"THE ROLE OF TOTAL KNEE ARTHROPLASTY IN SURGERY FOR ARTHRITIC DISORDERS OF KNEE JOINT CONDUCTED AT KLES DR. PRABHAKAR KORE HOSPITAL AND MEDICAL RESEARCH CENTRE, BELGAUM"

By

Dr. ABHISHEK GUPTA

Dissertation submitted to the
KLE University, Belgaum, Karnataka

In Partial Fulfillment
of the requirements for the degree of

MASTER OF SURGERY

in

ORTHOPAEDICS

Under the Guidance of

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Date:

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LIST OF ABBREVIATIONS USED

AAOS	-	American Academy of Orthopaedic Surgeons
AP	-	Anterioposterior
ASIS	-	Anterior superior iliac spine
CSE	-	Combined spinal epidural anesthesia
DVT	-	Deep vein thrombosis
GA	-	General anesthesia
HSS	-	Hospital for Special Surgery
KSS	-	Knee Society score
LMWH	-	Low molecular weight heparin
NSAIDS	-	Non steroidal anti inflammatory drugs
PCL	-	Posterior cruciate ligament
PMMA	-	Poly methyl methacrylate
sc	-	Subcutaneously
SF-36	-	Medical Outcomes Study Short Form-36
TCP	-	Total Condylar Prosthesis
TKA	-	Total knee arthroplasty
UKA	-	Unicompartmental knee arthroplasty
WOMAC	-	Western Ontario and McMaster Universities

ABSTRACT

Background and Objectives

Total knee arthroplasty is one of the most common orthopedic procedures performed. Because these procedures are elective and expensive and because the prevalence of arthritis is expected to grow substantially as the population ages, these procedures are likely to come under increasing scrutiny. The objectives of the present study were to study the outcomes of total knee arthroplasty in terms of pain relief, joint stability, range of motion and functional outcome and to study various complications following total knee arthroplasty.

Methods

The present one year descriptive study was conducted in the Department of Orthopaedics, KLES Dr. Prabhakar Kore Hospital and Medical Research Centre, Belgaum during the period of December 2006 to November 2007 on 20 patients with osteoarthritis who were undergoing unilateral total knee replacement. Functional outcome was evaluated with the help of a knee society clinical rating system and Knee Society Roentgenographic Evaluation and scoring system.

Results

The results of present series are excellent with 86.7% excellent clinical and 88.25% excellent functional results. The improvement in patients that underwent total knee arthroplasty was considered statistically significant ($p < 0.001$) based on knee Society knee scoring system.

Conclusion and interpretation

Total knee arthroplasty provides considerable pain relief, range of motion, stability in severely painful, refractory, deformed knees if performed taking into consideration preoperative patient's selection, intra operative soft tissue balancing, prosthesis alignment and post operative rehabilitation.

Keywords

Knee Society knee scoring system; Osteoarthritis; Total knee arthroplasty;

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INTRODUCTION

Total knee arthroplasty (TKA) is one of the most common orthopedic procedures performed. Throughout this report we use the term total knee arthroplasty in lieu of total knee replacement because the abbreviation for the latter may be readily confused with total knee revision. Because these procedures are elective and expensive and because the prevalence of arthritis is expected to grow substantially as the population ages, these procedures are likely to come under increasing scrutiny.[1,2]

Following John Charnley's success with hip replacement in the 1960s numerous attempts were made to design knee replacements. The history of knee replacement is the story of continued innovation to try to limit the problems of wear, loosening and loss of range of motion.[3]

The surgery involves exposure of the front of the knee, with detachment the vastus medialis from the kneecap. The kneecap is displaced to one side of the joint allowing exposure of the distal end of the femur and the proximal end of the tibia. The ends of these bones are then accurately cut to shape using cutting guides oriented to the long axis of the bones. The cartilages and the anterior cruciate ligament are removed. The posterior cruciate ligament (PCL) may also be removed but the collateral ligaments are preserved. In all the cases in this study the PCL was sacrificed. Soft tissue balancing is done at different stages throughout the procedure. Metal components are then fixed onto the bone using poly methyl methacrylate (PMMA) cement. During the operation any deformities

must be corrected and the ligaments balanced so that the knee has a good range of movement and is stable.[4]

Variations

The development of the current technology for knee replacement began in the 1950s, and hundreds of prosthetic designs have now been described in the literature. Prostheses vary by the knee compartments replaced, the level of femoral-tibial constraint, and the geometry of the articulating surfaces, fixation surfaces, and prosthetic materials used. Variation in surgical technique includes surgical approach, use of instrumentation, prosthetic positioning, patellar replacement, use of cement, and treatment of the cruciate ligaments and other soft-tissue releases. Each of these factors is believed to have important implications for patient outcomes.[3]

The most significant variations are between cemented and uncemented components, between operations which spare or sacrifice the PCL and between resurfacing the patella or not.[5,6]

Minimally Invasive Surgery is being developed in Total Knee replacement but has not yet found complete acceptance. The goal is to spare the patient the large cut in the quadriceps muscle which could increase post-operative pain or lengthen disability.[7] None of the cases in the present study though have been done by minimally invasive approach.

Unicompartmental knee arthroplasty (UKA), also called partial knee replacement, is an option for some patients. The knee is generally divided into three "compartments": medial, lateral, and patellofemoral. Most patients with

arthritis severe enough to consider knee replacement have significant wear in two or more of the above compartments and are best treated with total knee replacement. A minority of patients have wear confined primarily to one compartment, usually the medial, and may be candidates for unicompartmental knee replacement. Advantages of UKA compared to TKA include smaller incision, easier post-op rehabilitation, shorter hospital stay, less blood loss, lower risk of infection, stiffness and blood clots and easier revision if necessary. While most recent data suggests that UKA in properly selected patients has survival rates comparable to TKA, most surgeons believe that TKA is the more reliable long term procedure.[8,9,10] The present study has not however evaluated unicompartmental replacements.

There are many different designs of total knee replacement. All of them were devised to solve an apparent problem. Studying the outcome from one design versus another is expensive, time consuming and unrewarding because designs change frequently and may be withdrawn by the time a good long term study has been done.

Pre-operative work-up

Knee Arthroplasty is major surgery. Before the surgery is attempted blood work were obtained, usually a complete blood count, electrolytes and body chemistries, activated partial thromboplastin time and Prothrombin time to measure clotting, chest X-rays, electrocardiogram and blood cross matching for possible transfusion. Accurate X-rays of the affected knee is needed to measure the size of components for templating. Special investigations like Echocardiography, colour

doppler were done in selected cases. Appropriate anaesthetic precautions were taken for cardiologically high risk patients. Diabetes and hypertension if diagnosed in patients were brought in due control before pursuing with the operative procedure. Thorough history and physical examination was done to rule out any foci of infection in the body. Patients may be admitted on the day of surgery if the pre-op work-up is done on an out patient basis or may come into hospital one or more days before surgery.

Orthopaedic surgeons are increasingly challenged to find a prophylaxis regimen that protects patients from thromboembolism while minimizing adverse clinical outcomes such as bleeding.[11]

Post-operative rehabilitation

Protected weight bearing with walker and on cane with knee bending and isometric exercises is required until the quadriceps muscle has healed and recovered its strength. Care has to be taken to prevent extensor lag and knee stiffness. Post operative hospitalization varies depending on the health status of the patient and the amount of support available outside the hospital setting. Usually full range of motion is recovered over the first two weeks. At six weeks patients have usually progressed to full weight bearing. Complete recovery from the operation involving return to full normal function may take three months and some patients notice a gradual improvement lasting many months longer than that.

Risks and complications

According to the American Academy of Orthopaedic Surgeons (AAOS), “blood clots in the leg veins are the most common complication of knee replacement surgery. Your orthopaedic surgeon will outline a prevention program, which may include periodic elevation of your legs, lower leg exercises to increase circulation, support stockings and medication to thin your blood”.

Also according to AAOS, "the complication rate following total knee replacement is low. Serious complications, such as a knee joint infection, occur in less than two percent of patients. Major medical complications such as heart attack or stroke occur even less frequently. Chronic illnesses may increase the potential for complications. Although uncommon, when these complications occur, they can prolong or limit your full recovery”.[12]

The knee at times may not recover its normal range of motion (zero to 135^0 usually) after total knee replacement. Much of this is dependent on pre-operative function. Most patients can achieve zero to 110^0, but stiffness of the joint can occur. In some situations, manipulation of the knee under anesthetic is used to improve post operative stiffness. There are also many implants from manufacturers that are designed to be "high-flex" knees, offering a greater range of motion.[13] In none of the patients in this study high flex design has been used. In some patients, the kneecap is unstable post-surgery and dislocates to the outer side of the knee. This is painful and usually needs to be treated by surgery to realign the kneecap. This is very rare, but possible.

In the past, there was a considerable risk of the implant components loosening over time as a result of wear. As medical technology has improved however, this risk has fallen considerably. The risk of wear has been reduced by 79% in fixed-bearing knees and by 94% in mobile-bearing, also known as rotating platform knees. Knee replacement implants can last up to 20 years in many patients; whether or not they actually survive that long depends largely in part upon how active the patient is after surgery.[14]

Outcomes based on functional scales

The most commonly used functional measures were the Knee Society score (KSS) and the Hospital for Special Surgery scale (HSS). The Western Ontario and McMaster Universities (WOMAC) Arthritis Scale has only been used since 1991. The physical function component of the Medical Outcomes Study Short Form-36 (SF-36) is a generic functional outcomes measure not specific to knees.

The KSS is associated with longer follow up periods. For example, weighting for baseline patients the mean follow up for KSS and HSS is 66 and 67 months, compared to 45 months for WOMAC. However, weighting for baseline knees, KSS has a mean follow up of 90 months and WOMAC is 68 months, but HSS is only 61 months. The longest mean follow up time was 90 months (KSS scores weighted for baseline knees), well less than the 10 years that has been suggested in order to evaluate long term functional results. Only ten studies had a follow up time of at least 10 years.

Some information on attrition rate was reported for 49 studies. Of these the median percentage of subjects lost to follow up was two percent, the range was zero to 28%. If death is added to the definition, the range increases to zero to 56% with a median of 12%. Although there is no formal basis for translating the size of the scores, the generally accepted rule of thumb for the KSS and HSS scales is that a score of less than 60 is considered poor; 60 to 69 represents a fair result; 70 to 84 is considered a good result; 85 to 100 is considered an excellent result.

The functional scores after TKA are consistently higher. The mean effect size (defined as the number of standard deviations of change from baseline scores) for the HSS studies is 3.91 for those with follow up to two years, 3.01 for those two to five years, and 2.97 for those studies with more than five years of follow up. For the studies using KSS the mean effect size is 2.35 for those zero to two years, 2.73 for those two to five years, and 2.67 for those more than five years. For WOMAC studies the mean effect size for zero to two years of follow up is 1.62. The more generic SF-36 scores had the smallest mean effect size; for the studies with zero to two years of follow up it was 1.27.

When the unit of analysis was numbers of knees operated on, the perioperative complication rate (defined as occurring within six months of the TKA) was 5.4%; when the denominator was numbers of patients, the rate was 7.6%. The revision rate through five or more years is two percent of knees and 2.1% of patients.[15]

We differentiated "indications for TKA" from "correlates or factors related to outcomes." The former addresses what factors are needed to warrant a TKA (or conversely, what factors are contraindications to TKA either because the procedure is ineffective, unnecessary, or places the patient at unacceptably high perioperative risk); whereas the latter addresses whether outcomes vary according to the clinical or demographic factors. To address indicators would require a design that compared the outcomes of persons with the potential indicator with and without surgical treatment. However, it is possible to examine the potential for contraindications by examining only those who receive arthroplasties.

The number of studies that employed any analytic technique examining the functional outcome in terms of at least one independent variable of interest was limited. Only 12 of the 69 studies used any analysis that directly assessed the relationship of these patient variables to a change in functional status. Age, obesity, or gender does not seem to be significantly correlated with TKA outcomes. Whether outcomes vary according to arthritis type is unclear. Patients with rheumatoid arthritis seem to show more improvement than those with osteoarthritis but they have lower level of function preoperatively and few studies adjust for other risk factors such as obesity.[15,16,17]

The focus of current study was to highlight the outcomes of currently in vogue procedure of cemented TKA in terms of pain relief, joint stability, range of motion and functional outcome with the help of a definitive clinical and radiological scoring system, the KSS and study various complications among the patients undergoing TKA at KLES Hospital and MRC, Belgaum.

OBJECTIVES

The objectives of the present study were:

1. To study the outcomes of total knee arthroplasty in terms of pain relief, joint stability, range of motion and functional outcome with the help of a knee society clinical rating system and Knee Society Roentgenographic Evaluation and scoring system.

2. To study various complications following TKA.

Hypothesis

Null hypothesis (H^0)

There will be no improvement on knee society knee score in patients with osteoarthritis who have undergone total knee arthroplasty.

Alternative hypothesis

There will be improvement in knee society knee score in patients with osteoarthritis who have undergone total knee arthroplasty.

REVIEW OF LITERATURE

Anatomical aspects of the knee joint and contributing factors

The knee joint formed by the femur, tibia and patella consists of three partially separate compartments: patellofemoral, medial tibio-femoral and lateral tibio-femoral. Embryologically knee develops from the leg bud at 28 days with the formation of femur, tibia and fibula by 37 days. The knee joint arises from blastemal cells with the formation of patella, cruciate ligaments and menisci by 45 days. Laterally the knee joint capsule extends distally superficial to the proximal fibula. The tibio-femoral compartments are most complex and combined with ligamentous interaction which allows transverse rotation of the tibia on the femur during knee flexion and extension. Although an important insertion point for the lateral ligaments of the knee, the fibular head does not articulate with the knee joint.

The femoral condyles are asymmetric in size and shape. The medial femoral condyle is approximately 1.7 cm longer than the lateral condyle in its outer circumference. This asymmetry in length produces axial rotation of the tibia on the femur during flexion and extension. The width of each individual condyle is similar, with the lateral dimension being slightly wider than the medial when measured at the center of the intercondylar notch. In the sagittal axis the lateral femoral condyle extends more anteriorly than the femoral condyle. In the coronal plane medial condyle extends distally than the lateral condyle. Viewing the femur along its anatomic axis makes the valgus appearance obvious. However in normal weight bearing alignment condyles appear to be equal in length. The parallel

femoral condylar surfaces are created by the mechanical axis configuration of the lower extremity. The mechanical axis configuration is a straight line from the center of the femoral head that intersects the center of the knee and ankle joints. The distal femoral joint line forms a six degree angle to the long axis of the femoral shaft creating physiological valgus of the distal femoral joint line. The sagittal curvature of the condyles has a radius that decreases posteriorly. The condyles converge anteriorly to form trochlea, which articulates with patella .The highest bone strength is found at the posterior aspects of the condyles, with the central area being relatively weak. In contrast to the tibia, femoral trabecular bone strength is greater with increased distance from the subchondral plate.[18]

The medial tibial plateau is slightly concave and the lateral tibial plateau is slightly convex. In the sagittal plane the tibial condyles slope posteriorly approximately 10^0 In the frontal plane the condyles are essentially perpendicular to the long axis of tibia. The highest pressure concentrations are located on the uncovered cartilage of the medial compartment and on the menisci as well as on the uncovered cartilage of the lateral compartment. Trabecular bone of the tibial epiphysis and metaphysis is responsible for the load transmission. Compressive strength and stiffness depends on the bone density and trabecular structure. The medial tibial plateau is high strength area especially centrally and anteriorly. Strength is reduced at both plateaus towards periphery. Trabecular bone strength is significantly reduced at a distance of five mm from the surface. Preservation of bone stock of the tibial plateau should be considered in TKA, because optimum support is achieved by resecting 10 mm or less of tibial plateau. Excessive resection results in prosthetic loosening and alteration of desired component

position. The articular surface of the patella is divided into medial and lateral facets by a major vertical ridge. The medial facet is usually smaller than the lateral. A second vertical ridge near the medial border produces the narrow "odd" facet. The trabecular structure of the patella and the femoral trochlea is aligned normally to the joint surfaces.[18] The knee joint has the complex anatomic arrangement of the muscular and ligamentous attachments. The knee is described of having anterior, posterior, medial and lateral compartments. Key to this description of compartmentalization is the concept of layers about the knee useful in understanding the complex and the varied anatomy of the posterolateral and the posteromedial corners of the knee.[19]

The principal intraarticular structures of importance are the medial and lateral menisci and the anterior and posterior cruciate ligaments. The functions of menisci are distribution of joint fluid, nutrition, shock absorption, deepening of the joint and load or weight bearing function. The cruciate ligaments function as stabilizers of the joint and axes around which rotary motion, both normal and abnormal, occurs.

They restrict backward and forward motion of the tibia on the femur and assist in the control of both medial and lateral rotation of the tibia on the femur. The extensor mechanism includes the quadriceps muscle, quadriceps tendon, patella and patellar tendon. The distal quadriceps complex represents an aponeurosis of the four muscle bellies at the anterior aspect of the knee. Centrally, the rectus femoris continues over the anterior surface of the patella and is the only quadriceps component with continuity in the infra patellar ligament. A portion of the vastus medialis fibers (vastus medialis obliqus) is oriented at an

angle of approximately 60^0 to the rectus tendon. The muscle fibers become tendinous for only a few millimeters and inserted directly into the patella or continue as the medial retinaculum. The vastus medialis fibers are usually disrupted during medial parapatellar approach for TKA. The vastus lateralis fibers are oriented at an angle of approximately 30^0 to the rectus tendon. These fibers insert into the superolateral corner of the patella and contribute to lateral retinaculum. The vastus-intermedius lies deep to the other three muscles and insert directly to the superior pole of the patella.

