Rehabilitation Following Total Knee Arthroplasty (TKA)

Dr. Frank Layman

- Decades of Experience Treating Variety of Patient Populations in the Fields of Orthopedics and Sports Medicine
- Entrepreneur, Philanthropist, Author, Speaker
- BS in Sports Medicine/Athletic Training - Radford University
- MS in Physical Therapy - Old Dominion University
- EdD in Curriculum and Instruction with Concentrations in Administration and Sports Medicine - University of Virginia
- Transitional DPT and Manual Therapy Certification - University of St Augustine
- Heavily Involved in Educational Programs for PTs, PTAs, ATCs
- Administrator and Clinician for Hospital OPPT department in NC
- Adjunct Faculty P&L
- VP for Tapout Fitness Franchise

Innovative Coupling

- Area Director and Owner Tapout Fitness Franchise
- An innovative coupling with OPPT
Active member of the United States Army Reserves
- Officer with over two decades and recently picking up first Command at Fort Bragg

Member:
- American Physical Therapy Association
- North Carolina Physical Therapy Association

Proud To Serve

International and National Speaker and Educator
Evidence Based Practice

Dr. Frank Layman’s Critical Clinical Reasoning

- Assess for competing diagnostic possibilities
- Ruling it in
- Ruling it out
- COST - Cluster Orthopedic Special Tests
- Once estimated
- Test, Treat, and Re-Test
- Treat Appropriately (think Phases and Stages)

@DrFrankLayman

More => MORE

- There is an increasing volume of Total knee arthroplasty procedures being performed and are projected to be performed in the future.
- Clinicians would benefit from greater insights into the part they contribute to more successful outcomes.
This Course is
A Course to Better Outcomes

- Starting with an overview of Anatomy and Biomechanics
- The course discusses the history of knee arthroplasty, examines reasons for failure, readmittance and MUA.
- It describes the phases of postoperative rehabilitation and treatment approaches meant to improve range of motion advancement.
- The course focuses on care through the full spectrum of recovery.

Objectives

1) Increase depth of understanding of Total Knee Arthroplasty
2) Recognize and identify factors related to TKA failures
3) Improve treatment impact to decrease risk of PPP, CPSP, falls, gait dysfunctions and arthofibrosis
4) Improve understanding of Multimodal treatment approach for TKA
5) Improved intervention throughout the spectrum of care for TKA patients

Anatomy
Knee Stabilizers

- Medial
- Lateral
- Anterior
- Posterior
- Rotatory

Mechanical Alignment

- TKA aims at restoring the mechanical axis of the lower limb by:
  - Sequential soft tissue releases
  - Correction of bone defects by grafts or prosthesis augments
Background and Purpose

Total knee arthroplasty (TKA) is the most commonly performed inpatient surgical procedure within the USA and is estimated to reach 3.48 million procedures annually by 2030.

Relationship of Hospital and Surgeon Volumes to Outcomes

Greater short-term complication risks after total knee arthroplasty (TKA) have been associated with lower hospital and surgeon procedure volume, but the relationship between procedure volume and implant survival is uncertain. We examined the association between hospital and surgeon volume and TKA survivorship in the elderly population using 1997 to 2004 Medicare data. Kaplan-Meier method and Cox regression were used to determine implant survivorship and hazard ratios associated with procedure volume at 0.5, 2, 5, and 8 years.


Relationship of Hospital and Surgeon Volumes to Outcomes 2/2

The TKA patients in lowest-volume hospitals (1-25 procedures) had a higher risk of revision at 5 and 8 years compared with those operated on in highest-volume hospitals (>200 procedures) (adjusted odds ratio: 1.57 and 1.52, respectively). Surgeon volume was not significantly correlated with implant survivorship. Our findings suggest that TKA patients at low-volume hospitals have a greater revision risk at medium-term follow-up, but not in the short term.


Revisions

Infection was the most common etiology for revision TKA (20.4%), closely followed by mechanical loosening (20.3%). The most common revision TKA procedure performed was all component revision (31.3%).

Medicare was the primary payor for the greatest proportion of revisions (57.7%). The South census region performed the most revision TKAs (33.2%). The overall mean LOS was 4.5 days, with arthrotomy for removal of prosthesis without replacement procedures accounting for the longest stays (7.8 days). The mean total charge for revision TKAs was $75,028.07.

