Total Knee Arthroplasty Rehabilitation

Surgical Indications and Considerations

Anatomical Considerations: The knee is composed of the distal end of the femur, proximal portion of the tibia, and the patella. It has a medial and lateral meniscus in between the femur and tibia to cushion the joint, absorb and transmit weigh-bearing forces. Four ligaments, the anterior cruciate ligament (ACL), posterior cruciate ligament (PCL), medial collateral ligament (MCL) and lateral collateral ligament (LCL) provide anterior-posterior and medial-lateral support. The knee is an unstable joint, relying on ligaments, menisci, and balanced muscles on all sides of the joint, particularly the hamstrings and quadriceps, for cushioning and stability. It is more than a simple hinge joint, as the bone surfaces roll, glide, and rotate on each other.

Pathogenesis: Wear and tear of the knee joint is part of the normal aging process, however, osteoarthritis (OA) accelerates the degenerative wear of the meniscus. This form of arthritis usually results from some predisposing factor, such as an injury or deformity. Whether of unknown origin or secondary to trauma or disease, poor alignment of the leg bones may cause unequal weight distribution. This leads to excessive wear on one side of the joint surface versus another, and any irregularity of the knee joint results in wear and tear of the menisci. Over time, the menisci no longer function as an effective shock absorber/transmitter for the knee. Excessive localized pressure and damage to the joint result, possibly leading to bone-on-bone contact, causing symptoms of increased knee stiffness and pain. Remodeling of bone may also occur due to bone-on-bone contact, causing bony spurs. These spurs contribute to increased pressures within the joint, leading to pain and decreased function.

Rheumatoid arthritis is an inflammatory joint disease that is destructive to articular cartilage lining the surfaces of the knee joint. The inflammatory process can cause joint instability and deformity, muscle atrophy and weakness, swelling, stiffness, and pain.

Epidemiology: Total knee arthroplasty (TKA) is one of the most common orthopedic procedures: 171,335 primary total knee replacements occurred in 2001. Nearly 90% of patients who elected to have TKA had OA of the knee, 2/3 were female, and 1/3 were considered obese. Although patients as young as late-40's and as old as mid-90's have received total knee replacements, the "ideal" knee replacement candidate is between the ages of 65-75, as patients are healthy enough to recover well from surgery, yet old enough so replacement most likely lasts the rest of their lives (15-20 years). Obesity is the most modifiable risk factor, but prior knee injuries/trauma, and extreme physical or repetitive activity can also contribute to increased incidence of knee OA. Other causes of knee dysfunction leading to TKA include rheumatoid arthritis, trauma, congenital/acquired joint deformity, and tumors.

Diagnosis/Indications For Surgery

- Severe joint pain with weight bearing or motion that compromises functional activities (severity of pain correlates poorly with radiographic and structural changes in the joint)
- Extensive destruction of articular cartilage of the knee secondary to advanced arthritis
- Gross instability or limitation of motion
- Marked deformity of the knee such as genu varum or valgum
- Knee pain that does not respond to conservative therapy (medication, injections, physical therapy $\geq$ six months)
- Previous failed surgical procedure

Nonoperative Versus Operative Management: There are typically four major groups of nonsurgical treatments:

1) Health and behavior modification, including weight loss and patient education about behavior changes to reduce impact of disease, physical therapy and exercise to stretch, strengthen muscles surrounding the knee. Deyle et al concluded that a combination of manual physical therapy and supervised exercise is more effective than no treatment in improving walking distance and decreasing pain, dysfunction, and stiffness in patients with OA of the knee, possibly deferring or decreasing the need for surgical intervention. Vad et al proposed a progressive five-stage rehabilitation program for managing knee OA that ranges from protected mobilization to exercises to improve neuromuscular coordination, timing, and joint protection. Taping and bracing to support and protect the knee joint, foot orthoses to correct imbalances contributing to unequal weight bearing forces across the knee joint, and use of TENS for pain control are also included under this category.

2) Drug treatments, including simple pain relievers, nonsteroidal anti-inflammatory drugs (NSAIDs), COX-2 inhibitors, opiates, and glucosamine and/or chondroitin sulfate are several types of drugs used to treat knee OA.

3) Intra-articular treatments involve one or more injections into the knee joint.
Corticosteroid injections, limited to four or less per year, are helpful for significant swelling causing moderate to severe pain. Typically corticosteroid injections are not helpful if arthritis affects joint mechanics.
Viscosupplementation with hyaluronic acid, a molecule that is found in joints of the body, is a way of adding fluid to lubricate the joint and make it easier to move. It can be helpful for people whose arthritis does not respond to behavior modification or basic drug treatments. Three to five weekly shots are needed to reduce the pain, but relief is not permanent.

