Rehabilitation Techniques Following TKA and UKA

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Objectives

- To be able to understand the precautions/restrictions for rehabilitation after surgery based on the surgery performed
- To understand the chronic deficits seen after TKA and UKA
- To be able to properly identify deficits through static and dynamic assessments
- To be able to implement rehabilitation techniques based on limitations to allow return to competitive function

Surgical Precautions

- Total Knee Arthroplasty
  - Division of the quadriceps
  - Detachment of the vastus medialis
  - Division of the suprapatellar pouch
  - Division of the vastus medialis obliquus
- Unicondylar Knee Arthroplasty
  - Release of vastus medialis
  - Release of MCL
  - Release of ITB
Deficits Seen after TKA/UKA

- Range of Motion Deficits
- Strength Deficits
- Rate of Torque Development Deficits
- Dynamic Mobility Deficits
  - Return to sport
    - Pivoting/cutting, sprints, jumping

Range of Motion Deficits

  - 20 elderly normal subjects (mean age 67; range 49-88)
  - Assessed ROM during 11 functional activities: level walking, ascend/descend 5 degree slope, ascend/descend 20 steps, sit to/from stand from high and low chair, into/out of bath
  - On average, right knee exhibited 135.5 degrees of flexion and the left exhibited 136.5 degrees of flexion
  - Knee remains fixed ~18 degrees with stair negotiation and the flexion required is anywhere from 90-120 degrees.
  - Getting into and out of the bath requires ~135 degrees of knee flexion


- Only 3 of the eleven functions showed maximum knee flexion values less than 90 degrees, the other 8 required 100 degrees or more
- A knee excursion of 103 degrees is required during sit to stand from a low chair
- A target of 110 degrees of flexion would be most appropriate for rehabilitation, but this continues to limit the use of the bathtub
Strength Deficits

- Quadriceps femoris muscle weakness has a substantial impact on movement patterns (J Orthop Res 2005; 23: 1083-90).
- Patients with knee OA have reduced maximal and explosive strength of the quadriceps femoris muscle (Knee Surg, Sports Traumatol, Arthrosc 2012; 20:2017-25).
- Evidence suggests that quadriceps strength drops 50-60% following surgery and fails to recover past pre-operative levels (J Orthop Sports Phys Ther 2010; 40:559-67).
- Neural contributions are thought to predominate in the early postoperative period following TKA, likely giving way to disuse atrophy (J Bone Joint Surg Am 2005; 87:1047-53).
- 6 months after TKA, knee joint power in patients for the operated leg was significantly weaker than for the non-operated leg (The Knee 2014; 21:216-20).
- Weak leg extensor muscles in the 3rd month contribute to excessive load to the knee joint during mid stance of gait (The Knee 2014; 21:216-20).


- 59 patients scheduled for TKA
- Mean strength of the knee extensors was 89.1% of the non-affected leg
- Concentric knee flexor strength was more closely associated with TUG, 10mWT, and 6MWT than isometric knee flexor strength. No difference noted bw isometric/concentric knee extensor strength in test performance.
- 30s CST more closely associated with concentric and isometric knee extensor and flexor strength than the TUG and walking tests.
- Best measure of muscle strength if dynamometry is not available
- Patient reported measures of knee function are strongly influenced by pain levels.


- 24 patients, 6 months after undergoing TKA
- All strength measures were significantly correlated with performance in TUG, 3CT, and 6MWT
- TUG closely associated with normalized MCK, 3CTand 6MWT closely associated with peak isometric power at 30%body weight
- Ability to powerfully extend the knee against 30% of their body weight is a good clinical goal.
- Isometric strength reflects the forces a muscle can produce, but muscle power reflects the ability to generate over time which is imperative for ADLs such as stair climbing and sit-to-stand transfers.
Preliminary Investigation of Rate of Torque Development Deficits Following Total Knee Arthroplasty.

- 35 patients with TKA compared to 25 healthy controls.
- MVC and rate of torque development returned to pre-op levels at 6-months post-op, but both remained significantly lower than the healthy controls.
- Ability to generate rapid torque was significantly associated with performance in TUG and stair climbing test.
- Indication: Focus should be on strength as well as promoting rapid force generation.


