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Session 203: Restoring Balance & Function after Hip and Ankle Arthroplasty
Jason Handschumacher, DPT, OCS

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Objectives

- Identify current options in total hip and total ankle arthroplasty
- Discuss gait and balance mechanics and how these can be maximized post-operatively
- Review ankle and hip joint anatomy, the concepts of hip strategies and ankle strategies for balance and the effect of surgery on joint receptors
- Examine current literature on the importance of balance and proprioceptive training following each procedure
- Demonstrate which exercises and activities are most helpful, when to initiate each and which ones the patient should continue independently.

An Orthopedic Surgery but a Neurological Injury

Hip

- Total Hip Arthroplasty
  - First in 1940 (U.S.)
  - Over 1 million performed annually worldwide

- Posterior Approach
- Lateral Approach
- Postero-lateral Approach
- Anterior Approach

- Hemi-Arthroplasty
Ankle
- Total Ankle Arthroplasty
  - First performed in the 1970's – failures
  - Approx 5,000 performed annually
  - 7 prosthetic designs currently
  - Cemented / Screws and Plates
  - Cementless / Mobility designs
  - Modular fixation stems

Hip
- Materials
  - Cobalt-Chromium-Titanium Alloy
  - Oxinium™
    - Oxidized Zirconium – Ceramic Surface
  - Polyethylene Liners
- Head Size

- Bony In-growth / Cemented / Combination
Hip

- Lots of options / components

Hemi-Arthroplasty    Revision THA

Hemi-Arthroplasty

Posterior Approach

- 1891; T. Gluck; Germany; used ivory
- 1940; Dr. Austin Moore; Columbia, SC
- “Southern Approach”

- Piriformis and ER muscles split or taken down and repaired
- Can visualize more easily
- May still be needed for some revisions

Postero-Lateral approach – more common now, smaller incision

- “Large head” prosthesis/capsule repair – more stable

Direct Anterior / Antero-Lateral Approaches

- 1947 in France (Dr. Robert Judet)
- 1996 first in US (Dr. Joel Matta)
- More surgeons are learning the procedure
- Same implant components
Hip
Direct Anterior / Antero-lateral Approaches

- Smaller incisions (artery/LFC nerve)
- No bending precautions
- Need to avoid aggressive extension / ER – incision pain
- Limit repetitive SLR exercise also - tendonitis
- Ambulate better sooner
- Shorter hospital stay potentially

Hip
Dislocation Concerns

- Older / Smaller heads
- Most risk in first 8-10 weeks (tissue healing)
- Larger femoral heads and tissue repair
- Patient factors
  - Size, smokers, activity

HIP
Revision options

- Constrained Liner
**HIP**

**Dislocation Concerns**

- **Anterior vs. Posterior?**
  - Meta Analysis of 17 studies; 2300+ subjects (Higgins, et al. 2015)
  - Less Post-operative pain – some favor to Anterior
  - Shorter Length of stay and dislocation – Anterior
  - Overall though no clear superiority to either
  - “Recommend choice be based on patient characteristics, surgeon experience and patient preference”

**Hip**

- **Leg length??**
  - “Settles like a house”
  - Radiographs in surgery – precision
  - Have used lifts after 6 months
  - Low Back Pain
  - Gait mechanics study (Li, et al. 2015)
    - 12+ months post-op, confirmed on radiograph
    - Compared symptomatic LLI, asymptomatic LLI and control
    - Symptomatic had shortened stride, lower ground reaction force, lower hip moment
    - May affect prosthesis wear and adjacent joints
Hip
• Another option – Metal on Metal Resurfacing
  - Promising but some controversy due to prior failures
  - Fast, often same day discharges
  - Must monitor metal (Cobalt and Chromium) ion levels pre-op and post-op
    - Recent recommendation 5 years (Low, et al 2015)

Ankle
• Some Issues
  - Not as common as Hip, Knee
  - Rheumatoid Arthritis
  - 90% of people with RA will have ankles affected
  - More difficult to develop
    - First attempted in the 1970s (Bonasia et al, 2010)
    - Deemed inferior to ankle fusion – until 2000s
  - Lots of force – small area – less bone mass
Ankle

- Some Issues

- Goal: Relieve pain and try to restore some Talus mobility

- More often from trauma at some point
- Soft tissue changes over time
- Less often primary OA; likely RA instead

- Surgical approach / technique challenges

- Mobile bearing – Cementless (more common now)
**Ankle**

*Salto Talaris™ Ankle*

(Wood et al, 2010)

