Knee Arthroplasty in sever Varus knee

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Background: The knee joint is a modified hinge of synovial joint. It permits mainly flexion and extension movements, and small amount of rotation of the leg in the flexed position of the knee. It is described as a compound joint that includes two condylar joints between the femur and the tibia and a saddle joint between the patella and the femur. Osteoarthritis (OA) is a common chronic condition resulting in pain, fatigue, functional limitations, increased healthcare utilization and high economic costs to society Varus knee osteoarthritis is by far the commonest indication for total knee replacements in adults.Total knee arthroplasty is nevertheless indicated in patients with Varus osteoarthritis when marked joint destruction is present and pain or deformity compromise function.

Keywords: Varus knee, Knee Arthroplasty
DOI Number: 10.48047/NQ.2022.20.10.NQ551162 NeuroQuantology 2022; 20(10):12004:12011

Introduction

Varus knee osteoarthritis is by far the commonest indication for total knee replacements in adults.Total knee arthroplasty is nevertheless indicated in patients with Varus osteoarthritis when marked joint destruction is present and pain or deformity compromise function. [1]

A- Pre operative planning:

Preoperative planning is of paramount importance in primary total knee arthroplasty. A thorough preoperative analysis helps the surgeon envision the operation, anticipate any potential issues, and minimize the risk of premature implant failure. [2]

I- Clinical:

Obtaining a thorough history is crucial for patient selection and for the evaluation of potential postoperative complications. Factors that should be considered include the preoperative diagnosis, patient age. and sex, characteristics of the knee pain, level of activity, functional limitations, involvement of other joints, mechanical symptoms, and previous treatment.[2]

A new total knee rating system has been developed by The Knee Society to provide an up-to-date more stringent evaluation form. The system is subdivided into a knee score that rates only the knee joint itself and a functional score that rates the patient's ability to walk and climb stairs. The dual rating system eliminates the problem of declining knee scores associated with patient infirmity. [3]

The Knee Society considered all the commonly used existing rating systems. By consensus it was agreed that the knee rating and the functional assessment should be separate. With regard to the knee assessment, it was decided that only the three main parameters of pain, stability and range of motion should be judged and that flexion contracture, extension lag and

eISSN 1303-5150

misalignment should be dealt with as deductions. Thus, 100 points will be obtained by a well-aligned knee with no pain, 125 degrees of motion, and negligible antero-posterior and medio-lateral instability. Patient function considers only walking distance and stair climbing, with deductions for walking aids. The maximum function score, which is also 100, is obtained by a patient who can walk an unlimited distance and go up and down stairs normally. [3]

The form itself is largely self-explanatory: 50 points are allotted for pain, 25 for stability, and 25 for range of motion. Walking ability is expressed in blocks (approximately 100 meters). Stair climbing is considered normal if the patient can ascend and descend stairs without holding a railing [3]

The Knee Society has proposed this new rating system to be simple but more exacting and more objective. The rating is divided into separate knee and patient function scores. Thus, increasing age or a medical condition will not affect the knee score. It is hoped the rating system will become universally accepted and will be adopted by all authors, even if they wish to report results using a customary scoring method as well. [3]

Clinical evaluation of pain status, range of motion, the ability to walk and radiographic evaluation of the alignment of the knees should be performed pre and post operatively. In another word, pre-operative knee society score and functional knee score must be done. [3]

II- Radiological:

Preoperative varus deformity of the knee is a common malalignment in patients undergoing primary total knee arthroplasty. [4]

Preoperative Radiograph should include:

1- antero-posterior and lateral views long film of both hips and knees to :

   a- assess extra articular deformity of femur and tibia
   b- determine mechanical and anatomical axis
   c- calculate distal femur valgus cut
   d- significant bowing of the tibia precludes the use of an intramedullary tibial alignment guide
   e- Templates can be used to anticipate approximate component size and bone defects that would need to be treated intraoperative[4]

2- antero posterior and lateral standing views to assess:

a-overall limb alignment
b-Determine the anatomical and mechanical axes of the femur and the tibia.
c-for evaluation of the tibiofemoral joint space including formation of osteophytes on the joint margin or on the tibial spines, narrowing of the joint cartilage with sclerosis of subchondral bone, presence or absence of small cystic or pseudocystic areas with sclerotic walls in the subchondral bone, and/or altered shape of the distal femur or proximal tibia
d-assesment of femoral offset and tibial slope in lateral view[4]

3-specific sunrise view of the patella-femoral joint is important too. [4]

III- Pre-operative medical assessment:

The preoperative medical evaluation of candidates for TKA must be detailed and thorough to prevent potential complications that can be life-threatening or limb-threatening.