Common Cause for TKA

The most common cause of chronic knee pain and disability is arthritis. Although there are many types of arthritis, most knee pain is caused by just three types: osteoarthritis, rheumatoid arthritis, and post-traumatic arthritis.

- Osteoarthritis. This is an age-related “wear and tear” type of arthritis. It usually occurs in people 50 years of age and older, but may occur in younger people, too. The cartilage that cushions the bones of the knee softens and wears away. The bones then rub against one another, causing knee pain and stiffness.

- Rheumatoid arthritis. This is a disease in which the synovial membrane that surrounds the joint becomes inflamed and thickened. This chronic inflammation can damage the cartilage and eventually cause cartilage loss, pain, and stiffness. Rheumatoid arthritis is the most common form of a group of disorders termed “inflammatory arthritis.”

- Post-traumatic arthritis. This can follow a serious knee injury. Fractures of the bones surrounding the knee or tears of the knee ligaments may damage the articular cartilage over time, causing knee pain and limiting knee function.

Common Causes

- If the knee is severely damaged by arthritis or injury, it becomes difficult to perform simple activities, such as walking or climbing stairs and the pain is constant and limiting
- If nonsurgical treatments like medications, rehab, assistive devices and/or bracing are no longer beneficial then surgery is indicated. Join Knee replacement surgery was first performed in 1968. Since then, improvements in surgical materials and techniques have greatly increased its effectiveness. According to the Agency for Healthcare Research and Quality, more than 600,000 knee replacements are performed each year in the United States and that number is rising.

OA

- Osteoarthritis (OA) of the knee is one of the leading causes of disability among adults older than 65 years. Patients with OA experience significantly greater pain and functional deficits during normal daily activities, leading to a loss of productivity, and worsening quality of life. Although many conservative treatment modalities are available for the management of mild-to-moderate OA, end-stage arthritis of the knee is best managed with total knee arthroplasty (TKA).

  - PMCID: PMC5790068
  - PMID: 29416347
  - Total knee arthroplasty: improving outcomes with a multidisciplinary approach.
Interview - Part 1

Study: Physical Therapy Bests Steroid Injections for Treatment of Knee OA

- In this study: Physical Therapy versus Glucocorticoid Injection for Osteoarthritis of the Knee (New England Journal of Medicine, April 9, 2020)
- A new study in the New England Journal of Medicine finds a significant difference in WOMAC scores after one year and more positive patient perceptions of improvement for patients treated through physical therapy versus glucocorticoid injections.

The Study Continued

Researchers analyzed data from 156 patients (average age, 56; 48% female) diagnosed with knee OA between 2012 and 2017 who were active duty or retired service members or their family members from two military hospitals. The patients were divided into two treatment groups: One received physical therapist services, and the other received intraarticular glucocorticoid injections. Physical therapist services were provided in up to eight sessions over an initial four- to six-week period with the possibility of one to three sessions later on; steroid patients received an injection of a mixture of triamcinolone acetonide and lidocaine at outset, with the possibility of receiving as many as three injections over the one-year study period. Patients completed the Western Ontario and McMaster Universities Osteoarthritis Index, known as WOMAC, as well as the Global Rating of Change assessments at baseline and at the four-week, eight-week, six-month, and one-year marks. Researchers compared the results among patients at baseline and one year. APTA members Gail Deyle, PT, DPT, DSc, and Dan Rhon, PT, DPT, were among the authors of the study.

- Findings

The physical therapy group reported a bigger improvement in WOMAC scores. Patients in the physical therapy group averaged a 37 on the WOMAC after a year—a 70-point drop in the 0-to-240 scale in which lower scores indicate less pain and better function. The injection group also reported improvements in WOMAC scores but to a lesser extent— from an average score of 108 at outset to 55.8 after one year.
Early Intervention of OA

- While there is no cure for OA we need to recognize it early and do more to help patients manage it.
- Patient and community education
  - Management
  - Screening

Primary Goal

- One of the most important goals of primary total knee arthroplasty (TKA) is to achieve a functional range of motion (ROM). However, up to 20% of patients fail to do so, which can impair activities of daily living.


