): _____ Per Day: _____

- Initially start on your side on a firm bed, with the affected leg on top and the unaffected side underneath. The hips should be at the base of the bed, with both legs out straight and over the edge of the surface.
- With the top leg straight, bend the knee of the lower leg and use it to apply a downward pressure on the straight top leg.
- A stretch should be felt over the outside of the hip and upper thigh.

**Standing ITB Stretch**

Sets: _____ Hold (sec): _____ Per Day: _____

- Initially stand in an upright position, with the affected leg crossed over and behind the unaffected side.
- Keep the back leg (affected side) straight, though slightly bend the front leg (unaffected side).
- Whilst maintaining upper body position, gently push the hips out, in the opposite direction of the back leg (affected side) (1).
- A stretch should be felt over the outside of the hip, upper and lower thigh of the affected side.
- For an additional stretch, take the opposite arm up and over the head to further stretch the lateral hip/trunk (2).

**Side Lying Quadricep/ITB Stretch**

Sets: _____ Hold (sec): _____ Per Day: _____

- Initially start on your side on the floor or a firm bed, with the affected leg on top and the unaffected side underneath.
- Bend the knee of the top (affected) leg, initially providing a quadriceps stretch – ensure the thigh remains in line with the trunk, and does not push out too far forward.
- Then bend the knee of the bottom (unaffected) leg and bring it in front of the body, placing it over the affected side and providing an additional downward pressure.
- A stretch should be felt through the quadriceps (particularly the lateral musculature), and over the outside of the hip and upper thigh.

**Standing Gluteal Stretch**

Sets: _____ Hold (sec): _____ Per Day: _____

- Initially stand in an upright position, facing a solid bench or bed.
- Whilst standing on the unaffected side, bend the knee of the affected side, and raise it to rest on the bench.
- Maintain a straight back, and bend forward from the hips and/or bend into the unaffected support leg.
- A stretch should be felt through the gluteal musculature on the affected side.
- This stretch can also be undertaken on your back.
<table>
<thead>
<tr>
<th>Hip Flexor Stretch (supine)</th>
<th>Sets: _____ Hold (sec): _____ Per Day: _____</th>
</tr>
</thead>
</table>
| ![Hip Flexor Stretch (supine)](image) | ➢ While lying on your back, gently bend the knee and hip of the unaffected side, allowing the affected side to gently hang off the side of a firm bed.  
➢ Ensure the lower back is not arched, by trying to gently press the lower spine into the bed.  
➢ The stretch should only be taken through a comfortable range, though further weight can be added to the affected side for an increased stretch. |

<table>
<thead>
<tr>
<th>Hip Flexor Stretch</th>
<th>Sets: _____ Hold (sec): _____ Per Day: _____</th>
</tr>
</thead>
</table>
| ![Hip Flexor Stretch](image) | ➢ Initially kneel on a soft/padded surface, with the knees of both legs at 90° - the affected side should be at the back.  
➢ Whilst ensuring the trunk remains straight (no arching of the lower back), gently push the pelvis forward.  
➢ Emphasis should be placed on keeping the back straight, not arching the back and ensuring the pelvis remains level and not rotated.  
➢ A stretch should be felt through the front of the hip and thigh. |
Module 4

Complications of orthopaedic knee surgery.
Post-operative Complications Associated with Knee Surgery

- ROM -
  - FFD
    - patients held &/or rested knee in bent position
  - ACL: knee angle during graft fixation? (Austin, 2007)
  - Reduced flexion ROM
    - ROM exercise frequency & intensity too low
    - started mobilisation to late — adhesions form
    - require ‘Manipulation Under Anaesthetic’ (MUA)

- Anterior Knee Pain -
  - Damage to infra-patellar fat pad
  - Overemphasis of knee extensions, squats etc.
  - Post-op weakness (VMO, gluts) and tightness (ITB, lateral retinaculum)

Post-operative Complications -DVT-
  - Blood clot formation (thrombus) in deep vein (femoral/popliteal)
    - Many thrombi occur at time of surgery: traction/torsional forces on vessels cause early vascular injury (Bergqvist, 1993; Kwong, 2006)
  - Symptoms: excessive pain, swelling & ‘firmness’, heat
  - Assessment: Doppler ultrasound to assess flow velocity & direction
  - Treatment: anticoagulants, compression stockings
  - Contraindications: vigorous activity, massage?

Post-operative Complications -DVT-
  - Bilateral: clot visualised in right saphenous vein
  - Antegrade Doppler ultrasound

Clinical Details: Short distance circulation MS cell.

Findings: The DUS revealed a clot 2.5 cm in maximal length.

The authors recommend bilateral ultrasonography in all patients with knee surgery to rule out deep vein thrombosis.

Contraindications: vigorous activity, massage?
Post-operative Complications

-Infection-

Wound Infections
- Staples vs Sutures (vicryl/nylon)
  - staples ↓ damage to wound defences
- foreign material may compromise immune response (non-absorbable sutures)
- staples cross (not penetrate) incision site
- staples 4x ↑ risk of infection (Smith, 2010)
  - metallic reaction ↓ tension/support
- Poor hygiene/monitoring

-Systemic Infections

Post-operative Complications

-Neurovascular Injury-

- Peroneal nerve – foot drop?
- Saphenous nerve
  - infrapatellar branch (anterior knee)
  - sartorial branch (medial leg, dorsomedial ankle)
- Femoral, tibial, sciatic nerve
- Popliteal artery (supplies cruciates, joint, gastroc etc.)

Post-operative Complications

-Rare-

- Dislocation
- Fracture
- Frostbite? (McGuire, 2006)
Module 5

Functional aids and gait assessment in the post-operative care of orthopaedic knee surgery.
Practical: Functional Aids & Gait Assessment

1. Knee Braces
   - Protect
     - Immobilisation (RS)
     - Repair process (unloader, ACL/PCL)
   - Facilitate
     - ROM (hinge)
     - WB (unloader)

2. Crutches
   - Axillary (non WB)
   - Forearm (partial WB)
   - Canes/sticks (partial WB)

3. Teaching WB restrictions

4. Crutch use
   - Unilateral knee surgery
     - 3pt step to (2 crutches)
     - 3pt step through (2 crutches)
     - 2pt step through (1 crutch)
   - Bilateral knee surgery
     - 4pt (minimum 3pts of contact all times)
     - 2pt (2pts of contact)
   - Stairs
     - 2 crutches
     - 1 crutch

5. Biomechanical Assessment
   - Static
   - Dynamic
Functional Aids & Gait Assessment in Post-operative Care

Protective & Assistive Devices

Knee Bracing
- Richard Splint
- Hinge Brace
- Unloader Brace

Crutches
- forearm vs axillary
- sticks/canes

Gait Re-education

Questions to ask yourself regarding your "knee patient"

1. Is there a permitted PWB status?
2. Is the 'abnormal' gait pattern ↑ pain/inflammation & how is it affecting other areas?
3. If post-surgery, what stage is the patient at?
   - in-patient = ↑ focus on safe & independent function
   - out-patient = ↑ focus on gait quality

Learning a PWB Skill

Use of a crutch/cane
- patients may benefit from period of ↓ WB to ↓ load on weak/injured tissue
- crutch/cane may benefit patients with weak abductors, to ↑ lumbo-pelvic-hip mechanics

Other adjunct methods
- Hydrotherapy
- Mirrors & parallel bars
- Encouragement of symmetry & timing

Post-operative Gait Patterns
- Unilateral Knee Surgery-
Post-operative Gait Patterns
-Unilateral Knee Surgery-

3-point step-to-gait
3-point step-through-gait

Post-operative Gait Patterns
-Unilateral Knee Surgery-

1 crutch (step through)

Post-operative Gait Patterns
-Bilateral Knee Surgery-

4-point (3 points of contact)
2-point (2 points of contact)

Post-operative Gait Patterns
-Stairs-

Return to Full WB
-Assessing Abnormal Gait-

Correct biomechanics provides efficient movement patterns ↓ injury risk

Anatomical (static)

Poor technique &/or equipment Injury/Surgery Secondary (Dynamic)

Must be able to identify sources of abnormality & how they relate to patient's condition.

‘Ideal’ Static Lower Limb Alignment

• Bilateral WB axis: ASIS > patella > 2nd MT
• Ankles:
  - subtalar: no pronation/supination
  - talocrural: neutral (no dorsi/plantarflexion)
  - forefoot perpendicular to heel axis
• Knees: full ext, tibia perpendicular to ground
• Hips:
  - neutral (no IR/ER or flex/ext)
  - ASIS’s level, slight anterior pelvic tilt

ESSA Orthopaedic Knee CEO (Dr Jay R Ebert)
Common Structural Abnormalities

Q-angle
Leg Length Differences (must differentiate true & functional length differences)
- pelvic asymmetry
- circumduction of longer limb (to avoid ground contact)
- external hip rotation (↑ base of support)
- ↑ shoe wear on short side (↑ contact force)
- ↑ supination on short side (↑ height)

Genu Varum (bow leg) & Valgum (knock knee)

Femoral Anteversion & Inclination

Tibial Alignment
- Tibial varum: bowing, causing inversion at HS
- Tibial external torsion: toe-out gait, lateral stress (ITB)
- Internal tibial torsion: toe-in gait, lateral ankle instability

Common Dynamic Abnormalities

Excessive ST Joint Pronation

Produces:
- ↑ tibial IR & lateral patella subluxation
- ↑ knee compressive loads
- ↑ medial arch load
  - ↑ strain on plantar fascia
  - ↑ strain on calf musculature, contracts eccentrically harder/longer to control pronation