The infrapatellar tendon is composed primarily of rectus femoris fibers that extend distally over the anterior surface of the patella. The tendon ranges in length from 3.5 to 5.5 cm. The infrapatellar tendon inserts over the broad expansion of the tibial tubercle and blends with the fascia on the anterior aspect of the tibia. The tendon and its insertion must be carefully protected during the exposure of the knee joint. An arthritic knee with an extensor mechanism contracture and limited knee flexion is especially vulnerable. A safe exposure and improved postoperative flexion may be achieved with a modified V-Y quadricepsplasty for a quadriceps contracture and a tibial tubercle osteotomy for a patellar tendon contracture. Innervation of the quadriceps muscle is from the femoral nerve.[18]

The hamstring musculature is made up of the gracilis, semimembranosus and semitendinosus medially and the biceps femoris laterally. On the medial side, the semimembranosus has an extensive insertion and the gracilis and semitendinosus combine with the sartorius to create the pes anserinus (goose foot). The sartorius muscle arises from the anterior superior iliac spine (ASIS)

and runs down the front of the thigh, with innervation from the femoral nerve. Its insertion is expansive as a fascial covering (layer I) surrounding the deeper insertions of the remaining two pes tendons. The gracilis muscle originates from the pubic arch and runs medially in the thigh to insert approximately four cm below the joint line, with innervation from the obturator nerve. The semitendinosus originates from the ischial tuberosity, is innervated by the sciatic nerve, and travels in the thigh on the surface of the semimembranosus. Its tendon inserts posterior to the gracilis on the medial tibia. The semimembranosus muscle originates from the ischial tuberosity via a long tendon and courses medially and deep to the biceps femoris, with five insertions on the medial knee. It provides a strong expansion posteriorly and medially to the knee, continuing to form the posterior oblique ligament of the knee with condensations of layers II and III. Its innervation is also the sciatic nerve. The biceps femoris arises in the form of two heads: the long head from the ischial tuberosity in common with the semitendinosus and the short head from the linea aspera and lateral intermuscular septum. The innervation is dependent on the belly: the long head via the sciatic nerve, the short head via the lateral popliteal nerve. Insertion of both muscle bellies is through a common tendon to the fibular head with expansions to the lateral tibia.

The gastrocnemius is composed of two muscle bellies: the medial and lateral heads. Both heads originate from the respective femoral condyle in the posterior aspect. The tendinous portions insert into the common tendon of the soleus, fascia and the tendo achillis. The popliteus has a tendinous origin at the lateral femoral condyle, inserting via a muscle belly distally on to the posterior

surface of the tibia just above the soleal line. In its static function, the popliteus restricts posterior translation, varus rotation and external rotation of the tibia on the femur. Due its oblique orientation on the tibia, the popliteus is also a dynamic restraint to the tibial external rotation.[20]

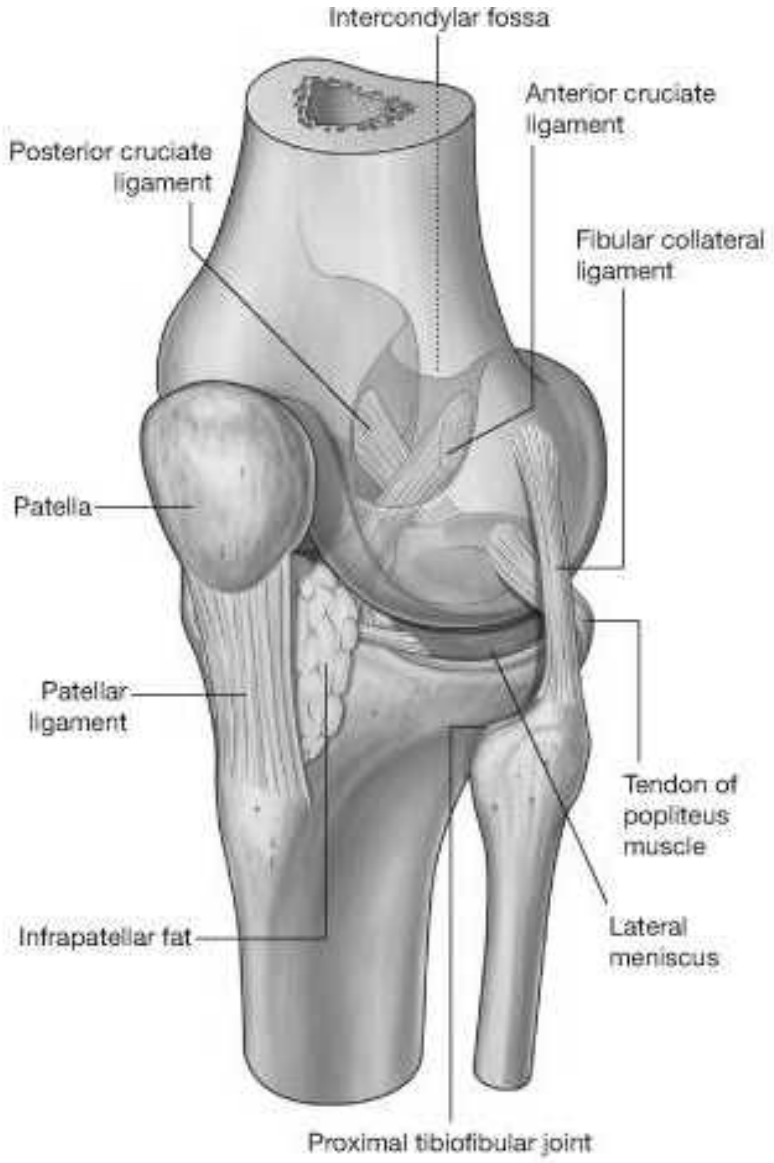


Figure No. 1: Anatomy of the knee joint (extension)

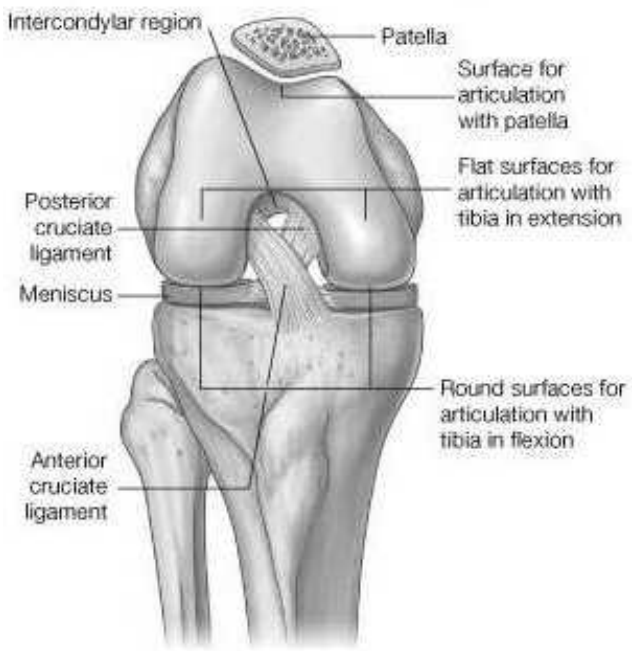


Figure No. 2: Anatomy of the knee joint (flexion)

Neurovascular elements include eight arteries that provide the major blood supply to the knee supreme genicular artery, medial and lateral superior genicular arteries, medial and lateral inferior genicular arteries, and middle genicular artery, anterior and posterior tibial recurrent arteries. These vessels are vulnerable to injury during meniscal excision and exposure of the posterior corners of the knee. The popliteal vessels are surprisingly close to the bone at the level of the tibial cut. A magnetic resonance imaging study has documented this distance as three to 12 mm in extension and nine to 15 mm in 90^0 flexion.

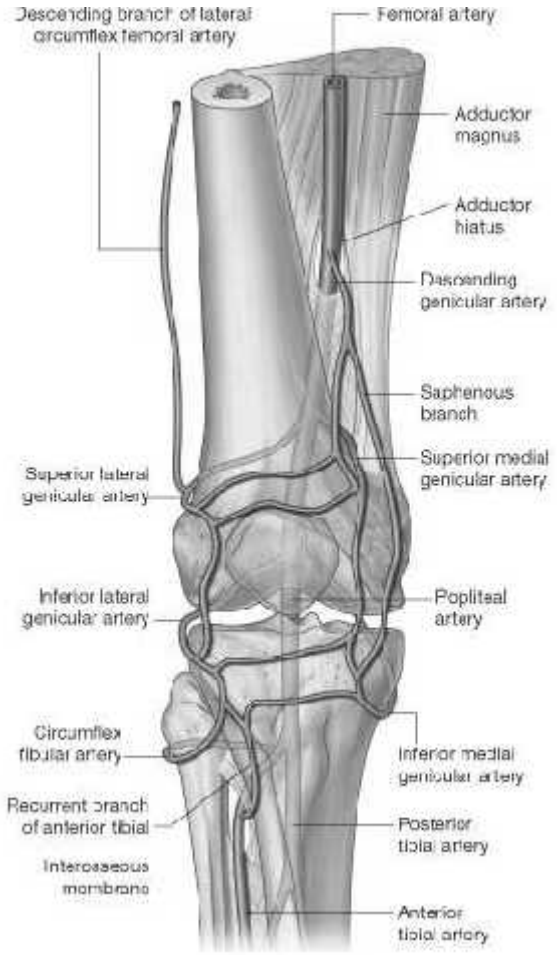


Figure No. 3: Blood supply of the knee

The patella is supplied by two systems of vessels: the midpatellar vessels penetrating the middle third of the anterior surface and the polar vessels entering the apex behind the patellar ligament. A vascular anastamotic ring surrounds the patella, with oblique branches converging on the anterior surface. The distal half of patella has a dual blood supply, but the upper half is supplied only the midpatellar vessels. The patella is susceptible to ischemia if these vessels are damaged. Excision of prepatellar fat pad and extensive lateral retinacular release during the TKA may result in devascularisation.[18]

Anterior and posterior groups of afferent nerve supply the knee. The anterior group includes branches of the femoral, common peroneal and saphenous nerves and articular afferents from the terminal portions of the nerve to the vastus medialis, vastus lateralis, and vastus intermedius. The lateral articular and recurrent peroneal nerves originate from the common peroneal supplying the lateral capsule and the collateral ligament. The primary articular afferent branch of the saphenous nerve is the infra patellar branch, which innervates the inferomedial capsule, the patellar tendon and the anterior skin. Transection of these branches with the medial skin incision may result in the bothersome numbness for the patient. The posterior group is composed of the posterior articular and obturator nerves. The posterior articular nerve is a branch of the posterior tibial nerve, and its fibers penetrate the oblique popliteal ligament and the posterior capsule. These fibers supply the capsule, peripheral menisci, cruciate ligaments and infra patellar fat pad.[20]

BIOMECHANICS OF THE KNEE

Knee motion during normal gait has been studied by many investigators, who have found it to be much more complex than simple flexion and extension. Knee motion occurs in flexion and extension, abduction and adduction and rotation about the long axis of the limb. Knee flexion, which occurs about a varying transverse axis, is a function of both the articular geometry of the knee and the ligamentous restraints. Failure to account for these complex knee motions and their attendant stresses was a short coming in many early knee prosthesis designs and probably is the main factor in the dismal longevity of pure hinged prostheses. Many current prostheses designs attempt to closely reproduce normal

knee kinematics, where as others settle for an approximation of normal motion, especially with regard to PCL function.

The tibiofemoral joint displays two degrees of freedom. The first degree of freedom allows movements of flexion and extension in the sagittal plane. The axis of rotation intersects the femoral condyle at an angle to the mechanical and anatomic axis. The optimal axis are fixed, where as the screw axis is instantaneous. The symmetric optimal axis is constrained in such a way that axis is the same for both right and left knees. The screw axis may sometimes but not always coincide with the optimal axis, depending on the motion of the knee joint. The second degree of freedom is axial rotation around the long axis of the tibia. There is an automatic axial rotation that is involuntarily linked to flexion and extension. When the knee is flexed, the tibia internally rotates. Conversely, when the knee is extended, the tibia externally rotates.

This coupled motion is called the screw-home mechanism. Several explanations have been given for this rotational movement. It has been suggested that the unequal curvature of the femoral condyles may cause this rotational movement because different degrees of rotation are required for the different bony geometry. Similarly, different anterior/posterior femoral condyle dimensions may be a cause. Soft tissue factors have also been cited. This may involve tightening of either or both the anterior and posterior cruciate ligaments. However, the most likely explanation is that the rotation is a combination of these factors.[18]

Tibiofemoral joint articulating surface motion is a planar motion of the two adjacent body segments and can be described by the concept of the instant center of motion. As one body segment rotates about the other, at any instant, there is a point that does not move. This point has zero velocity and acts as a center of rotation. This technique yields a description of motion at one point only and is not applicable if motion of 15^0 or greater exists in other planes. When the instantaneous center of rotation is at the contact point between the femur and tibia, the instantaneous velocity is zero and the tibia is rolling around the femoral surface. An understanding of the motion between the articulating surfaces of the knee joint is important for understanding causes of wear, instability and loosening of implants of the TKA. A study that analyzed the surface motion of the tibio femoral joint from 90^0 of flexion to full extension in 25 normal knees and thereby determined the instant center pathway found the pathway to be semicircular and located in the femoral condyle. The centers fall within a circle with a diameter of 2.3 cm. They recognized that the knee does not rotate on a single axis like a hinge, but rather the femoral condyles roll and glide on the tibia with a changing center of rotation. This concept is known as “femoral roll-back”. Knee articulating motion is a combination of gliding and rolling between the femoral and tibial surfaces. The ratio of rolling to gliding is not constant throughout the range of flexion and is controlled by both the anatomy of the joint surfaces and constraints imposed by the anterior and posterior cruciate ligaments.[21]

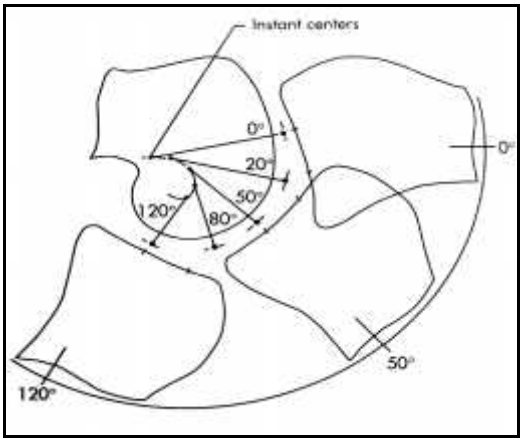


Figure No 4: Instant center of flexion and extension (rotation)

Authors of another study considered the rolling/gliding ratio to be controlled by the basic model of a crossed four-bar linkage. In this model, the tibial and femoral insertions of both cruciate ligaments are fixed to their respective surfaces and can be represented by two crossed bars. The cruciate bars are linked together at their attachments to the tibia and femur, and this link constitutes the two additional bars of the four-bar linkage. The four-bar crossed-link model guides the femoral and tibial surfaces past one another. The tibiofemoral contact point has been shown to move posteriorly as the knee is flexed, reflecting the coupling of ant/post motion with flexion/extension. During flexion, the weight–bearing surfaces move backward on the tibial plateaus and become progressively smaller. It has been shown that in an intact knee at full extension, the center of pressure is approximately 25 mm from the anterior edge of the knee joint line. This contact point moves posteriorly with flexion to approximately 38.5 mm from the anterior edge of the knee joint.[18]

The primary function of the patellofemoral joint is to increase the lever arm of the extensor mechanism about the knee thus increasing the efficiency of

the quadriceps contraction. The quadriceps and patellar tendons insert anteriorly on the patella, with the thickness of the patella displacing their force vectors away from the center of rotation of the knee. This displacement or lengthening of the extensor lever arm changes throughout the arc of the knee motion. The extensor lever arm is greatest at 20^0 of flexion and the quadriceps force required for knee extension increases significantly in last 20^0 of extension. As a consequence of its role in transmitting the force of contraction of the quadriceps muscle to the patellar tendon around a variably flexed knee, the patella experiences a joint reaction force as the trochlea opposes its posterior displacement. This joint reaction force depends on both the angle of knee flexion and the magnitude of the forces transmitted to the patella from the quadriceps and patellar tendons. During standing, the joint reaction force increases with increasing knee flexion as the force vectors of quadriceps and patellar tendons become more parallel to the joint reaction force. It has been calculated, patellofemoral joint reaction forces is of two to five times body weight during activities of daily living; during squatting to 120^0 of knee flexion, the joint reaction force may be as high as seven to eight times body weight. During knee flexion, the patella makes a rolling/gliding motion along the femoral articulating surface. Throughout the entire flexion range, the gliding motion is clockwise. The mean amount of patellar gliding for all knees is approximately 6.5 mm per 10^0 of flexion between zero degrees and 80^0 and 4.5 mm per 10^0 of flexion between 80^0 and 120^0.[22]

Stability of the knee

The constraints provided by the femoral and tibial joint surfaces are not adequate for functional stability. The distal femur is convex, where as the proximal tibia is partially flat, slightly concave medially and slightly convex laterally. However, the tibial intercondylar eminence and the articular geometry do provide some potential for stability. In a study it was found that geometric conformity of the condyles was the most important criterion for decreasing laxity under load bearing. They stated that in order to perform anterior/posterior, rotary and medial/lateral movements, the femur must ride upward on the tibial curvature. Similarly, to rotate the femur "screws out", giving an upward movement. Medial/lateral motion produces this effect to an even greater degree because of the tibial spines. This is called the "uphill principle". These authors concluded that under low loading conditions, the soft structures (ligaments, capsule and meniscus) provided joint stability and that as loading increases; the condylar surface conformity becomes the most important factor.[18,23]

The ligament structures are able to resist translational forces and thus prevent translation of their bony attachments if the translation takes place in the direction of ligament fibers. This principle is particularly relevant provision of anterior/posterior translational stability. A study has shown that the hamstrings provide an active restraint to anterior displacement in the tibia. This restraint indicates that muscle contraction contributes to the stability of the knee joint by increasing the stiffness of the joint. The collateral ligaments provide varus/valgus stability of the knee. The rotational forces are not resisted by the ligaments acting alone. Increased compressive force generated at the joint articular surface

produce a torque that resists the rotation movement. The importance of muscle forces contributing to knee joint stability in the frontal plane has been indicated by another study. At full knee extension the knee may be expected to show a balance of compressive forces between the medial and lateral compartments in response to axial loading.[18,24,25]

Forces across the knee joint

Understanding the loads across the knee joint is important for understanding knee prosthesis design and preference. The knee muscles are relatively inefficient because of small, effective moment arms compared with the externally applied forces and moments. This constraint requires muscles to contract at high forces to maintain joint equilibrium. Consequently, knee joint shear and contact forces are surprisingly high in magnitude.