Multimodal Treatment Approach

- Avoiding the slipery slope
- Hypomobility vs Contractures
- Not overwork a patient
- Improving the patients awareness and need for behavioral modification not overdoing it
- Manual Stretching
- Self stretching
- Joint mobilizations
- PNF
- ME
Multimodal Treatment Approach

- Neural glides and tensors
- STM
- Scar management desensitization
- CRS
- MRE
- Stress strain curve and the rebound effect
- Mechanical stretching Static and dynamic
- Open vs close chain exercises and rotation of the tibia
- Use of modalities
- Therex

Adding Advantage

- Pre-fatigue and Overtraining and Reactivity of tissue
- 2 Vinnettes
- Interview doc

Successful Procedure

- Total knee arthroplasty (TKA) is one of the most successful orthopaedic procedures that reliably alleviates pain and restores function in patients who have degenerative knee joint diseases including osteoarthritis and rheumatoid arthritis.
- A recent audit revealed that 153,133 primary knee arthroplasties were performed in 396 centers throughout England and Wales in a 2-year period (01/07/2008-30/06/2010) and over 1.5 million are performed worldwide each year.

Nicole Abdul, David Dixon, Andrew Walker, Joanna Horabin, Nick Smith, David J. Weir, Nigel T. Brewster, David J. Deehan, Derek A. Mann & Lee A. Borthwick

Fibrosis is a common outcome following total knee arthroplasty. Scientific Reports volume5, Article number: 16469 (2015) Published: 10 November 2015
TKA Involves

- The surgery involves the resection of diseased or damaged bone from intra-articular areas of the knee followed by attachment of metal and polyethylene prosthetic replacements. Success rates for the operation are very high resulting in a substantial restoration of function and alleviation of pain and associated morbidity\(^3\). However, although a very high success rate is observed with TKA surgery, some 3–10% of individuals go on to develop fibrosis in the form of arthrofibrosis post-surgery\(^4,5,6\).

Arthrofibrosis

- Arthrofibrosis, defined as abnormal scarring of the joint in which the formation of dense fibrous tissue and tissue metaplasia prevents normal range of motion, represents a significant clinical challenge and drastically reduces quality of life of those affected individuals.


**THE STIFF JOINT**

- Capsule / Ligaments / Muscles / Tendons / Skin
- Collagen Loss of Elasticity
- Collagen Disorganized
- Adhesion Formation

- 1. Manual Stretch
- 2. Dynamic Stretch
- 3. Static Stretch
To date, no prophylactic intervention is available and treatment for arthrofibrosis is restricted to aggressive physiotherapy or revision surgery.


**PT/MUA/Revision**

- Due to the importance of the infrapatella fat pad studies have shown procedures that preserve the infrapatella fat pad lead to greater function.
- Fibrous tissue around this area and the patella femoral joint need to be addressed.
- Recommendation for clinical practice: Early and prolonged patella mobilization.

**Scar Tissue Management**
MUA

Total knee arthroplasty is a successful surgery for the majority of patients with osteoarthritis of the knee. Approximately 5% of patients undergoing total knee arthroplasty experience loss of motion or arthrofibrosis. Manipulation under anesthesia (MUA) is generally indicated for patients who do not achieve >90° of flexion by 6-12 weeks postoperatively. Complications from MUA are rare but can be devastating.


MUA

Stiffness after TKA is a common problem that can be improved with MUA and/or arthroscopic lysis of adhesions with few complications.

Rehab following these procedures has been 5x/week for 2 weeks then declined to typical 2-3x/week frequencies.

Rehab follow up should be Individualized and aggressive.

Interview - Part 2
Revisions and Readmission

Revision surgery for failed total knee arthroplasty (TKA) continues to pose a substantial burden for the United States healthcare system. The predominant etiology of TKA failure has changed over time and may vary between studies. This report aims to update the current literature on this topic by using a large national database. Specifically, we analyzed: (1) etiologies for revision TKA; (2) frequencies of revision TKA procedures; (3) various demographics including payer type and region; and (4) the length of stay (LOS) and total charges based on type of revision TKA procedure.


Continued Readmission

CONCLUSIONS:

Patients having revision TKA, whether for infection or other causes, are more likely to have an unplanned readmission to the hospital than are patients having primary TKA. When assessing hospital performance for TKA, it is important to distinguish among these surgical procedures.

CONCLUSION:

Without appropriate measures in place, the burden of revision TKAs may become overwhelming and pose a strain on providers and institutions. Continued insight into the etiology and epidemiology of revision TKAs may be the principle step towards improving outcomes and mitigating the need for future revisions.