Excessive ST Joint Supination

Produces:
- Weak pronators, tight/spasmodic supinators, compensatory (structural abnormalities)
  - ↓ mobility, ↑ rigidity, poor shock absorption
  - lateral ankle instability
  - ↑ lateral stress (ITB tightness, ITBS)

Pelvic Abnormalities

Excessive anterior tilt: weak pelvic stabilizers, tight hip flexors
  - Produces:
    - tight hamstrings
    - tight external rotators, compensating for weak gluteals
    - excessive lumbar lordosis
    - ↑ knee flexion at HS/MS, ↑ in extensor mechanism loading

Excessive lateral tilt: weak hip abductors, contralateral hip drop
  Produces: excessive strain on lateral hip, adductors, TFL, ITB, knee, lumbar spine

Biomechanical Assessment

1. Static Assessment
2. Dynamic Assessment
Module 6

Hydrotherapy for orthopaedic knee surgery.
Hydrotherapy following Orthopaedic Knee Surgery

Orthopaedic Hydrotherapy

- Advantages
  - Early return to exercise
  - Promote circulation & healing
  - Partial weight bearing - gait retaining, low impact
  - Resistance variable
  - Warm water - reduced spasticity, pain relief, confidence

- Disadvantages
  - Infection risk
  - Fear
  - Over exertion

Advantages

- Early return to exercise
- Promote circulation & healing
- Partial weight bearing - gait retaining, low impact
- Resistance variable
- Warm water - reduced spasticity, pain relief, confidence

Disadvantages

- Infection risk
- Fear
- Over exertion

Water Depth & WB

- The amount of weight transferred to lower limbs depends on water depth and speed

32° - 36°

- Warm water decreases muscle guarding & pain
- Cooler water may allow for increased exercise tolerance/intensity

Water Temperature

- Warm water decreases muscle guarding & pain
- Cooler water may allow for increased exercise tolerance/intensity

Group Sessions

- Improve compliance & assist with feelings of anxiety & depression associated with injury

Patients report

- Easier movements
- Improved feeling of well being & accomplishment
- Can complete more functional tasks

Designing Hydro Programs

- Exercise type depends on
  - Pain
  - Injury/surgery recovery time
  - Contraindications

- Must use good instructions/demonstrations

- Start with simple movements → complex actions

Orthopaedic Hydrotherapy

- Patients report
  - Easier movements
  - Improved feeling of well being & accomplishment
  - Can complete more functional tasks

- Group Sessions
  - Improve compliance & assist with feelings of anxiety & depression associated with injury

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- Patients report
  - Easier movements
  - Improved feeling of well being & accomplishment
  - Can complete more functional tasks

- Group Sessions
  - Improve compliance & assist with feelings of anxiety & depression associated with injury
Exercise Progressions

- Modify
- Sets & reps
- Load (water depth & resistance)
- Speed & range of movt.

- Exercise Type
- Gait
- Knee ROM
- Knee/hip Strength
- Stretching
- Balance

Gait Re-training

Knee ROM

Hip & Knee Strength

Flexibility

Balance Activities
Home Pool Programs

Things to Consider

- Pool Entrance (stairs/ramps etc.)
- Water Temperature (32° - 36°)
- Pool Depth
- Is Supervision Required?
# HYDROTHERAPY KNEE PROGRAM

<table>
<thead>
<tr>
<th>Walking (Forwards, Back, Side)</th>
<th>Time: _____</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Initially walk forward, with emphasis on bilateral heel-to-toe motion and upright posture.</td>
<td></td>
</tr>
<tr>
<td>- Backwards and side-to-side walking can also be incorporated.</td>
<td></td>
</tr>
<tr>
<td>- If you have difficulty with gait or lack confidence in the water you can begin walking at the side of the pool using the guide rail.</td>
<td></td>
</tr>
<tr>
<td>- The depth of water will dictate knee load.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Hip Flexion &amp; Extension</th>
<th>Sets: _____ Reps: _____</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Initially stand on the floor or a box on the unaffected leg, closest to the wall/rail.</td>
<td></td>
</tr>
<tr>
<td>- In an alternating fashion, flex and extend the hip of the affected leg, ensuring the leg and back remain straight.</td>
<td></td>
</tr>
<tr>
<td>- Emphasis is placed on correct upright posture, with abdominal bracing.</td>
<td></td>
</tr>
<tr>
<td>- A flotation device can be used under the arch of the affected leg for additional load.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Hip Abduction &amp; Circumduction</th>
<th>Sets: _____ Reps: _____</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Initially stand on the floor or a box on the unaffected leg.</td>
<td></td>
</tr>
<tr>
<td>- In an alternating fashion, abduct (out to the side) and circumduct (full circles) the hip of the affected leg, ensuring the leg and back remain straight.</td>
<td></td>
</tr>
<tr>
<td>- Emphasis is placed on correct upright posture, with abdominal bracing.</td>
<td></td>
</tr>
<tr>
<td>- A flotation device can be used under the arch of the affected leg for additional load.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Knee &amp; Hip Flexion</th>
<th>Sets: _____ Reps: _____</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Initially stand on the floor or a box on the unaffected leg.</td>
<td></td>
</tr>
<tr>
<td>- Lift the thigh of the affected leg, whilst bending the knee to 90°, progressing further as tolerated.</td>
<td></td>
</tr>
<tr>
<td>- Motion is paused for 2 secs at the beginning and end of the range.</td>
<td></td>
</tr>
<tr>
<td>- Emphasis is placed on correct upright posture, with abdominal bracing.</td>
<td></td>
</tr>
<tr>
<td>- A flotation device can be used under the arch of the affected leg for additional load.</td>
<td></td>
</tr>
<tr>
<td><strong>Cycling</strong></td>
<td>Time: _____</td>
</tr>
<tr>
<td>-------------</td>
<td>------------</td>
</tr>
</tbody>
</table>
| ➢ Use a rail or flotation device to support the upper body, thereby suspending the body in deeper water to lift the legs off the floor.  
➢ A cycling motion is then initiated with the legs.  
➢ Emphasis is placed on improving knee and hip ROM and muscular coordination. |

<table>
<thead>
<tr>
<th><strong>Hip Abduction/Adduction</strong></th>
<th>Time: _____</th>
</tr>
</thead>
</table>
| ➢ Use a rail or flotation device to support the upper body, thereby suspending the body in deeper water to lift the legs off the floor.  
➢ While maintaining straight legs abduct (take out) the thighs to their end of range, and then adduct them (pull in) back to neutral. |

<table>
<thead>
<tr>
<th><strong>Hip ‘Scissor Kicks’</strong></th>
<th>Time: _____</th>
</tr>
</thead>
</table>
| ➢ Use a rail or flotation device to support the upper body, thereby suspending the body in deeper water to lift the legs off the floor.  
➢ While maintaining knee extension, the patient performs a “scissor-like” movement of the legs by reciprocally flexing and extending the thighs. |

<table>
<thead>
<tr>
<th><strong>Calf Raises</strong></th>
<th>Sets: _____ Reps: _____</th>
</tr>
</thead>
</table>
| ➢ Stand supported by the rail with weight evenly distributed between both legs.  
➢ Begin with performing calf raises on a flat surface of the pool, progressing to a step.  
➢ Motion is paused for 2 seconds at end of range.  
➢ Emphasis is placed on correct upright posture, with abdominal bracing. |

<table>
<thead>
<tr>
<th><strong>Squats</strong></th>
<th>Sets: _____ Reps: _____</th>
</tr>
</thead>
</table>
| ➢ Stand supported by the rail with weight evenly distributed between both legs.  
➢ Keeping the back straight, the body is lowered by flexing the thighs and hips, until knee flexion reaches 90˚, ensuring the knees do not push forward of the toes.  
➢ The knees and thighs are then extended and the body is elevated to neutral. |
### Lunges

Sets: _____ Reps: _____
- Perform a standard lunge, stepping out in front of the body with the affected leg.
- Emphasis is placed on correct upright posture, with abdominal bracing.
- The knee of the front leg should not progress further forward than the toes, while the ideal lowered position should provide 90° in both knees.

### Step-ups

Sets: _____ Reps: _____
- Stand facing the step.
- Proceed to step up straight ahead with the affected leg, ensuring the knee always remains on a line between the hip and foot.
- Then step backward off the step, leading with the unaffected side, controlling the body to the ground with the affected side.
- Emphasis should be placed on maintaining balance, correct upright posture, abdominal bracing, good knee alignment and pelvic/gluteal control.

### Lateral Step-ups

Sets: _____ Reps: _____
- Initially stand perpendicular to a step, with the affected side closest to the step.
- Proceed to step up side-ways, ensuring the knee always remains on a line between the hip and foot.
- Emphasis should be placed on maintaining balance, correct upright posture, abdominal bracing, good knee alignment and pelvic/gluteal control.

### Balance

Sets: _____ Hold: _____
- In a stationary, standing position, flex the thigh of the unaffected leg lifting it off the ground.
- Attempt to maintain balance for 10-30 seconds, assisted by a rail as needed.
- Emphasis is placed on correct upright posture, with abdominal bracing.
- Increase demand for closing the eyes and/or progressing to more shallow water.