Because most-patients who undergo TKA are elderly and comorbid diseases must be considered. Patients with multiple medical risk factors have been shown to require longer hospital stays. Smokers, in particular, tend to have longer operative times and increased hospital charges after undergoing joint replacement. [5]

Patients must have adequate cardiopulmonary reserve to withstand general or epidural anesthesia, and to withstand a blood loss of 1000 to 1500 mL over the perioperative period. A routine preoperative electrocardiogram should be obtained. Patients who have a history of coronary artery disease, mild congestive heart

eISSN 1303-5150

failure, chronic obstructive pulmonary disease, or restrictive pulmonary disease should be evaluated by appropriate medical consultants.[5] Vascular supply to the operative leg also should be evaluated. If adequate vascularity is questionable, noninvasive arterial studies should be obtained; a vascular surgery consultation may be necessary. [5]

Fig.(1): Anteroposterior long film of both lower limbs inSeveral cases of knee osteoarthritis associated with extra-articular deformity. Anteroposterior X-rays of the whole lower limbs in the standing position (teleradiography). Arrows point to the extra-articular deformity, right femur in the right and left images and left tibia in the central image

The presence of surgical scars should be noted during the skin examination because it can inform the decision of whether to use a standard midline surgical incision. When multiple previous incisions are encountered, it has traditionally been recommended that the most lateral incision be used and that at least 5 or 6 cm of skin bridging be provided between incisions to avoid postoperative skin complications. Dementia, diabetes mellitus, a body mass index .40, and renal and cerebrovascular diseases have been shown to be independent predictors for in-hospital mortality and postoperative complications after primary TKA. [5]

Routine preoperative laboratory evaluation should include complete blood cell count, electrolytes, and urinalysis. Preferably, these tests are performed a few days before surgery so that measures can be undertaken for any correctable abnormalities. The routine use of a chest radiograph usually is not cost-effective as a screening tool, but it is indicated in patients with a history of cardiopulmonary disease. Similarly, routine preoperative evaluation of coagulation studies is unnecessary except in patients with a history of bleeding or coagulopathy. Patients receiving anticoagulant medications must be managed appropriately to limit blood loss while ensuring medical stability in the perioperative period.[5]

In brief the most important points in medical optimization before TKR are:

1. BMI (< 35–40 kg/m2)
2. hemoglobin (> 11–12 g/dL)
3. a measure of glucose control (e.g., hemoglobin A1c < 7.0–7.5 percent)
4. no tobacco use for > 30 days
5. methicillin-resistant Staphylococcus aureus colonization status
6. nutritional status as indicated by albumin (> 3.0–3.5 g/dL)[5]

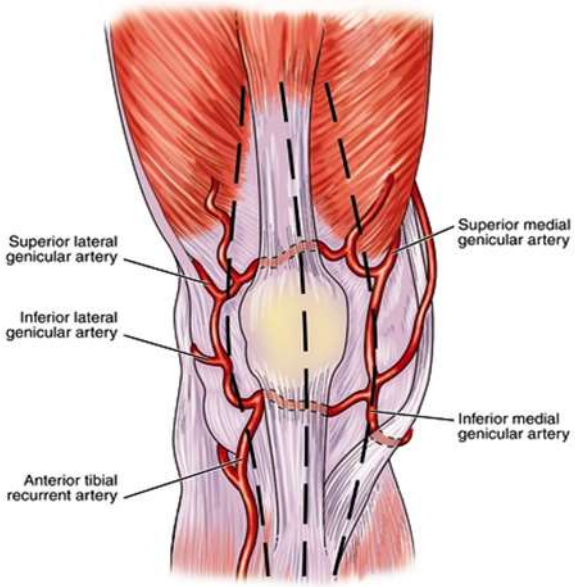

Fig.(2): Different approaches to the knee in releation to its blood supply

B-Surgical exposures in TKA:

What makes the exposures of the knee an important point to search on, is that it is the main way to reach the knee joint in total knee arthroplasty (TKA) procedure. [6]

Use of pneumatic tourniquet has become a routine in lower limb surgery A tourniquet can be applied to the thigh and just inflated in cases of excessive intraoperative bleeding[6]