Readmission Cont

Infection was the most common etiology for revision TKA (20.4%), closely followed by mechanical loosening (20.3%). The most common revision TKA procedure performed was all component revision (31.3%).
Other Insights

- High rate of knee replacements and joint replacements continue to increase
- Significant number of problems following p/o measures
- Scar tissue and lack of recovery of ROM, joint mobility, biomechanics is an issue and it starts p/o
- Reactivity of tissue unaddressed
- Pain and inflammation unaddressed or under addressed
- Poor management of p/o care
- Case study
- Expectations and the Impact of Unrealistic Expectation

Treatment

- CRS
- MWM
- CPM
- Use of recumbent bike
- L-spine involvement in slower progression
- Paradigm
  - Stages and phases
  - Scar management measures
  - Implant mal position largest cause of failure/dysfunction
  - Early integration of MPT
  - Prehab
  - Emphasis on proximal stability
  - Restoring mobility and biomechanics
  - Review of biomechanics of the knee

What The Literature Reveals

- Literature
- Number of TKA/year increasing
- Increases expected in revisions
- Number of failures due to surgical error will increase as a result
- Number of problems due to poor/inefficient rehab to increase (what is the long term regional impact on a patient and the associated costs?)
Contributing to Better Outcomes

Procedural:
1. Increase Volumes of hospital and surgeon
2. Surgical considerations for mitigating Blood loss

Rehabilitative:
1. BMI
2. Deconditioning and Quad deficits prior to surgery
3. Contractors/compromised rom/strength/NMC
   All these support a Case for PreHab

Scar Tissue Management

- Better Scar management
  - Multimodal Treatment approach
  - Regional Interdependence Model
  - Advanced treatments specific to scar tissue deposition
    - DN
    - Static/dynamic Progressive Stretch

Working For Better Outcomes

- As with anything there are a lot of variables that determine outcomes after an injury or surgery
- We as Physical medicine specialist cant be complacent
- More critical clinical skills
- Improved MPT skills
- Better use of Prehab
- Better understanding and preparedness for scar tissue management
- A better understanding of progression in rehab
- Better integration of rehab p/o
- ECF/HH to OPPT
- Improved understanding of stages and phases and recognition of over/undertraining, reactivity of tissue and modifications required to improve outcomes
Refining an Eclectic Approach

- This should not compromise well rounded approach to care considering and working for QD to HS ratio 3:1
- Recovery of GM strength and spinal stability
- Restoration of LE biomechanics
- Good mobility and flexibility
- Mitigation of pain and gait deviation/compensations to fluid movement
- Restoration of LE proprioception
- Foot posture/LE alignment

Joint Mobilization
Do or Don’t

- Efficacy of using Joint mobilizations
- Somatosensory pain - ensuring enough is being done to address pain and hypertonicity p/o

PPP Persistent Postoperative Pain

RESULTS:

- The prevalence of moderate to severe PPP was 21% (n=60) and 16% (n=45) 6 and 12 months after surgery, with 55% (n=33) and 60% (n=31) of PPP likely neuropathic in nature. At 6 months, a combination of preoperative pain intensity, expected pain, trait anxiety, and temporal summation (Akaike information criterion, 309.9; area under receiver operating characteristic (ROC) curve, 0.70) was able to correctly classify 66% of patients into moderate to severe PPP and no to mild PPP groups. At 12 months, preoperative pain intensity, expected pain, and trait anxiety (Akaike information criterion, 286.8; area under ROC curve, 0.66) correctly classified 66% of patients.

CPSP Chronic Postsurgical Pain

- (CPSP) affects 10 to 30% of surgical patients overall and 16 to 20% of patients after knee surgery. Patients report persistent pain in the absence of infection, mechanical disorders, or complex regional pain syndrome type I. In many cases, the mechanism is neuropathic pain related to an intraoperative nerve injury or impaired pain modulation with central sensitization. The clinical risk factors and pathophysiology of CPSP are being actively investigated. Risk factors include preoperative pain, diffuse pain, severe pain during the immediate postoperative period, anxiety, depression, or cognitive distortions such as catastrophizing, and comorbidities. The diagnosis rests on clinical grounds and should be established as early as possible to optimize the chances of improvement. The management of CPSP combines a number of perioperative prophylactic strategies and the treatment of chronic neuropathic pain. Local treatments consist of transcutaneous electrical nerve stimulation and lidocaine patches combined with tramadol. When this treatment is inadequately effective, an antidepressant or anticonvulsant can be added. A capsaicin patch is the third-line treatment, and step III opioids are the last option. Rehabilitation therapy and physical exercises are beneficial. Psychological counseling and/or cognitive behavioral therapy should be offered, if indicated, by the results of the evaluation.