### Patter Kick

Time: _____
- With the aid of a flotation device, undertake a kicking action sufficient to maintain motion across the pool surface.
- Emphasis is placed on keeping the body horizontal, while the knees should remain fully extended, with force generated from the hips.
<table>
<thead>
<tr>
<th>Exercise</th>
<th>Sets: ___</th>
<th>Hold: ___</th>
</tr>
</thead>
</table>
| **Hamstring Stretch** | ![Hamstring Stretch Image]  | - Stand on the unaffected leg, with the affected leg out straight on a ledge/step.  
- Whilst keeping the back and knee straight, gently bend forward at the hips until a stretch is felt down the back of the thigh and knee. |
| **Quadricep Stretch** | ![Quadricep Stretch Image]  | - Stand on the unaffected leg, facing away from the ledge/step.  
- Place the foot of the affected leg on the ledge behind.  
- Stand up tall, and push hips forward until stretch is felt in the front of the thigh.  
- Bend the supporting leg to increase the stretch. |
| **Calf Stretch** | ![Calf Stretch Image]  | - Stand on a step with the heel of the affected leg hanging over the edge of the step.  
- Lower the heel down below the step until you feel a stretch in the calf. |
Module 7

Pre- and post-operative imaging and clinical assessment for orthopaedic knee surgery.
Pre- and Post-operative Knee Assessment

Subjective Assessment
- Cheap, easy, specific (or non-specific), can be scored ‘retrospectively’ & modifiable for language & cross-cultural differences
  - Knee specific, QOL, sports and activity related
    - Knee Injury & Osteoarthritis Outcomes Score (KOOS)
    - Knee Pain Scale (KPS)
  - General well-being, QOL & ‘perceived’ health
    - Short-Form Health Survey (SF-36)
  - Patient Satisfaction Questionnaires

Knee Injury & Osteoarthritis Outcome Score (KOOS)

Knee Pain Scale (KPS)

Short Form Health Survey (SF-36) Quality of Life
Short Form Health Survey (SF-36)

- Validated with ACL, TKR & MACI (Johnson; Ungard, 2001, Bartlett, 2005)
- Pre-op psychosocial variables related to post-op outcome
  - ↓ 'mental' health associated with ↓ outcome? (Lavernia, 2004)
- Simple knee function score does not incorporate all of patient benefits after knee surgery

Functional Assessment

- General Functional Assessment
  - girth measures (thigh/shank)
  - active knee ROM
- Specific Strength Tests
  - SLR strength
  - Isokinetic dynamometry
- Functional Tests
  - General function
  - Balance/proproprioception
  - Sport specific

3RM SLR

Isokinetic Dynamometry

Functional Tests

- Validated activity or sport specific functional tests (Keskula, 1996)
- Objective assessment of components of the patient's ability in a structured, controlled setting
- Functional
  - 6-min walk
  - Sit-to-stand
  - Timed up & go
  - Balance assessments
  - Sport specific tests

Functional Tests

- Six minute Walk Test

  • assess the ability to ambulate as far & fast as comfortably possible in 6min, between two markers set 25m apart
**Functional Tests**

- **Sit to Stand Test**
  - Assess the ability to stand up from a seated chair position (arms crossed over chest), then sit down without interruption
  - 5 or 10 rep test

- **Timed Up & Go Test**
  - Assess the ability of the patient to rise from a chair (without using arms), ambulate out and back over a 3m distance, then sit back into the chair

**Sport Specific Tests**

- 1. Timed hop test
- 2. Single hop test
- 3. Triple hop test
- 4. Crossover hop test

**Balance Assessment**

- Berg Balance Scale
  - 14pt scale for older & less able cohort
- Fullerton Advanced Balance (FAB) Scale
  - 10pt, more functional & relevant to fall risk
- Romberg's test (& variations)
- Other
  - double/single leg balance
  - eyes open/closed
  - stable/unstable surfaces

**Common Radiological Knee Examinations**

- Standard X-rays
- CT Scan
- Magnetic Resonance Imaging (MRI)
- Nuclear Medicine Bone Scan
- Ultrasound
Common Radiological Knee Examinations

**Standard X-rays**
- first study ordered in skeletal evaluation (available, quick, cheap)
- uses radiation passed through tissues
  - passes through less dense matter (air, water, soft tissue)
  - absorbed by dense matter (bones, tumours)
- evaluation of joint space/fractures

**Post-surgery**
- TTT
- HTO
- TKR
1. Placement
2. Bony integration
3. Problems?

**CT**
- X-rays & computing algorithms for 3D imaging
- better resolution of fracture lines
- evaluates degree of articular displacement
- pre- & post-op: used in place of MRI with metallic artefact

**MRI**
- strong magnetic field and high frequency radio-waves (Eckstein et al., 2001)
- cross-sectional pictures
- soft tissue (e.g. cartilage, patella tendon, ACL tears)
- Pre-op: superior diagnostic tool
- Post-op: soft tissue repair/progress

What scores are clinically meaningful?
- Clinical vs radiological vs combination?
- Dependent on patient cohort?
- Dependent on patient goals?
  - return to activity/sport (↓ pain & symptoms, ↑ QOL & ADLs)
  - long-term prevention or postponing of TKA (radiological outcomes – prosthetic stability, regeneration of hyaline-like repair tissue following cartilage repair)
Knee Radiology - Definition of Terms

- Chondral defect
- Osteochondral defect

- Chondral de-lamination
- Chondral fissuring/ulceration

- Signal intensity
  - Hypointense
  - Isointense
  - Hyperintense

- Subchondral bone
- Subchondral lamina
- Subchondral oedema

- Subchondral cyst
- Subchondral sclerosis

- Femoral trochlea depth
- Femoral trochlea (sulcus) angle
- Patella tilt angle
  - avg 17° (abn <8°)
- Congruence angle
  - avg ≤6°/11°@45° (abn >20°)
- Tubercle lateralization
  - abn >9mm
Knee Radiology - Definition of Terms

- Genu varus (bow) deformity
- Genu valgus (knock knee) deformity

Knee Radiology - Definition of Terms

- Osseous integration

Knee Radiology - Definition of Terms

- Chondrocalcinosis
- Osteophytes
- Osteophytic lipping

So what are we looking for?

- Articular cartilage
- Menisci
- Bone
- Ligaments & tendons

K.M

P.S
Appendices
Common Subjective and Objective Tools to Assess the Knee

Subjective Assessment

1. **Knee Injury and Osteoarthritis Outcome Score (KOOS)**\(^1-3\)
   A self-administered questionnaire used to assess knee pain and function, encompassing areas of pain, symptoms, activities of daily living, sport and recreation and knee related quality of life.

2. **Knee Pain Scale**\(^4,5\)
   A self-administered questionnaire used to assess the frequency and severity of knee pain while undertaking a variety of ambulatory and transfer activities

3. **Visual Analogue Scale**
   A visual reported scale used to assess the frequency and severity of knee pain, during nominated activities. It consists of two subscales, whereby the patient rates both their frequency (VAS-F), and severity (VAS-S) of knee pain, on a scale of 0-10.

4. **Short Form Health Survey (SF-36)**\(^6-9\)
   A self-administered questionnaire used to evaluate the general health of the patient. The SF-36 produces two norm-based component scores, the Physical Component Score (PCS) and the Mental Component Score (MCS), which are calculated from eight subsets of health. These include: physical functioning; role limitations due to physical health; bodily pain; general health perceptions; vitality; social functioning; role limitations due to emotional problems; and mental health.

Functional Assessment

1. **Timed Up and Go Test**\(^10,11\)
   A timed test that assesses the ability of the patient to rise from a chair (without using their arms as a lever), ambulate out and back over a 3m distance, then sit back into the chair. The average amongst three attempts is then computed.

2. **Sit-to-Stand**\(^12-14\)
   A timed test that assesses the ability of the patient to stand up from a seated chair position (with their arms crossed over the chest), then sit down without interruption. The best average between two trials is computed, though it can be performed as a 5 or 10 repetition test.

3. **6-min walk test**\(^15,16\)
   A timed test that assesses the ability of the patient to ambulate as far and as fast as comfortably possible, between two markers set 25m apart, over a 6min period.

4. **Functional hop tests**\(^17-19\)
   Both time and distance orientated hop tests designed to assess more sport-specific demands, in the patient’s return to higher demand activity, including:
   - Timed hop test (to cover 6m)
   - Single hop test for distance
   - Triple hop test for distance
   - Crossover hop test
5. Three-repetition Maximum Straight Leg Raise Test (3RM SLR)
A test used to assess the strength of the patient's quadriceps and hip flexor musculature. With the patient in a supine position, the test leg fully extended and the opposite knee flexed at approximately 90° with the foot fixed flat on the bench, a progressive weight (ankle weight, cable etc.) is attached to the ankle of the test leg, and the patient was instructed to lift the leg to the height of the bent knee three times, without a prolonged rest on the bench between repetitions. The size of the weight lifted is continually increased until a 3RM was reached.

6. Knee Range of Motion
Used to assess active knee flexion and extension in the knee. The patient lay supine with both legs extended, then moving the foot of the test knee proximally as far as possible, with the maximum knee flexion being recorded. The patient then straightens the leg, with the maximum extension, or hyperextension, being recorded. Anatomical landmarks for goniometer position include the medial malleolus (ankle), lateral femoral condyle (knee) and the greater trochanter (hip).

7. Lower limb girth
Used to assess muscular loss/development in the muscles directly affecting the knee, including:
- Mid thigh girth: with the patient seated on an adjustable chair allowing the feet to be flat on the floor, and knees flexed to 90°, a midway point is drawn on the upper leg of the patient on a line bisecting the centre of the inguinal crease, down the middle of the thigh to the most anterior protrusion of the patella. Thigh girth is then measured with the patient standing upright in a neutral position.
- Maximal calf girth: with the patient standing in an upright neutral position, with equal weight on each leg, a tape measure is used to find the maximum calf girth.

8. Balance/Proprioceptive Assessment
- Berg Balance Scale (BBS) 20-22: a 14 point scale designed to assess the balance of an older cohort, more specific to falls risk.
- Fullerton Advanced Balance Scale (FABS) 23,24: a 10 point dynamic scale designed to assess the balance and coordination of a more able cohort.