Surgical Prep, Draping: Perioperative infection has become relatively rare in joint replacement, due to careful aseptic technique, improved operating room conditions and judicious use of perioperative antibiotics. Prepping and draping is an important preliminary step in avoidance of infection and should be performed carefully under supervision of the operating surgeon. The best is to use an iodine with alcohol formulation for prepping and to apply this to the entire leg including the foot. Draping is then completed, including a stocking to cover the leg, an adhesive U-drape to exclude the proximal region and an extremity drape to cover the entire field. The operative site is then exposed by cutting the stocking in the midline, and an iodine-impregnated adhesive sheet is then applied over the area.[6]

The skin incision for TKA should allow easy access to the chosen deep approaches, be extensile and, where appropriate and possible, incorporate previous incisions. A sound understanding of the blood supply of the skin around the knee joint is important and should be respected. The anterior midline incision is the gold standard as it provides access to the medial and lateral aspects of the knee. It is usually centred over the medial edge of the patella, for the more common medial parapatellar arthrotomy. [7]

The technique of exposing the knee for various operations, especially total knee arthroplasty, has evolved for more than a century[7]

I-The Medial Parapatellar Approach & Its Modifications:

This is the standard and most commonly used approach for TKA and is an excellent extensile approach that can be used in virtually all primary knee arthroplasty. Following the skin incision, the arthrotomy will divide extensor mechanism, capsule and synovium in one layer and will usually begin approximately 5 cm proximal to the superior pole of the patella, leaving a 5–10 mm cuff of tendon attached to the vastus medialis obliquus (VMO) and distally around the medial edge of the patella and patellar tendon to the level of the tibial tubercle. A small cuff of retinaculum should be left on the patella, and paratenon on the tendon, for later closure. A transverse pen marking can be made at the level of the patella prior to the arthrotomy to guide later closure .

Advantages:

It provides excellent exposure, simple to perform, practical, expansile and transformable.

Disadvantages:

The approach disrupts the anastomotic ring of blood vessels located circumferentially around the patella, traversing the quadriceps and patellar tendon. Use of the medial parapatellar incision, by necessity, divides the superior medial genicular artery and the inferior medial genicular artery. When coupled with division of the superior lateral genicular artery, inferior lateral genicular artery, as well as the anterior tibial recurrent artery (commonly occurring with a lateral retinacular release), the blood supply to the patella can be jeopardized. [7]

B- In this approach, disruption of the vastus medialis muscle fibers at its tendinous insertion compromises the integrity of the medial side of the extensor mechanism and hence the stability of the patella and causes patellar maltracking.

C- Additionally, muscle-to-tendon repairs are not as strong as tendon-to-tendon repairs and must be protected with restricted motion to allow for adequate healing. To avoid some of these difficulties, modifications have been made by various authors to this "medial parapatellar" approach.[7]

II-The Subvastus (Southern) Approach:

This approach is considered by proponents to be more “biological” than the medial parapatellar arthrotomy as it does not violate the quadriceps tendon and lifts the vastus medialis muscle as a whole.

Surgeons today are not only interested in the long term results of the implant but also return to function, shorter hospital stays, decreased complications, and less analgesia complications. Preservation of the patella blood supply also is

important even if a lateral patella release is performed. The subvastus approach offers some of these advantages .

Despite its theoretical advantages, information on the success of this approach is limited.

Through proper patient selection, extension procedures for this subvastus approach can and should be avoided.[8]

PATIENT SELECTION:

It should not be considered in Patients:

1. Who are obese.
2. With significant patella baja.
3. With severe flexion contractures.
4. With wounds with potential for ischemic complications.

Advantages of the subvastus approach:

1. Patellar blood supply preservation.
2. Decreased analgesic requirements.
3. Earlier straight-leg rising.
4. Shorter hospital stays.
5. If compared with medial parapatellar approaches, no difference was noted in range of motion; but the subvastus approach appeared to have better patella tracking.[8]

III-The Midvastus Approach

The midvastus approach evolved as surgeons attempted to capture the advantages of a subvastus surgical approach without compromising full exposure of the knee.