Proprioception, Sensory Orientation, Knee Pain Related to Future Fall Risk


CONCLUDED

Rehab intervention efforts should target deficits in knee proprioception and sensory orientation and operated knee pain to prevent future falls in individuals with TKA.

Polling Question #6
SLS Static and Dynamic Balance
For Stability

- Early and regular WS
- FOAM and Dynamic gait training
- Ease of reproducibility of IHEP
- Depending on the source 8% p/o get stiff develop scar tissue get infected platform issues/misalignment

Biomechanical Therapy

- One group underwent a biomechanical therapy in which participants followed a walking protocol while wearing a foot-worn biomechanical device that modifies knee biomechanics and the control group followed a similar walking protocol while wearing a foot-worn sham device.

CONCLUSION:
- A postoperative biomechanical therapy improves outcomes following TKA and should be considered as an additional therapy postoperatively.


IDing Blood Clots

- Warning signs of blood clots. The warning signs of possible blood clots in your leg include:
  - Increasing pain in your calf
  - Tenderness or redness above or below your knee
  - New or increasing swelling in your calf, ankle, and foot
- Warning signs of pulmonary embolism. The warning signs that a blood clot has traveled to your lung include:
  - Sudden shortness of breath
  - Sudden onset of chest pain
  - Localized chest pain with coughing
  - Best non-invasive diagnostics Ultrasound and Spiral CT
Pain

- Early stages component parts of gait
- OA management
- Just because pain management efforts are temporary doesn’t mean they are not worth while.
- Pain inhibition is a factor in fibrous tissue build up
- Pain patterns somatosensory pain
- Smudging
- Relief of pain can help with physical advances

Swelling’s Impact

- Total knee arthroplasty (TKA) is a successful surgical technique for patients with advanced knee osteoarthritis; however, some peri-operative complications can not be predicted or avoided completely. This study aimed to investigate the factors affecting limb swelling after primary total knee arthroplasty, to guide and improve patient rehabilitation.
- CONCLUSIONS:
- Lower limb swelling after total knee arthroplasty is related to early post-operative hidden blood loss. The patient’s hemoglobin level should be monitored. The degree of limb swelling is correlated with the patient’s body mass index and the amount of hidden blood loss. Early intramuscular deep vein thrombosis formation has little effect on limb swelling.
Treatments

- High rate of knee replacements and joint replacements continue to increase
- Significant number of problems following p/o measures
- Scar tissue and lack of recovery of rom, joint mobility, biomechanics is an issue and it starts p/o
- Reactivity of tissue unaddressed
- Pain and inflammation unaddressed or under addressed
- Poor management of p/o care
- Case study
- Expectations
- Literature
- Number of TKA/year increases expected

Treatments

- Number of failures due to surgical error
- Number of problems due to poor/inefficient rehab will go up exponentially with number of procedures
- CRS MWM
- CPM
- Use of recumbent bike
- L-spine involvement in slower
- Paradigm

Treatments

- Stages and phases
- Scar management measures
- Implant mal position largest cause of failure/dysfunction
- Early inigration of MPT
- Prehab
- Emphasis on proximal stability
- Restoring mobility and biomechanics
- Review of biomechanics of the knee
In summary, knee stiffness after TKA has a multifactorial etiology with several risk factors, including demographic variables, specific comorbidities, and certain diagnoses. Important findings include a higher frequency of MUA with nonwhite race and a lower frequency of MUA with older age. In comorbidities, diabetes, high cholesterol levels, and tobacco smoking were associated with an increase in the frequency of MUA. In knee-specific factors, preoperative knee ROM of less than 100° and knee osteonecrosis were associated with increased frequency of MUA. We found no evidence that retention or sacrifice of the posterior cruciate ligament played a significant role and no differences between men and women after controlling for potential baseline confounding variables. Patients may benefit from preoperative counseling when they have multiple risk factors to set realistic ROM expectations. More prospective studies are necessary to better evaluate if specific patient demographics or comorbidities may affect the frequency and clinical outcomes of MUA.
Preparing for Surgery

