DISSERTATION ON

ANALYSIS OF COMPONENTS ALIGNMENT IN TOTAL KNEE REPLACEMENT USING TRADITIONAL JIGS AND ITS RELATIONSHIP TO THE FUNCTIONAL OUTCOME

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CERTIFICATE

This is to certify that this dissertation titled **"Analysis of Components Alignment in Total Knee Replacement using Traditional Jigs and its Relationship to the Functional outcome"** is a bonafide record of work done by **Dr.SHANMUGARAJA.M,** during the period of his postgraduate study from September 2013 to May 2015 under guidance and supervision in the **INSTITUTE OF ORTHOPAEDICS AND TRAUMATOLOGY,** Madras Medical College and Rajiv Gandhi Government General Hospital, Chennai-600003, in partial fulfillment of the requirement for **M.S.ORTHOPAEDIC SURGERY** degree examination of The Tamilnadu Dr. M.G.R. Medical University to be held in April 2016.

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DECLARATION

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CONTENTS

INTRODUCTION

INTRODUCTION

Osteoarthritis is the most prevalent chronic joint disease affecting ambulation of a person. The incidence of osteoarthritis is rising because of the ageing population and the epidemic of obesity[1,2,3]. Pain and loss of function are the main clinical features that lead to treatment.

Total knee arthroplasty is now a reliable treatment for severe arthritis. Long term survivorship of total knee replacement depends on the proper alignment of the components. If there is malalignment in the components like when the tibial component is placed more in internal rotation then the length the patellar tendon increases, which causes maltracking of patella and rupture of extensor mechanism. Thus malalignment of components leads to various complications and affects the outcome of Total knee replacement.

It is very important to assess the position of the components intraoperatively to avoid these complications. There are various methods available to assess the components alignment during the surgery.

This is a prospective study of fifteen patients to assess the components alignment and the functional outcome of total knee arthroplasty.

AIMS

AND

OBJECTIVES

AIM AND OBJECTIVES

To assess the components alignment in total knee replacement done using traditional jigs which include

- Varus, valgus and rotational alignment of tibial and femoral components
- Posterior tibial slope and posterior condylar offset preoperatively and post operatively

To assess the relationship between components alignment and the functional outcome.

APPLIED ANATOMY

APPLIED ANATOMY

Type

The tibiofemoral joint is a synovial joint of complex type which allows some degree of abduction, adduction and rotatory movements. The patellofemoral joint is also a type of synovial joint of gliding type. (Fig.1)

Fig. 1. Synovial Joint

THE SKELETAL FRAMEWORK OF THE KNEE JOINT

FEMUR

The lateral femoral condyle is 1.7 cm smaller than the medial femoral condyle in its outer circumference. Because of this asymmetry, during flexion and extension axial rotation of tibia on femur takes place.

At the level of intercondylar notch the width of lateral femoral condyle is more than the medial femoral condyle. In coronal plane medial condyle extends distally than the lateral condyle. (Fig. 2) There is valgus angulation of the femur along its anatomical axis. But during weight bearing both the femoral condyles appears to be equal. The straight line drawn from the center of the head of femur, knee joint and the ankle joint is called as the mechanical axis. There is physiological valgus of 6 degree between the anatomical and mechanical axis of femur. Patella articulates with trochlea anteriorly which is formed by the convergence of the both femoral condyles. Maximum bone strength is found at posterior aspects of 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.

Fig 2 Distal Femur

TIBIA

The lateral tibial plateau is convex and medial plateau is concave. In sagittal plane the tibial condyles slope posteriorly approximately 10°. In the frontal plane the condyles makes 90° to the axis of tibia. (Fig. 3) The highest pressure concentrations are located on the cartilage and menisci of the medial compartment. Trabecular bone of 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 strongest especially centrally and anteriorly. Strength is reduced at both plateaus towards periphery. Trabecular bone strength is significantly reduced at a distance of 5 mm from the surface. Preservation of bone stock on the tibia as much as possible is considered in total knee replacement, 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.

Fig 3 Proximal tibia

PATELLA

The inner 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. (Fig. 4) Trabecular structure of the patella and the femoral trochlea is aligned normally to the joint surfaces.

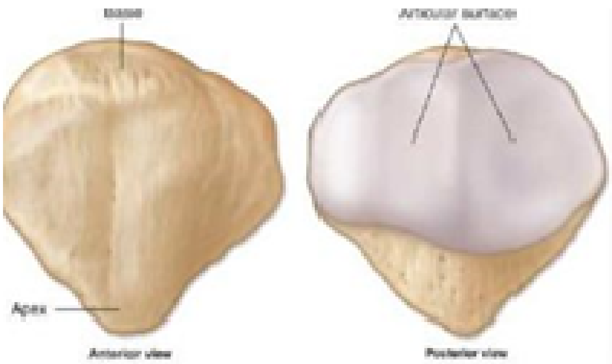


Fig 4 Patella

LIGAMENTS

The ligaments may be divided mainly into two types based on whether it is inside the capsule or outside the capsule. (Fig. 5)

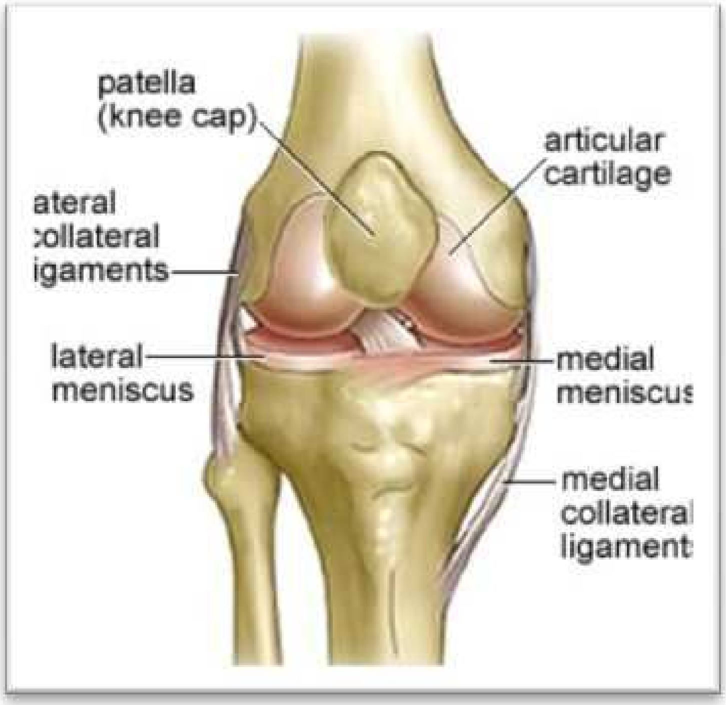


Fig.5 Ligaments in knee joint

EXTRACAPSULAR LIGAMENTS OF KNEE JOINT

The ligamentum patellae start from the lower end of patella and attaches on the tibial tuberosity. The common tendon of quadriceps muscle continues down as the Ligamentum patella.

Lateral collateral ligament of the knee is attached between the lateral condyle of femur and head of fibula. Popliteus tendon passes between the lateral collateral ligament and lateral meniscus.

Medial collateral ligament is a band like structure attached between medial condyle of the femur and medial surface of tibial shaft.

INTRACAPSULAR LIGAMENTS OF KNEE JOINT

Anterior cruciate and the posterior cruciate ligaments are the two main intra capsular ligaments. Intracapsular ligaments are the main stabilizers of the femorotibial joint. (Fig.6)

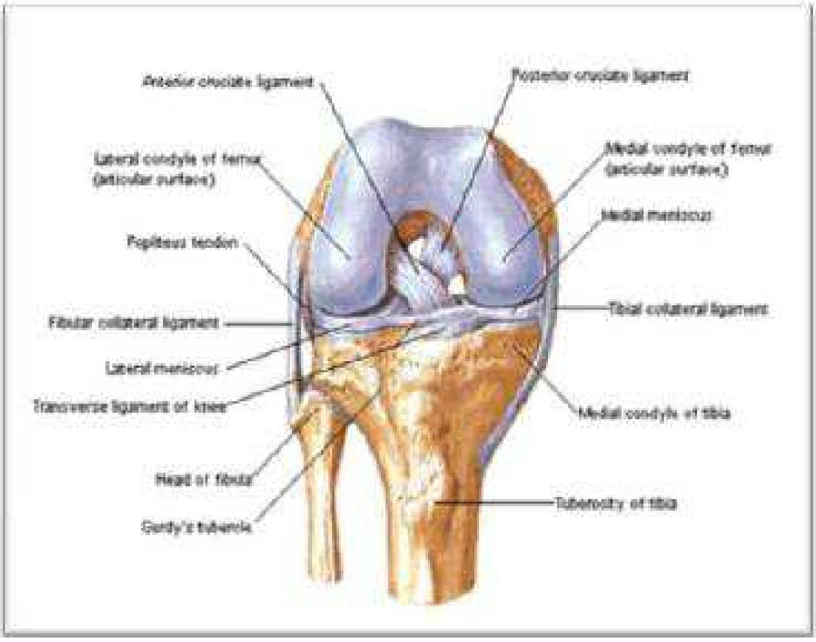


Fig.6 Intracapsular ligaments of knee

ANTERIOR CRUCIATE LIGAMENT (ACL)

ACL arises from the intercondylar region of the tibia and it passes upward, laterally, and attached to medial surface of lateral condyle of the femur in its posterior aspect. Forward movement of tibia on femur is blocked by the anterior cruciate ligament.

POSTERIOR CRUCIATE LIGAMENT (PCL)

The PCL is attached to the tibia at the intercondylar area in the posterior aspect and the passes upwards, medially and attached to medial condyle of femur at the anterior aspect of the lateral surface. Posterior movement of tibia on femur is blocked by posterior cruciate ligament. (Fig.7)

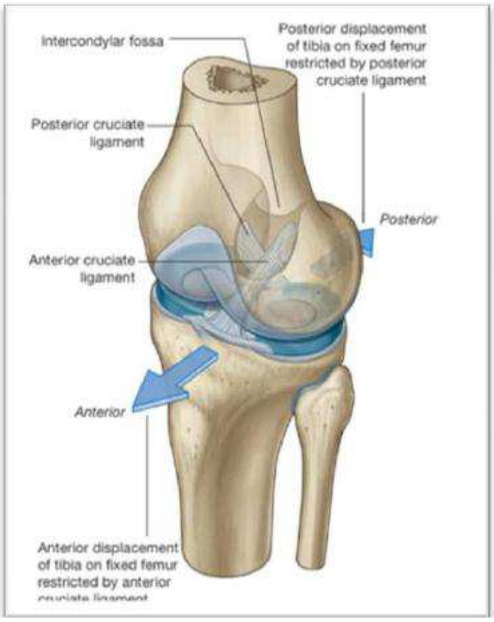


Fig.7. Function of ACL and PCL

MENISCI

The knee joint also has a structure made of cartilage, which is called the meniscal cartilage. (Fig. 8) The inner border of the menisci are thin , concave and forms the free edge, outer border of the menisci is thick and it is attached to the knee joint capsule. The main functions of the menisci are, it deepens the articular surface of the knee joint and it acts as a cushion between the femur and the tibia. The femoral condyle is in contact with the upper aspect of the menisci and the tibial plateau is in contact with lower surface of menisci.

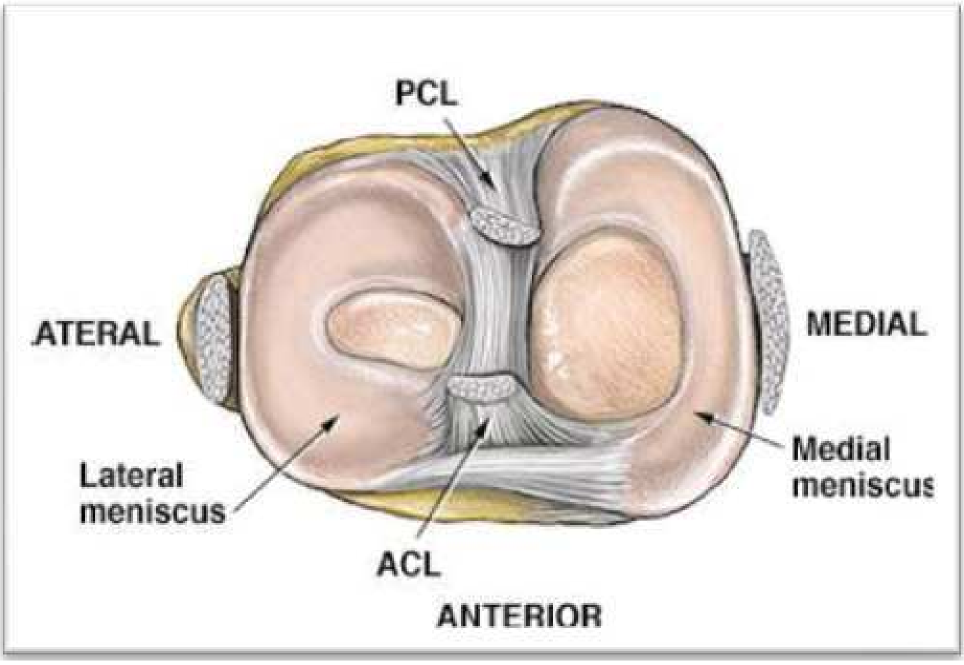


Fig.8 Mensici

THE MUSCULATURE AROUND THE KNEE JOINT

The extensor mechanism is formed by the quadriceps muscle and its tendon, patella and patellar tendon. Distal quadriceps complex represents an aponeurosis of the four muscle bellies at the anterior aspect of the knee. Rectus femoris continues down on the anterior surface of 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 55-60 degree 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 total knee arthroplasty.