It differs from the subvastus approach in that the vastus medialis muscle is split in line with its fibers rather than subluxated laterally in its entirety. The split in the vastus medialis starts at the superomedial border of the patella and extends proximally and medially toward the intermuscular septum. A safe zone of 4.5 cm of the vastus medialis can be sharply split from the margin of the patella and can be bluntly dissected further if desired.[8]

Advantages:

This approach preserves the supreme genicular artery to the patella and the quadriceps tendon .

Contraindication:

Relative contraindications to the midvastus approach include obesity, previous upper tibial osteotomy, and limited preoperative flexion of less than 80 degrees. [8]

Careful attention to hemostasis is mandatory, because postoperative hematomas have been described with both the subvastus and midvastus approaches. [8]

IV-The lateral parapatellar approach:

A lateral parapatellar retinacular incision , may be considered in TKA for fixed valgus deformity that are isolated or combined with flexion contracture or external tibial torsion. Fixed varus deformity is the only relative contraindication. [8]

The basic principles of knee replacement surgery apply to the reconstruction of arthritic deformed knees include:

(A) Restoration of the mechanical axis and normal joint line.

(B) Ligamentous balance (gap kinematics).

(C) Proper component selection including augments

(D) Patello-femoral joint tracking[9]

***(A*) Restoration of the mechanical axis and normal joint line:**

The arthritic knee must be anatomically realigned for any total knee arthroplasty to be successful in long term. Correction of preoperative deformity optimizes load bearing over prosthetic contact surfaces and at the interfaces. Residual malalignment after total knee arthroplasty may result in an inferior result cosmetically, functionally, and in long term.

Restoring the varus knee to its normal angle and stability requires both bony and ligamentous anatomic abnormalities to be corrected. [10]

Bone preparation:

Correct handling of the bony defects of both the femur and the tibia are essential for restoration of the joint line to its normal position and for establishing ligamentous stability through a functional arc of motion[11].

There are two methods of bone handling in total knee arthroplasty with deformity and bone deficiency:

(1) Generous cuts: to bypass the defects and make the deficient side is the reference side:

It is generally accepted that in cases with large tibial defects, resecting the proximal tibia to achieve a flat surface for seating the tibial component should not be done because it damages ligament attachments, increases lateral laxity and sacrifices excessive amounts of bone.

Femoral resection is even more crucial because of its effect on joint line position relative to the patella and to ligament attachments.

Often the distal portion of the medial femoral condyle is so deficient in the varus knee that resection of the lateral femoral condyle to a level that will allow seating on the femoral component medially results in severe over resection laterally (the deficient side is the reference side). lateral over-resection may damage the femoral attachment of the lateral collateral ligament (LCL) and results in lateral laxity when the knee is fully extended. The ligament imbalance must be corrected by a thick tibial component. The knee is excessively tight in flexion because the posterior cruciate and MCL are tightened by the elongated tibial segment.[12]

Disadvantages:

-Elevation joint line

-Patellofemoral problems (patella infera)

-Increased lateral laxity

-Bone quality decreased

-Loss of bone stock (revision).

-Decreased range of motion [12]

(2) Measured resection technique (restoration of the joint line)

The amount of bone resected to accommodate the prosthesis usually corresponds to the thickness of the component being implanted, otherwise known as “matched resection” in which the thickness of the resection is “matched” to the thickness of the implant. This thickness is implant specific with minor variations between implants. There are five standard femoral cuts in all prosthetic designs.

So, the ideal management is to use the intact joint surfaces on the lateral femoral condyle and lateral tibial plateau as the reference level for resection of the distal femoral surfaces. By using this method (measured bone resection), the joint line is not raised, and ligament balancing in flexion and extension is not so complex. When the deficiency of the medial femoral condyle is severe, no bone is removed from the distal surface of the medial condyle, and bone grafting is done to make up for the deficiency. This technique allows the knee to maintain ligament balance based on intact lateral femoral condylar surface throughout the range of motion (ROM). [13]

Advantages:

1-Restoration of the joint line

2-Anatomical as regard patellofemoral joint

3-No increase in the medial laxity

4-preservation of bone stock

Femoral and tibial cuts in measured bone resection technique:

Femoral cuts:

The distal femur was cut at 5-7˚ valgus to the femoral shaft axis using intramedullary instrumentation (perpendicular to the mechanical axis of the femur. For severe varus deformities one may slight increase the valgus cut angle to facilitate soft tissue balancing. The thickness of this cut is determined by the extent of the medial femoral condylar bone defect and the severity of the flexion contracture. If there is existing loss of bone due to an erosive defect of 2mm, then the resection on the medial side was decreased by 2 mm. if there is a very severe flexion contracture, then an additional 2mm was resected at an early or a later stage [14]