4) Alternative therapies include the use of acupuncture and magnetic pulse therapy. Acupuncture is adapted from a Chinese medical practice. It uses fine needles to stimulate specific body areas to relieve pain or temporarily numb an area. Magnetic pulse therapy is painless and works by applying a pulsed signal to the knee, which is placed in an electromagnetic field. Because the body produces electrical signals, proponents think that magnetic pulse therapy may stimulate the production of new cartilage. Many forms

of therapy are unproven but reasonable to try provided they are through a qualified practitioner and the primary physician is informed of the patient's decision to try these therapies.

Elective total knee replacement is, more often than not, the last effort in managing joint pain and dysfunction caused by arthritis when non-operative treatment of knee pain is not effective. When erosion of articular joint surfaces becomes severe, TKA is the surgical procedure of choice to decrease pain, correct deformity, and improve functional movement.

Surgical Procedure: An incision is made down the front of the leg from mid-thigh to several inches below the knee. The quadriceps muscles are either split down the middle or shifted, along with the patella, to the side of the thigh. The distal end of the femur and proximal end of the tibia are sawed off; the menisci and ACL are excised as well. The PCL may also be cut; the pros and cons of sparing the PCL is currently of debate in knee replacement surgery. The knee replacement consists of three components that help the surgeon tailor the device to the patient. A curved femoral component is usually made of shiny chrome alloy; it is attached to the femur and "replaces" the femoral condyles. The metal tibial component has a flat top with a spike that goes into a 2" hole that the surgeon drills into the tibia. A disc, made of polyethylene, is cemented to the top of the tibial component. Depending on its condition, the patella is either left intact or the inside resurfaced- the patella is never totally replaced. If the patella is resurfaced, polyethylene is also used to cover the inside.

Total knee arthroplasty components are either held in place with bone cement (cemented fixation), utilize bone ingrowth via a porous prosthesis (uncemented fixation), or combine cemented fixation of the tibial component and uncemented fixation of the femoral component (hybrid). Uncemented fixation has been used primarily for the active patient in whom the risk of prosthetic loosening over time is most likely, however, the ultimate decision rests with the attending surgeon.

Preoperative Rehabilitation

- Ensure adequate strength of trunk and upper extremities for support during use of assistive devices
- Instruction in use of walker/crutches/or cane to maintain desired postoperative weight bearing status (touchdown weight bearing for uncemented or hybrid replacements, weight bearing as tolerated for cemented replacements)
- Review of post-operative exercises, bed mobility and transfers, use of continuous passive motion (CPM) machine as indicated per physician
- General strengthening, flexibility, and aerobic conditioning

While it seems reasonable to believe patients undergoing TKA would benefit from preoperative strengthening exercises, there is no evidence to support this assumption, either in improving functional outcome or shortening hospital stay (D'Lima et al., Rodgers et al.).

However, a study by Jones et al showed that patients who have greater preoperative dysfunction may require more intensive physical therapy intervention after surgery because they are less likely to achieve similar functional outcomes to those of patients who have less preoperative

dysfunction.

POSTOPERATIVE REHABILITATION

Note: The following rehabilitation progression is a summary of the guidelines provided by Kisner and Colby. Refer to their publication to obtain further information regarding criteria to progress from one phase to the next, anticipated impairments and functional limitations, interventions, and goals.

*Use of a CPM device is often initiated by the first day after surgery, per physician protocol. It has been suggested that CPM decreases postoperative pain, promotes wound healing, decreases incidence of deep venous thrombosis (DVT), and enables the patient to regain knee flexion more rapidly during early postoperative days. However, Kumar et al conducted a randomized prospective study that found no statistically significant difference in range of motion gains using a CPM device versus active movement. Continuous passive motion units may be recommended as an adjunct to, not a replacement for, a supervised postoperative rehabilitation program.

Phase I: Maximum Protection: Weeks 1-2

Goals: Control postoperative swelling
Minimize pain
Knee ROM 0-90°
Muscle strength 3/5-4/5
Ambulation with or without use of an assistive device
Establish home exercise program

Intervention:

- Passive range of motion (PROM)-CPM as indicated per physician
- Ankle pumps to decrease risk of DVT
- Bed mobility and transfers usually initiated 24-48 hours post-surgery, depending on surgical procedure and co-morbidities
- Heel slides in supine or sitting to increase knee flexion
- Muscle-setting exercises of the quadriceps, hamstrings, and hip adductors, possibly coupled with neuromuscular electrical stimulation
- Assisted progressing to active straight-leg raises in supine, prone, and sidelying positions
- Gravity-assisted knee extension in supine by periodically placing a towel roll under the ankle and leaving the knee unsupported
- Gentle inferior and superior patellar glides
- Neuromuscular inhibition techniques such as agonist-contraction techniques to decrease muscle guarding, particularly in the quadriceps, and increase knee flexion
- Gentle stretches for the hamstrings, calf, and iliotibial band
- Pain modulation modalities
- Compressive wrap to control effusion