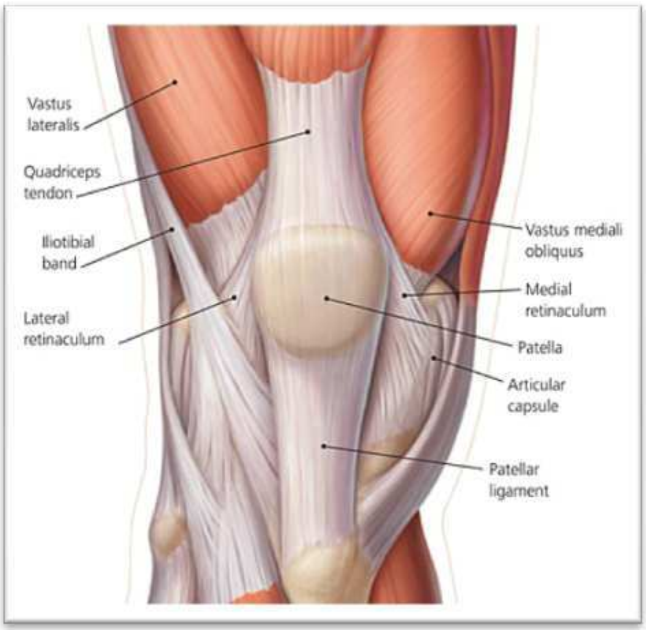


Fig.9 Extensor mechanism

The vastus lateralis fibers are oriented at an angle of approximately 30° to the rectus tendon. These fibers inserts into superolateral corner of patella and forms the lateral rectinaculum. The vastusintermedius muscle lies very deep to the other vastus muscles and it is attached to the superior end of patella. (Fig. 9)

Infrapatellar tendon is composed primarily of rectus femoris fibers that extend distally over the patella on its anterior surface. The tendon ranges in length from 3.5 to 5.5 cm. The infrapatellar tendon inserts at 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 [4].

Gracilis, semitendinosus, semitmembranosus and biceps femoris forms the hamstring group of muscle. 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). Sartorius which is supplied by the femoral nerve arises from anterior superior iliac spine (ASIS). Gracilis which is by obturator nerve and it arises from public arch, goes medially in thigh and inserted below the knee joint. . Semitendinosus which is supplied by sciatic nerve, arises from the ischial tuberosity, and it is attached to medial surface of tibia just posterior to gracilis. Semimembranosus which is innervated by the sciatic nerve arises from the ischial tuberosity and it goes medially and deeper to biceps femoris, with five insertions on the medial surface of the knee. The biceps femoris muscle has two heads, the long head and short head. The long head originates from the ischial tuberosity and the short head originates from linea aspera and lateral intermuscular septum. The sciatic nerve supplies the long head and the lateral popliteal nerve supplies the short head. Both long head and short head of the biceps femoris join to form a common tendon and it is attached to the fibular head and some expansions attached to the lateral tibia.

The gastrocnemius muscle is formed from the two muscle bellies, lateral and the medial heads. The lateral head originates from the lateral condyle and medial head arises from medial condyle of femur. Popliteus muscle arises from lateral condyle of femur and it is attached to tibia in the posterior surface above the soleal line. The main function of the popliteus muscle is the restriction of the posterior translation of tibia on femur and restriction of the varus and external rotation of the tibia. (Fig. 10)

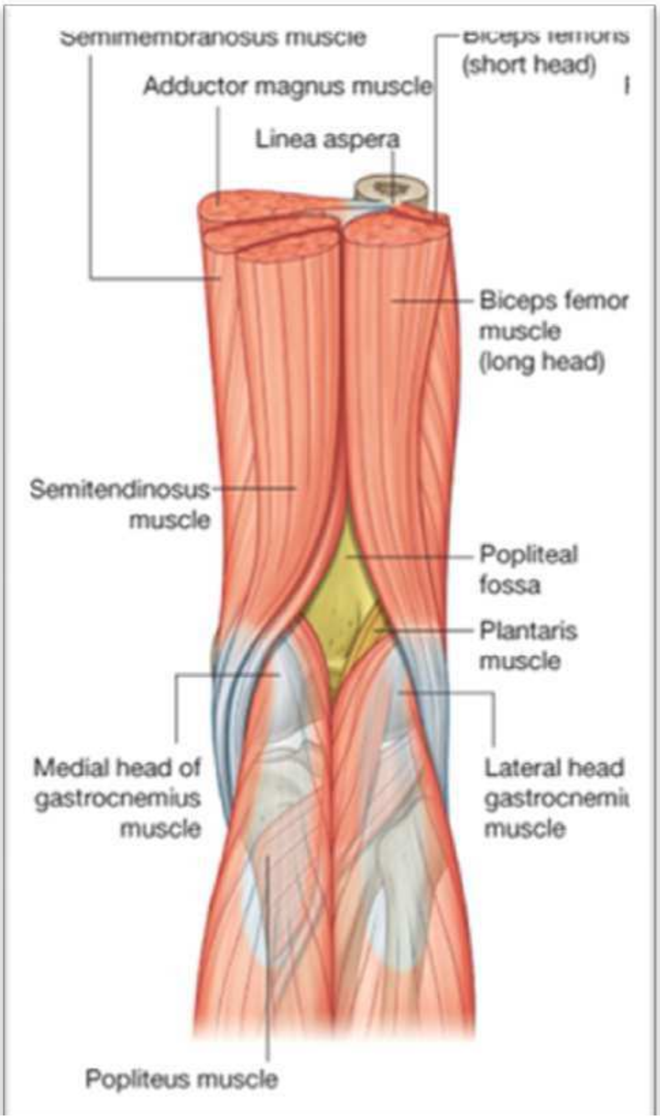


Fig.10 Posterior aspect of knee joint

VASCULAR SUPPLY OF KNEE JOINT VESSELS

Eight arteries provides the major blood supply to the knee are superior genicular, medial and lateral superior genicular,lateral superior genicular, medial and lateral inferior genicular,middle genicular, anterior and posterior tibial recurrent arteries. (Fig. 11) These vessels are vulnerable to injury during meniscal excision and exposure of the posterior corners of the knee joint. The popliteal vessels are close to bone during the level of tibial cut.

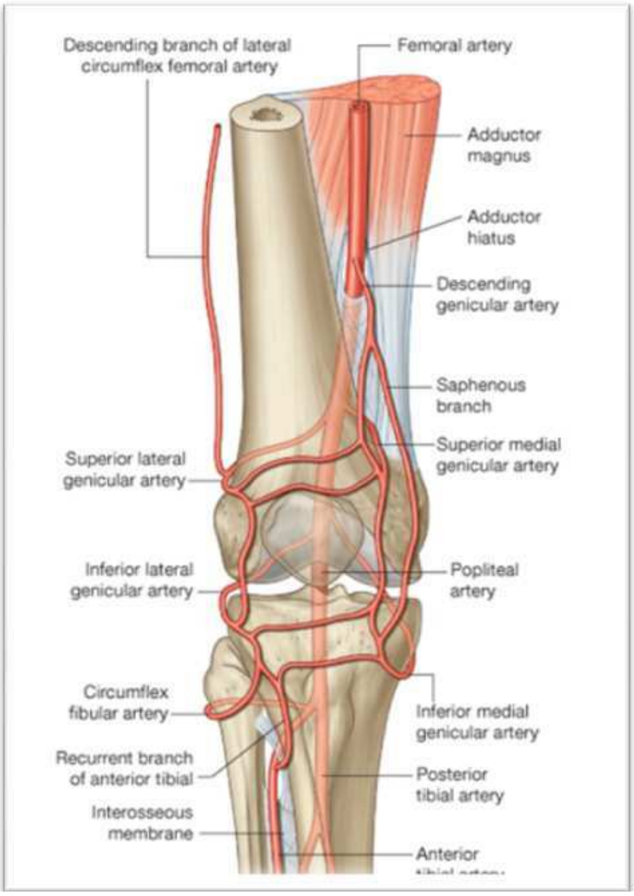


Fig.11 Blood supply of knee joint

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 anastomotic ring surrounds the patella, with oblique branches converging on the anterior surface. The distal half of patella is susceptible to ischemia if these vessels are damaged. Excision of prepatellar fat pad and extensive lateral release during the total knee arthroplasty may result in devascularization.

KINEMATICS OF THE KNEE JOINT

The knee motion during normal gait is not simple comprising of just flexion and extension, it is more complex, it includes flexion, extension, rotation, adduction and abduction. (Fig. 12)

The articular geometry of the knee and the presence of various ligaments plays an important role in this complex motion of knee joint. Because of the complex motion of knee joint, designing an ideal implant for the knee joint and increasing the longevity of the implant is quite challenging.

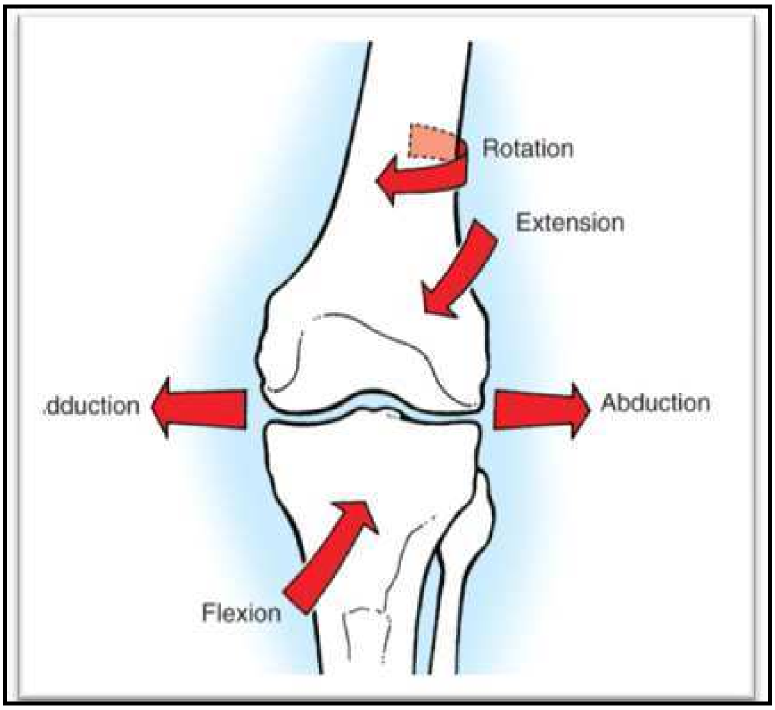


Fig.12 Kinematics of knee joint

Kettlekamp [5], analysed kinematics of knee joint and he concluded that “normal gait requires 67° of knee flexion during the normal swing phase, 83° of knee flexion during stair climbing, 90° of knee flexion for descending stairs and 93° of knee flexion to get up from a chair”.

TIBIO-FEMORAL JOINT ARTICULATING SURFACE MOTION

The planar motion of the two adjacent body segments can be described by the concept of the instant center of motion. As one body segment rotates about the other, at any given instant, there is a point that does not move. This point has the 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 degree or greater exists in other planes. When the instantaneous center of rotation is at the contact point between 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 knee joint is important for understanding causes of wear, instability and loosening of implants of the total knee arthroplasty.(Fig.13)

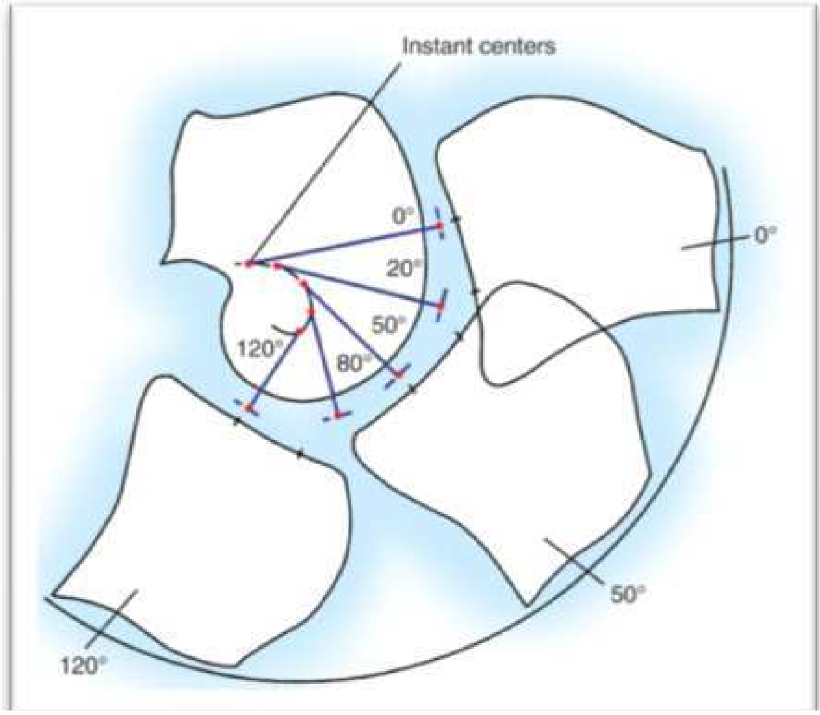


Fig.13 Tibiofemoral joint motion

They 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.