Tibial cuts:

Like the femoral resection, resection of the proximal tibial surface is based on the height of the intact lateral bone surface. A maximum thickness of 8-10 mm cut is removed from the lateral tibial plateau perpendicular to the mechanical axis of the tibia, which often leaves a large bony defect (in severe cases of varus deformity) on the medial side of the tibia to be

reconstructed either by bone graft or metal augmentation with or without use of long stem tibial component**.** [(15)]

This cut equally affects flexion and extension gaps. The depth of the cut is usually 8–10 mm, but will be varied depending on implant thickness and patient factors. In particular, if the knee has equivalent significant restriction in extension and flexion, increased tibial resection will be benefitcial in restoring range of motion.[(16)]

(B) Ligamentous balance (Gap Kinematics):

It is the second and more complex task after bone preparation. The relationship of the proximal tibia to the distal femur, as represented by the gap created by bone deficiency, and how it changes while performing ligament balancing, may be referred to as ***gap kinematics***. Proper balancing of the joint gaps must be achieved so that once the gaps are filled with suitably articulating knee components, the static tension of the surrounding soft-tissue sleeve will allow for a stable construct. If asymmetry and inequality exist in the soft-tissue sleeve, properly articulating components may have no primary support to keep them stable under antagonistic dynamic forces, Therefore, it is mandatory to create an essentially stable joint gap throughout the entire range of flexion and extension. [(17)]

The need for balancing the soft-tissue sleeve of the knee to create rectangular gaps is well recognized as a critical step in TKA. However, most published reports of clinical outcomes following TKA in the varus osteoarthritic knee have addressed implant longevity and/or alignment. [(18)]

When the surgical technique and the implant design are decided on, the extent of the deformity with its osseous and soft-tissue components is of crucial importance. The bone inventory, the soft-tissue situation, and the implant constraint must be assessed as interdeterminative components of a complex system. Therefore, the use of a systematic classification system for knee joint deformities, from which one can derive an algorithm that facilitates the decision for a certain implant constraint and the appropriate soft-tissue treatment. The required soft-tissue release must be carried out in a dosed manner, adjusted to the individual situation, to prevent excessive release and the resulting instability and to avert the necessity of using an implant with a higher degree of constraint.

Hence, the soft-tissue balancing procedures are meant as suggestions, which can be varied, e.g., regarding their sequential order and timing. The principles involved in soft-tissue balancing are illustrated by means of a strongly simplified model. [(19)]

(C) Component Selection

Another important consideration in the management of varus deformity is prosthesis selection with regard to the degree of component constraint. Ideally, if proper soft tissue balance is restored, a minimally constrained component then can be implanted. Although most surgeons agree that a more constrained posteriorly stabilized component should be used if significant deformity necessitates PCL sacrifice for soft-tissue balancing, it is not universally accepted. Such prosthesis provides some degree of posterior stabilization as well as protection against posteromedial, posterolateral, straight medial, or straight lateral translation, but it will not protect against residual lateral laxity, which is one of the major considerations in achieving proper balance. The surgeon should resist the temptation, when possible, to move to a more highly constrained prosthesis, such as a totally stabilized prosthesis, to compensate for shortcomings in achievable soft-tissue balancing. Although highly constrained components may be necessary in difficult revision cases, they are infrequently necessary for primary total knee arthroplasty.[(20)]

The patient with severe varus knee deformity also may have a contracted, fibrosed and non functioning PCL and acts as a central tether that should be released for balancing the soft tissues Therefore, it is preferred to sacrifice the PCL and use a posterior cruciate-substituting prosthesis.[(21)]

Component selection for the varus knee with an extremely deficient medial femoral and tibial condyle may require the use of component augmentation if the femoral or tibial components being cemented and in some cases the use of more constraint prosthesis like constraint condylar knee (CCK). The medial femoral condyle may have had little or no distal femoral bone resected or, similarly, little to no bone resected from the chamfer and posterior cuts, as well. These cuts may require component augmentation. However, if the femoral component is being press-fit, then as long as native bone is resting on one of the chamfer cuts (as is usually the case for the posterior bevel or chamfer cut), then the remaining defect can be filled with autograft bone taken from other cuts during the procedure. [21]

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