Joint forces during stair ascent and descent are slightly higher than those used for walking. The forces increase during isokinetic exercise and in rising from chair and are greatest during downhill walking. Moreover, the peak forces during stair walking and exercise, either isokinetic or cycling, occurs at greater degrees of knee flexion.[26]

Historical aspects of development of knee prosthesis

The concept of improving knee joint function by modifying the articular surfaces has received attention since the 19th century. Gunston and Marmor were pioneers in North America. Marmor's design allowed for unicompartmental operations but these designs did not always last well. In the 1970s the "Geometric" design found favour as well as John Insall's Condylar Knee design.

Hinged knee replacements for salvage date back to Guepar but did not stand up to wear. The history of knee replacement is the story of continued innovation to try to limit the problems of wear, loosening and loss of range of motion.[27]

A study conducted in 1860 suggested the interposition of soft tissues to reconstruct the articular surface of a joint. Subsequently, pig bladder, nylon, fascia lata, prepatellar bursa and cellophane were some of the materials used for this purpose. The results were disappointing. [28]

In another study around the same time the researcher resected the entire knee joint, which resulted in mobility of the newly created subchondral surfaces. Encouraged by the relative success of hip cup arthroplasty.[29]

In 1940 the successful use of the metallic interposition femoral mold were reported but later results were found to be unsuccessful. A second line of development in knee arthroplasty occurred parallel to the concept of interposition arthroplasty and later surface replacement.[30]

Hinged prosthesis was developed in 1951, which was initially made of acrylic and later of metal.[31]

A similar device even with simpler mechanical characteristics was described in 1951. These designs were uncemented.[32] Later it was followed by the development of Guepar hinged prosthesis which was a cemented model with axis of rotation placed more posteriorly. Loosening and infection continued to be frequent as in previous hinged designs. More recent versions of hinged prosthesis have included the spherocentric knee and the kinematic Rotating Hinge and a

model that is a cross breed, the TCP (Total Condylar Prosthesis) III/Constrained Condylar Knee.[27]

A different type of hemiarthroplasty was described in 1958 for treating painful varus or valgus deformities of the knee.[33]

Acrylic tibial plateau prosthesis was inserted into the affected side to correct deformity, restore stability and relive pain. Later versions of this prosthesis were made of metal and somewhat similar to Mckeever's prosthesis.[34] Surgeons at St. George's hospital in Hamburg in 1971 had designed a sledge type of prosthesis. In 1970 at Hospital for Special Surgery, a duo-condylar and uni-condylar devices with low conformity and anatomic geometry to allow laxity and freedom of motion and with curved condylar shapes to reduce bone resection was developed.[35]

Working with Charnley, another author in 1971 designed and documented encouraging results with a polycentric knee arthroplasty.[21]

Experience with the Imperial College London Hospital prosthesis developing as "roller-in-trough" design was reported in 1972.[36]

In 1972, researchers developed a Geometric knee, which was conforming and provided stability which required preservation of the both cruciate ligaments.[37]

A modular knee for uni and bi compartment replacement was designed and work was published in 1979.[38]

The TCP was designed in 1974.[35] In 1993 the authors stated that the original cemented TCP has set the standard for the survivorship by which other knee replacements are currently measured. They reported a prosthetic survivorship of 94% at 15 year follow up.[39] Because of short comings of the TCP in terms of range of movement and posterior subluxation, the Insall-Burstein PCL substituting or posterior stabilized design was developed in 1978 by adding a central cam mechanism to the articular surface geometry of the TCP.[40] Concurrently with the development of PCL sacrificing TCP prosthesis, the Duo Patellar Prosthesis was developed as a derivative of Duo Condylar prosthesis. The sagittal plane contour of the femoral component was anatomical with the anterior bridge of Duo Condylar prosthesis enlarged to form an anterior flange for patella articulation. Originally the medial and lateral tibial plateau components were separate, but this was soon revised to a one piece tibial component with a cut out for PCL retention. The Duo Patellar evolved into kinematic prosthesis.[16,27,41]

Biomechanics of total knee arthroplasty

Longitudinal and rotational alignment of knee

Numerous studies have shown a correlation between long term success of TKA and restoration of near- normal limb alignment. Malalignment of total knee prostheses has been implicated in long term difficulties including femoro-tibial instability, patellofemoral instability, patella fracture, stiffness, accelerated polyethylene wear and implant loosening.

An important advance in total knee surgery has been the recognition of the need to implant well-aligned prostheses and the development of accurate instrumentation necessary to do so.

Normally the anatomical axis of the femur and the tibia form a valgus angle of six degrees ± two degrees. The mechanical axis of the lower limb is defined as the line drawn on standing long leg anterioposterior (AP) roentgenograms from the center of the femoral head to the center of the talar dome .This mechanical axis typically should project through the center of the knee joint, described as a "neutral" mechanical axis. During normal gait, the mechanical axis is inclined three degrees from the vertical axis of the body, with the feet closer to the middle line than the hips. When the mechanical axis lies to the lateral side of the knee center, the knee is in mechanical valgus alignment. In mechanical varus alignment, the mechanical axis of the limb lies to the medial side of the knee center. The amount of varus or valgus deformity can be determined on the AP roentgenogram by first drawing the mechanical axis of the femur, a line from the center of the femoral head to the center of the intercondylar notch, and extending this line distally. The mechanical axis of the tibia runs from the center of the tibial plateau to the center of the tibial plafond, thus accounting for any bowing of the tibia. The angle formed between these separate mechanical axis of the femur and tibia determines the varus or valgus deviation from the neutral mechanical axis. By determining the tibial mechanical axis using the center of the tibial plateau and the femoral mechanical axis using the center of the intercondylar notch, any medial or lateral subluxation through the knee joint is disregarded. It was argued that rotation affects the mechanical axis of the femur

apparent on the AP roentgenogram, thus lessening the value of these pre operative measurements.[27,42]

In a normal knee, the tibial articular surface is in approximately three degree of varus with respect to the mechanical axis, and the femoral articular surface is in a corresponding nine degrees of valgus. It was argued that the total knee components should be placed in these anatomical amounts of varus and valgus alignment.[43] However multiple studies have demonstrated that tibial components placed in more than five degrees of varus tend to fail by subsiding into more varus. Because the accuracy of the tibial component alignment has been demonstrated to be in the range of ± three degrees the concept of an anatomical three degrees varus tibial cut has largely been abandoned to prevent varus malalignment and early failure. Tibial components are generally implanted perpendicular to the mechanical axis of the tibia in the coronal plane, with varying amounts of posterior tilt in the sagittal plane depending on the articular design of the component to be implanted. The femoral component is usually implanted in five to seven degrees of valgus, the amount necessary to re-establish a neutral mechanical axis of the limb.[44,45]

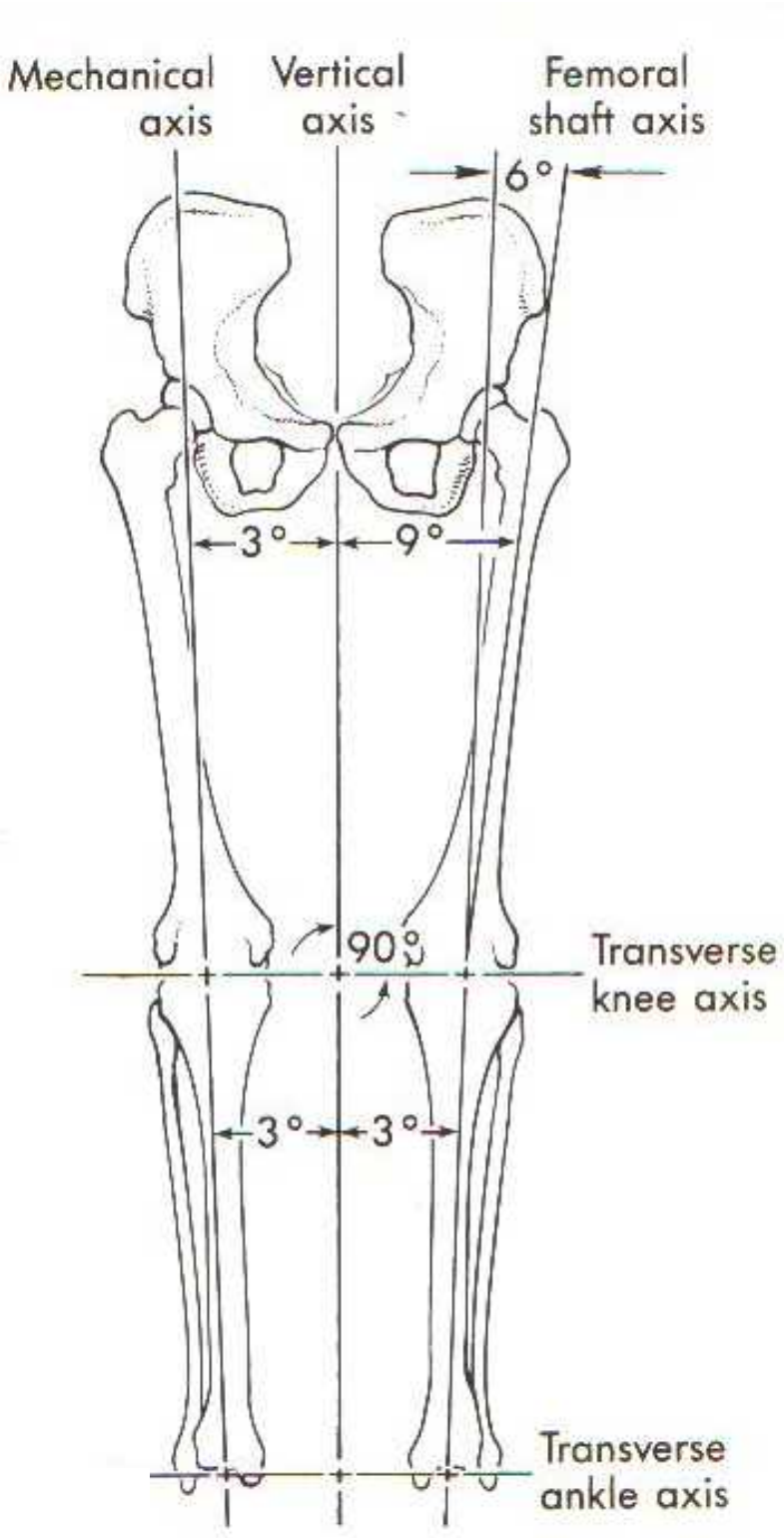


Figure No 5: Lower extremity axial alignment

Rotational alignment of the total knee components is difficult to discern roentgenographically, making the assessment of rotation primarily an intra-operative determination. Because of the proximal tibial cut is performed perpendicular to the mechanical axis of the limb instead of in the anatomically correct three degree of varus, rotation of the femoral component also must be altered from its anatomical position. To obtain a rectangular flexion space, with equal tension on the medial and the lateral collateral ligaments, the femoral components must be externally rotated approximately three degree. This can be accomplished by rotating the femoral component three degree relative to the posterior condylar axis, as is done in the measured resection technique. This slight external rotation also can be accomplished by making the anterior and posterior femoral cuts parallel to the cut surface of the tibia with the collateral ligaments under equal tension in 90^0 of knee flexion, and is done in the flexion-extension gap technique. These two techniques are distinctly different: rotational alignment in the measured resection technique is based on bony landmarks and in the flexion–extension gap technique is based on ligamentous tensioning in flexion. Both techniques require some modification and judgment in knees with significant deformity caused by posterior femoral bone deficiency, ligamentous contracture or laxity. Both techniques can be used concurrently for more difficult knee reconstruction.

Authors have pointed out that the “normal” angle of varus is variable due to anatomic factors such as pelvic width, femoral neck varus, femoral and tibial bowing and femoral length. Because of this arrangement, the distribution of body weight when standing is more medial than lateral in each knee. [26]

Dynamic alignment

During normal walking, the center of gravity of the body moves toward the supporting leg during each gait cycle. However, the distribution of contact forces across the knee joint is not symmetric; it is estimated that between 60% and 75% of these forces are carried by the medial compartment of the knee.

It was noted that during normal walking, a greater medial load than would be predicted is observed because of the laterally directed ground reaction force. The forces do not rest on a perpendicular tibial plateau; the anatomic tibial plateau is sloped five to 10^0 posteriorly and distally. However, when the menisci are taken into account, tibial plateaus are not posteriorly sloped; only the bony surfaces give the appearance of posterior slope. Furthermore, the medial tibial subchondral bone is concave "dished" relative to the more convex lateral tibial subchondral surface. Combined with the three degree angle of the tibial anatomic axis relative to the transverse knee axis, a varus moment is imparted during normal gait. This lateral "thrust" is resisted by the lateral stabilizing force arising from the lateral collateral ligament, the cruciate ligaments, the ligamentum patellae and the ilio-tibial band.[25]

Patellofemoral Joint

It is well known that the patello-femoral joint reaction forces increases drastically during activities of daily living particularly during squatting. These forces in the knee are resisted by thick articular cartilage in the normal knee, but they may exceed the yield strength of polyethylene, leading to deformation of polyethylene patella components over time.

In a study conducted in 1988, the authors have described variations in the area of contact between the patella and the trochlea during knee flexion. The inferior articular surface of the patella first contacts the trochlea in approximately 20^0 of knee flexion. The midportion of the patella articulates with the trochlea in approximately 60^0 of flexion and the superior portion of the patella articulates at 90^0 of flexion. In extreme flexion, beyond 120^0, the patella articulates only medially and laterally with the femoral condyles and the quadriceps tendon articulates with the trochlea.[23,24,42]

Patellofemoral contact zones

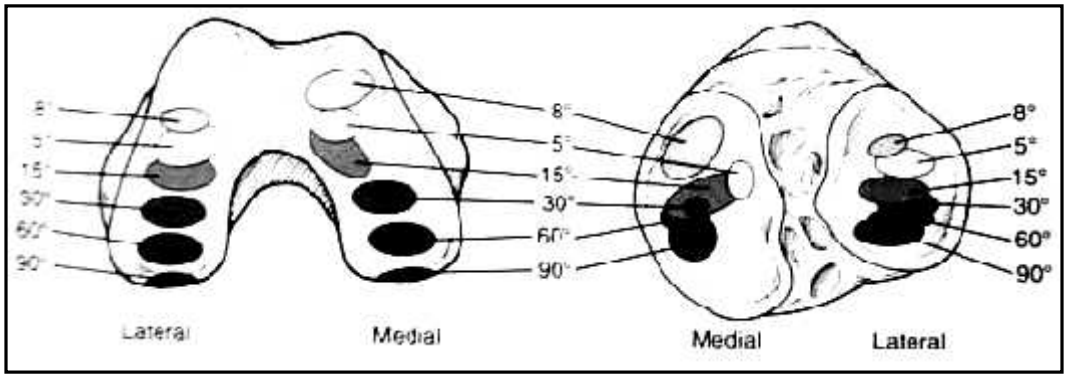


Figure No. 6: Patellofemoral contact zones

These relationships may be altered in knee arthroplasty with nonanatomical patellofemoral geometry, variations in the joint line relative to the tibial tubercle and patella infera from patellar tendon contracture.

In another study it was found that elevation of joint line of more than eight mm caused patello femoral pain and limited overall range of motion and predisposed to late patella fracture. Patella baja, a vertical distance of less than 10 mm between joint line and bottom edge of the patellar component, also correlated

with patellofemoral symptoms. Changes in the patellar area of contact with flexion have a significant impact on the prosthetic patellofemoral joint. Eccentric loading of the patellofemoral joint leads to shear forces within the patellar component and at the prosthesis-bone interface. Even if the medial-lateral geometry of the patellofemoral articulation is perfectly conforming, the inferior-to-superior migration of the area of contract on the patella with increasing knee flexion leads to eccentric forces on the polyethylene patellar component. These forces may lead to failure of metal-backed patellar components, localized polyethylene wear or component loosening.[23]

Patellofemoral stability is maintained by a combination of the articular surface geometry and soft tissue restraints. The Q-angle is the angle between the extended anatomical axis of the femur and the line between the center of the patella and tibial tubercle. The quadriceps acts primarily in line with the anatomical axis of the femur, with exceptions of the vastus medialis obliqus, which acts to medialize the patella in terminal extension. Limbs with larger Q angle have a greater tendency to lateral patellar subluxation. Because the patella does not contact the trochlea in early flexion, lateral subluxation of the patella in this range is resisted primarily by the vastus medialis obliqus fibers. As the angle of flexion increases, the bony constraints play a dominant role in preventing subluxation. Prosthetic alignment and position, pre-op rotational and angular deformity and operative soft tissue balancing all have significant effects on patellofemoral tracking.[27]

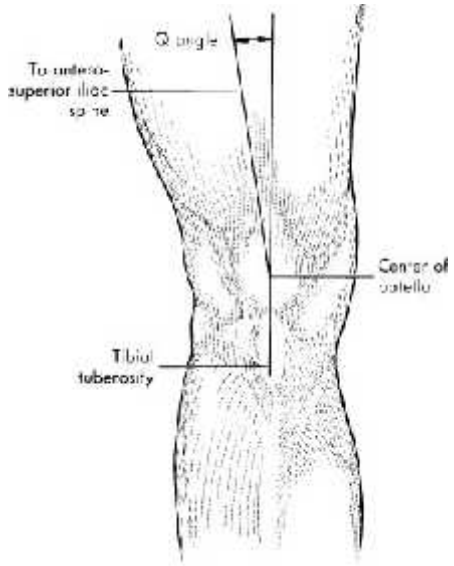


Figure No. 7: Q Angle

Patellofemoral tracking

Patellofemoral tracking is affected by multiple factors, each of which must be inspected during trial reduction and before final component implantation. Any factor that increases the Q angle of the extensor mechanism can cause lateral maltracking of the patella. Internal rotation of the tibial component lateralizes the tibial tubercle increasing the Q-angle and the tendency to lateral patella subluxation. Similarly, internal rotation or medial translation of the femoral component can increase lateral patellar subluxation by moving the trochlea more medial. If the patella is to be resurfaced, the prosthetic patella should be medialized to approximate the median eminence of the normal patella, rather than simply centering the prosthetic button on the available bone. Centralization of the patellar component requires the bony patella to track more medial, which forces it to function with a higher Q-angle. Increasing the anterior displacement of the

patella during knee motion also can lead to patella instability or limited flexion. Anterior displacement can be caused by placing the trochlea too far anterior with an over sized femoral component or by under resection of the patella before resurfacing, which results in an overall increase in patellar thickness after resurfacing.[23,27]

PRINCIPLES OF TOTAL KNEE ARTHROPLASTY

The principles of TKA include

a) Proper instrumentation and familiarity with its usage.
b) Minimal removal of the tibial plateau at right angles to the long axis of the tibia.
c) Femoral cuts at right angles to the mechanical axis.
d) Maintenance of soft tissue envelope, especially the medial and lateral collateral ligaments, posterior capsule and ilio-tibial band at equal tension both in flexion and extension – providing static stability to the joint and equal flexion and extension gaps.
e) Provision of dynamic stability by the quadriceps, hamstrings and gastrocnemius muscles.
f) Re-alignment of quadriceps mechanism for stability of the patella and its proper excursion.