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 both cruciate ligaments.

Muller considered that rolling to gliding ratio to be controlled by the basic model of a crossed four-bar linkage. In this mode, 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 tibiofemoral contact point moves posteriorly when the knee is flexed.

The weight bearing surface of knee moves backwards on tibia and it is smaller during the flexion of the knee joint. According to Muller "In a normal knee during the full extension , center of pressure is 25 mm from the anterior border of the knee joint and it moves posteriorly during the knee flexion to 38.5 mm from the anterior border of the knee joint".

PATELLOFEMORAL MOTION

The main advantage of the patellofemoral joint is increasing the extensor leaver arm and thereby increasing the strength of the quadriceps contraction. The quadriceps tendon is attached to superior end of patella and patellar tendon is arises from inferior end of patella and displaces force vector away from knee joint. According to Muller "the extensor lever arm was maximum at 20 degree of knee flexion and the quadriceps force needed for the knee extension increases in the last 20 degree of knee extension". As the patella transmits the contractile force from the quadriceps to patellar tendon, it experiences an opposite force from the trochlea. This is called as joint reaction force. It depends on amount of flexion of knee and amount of force transmitted to patellar tendon. It increases with increase in degree of flexion of the knee. Biomechanical studies showed that “joint reaction force is around 2 to 5 times the body weight during the normal activities and increased to about 7 to 8 times the body weight during squatting”. During the knee flexion patella glides through the trochlea, always in the clockwise motion.

KNEE JOINT STABILITY

The muscles, ligaments, menisci, osseous geometry and joint capsule all combine in a complex manner to produce joint stability. If any of these structures malfunction or disrupted, knee joint instability occurs. These factors are all interdependent and serve the function of both determining normal motion and limiting motion beyond a certain point.

JOINT SURFACE

The constraints provided by the femoral and tibial joint surfaces are not adequate for functional stability. The distal femur is convex, whereas the proximal tibia is partially flat, slightly concave medially and slightly convex laterally. However, the tibial intercondylar eminence and the articular geometry provide some potential for stability. Heish and Walker found that geometric conformity of the condyles was the most important criteria for decreasing laxity under load bearing. They stated that in order to perform anterior or posterior, rotatory and medial or lateral movements, the femur must ride upward on the tibial curvature. 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.

LIGAMENTOUS STABILITY

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 and posterior translational stability. Li et al have showed 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 and 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. Burstein and Wright have also indicated the importance of muscle forces contributing to knee joint stability in the frontal plane. 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.

JOINT LOADING

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 external 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.

REVIEW

OF

LITERATURE

REVIEW OF LITERATURE

HISTORY OF DEVELOPMENT OF KNEE PROSTHESES

The evolution of total knee replacement in its modern form is about three and half decades old. In the 19^{th} century the concept of knee replacement gained importance. In 1860, Verneuil concluded that the soft tissues interposition will lead to the articular surface reconstruction of joint. The results were not good. In the year 1860, Ferguson suggested that resection of the joint causes formation of subchondral surface which aids in mobility.[6]

After the success of the hip arthroplasty, Cambell in the year 1940, reported the first case of metallic femoral replacement but the results were not good.

Fig.14 Wills C.Cambell

In 1957, Waldius developed the first hinged knee prosthesis (Fig. 15), which was first made up of acrylic then later made up of metal.[7] Shiers in the year 1965 described a device with simple mechanical characteristics.[8] These designs were uncemented. 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.

Fig.15 Hinged prosthesis

More recent versions of hinged prosthesis have included the spherocentric knee and the kinematic Rotating Hinge.

In 1966, Macintosh described hemiarthroplasty for varus and valgus deformities.[9] He used Acrylic based tibial prosthesis to correct the deformity, relive the pain and to restore the stability of the knee joint.

The work of Sir John Charnley on total replacement of the hip joint with low friction arthroplasty, introduced in 1958 had generated surgical and engineering interest in applying such a concept to the knee. Surgeons at St.George's hospital in Hamburg in 1971 had designed a sledge type of prosthesis. In 1970 at Hospital for Special Surgery, Peter Walker, Ranawat CS, Insall JN developed a duo-condylar and unicondylar devices with low conformity and anatomic geometry to allow laxity and freedom of motion and with curved condylar shapes to reduce bone resection.[10]

Fig.16 Sir John Charnely

In 1971, Gunston working with Charnley, had designed and documented encouraging results with a polycentric knee.[11] In 1972, Coventry et al[12] developed a Geometric knee, which was conforming and provided stability which required preservation of the both cruciate ligaments. Marmor designed a modular knee for uni & bi compartment replacement and published his work in 1973.[13]

Fig.17 John Nevil Insall

TCP which was called as total condylar prosthesis first devised by Insall was the important landmark in the history of total knee replacement. (Fig. 18) It marked the beginning of the modern knee replacement.

TCP was based on the previous ICLH design (Imperial college London hospital) and in this both the anterior and posterior cruciate were sacrificed and the stability is maintained by the inherent articular surface geometry. According to Ranawat et al[14] 15 years survivorship of this type of implant was 94%.

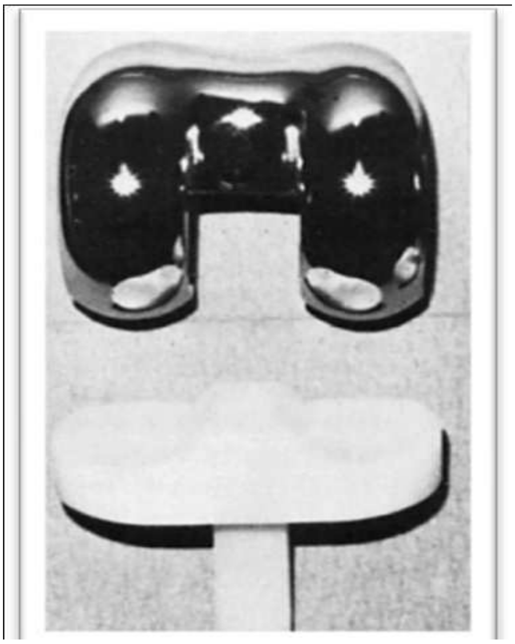


Fig.18 Total condylar prosthesis

Duopatellar Prothesis was devised followed by the total condylar prosthesis. In this prosthesis posterior cruciate ligament was retained. First it was designed in such a way that the medial and the lateral tibial component was a separate one, but later it was made into a single piece. It has a cut for the retention of the posterior cruciate ligament. In this duo patellar prosthesis, the patellar component was made up of all polyethylene dome like that of total condylar prosthesis. During the 1980s this duopatellar prosthesis was most commonly used by most of the surgeons.[15]

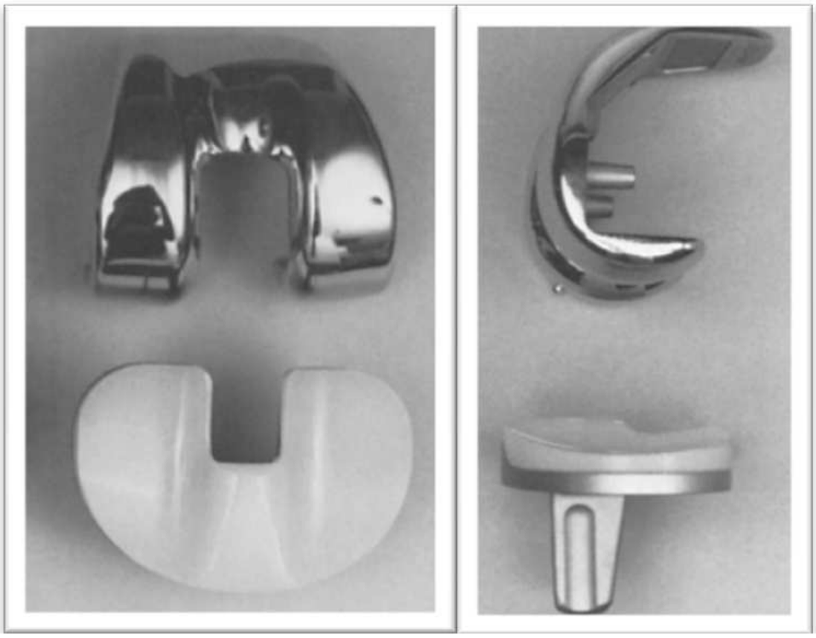


Fig.19 Cruciate retaining total condylar prosthesis

In view of short comings of the Total Condylar Prosthesis (TCP) in terms of tendency to subluxate posteriorly and inability of the prosthesis for "rolling back" mechanism, the Install- Burstein devised a newer prosthesis. He devised cruciate substituting design in which Posterior cruciate ligament is cut and stability was achieved by adding a cam mechanism which aids in femoral roll back (Fig. 20).[16]

Fig.20 Posterior cruciate substituting prosthesis

After the invention of this design it was most commonly used all over and even the most current designs were the derivatives of the initial Inasall design. During the early periods, Patellofemoral complications were more common and it was the most common cause for the revision in those patients. However with the subsequent development of most recent designs with increased surface area for the patellofemoral component those problems were overcomed and the rate of patellar subluxation was reduced.

Deep dish design was used in some of the designs. It was same as total condylar prosthesis in which the sagittal concavity was used to achieve the anteroposterior stability (Fig. 21).

Fig.21 Deep dish design

Laskin et al compared the posterior stabilized design with the deep dish design, and he concluded that there was no difference between these two designs in terms of range of motion, stability and pain. The main advantage of this design was less removal of bone, more of bone preserving, there was less chance for post op fracture .In deep dish design with proper balancing there was no significant difference in the knee flexion when compared to cruciate stabilized designs.[17]

COMPONENTS ALIGNMENT IN TOTAL KNEE REPLACEMENT

There are various studies which showed that the results of arthroplasty depends on restoration of normal limb alignment. . There is positive correlation between the success of TKR and the alignment of normal limb kinematics.

In 1988,Rand and Coventry[18] study showed that “rate of survival of 90% at ten years for patients with less than 4° of deviation from the neutral axis”.

In 1991, “Jeffrey et al[19] analysed the outcome after TKA in 115 patients and they found a rate of 24% of prosthetic loosening when the mechanical axis exceeded ±3° varus/valgus deviation, while it was only 3% in those patients with an axis within a range of ±3°”.

In 1993 according to Berger, Rubash and Richard et al[20], “The posterior condylar angle was measured as the angle between the posterior condylar surfaces and the surgical epicondylar axis. Measurement of the posterior condylar angle referenced from the surgical epicondylar axis yielded a mean posterior condylar angle of 3.5[degrees] (+/-1.2[degrees]) of internal rotation of femoral component. Thus, rotational alignment of the femoral component can be accurately estimated using the posterior condylar angle. The posterior condylar angle, referenced from the surgical epicondylar axis, provides a visual rotational alignment check during primary arthroplasty and may improve alignment of the femoral component at revision”.

In 1994 study by Ritter et al[21] “ 421 TKAs were analysed with regard to the femorotibial alignment and the highest rate of aseptic loosening was found in patients with a varus malalignment”.

In 1998, “Hvid and Nielsen[22] investigated the overall post-operative alignment of the limb in 138 consecutive TKAs and they reported superior long-term results for a femorotibial angle of between 5 and7°”.

In 2001, study by Barrack et al[23] stated that “the malrotation of components leads to maltracking of the patella and increased polyethylene wear and increased incidence of patellofemoral pain”.

“Bellemans et al[24] defined posterior condylar offset as the maximum thickness of the posterior condyle projected posteriorly to a line tangential to the posterior cortex of the femoral shaft”. In 2002 , study by Belleman et al showed that “decreasing posterior condylar offset in TKRs restricted the range of movement due to impingement of the tibial component on the posterior femoral shaft during flexion, exacerbated by paradoxical forward movements of the femur, a high posterior lip of the insert and reduced posterior tibial slope".

According to Bellman et al "significant correlation between FCO and maximal knee flection in 150 arthroplasties of the knee; every 1 mm increase in femoral condylar offset lead to a 6.1° increase in postoperative maximal flexion".

According to Figgie, "tibial component rotation was the most important factor for patellofemoral tracking and they attributed patellar fracture to improper rotational alignment of either the tibial component or the femoral component".