- 85 patients (72% women; mean age 67 yrs)
- POD1: Knee swelling increased 35%
- POD14: Knee swelling remained 28% higher than pre-op levels
- POD90: Knee swelling remained 11% higher than pre-op levels
- Greater knee swelling was associated with lower quadriceps strength and decreased gait speed.
- Petteerson, et al., found that patients had 56% and 28% reduction in quadriceps strength from pre-op levels at POD30 and POD90.

Assessment

- Static strength via manual muscle testing of the hip, knee, and ankle
- Range of motion measurements: active and passive
- Muscle length assessment: HS 90/90, Thomas Test, Ely’s Test, etc.
- Balance Assessment: Rhomberg, Tandem Stance, SL
- Dynamic Assessment (might not be able to perform at initial evaluation)
  - Double leg squat
  - Single leg squat
  - Forward lunge
  - Side lunge
**Treatment Interventions**

- Neuromuscular Electrical Stimulation
- Strengthening Exercises
- Balance/Proprioception Training
- Joint Mobilizations
- Gait Training

- Joint Mobilizations and Gait Training will not be addressed in this presentation.

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**4 Randomized Controlled Trials**

<table>
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<tr>
<th>Study</th>
<th>N, Group</th>
<th>NMES Interventions</th>
<th>Timepoint, Interim/Post</th>
<th>NMES Summary</th>
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<td>6 months after TJA; 10 sessions, 1×/week for 4 weeks</td>
<td>Max</td>
<td>12</td>
<td>50</td>
<td>100</td>
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<tr>
<td>Avramidis et al., 2013</td>
<td>36, 36</td>
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<td>Levine et al., 2012</td>
<td>35, 35</td>
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<tr>
<td>Loh et al., 2013</td>
<td>35, 35</td>
<td>12 days prior to surgery</td>
<td>Max</td>
<td>29</td>
<td>35</td>
<td>80</td>
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**Results**

- Stevens-Lapsley, et al. (NMES treatment started 2 days post-op) 8 months following surgery, patients receiving NMES demonstrated 20% improvement in quadriceps strength relative to pre-op values, whereas patients in the control group hovered around their pre-surgical strength.

1 year following surgery: patients in the NMES group improved their 6MWT distance by an average of 120 meters compared to pre-surgical levels, whereas patients in the control group improved by an average of 43 meters.

- Avramidis, et al. (NMES treatment started 2 days post-op) Patients in the NMES group demonstrated improvement in walking speed vs the control group at 6 weeks and 3 months. No difference was found at 1 year.

- Levine, et al. (NMES treatment started 14 days prior to surgery) Designed to examine non-inferiority of unsupervised NMES relative to supervised PT. Non-inferiority was demonstrated for all measures of performance (TUG, ROM, WOMAC) by 6 months following surgery.

- Peterson, et al. (NMES treatment started 4 weeks post-op) No significant differences between the control group and the NMES group at any stage after TJA.

- Take home points
  - NMES should start early after TKA
  - Higher overall volume may be required to achieve a treatment effect
  - Petterson, et al: 3-4.5 hours of NMES
  - Stevens-Lapley, et al: 20 hours of NMES
  - Intensity is critical to achieving gains in strength
  - Appears to be most beneficial when used as an adjunct to supervised treatment


- 19 studies included in this review (3 excellent, 12 good, 4 fair)
- Average age across all studies ranged 65 - 73 years
- Findings:
  - Treatments should include at least 12 supervised visits
  - Quadriceps strength has a strong correlation to functional performance and needs to be addressed
  - Functional exercises need to be included in rehab for carryover to ADLs

Eccentric Versus Concentric Exercises

- 18 healthy subjects were used
  - All 18 performed concentric exercises for the first 4 weeks, then the group was divided into two. One group continued with concentric exercises, the other began eccentric exercises.
  - Concentric training improved both peak torque and electrical activation in all types of contractions, mainly in the vastus medialis and lateralis muscles
  - Eccentric training significantly improved the electrical activation of all muscles