Arguments for cruciate excision

Correction of deformity: Correction of fixed varus, valgus, flexion contracture and mixed combination of deformities is facilitated by excision of cruciate ligaments.

Simpler technique

Facilitates surgical exposure, especially in tight knees and also making it easier to make correct bone cuts and obtain accurate placement of prosthesis.

Reduces wear

Allows use of a more conforming articulation, which increases contact area and reduces contact stresses.

Arguments against cruciate excision

Decreased range of motion

Without a functional PCL or PCL substituting mechanism femoral rollback does not occur thus limiting the ultimate flexion.

Instability

Failure to obtain flexion and extension balance can result in anterior-posterior laxity that may exceed the stability imparted by the moderately conforming articulating surfaces. The increased conformity of articulating surfaces used in the TCP theoretically results in increased stress at the bone-cement interface.

Design goals

In broad terms, the design goals of any knee replacement are;

- Relief of pain.
- Unlimited functional ability.

- Durability for the life of the patient.
- Reproducibility in the operating room.
- Low cost.

The TKA designs can be classified into cruciate-retaining, cruciate-sacrificing, cruciate-substituting, constrained condylar and hinged designs.

Cruciate sacrificing designs compensate for the absence of the PCL by cupping up of the tibial component, which increases the articular conformity to reduce translation and rotation during knee flexion.

Cruciate retaining designs rely on the integrity of the collateral and PCL; require less conforming articular surfaces to allow proper ligament function during knee range of motion.

Posterior stabilized designs evolved from the cruciate sacrificing components with the addition of a tibial post and femoral housing mechanism to prevent posterior subluxation. Posterior stabilized prostheses require the presence of competent collateral ligaments and should not be regarded as a constrained design, which also provides medial- lateral stability.

Constrained condylar prostheses with added height and conformity of the poly ethylene tibial spine and the femoral housing render medial-lateral stability and are used primarily in complex arthroplasties with compromised or absent collateral ligaments.

Hinged designs provide the most inherent stability but have an increased incidence of complications, including mechanical loosening. Hinged components

are used for unique situations such as tumor excision necessitating resection of the collateral ligaments.

The most important of the design objectives are the following: A salvage procedure should be readily available. The implantation of the prosthesis should require the removal of no more bone than for primary arthrodesis and should leave large, flat surfaces of cancellous bone. The chances of loosening should be minimized.

The femoral and tibial components should be incompletely constrained relative to each other so that twisting, varus or valgus moments cannot be transmitted to the bonds between prostheses and the skeleton. The friction between the components should be minimized. Any hyper-extension limiting arrangement should be progressive and not sudden in action. The prosthetic component should be fitted to the bone by means that spread the loads over the largest possible areas of the bone prostheses interface.

The rate of production of wear debris should be minimized and the debris produced should be as innocuous as possible. This leads to a preference for metal on plastic bearing surfaces, which should be as large as possible to keep the surface stresses low. The probability of infection should be minimized by having compact prosthetic components with few dead spaces. The consequences of infection should be minimized by avoiding long intramedullary stems and intramedullary cement. A standard insertion procedure should be available. The prostheses should give motion from five degrees of hyper extension to at least 90^0 of flexion. Some freedom of rotation should be resisted. Excessive movements in

any direction should be resisted by the soft tissues, particularly the collateral ligaments.[22,40]

CURRENT REPLACEMENT DESIGNS

The TCP has led to a series of posterior stabilized design.[40] The Duo Patellar prosthesis evolved into kinematic I and II and the press fit condylar knee. Among the cementless designs the first was the porous coated anatomic I[46] and the other examples of this type are porous coated anatomic II, the Miller Galante,[47] the Miller Galante II, Tricon M, Genesis and Ortholoc. Cementless prosthesis has all been PCL retaining designs with very unconstrained surfaces (either flat on flat or curved on flat to minimize fixation stresses that might interfere with bone in growth). The Freeman – Swanson prosthesis has been modified into the Freeman – Samuelson prosthesis, still using serrated poly ethylene pegs for cementless fixation but now offering a metal based plate with intramedullary rods for the tibia and femoral components. Of the meniscal weight bearing designs concerns exists regarding the long term durability of fixed bearing prosthesis in younger more demanding patients, especially regarding problems related to poly ethylene wear and osteolysis. A mobile bearing prosthesis seems to be the plausible solution to this problem because it eliminates the relationship between articular conformity and freedom of rotation that exists in fixed bearing prosthesis, as rotation occurs at the interface between the superior surface of the tibial base plate and the inferior surface of the poly ethylene insert.[41,42,48,49]

Oxford knee was developed in 1976, a bicondylar knee replacement featuring a single sagittal radius of curvature on the femoral condyles that mate with totally congruent tibial poly ethylene inserts or "menisci" that are free to move on a polished metal tibial base plate. Thus the menisci articulate both with the femoral condyles and the tibial base plate. Stability is provided by the intact cruciate and collateral ligaments. Posterior extrusion of poly ethylene was a complication seen with this design.[50]

The total knee experience at a hospital in Baltimore with the universal instruments and TCP and kinematic prosthesis in 1978 and 1979 and with the PCA prosthesis with and without cement since 1980 has led to the development of philosophy that impacts on all aspects of TKA. Of Seventy one knees were operated on patients with osteoarthritis. Forty five knees were cemented and twenty six were uncemented on observation post surgically there were no differences in clinical results in two series with overall results of sixty five (excellent), four (fair), two (poor).[27]

Functional outcome measures in the effectiveness of total knee arthroplasty

The most commonly used functional measures were the KSS and the HSS. The WOMAC has only been used since 1991. The physical function component of the SF-36 is a generic functional outcomes measure, not specific to knees.

The KSS is associated with longer followup periods, perhaps because it was in use earlier. For example, weighting for baseline patients the mean followup for KSS and HSS is 66 and 67 months, compared to 45 months for

WOMAC. However, weighting for baseline knees, KSS has a mean followup of 90 months and WOMAC is 68 months, but HSS is only 61 months. The longest mean followup time was 90 months (KSS scores weighted for baseline knees), well less than the 10 years that has been suggested in order to evaluate long term functional results. Only ten studies had a followup time of at least 10 years.

Some information on attrition rate was reported for 49 studies. Of these the median percentage of subjects lost to followup was two percent, the range was zero to 28%. If death is added to the definition, the range increases to zero to 56% with a median of 12%. Although there is no formal basis for translating the size of the scores, the generally accepted rule of thumb for the KSS and HSS scales is that a score of less than 60 is considered poor; 60 to 69 represents a fair result; 70 to 84 is considered a good result; 85 to 100 is considered an excellent result.[51,52]

The knee society roentgenographic evaluation was developed for uniform reporting of roentgenographic results of TKA so comparison could not only be done between institutions but also different implants. The system is easy to use, fast and is on one sheet of paper. The dual rating system eliminates the problem of declining knee scores associated with patient infirmity.[52,53]

From 1979 to 1984, eighty patients (119 Knees) were arbitrarily selected for treatment with knee arthroplasty in which a PCL-substituting Replacement was used. The average age of the forty-nine women and thirty-one men was 66.9 years (range, Twenty-two to eighty-four years). Sixty-one right and 58 left knees were operated on, and bilateral replacement was performed in 39 of the 80

patients. The diagnosis was osteoarthritis in 58 patients (88 knees), rheumatoid arthritis in 14 patients (22 knees), osteonecrosis in three patients (four knees) and traumatic arthritis secondary to a fracture of the tibia or femur in five patients (five knees). The average preoperative score on the hospital for special surgery knee-rating scale was 47.5 Points and the average range of motion preoperatively was 88^0 (range, 30 to 140^0). Of the 119 knees, 87 had a varus alignment (maximum, 30^0) and thirty-two, a valgus alignment (maximum, 35^0) before knee replacement.

After follow-up of two to eight years, the average score on the hospital for special surgery scale was 90 Points, and the average range of motion was 107^0. Of the 119 knees, 83% were rated as excellent; 15%, as good; none, as fair; and two percent, as poor. Radiolucencies of one millimeter were present in 76% of the knees; of two millimeters, in seven percent; and of three millimeters, in three percent. No statistically significant correlation between Radiolucencies and the clinical result was found. The results in knees of patients who had rheumatoid arthritis were not as good as those in knees of patients who had other diagnoses (f = 11.44). Our experience suggested that the PCL substituting design provides more motion than do the cruciate-sacrificing surface-replacement designs, with no deleterious effects.[6]

Twenty seven knees treated between 1974 and 1980 had a TCP type knee arthroplasty without patellar resurfacing; the average follow-up period was 5.2 years. Compared with a previously reported group of 100 consecutive TCP arthroplasties, the overall results in this series were very similar. However, there was a significant difference in stair climbing ability, and one-third of the patients

could not use the operated knee for this activity. In most knees the patella could be resurfaced. A working hypothesis assumes that the patellar button can be omitted in (a) patients with relatively normal patellar cartilage, or (b) relatively young, active, or obese patients. One hundred TKA with a TCP and without patellar resurfacing were followed for minimum of two years. 84% of the knees were affected by osteoarthritis. There were 18 excellent, 53 good, 18 fair and 11 poor results.

At the most recent follow up, 29 knees, nine of which were affected by RA, were still painful in the patellofemoral area. The height and weight of the person definitely influenced the amount of patellofemoral pain postoperatively. The small patients who had osteoarthritis were exceptionally free of pain, regardless of sex, age or level of activity. It seems that the best approach to patellofemoral replacement includes resurfacing of the patella in all patients who have rheumatoid arthritis and in patients who have osteoarthrosis if they have preoperative patellofemoral pain or more than 160 cm tall, weigh more than 60 kgs, and have advanced changes in patella at the time of operation.[54]

TKA was found to be associated with substantial functional improvement, with the effect sizes varying with the measure that was used. Physician-derived measures showed effect sizes of 2.35 and 3.91, whereas patient-derived measures showed smaller effect sizes.[51]

The percentage of knees with a KSS of more than or equal to 80 points at an average of eighty months was 88% in the obese group, which was significantly lower than the 99% rate in the non obese group at the same time. The morbidly

obese subgroup had a significantly higher revision rate than did the non-obese group ($p = 0.02$). The results of the study suggest that any degree of obesity, defined as a body mass index of more than or equal 30, has a negative effect on the outcome of TKA.[55]

The knee society pain and function scores had moderate-to-strong correlations with the corresponding pain and function domains of the WOMAC and SF-36 ($r = 0.31$ to 0.72). Measurement of the standardized response mean showed the KSS to be more responsive (standardized response mean, 2.2) than the WOMAC (standardized response means, 2.0 for pain and 1.4 for function) and the SF-36 (standardized response means, 1.0 for bodily pain and 1.1 for physical functioning).The mean modified knee society clinical score improved from 30 points preoperatively to 93 points postoperatively, and the mean functional score improved from 34 to 81 points. The mean range of motion was 110° both preoperatively and postoperatively. The mean coronal alignment was corrected from 15° of valgus preoperatively to five degrees of valgus postoperatively. Three patients underwent revision surgery because of delayed infection, premature polyethylene wear, and patellar loosening in one patient each. There were no cases of delayed instability.[15]

The inside-out release technique to correct a fixed valgus deformity in patients undergoing primary TKA is reproducible and provides excellent long-term results.[56]

The mean knee society function score was 65 and the mean clinical score was 89. The overall survival rate of the knee was 91.5% with revision for any

reason as the end point and 97.2% with aseptic loosening as the end point. The rate of revision of the tibial insert because of wear-related aseptic loosening was 2.5%. We found no relationship between revision and the shelf life or method of sterilization of the polyethylene insert. Radiolucent lines were present in 62% (21) of 34 knees; all radiolucent lines were nonprogressive. None of the implants were loose according to the criteria of the knee society. This long-term analysis indicates that the press-fit condylar total knee implant is a successful implant system with excellent longevity.[57]

At a minimum two year follow-up, TKA with patellar resurfacing had significantly lower KSS (Mann Whitney u test; p = 0.036). TKA with patellar resurfacing exhibited a greater degree of knee flexion contracture (Mann-Whitney u test; p = 0.020) and significantly less knee extension at heelstrike during walking in those subjects undergoing gait analysis (independent t-test; p = 0.013). The presence of a knee flexion contracture was a significant predictor of post-surgery anterior knee pain (exp [beta] = 4.1, CI: 1.1 to 14.9, p = 0.033). Post-surgery knee society function scores and patellar function scores were significantly better in those patients with TKA without patellar resurfacing (Mann-Whitney test; p = 0.031 and 0.017 respectively).[58]

Knee scores were higher in patients with diabetes preoperatively (47 versus 38) and postoperatively up to seven years (80 versus 75). The average preoperative and postoperative pain scores also were higher in patients with diabetes. Four deep infections (1.2%) occurred in patients with diabetes versus 35 deep infections (0.7%) in patients without diabetes. The revision rate (including infections) was greater in patients with diabetes (3.6% versus 0.4 %). Knee and

pain scores were similar in patients with insulin-dependent and noninsulin-dependent diabetes. Postoperative function scores, however, were lower in patients with insulin-dependent diabetes. In the study group, all deep infections occurred in patients with insulin-dependent diabetes.[59]

A study on navigated knee replacement conducted in 2007 found that Navigated knee replacement provides few advantages over conventional surgery on the basis of radiographic end points.[60]

Complications following knee replacement

Early complications

1. Infection

Infection remains one of the most dreaded complication affecting TKA patients.[27]

Risk factors

a. Rheumatoid arthritis
b. Diabetes
c. Psoriasis
d. Steroid therapy
e. Revision TKA
f. Previous infection
g. Obesity
h. Malignancy

Predominantly two types

a. Early inoculation during surgery seen within six months. May be superficial or deep. Only 20% respond to antibiotic therapy. Re-exploration with thorough debridement and wash and change of plastic component may improve the success rate of joint salvage 50%.

b. Late infection usually haematogenous route. Antibiotics have no role. May be treated with;
   - Re-implantation of prosthesis under antibiotic cover one stage or two staged.
   - Resection arthroplasty and permanent use of orthosis.
   - Arthrodesis (70% fusion rate).

2. Deep vein thrombosis (DVT) (40 to 84% without prophylaxis)[27]

Symptomatic pulmonary embolism in half to three percent[27]

Various treatment modalities suggested;

a. Mechanical calf pumps, foot pumps, stockinette, active mobilization.

b. Chemical: Heparin and its derivatives. No anticoagulation prophylaxis required unless increased risk as indicated by history of oestrogen use, previous history of thromboembolism, elderly, cardiovascular risk such as a known case of congestive cardiac failure, hypertension or myocardial infarction, stroke, nephritic syndrome, cancer, varicose veins, indwelling femoral vein catheter, obesity, smoking.

3. Skin problems

Common skin problems encountered are marginal necrosis at wound edges, extensive sloughing of wound, partial healing with a sinus formation, collection of haematoma within. Meticulous technique and essentially gentle handling of the skin flaps, proper haemostasis and minimum use of diathermy can usually prevent all these.

4. Joint instability

Direct sequelae of technical error during the soft tissue balancing and improper choice of implant.

5. Fractures

Intra operative and postoperative periprosthetic fractures are not uncommon. Reported risk factors include anterior femoral notching, osteoporosis, rheumatoid arthritis, revision arthroplasty.[61,62]

6. Patello femoral complications

- Patellar fractures.
- Patellar component failure.
- Patellar component loosening.
- Patellar clunk syndrome.
- Extensor mechanism rupture (usually the patellar tendon).

- Polyethylene wear increased pressure due to maltracking metal backing poor quality of polyethylene.
- Infra patellar scarring, scar tissue impingement.

These problems have led many surgeons to advocate TKA without patellar resurfacing for patients with osteoarthritis and adequate patellar cartilage. To avoid replacement thickness of the remaining patella and the implant should be equal to the pre replacement thickness of entire patella.[63]

Delayed complications

These are seen after a few months to years after TKA and include ;

1. Delayed infection: Management is essentially the same as in acute infection.
2. Delayed patellofemoral problems especially retropatellar and anterior pain.
3. Aseptic loosening.
4. Wear and deformation usually micro particular and leads to loosening.
5. Component breakage.

Assessment of the last two complications can be difficult of X-rays alone and the management essentially amounts to revision.[27]

Rare complications

1. Arterial thrombosis after TKA: A rate but devastating complications, frequently requiring amputation. Doppler studies unreliable and

arteriogram and transcutaneous oxygen measurements may be more reliable as indicators. Performing TKA without tourniquet in patients with significant vascular disease is one method to prevent this.[64,65]

2. Peroneal nerve palsy: Common after correction of fixed valgus – flexion deformities in rheumatoid arthritis (1.8%). Usually recovers spontaneously.[66]

METHODOLOGY

The present study was conducted in the Department of Orthopaedics, KLES Dr. Prabhakar Kore Hospital and Medical Research Centre, Belgaum on patients with osteoarthritis.

Study design

One year descriptive study

Method of data collection

Source of data

Patients operated for total knee replacement in Department of Orthopedics, KLES Dr. Prabhakar Kore Hospital and Medical Research Center, Belgaum, Karnataka between December 2006 to November 2007 were selected as study population.