According to Merkow and Ranawat "patellar dislocation, subluxation, tilt, and excessive patellar wear result from malrotation of the tibial and femoral components".

The recent rotating platform design allows minor correction of rotational malalignment. Even though it improves the congruency of articulation it does not improve the maltracking of the patella in the trochlear groove, as showed in a study by Pagnano et al. in 2004 when comparing rotating platform TKA with a fixed bearing, PCL-substituting design.[25]

There are various factors affecting the patellofemoral tracking during the total knee replacement. Any condition which tends to increases the Q angle leads to maltracking of patella. If the tibial component is placed in more degree of internal rotation it rotates the tibial tuberosity laterally, increases the Q angle and thereby causing patellofemoral maltracking. More internal rotation of the femoral component causes shifting of the trochlear groove more medially and there by causes patella femoral maltracking. In case of patellar resurfing, the patellar component should be more medialised otherwise it causes patellofemoral maltracking. The rotational alignment of the tibial and the femoral component plays a very important role in the patellar tracking. Any deviation in the rotational alignment causes maltracking of patella and eventually failure of the replacement.

PCL-retaining and substituting prostheses both have excellent results of 10 to 15 years of results. In a case of bilateral knee replacement one side with cruciate retaining and the other side with cruciate substituting prosthesis there were no significant differences between the functional outcome and the patient satisfaction.

In cruciate retaining prosthesis because of effective femoral roll back it achieves increased range of motion. In cruciate substituting prosthesis femoral roll back was achieved by the post cam mechanism.

When compared to the original total condylar prosthesis both designs had greater range of flexion.

In various studies done to compare the results of PCL-retaining and the PCL-substituting prostheses showed that there was no significant difference of flexion attained in long-term follow-up.

In the cruciate substituting prosthesis, during the knee flexion the posterior displacement of the tibial post contacts the femoral cam, which results in increased stress borne by the prosthesis and it was transferred to the bonecement interface. Because of this many authors suggest that in cruciate substituting designs there was more chance of loosening and higher rates of failure. But rate of loosening of these two designs were similar at 10-year follow-up and this argument does not seem to be valid.

According to the study conducted by Andriacchi and Galante, Kelman et al.[26] and others, regarding the gait analysis " patients with cruciate retaining prostheses have more symmetrical gait, especially during stair climbing, when compared to the patients with PCL-sacrificing /substituting prosthesis".

Gait analysis done by Wilson et al. showed that there is no significant change in the gait of patients with cruciate substituting designs when compared with normal individuals. It was in contradiction to the previous studies. These observations are further supported by the study conducted by Stiehl et al, Victor, Banks, and Dennis et al.[27,28]

Patellofemoral joint function is affected by the elevation in the joint line when compared to the initial joint line during the total knee replacement. When compared with the cruciate retaining prosthesis regarding the flexion / extension gap with the elevation in the joint line the cruciate retaining prosthesis do not tolerate with the change in preoperative joint level. The position of the patella in relation to the femur is altered more in cruciate substituting prosthesis than with the cruciate retaining prosthesis. According to the study by Figgie et al "the joint line elevation will alter patellofemoral mechanics and it result in more postoperative pain and subluxation of the patella".[29]

Hozack et al reported patellar clunk syndrome seen in case of cruciate substituting designs. It was because during the knee flexion the patella contacts this "box", the patella and hypertrophic synovium can bind in this mechanism.[30]

Many authors suggest that during the course of the disease the PCL was contracted and diseased and it was difficult to balance the PCL during the surgery. Ritter and Scott et al devised intraoperative tests of PCL balance during the surgery.[31,32,33]

According to the study conducted by Scott and Volatile “In case of severe fixed knee deformity, the extensive collateral ligament release on the concave side of the fixed knee may not effective without the release of contracted PCL”.[34]

According to the study conducted by Laskin et al. “In case of preoperative fixed flexion contracture with varus or valgus deformities of 10 to15 degrees or more treated with PCL retention design had less postoperative flexion when compared to the PCL substituting designs”.[35,36] There was also residual flexion contracture and alteration in the mechanical axis when such patients are treated with the cruciate substituting designs.

According to the study conducted by Faris et al “In a large case series there was no significant difference found between the preoperative deformity and postoperative outcome treated with PCL retention”.[37]

In cruciate substituting prosthesis there was alteration in the geometry in the sagittal plane and it lead to increased rate of polyethylene wear due to the contact stress in the cruciate substituting designs. Several studies showed that accelerated polyethylene wear was due to the greater contact stress in case of a cruciate substituting designs. This wear was accelerated by the intact tight PCL which increases the contact stress.

According to study by Wasielewski and Wright et al by collecting large number of polyethylene specimens , if the PCL was tight during the knee flexion it causes the femoral condyles to override the tibial polyethylene which leads to increased contact stress and accelerated polyethylene wear.[38,39,40]

More recently, Dennis et al reported that in a case of cruciate retaining designs, if the PCL was poorly functioning it causes paradoxical anterior tibial translation during the knee flexion which lead to increased wear.[41]

According to the study by Puloski and O'Rourke et al “In a case of cruciate substituting designs , tibial post was the most common site for wear and breakage, particularly when the femoral component impinge on the tibial post anteriorly during the knee hyperextension”.[42,43]

Retrieval analysis by Cook, Dichiara et al., Mayor and Collier, and Ranawat, of the cementless implants showed that “there was little or no bony ingrowth into the tibial trays removed at the time of component revision”.[44,45,46]

Studies by Bloebaum, Rubman, and Hofmann and Sumner et al. regarding the bony ingrowth had been more favorable. According to Sumner et al. “when the Miller- Galante prostheses removed for reasons other than the loosening or infection, the average area of bony ingrowth was found to be 27% of the available porous surface and the bone ingrowth was maximum in the region of fixation screws ,pegs and in the anterior half of the tray”.[47,48]

According to Duffy , Berry and Rand et al “when compared with the 94% of survival rate of the cemented TKA ,many of the cementless TKA systems had poor survival rates, only 72% had 10-year survivorship with the cementless design”.[49]

According to the study by Barrack et al[50] “8% revision rate of a cementless mobile-bearing design when compared with none of the revisions in its cemented counterparts”.The main reason for the revisions was lack of tibial ingrowth in cementless TKA. Osteolysis was most commonly reported with the cementless prostheses than with cemented prosthesis.

According to Engh et al “use of porous coating on the tibial baseplate with intervening smooth metals shows high rate of osteolysis because of easy access to the metaphyseal bone”. Based on the study by Bergers et al “there was 12% tibial osteolysis and 8% tibial loosening in his study of 134 knees with cementless fixation”.[51,52] This leads many surgeons to abandon cementless fixation in TKA.

COMPLICATIONS DUE TO MALALIGNMENT OF COMPONENTS

PERIPROSTHETIC FRACTURES

Periprosthetic fracture can also occur after total knee replacement , incidence is about 0.3 to 2 percent .Supracondylar fractures femur can occur infrequently after TKA (0.3% to 2%). According to Lesh “Risk factors for periprosthetic fracture were anterior femoral notching, severe osteoporosis, rheumatoid arthritis, prolonged steroid use, female gender, case of revision arthroplasty, and in neurological disorders”. (Fig. 22).

Fig.22 Periprosthetic fracture

According to Lesh et al "31.5% of periprosthetic supracondylar femur fractures were due to a notched femur".[53]

Ritter et al study concluded that "there was no relationship between the femoral notching and the incidence of periprosthetic fracture , in their series of 1089 TKAs, 30% had a notched distal femur but only two fractures were occurred" .[54]

Healy, Silisky, and Incavo reported primary union in 18 of 20 patients at an average of 18 weeks after open fixation of femoral fractures using blade plates, buttress plates with bone grafting.[55]

Ritter et al described a technique using Rush pins with minimal soft tissue dissection. All fractures healed in this series, with two valgus malunions.

Henry reported fixation with a locked supracondylar intramedullary nail. In a multicenter series of 20 patients treated with this method, primary union occurred in all patients at an average of 10 weeks.[56](Fig.23)

Fig.23 Fixation using intramedullary nails

PATELLOFEMORAL COMPLICATIONS

According to the study by Briard et al component malalignment leads to patellofemoral complications like maltracking of patella and patellar fractures. Patellar fracture after TKA was uncommon, occurring in 0.5% of 2887 knees reported by Brick and Scott and in 0.68% of 12,464 knees reported by Ortiguera and Berry. Patellar fracture can be due to excessive resection, maltracking of patella ,vascular insuffiency due to lateral release ,more than 115° of knee flexion , trauma, thermal necrosis at the time of PMMA polymerization and in case of revision TKA.[57,](Fig. 24) Periprosthetic patellar fractures was classified by

Ortiguera and Berry[58]“Fractures associated with an intact extensor mechanism and stable implant (type I) should be treated conservatively with a knee immobilizer or cylinder cast for 6 weeks ,Displaced fractures with discontinuity in extensor mechanism (type II) should be treated surgically ,Loose patellar components (type III) are excised and not replaced because this will impair with fracture healing”.

Fig.24 Patella fracture

MATERIALS

AND

METHODS

MATERIALS AND METHODS

This study was done to analyse the clinical, functional outcome using knee society score and alignment of components using radiography and CT scan in total knee arthroplasty. A prospective study was done between the period of september 2013 – may 2015. 15 patients who underwent total knee arthroplasty in Institute of Orthopaedics and Traumatology, Madras Medical College were assessed clinically, functionally and radiologically.

The follow up period was at 3 months, 6 months. The study was conducted at the Institute of Orthopaedics, Madras Medical College , Chennai.

The data was entered in Microsoft Excel 2010 and paired ‘ t ‘ test and Chi-Square test were used to assess the statistical significance.

Inclusion Criteria

1) All patients with arthritis knee undergoing primary total knee replacement

Exclusion Criteria

1) Paralytic conditions which affects early mobilisation
2) Post traumatic knee
3) Psychiatric illness
4) Ipsilateral hip and ankle pathology
5) Infection

Preopertive Evaluation:

All patients invoved in the study were assessed clinically and radiologically

Clinical Assessment

Detailed history of all patients was taken. All patients were assessed clinically and functionally using the Knee Society Score. Preoperative medical evaluation of all patients was done to prevent the potential complications that were life-threatening or limb-threatening. All the cases were investigated and comorbid medical conditions brought under control before surgery pre op hemoglobin kept at minimum of 12 gms% and assessed.

Any limb length discrepancies were noted. Presence of any hip and foot deformities was assessed. The extensor mechanism was assessed for any quadriceps contractures. The knee deformities were examined for any fixed varus or valgus deformities or presence of any fixed flexion contracture.

Radiographic Assessment

Standard guidelines were utilized to get knee radiographs – standing anteroposterior view and a lateral view, presence of osteophytes, any bone defects in the tibia and femur and the quality of bone was assessed.

Kellegren and Lawrence radiological grading was used to evaluate the severity of the arthritis and graded from I to IV as follows:

Grade		**Definition**
I	Doubtful	small osteophyte, significance doubtful
II	Mild	Osteophyte Present, Joint Space maintained
III	Moderate	Moderate decrease in joint space
IV	Severe	Joint space greatly decreased, Sclerosis of Subchondral bone present

In the x rays following measurements were taken

1) Posterior condylar offset
2) Posterior tibial slope

Pre operative CT scanogram of both lower limbs from hip to ankle joint and following measurements were taken

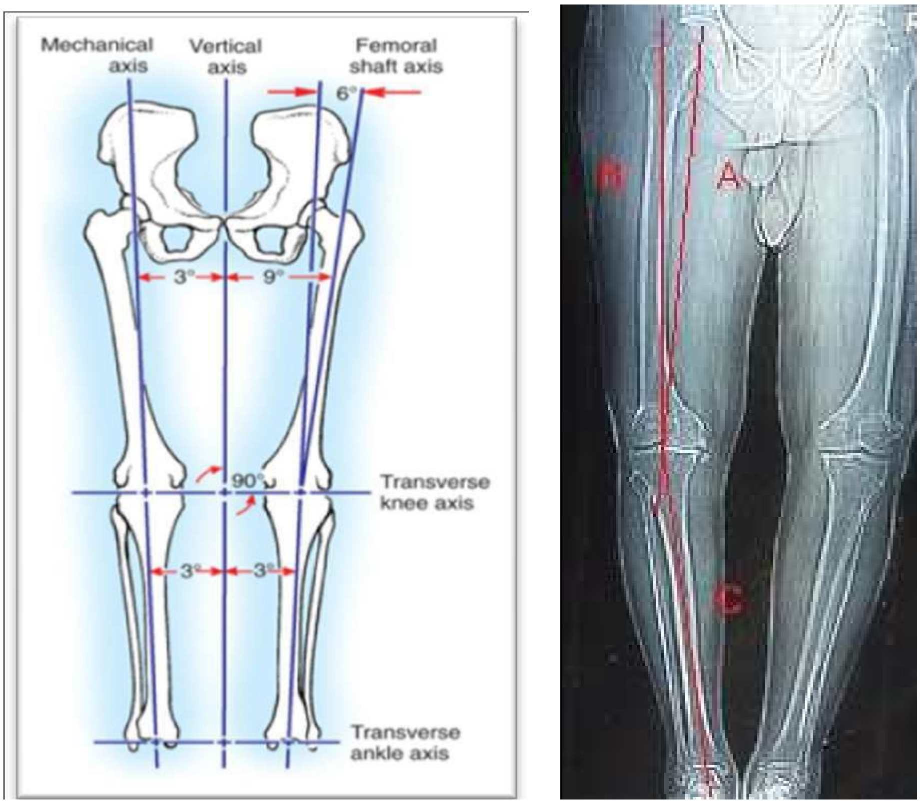
1) Angle between anatomical and mechanical axis of femur

2) Varus / valgus deformity of knee joint.