9. Isokinetic dynamometry: specific equipment required.

References


23. Hernandez D, Rose DJ. Predicting which older adults will or will not fall using the Fullerton Advanced Balance scale. *Arch Phys Med Rehabil.* Dec 2008;89(12):2309-2315.

**KNEE INJURY & OSTEOARTHRITIS OUTCOME SCORE**

SUBJECT: ________________________  TEST : PRE / POST______  DATE:_______

Instructions: Please tick (4) the most appropriate response.

### PAIN

1. How often is your knee painful? Never Monthly Weekly Daily Always

What degree of pain have you experienced in the last week when.....?

<table>
<thead>
<tr>
<th>Activity</th>
<th>None</th>
<th>Mild</th>
<th>Moderate</th>
<th>Severe</th>
<th>Extreme</th>
</tr>
</thead>
<tbody>
<tr>
<td>Twisting/pivoting on your knee</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Straightening your knee fully</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bending knee fully</td>
<td></td>
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</tr>
<tr>
<td>Walking on a flat surface</td>
<td></td>
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</tr>
<tr>
<td>Going up or down stairs</td>
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<td></td>
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</tr>
<tr>
<td>At night while in bed</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Sitting or lying</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standing upright</td>
<td></td>
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</tr>
</tbody>
</table>

### SYMPTOMS

<table>
<thead>
<tr>
<th>Symptom</th>
<th>None</th>
<th>Mild</th>
<th>Moderate</th>
<th>Severe</th>
<th>Extreme</th>
</tr>
</thead>
<tbody>
<tr>
<td>How severe is your stiffness after first waking in the morning?</td>
<td></td>
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<tr>
<td>How severe is your stiffness after sitting, lying or resting later in the day?</td>
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<tr>
<td>Do you have swelling in your knee?</td>
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<tr>
<td>Do you feel grinding, hear clicking, or any other type of noise when your knee moves?</td>
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<tr>
<td>Does your knee catch or hang up when moving?</td>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>
**ACTIVITIES OF DAILY LIVING**
What degree of difficulty have you experienced in the last week….?

<table>
<thead>
<tr>
<th></th>
<th>None</th>
<th>Mild</th>
<th>Moderate</th>
<th>Severe</th>
<th>Extreme</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Descending stairs</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>2. Ascending stairs</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>3. Rising from sitting</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>4. Standing</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>5. Bending to floor/pick up object</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>6. Walking on flat surface</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>7. Getting in/ out of car</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>8. Going shopping</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>9. Putting on socks/ stockings</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>10. Rising from bed</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>11. Taking off socks/ stockings</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>12. Lying in bed (turning over maintaining knee position)</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>13. Getting in/out of bath or shower</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>14. Sitting</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>15. Getting on/ off toilet</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>16. Heavy domestic duties (shovelling, scrubbing floors etc.)</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>17. Light domestic duties (cooking, dusting)</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>SPORT AND RECREATION FUNCTION</td>
<td>None</td>
<td>Mild</td>
<td>Moderate</td>
<td>Severe</td>
<td>Extreme</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>------</td>
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<td>---------</td>
</tr>
<tr>
<td>What difficulty have you experienced in the last week ....?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Running</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>2. Jumping</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>3. Turning/Twisting on you injured knee</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Kneeling</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Squatting</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>KNEE-RELATED QUALITY OF LIFE</th>
<th>Never</th>
<th>Monthly</th>
<th>Weekly</th>
<th>Daily</th>
<th>Always</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. How often are you aware of your knee problems?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Have you modified your lifestyle to avoid potentially damaging activities to your knee?</td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>3. How troubled are you with lack of confidence in your knee?</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>4. In general, how much difficulty do you have with your knee?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Score all items from 0 = Best  4= Worst

<table>
<thead>
<tr>
<th>Scale</th>
<th>Possible Raw Score Range</th>
<th>Actual Raw Score</th>
<th>Transformed Score 0-100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pain</td>
<td>36</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Symptoms</td>
<td>28</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ADL</td>
<td>68</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sport/Rec</td>
<td>20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>QOL</td>
<td>16</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Transformed scale = 100 – Actual raw score x 100 / Possible raw score range

Example: A pain raw score of 16 would be transformed as follows:

\[
100 - \frac{16 \times 100}{36} = 66
\]
KNEE PAIN SCALE

1. PAIN FREQUENCY

Using the following scale,

<table>
<thead>
<tr>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>always</td>
<td>almost always</td>
<td>sometimes</td>
<td>almost never</td>
<td>never</td>
</tr>
</tbody>
</table>

Please indicate HOW OFTEN in the past week you have experienced pain in your knee (by placing the corresponding number in the space provided) when you:

```
L  
R  
```

a. got in or out of bed
b. walked on level ground
c. got into or out of a chair
d. walked up stairs or an incline
e. got in or out of a car
f. walked down stairs or a decline

2. PAIN SEVERITY

Using the following scale,

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>no pain</td>
<td>mild</td>
<td>uncomfortable</td>
<td>distressing</td>
<td>horrible</td>
<td>excruciating</td>
</tr>
<tr>
<td>pain</td>
<td>pain</td>
<td>pain</td>
<td>pain</td>
<td>pain</td>
<td>pain</td>
</tr>
</tbody>
</table>

Please indicate HOW SEVERE the average pain in your knee has been in the past week (by placing the corresponding number in the space provided) when you:

```
L  
R  
```

a. got in or out of bed
b. walked on level ground
c. got into or out of a chair
d. walked up stairs or an incline
e. got in or out of a car
f. walked down stairs or a decline
SF-36 Health / Quality of Life Questionnaire

Name: __________________________   PCS = __________________
Date: __________________________  MCS = __________________

Please try to answer all of the questions by placing a mark in one box for each line.

1. In general would you say your health is:
   □ Excellent □ Very good □ Good □ Fair □ Poor

2. Compared to one year ago, how would you rate your health, in general, now?
   □ Much better □ A bit better □ Much the same □ A bit worse □ Much worse

3. The following items are about activities you might do during a typical day: Does your health now limit you in these activities?

<table>
<thead>
<tr>
<th>Yes, limited a lot</th>
<th>Yes, limited a little</th>
<th>No, not limited at all</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Vigorous activities such as running, lifting heavy objects, participating in strenuous sports</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>b) Moderate activities such as moving a table, pushing a vacuum cleaner, bowling or playing golf</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>c) Lifting and carrying groceries</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>d) Climbing several flights of stairs</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>e) Climbing one flight of stairs</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>f) Bending, kneeling or stooping</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>g) Walking more than one mile</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>h) Walking several blocks</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>i) Walking one block</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>j) Bathing and dressing yourself</td>
<td>□</td>
<td>□</td>
</tr>
</tbody>
</table>

4. During the past four weeks have you had any of the following problems with your work or other daily activities as a result of your health?

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Cut down on the amount of time you spent on work or other activities</td>
<td>□</td>
</tr>
<tr>
<td>b) Accomplished less than you would like</td>
<td>□</td>
</tr>
<tr>
<td>c) Were limited in the kind of work or other activities</td>
<td>□</td>
</tr>
<tr>
<td>d) Had difficulty performing your work or other activities</td>
<td>□</td>
</tr>
</tbody>
</table>

5. During the past four weeks have you had any of the following problems with your work or other activities as a result of any emotional problems (such as feeling depressed or anxious)?

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Cut down on the amount of time spent on work or other activities</td>
<td>□</td>
</tr>
<tr>
<td>b) Accomplished less than you would like</td>
<td>□</td>
</tr>
<tr>
<td>c) Didn’t do work or other activities as carefully as usual</td>
<td>□</td>
</tr>
</tbody>
</table>
6. During the past four weeks to what extent has your physical or emotional health interfered with your normal social activities with family, friends, neighbours or groups?

☐ Not at all  ☐ A little bit  ☐ Moderately  ☐ Quite a bit  ☐ Extremely

7. How much bodily pain have you had during the past four weeks?

☐ None  ☐ Very mild  ☐ Mild  ☐ Moderate  ☐ Severe  ☐ Very severe

8. During the past four weeks how much did pain interfere with your normal work (including work outside the home and housework)?

☐ Not at all  ☐ A little bit  ☐ Moderately  ☐ Quite a bit  ☐ Extremely

9. These questions are about how you feel and how things have been with you during the past four weeks. For each question please give one answer that comes closest to the way in which you have been feeling. How much of the time during the past four weeks –

<table>
<thead>
<tr>
<th>Question</th>
<th>All of the time</th>
<th>Most of the time</th>
<th>A good bit of the time</th>
<th>Some of the time</th>
<th>A little of the time</th>
<th>None of the time</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Did you feel full of life?</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>b) Have you been a very nervous person?</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>c) Have you felt so down in the dumps that nothing could cheer you up?</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>d) Have you felt calm and peaceful?</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>e) Did you have a lot of energy?</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>f) Have you felt downhearted and blue?</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>g) Did you feel worn out?</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>h) Have you been a happy person?</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>i) Did you feel tired?</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

10. During the past four weeks how much of the time has your physical or emotional problems interfered with your social activities (like visiting friends, relatives, etc.)?