- 28 male students (15 in training group, 13 in control)
- 26.2% increase in maximal eccentric strength in training group and 1RM of the training group increased 31.1% (7.8% increase in control group)
- Maximum isometric strength did not change significantly in either group

| Table 2: Development of power parameters in the eccentric and control groups |
|-----------------------------|-----------------------------|-----------------------------|-----------------------------|
|                             | T1 (n = 15)                 | T2 (n = 15)                 | Controls (n = 15) |
| Effective force (kg)        | 163.9 ± 6.3                 | 325.7 ± 41.0                | 176.1 ± 54.7                 |
| 1RM (kg)                    | 306.6 ± 51.3                | 125.5 ± 38.9                | 91.5 ± 60.7                  |
| Max eccentric strength (kg) | 248.0 ± 97.3                | 379.2 ± 95.3                | 207.1 ± 92.0                |
| RFD (Wcm⁻¹)                 | 115.6 ± 22.8                | 11.6 ± 2.8                  | 115.6 ± 22.8                |
| Max RFD (Wcm⁻¹)             | 430 ± 60                    | 36.6 ± 6.1                  | 36.6 ± 6.4                  |
| CMJ (cm)                    | 43.1 ± 7.6                  | 43.1 ± 7.3                  | 42.7 ± 5.8                  |
| Squat jumps (cm)            | 464 ± 61                    | 464 ± 61                    | 464 ± 61                    |


- Mean load per lift increased 77% and max load lifted in each training session increased almost 76% in the training group.
- At the end of the study, the mean load lifted was 214.2% of the 1RM and 109.1% of the eccentric maximum strength.
- No improvement noted in squat jumps or countermovement jumps even though max eccentric and concentric-eccentric max strength improved.
- Authors hypothesized that lack of quick paced movements with training contributed to lack of improvement in rate of force development.


- 20 male subjects (12 in training group, 8 in control group)
- Maximum voluntary contraction increased 28% in the training group
- RFD increased in the early phase of rising joint torque
- Maximum RFD increased 48%
- Eccentric exercises elicited adaptations to perform explosive muscle actions in the very initial phase of contraction.

- 16 non-strength trained men
- 2 groups: one performed isometrics at a short quadriceps length (SL) and the other at a long quadriceps length (LL)
- Peak concentric torque didn't change in the SL group but there were increases in torque at 30, 60, 90, and 120 rad/sec in the LL group
- Quadriceps muscle cross-sectional area increased only in the LL group in rectus femoris, vastus lateralis, and vastus medialis muscles

What does all of this mean for exercise selection?

- Exercises should include eccentric and concentric actions
- There should be an explosive component to these strengthening exercises
- Isometric exercises at higher angles of knee flexion should increase muscle mass and peak torque
- Strengthening exercises should address the knees, hips, and trunk
- Proprioceptive components need to be integrated
- Sport specific exercises must be integrated for carryover to sport

Strengthening Exercises

- Leg Extensions: Single leg, double leg, eccentrics with both legs kicking up and affected lowering weight down
- Cybex Isokinetics: 60, 90, 120, 180, 240 rad/sec
- Cybex Isometrics: knee flexed ~87 degrees
- Bulgarian Step Ups
- Patient starts with operated leg up on step. They lean forward so that all of the weight is on that leg, and slowly they push themselves up to the height of the opposite leg.

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Strengthening Exercises

- Hamstring curls on leg machine
  - Can do double leg HS curls, single leg HS curls, and HS curls with both legs cutting down and operated leg controlling return to start position.

- Hamstring curls on therapy ball
  - Have patient start in bridge, then curl legs up. Can do with both legs or single leg. Can have patient maintain bridge entire time or lower body back to table in between reps.

- Bridging with eccentric hamstring slidesouts
  - Patient starts in bridge position, slowly controls legs sliding out against resistance as they lower their body to the floor, then cuts legs back in.

- Hamstring stool scoots
  - Patient sits on stool and performs HS curls and pulls themselves around the gym. Can do single or double leg, fast or slow, can add weight to the stool.

- Clock Drill
  - Patient starts by standing on the operated knee. 90% of their weight is on the operated leg as they slowly slide the opposite leg forward. They hold that position for a few seconds, and return to start. They then slide the non-operated leg out to the side, then return to the start, and then slide that leg behind them.
  - Drill can be progressed by added different times on the “clock.”
**Balance/Proprioception Exercises**

- Standing 4 way hip exercise with theraband around ankle
- Can progress from standing on ground, to airex pad, air disc or wobble board
- Bosu Exercises
  - Squats with dome side up or down, step ups with dome up, SA with dome up domed side down
- Rocker Board Exercises
  - Taps forward (double or single leg), taps side to side, balancing in the center, squat on rocker board
- SLS Exercises
  - Can do on ground, beam, with eyes open/closed, while playing catch, etc.