Measurement

Anatomical and mechanical axis of femur.

CT scanogram from the hip to the ankle joint was taken. The line from the center of the femoral to the center of the knee is called as mechanical axis of femur. The line drawn from the center of the proximal femur to the center of the knee is called as anatomical axis of femur . The angle between this two lines is usually 6° to 7°. The line drawn from the center of the femoral head to the center of the ankle joint usually passes through the center of the knee joint. Any deviation from the center of the knee joint medially or laterally represents varus or valgus deformity of the knee joint. (fig 25)



(Fig 25)

A is mechanical axis of femur

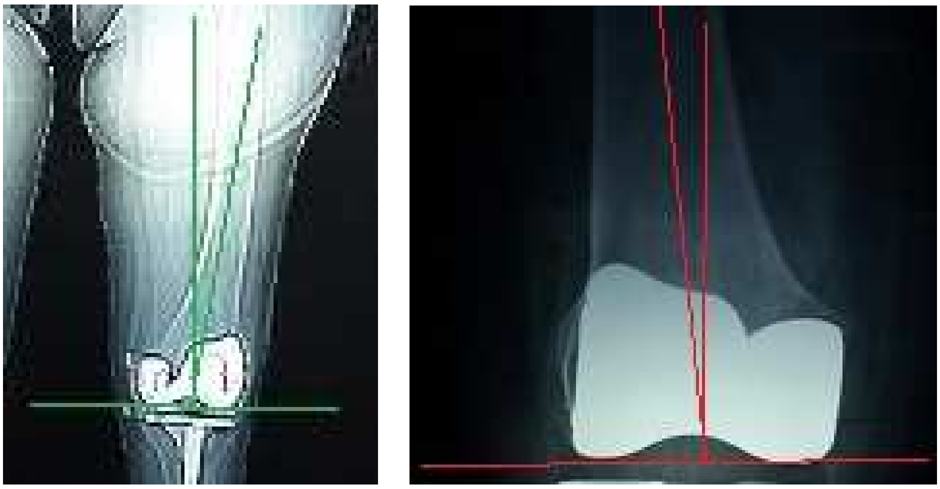
B is anatomical axis of femur

C is Tibial axis

Femoral component alignment

1) Axial alignment of femoral component

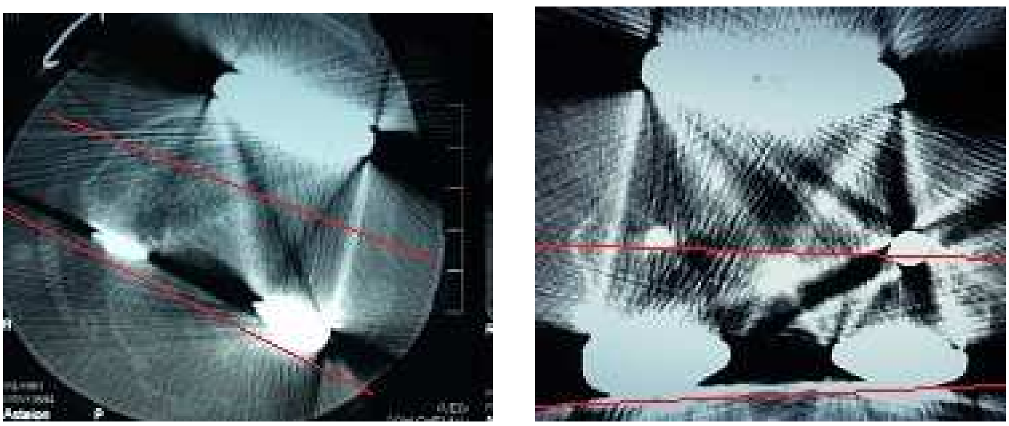
The normal axial alignment of the femoral component is 7 ± 3° valgus to the long axis of femur.(fig 26)



(Fig 26) The angle between the two lines indicate the valgus alignment of femur.

2) Rotational alignment of femoral component

CT scan was used to determine the femoral component rotation. It was calculated by angle between the line from medial sulcus of medial epicondyle to lateral epicondylar prominence and the line along the posterior condylar axis. Normal angle is 3.5 ± 1.2° internal rotation.(fig 27)



(Fig 27)The angle between the two lines indicate the rotational alignment of femur.

Tibial component alignment

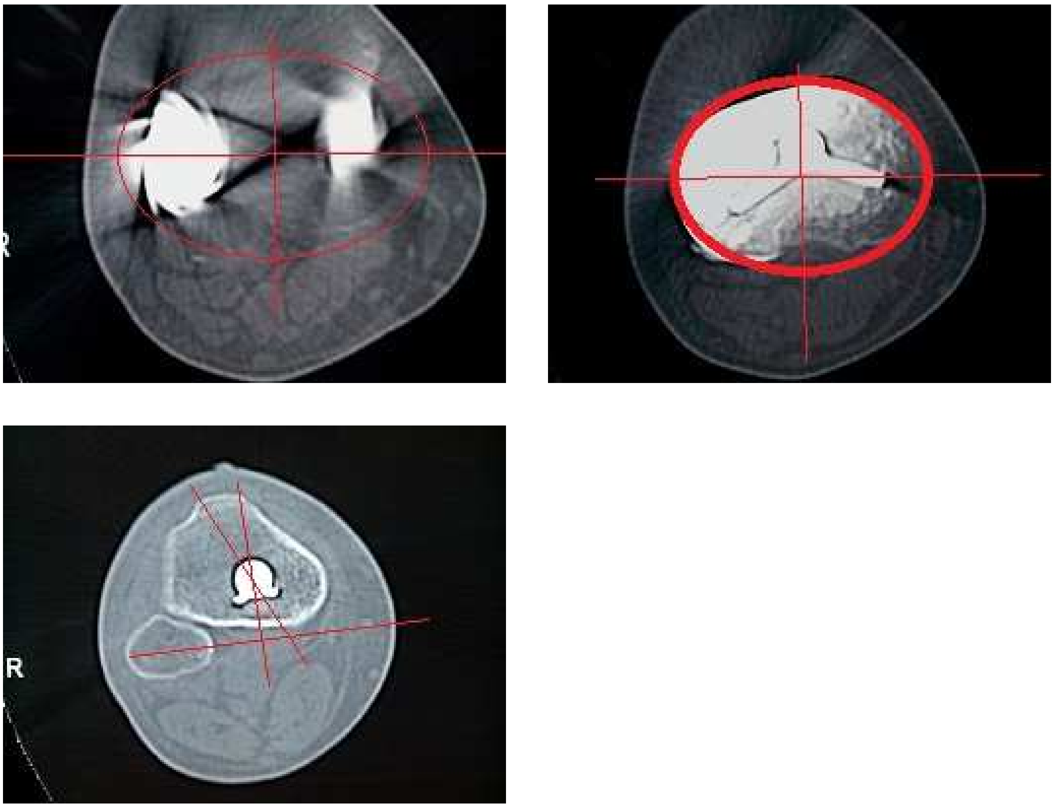
1) Axial alignment of tibial component

The normal tibial component alignment is 90 ± 3° to the long axis of tibia.(fig.28)

(Fig 28)The angle between the two lines indicate the alignment of tibial components

2) Rotational alignment of tibial component

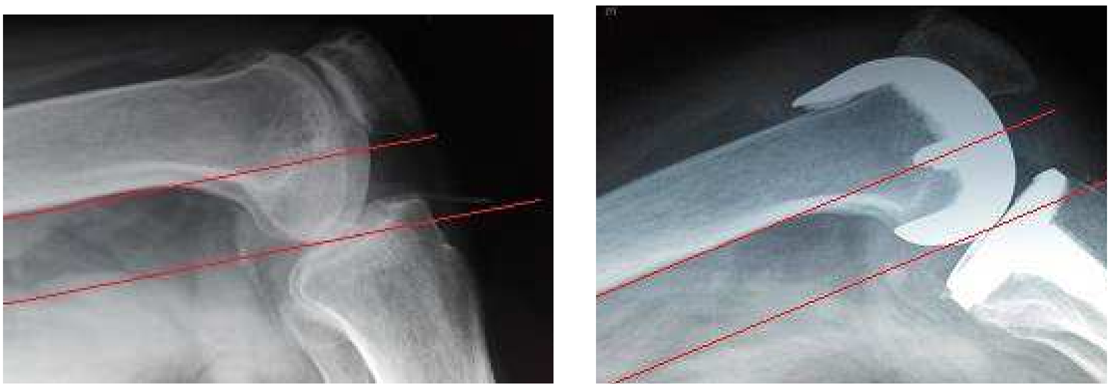
CT scan was used to determine the rotational alignment of the tibial component. Central point of tibial plateau was located and a line along the posterior aspect of the tibial tray was drawn. A line perpendicular to this through the center was drawn . Then it was superimposed at the level of tibial tubercle and a line drawn from the tibial tubercle to the center. The angle between this two lines indicates the rotational alignment of tibial component(fig.29). It is usually 18±2° of internal rotation.



(Fig.29)

Posterior condylar offset

Distance between the line drawn along the posterior aspect of femur to the posterior femoral condyle in the lateral radiograph (fig 30).



(Fig 30)

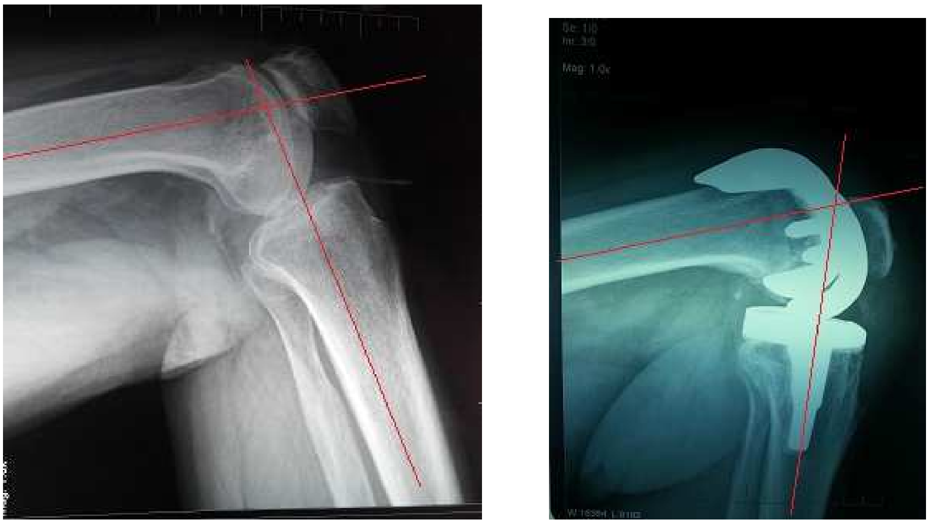
Posterior tibial slope

In the lateral radiograph, the angle between the tibial slope and the perpendicular to the long axis of the tibia is the posterior tibial slope (fig 31). The normal posterior tibial slope is 7° to 10°.

(Fig 31)The angle between the two lines indicate the posterior tibial slope.

Knee Flexion

Flexion is calculated by taking lateral radiograph with knee in full flexion. Angle between the line along the long axis of femur and tibia indicates the flexion of the knee(fig 32).



(Fig 32)

Implant used :

For all our cases we used smith and nephew genesis II implant with deep dish.

Surgical Technique

Spinal anaesthesia was given for all the patients.

Steps we followed during surgery

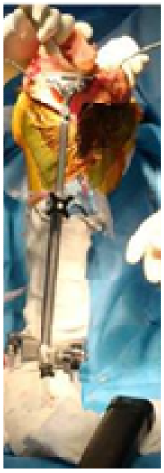
- Operative leg was painted and draped , stockinet applied, tourniquet applied
- Then knee was flexed to 90° and anterior midline incision 5cm above superior pole of patella to tibial tubercle was made

- Then through medial parapatellar approach knee joint was opened and patella was everted and lateral patella femoral ligament released.
- Then ACL was cut and all the surrounding osteophytes, lateral and medial meniscus was removed.
- Then lateral plateau was exposed with careful retraction of everted patella to avoid tension to the patellar tendon.
- Then the external tibial alignment jig was placed centred over the medial one third and lateral two third of the tibial tuberosity to the second toe and tibial cut was made with neutral posterior slope.
- Then posterior condylar axis, whiteside line and trasepicondylar line was made over the femoral condyle and femoral entry point was made superior and medial to the intercondylar notch.
- Then intramedullary jig for femur inserted and then distal femoral cut made with 6° of valgus.
- Then flexion and extension gap was checked.
- Then femoral component size was measured using posterior reference guide and then 4 in 1 block resection guide placed and then anterior, posterior cut and chamfer cut was made .