☐ All of the time  ☐ Most of the time  ☐ Sometimes  ☐ A little of the time  ☐ Never

11. How true or false is each of the following statements for you?

<table>
<thead>
<tr>
<th>Statement</th>
<th>Definitely True</th>
<th>Mostly True</th>
<th>Don’t Know</th>
<th>Mostly False</th>
<th>Definitely False</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) I seem to get sick a little easier than most people</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>b) I am as healthy as anybody I know</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>c) I expect my health to get worse</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>d) My health is excellent</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>
Berg Balance Scale

**Description:**
14-item scale designed to measure balance of the older adult in a clinical setting.

**Equipment needed:**
Ruler, 2 standard chairs (one with arm rests, one without)
Footstool or step, Stopwatch or wristwatch, 15 ft walkway

**Completion:**

- **Time:** 15-20 minutes
- **Scoring:** A five-point ordinal scale, ranging from 0-4. “0” indicates the lowest level of function and “4” the highest level of function. Total Score = 56

**Interpretation:**

- 41-56 = low fall risk
- 21-40 = medium fall risk
- 0 – 20 = high fall risk

**Criterion Validity:**
“Authors support a cut off score of 45/56 for independent safe ambulation”.

Riddle and Stratford, 1999, examined 45/56 cutoff validity and concluded:
- Sensitivity = 64% (Correctly predicts fallers)
- Specificity = 90% (Correctly predicts non-fallers)
- Riddle and Stratford encouraged a lower cut off score of 40/56 to assess fall risk

**Comments:** Potential ceiling effect with higher level patients. Scale does not include gait items

**Norms:**

<table>
<thead>
<tr>
<th>Age (y)</th>
<th>Group</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>60-69</td>
<td>Male</td>
<td>1</td>
<td>51.0</td>
<td>—</td>
<td>35.3 – 66.7</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>5</td>
<td>54.6</td>
<td>0.5</td>
<td>47.6 – 61.6</td>
</tr>
<tr>
<td></td>
<td>Overall</td>
<td>6</td>
<td>54.0</td>
<td>1.5</td>
<td>52.4 – 55.6</td>
</tr>
<tr>
<td>70-79</td>
<td>Male</td>
<td>9</td>
<td>53.9</td>
<td>1.5</td>
<td>48.7 – 59.1</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>10</td>
<td>51.6</td>
<td>2.6</td>
<td>46.6 – 56.6</td>
</tr>
<tr>
<td></td>
<td>Overall</td>
<td>19</td>
<td>52.7</td>
<td>2.4</td>
<td>51.5 – 53.8</td>
</tr>
<tr>
<td>80-89</td>
<td>Male</td>
<td>10</td>
<td>41.8</td>
<td>12.2</td>
<td>36.8 – 46.8</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>24</td>
<td>42.1</td>
<td>8.0</td>
<td>38.9 – 45.3</td>
</tr>
<tr>
<td></td>
<td>No Device</td>
<td>24</td>
<td>46.3</td>
<td>4.2</td>
<td>44.1 – 48.5</td>
</tr>
<tr>
<td></td>
<td>Device</td>
<td>10</td>
<td>31.7</td>
<td>10.0</td>
<td>23.8 – 35.1</td>
</tr>
<tr>
<td></td>
<td>Overall</td>
<td>34</td>
<td>42.0</td>
<td>9.2</td>
<td>38.8 – 45.3</td>
</tr>
<tr>
<td>90-101</td>
<td>Male</td>
<td>2</td>
<td>40.0</td>
<td>1.4</td>
<td>38.0 – 51.1</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>15</td>
<td>36.9</td>
<td>9.7</td>
<td>32.8 – 40.9</td>
</tr>
<tr>
<td></td>
<td>No Device</td>
<td>7</td>
<td>45</td>
<td>4.2</td>
<td>40.9 – 49.1</td>
</tr>
<tr>
<td></td>
<td>Device</td>
<td>10</td>
<td>31.8</td>
<td>7.6</td>
<td>28.4 – 35.2</td>
</tr>
<tr>
<td></td>
<td>Overall</td>
<td>17</td>
<td>37.2</td>
<td>9.1</td>
<td>32.5 – 41.9</td>
</tr>
</tbody>
</table>
# Berg Balance Scale

Name: ________________________________  Date: ____________________

Location: ________________________________  Rater: ___________________

<table>
<thead>
<tr>
<th>ITEM DESCRIPTION</th>
<th>SCORE (0-4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sitting to standing</td>
<td></td>
</tr>
<tr>
<td>Standing unsupported</td>
<td></td>
</tr>
<tr>
<td>Sitting unsupported</td>
<td></td>
</tr>
<tr>
<td>Standing to sitting</td>
<td></td>
</tr>
<tr>
<td>Transfers</td>
<td></td>
</tr>
<tr>
<td>Standing with eyes closed</td>
<td></td>
</tr>
<tr>
<td>Standing with feet together</td>
<td></td>
</tr>
<tr>
<td>Reaching forward with outstretched arm</td>
<td></td>
</tr>
<tr>
<td>Retrieving object from floor</td>
<td></td>
</tr>
<tr>
<td>Turning to look behind</td>
<td></td>
</tr>
<tr>
<td>Turning 360 degrees</td>
<td></td>
</tr>
<tr>
<td>Placing alternate foot on stool</td>
<td></td>
</tr>
<tr>
<td>Standing with one foot in front</td>
<td></td>
</tr>
<tr>
<td>Standing on one foot</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>_____</td>
</tr>
</tbody>
</table>

**GENERAL INSTRUCTIONS**

Please document each task and/or give instructions as written. When scoring, please record the lowest response category that applies for each item.

In most items, the subject is asked to maintain a given position for a specific time. Progressively more points are deducted if:

- the time or distance requirements are not met
- the subject’s performance warrants supervision
- the subject touches an external support or receives assistance from the examiner

Subject should understand that they must maintain their balance while attempting the tasks. The choices of which leg to stand on or how far to reach are left to the subject. Poor judgment will adversely influence the performance and the scoring.

Equipment required for testing is a stopwatch or watch with a second hand, and a ruler or other indicator of 2, 5, and 10 inches. Chairs used during testing should be a reasonable height. Either a step or a stool of average step height may be used for item # 12.
Berg Balance Scale

SITTING TO STANDING
INSTRUCTIONS: Please stand up. Try not to use your hand for support.
( ) 4 able to stand without using hands and stabilize independently
( ) 3 able to stand independently using hands
( ) 2 able to stand using hands after several tries
( ) 1 needs minimal aid to stand or stabilize
( ) 0 needs moderate or maximal assist to stand

STANDING UNSUPPORTED
INSTRUCTIONS: Please stand for two minutes without holding on.
( ) 4 able to stand safely for 2 minutes
( ) 3 able to stand 2 minutes with supervision
( ) 2 able to stand 30 seconds unsupported
( ) 1 needs several tries to stand 30 seconds unsupported
( ) 0 unable to stand 30 seconds unsupported

If a subject is able to stand 2 minutes unsupported, score full points for sitting unsupported. Proceed to item #4.

SITTING WITH BACK UNSUPPORTED BUT FEET SUPPORTED ON FLOOR OR ON A STOOL
INSTRUCTIONS: Please sit with arms folded for 2 minutes.
( ) 4 able to sit safely and securely for 2 minutes
( ) 3 able to sit 2 minutes under supervision
( ) 2 able to sit 30 seconds
( ) 1 able to sit 10 seconds
( ) 0 unable to sit without support 10 seconds

STANDING TO SITTING
INSTRUCTIONS: Please sit down.
( ) 4 sits safely with minimal use of hands
( ) 3 controls descent by using hands
( ) 2 uses back of legs against chair to control descent
( ) 1 sits independently but has uncontrolled descent
( ) 0 needs assist to sit

TRANSFERS
INSTRUCTIONS: Arrange chair(s) for pivot transfer. Ask subject to transfer one way toward a seat with armrests and one way toward a seat without armrests. You may use two chairs (one with and one without armrests) or a bed and a chair.
( ) 4 able to transfer safely with minor use of hands
( ) 3 able to transfer safely definite need of hands
( ) 2 able to transfer with verbal cuing and/or supervision
( ) 1 needs one person to assist
( ) 0 needs two people to assist or supervise to be safe

STANDING UNSUPPORTED WITH EYES CLOSED
INSTRUCTIONS: Please close your eyes and stand still for 10 seconds.
( ) 4 able to stand 10 seconds safely
( ) 3 able to stand 10 seconds with supervision
( ) 2 able to stand 3 seconds
( ) 1 unable to keep eyes closed 3 seconds but stays safely
( ) 0 needs help to keep from falling

STANDING UNSUPPORTED WITH FEET TOGETHER
INSTRUCTIONS: Place your feet together and stand without holding on.
( ) 4 able to place feet together independently and stand 1 minute safely
( ) 3 able to place feet together independently and stand 1 minute with supervision
( ) 2 able to place feet together independently but unable to hold for 30 seconds
( ) 1 needs help to attain position but able to stand 15 seconds feet together
( ) 0 needs help to attain position and unable to hold for 15 seconds
**Berg Balance Scale** continued…..

**REACHING FORWARD WITH OUTSTRETCHED ARM WHILE STANDING**

**INSTRUCTIONS:** Lift arm to 90 degrees. Stretch out your fingers and reach forward as far as you can. (Examiner places a ruler at the end of fingertips when arm is at 90 degrees. Fingers should not touch the ruler while reaching forward. The recorded measure is the distance forward that the fingers reach while the subject is in the most forward lean position. When possible, ask subject to use both arms when reaching to avoid rotation of the trunk.)

( ) 4 can reach forward confidently 25 cm (10 inches)
( ) 3 can reach forward 12 cm (5 inches)
( ) 2 can reach forward 5 cm (2 inches)
( ) 1 reaches forward but needs supervision
( ) 0 loses balance while trying/requires external support

**PICK UP OBJECT FROM THE FLOOR FROM A STANDING POSITION**

**INSTRUCTIONS:** Pick up the shoe/slipper, which is place in front of your feet.

( ) 4 able to pick up slipper safely and easily
( ) 3 able to pick up slipper but needs supervision
( ) 2 unable to pick up but reaches 2-5 cm(1-2 inches) from slipper and keeps balance independently
( ) 1 unable to pick up and needs supervision while trying
( ) 0 unable to try/needs assist to keep from losing balance or falling

**TURNING TO LOOK BEHIND OVER LEFT AND RIGHT SHOULDERS WHILE STANDING**

**INSTRUCTIONS:** Turn to look directly behind you over toward the left shoulder. Repeat to the right. Examiner may pick an object to look at directly behind the subject to encourage a better twist turn.