Sample Size

Twenty male and female patients with osteoarthritis who were undergoing unilateral total knee replacement were selected for the study.

Sampling procedure

The sample size was calculated considering 80% of average cases undergoing total knee replacement at KLES Dr. Prabhakar Kore Hospital and Medical Research Centre, Belgaum Karnataka over a period of last three years.

Selection criteria

Inclusion criteria

- Patients with a confirmed clinical and radiological diagnosis of osteoarthritis.
- Those patients undergoing TKA and willing to participate in the study.

Exclusion criteria

The study would exclude all the patients of knee arthritis caused by;

1. Infection
2. Neuropathic joint disorders like charcot's disease.
3. Psychogenic arthritis.
4. Patients with failure of a high tibial or supracondylar osteotomy,
5. Absence of sufficient neuromuscular control of hamstrings or quadriceps musculature.
6. Patients unwilling to participate in the study.

Procedure

Patients undergoing total knee replacement in the Department of Orthopaedics at KLES Dr. Prabhakar Kore Hospital and Medical Research Centre, Belgaum with osteoarthritis were evaluated and selected by detailed medical history and physical examination. The study was approved by the Ethical and Research Committee of Jawaharlal Nehru Medical College, Belgaum.

After finding the suitability as per inclusion and exclusion criteria they were selected for the study and briefed about the nature of the study, the

interventions used and written informed consent was obtained (Annexure–I). The consented patients were enrolled in the present study. Further, descriptive data of the participants like name, age, sex, detailed history, were obtained by interviewing the participants and clinical examination and necessary investigations were recorded on predesigned and pretested proforma (Annexure-II).

Pre operative evaluation

- History
- Clinical examination
- Laboratory investigations
- Radiological

Clinical assessment

Detailed history and proper clinical examination is essential to find out: Duration of illness, focus of infection in the body, sensory motor examination, vascularity of limb, ambulatory status of the patient, deformities of the knee, range of motion of the knee and status of the other joints.

Laboratory investigations

- Complete blood count
- Mini-renal
- Urine analysis
- Electrocardiogram
- Blood sugar level.

Radiological assessment

Standing AP view of the knee was taken:

- To assess the collateral ligament laxity or subluxation of tibia if present.
- To see for the presence of the medial and lateral osteophytes.
- Other information can also be obtained about bony defects in tibia and femur, medio-lateral sizing of the femoral and tibial components, level of tibial cut, quality of bone and also to see the curvature of the tibia.

Supine lateral view of the knee was taken

Look for osteophytes (patellar, femoral and tibial), AP sizing of the tibial and femoral components and anterior curvature of the femur.

Surgical technique:

This basic surgical technique includes the midline skin incision and medial parapatellar retinacular approach gives a wide exposure of the knee and facilitates lateral dislocation of the patella. Anterior cruciate ligament, PCL and both the menisci were removed. Ligament balancing was performed prior to bone resection by release of the contracted soft tissues on the concave side of any fixed angular deformity. In the knee with varus deformity, this release was performed distally by recession of the capsular flap consisting of the tibial insertion of the superficial collateral ligament, the deep collateral ligament and at times, the pes anserinus tendon.

It is possible to correct relatively minor flexion contractures by removal of more bone, but when a contracture is severe (45^0 or more) it is advisable to divide

the posterior capsule transversely. The median or central part of the capsule was removed with the cruciate ligaments and the remainder was cut until the muscle fibers of the gastrocnemius were seen. The appropriate ligament and soft-tissue releases were done before beginning the bone cuts. Soft tissue balancing is of utmost importance for the success of a TKA.

The bone cuts were performed using provided standard jigs and cutting blocks in the order of tibial cut at 90^0 to the long axis and less than seven degree of posterior sloping and sizing, distal femoral cut at five degree valgus to the anatomical axis and perpendicularly in sagittal plane, anterior-posterior and chamfer cuts, femoral notch cut and peg holes, tibial notch cut, trial reduction and final seating and final component fixation with cement. Tibial cuts were made prior to femoral cuts. Flexion and extention gaps were measured at regular intervals to access the balancing. Patellar resurfacing was done in cases with grossly eburnated patella and patelloplasty in rest of them.

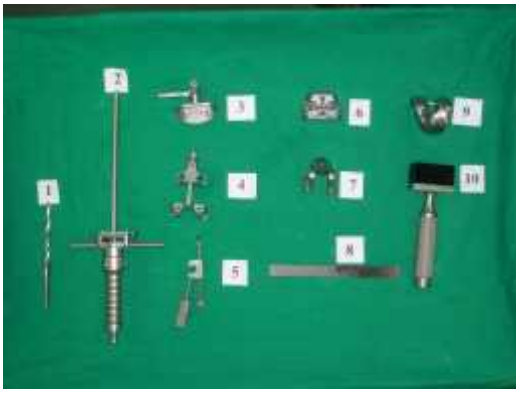
Patellaplasty consists of;

- Osteophyte removal to allow better seating of patella on the trochlear groove of the femoral component.
- Patellar rim cautery to provide denervation.
- Division of patello femoral ligament when it was tight.
- Soft tissue release from the lateral patella to avoid maltracking.

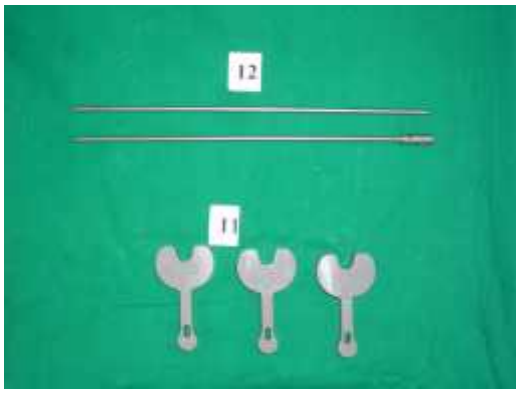
This was followed by final check of tracking and closure in layers.

Instrumentation assembly

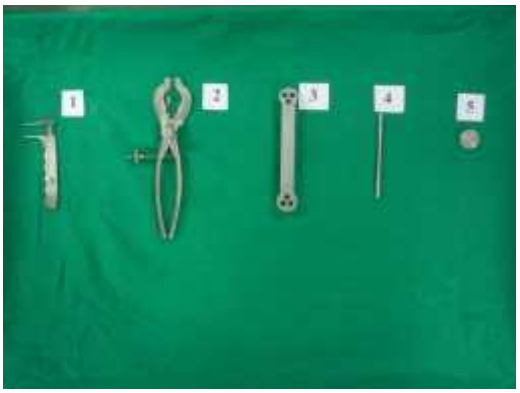
Photograph No. 1:
Tibial preparation assembly



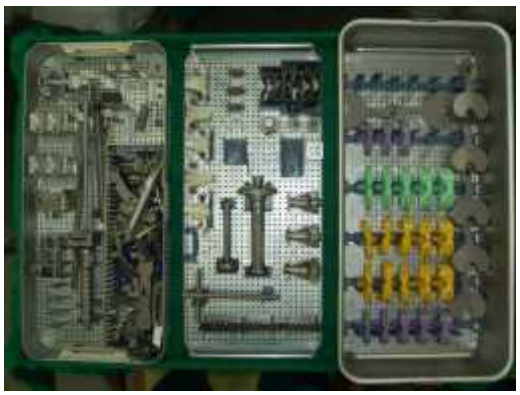
Photograph No. 2:
Femur preparation assembly



Photograph No. 3:
Femur preparation assembly



Photograph No. 4:
Patella preparation assembly



Photograph No. 5:
Tibial preparation assembly kit

Photograph No. 6:
Femur preparation assembly kit

Tibial preparation assembly

1. Extramedullary alignment guide assembly
2. Cut guide
3. Tibial depth resection stylus
4. Resection guage
5. Oscillating saw blade
6. Tibial sizing plate provisional with modular handle
7. Stem tibial drill guide
8. Stem tibial drill
9. Broach impactor assembly
10. Stemmed tibial plate provisional
11. Articular surface provisional

Femur preparation assembly

1. Drill
2. Distal placement guide/ intramedullary alignment guide
3. Distal femoral cutting guide
4. Ap sizing & rotation guide
5. Anterior boom
6. Femoral finishing guide
7. Notch guide
8. Osteotome
9. Femoral provisional
10. Femoral component impactor
11. Spacer/ alignment guide
12. Alignment rods

Patella preparation assembly

1. Caliper
2. Patellar saw guide
3. Patellar drill guide
4. Patellar drill bit
5. Patellar provisional

Post operative protocol

- The knee was immobilized in a Jones compression bandage and knee immobilizer.
- First post operative day, patient was taught static quadriceps exercises, ankle-toe movements, check X-rays are taken.
- Second post operative day dressing changed and smaller dressing was applied. Patient is made to walk full weight bearing within the limits of pain with the knee immobilizer on initially with a walker and later with a tripod (Fourth day onward), active exercises initiated.
- Eighth post operative day staircase climbing was initiated as per patients tolerance.
- Twelfth post operative day sutures were removed and patient was discharged from the hospital to be reviewed after one month.
- Intravenous antibiotics were given for 72 hours oral antibiotics for further five days only if persistent wound leakage was present or any signs of local infection were observed.

Method of Evaluation

Clinical assessment was done by the KSS which is divided into Knee score (100 points), Knee Function Score (100 points). Both points were initially valued at zero, and points were awarded or deducted according to the specific criteria. The knee score and functional score were considered separately. Scores between 100 and 85 were excellent; between 84 and 70 were good; between 69 and 60 were fair and less than 60 were poor results.[52]

Radiological assessment by Knee Society roentgenographic scoring system

The tibiofemoral angle is the angle formed by the long axis of the tibia and the long axis of the femur, as seen on the AP radiograph of the knee.

The varus-valgus position of the tibial component was determined on the AP radiograph. If the angle formed by the tibial plateau and the long axis of the tibia, measured on the medial side of the long axis, was 90^0, no varus or valgus angulation was present. An angle of more than 90^0 indicated valgus angulation, and an angle of less than 90^0 indicated varus angulation.

The flexion-extension position of the tibial component was determined on the lateral radiograph. If the posterior angle formed by the plateau of the implant and the long axis of the tibia was 90^0, no flexion or hyperextension deformity was present. An angle of more than 90^0 indicated a hyperextension deformity, and an angle of less than 90^0 indicated a flexion deformity. Similar determinations of the position of the femoral component were made on the AP and lateral radiographs.[67]

The ideal placement of the tibial component was defined as 90 ± 5^0 to the long axis of the tibial shaft on both the AP and lateral X-rays. The desired placement of the femoral component was five ± five degree of valgus on the AP X-rays. In the AP view the tibial bone cement and cement implant interface were assessed for the presence of radiolucent areas, lines of reactive sclerotic bone or both. Femoral and tibial angles were measured. In the lateral view femoral flexion, tibial angle, femoral component bone interface and patellar interface were assessed.[52]

Method of Statistical Analysis

The following methods of statistical analysis have been used in this study.

1. Student "t' test.

1. The student 't' test was used to determine whether there was a statistical difference between two groups in the parameters measured.

   Student's t test is as follows:

$$t=\frac{\bar{x}_1-\bar{x}_2}{s\sqrt{\frac{1}{n_1}+\frac{1}{n_2}}} \sim\sim\sim t_{n1+n2-2} \quad \text{Where } s^2=\frac{(n_1-1)s_1^{\,2}+(n_2-1)s_2^{\,2}}{(n_1+n_2-2)}$$

2) Proportions were compared using Chi-square test of significance

Chi-Square (χ^2) test for (r x c tables)

Rows	Columns			Total
	1	2……..	c	
1	a_1	a_2	a_c	t_1
2	b_1	b_2	b_c	t_2
.	.	……	.	.
.	.	……..	.	.
R	h_1	h_2	h_c	t_r
Total	n_1	n_2	n_c	N

a,b…..h are the observed numbers.

N is the Grand Total

$$\chi^2 = N\left[\frac{1}{t_1}\sum_1^c \frac{a_1^2}{n_i} + \frac{1}{t_2}\sum_1^c \frac{b_1^2}{n_i} + \ldots\ldots\ldots\ldots + \frac{1}{t_r}\sum_1^c \frac{h_1^2}{n_i} - 1\right]$$

DF=(r-1)*(c-1), where r=rows and c=columns

DF= Degrees of Freedom (Number of observation that are free to vary after certain Restriction have been placed on the data)

3) Paired ‘t’ test:

A paired ‘t’ test was performed to determine whether there was difference between the pre and post measurements .

$$t = \frac{\overline{X}}{s\sqrt{\frac{1}{n}}}$$

Where $\bar{X}$ is the mean difference in each set of paired observation, s =SD of the difference and n is the number of observation.

4) "p" value:

In statistical hypothesis testing, the p value is the probability of obtaining a result at least as extreme as the one that was actually observed, given that the null hypothesis is true. More technically, a p value of an experiment is a random variable defined over the sample space of the experiment such that its distribution under the null hypothesis is uniform on the interval [0, 1].

Generally, one rejects the null hypothesis if the p-value is smaller than or equal to the significance level, often represented by the Greek letter α (alpha). If the level is 0.05, then the results are only five percent likely to be as extraordinary as just seen, given that the null hypothesis is true. In all the above test a p value of less than 0.05 was accepted as indicating statistical significance.

RESULTS

Assessment was done by the KSS which is divided into Knee score (100 points) and Knee Function Score (100 points). Both points were initially valued at zero, and points were awarded or deducted according to the specific criteria. The knee score and functional score were considered separately. Scores between 100 and 85 were excellent; between 84 and 70 were good, between 69 and 60 were fair and less than 60 were poor results. This study included 20 patients with 20 knees operated for TKA. All these patients were followed up at three weeks, six weeks, three months, six months and one year. All the 20 (100%) knees available were completely pain free at one year.

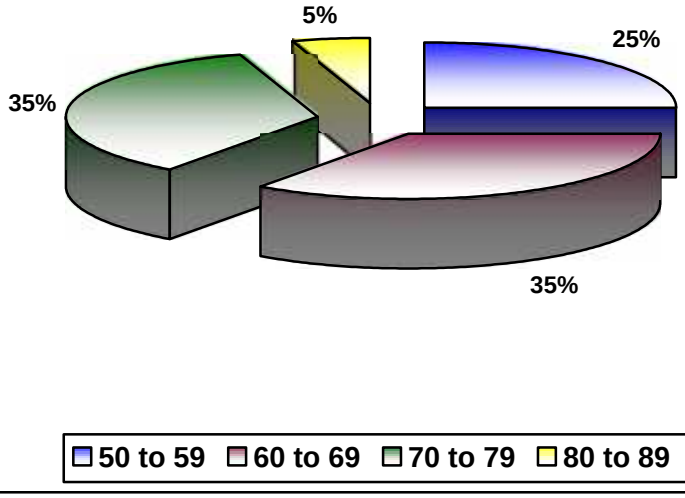
In none of the 20 patients of osteoarthritis who participated in this study a valgus deformity was encountered which indicated varus as distinctly predominant deformity in this condition. Maximum varus deformity corrected was 40^0 and maximum fixed flexion deformity being corrected was 40^0. The preoperative motion ranged from 50 to 100^0 with an average of 67^0 which improved to average post operative range of 100^0. The best recorded post operative ROM was 120^0 and the minimum was 85^0. There was extension lag in two knees of 10^0 each. No residual flexion contracture or post operative knee instability was observed in this study.

Sixteen knees (80%) had excellent and four knees (20%) had good knee score and the functional results were excellent in 17 (85%), good in three (15%). No fair or poor results were noted in this study.

Table No. 1: Age distribution of all the patients

Age group (Years)	Frequency	Percentage
50 to 59	05	25%
60 to 69	07	35%
70 to 79	07	35%
80 to 89	01	5%
Total	20	100%

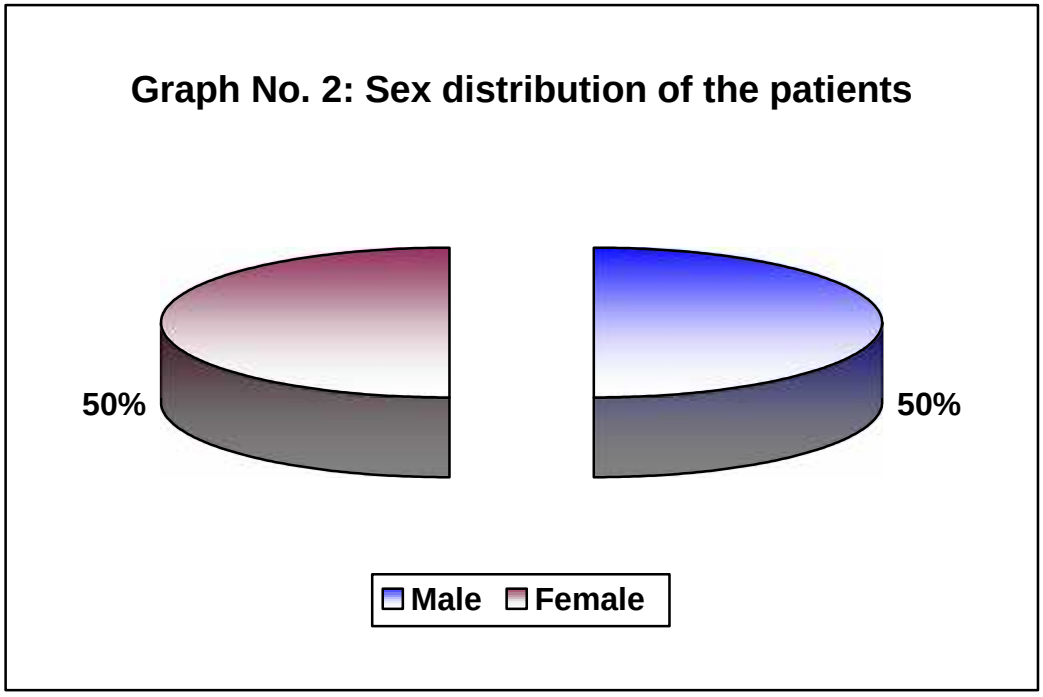
Graph No. 1: Age distribution of the patients



This study included patients with age ranging from 53 to 84 years at an average of 66.85 years at the time of surgery with a standard deviation of 7.78. Majority of them (seven each) were in 60 to 69 and 70 to 79 year age group. Mean age of males at the time of surgery was 69.6 ± 8.55 years and that of females was 64.17 ± 6.15 years.