- 100 ankles

- 5% revision (2 fusion, 3 component exchange)
- 4 year survival rate 96.3% (comparable to others)

**Ankle**

*Mobility™ Total Ankle Replacement*

(Wood et al, 2010)

- 100 ankles

- 5% revision (2 fusion, 3 component exchange)
- 4 year survival rate 96.3% (comparable to others)

**Ankle**

*HINTEGRA™*

- Simultaneous Bilateral TAR (Barg et al, 2011)
- Improved function, pain, ROM
- 6/52 ankle required revision
Ankle
- INBONE™ System
- INVISION™ (Revisions)

Balance, Proprioception, Gait
Balance and Proprioception

- Proprioception – “The reception of stimuli produced within the organism”
  - Cerebellum
  - Spinal Cord Reflexes
  - Muscle Spindles
  - Golgi Tendon Organs
  - Vision
  - Vestibular
  - Cerebrum – aware of what is going on

- Balance – Physical equilibrium
  - Even weight distribution
  - “Good leg Bad leg”

Balance and Proprioception

- Postural Control
  - Ankle Strategy
    - Primary
    - Most adaptive / efficient
  - Hip Strategy
    - For larger perturbations
    - More common as we age
  - Stepping Strategy
    - Last resort
    - Avoid fall

Balance and Proprioception

- Joint capsule receptors
  - Free Nerve Endings
    - Joint capsule and surrounding connective tissue
    - Sense extremes of flexion or extension
  - Golgi Type Endings
    - Only in ligaments
    - Active at end ranges – protective

- Ruffini Endings
  - Only in capsule
  - Sense stretch – active at rest and motion

- Paciniform Endings
  - At capsule attachment to periosteum
  - Sense motions / acceleration
Gait

- ROM needed – stance phases
  - Hip extension (10 degrees+) and ER
  - Ankle Dorsiflexion (10 degrees+)
  - 1st MTP Extension (60 degrees)
  - Trunk counterrotation

- Stance control
  - Hip muscles – activation and strength
  - Symmetry – weight acceptance
  - Single limb balance

How Are They Doing Post-op?

Balance and Proprioception

- Surgery effects on capsule (Hip)
- Dynamic Posturography and Proprioception Testing (THR compared to controls)
- THR – overall little effect on capsule – proprioception / compensated for quickly
  - Good sensory integration of all 3 systems

- Hip capsule has fewer joint receptors than the ankle
- Ankle responses primary still

Balance and Proprioception

- Delayed motor responses
- Motor deficit in gait requiring compensations
- Altered weightbearing
- Abductor weakness
- Require more vestibular and visual input in challenging tasks

Balance and Proprioception

- Hip / Knee / Ankle 12 months post-op (Butler, et al. 2014)
  - Timed SLS – barefoot – firm surface
  - “Pass” >10 sec  Hip 63%  Knee 69%  Ankle 9%

- THA / Hip Resurfacing / Controls 15 months post-op (Symanski et al., 2012)
  - 25 sec SLS on either operative on non operative leg
  - 25% of THA patients could; 100% of resurfacing and controls could

- Ankle
  - Balance (Joint receptors in capsule) (Lee, et al. 2010)
    - Deficits at 15 mo. compared to controls - Primarily in Sagittal plane

Gait

- THA
  - Systematic Review, 35 articles included, comparison to controls, > 6 mo follow-up
  - Decreased sagittal plane motion (extension)
  - Decreased sagittal power generation
  - Decreased abduction and ER moments (stance)
    - (Kolk, et al. 2014)
Gait

- Hip / Knee / Ankle / Controls 6 months post-op (Casartelli et al, 2013)
  - Self selected and Fast walking speeds on force mat
  - Marked difference in Ankle compared to Knee and Hip
    - Decreased stance time on operative side
    - Decreased stance time compared to controls
  - Slower velocity
  - No significant difference between Hip and controls

- Ankles at 2 years compared to pre-op (Queen et al, 2014)
  - Improved speed
  - Improving – but still asymmetrical pattern

Rehabilitation

Hip

- ROM
  - Flexion to sit
  - Abduction to get out of bed
  - Extension and ER to walk
    - Early but gently

- Strength
  - "Strongest butt ever"
  - Closed chain early if possible

- Balance
  - Symmetry training – “Use the ‘bad’ leg”
Hip Exercise Considerations
- PROM – AROM – Strength – Functional Use
- HEP early
- Open chain has a place; closed chain when ready
- Eccentric overloading for hypertrophy
- Challenge Functionally