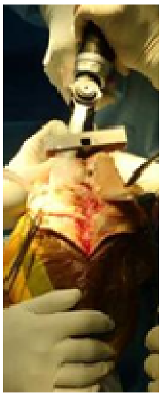
- Then the tibial trial base was placed and then flexion extension gap and varus valgus stability checked.
- Then entry hole for tibial stem made then using threated keel punch entry made in tibia.
- Then trial reduction done and flexion, extension gap , varus/ valgus stability and patellar tracking was checked .
- Then bone cement was prepared and spread over the cut surfaces of femur and tibia and the implant was inserted and then once the cement sets poly of appropriate size inserted
- Then osteophytes in the patella and circumferential denervation of patella done
- Through wound wash given, drain kept and wound closed in layers. Sterile dressing done.

Midline skin incision

Medial parapatellar approach



Eversion of patella **External alignment jig for tibia**



Femoral resection jig **Rectangular extension gap**

Post – Op Protocol

Postoperative physical therapy and rehabilitation greatly influence the outcome of TKA. Initially, a compressive dressing applied to relieve pain and to decrease postoperative haemorrhage. Passive knee extension was encouraged by placing the patient's foot on a pillow while in bed.

The postoperative rehabilitation protocol includes lower extremity muscle strengthening, concentrating on the quadriceps; gait training, with weight bearing and instruction in performing basic activities of daily living. The patients were started on IV antibiotics and DVT prophylaxis in the form of subcutaneous low molecular weight heparin.

1st post op day, patient was taught static quadriceps exercises.

2nd post op day, the dressing was debulked and wound inspected. Patient was made to walk full weight bearing within the limits of pain and advised to continue static quadriceps exercises.

IV antibiotics were given for the first 72 hours post op and DVT prophylaxis was given for the first ten days post operatively.

12th post op day, sutures were removed and patient was advised to continue regular physiotherapy.

Follow Up

The patient was assessed clinically, functionally using knee society score and radiologically at an interval of 3 months and 6 months.

OBSERVATION

AND

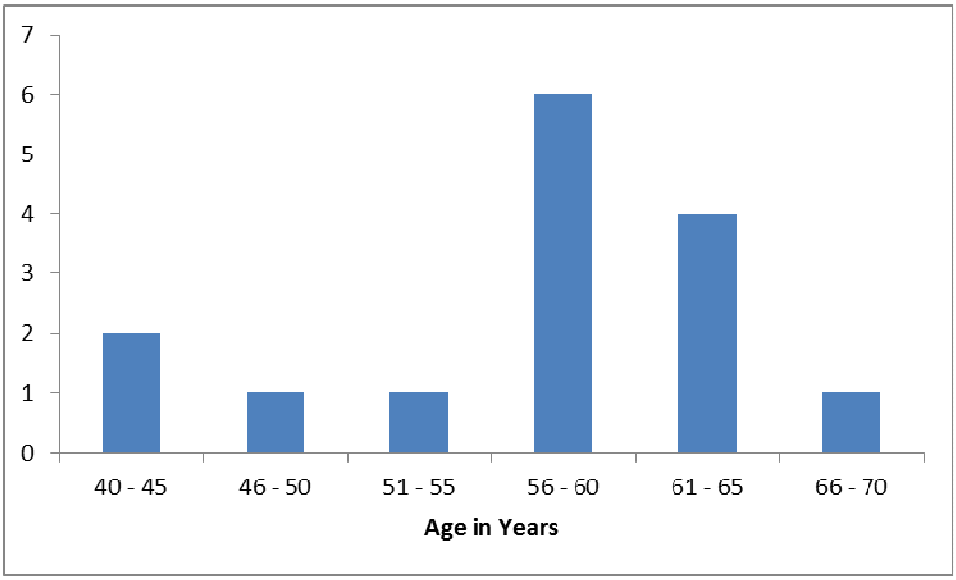
RESULTS

OBSERVATION AND RESULTS

Table I : Age Distribution

Age in years

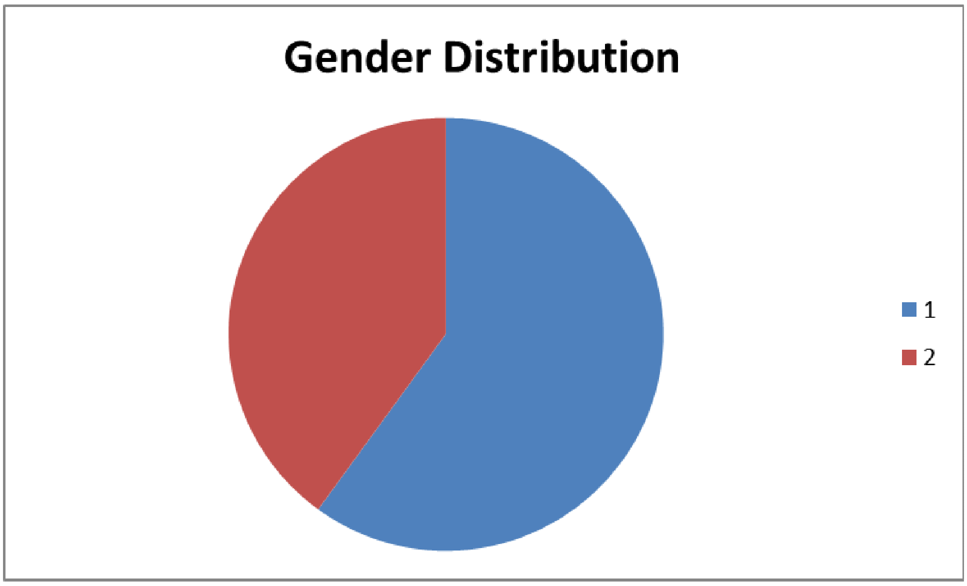
Age in years	Frequency	Percent
40-45	2	13.3
46-50	1	6.7
51-55	1	6.7
56-60	6	40.0
61-65	4	26.7
66-70	1	6.7
Total	15	100.0



Most of the patients are in the age group of 56 to 60 which accounts for 40% in the study . Mean age is 57.2 .

Table 2 : Gender Distribution

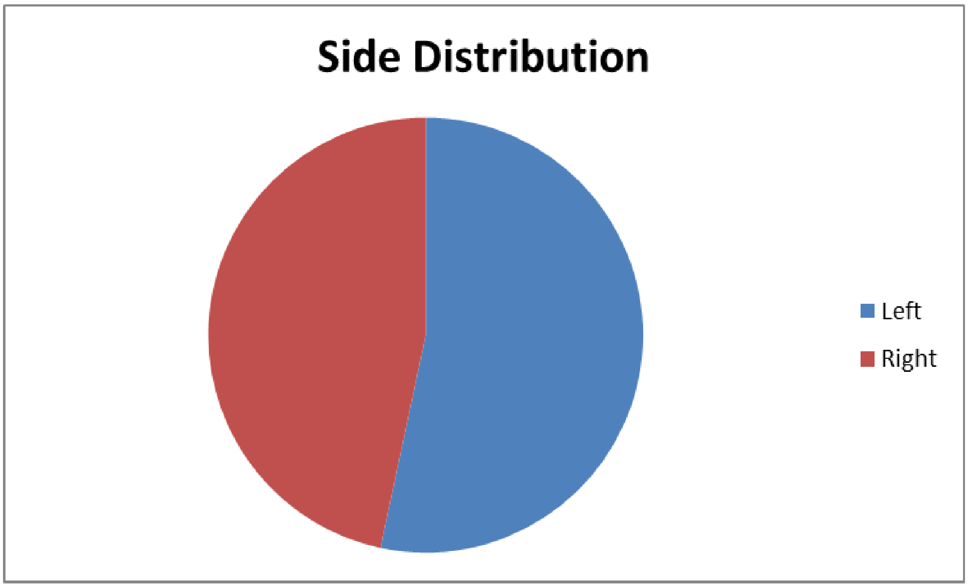
Sex	Frequency	Percent
Male	9	60.0
Female	6	40.0
Total	15	100.0



There were male predominance in the study, 60% were males and 40% were females

Table 3 : Side Distribution

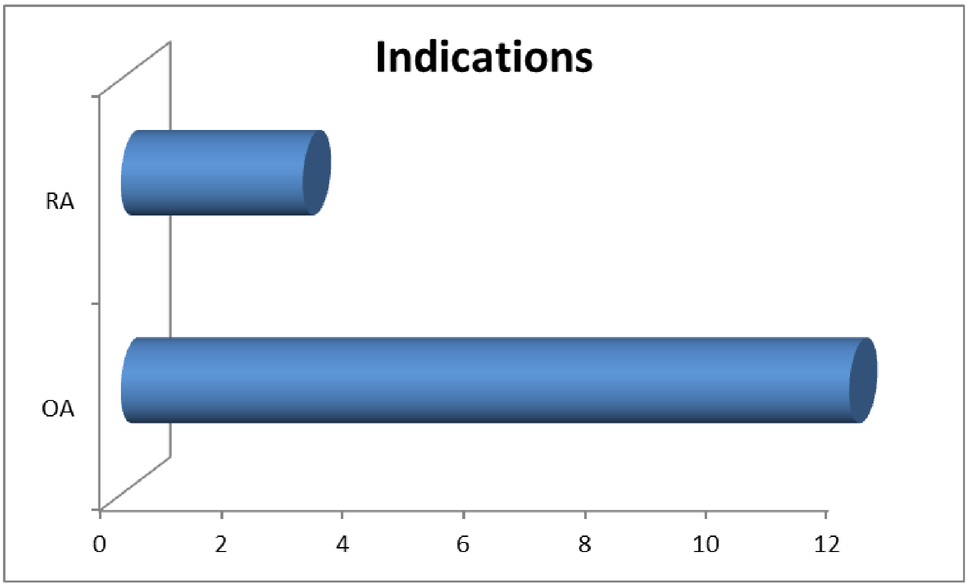
Side	Frequency	Percent
Left	8	53.3
Right	7	46.7
Total	15	100.0



There was predominance of left side in our study.

Table 4 : Comparison of Indications

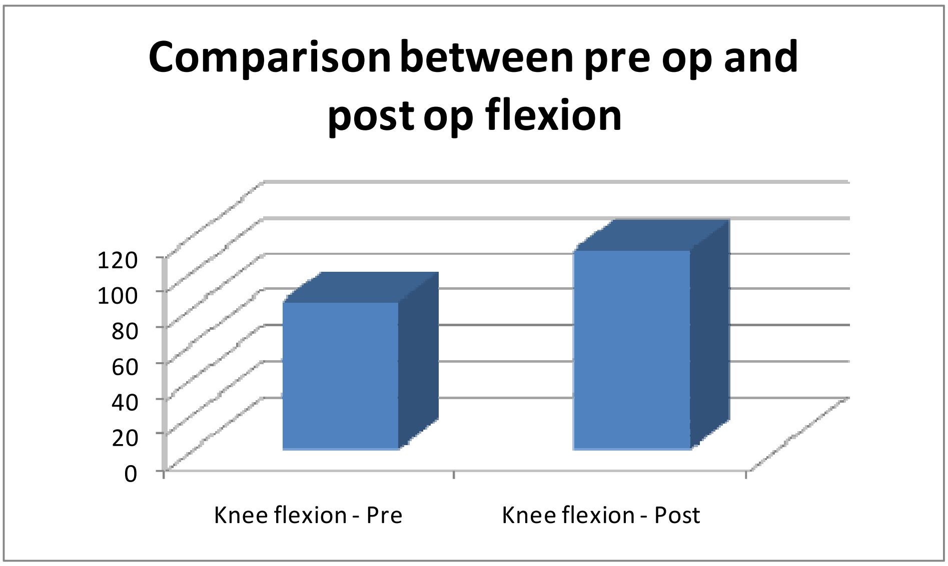
Indication	Frequency	Percent
OA	12	80.0
RA	3	20.0
Total	15	100.0



The most common indication for total knee replacement in our study was osteoarthritis knee.