( ) 4 looks behind from both sides and weight shifts well
( ) 3 looks behind one side only other side shows less weight shift
( ) 2 turns sideways only but maintains balance
( ) 1 needs supervision when turning
( ) 0 needs assist to keep from losing balance or falling

**TURN 360 DEGREES**

**INSTRUCTIONS:** Turn completely around in a full circle. Pause. Then turn a full circle in the other direction.

( ) 4 able to turn 360 degrees safely in 4 seconds or less
( ) 3 able to turn 360 degrees safely one side only 4 seconds or less
( ) 2 able to turn 360 degrees safely but slowly
( ) 1 needs close supervision or verbal cuing
( ) 0 needs assistance while turning

**PLACE ALTERNATE FOOT ON STEP OR STOOL WHILE STANDING UNSUPPORTED**

**INSTRUCTIONS:** Place each foot alternately on the step/stool. Continue until each foot has touch the step/stool four times.

( ) 4 able to stand independently and safely and complete 8 steps in 20 seconds
( ) 3 able to stand independently and complete 8 steps in > 20 seconds
( ) 2 able to complete 4 steps without aid with supervision
( ) 1 able to complete > 2 steps needs minimal assist
( ) 0 needs assistance to keep from falling/unable to try

**STANDING UNSUPPORTED ONE FOOT IN FRONT**

**INSTRUCTIONS:** (DEMONSTRATE TO SUBJECT) Place one foot directly in front of the other. If you feel that you cannot place your foot directly in front, try to step far enough ahead that the heel of your forward foot is ahead of the toes of the other foot. (To score 3 points, the length of the step should exceed the length of the other foot and the width of the stance should approximate the subject’s normal stride width.)

( ) 4 able to place foot tandem independently and hold 30 seconds
( ) 3 able to place foot ahead independently and hold 30 seconds
( ) 2 able to take small step independently and hold 30 seconds
( ) 1 needs help to step but can hold 15 seconds
( ) 0 loses balance while stepping or standing

**STANDING ON ONE LEG**

**INSTRUCTIONS:** Stand on one leg as long as you can without holding on.

( ) 4 able to lift leg independently and hold > 10 seconds
( ) 3 able to lift leg independently and hold 5-10 seconds
( ) 2 able to lift leg independently and hold ≥ 3 seconds
( ) 1 tries to lift leg unable to hold 3 seconds but remains standing independently.
( ) 0 unable to try of needs assist to prevent fall

( ) TOTAL SCORE (Maximum = 56)
Scoring Sheet for
Fullerton Advanced Balance Scale

Name: ________________________________ Date of Test: ____________

1. Stand with feet together and eyes closed
   ( ) 0 Unable to obtain the correct standing position independently
   ( ) 1 Able to obtain the correct standing position independently but unable to maintain the position or keep the eyes closed for more than 10 seconds
   ( ) 2 Able to maintain the correct standing position with eyes closed for more than 10 seconds but less than 30 seconds
   ( ) 3 Able to maintain the correct standing position with eyes closed for 30 seconds but requires close supervision
   ( ) 4 Able to maintain the correct standing position safely with eyes closed for 30 seconds

2. Reach forward with outstretched arm to retrieve an object (pencil) held at shoulder height
   ( ) 0 Unable to reach the pencil without taking more than two steps
   ( ) 1 Able to reach the pencil but needs to take two steps
   ( ) 2 Able to reach the pencil but needs to take one step
   ( ) 3 Can reach the pencil without moving the feet but requires supervision
   ( ) 4 Can reach the pencil safely and independently without moving the feet

3. Turn 360 degrees in right and left directions
   ( ) 0 Needs manual assistance while turning
   ( ) 1 Needs close supervision or verbal cueing while turning
   ( ) 2 Able to turn 360 degrees but takes more than four steps in both directions
   ( ) 3 Able to turn 360 degrees but unable to complete in four steps or fewer in one direction
   ( ) 4 Able to turn 360 degrees safely taking four steps or fewer in both directions

4. Step up onto and over a 6-inch (15 cm) bench
   ( ) 0 Unable to step up onto the bench without loss of balance or manual assistance
   ( ) 1 Able to step up onto the bench with leading leg but trailing leg contacts the bench or swings around the bench during the swing-through phase in both directions
   ( ) 2 Able to step up onto the bench with leading leg, but trailing leg contacts the bench or swings around the bench during the swing-through phase in one direction
   ( ) 3 Able to correctly complete the step up and over in both directions but requires close supervision in one or both directions
   ( ) 4 Able to correctly complete the step up and over in both directions safely and independently
5. Tandem walk
   ( ) 0 Unable to complete 10 steps independently
   ( ) 1 Able to complete the 10 steps with more than five interruptions
   ( ) 2 Able to complete the 10 steps with three to five interruptions
   ( ) 3 Able to complete the 10 steps with one to two interruptions
   ( ) 4 Able to complete the 10 steps independently and with no interruptions

6. Stand on one leg
   ( ) 0 Unable to try or needs assistance to prevent falling
   ( ) 1 Able to lift leg independently but unable to maintain position for more than 5 seconds
   ( ) 2 Able to lift leg independently and maintain position for more than 5 but less than 12 seconds
   ( ) 3 Able to lift leg independently and maintain position for more than 12 but less than 20 seconds
   ( ) 4 Able to lift leg independently and maintain position for the full 20 seconds

7. Stand on foam with eyes closed
   ( ) 0 Unable to step onto foam or maintain standing position independently with eyes open
   ( ) 1 Able to step onto foam independently and maintain standing position but unable or unwilling to close eyes
   ( ) 2 Able to step onto foam independently and maintain standing position with eyes closed for 10 seconds or less
   ( ) 3 Able to step onto foam independently and maintain standing position with eyes closed for more than 10 seconds but less than 20 seconds
   ( ) 4 Able to step onto foam independently and maintain standing position with eyes closed for 20 seconds

Do not perform test item 8 if score is 2 or lower on test item 4. Also do not introduce test item 8 if test item 4 was not performed safely and/or it is contraindicated to perform this test-item (review test administration instructions for contraindications). Give test item 8 a score of 0 and proceed to test item 9.

8. Two-footed jump
   ( ) 0 Unable to attempt or attempts to initiate jump but one or both feet do not leave the floor
   ( ) 1 Able to initiate jump with both feet but one foot either leaves the floor or lands before the other
   ( ) 2 Able to perform jump with both feet but unable to jump farther than the length of feet
   ( ) 3 Able to perform jump with both feet and achieve a distance greater than the length of feet
   ( ) 4 Able to perform jump with both feet and achieve a distance greater than twice the length of feet
9. Walk with head turns
   ( ) 0 Unable to walk 10 steps independently while maintaining 30° head turns at an established pace
   ( ) 1 Able to walk 10 steps independently but unable to complete required number of 30° head turns at an established pace
   ( ) 2 Able to walk 10 steps but veers from a straight line while performing 30° head turns at an established pace
   ( ) 3 Able to walk 10 steps in a straight line while performing 30° head turns at an established pace but head turns less than 30° in one or both directions
   ( ) 4 Able to walk 10 steps in a straight line while performing required number of 30° head turns at established pace

10. Demonstrate reactive postural control
   ( ) 0 Unable to maintain upright balance; makes no observable attempt to step; requires manual assistance to restore balance
   ( ) 1 Unable to maintain upright balance; takes two or more steps and requires manual assistance to restore balance
   ( ) 2 Unable to maintain upright balance; takes more than two steps but is able to restore balance independently
   ( ) 3 Unable to maintain upright balance; takes two steps but is able to restore balance independently
   ( ) 4 Unable to maintain upright balance but able to restore balance independently with only one step

TOTAL POINTS SCORED: _______________  40 POINTS POSSIBLE MAXIMUM SCORE

Evaluating Risk for Falls:
Long Form Fullerton Advanced Balance (FAB) scale Cut-Off Score: ≤ 25/40 Points
Test Administration Instructions for the Fullerton Advanced Balance (FAB) Scale

1. Stand with feet together and eyes closed

**Purpose:** Assess ability to use somatosensory (i.e., ground and body position) cues to maintain upright balance while standing in a reduced base of support and vision unavailable.

**Equipment:** Stopwatch with lanyard (for placing around neck).

**Safety Procedures:** Position person being tested in a corner (if available) or close to a wall. Stand close to participant in case of loss of balance. Hold watch at eye level so participant and time can be monitored simultaneously.

**Testing procedures:** Demonstrate the correct test position and then instruct the participants to move the feet independently until they are together. If some participants are unable to achieve the correct position due to lower extremity joint problems, encourage them to bring their heels together even though the front of the feet are not touching. Have participants adopt a position that will ensure their safety as the arms are folded across the chest and they prepare to close the eyes. Begin timing as soon as the participant closes the eyes. (Instruct participants to open the eyes if they feel so unsteady that a loss of balance is imminent.)

**Verbal instructions:** “Bring your feet together, fold your arms across your chest, close your eyes when you are ready, and remain as steady as possible until I instruct you to open your eyes.”

2. Reach forward to retrieve an object (pencil) held at shoulder height with outstretched arm

**Purpose:** Assess ability to lean forward to retrieve an object without altering the base of support; measure of stability limits in a forward direction.

**Equipment:** Pencil and 12-inch ruler

**Safety Procedures:** Position person facing out from corner (if available) or close to wall. Position self to side of participant’s outstretched hand. Use arm holding pencil in horizontal position to manually assist client if a loss of balance occurs.