**Balance/Proprioception Exercises**

- Romanian Deadlifts (RDLs)
  - Patient stands on operated leg, while keeping knee almost fully extended they hinge forward at the hips and end up with opposite leg, trunk, and arm in straight line
- Dips
  - Patient is standing on the operated leg with opposite leg in the air. Slowly they bend knee of stance leg and reach forward toward target. Exercise can be progressed by adding targets to right/left or making target lower

**Explosive Exercises**

- Bosu squats: dome side or flat side up, 5 second eccentric lower, 5 second hold at bottom, with explosive return to standing (can add med ball chest pass)
- Lunges
  - Forward and Side: Slow, eccentric lowering with explosive push back to starting position

- Explosive Exercises

- **Explosive Exercises**

- **Explosive Exercises**
Explosive Exercises

- **Squat Jumps**
  - Slowly drop down into squat position (5 second eccentric), then quickly jump into the air as both feet leave the ground. Can add weight as needed.

- **Split Squat Jumps**
  - The patient doots in a lunge position, then quickly jumps into the air as both feet leave the ground. The patient then lands in a lunge position with the opposite leg forward.

Aquatic Based Exercises

- Jumping Activities: single and double leg
- Flutter kicks with/without kickboard
- Water jogging
- Lateral push-offs
- Pivoting movements
- Back-peddling
- Side-shuffling
- Squat jumps
- Split squat jumps

Plyometric Based Exercises

- Patient can be unweighted to very specific percentages of body weight from full WB to only 20% WB
- Alter G can be used for side-shuffling, back-peddling, jogging, and sprinting
- Allows for transition back into dynamic loading in a controlled manner to reduce excessive load through knee joint

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www.aquajogger.com

(www.alterg.com)
Plyometric Based Exercises

- 8 elastic cords to add up to 160 pounds of resistance
- Perform double leg jumps, perform jumping jacks, perform side to side jumps (feet start together turned outwards at 45 degree angle on one side of the platform for the push-off, you land with feet turned outwards at 45 degree angle on the opposite side of the platform), alternating single leg jumps, and consecutive single leg jumps


- Assessed return to sport and whether or not return to sport was affected by patient motivation
- 347 patients surveyed by questionnaire
- 347 TKA pts <75 yrs old
- Light Sports: stationary cycling, cycling, stretching, swimming, golf
- Intermediate Sports: Gardening, hiking, gymnastics, strength exercising, sailing, dancing
- Strenuous Sports: cross-country skiing, downhill ski racing, tennis/squash, running more than 500 m
- Strong correlation was found between motivation and sports participation
- Results: 56%, 66%, and 10% of patients participated in light, intermediate, and strenuous sports, respectively (this includes motivated and unmotivated patients)

- 110 patients surveyed by questionnaire
- Assessed for their participation in low-impact sport pre and post-operatively.
- 63.6% of TKA and 85.3% of UKA patients resumed sport post-operatively.
- Avg. time to resume sport and avg. session length post-operatively:
  - TKA: 4.1 months (62.7 min pre, 37.5 min post)
  - UKA: 3.6 months (85 min pre, 92.1 min post)


- 93 patients aged <60 yrs (109 knees)
- Return to regular physical activity rate of 93%
- 77% of patients resumed to physical activity in 6 months
- High-impact sports (tennis, jogging, skiing) showed a significant decrease in participation and low-impact sports (swimming, aerobics) had a significant increase
- 94% of patients reported improvement in their physical condition due to surgery


- Retrospective study of 131 patients
- High impact sport: an activity or sport characterized by intense and/or frequent wear and trauma of weight-bearing joints (foot, knee and hip)
- Low impact sport: sports with minimal wear and trauma to weight-bearing joints
- 78 participated in sports pre-op, and 69 participated in sports 4 yrs post-op (7 participated in high impact sports pre-op, only 3 did post-op)
- Patients shifted from high impact sports towards low impact sports
- There was an increase in weekly frequency of sports