Manual Therapy (Video)
- Hip extension / ER
  - Prone / Sidelying / Standing technique

Are there precautions?
- Was the Piriformis repaired / not affected?
- Know open and closed chain joint positions
- "Standard" for Posterior approach
- Extension / ER (Anterior – regain cautiously)
- Repetitive hip flexion (Anterior – soft tissue irritations)

HIP Exercises – Some Favorites
- Glute max progression
  - Modified from “Powers Program” (Chris Powers, PT, PhD, FAPTA – University of Southern California)

Activation (Video)
- Static holds – work up to 5 reps 60 seconds with band
- Clams at 45 degrees
- “Fire Hydrants” – stance position
- Squat with bands
- Surfer

Strengthening
- 2-3 sets of 8-12 reps. 2-3 days a week (Eccentrics to failure)
**Hip**

<table>
<thead>
<tr>
<th>Exercise</th>
<th>Glute Med (%MVIC)</th>
<th>Glute Max (%MVIC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forward Step Up</td>
<td>44%</td>
<td>74%</td>
</tr>
<tr>
<td>Side Bridge</td>
<td>74%</td>
<td></td>
</tr>
<tr>
<td>Single Leg Deadlift</td>
<td>58%</td>
<td>59%</td>
</tr>
<tr>
<td>Single Limb Squat</td>
<td>64%</td>
<td>59%</td>
</tr>
<tr>
<td>Standing Pelvic Drop</td>
<td>57%</td>
<td></td>
</tr>
<tr>
<td>Transverse Lunge</td>
<td>48%</td>
<td>49%</td>
</tr>
<tr>
<td>Unilateral Bridge / Bilateral Bridge</td>
<td>47% / 28%</td>
<td>40% / 27%</td>
</tr>
<tr>
<td>Quadruped Hip extension (knee flexed)</td>
<td>42%</td>
<td>56%</td>
</tr>
<tr>
<td>Clams (at 30 degrees; no resistance)</td>
<td>39%</td>
<td>34%</td>
</tr>
<tr>
<td>Sidelying Abduction (no resistance)</td>
<td>39-81%</td>
<td>21%</td>
</tr>
<tr>
<td>Sidestep in Squat position (T-band)</td>
<td>36%</td>
<td>25% (TFL 36%)</td>
</tr>
<tr>
<td>Unilateral Mini-Squat/Unilateral Mini-Squat</td>
<td>36%</td>
<td>37%</td>
</tr>
</tbody>
</table>

(Reiman, 2011  Berry, 2015  Selkowitz, 2016)

**HIP**

- **Strengthening**
  - Early Extension / Glute Sets
  - Bridge with ER / Bridge with marching
  - S/L hip 4 ways (check IR precautions with surgeon)
  - Use ball to limit initially
  - Clams (ball between feet) at 30 degrees hip flexion
  - Backwards hip circles ("Belly up to the bar")

- **Strengthening Progression**
  - Step up – (dorsiflex stance leg ankle)
  - Forward step ups (dorsiflexion)
  - Single Limb Squat
  - Single Limb Deadlift
  - Pelvic Drop
  - Side step Squat Position – Closed chain NR

**Hip**

- **Strength / Balance Combined**
  - Standing hip extension to Swiss ball
  - Star points
  - Cone taps
  - Alternating heel taps
  - Side step up / over
  - "Steamboats" – Standing Hip 4 ways
    (Video)
Functional Exercises

- Proprioceptive training (Hip)
- Facilitation

- Start in Acute phase / Home Health
  - PNF / Diagonals / Eyes closed
  - Addition of standing trunk rotations; lunge walk; weight shifts in straddle position
  - Improved Berg and TUG scores – THA patients (Jogi et al, 2015) [Video]

- Early weightbearing
  - Foam pads / Rockerboards / BOSU ball if appropriate
  - Multi direction (primarily transverse plane)
  - Eyes closed / weight shift to the “bad side”

- Improved Berg and TUG scores – THA patients (Jogi et al, 2015) [Video]
- Early weightbearing

Hip

- Return to Activity (Vogel, et al, 2011)