**Testing procedures:** Provide participant with sagittal view of desired movement. Instruct the participant to raise the preferred arm to 90° and extend it with fingers outstretched. Use the ruler to measure a distance of 10 inches from the end of the fingers of the outstretched arm. Hold the object (pencil) horizontally and level with the height of the participant’s shoulder. Be sure not to move the pencil once the instructions are provided. Instruct the participant to reach forward, grasp the pencil, and return to the initial starting position without moving the feet, if possible. (It is acceptable to raise the heels as long as the feet do not move while reaching for the pencil.) If the participant is unable to reach the pencil within 2-3 seconds of initiating the forward lean, indicate to the participant that it is okay to move the feet in order to reach the pencil. Record the number of steps taken by the participant in order to retrieve the pencil.

**Verbal instructions:** “Try to lean forward to take the pencil from my hand and return to your starting position without moving your feet.” After allowing 2-3 seconds of lean time: “You can move your feet in order to reach the pencil.”

Revised Sept 2008 (DR)
3. Turn 360 degrees in right and left directions

**Purpose:** Assess ability to turn in a full circle in both directions in the fewest number of steps without loss of balance

**Equipment:** None

**Safety Procedures:** Position person being tested about one foot in front of a wall and facing you. Stand close enough during test to provide manual assistance if a loss of balance occurs.

**Testing procedures:** Verbally explain and then demonstrate the task to be performed, making sure to complete each circle in four steps or less and pause briefly between turns. Instruct the participant (who is facing you) to turn in a complete circle in one direction, pause, and then turn in a complete circle in the opposite direction. Count the number of full steps taken to complete each circle. Stop counting steps as soon as the participant is facing you after completing each turn. Allow for a small correction in foot position before a turn in the opposite direction is initiated.

**Verbal instructions:** “In place, turn around in a full circle, pause, and then turn in a second full circle in the opposite direction. Do not begin the full circle in the opposite direction until you are facing me.”

4. Step up onto and over a 6-inch bench

**Purpose:** Assess ability to control body in dynamic task situations; also a measure of lower body strength and bilateral motor coordination.

**Equipment:** 6-inch-high bench (18- by 18-inch stepping surface)

**Safety Procedures:** Position bench close to a wall and self on opposite side of bench. Adopt close supervisory position and move with participant as she/he steps up and over the bench in each direction.

**Testing procedures:** Verbally explain the movement to be performed before demonstrating the step up onto and over the bench (at normal speed) in both directions. Instruct the participant to step onto the bench with the right foot, swing the left leg directly up and over the bench, and step off the other side, then repeat the movement in the opposite direction with the left leg leading the action. Encourage the participant not to touch the wall or you to maintain balance during the test. During performance of the test item, watch to see that the participant’s trailing leg (a) does not make contact with the bench, or (b) swing around, as opposed to directly up and over, the bench. Verbally cue which leg should be leading the action just prior to the start of the movement in each direction.

**Verbal instructions:** “Step up onto the bench with your right leg, swing your left leg directly up and over the bench, and step off the other side. Repeat the movement in the opposite direction with your left leg as the leading leg.”

5. Tandem walk

**Purpose:** Assess ability to dynamically control center of mass with an altered base of support

**Equipment:** Masking tape

**Safety Procedures:** Set the tandem walk line approximately 12 inches away from a wall. Monitor the participant closely during performance of the test item and walk forward with the client as he/she completes the test item. Be ready to provide manual assist if a loss of balance occurs.

**Testing procedures:** Verbally explain and demonstrate how to perform the test item correctly before the participant attempts to perform it. Instruct the participant to walk on the line in a tandem position (heel-to-toe) until you tell him/her to stop. Allow the participant to repeat the test item one time if unable to achieve a tandem stance position within the first two steps. The participant may elect to step forward with the opposite foot on the second attempt. Score as interruptions any instances where the participant (a) takes one or more steps away from the line when performing the tandem walk or (b) is unable to achieve correct heel-to-toe position during any step taken along the course. Do not ask the participant to stop until 10 steps have been completed.

**Verbal instructions:** “Walk forward along the line, placing one foot directly in front of the other such that the heel and toe are in contact on each step forward. I will tell you when to stop.”
6. **Stand on one leg**

**Purpose:** Assess ability to maintain upright balance with a reduced base of support.

**Equipment:** Stopwatch and lanyard.

**Safety Procedures:** Position the person being tested in a corner (if one is available) or close to a wall. Stand in a close supervisory position and on the side of the raised leg.

**Testing procedures:** Instruct the participant to fold the arms across the chest, lift one leg off the floor, and maintain balance until instructed to return the foot to the floor. Begin timing as soon as the participant lifts the foot from the floor. Stop timing if the legs touch, the raised leg contacts the floor, or the participant lifts the arms off the chest before the 20 seconds has elapsed. Allow the participant to perform the test a second time with the other leg raised if they touch down quickly on the first attempt or are unsure as to which leg should be raised.

**Verbal instructions:** “Fold your arms across your chest, lift one leg off the floor (without touching your other leg), and stand with your eyes open until I ask you to put your foot down.”

7. **Stand on foam with eyes closed**

**Purpose:** Assess ability to maintain upright balance while standing on a compliant surface with eyes closed

**Equipment:** Stopwatch and lanyard; two Airex® pads, with a length of nonslip material placed between the two pads and an additional length of nonslip material between the floor and first pad if the test is being performed on an uncarpeted surface.

**Safety Procedures:** Position person to be tested in a corner (if one is available) or close to a wall. After demonstrating the test item, place the Airex® pads in front of the person if standing in a corner. Adopt a close supervisory position and hold watch at a height that allows for simultaneous monitoring of the participant's arm position and eyes as well as the time. Instruct the participant to open the eyes if she/he feels so unsteady that a loss of balance is imminent. Manually assist the client off the foam pads if he/she appears unsteady.

**Testing procedures:** Following a demonstration of the task, instruct the participant to step up onto the foam pads without assistance, position the feet shoulder width apart, fold the arms across the chest, and close the eyes when ready. Begin timing as soon as the eyes close. Stop the trial if the participant (a) opens the eyes before the timing period has elapsed, (b) lifts the arms off the chest, or (c) loses balance and requires manual assistance to prevent falling. Instruct the participant to step forward off the foam at the completion of the test item. Provide manual assistance if needed.

**Verbal instructions:** “Step up onto the foam and stand with your feet shoulder-width apart. Fold your arms over your chest, and close your eyes when you are ready. I will tell you when to open your eyes.”

8. **Two-footed jump for distance** (Do not introduce this test item if participant cannot perform test item 4 safely, has a diagnosis of osteoporosis, or complains of lower body joint pain. Score a zero on the test form and move immediately to test item #9.)

**Purpose:** Assess upper and lower body coordination and lower body power.

**Equipment:** 36-inch ruler; masking tape.

**Safety Procedures:** Position the person close to a wall and adopt a close supervisory position during the jump. Demonstrate the jump but do not jump more than twice the length of your own feet. Stand to the side of the participant and move forward as he or she jumps. Place your hand on the participant's back to steady him/her as soon as the feet contact the ground following the jump.

**Testing procedures:** Instruct the participant to jump as far but as safely as possible while performing a two-footed jump (i.e., leave the floor with two feet and land on two feet). Demonstrate the correct movement prior to the participant performing the jump. Use the ruler to measure the length of the foot and then multiply by two to determine the ideal distance to be jumped. Observe whether the participant leaves the floor with both feet and lands with both feet. Position the ruler on the floor and on the opposite side of the participant and close to the wall so that you can glance down and see how far the participant jumped.

Revised Sept 2008 (DR)
Verbal instructions: “Jump as far but (emphasize) as safely as you can. Try and make sure that both feet leave the floor and land at the same time.”

9. Walk with head turns

Purpose: Assess ability to maintain dynamic balance while walking and turning the head from side-to-side.

Equipment: Metronome set at 100 beats per minute

Safety Procedures: Position yourself directly behind the participant during the standing portion of the test item so you can clearly see how far the head turns in either direction. Move to a position that is behind and slightly to the side of the participant during the walking portion of this test item. Stand close enough that you can provide manual assistance if the participant becomes unstable while walking.

Testing procedures: After first demonstrating the test item, ask the participant to practice turning the head in time with the metronome while standing in place. Watch to see that the participant is turning the head the required distance to both sides and at the required speed. Provide verbal cueing if the participant is not performing the head turns correctly. Once the participant appears to have the correct head turning rhythm (after no more than 4 to 6 head turns), instruct him/her to begin walking forward. The head turns should be to the beat of the metronome. Begin counting steps as soon as the participant begins to walk forward with head turns. Observe whether the participant deviates from a straight path while walking or is unable to turn the head the required distance (in one or both directions) and/or at the required speed. If the participant is unable to achieve the correct head turning rhythm while standing it is highly unlikely he/she will be able to achieve it while walking (making the scoring of the test item a little easier). Also, in most cases, the steps will be synchronized with the head turns, making the counting of 10 steps easier.

Verbal instructions: “Begin turning your head to the beat of the metronome while standing in place. Start walking forward while turning your head from side-to-side with each beat of the metronome. I will tell you when to stop.”

10. Reactive postural control

Purpose: Assess ability to efficiently restore balance following an unexpected perturbation

Equipment: None

Safety Procedures: Position the client approximately 3-4 feet in front of a wall. Stand immediately behind the participant and adopt a wide base of support during the leaning portion of the test. Be ready to move your feet quickly once you release your hand and the participant begins to lose balance. Flex the elbow and release your hand as soon as you determine that the participant is exerting sufficient pressure against your hand to require that he/she must step backwards one or more times to restore balance. This release should be unexpected, so do not prepare the participant for the moment of release or allow the participant to lean too far back onto your hand before releasing it.