Table No. 2: Sex distribution of the patients

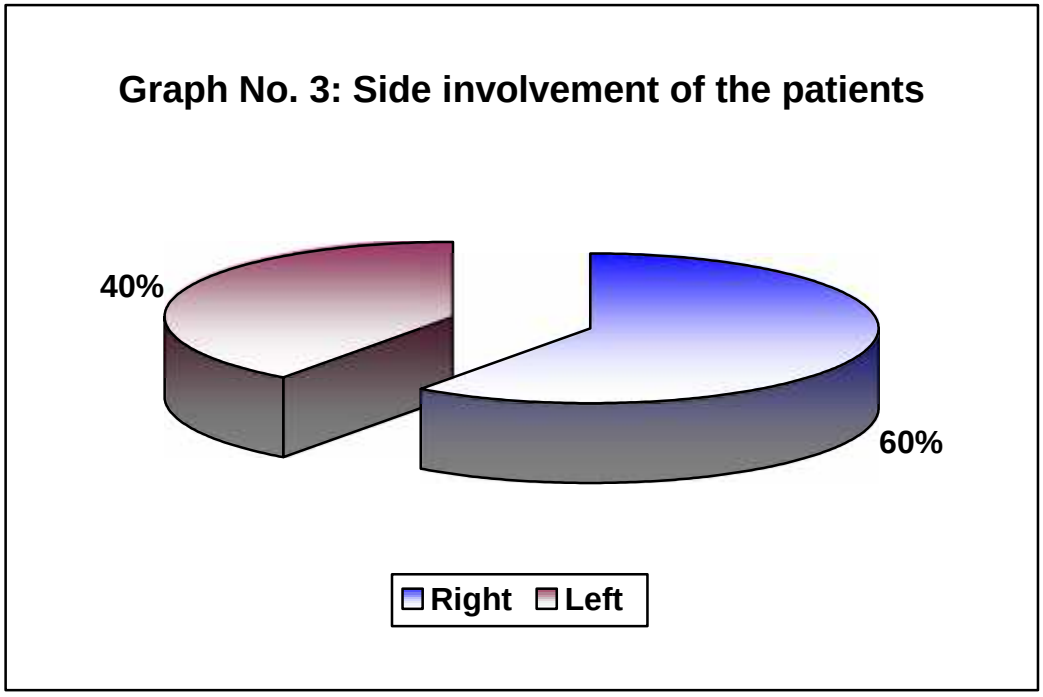
Gender	Frequency	Percentage
Male	10	50%
Female	10	50%
Total	20	100%



There were total 20 participants in the study out of which 10 (50%) were males and 10 (50%) were females with male to female ratio of 1:1.

Table No. 3: Side involvement of the patients

Side involved	Frequency	Percentage
Right	12	60%
Left	08	40%
Total	20	100%



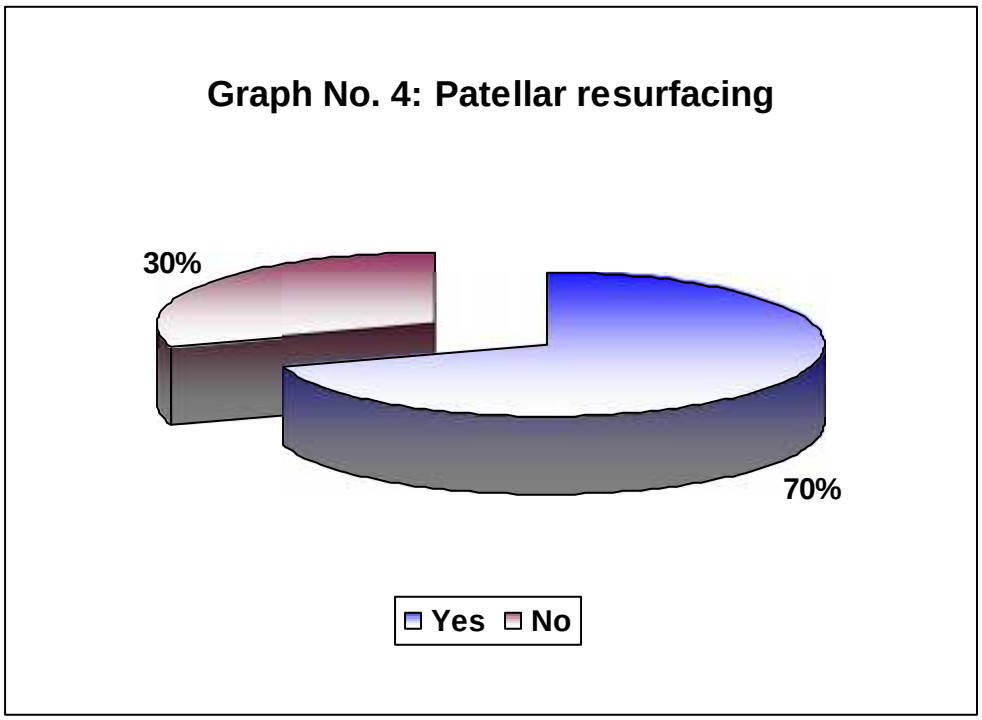
Majority of patients 12 (60%) were operated upon the right knee joint and left knee in rest eight (40%). The study does not study the results of TKA in bilateral cases and included only unilateral cases.

Hospital stay

The hospital stay ranged from five to 23 days with a mean of 11.95 ± 3.97 days

Table No. 4: Patellar resurfacing

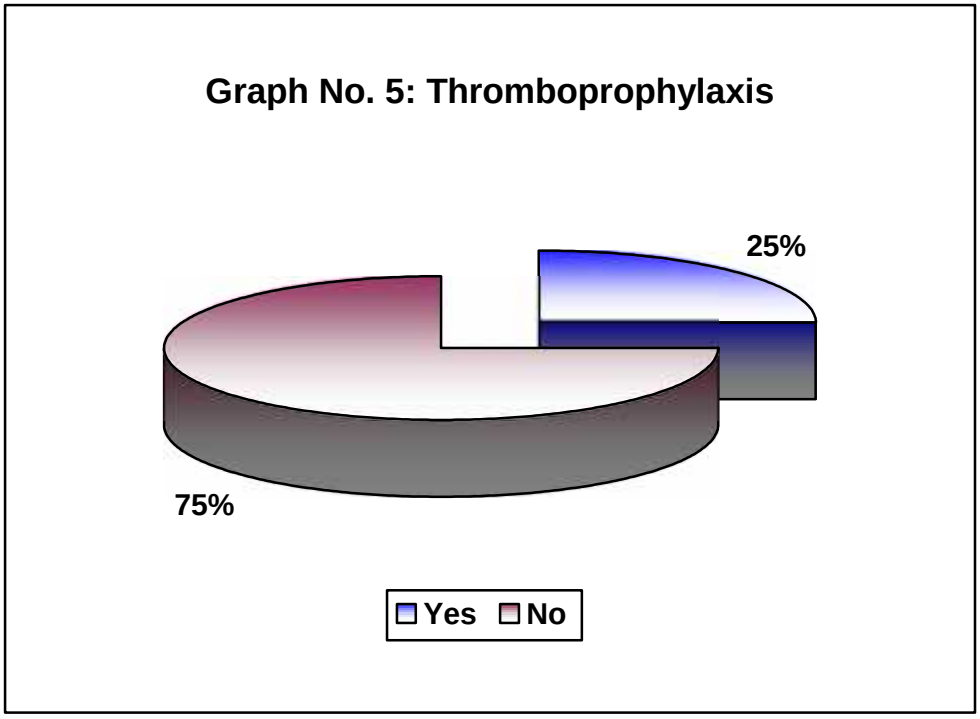
Patellar resurfacing	Number	Percentage
Yes	14	70%
No	06	30%
Total	20	100%



Out of 20 patients who underwent TKA, patella was found to be grossly eburnated and resurfaced in 14 (70%) patients and patelloplasty was done in six patients (30%).

Table No. 5: Thromboprophylaxis

Thromboprophylaxis	Number	Percentage
Yes	05	25%
No	15	75%
Total	20	100%



Out of 20 patients who underwent TKA, enoxaparin and aspirin thromboprophylaxis was administered in five (25%) at risk patients. No thromboprophylaxis was given in the remaining patients (75%).

CLINICAL RESULTS

Knee clinical score (knee score)

The average pre operative knee clinical score was 25.95 which improved to an average post operative score of 86.7

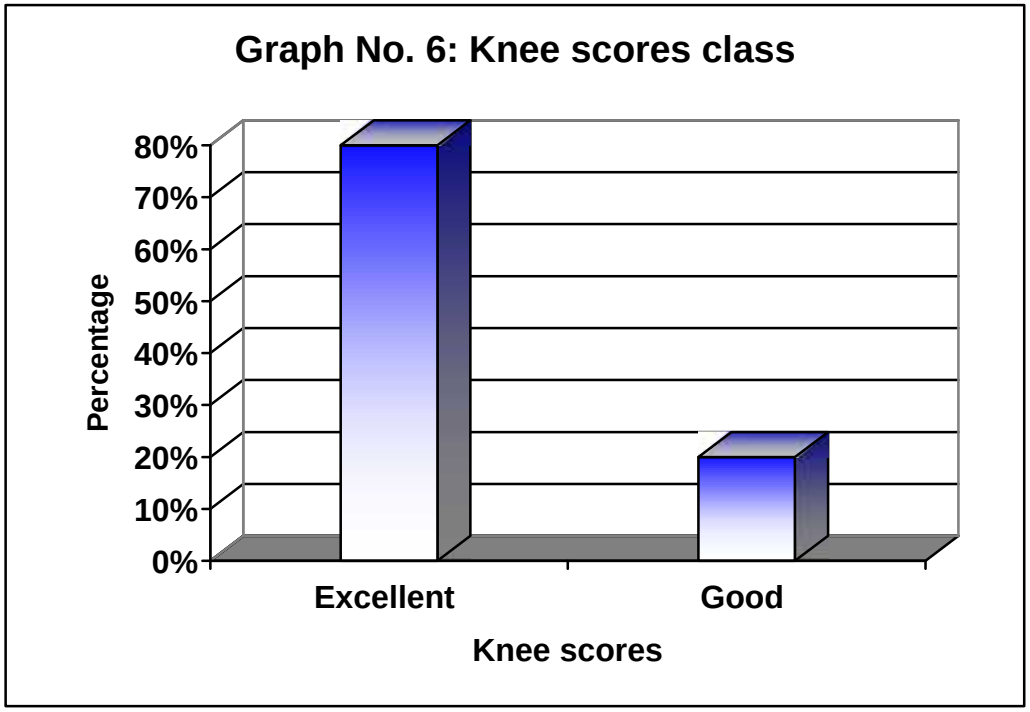
Table No. 6: Pre operative and Post operative Knee Clinical Scores

Side involved	No. of Patients	Mean	S.D.	Error
Pre operative	20	25.95	7.71	1.72
Post operative	20	86.70	4.59	1.06

According to knee society clinical scoring system the average score for all the 20 knees was 86.70 points which is considered as excellent. Sixteen knees (80%) had excellent, four knees (20%) were good and no knees had fair or poor results.

Table No. 7: Knee clinical score class distribution

Knee score class	Frequency	Percentage
Excellent	16	80%
Good	4	20%
Total	20	100.0



FUNCTIONAL RESULTS

The average pre operative knee function score was 34.5 which increased to a post operative average of 88.25.

Table No. 8: Showing pre operative and post operative knee function knee scores

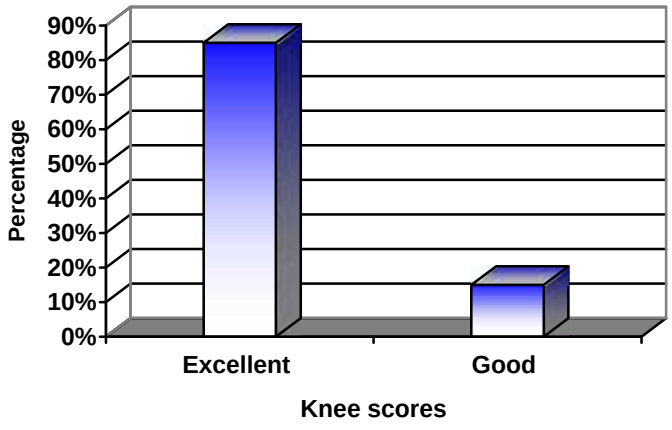
Side involved	No. of Patients	Mean	S.D.	Error
Function score Pre	20	34.5	7.59	1.69
Function score Post	20	88.25	5.91	1.32

Overall the functional results were excellent in 17 (85%), good in three (15%) and no fair or poor results were observed.

Table No 9: Knee function score class distribution

Knee score class	Frequency	Percentage
Excellent	17	85%
Good	03	15%
Total	20	100.0

Graph No. 7: Knee function scores class



Out of 20 knees which had excellent knee clinical scores, all of them had excellent knee function scores (100%). Out of four knees which had good knee

clinical scores, one of them had excellent and three had good knee function scores.

Table No. 10: Knee clinical and functional score distribution.

Knee score class		Knee function score class		Total
		Excellent	Good	
Excellent	Patients	16	0	16
	Percentage	100%	0.0%	100.0%
Good	Patients	01	03	04
	Percentage	25%	75%	100.0%
Total	Patients	17	03	20
	Percentage	85%	15%	100.0%

The P value was significant (< 0.001) when the pre and post operative knee clinical and functional scores were compared.

Table No. 11: Comparison between pre operative and post operative knee clinical and functional scores

Score class	Paired differences		't' value	'p' value
	Mean	S.D.		
[Knee Score Pre – Knee Score Post]	60.75	7.09	38.30	<0.001
[Function Score Pre – Function Score Post]	53.75	6.25	38.42	<0.001

Radiological results

The radiographic scoring system of the Knee Society was used to determine the over-all alignment of the knee, the respective positions of the prosthetic components relative to the bone, and the presence of radiolucent lines in zones adjacent to the cement mantle.

The mean tibiofemoral angle (overall alignment) was seven degrees of valgus (range, two degrees of varus to 11^0 of valgus). The mean femoral angle was 97^0 (range, 92^0 to 100^0), or seven degrees of valgus on the AP radiograph and mean femoral flexion 12^0 (range, seven degrees to 21^0) on the lateral radiograph. The mean tibial angle was 90^0 (range, 88^0 to 95^0) on the AP radiograph and 88^0 (range, 84^0 to 95^0) on the lateral radiograph. Changes in the thickness of the polyethylene or asymmetry between the heights of the lateral and medial spaces on the AP radiograph made with the patient bearing weight were considered as possible evidence of polyethylene wear. The radiographs were evaluated for changes in the bone that were consistent with osteolysis and for location and progression of radiolucent lines. Till the last follow up no evidence of polythene wear was observed. No radiolucent lines, lines of reactive sclerotic bone or both were observed beneath both tibial and femoral components

Table No. 12: Complications

Complications	Frequency	Percentage
Deep vein thrombosis	01	5.0%
Post op knee stiffness	01	5.0%
Post op extensor lag	02	10.0%
Poor wound healing	01	5.0%

One patient had post operative knee stiffness which resolved with aggressive physiotherapy and did not require manipulation under anesthesia. Two patients had extensor lag of 10^0 post operatively which did not affect their functional needs.

One patient suffered acute DVT involving the short sephanous vein at the sephano-popliteal junction as determined by Color Doppler. The patient was complaining of persistent calf pain which was not getting relieved by conventional non steroidal anti inflammatory drugs (NSAIDS). DVT prophylaxis was not given in patients on a regular basis unless increased risk as indicated by history of oestrogen use, previous history of thromboembolism, elderly, cardiovascular risk such as a known case of congestive cardiac failure, hypertension or myocardial infarction, stroke, nephritic syndrome, cancer, varicose veins, indwelling femoral vein catheter, obesity, smoking. In those indicated, low molecular weight heparin (LMWH) in the form of Enoxaparin 20 mg subcutaneously (sc) was given for a week starting from 2^{nd} post operative day and Aspirin 150 mg twice a day for next one and a half month. In this particular

established case of DVT, Enoxaparin 40 mg sc was given for five days and tablet warfarin 10 mg on first day, five mg for next four days and two mg subsequently. Prothrombin time and International Normalized Ratio were monitored at regular interval throughout the course of therapy. The patient recovered uneventfully.

No infections, periprosthetic fractures, pulmonary embolism, neurovascular injury, patellar complications like subluxation, maltracking or instability, anterior knee pain were seen in the present study. Long term complications like implant loosening or failure, polythene wear were absent because of short duration of the study.

DISCUSSION

The results of the present study showed that patients who underwent TKA improved significantly on the KSS proving TKA as an effective procedure that is associated with substantial functional improvement. Patients managed at hospitals and by surgeons with greater volumes of TKA have lower risks of perioperative adverse events following primary arthroplasty.

Traditionally, clinical rating scores have been used to assess results following TKA.

These rating systems aggregate weighted scores for pain, range of motion, stability, alignment, and functional ability. Using these scoring systems, investigators have reported successful results in more than 90% of patients. In a review of the English-language literature, it was found that there were more than 34 different rating systems, none of which had been demonstrated to be reliable or valid in published studies. They also found that some authors provided little or no information on how the weighting algorithms had been derived except that they were modifications of previously reported rating systems.[15]

Since it was published in 1989, the Knee Society Clinical Rating System has been widely accepted as an objective measure of knee status in patients undergoing TKA. Authors have found that it was a responsive measure of outcome following TKA. Patient self-reported measures of outcome, such as the WOMAC and the SF-36 underwent vigorous psychometric validation before the orthopaedic community accepted them as appropriate for this population of patients.[15] The aim of the present

study was to measure effectiveness of primary cemented TKA on the basis of KSS in patients suffering from primary osteoarthritis of the knee.