Table 5: Comparison between pre op and post op flexion

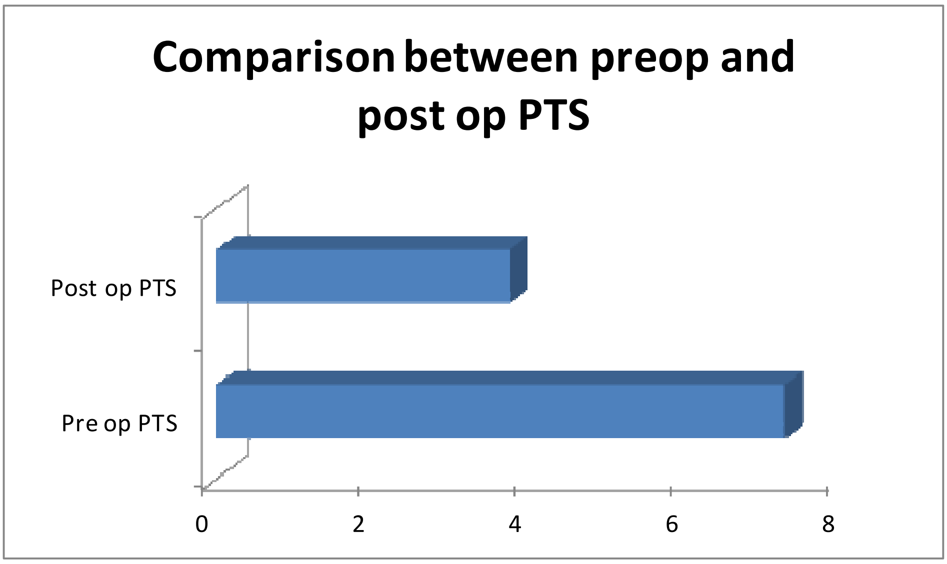
Knee flexion	Mean	P value
Pre op	82.67°	< 0.001
Post op	111.67°	



The mean preoperative knee flexion was 82.67° and the mean post operative knee flexion increased to 111.67° with significant p value of < 0.001.

Table 6: Comparison between pre op and post op posterior tibial slope

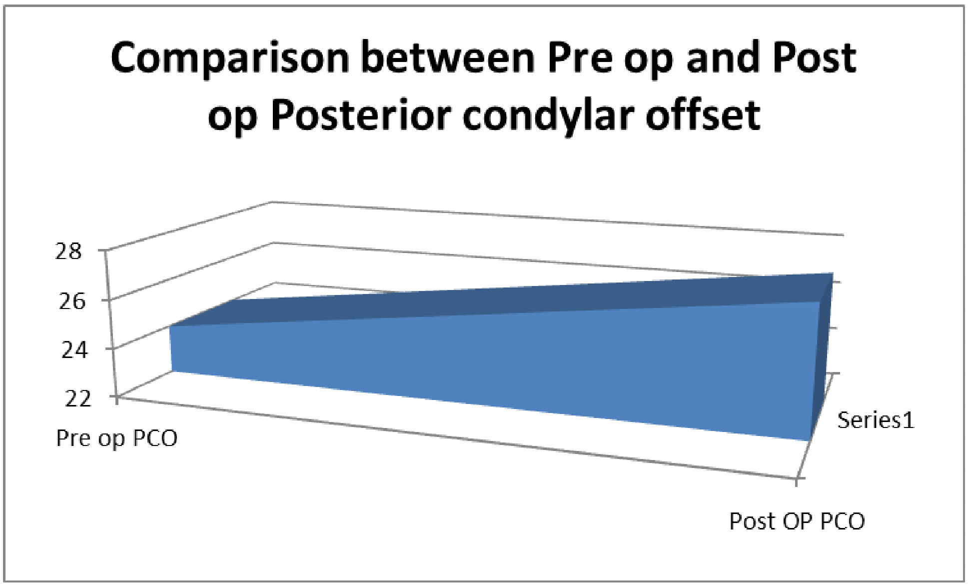
Posterior tibial slope	Mean
Pre op	7.24°
Post op	3.73°



The mean post op posterior slope decreased from 7.24° to 3.73°.

Table 7: Comparison between pre op and post op posterior condylar offset

Posterior condylar offset	Mean	P value
Pre op	24.00 mm	< 0.001
Post op	27.20 mm	

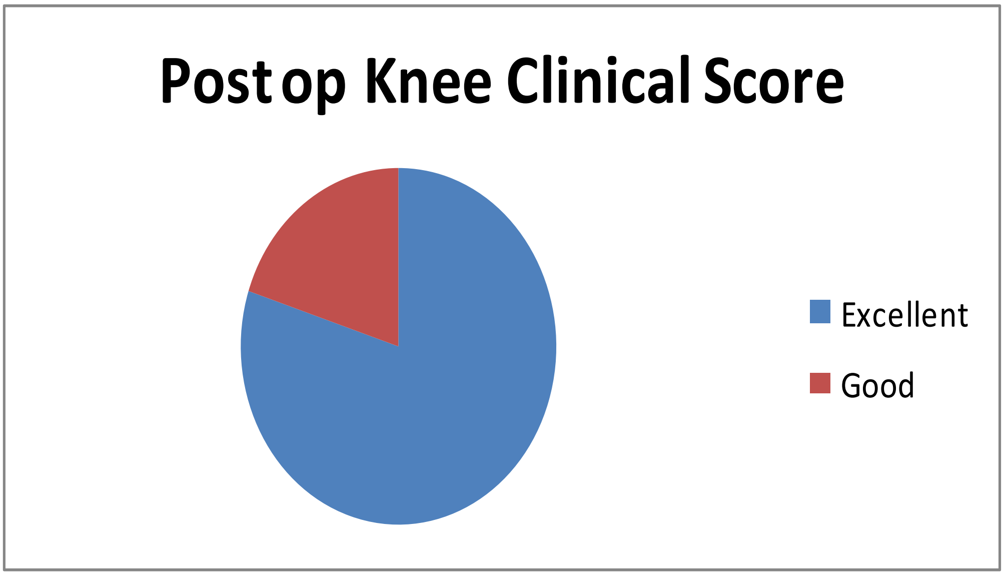


The mean preoperative posterior condylar offset is 24 mm which is increased to 27.20 mm with significant p value of < 0.001. There is positive pearson Correlation (0.093) between post operative increase in posterior condylar offset and increase in post operative knee flexion.

Table 8: Comparison between preop and post op knee society score.

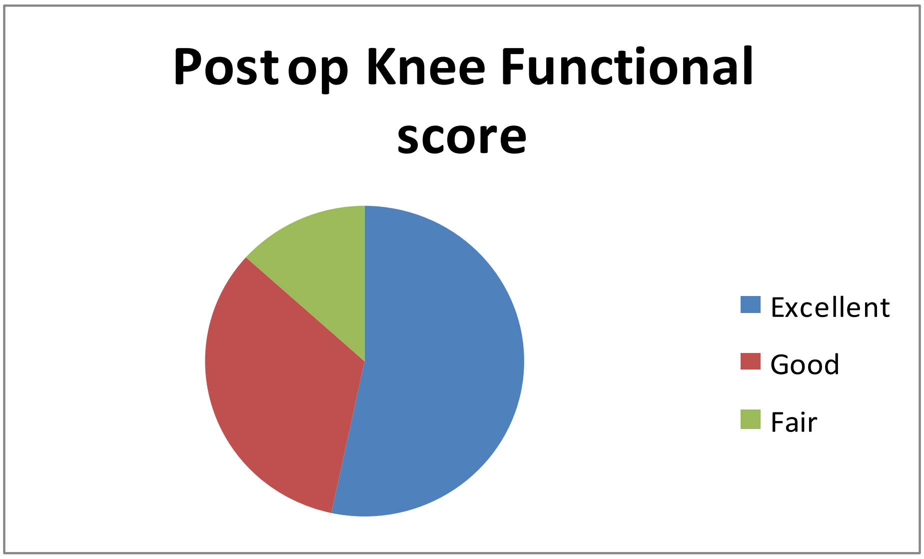
Knee Clinical Score

Knee clinical score	Mean	P value
Pre op	28.13	< 0.001
Post op	94.60	



Knee Functional score

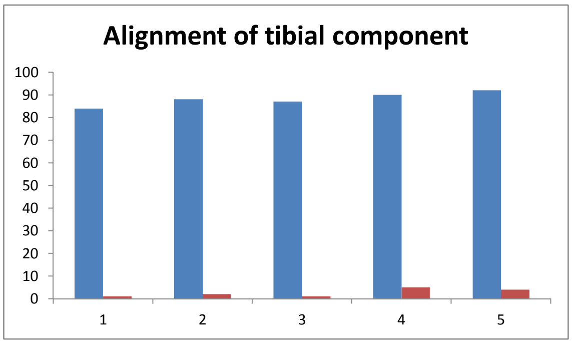
Knee functional score	Mean	P value
Pre op	39.67	< 0.001
Post op	83.33	



There is significant improvement in knee clinical and knee functional score after surgery with p valve < 0.001.

Table 9:

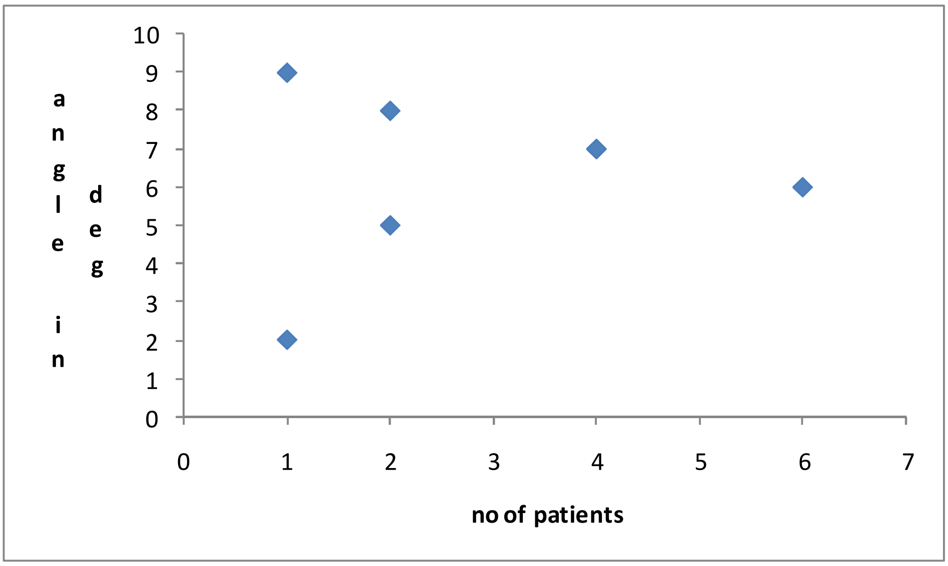
Alignment of tibial component



Tibial alignment ranges from 84° to 92° with maximum number of patients have 90°.

Table 10:

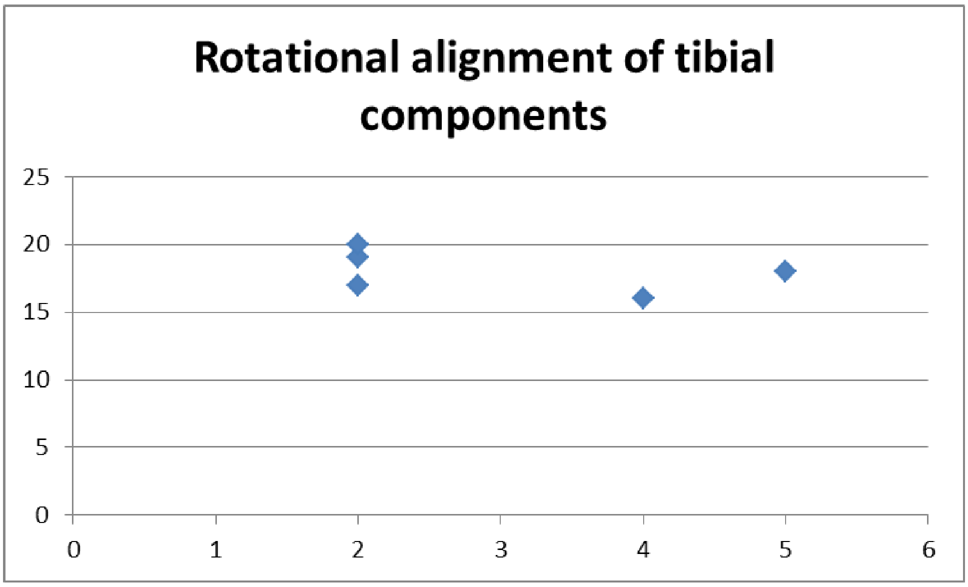
Valgus alignment of femoral component



Femoral component alignment from 2° to 9° of valgus with maximum no of patients has 6° of valgus

Table 11:

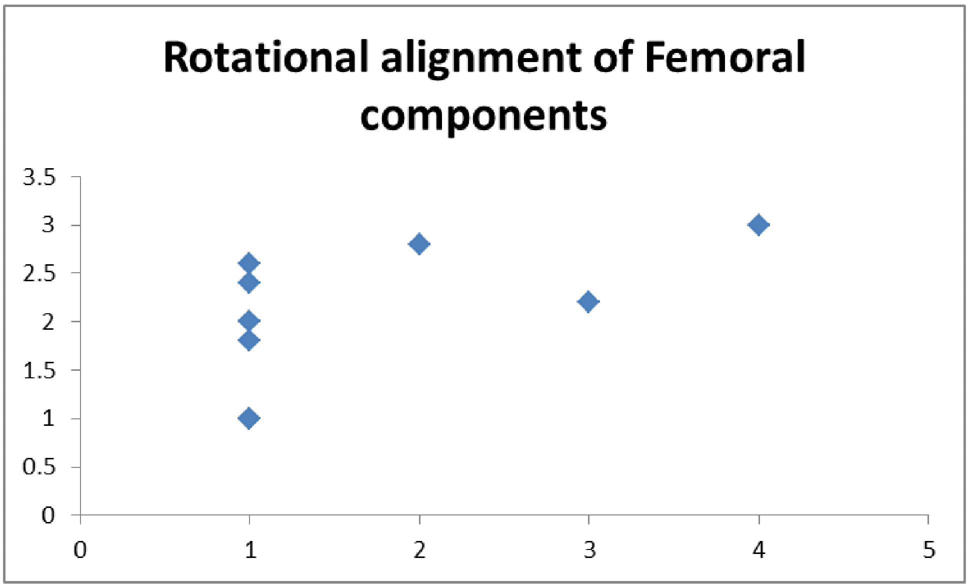
Rotational alignment of tibial components



Tibial component rotational alignment from 16° to 20° with maximum patients has 18° of internal rotation.