Testing procedures: Instruct the participant to stand with his or her back to you. Extend your arm with the elbow locked and place the palm of your hand in the middle of the participant’s back. Instruct the participant to lean back slowly against your hand until you tell him or her to stop. Quickly flex your elbow until your hand is no longer in contact with the participant’s back at the moment you estimate that a sufficient amount of force has been applied to require a movement of the feet to restore balance. Try to quickly release your hand while you are still giving the verbal instructions.

Verbal instructions: “Slowly lean back into my hand until I ask you to stop.”
### Interpretation of the Individual Test Items on the Fullerton Advanced Balance (FAB) Scale for Possible Underlying Impairments

<table>
<thead>
<tr>
<th>Item</th>
<th>Possible impairments</th>
<th>Recommended exercises</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Stand with feet together and eyes closed</td>
<td>1. Weak hip abductors/adductors</td>
<td>Lateral weight shifts against resistance; side leg raises against gravity/resistance</td>
</tr>
<tr>
<td></td>
<td>2. Poor COG control</td>
<td>Progressive standing balance activities with reduced base of support; seated/standing balance activities emphasizing weight shifts in multiple directions</td>
</tr>
<tr>
<td></td>
<td>3. Poor reception and/or central organization of somatosensory information.</td>
<td>Multisensory training; standing balance activities with vision reduced, engaged, or absent (reduced base of support and weight-shifting activities in anterior-posterior and lateral directions)</td>
</tr>
<tr>
<td></td>
<td>4. Fear-of-falling</td>
<td>Confidence-building activities - slower progression through standing balance activities with vision manipulated. See HAQ #12 response for confirmation.</td>
</tr>
<tr>
<td>2. Reach forward to retrieve object</td>
<td>1. Reduced limits of stability</td>
<td>Seated/standing trunk leaning activities; seated/standing weight shift activities in multiple directions</td>
</tr>
<tr>
<td></td>
<td>2. Reduced ankle ROM</td>
<td>Ankle circles, heel lifts, and drops from height; ankle strengthening with resistance band</td>
</tr>
<tr>
<td></td>
<td>3. Fear of falling</td>
<td>Confidence-building activities—slower progression through COG activities to ensure success is high.</td>
</tr>
<tr>
<td></td>
<td>4. Lower body muscle weakness</td>
<td>Wall sits or chair stands; LB exercises against resistance (gravity; ankle weights).</td>
</tr>
<tr>
<td>3. Turn in a full circle</td>
<td>1. Poor dynamic COG control</td>
<td>Standing weight transfer activities; gait pattern enhancement (turns, directional changes) and variation (altered step lengths, cone walking).</td>
</tr>
<tr>
<td></td>
<td>2. Poor central organization and integration of sensory information.</td>
<td>Multisensory training (emphasize use of vision, vestibular systems for balance). Gaze stabilization emphasized. Head and eye movement coordination exercises; turning; directional changes; marching and walking with head turns.</td>
</tr>
<tr>
<td></td>
<td>3. Lower body weakness</td>
<td>LB exercises with resistance; emphasize hip and knee flexion; hip abduction/adduction; ankle dorsiflexion/ankle plantarflexion.</td>
</tr>
<tr>
<td>4. Step up and over</td>
<td>1. Poor dynamic control of body</td>
<td>Seated/standing/moving balance activities emphasizing weight shifts, and transfers against gravity. Standing COG activities with reduced base of support</td>
</tr>
<tr>
<td></td>
<td>2. Lower body weakness</td>
<td>LB exercises with resistance (own body/resistance band; emphasize sustained unilateral stance positions) and hip abductor strengthening.</td>
</tr>
<tr>
<td></td>
<td>3. Reduced ROM at ankle, knee, hip</td>
<td>Flexibility exercises emphasizing hip/knee/ankle flexion; seated and standing.</td>
</tr>
<tr>
<td></td>
<td>4. Poor central organization and integration of sensory inputs</td>
<td>Standing and moving multisensory training activities (emphasize use of different sensory inputs for balance).</td>
</tr>
<tr>
<td>Item</td>
<td>Possible impairments</td>
<td>Recommended exercises</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>-----------------------------------------------------------</td>
<td>----------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>5. Tandem walk</td>
<td>1. Poor dynamic control of body</td>
<td>Standing activities with altered base of support</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Moving COG control activities; emphasize anterior-posterior directional control during weight shifts</td>
</tr>
<tr>
<td></td>
<td>2. Poor central organization and integration of sensory inputs</td>
<td>Standing and moving multisensory training activities (emphasize use of vision and somatosensation for balance)</td>
</tr>
<tr>
<td></td>
<td>3. Weak hip abductors/adductors</td>
<td>Side leg raise against gravity/resistance; lateral weight shift and lunge activities</td>
</tr>
<tr>
<td>6. Stand on one leg</td>
<td>1. Poor COG control</td>
<td>Standing weight shifts and transfers in multiple directions; reduced base of support activities</td>
</tr>
<tr>
<td></td>
<td>2. Lower body muscle weakness</td>
<td>LB exercises with resistance (body/resistance band); emphasize hip abductors/adductors</td>
</tr>
<tr>
<td></td>
<td>3. Poor use of vision</td>
<td>Activities emphasizing gaze stabilization.</td>
</tr>
<tr>
<td></td>
<td>4. Impaired reception of somatosensory Inputs</td>
<td>Standing multisensory activities emphasizing use of vision and vestibular systems for balance</td>
</tr>
<tr>
<td>7. Stand on foam with eyes closed</td>
<td>1. Poor central organization and integration of sensory information</td>
<td>Seated/standing activities performed with reduced/engaged/absent vision on altered surfaces</td>
</tr>
<tr>
<td></td>
<td>2. Lower body muscle weakness</td>
<td>LB exercises with resistance (body/resistance band); emphasize quadriceps, gastrocnemius/soleus, hip abductor muscle groups</td>
</tr>
<tr>
<td></td>
<td>3. Heightened fear of falling when vision absent</td>
<td>Confidence-building activities with vision engaged, slowly progressing to activities with reduced and absent vision</td>
</tr>
<tr>
<td>8. Two-footed jump</td>
<td>1. Poor dynamic control of body</td>
<td>Standing/moving COG activities emphasizing leaning away from and back to midline</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Seated balance activities against gravity</td>
</tr>
<tr>
<td></td>
<td>2. Poor upper and lower body coordination</td>
<td>Selected exercises to improve UB and LB coordination; multiple task activities</td>
</tr>
<tr>
<td></td>
<td>3. Lower body muscle weakness</td>
<td>LB exercises with resistance (body/resistance band) performed at progressively faster speeds. Emphasize knee and hip flexion, hip abduction, ankle dorsiflexor/plantarflexion.</td>
</tr>
<tr>
<td>9. Walk with head turns</td>
<td>1. Poor central organization and integration of sensory inputs</td>
<td>Head and eye movement coordination exercises; gait pattern enhancement (turns, directional changes); standing and moving multisensory activities emphasizing use of vision and vestibular systems for balance</td>
</tr>
<tr>
<td></td>
<td>2. Poor dynamic control of body</td>
<td>Standing/moving activities with head turns; progressively increase speed and frequency of head turns</td>
</tr>
<tr>
<td>10. Reactive postural control</td>
<td>1. Absent postural strategy (i.e., step)</td>
<td>Activities emphasizing step strategy (i.e., voluntary step activities progressing to resistance band release activity) in all directions</td>
</tr>
<tr>
<td></td>
<td>2. Poor dynamic control of body</td>
<td>Standing and moving COG control activities; volitional stepping activities in multiple directions</td>
</tr>
<tr>
<td></td>
<td>3. Lower body muscle weakness</td>
<td>LB exercises with resistance; emphasize hip and knee flexion; hip abduction/adduction; dorsiflexor/plantarflexion</td>
</tr>
</tbody>
</table>

*Note: COG=center of gravity; LB=lower body; UB=upper body.*
Radiological Assessment of the Knee: Definition of Terms

1. Chondral lesion: defect extending into the cartilage only.
2. Osteochondral lesion: defect penetrating the articular cartilage, extending into the underlying subchondral bone.
3. Chondral de-lamination: cartilage has broken/peeled away from itself or the underlying subchondral bone.
4. Chondral fissuring: fissures, or a split like appearance in the cartilage surface.
5. Signal intensity: a subjective evaluation of the tissue contrast, reflecting changes in (or abnormal) soft tissue or differing levels of repair tissue maturation.
6. Subchondral lamina: the subchondral plate, the junction between the subchondral bone below and the cartilage above.
7. Subchondral bone: the bone beneath the cartilage cover.
8. Subchondral cyst: fluid filled sac that forms within the subchondral bone.
10. Subchondral Sclerosis: increased bone density and/or thickening of the subchondral bed.
11. Femoral trochlear (sulcus) angle: a measure of the gradient of the angle of the trochlea groove.
12. Femoral trochlear depth: a measure of the depth of the trochlea groove.
13. Patella tilt angle: a measure of abnormal tilt of the patella, affected by muscular imbalance and/or tight retinaculum.
14. Congruence angle: measure of patella centralization and/or subluxation, with respect to the trochlea groove.
15. Tubercle laterisation: a measure of abnormal lateral tibial tubercle position, contributing to lateral patellofemoral maltracking.
18. Osseous integration: the degree of connection/interface between the bone surface and, most commonly, a prosthetic component.
20. Joint effusion: an increase in the normal amount of joint intra-articular fluid.
22. Osteophyte (bone spur): bony deposit/projection that forms, predominantly in arthritic joints.
23. Osteophytic lipping: excessive bony deposition around the outer knee joint.