- Gait training

Phase II: Moderate-Minimum Protection: Weeks 3-6

Goals: Diminish swelling and inflammation
Increase ROM 0-115° or more
Increased dynamic joint stability/full weight bearing per implant status
Muscle strength 4/5-5/5
Return to functional activities
Adhere to home exercise program

Intervention:

- Interventions listed in Phase I
- Patellar mobilizations
- Tibiofemoral joint mobilization if appropriate and needed
- Soft tissue mobilization to quadriceps or hamstrings myofascia
- Incision mobilization after suture removal, when incision is clean and dry
- Progressive passive stretches to hamstrings, gastrocnemius, soleus, quadriceps within a pain-free range
- Stationary bike or peddler without resistance to increase flexion ROM
- Pain-free progressive resisted exercises using ankle weights, theraband/tubing
- Proprioceptive training such as weight shifting, tandem walking, lateral stepping over/around objects, obstacle courses, lower extremity proprioceptive neuromuscular facilitation (PNF), front and lateral step-ups, closed-kinetic chain activities
- Closed-kinetic chain strengthening, such as ¼ squats, ¼ front lunges
- Gait training as needed to decrease limp, wean off assistive device
- Protected, progressive aerobic exercise, such as cycling without resistance, walking, or swimming

Phase III: Return to Activity: Week 6 and beyond

Goals: Progress ROM 0-115° as able, to a functional range for the patient
Enhance strength and endurance and motor control of the involved limb
Increase cardiovascular fitness
Develop a maintenance program and educate patient on the importance of adherence, including methods of joint protection

Intervention:

- Continue interventions of previous phases; advance as appropriate
- Implement exercises specific to functional tasks, such as transferring from sit-to-stand, lifting, carrying, push/pulling, squat/crouching, return to work tasks, return to sport tasks
- Improve cardiorespiratory and muscle endurance with activities such as bicycling, walking, or aquatic programs

Selected References:

Avramidis K, Strike P, Taylor P, Swain I. Effects of electrical stimulation of the vastus medialis muscles in the rehabilitation of patients after total knee arthroplasty. *Arch Phys Med Rehab.* 2003;84:1850-1853.

D'Lima D, Colwell C, Morris B, Hardwick M, Kozin F. The effect of preoperative exercise on total knee replacement outcomes. *Clin Orthop.* 1996;1(326):174-182.

Deyle G, Henderson N, Matekel R, Ryder M, Garber M, Allison S. Effectiveness of manual physical therapy and exercise in osteoarthritis of the knee: A randomized controlled trial. *Ann Intern Med.* 2000;132:173-181.

Fitzgerald G, Oatis C. Role of physical therapy in management of knee osteoarthritis. *Curr Opin Rheumatol.* 2004;16:143-147.

Goodman C, Boissonnault W. *Pathology: Implications for the Physical Therapist.* Philadelphia, W.B. Saunders Company, 1998.

Jones C, Voaklander DC, Suarez-Almazor ME. Determinants of function after total knee arthroplasty. *Phys Ther.* 2003;83:696-706.

Kisner C, Colby LA. *Therapeutic Exercise Foundations and Techniques.* Philadelphia, F.A. Davis Company, 2002.

Kramer JF, Speechley M, Bourne R, Rorabeck C, Vaz M. Comparison of clinic- and home-based rehabilitation programs after total knee arthroplasty. *Clin Orthop.* 2003;1(410):225-234.

Kumar PJ, McPherson EJ, Dorr L, Wan Z, Baldwin K. Rehabilitation after total knee arthroplasty: A comparison of 2 rehabilitation techniques. *Clin Orthop.* 1996;1(331):93-101.

Moore K, Dalley A. *Clinically Oriented Anatomy, 4th ed.* Baltimore, Lippincott Williams and Wilkins, 1999.

Ranawat CS, Ranawat AS, Mehta A. Total knee arthroplasty rehabilitation protocol. What makes the difference? *J Arthroplasty.* 2003;18(3):27-30.

Rodgers JA, Garvin KL, Walker CW, Morford D, Urban J, Bedard J. Preoperative physical therapy in primary total knee arthroplasty. *J Arthroplasty.* 1998;13:414-421.

Vad V, Hong HM, Zazzali M, Agi N, Basrai D. Exercise recommendations in athletes with early osteoarthritis of the knee. *Sports Med.* 2002;32(11):729-739.