<table>
<thead>
<tr>
<th>Recommended</th>
<th>Recommended with Experience</th>
<th>Not Recommended</th>
</tr>
</thead>
<tbody>
<tr>
<td>Golf, Swimming, Hiking</td>
<td>Weightlifting (Free Weights)</td>
<td>Singles Tennis / Handball</td>
</tr>
<tr>
<td>Doubles Tennis / Bowling</td>
<td>Cross Country Skiing</td>
<td>Racquetball / Squash</td>
</tr>
<tr>
<td>Stairclimber, Elliptical</td>
<td>Downhill Skiing</td>
<td>Jogging / Running</td>
</tr>
<tr>
<td>Walking/Speedwalking</td>
<td>Ice Skating / Rollerblading</td>
<td>Snowboarding / High Impact Aerobics</td>
</tr>
<tr>
<td>Stationary Skiing</td>
<td>Pilates</td>
<td>Contact Sports (Football, Soccer, Hockey)</td>
</tr>
<tr>
<td>Dancing, Cycling, Rowing</td>
<td></td>
<td>Baseball / Softball</td>
</tr>
<tr>
<td>Weight Machines, Low-Impact Aerobics</td>
<td></td>
<td>Martial Arts / Water skiing</td>
</tr>
</tbody>
</table>

Ankle

- Post – op Timeline (approximate)

  - 0-4 weeks
    - Inpatient – 2.5 days average
    - Some locations starting to do as OP procedure (Gonzalez, et al 2017)
    - Strict elevation – control swelling
    - NWB 2 weeks – uncemented prosthesis
    - WB in boot 2-4 weeks (post-op Radiographs)
    - Swelling management, basic circulation exercises
Ankle

- Post-op Timeline

  - 4 weeks – 3 months
  - Outpatient phase

  - May stay in boot beyond 4 weeks (pt. and surgeon specific)

Ankle

- Rehabilitation

  - Regain ROM – may have years of soft tissue problems – may have achilles lengthened also

  - Know surgeon expectations

    - ~10 degree DF ~35 degree PF, Inv/Ev arc ~25 (depends on prosthesis)

    - 10 – 60 degree total arc averages reported; 0-14 degrees gained on average (Gougoulias et al, 2010)

Ankle

- Rehabilitation

  - Primary DF / calf mobility for gait

  - Manual techniques / Instrument Assisted / Massage Rollers

  - Address the overall foot / MTP joints

    - Joint Mobilizations / Self mobilization

  - Ice regularly – feet swell – Compression socks

  - Cautious progression based on pain

    - Tendon transfer? – May wait 2-3 months for resistance
Ankle

- Exercises – Some Favorites
  - NWB initially
    - AROM, Theraband, Towel stretches, Marble pick ups
  - PWB (Video)
    - Seated heel raises (focus on 1st MTP), seated toe raises, “Windshield Wipers”, BAPS board
    - Progression – pressure down through knee then to sitting on high stool

Functional Exercises

- Proprioceptive training (Ankle)
  - Start in Acute phase / Home Health
  - Strict elevation early
    - ROM/stretching only
  - Delayed weightbearing
    - Seated ball rolling (PWB) eyes closed
    - Weight shifts / Stepping
    - Foam pads / BAPS when ready
  - Multi direction (primarily sagittal plane)

Ankle

- Exercises – Some Favorites
  - FWB (Video)
    - Wall stretches, slant board, N-fnocker boards, SLS on rolled towel
    - Like to do barefoot if able
    - Wearable devices

Janda Sandals
StepRight Stability System
Gait exercises

- Single Limb stance / stance phase
- Skating
- Goal Specific

Real Patients

Hip
- THA – Balance
  - Cindy – Left Ant - THA
  - 2 level lumbar fusion about 2 years ago
  - She needs some hip mobility – agree?
  - Desires quite active lifestyle

- Hip extension ROM progression
  - Glute sets/hip extension supine then standing (early)
  - “Thomas” test stretch eventually
  - Rockerboard progression

"Video"
Hip

- Hip Resurfacing Patient
  - Lori – I had seen her pre-op but had persistent pain
  - Same day hospital D/C
  - 9 days post-op [Video]
  - At 3 weeks walking very briskly on treadmill 4-5 days / week
  - Has since had the same procedure on her other hip – very pleased

Hip

- Carol –
  - 88 years old
  - Dislocated THA
  - Revision THA
  - SNF for 3 months – no therapy – "W/C Bound"
  - Today – [Video]

Ankle

- TAR – Balance
  - John – TKA patient
  - Had Left TAR about 7 years ago
  - Never did balance training at all
  - Simple home balance exercises [Video]
    - Pat – InBone system 4 months prior
    - Video (after about 2 weeks of just home balance exercises)