In the present study the mean age of patients was 66.85 years (range, 53 years to 84 years), 50% were women and included only those patients that had osteoarthritis requiring unilateral arthroplasty ie no bilateral TKA cases were assessed. In a study that analysed 74 patients patients, mean age was 64 years, 79.7% were women, 61.6% had osteoarthritis and 37.5% underwent bilateral arthroplasty.[67] In another study mean patient age was 68 years, 67.8% of patients were women, 89.25% had osteoarthritis and 20.66% underwent bilateral knee arthroplasty.[68] A long term study on 85 patients mean age was 65 years, 80% of patients were women, 44.64 % had osteoarthritis, and 29.41% underwent bilateral knee arthroplasty.[39] Another long term study that evaluated functional outcomes following TKA was performed involving 88 young, active patients with a mean age of 51 years (range, 22 to 55 years), 65% were women patients, 100% had osteoarthritis, 29.5% underwent bilateral arthroplasty, concluded that insertion of a cemented posterior stabilized knee arthroplasty as an acceptable option for younger patients who have osteoarthrosis that has not responded to non-operative treatment and should continue to be considered with caution and activities that involve impact should be avoided.[69] In a meta-analysis that reviewed outcomes following tricompartmental knee arthroplasty the mean patient age was 65.0 years, 71.7% of patients were women, 62.6% had osteoarthritis, and 26.6% underwent bilateral knee arthroplasty. It postulated that patient characteristics influence outcomes and include the knee pathology, age and weight, comorbid illnesses, and previous knee surgeries.[3]

It was found in a study that following TKA, patients detected motion significantly faster and reproduced joint position with less error. These changes may result from the retensioned capsuloligamentous structures and reduced pain and inflammation. The balance index also improved significantly from the preoperative to the postoperative evaluation and correlated well with the current study results.[70]

In one study it was observed that knee function was not improved by patella resurfacing when compared to a matched group of patients without resurfacing. Another study concluded that TKA with patellar resurfacing exhibited inferior clinical results as compared to TKA with patellar retention and associated with post operative knee pain.[71]

However another study found that TKA with retention of the patella yielded clinical results that were comparable with those after TKA with patellar resurfacing and concluded that postoperative anterior knee pain is related either to the component design or to the details of the surgical technique, such as component rotation, rather than to whether or not the patella is resurfaced.[72]

It has generally been recognized that the patella should routinely be replaced in rheumatoid arthritis. The practice of replacing it in osteoarthritis patients is still somewhat controversial. In a recent prospective, randomized study of 514 total knee arthroplasties with mean duration of follow-up of 5.3 years overall prevalence of anterior knee pain was 25.1% in the nonresurfacing group, compared with 5.3% in the resurfacing group ($p < 0.0001$).[73]

A meta-analysis of randomized controlled trials arthroplasties published in 2005 comparing total knee performed with and without patellar resurfacing

concluded that patellar resurfacing reduces the risks of reoperation and anterior knee pain after total knee arthroplasty.[74] In the present study, 14 (70%) of the 20 patella were resurfaced and rest were left after patelloplasty and there was no anterior knee pain in any of the patients.

A prospective study to assess the clinical outcome, complications and survival of the NexGen Legacy posterior-stabilised-Flex total knee arthroplasty in a consecutive series of 278 knees between May 2003 and February 2005 with a mean follow-up of 3.8 years reported a mean maximum flexion of 135^0 (110^0 to 150^0). It concluded that although the system provided excellent short-term outcome, it warranted ongoing evaluation to confirm the long-term durability and functioning of the implant.[75]

Another study that compared high-flex TKA to a matched group of posterior stabilized TKA with an average follow-up of 28 months found no significant difference in KSS between the two groups. The high-flex group had an averaged 138 degrees of knee flexion, which was significantly higher than the posterior stabilized group (average, 126^0). Eighty percent of patients in high-flex group were able to squat, which was significantly higher than in posterior stabilized group (32%). For the patients without special demands, the additional knee flexion from high-flex design made no significant difference on the results. In patients with a small bone frame, occasionally, their bone stock of the posterior femoral condyle is inadequate for high-flex TKA.[76] In our cases that were from relative higher socio economic class, increased flexion as required for squatting was not a major requirement. Besides the increased cost, absence of long term results with the implant precluded the use of this design in our study.

The Fifth Consensus Conference on antithrombotic therapy of the American College of Chest Physicians has recommended seven to 10 days therapy with warfarin or LMWH for DVT prophylaxis following TKA. Caution needs to be taken as disadvantages of warfarin include drug interactions, continued monitoring, delayed onset of action and bleeding complication. Although LMWH have been shown to be effective in DVT prophylaxis after TKA the disadvantages include subcutaneous administration, increased incidence of bleeding complications and transfusion requirements and disastrous neurological complications as well as epidural hematomas when used with epidural or spinal anesthesia.[11] In most of the cases 17 (85%) combined spinal epidural Anesthesia (CSE) was used and in the remaining three (15%) general anesthesia (GA) with Epidural Anesthesia was used so the use of LMWH was restricted prophylactically only for those at risk as enumerated above.

The reported incidence of DVT after TKA without prophylaxis is 40% to 84% with proximal DVT eight percent to 24%.[77] Without the use of preventive measures, symptomatic pulmonary emboli are reported at levels as high as 10% and as low as 1.5% in knee arthroplasty, with fatal pulmonary embolism reported at 0.7%.[11] Though incidence of DVT is very high, that of proximal DVT is low and that of fatal thromboembolism is extremely low.[78,79] Concerns have also been expressed regarding efficacy and side effects of various methods used for prophylaxis. These have made the issue of prophylaxis for DVT controversial.

In a recent prospective study conducted on 46 knees in 26 Indian patients who underwent TKA without any thromboprophylaxis no case of DVT was detected. The results suggest that the incidence of DVT in Indian patients is very

low and is not comparable with American and European populations. It is therefore not cost effective to advise prophylaxis in Indian patients undergoing total hip arthroplasty (THA) or TKA who have no known risk factors for DVT.[80] Other reports have also shown that the rate of proximal DVT in the Asian population is very low (4.4%) without pulmonary embolism.[81]

As thrombogenesis is a complex process, it is difficult to explain the difference in findings between Asian and those reported in the Western literature. They may be attributed to the genetic differences between the populations as well as differences in diet and lifestyle.[82] Recently, factor V Leiden has been postulated as a risk factor for thrombosis. The relative risk of thrombosis in patients with factor V Leiden has been shown to be more than 10 times greater than for those with a deficiency of protein C, protein S, or antithrombin III.[83] It was found in 5.27% of white people compared with 0.45% of Asians during the screening of 4047 people in the United States.[84] This difference in prevalence of factor V Leiden may be responsible for difference in incidence of DVT.

In cases of bilateral simultaneous TKA, a study reported DVT in 73.6% of patients.[85] Another study reported DVT in all six patients who underwent bilateral TKA.[86] One reason for low incidence five percent (one case) in the present study may be because only unilateral cases were considered.

The importance of DVT in the calf, however, is poorly understood and the treatment is controversial. Some studies have reported that the risks of treatment may be greater than those of the thrombosis itself. [87,88,89]

Besides, thromboprophylaxis doesn't give a complete immunity against DVT. The incidence of DVT after TKA may be as high as 68% in patients who receive prophylaxis for DVT.[90]

Recently, a meta-analysis has suggested that LMWH is more effective than warfarin, low-dose heparin or a placebo in this setting.[91]

A study published in 2004 evaluated the effectiveness of once daily administration of enoxaparin subcutaneously for the prevention of DVT and advocated its use for the same.[92]

In a placebo and low-molecular-weight heparin comparison trials in total knee arthroplasties authors demonstrated reduced ($p < 0.0001$) DVT from 65% with placebo to 19% with enoxaparin.[93]

In the current study too enoxaparin was given subcutaneously for thromboprohylaxis in those patients who were considered to be at risk of DVT.

A number of international studies that evaluated their results on the basis of KSS found Knee Scores of 92,[67] 87,[68] 94,[69] 93.7[94] and 92.[95] The results of this study (86.7) are in accordance with them and envisage good outcome.

Also good to excellent results were seen in 96%,[67] 79%,[68] 92%,[39] 94%[69] and 86%[95] in prominent researches. In the present study 100% patients had good (20%) to excellent (80%) results. A relative small sample size and shorter follow up may be a reason for this exceptional outcome.

A study that evaluated the radiological results of the posterior stabilized total knee prosthesis on the basis of the knee society roentgenographic system

observed that the mean tibiofemoral angle was eight degrees of valgus. The mean position of the femoral component was 97^0 on the AP radiograph and 13^0 of flexion on the lateral radiograph. The mean position of the tibial component was 90^0 on the AP radiograph and 88^0 on the lateral radiograph.[67]

Another study that analysed the radiographs of 104 knees according to the method of the Knee Society found the mean tibiofemoral angle was 5.6^0 of valgus (10^0 varus to 12^0 valgus). The mean valgus position of the femoral component on the AP radiographs was 96.5^0 (90^0 to 112^0) and the mean flexion was three degrees on the lateral radiographs (five degrees extension to 20^0 flexion). The mean position of the tibial component was 89^0, that is slightly varus (84^0 to 98^0). The mean position of the tibial component on the lateral radiographs was 88^0 (84^0 to 98^0), that is slight flexion.[68]

A 15 year survivorship study with average length of roentgenographic follow-up periods of 10.5 years found that on the AP views, the average femoral flexion angle was 95.9^0, with a range of 88^0 to 102^0. The average tibial angle was 88.4^0, with a range of 83^0 to 95^0. The total femoraltibial valgus angle was 4.2^0 of valgus, with a range of 5^0 varus to 23^0 valgus. On the lateral views, the average lateral femoral flexion was 7.7^0 (range, 0^0 to 24^0). The lateral tibial angle averaged 89.8^0 (range, 83^0 to 99^0).[39]

The radiographic result of our study are consistent with the above mentioned notable studies with 96.4% survivorship at 11 years,[67] 92.3% at ten years,[68] 94.1% clinical and 90.9% radiological survival at 15 years.[39] Although good roentgenographic results may indicate a positive development they cannot

be construed as predictors of good functional outcomes as radiographs and functions are poorly correlated.[68,96,97] The fact that no signs of osteolysis, polythene wear or radiolucencies were observed in our X rays was probably because of the short duration of study.

The success of TKA depends not only on surgical technique, prosthesis and material design but also on patient selection and a good rehabilitation programme. In the present study extensive preoperative patient selection and planning with post operative extensive rehabilitation programme under supervision of qualified physiotherapists was carried out which resulted in 88.25% excellent functional knee society scores.

Limitations of the study were small sample size and comparison of the KSS with other functional scales that are also employed like WOMAC, SF-36 etc. Recommendations for further research studies on a larger sample size and comparison of functional outcomes on more than two scales.

Strength of the study lies in the effectiveness of the KSS in evaluating functional changes in patients undergoing TKA.

Newer questions raised could be the comparison of the efficacy of TKA with different implant systems using the KSS.

CONCLUSION

The results of present series are excellent with 86.7% excellent clinical and 88.25% excellent functional results and are on par with the other global studies. Correction of deformities in most of the patients to the physiological range of valgus and reproducibility of the technique is excellent. Lower complication rate and no incidence of anterior knee pain in this study with majority of patella resurfaced are encouraging when compared with the studies without patellar resurfacing. The study also indicates that PCL substituting designs give good clinical and functional outcomes.

The present study demonstrated that there was significant improvement in patients that underwent TKA. The improvement was considered statistically significant ($p < 0.001$) based on KSS. Further it was observed that the KSS was an effective measure in evaluating and predicting patients functional status pre and post operatively. KSS scoring system is found to be relevant, simple but more exacting and more objective.

With the encouraging results obtained in the study we conclude that TKA provides considerable pain relief, range of motion, stability in severely painful, refractory, deformed knees if performed taking into consideration preoperative patient's selection, intra operative soft tissue balancing, prosthesis alignment and post operative rehabilitation.

SUMMARY

The present study was conducted in the Department of Orthopaedics, KLES Dr. Prabhakar Kore Hospital and Medical Research Centre, Belgaum. Twenty male and female patients with osteoarthritis who were undergoing unilateral total knee replacement were selected for the study. After finding the suitability as per inclusion and exclusion criteria they were selected for the study and a written informed consent was obtained. Clinical examination and necessary investigations were recorded on predesigned and pretested proforma both pre and post operatively and at regular follow ups. The final results were analyzed using appropriate statistical tests.

The focus of current study was to highlight the outcomes of currently in vogue procedure of cemented TKA in terms of pain relief, joint stability, range of motion and functional outcome with the help of a definitive clinical and radiological scoring system, the KSS and study various complications among the patients undergoing TKA.

1. This study included patients with age ranging from 53 to 84 years at an average of 66.85 years at the time of surgery.
2. In this study, 10 (50%) were males and 10 (50%) were females.
3. All the patients had varus deformity and none had a valgus deformity. Five of them also had fixed flexion deformity.
4. The diagnosis was osteoarthritis in all 20 (100%) patients.
5. All cases that required only unilateral arthroplasty were included.
6. All the 20 (100%) knees had a cruciate substituting prosthesis.

7. Fourteen (70%) patellas were resurfaced and patelloplasty was done in remainders (30%).
8. Thromboprophylaxis was administered in five patients (25%).
9. Of the 20 knees available with an average follow-up of one year, all (100%) were completely pain free.
10. The average pre operative ROM was 67^0 (50 to 100^0) which improved to 100^0 postoperatively. The best recorded ROM was 120^0 and the minimum was 85^0.
11. All the patients in the study had post operative valgus of the knee with an average valgus of 7^0.
12. The hospital stay ranged from five to 23 days with a mean of 11.95 ± 3.97 days.
13. The average pre operative knee clinical score was 25.95 which improved to an average post operative score of 86.7.
14. The average pre operative knee function score was 34.5 which increased to a post operative average of 88.25.
15. The clinical knee society scores were excellent in 16 knees (80%) and good in four knees (20%). The functional results were excellent in 17 (85%), good in three (15%). No fair or poor results were observed in this study.
16. The p value was significant (< 0.001) when the pre and post operative knee clinical and functional scores were compared.
17. One patient had post operative knee stiffness that improved with physiotherapy, two had minor extensor lag, one had delayed wound healing and one case had DVT involving short sephanous vein which resolved uneventfully on medication.

The results of the present study showed that patients who underwent TKA improved significantly on the KSS proving TKA as an effective procedure that is associated with substantial functional improvement. Further it was observed that the KSS was an effective measure in evaluating and predicting patients functional status pre and post operatively. In the present study extensive preoperative patient selection and planning, meticulous operative approach with post operative extensive rehabilitation programme was carried out which resulted in excellent results with minimum complications.

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ANNEXURE I – CONSENT FORM

THE ROLE OF TOTAL KNEE ARTHROPLASTY IN SURGERY FOR ARTHRITIC DISORDERS OF KNEE JOINT CONDUCTED AT KLES DR. PRABHAKAR KORE HOSPITAL AND MEDICAL RESEARCH CENTRE, BELGAUM

Principal Investigator: Dr. Abhishek Gupta

Since you have been diagnosed as a case of arthritic disorder of the knee joint you are eligible to be a part of the above study and hence asked to participate. This research is about the role of Total Knee Arthroplasty procedure in terms of pain relief, joint stability, range of motion and functional outcome and study various complications.

If you agree to participate we would ask you clinical history and do clinical and relevant radiological examination and investigations.

Your decision to participate or not in the study will not affect the quality of treatment you receive. Further you may withdraw from this study at any time.

All the information regarding the subject of research or that collected will be informed to you. This information is kept confidential to extent permitted by the law. Any information which identifies you will not be released without your written consent. This study does not have any damaging aspects and there is no chance of injury. There is no extra cost incurred by you but however you will have to pay for the investigations and the procedure which is a part of the protocol of treatment. There is no commitment for any reimbursement or compensation for the participations. Your participation in this study is entirely

voluntary. You may withdraw from the study at any time or can be excluded from the study.

If you have any questions about your rights on research as research participant, you may contact Dr. V.D. Patil, Principal and Chairman, J.N. Medical College Institutional Ethical Committee for Human Subjects Research, Phone no.0831-2471350 at J. N. Medical College, Belgaum.

If any complications and questions regarding this study, you may contact Dr. Abhishek Gupta, Postgraduate, Department of Orthopedics, J. N. Medical College, Mobile : 9844505175, OR

Dr. S. M. Antin, Professor, Department of Orthopedics, J. N. Medical College, Belgaum.

Signature of subject _____ Date: _____

Name _____

Signature of authorized representative _____ Date: _____

Name _____

Relation to the subject_____

Signature of Witness _____ Date: _____

Name _____

Signature of the Investigator Date: _____

Name: _____

ANNEXURE II – PROFORMA

THE ROLE OF TOTAL KNEE ARTHROPLASTY IN SURGERY FOR ARTHRITIC DISORDERS OF KNEE JOINT CONDUCTED AT KLES DR. PRABHAKAR KORE HOSPITAL AND MEDICAL RESEARCH CENTRE, BELGAUM

Evaluator's Name: Date:

Patient's Name: I.P. Number:

Date of Admission (DOA):

Date of Surgery (DOS):

Date of Discharge (DOD):

Affected knee joint: Left/ Right

Occupation: Unable to work (or Bedridden)/ Sedentary/ routine household works/ heavy manual labour

Type of Disease: Osteoarthritis (Primary or secondary)/ Rheumatoid Arthritis(RA) /Metabolic arthritis (Gout, Pseudogout)/ non specific monoarthritis/ special forms like haemophilic arthritis or psoriatic arthritis/ degenerative arthritis due to primary synovial conditions such as osteochondromatosis or pigmented villonodular synovitis/ Inflammatory arthritis such as Systemic Lupus Erythematosus(SLE) or Juvenile RA or osteonecrosis or Ankylosing Spondylitis / Post Traumatic Arthritis.