- Prehab
- Home modifications
- Considerations for ECF/HH

Hip, Knee, Ankle and Foot

- Early on ensure the patient has sufficient:
- Dorsiflexion, Gt Toe Ext
- Hip motion and mobility
- 30-40 Hip flexion: level walking
- 60-66 Hip flexion: up stairs
- 45 Hip flexion: down stairs
- 90-112 Hip flexion: sitting
- 120 Hip flexion: don socks
- 125 Hip flexion: stoop
- 115 Hip flexion: squat
- 120 Hip flexion: normal ROM
- 60 Knee flexion: level walking
- 83-105 Knee flexion: up stairs
- 83-107 Knee flexion: down stairs
- 93 Knee flexion: sitting

- 106 Knee flexion: tie shoes
- 117 Knee flexion: squat and pick up object
- >10 Dorsiflexion: level walking
- 14-27 Dorsiflexion: up stairs
- 21-36 Dorsiflexion: down stairs
- >15 Plantarflexion: level walking
- 15-30 Plantarflexion: up stairs
- 24-31 Plantarflexion: down stairs
- 8-12 calcaneotalar inversion to walk normally
- 4-6 calcaneotalar eversion to walk normally
- 35-50 great toe extension
List of Low impact activities TKA pts can return to

- RTS are gender, BMI, restricting comorbidities, complications, and psychosocial factors such as motivation and kinesiophobia of the patients. Conflicting results of a possible negative influence of age on postoperative activity have been mentioned previously, but the influence of age on RTS was also not clear from our included studies.
- Patients are able to return to both low- and higher-impact sports after both TKA and UKA, with overall percentages varying from 36 to 89 and from 74 to ~100 %, respectively. Participation in sports seems more likely after UKA than TKA, with mean total numbers of sports postoperatively of 1.1-4.6 sports per patient after UKA and 0.2-1.0 after TKA. RTS after TKA for low-impact sports was 94, 64 % for intermediate-impact sports, and 43 % for high-impact sports.

CONCLUSIONS:
The resumption of physical activity and sport is a paramount expectation for active patients. A clearer definition of physical activity and sports realistically achievable after a knee prosthesis is necessary but not yet fully available.

Resumption of physical activity and sport after knee replacement.
Pisanu F1, Andreozzi M1, Costagli F2, Caggiari G1, Saderi L3, Sotgiu G3, Manunta AF1.

No-Low-High Impact Sports

- Conclusion: After hip or knee arthroplasty, participation in no-impact or low-impact sports can be encouraged, but participation in high-impact sports should be prohibited.

B J McGrory 1, M J Stuart, F H Sim
Low Impact

- In most studies reviewed: low-impact activities including:
  - level surface walking
  - stair climbing
  - level surface bicycling
  - Swimming
  - Exercise Class
  - Dance
  - Golf
- Walking, swimming and bicycling were the three most common sports activities both before and after TKA

Phase IV and RTP

- Should active patients RTplay
- What are the risks
- What are criteria for RTplay

Acknowledging The Decline

- The present study has shown that patients are adopting lower impact activities to participate in after TKA. The total number of patients performing a sport decreases postoperatively and the total amount of sport played decreases.

- Effect of Total Knee Arthroplasty on Recreational and Sporting Activity

Urjit Chatterji 1, Mark J Ashworth, Peter L Lewis, Peter J. Dobson
Following joint replacement, participation in sporting activity is common principally determined by pre-operative patient activity levels, BMI and patient age. The type of joint replaced is of less significance. Total time spent performing activity does not change but tends to be at a lower intensity. There is little evidence in the literature of an association between high activity levels and early implant failure.

BMI and presurgical Fit Levels

- Goals and Pt education for p/o TKA Fit Levels
- This can be an opportunity for prehab; great chance to educate your docs

Quad Strength In Relation To Functional Performance

- Functional measures underwent an expected decline early after TKA, but recovery was more rapid than anticipated and long-term outcomes were better than previously reported in the literature. The high correlation between quadriceps strength and functional performance suggests that improved postoperative quadriceps strengthening could be important to enhance the potential benefits of TKA.

WRAP UP AND QUESTIONS:

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