Complaints

Pain :

Swelling :

Joint Stiffness :

Inability to walk :

Seasonal Variation :

Clinical Examination

Swelling :

Deformity : Varus / Valgus

Tenderness :

Crepitus :

Instability : AP/ ML

Movements :

Flexion :

Extension :

Investigations

Radiograph Knee Joint (Weight Bearing)

AP View :

Lateral View :

Other Investigations

CBC :

Mini Renal :

Urine Routine :

ECG :

Chest x- ray PA view:

Blood sugar levels:

Previous implant if any

Previous surgery to knee joint if any

Previous intra articular medication into the affected knee joint if any

Pre operative assessment

- Knee Society Clinical Rating System Score
- Knee society Roentgenograpic Evaluation and scoring system score
- Pre operative medical evaluation – CVS/ CNS/ RS/ GIT/ Any other foci of infection elsewhere in the body

Operative intervention

Thromboprophylaxis

Type of Anaesthesia

Antibiotics

With / without Tourniquet (If with, tourniquet time)

Implant

Type

Size

Femoral

Tibial

Patellar

Intraoperative complications if any

Suction drain placed / not placed

Post operative management

Duration

Antibiotics parental/ oral

Analgesics parental/ oral

Limb elevation

Drain removal

Suture removal

Post opr X ray

Physiotherapy

Movements

Flexion

Extension

Instability if any

Complications

Immediate

Neurovascular injury

Pyrexia

Infection

Skin healing/ necrosis

Thromboembolism

Fat embolism

Instability

Others

Late

Deep vein thrombosis

Periprosthetic fracture

Implant loosening

Joint stiffness

FOLLOW UP

Evaluator's Name: Date

Patient's Name I.P. Number

Date of Admission (DOA)

Date of Surgery (DOS)

Date of Discharge (DOD)

Affected knee joint: Left/ Right

Knee society Clinical rating System knee score

Patient category

a. Unilateral / bilateral
b. Unilateral with other knee symptomatic
c. Multiple arthritis or medical infirmity

PAIN	Points	Pre Opr	Post Opr
None	50		
Mild or Occasional	45		
Stairs only	40		
Walking & Stairs	30		
Moderate			
Occasional	20		
Continual	10		
Severe	0		

RANGE OF MOTION	
(5^0 = 1 POINT)	25
STABILITY (Maximum movement in any position)	
Anterioposterior	
< 5 mm	10
5- 10 mm	5
10 mm	0
Mediolateral	
$<5^0$	15
6^o-9^o	10
10^o-14^o	5
15^o	0
Subtotal	_____
DEDUTIONS (Minus)	
Flexion Contracture	
5^o- 10^o	2
10^o- 15^o	5
16 ^{o}- 20^o	10
$>20^o$	15
Extention Lag	
$<10^o$	5
10^o – 20^o	10
$>20^o$	15
Alignment	
5^o- 10^o	0

$0^o - 4^o$	3 points each degree
11^o- 15^o	3 points each degree
Other	20
Total deductions	_____
Knee score	_____

(if total is minus number, score is 0.)

Function

Walking

Unlimited	50
>10 blocks	40
5- 10 blocks	30
< 5 blocks	20
House bound	10
Unable	0

Stairs

Normal up & down	50
Normal up; down With rail	40
Up & down with rail	30
Up with rail; Unable down	15
Unable	0

Subtotal _____

Deductions (minus)

Cane	5
Two canes	10
Crutches	20
Total deductions	_____
Function score	_____

Knee Society Roentgenographic Evaluation and scoring system.

Evaluator Name _____ Date _____

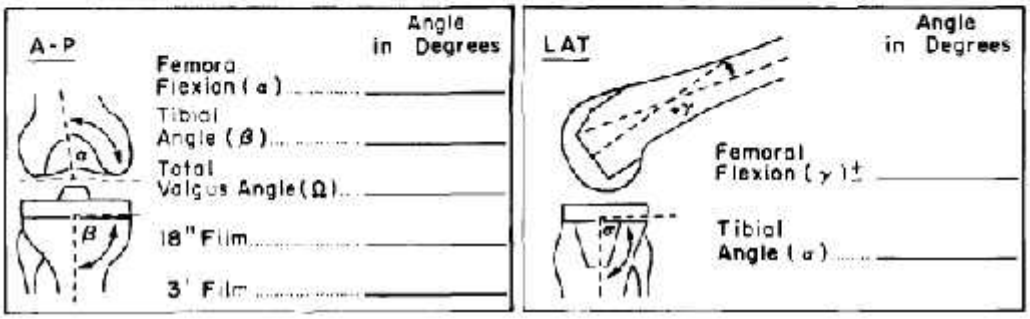
Patient Name/Number _____ Pre-op ☐ Post-op ☐

Surgeon Name _____ Hospital Number _____

X-Ray Date _____ Prior Implants _____

Joint: Left Knee ☐ Right Knee ☐

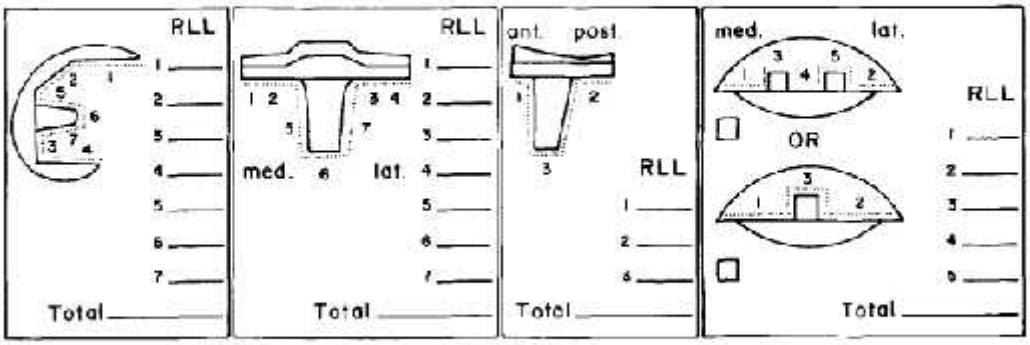
ALIGNMENT: Recumbent ☐ Standing ☐



IMPLANT/BONE SURFACE AREA

Percent area of tibial surface covered by implant

RADIOLUCENCIES: Indicate depth in millimeters in each zone



PATELLAR PROBLEM LIST

Angle of prosthesis _____

Placement Med-Lat _____

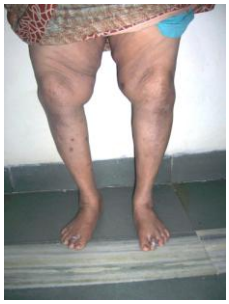
Sup-Inf _____

Subluxation _____

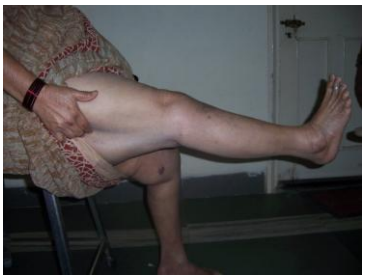
Dislocation _____

ANNEXURE III – PHOTOGRAPHS

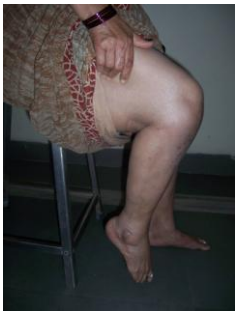
PRE-OPERATIVE (CASE I)



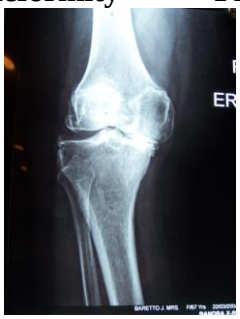
Photograph No. 7:
Varus deformity



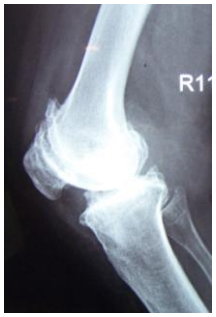
Photograph No. 8:
Fixed flexion deformity



Photograph No. 9:
Maximum flexion

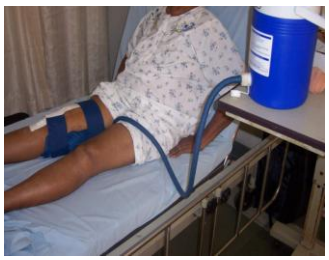


Photograph No. 10:
Radiograph AP View

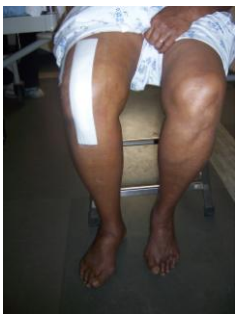


Photograph No. 11:
Radiograph Lateral View

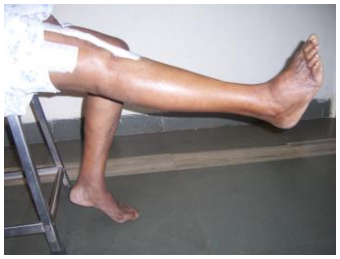
IMMEDIATE POST OPERATIVE (CASE I)



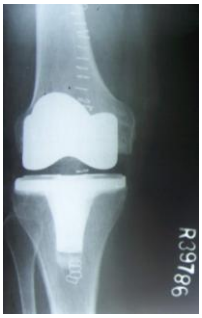
Photograph No. 12:
Cryotherapy



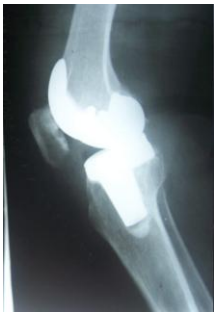
Photograph No. 13:
Dressing



Photograph No. 14:
Correction of flexion deformity

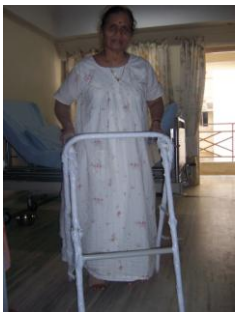


Photograph No. 15:
Radiograph AP View



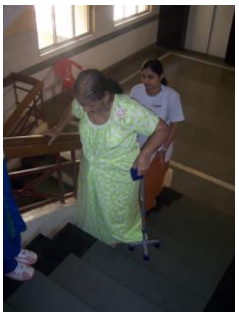
Photograph No. 16:
Radiograph Lateral View

IMMEDIATE POST OPERATIVE REHABILITATION (CASE I)



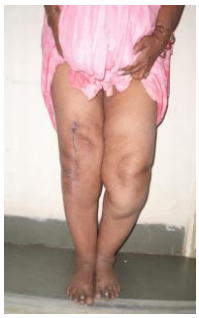
Photograph No. 17: Mobilization with Walker

Photograph No. 18: Mobilization with Tripod

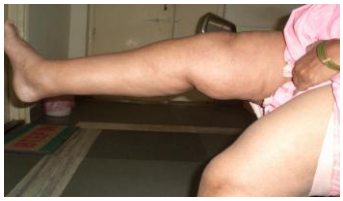


Photograph No. 19: Stair Climbing

POST OPERATIVE FOLLOW UP (CASE I)

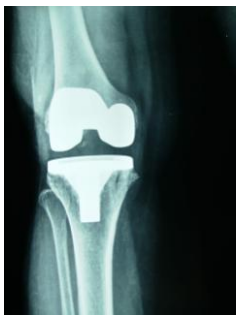


Photograph No. 20: Varus deformity corrected

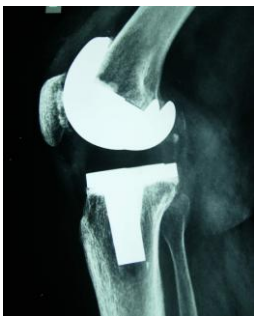


Photograph No. 21: Flexion deformity corrected

Photograph No. 22: Increased maximum flexion

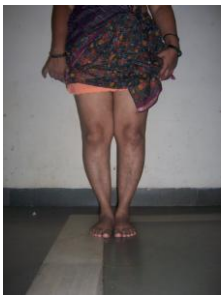


Photograph No. 23: Radiograph AP View

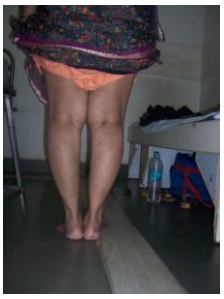


Photograph No. 24: Radiograph Lateral View

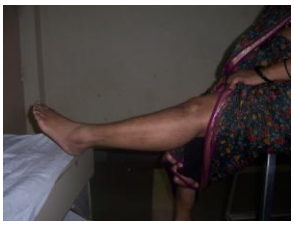
PRE-OPERATIVE (CASE II)



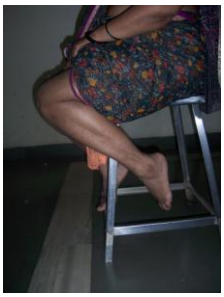
Photograph No. 25: Varus deformity



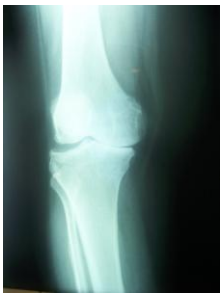
Photograph No. 26: Varus deformity



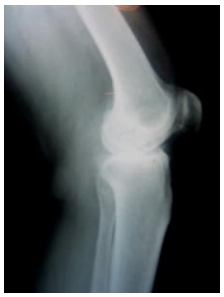
Photograph No. 27: No flexion deformity



Photograph No. 28: Maximum Flexion

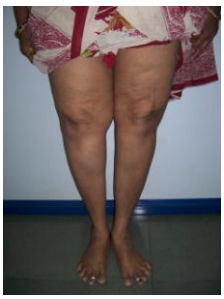


Photograph No. 29: Radiograph AP view

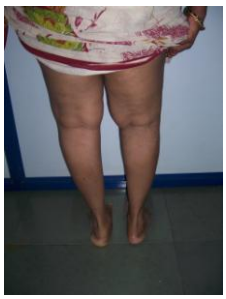


Photograph No. 30: Radiograph Lateral view

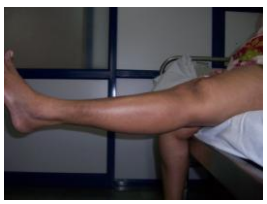
POST OPERATIVE (CASE II)



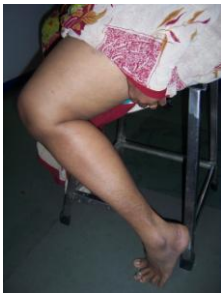
Photograph No. 31: Varus deformity corrected



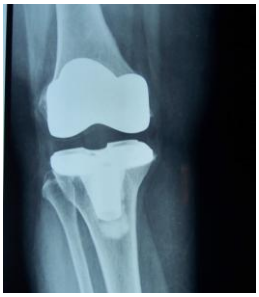
Photograph No. 32: Varus deformity corrected



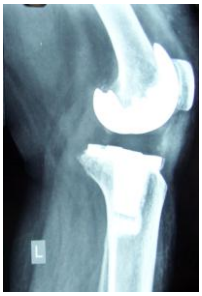
Photograph No. 33: No flexion deformity / extensor lag



Photograph No. 34: Maximum flexion



Photograph No. 35: Radiograph AP view



Photograph No. 36: Radiograph Lateral view

MASTER CHART

Sl. No.	IP No.	Age	Sex	Diagnosis	Deformity		Side	Hospital stay	KNEE SOCIETY				Implant Size				Anaesthesia	Complications	Results	
									Clinical Score		Functional Score									
					VAR	FFD			Pre	Post	Pre	Post	FC	TC	A	P			Clinical	Functional
1	217691	73	F	OA	20^0	-	R	17	42	94	35	90	C	3	17	-	CSE	-	E	E
2	228779	70	M	OA	25^0	-	R	11	31	83	30	85	E	3	17	32/8.5	CSE	-	G	E
3	231602	58	M	OA	25^0	-	L	12	18	94	40	95	D	3	10	29/8	CSE	-	E	E
4	224557	71	M	OA	20^0	-	R	10	26	86	45	85	D	4	12	29/8	CSE	-	E	E
5	258225	59	F	OA	30^0	-	R	11	36	90	30	95	C	2	10	29/8	CSE	-	E	E
6	225715	65	F	OA	20^0	20^0	R	23	14	80	25	80	C	2	12	-	CSE	Thrombosis in SSV	G	G
7	270342	65	M	OA	30^0	20^0	R	10	18	90	20	85	E	4	12	35/9	CSE	-	E	E
8	225107	66	F	OA	20^0	-	R	13	26	88	35	90	C	2	14	29/8	CSE	-	E	E
9	229392	53	F	OA	10^0	-	L	8	33	85	30	85	D	2	10	29/8	CSE	-	E	E
10	263775	78	M	OA	20^0	-	R	9	19	90	35	95	C	2	12	-	CSE	-	E	E
11	255429	66	F	OA	10^0	-	R	13	34	88	35	95	C	2	14	32/8.5	CSE	-	E	E
12	211744	73	M	OA	40^0	40^0	L	6	12	76	25	75	E	5	10	35/9	GA+EPI	Post op knee stiffness	G	G
13	214760	58	F	OA	10^0	-	L	15	21	85	40	90	D	3	14	29/8	CSE	-	E	E
14	225309	68	F	OA	15^0	-	R	11	28	90	40	95	C	2	10	-	CSE	-	E	E
15	205301	59	M	OA	15^0	-	L	13	28	90	35	85	D	3	14	-	GA+EPI	-	E	E
16	222780	62	F	OA	30^0	30^0	L	10	26	80	25	80	D	2	12	29/8	CSE	Post op extensor lag 10^0	G	G
17	228450	76	M	OA	10^0	-	R	5	33	86	35	85	D	3	14	-	GA+EPI	-	E	E
18	236600	71	F	OA	20^0	-	R	13	29	89	35	90	C	2	12	29/8	CSE	-	E	E
19	214119	84	M	OA	20^0	-	L	19	21	85	50	95	E	5	10	32/7.7	CSE	Poor wound healing	E	E
20	246457	62	M	OA	25^0	40^0	L	16	24	85	45	90	F	4	14	32/8.5	CSE	Post op extensor lag 10^0	E	E

ANNEXURE IV – KEY TO MASTER CHART

A	- Articular surface component
CSE	- Combined spinal epidural anaesthesia
E	- Excellent
F	- Female
FC	- Femoral component
FFD	- Fixed flexion deformity (pre operative)
G	- Good
GA + EPI	- General anaesthesia with epidural anaesthesia
IP. No.	- In patient number
L	- Left
M	- Male
OA	- Osteoarthritis
P	- Patellar implant
R	- Right
Sl. No.	- Serial number
SSV	- Short sephanous vein
TC	- Tibial component
VAR	- Varus (pre operative)