Table 12:

Rotational alignment of femoral components



Rotational alignment of femoral component ranges from 1.8° to 4° with maximum patients has 3° of internal rotation.

DISCUSSION

DISCUSSION

Total knee arthroplasty is successful procedure and is associated with good functional improvement. There is good relief of joint pain, increased mobility, correction of deformity and an improvement in the quality of life of the patients following total knee arthroplasty.

In this study fifteen patients were included who met the inclusion criteria and total knee replacement were done.

In our study the mean tibial component alignment in coronal plane was 89.53° and sagittal plane was 3.73°, except one patient who had malalignment of tibial component in the coronal plane. We were able to achieve alignment of the tibial component within normal limit using external alignment jig for tibia.

According to Jeffery et al[59] distal femoral resection was based on the intramedullary guide for femur and there was high chance for coronal malalignment of femoral component. But, in our study the coronal alignment was well maintained using intramedullary cutting jig for femur.

The mean coronal alignment of femoral component in our study was 6.33°, except for one patient who had malalignment of femoral component in coronal plane.

"Müller et al reported in his study that there was 30 % malalignment of femoral components using intramedullary jigs for femur in posterior stabilised knee and associated with poor functional outcome".

In our study there was one patient (6.66%) had malalignment of femoral component using intramedullary jigs for femur with suboptimal functional outcome.

According to the study by Young Wan Moon et al in total knee replacement done in 154 knees there was 34% malalignment of femoral and tibial components using jigs in posterior stabilized knees, in our study there was two patients (13.3%) who had malalignment.

According to the study by Khardwakar and Kent et al, in 83 patients using intramedullary jigs for femur, taking 6° valgus cut for all patients was safe with postoperative mean valgus alignment of femoral component of 5.4° In our study also, 6° valgus cut was taken and the mean postoperative valgus angle was 6.33° with good functional outcome.

According to Fujisawa et al “the postoperative mechanical axis should pass through the lateral one third of the tibial plateau with ideal postoperative lower limb alignment of 3°-6° of valgus from the mechanical axis or 8°-10° of anatomical valgus”. In our study the mean valgus angle was 6.33°.

According to Bellman et al[60] “significant correlation between femoral condylar offset and maximal knee flection in 150 arthroplasties of the knee; every 1 mm increase in femoral condylar offset lead to a 6.1° increase in postoperative maximal flexion”. In our study postoperative posterior condylar offset increased by a mean of 3.20 mm and the knee flexion increased by a mean of 29° with significant p value < 0.001.

According to Bergar and Rubash the ideal placement of tibial component is 18±2° of internal rotation. In our study using the external alignment jigs for tibia, mean rotational alignment was 17.73°.

According to Rubash, Richard and Berger et al “rotational alignment of the femoral component can be accurately estimated using the posterior condylar angle. The posterior condylar angle, referenced from the surgical epicondylar axis, provides a visual rotational alignment check during primary arthroplasty and may improve alignment of the femoral component at revision”.

The rotational alignment of the femoral component which was saved in the registry report is 3.5±1.2°. In our study posterior condylar line was used as reference and the mean rotational alignment of the femoral component for femur was 3.14°.

There was significant increase in flexion following total knee replacement. The mean preoperative flexion was 82.67° which increased to 111.67°.

According to Lee M.Longstaff et al[61] "Good Alignment of components in total knee arthroplasty leads to faster rehabilitation and better functional outcome". In our study knee society score was used to assess the outcome of total knee arthroplasty and there was significant improvement of Knee Clinical Score and Knee Functional Score following Total Knee Arthroplasty.

Two patients had fixed flexion deformity of 5° which was corrected with postoperative physiotherapy.

In our follow up study the component position and alignment was well maintained. Long term follow up results are needed to strengthen the study.

CONCLUSION

CONCLUSION

Restoration of neutral alignment is an important factor affecting the long-term results of total knee arthroplasty.

- Intramedullary jig for femur gave satisfactory coronal plane alignment of the femoral component.
- For rotational alignment of the femur in addition to the posterior condylar line, transepicondylar axis and whiteside line must also be compared.
- Extramedullary alignment jig for tibia provided satisfactory coronal plane alignment of the tibial component.
- It is ideal to compare the position of the components with the anatomical landmark intraoperatively in addition to the jigs.

When all the landmarks are used in total knee replacement using traditional jigs we can achieve proper component alignment.

Large sample size and long term follow up are needed to further strengthen the study.

CASE ILLUSTRATION

CASE ILLUSTRATIONS

Case I

Mr.Radhakrishnan 58/m

Diagnosis: Osteoarthritis right knee

Pre op knee flexion	70°
Post op knee flexion	115°
Pre of Knee clinical score	31
Pre op Knee functional score	92
Post op Knee clinical score	20
Post op Knee functional score	80
Preop Posterior condylar offset	26mm
Postop Posterior condylar offset	28mm
Pre op Posterior tibial slope	7°
Post op Posterior tibial slope	4°
Femoral component alignment Valgus Rotational	 8° 4°
Tibial component alignment Axial Rotational	 92° 16°

Case I

Pre Op **Post Op**

Post Op CT

Clinical Picture

Case II

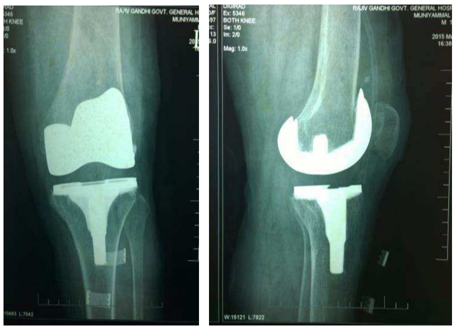
Mrs Muniyammal 68/f

Diagnosis: Osteoarthritis left knee

Pre op knee flexion	75°
Post op knee flexion	105°
Pre of Knee clinical score	22
Pre op Knee functional score	98
Post op Knee clinical score	30
Post op Knee functional score	90
Preop Posterior condylar offset	22mm
Postop Posterior condylar offset	26mm
Pre op Posterior tibial slope	7°
Post op Posterior tibial slope	3°
Femoralcomponent alignment Valgus Rotational	 9° 2.4°
Tibial component alignment Axial Rotational	 92° 16°

Case II

Preop Xray **Post Op X rays**



Post op CT

Clinical Picture

Case III

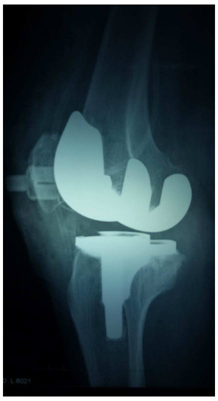
Mrs Krishnamoorthi 65/m

Diagnosis: Osteoarthritis right knee

Pre op knee flexion	95°
Post op knee flexion	120°
Pre of Knee clinical score	39
Pre op Knee functional score	99
Post op Knee clinical score	50
Post op Knee functional score	90
Preop Posterior condylar offset	28mm
Postop Posterior condylar offset	32mm
Pre op Posterior tibial slope	9°
Post op Posterior tibial slope	4°
Femoralcomponent alignment Valgus Rotational	 5° 3°
Tibial component alignment Axial Rotational	 90° 16°

Case III

Pre op **Post op**



Post op CT

Clinical Picture

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ANNEXURE

PROFORMA

Analysis of components alignment in Total knee replacement using traditional jigs and its relationship to the functional outcome

Name: Age/Sex: IP Number:

Address with contact no.:

Diagnosis:

Date of admission: Date of surgery:

Procedure done:

Pre operative period

Knee movements:

Flexion:

Extension:

Valgus / varus deformity:

Fixed flexion deformity:

Pre op CT scanogram:

Angle between anatomical and mechanical axis:

Valgus /varus angulation:

Level of Isthmus:

Pre op Xrays:

Posterior condylar offset:

Posterior tibial slope:

Surgery**:**Cruciate retaining / cruciate substituting total knee replacement

Approach:

Femoral jig:

Length of the jig:

Degree of valgus cut taken:

Tibial jig:

Extramedullary / Intramedullary jig:

Releases Done:

Implant used:

Femoral Component:

Tibial component:

Poly:

Cementation:Yes / no

Augmentation: Yes / no

Blood loss:

Duration of the surgery:

Post operative period:

Drain:

Weight bearing started on:

Physiotherapy given:

Suture Removed on:

Radiological outcome:

Post op CT scanogam

Angle between mechanical and anatomical axis :

Femoral component

Varus:

Valgus:

Rotation:

Tibial Component

Varus:

Valgus:

Rotation

Post op xrays

Posterior condylar offset:

Posterior tibial slope:

Post op Knee Movements:

Flexion:

Extension :

Functional outcome:

Knee society score:

2nd POD:

6th POD:

6th week:

CONSENT FORM

Name of the patient;_________________________ Date:__________

S/W/D Of:__________________________________

Theses No:_____Address:______________________________

______________________________________.

Phone No:

1. I,____________________________ S/W/D Of:___________________ , resident of ____ Have been informed by the doctor that the clinical diagnosis of my disease is ____
2. I have been further informed by the doctor that the treatment planned for my disease is_________________________________.
3. I have been given the options to ask for any second opinion regarding the diagnosis and treatment.
4. I have been informed that after surgery, I will not be able to squat on the ground and sit cross legged.
5. The risks of the surgery have been discussed with me in the language I understand. The major risks which have been discussed include :
   A: Infection
   B: Deep Vein Thrombosis and Pulmonary Embolism
   C:Anaesthetic Risks
6. I have been given the opportunity to ask all questions and I have been satisfactorily answered
7. I am aware that in the practice of medicine , other untoward/unexpected risks or complications not discussed may occur. I further understand that during the course of the proposed surgical procedure , unforeseen conditions may be revealed necessitating the performance of additional rectifying /modifying surgery.
8. The translation of the above has been made explained to me in the language I best understand

Date of surgery: Signature Of The Patient/Authorizing Person (With Relation)

Witness 1:

Witness 2:

ANNEXURE

KNEE SOCIETY KNEE SCORE

KNEE CLINICAL SCORE

Pain	**50 (Maximum)**
Walking	
None	35
Mild or occasional	30
Moderate	15
Severe	0
Stairs	
None	15
Mild or occasional	10
Moderate	5
Severe	0
R.O.M.	**25 (Maximum)**
For each 5º= 1 point	
Stability	**25 (Maximum)**
Medial/Lateral	
0-5 mm	15
6-10 mm	10
> 10 mm	5
Anterior/Posterior	
0-5 mm	10
6-10 mm	8
> 10 mm	5
Deductions	
Extension lag	
None	0
<5 degrees	-2
5-10 degrees	-5
>11 degrees	10
Fixed Flexion Deformity	
< 5 degrees	0
6-10 degrees	-3
11-20 degrees	-5
> 20 degrees	-10
Malalignment	
5-10 degrees	0
(5º = -2 points)	
Pain at rest	
Mild	-5
Moderate	-10
Severe	-15
Total Knee Score	**100 (Maximum) =**

ANNEXURE -
FUNCTIONAL KNEE SCORE

Walking		
Unlimited	55	
10-20 blocks	50	
5-10 blocks	35	
1-5 blocks	25	
< block	15	
Cannot	0	
Stairs Up		
Normal	15	
Hands balance	12	
Hands pull	5	
Cannot or bizarre	0	
Stairs Down		
Normal	15	
Hands balance	12	
Hands hold	5	
Cannot or bizarre	0	
Chair		
Normal	15	
Hands balance	12	
Hands pull	5	
Cannot	0	
Functional Deductions		
Cane	-2	
Crutches	-10	
Walker	-10	

Functional Score 100 (Maximum) =

INSTITUTIONAL ETHICS COMMITTEE
MADRAS MEDICAL COLLEGE, CHENNAI-3

EC Reg No.ECR/270/Inst./TN/2013
Telephone No. 044 25305301
Fax : 044 25363970

CERTIFICATE OF APPROVAL

To
Dr.M.Shanmugaraja
Post Graduate M.S.(Orthopaedics)
Madras Medical College
Chennai 600 003

Dear Dr.M.Shanmugaraja,

The Institutional Ethics Committee has considered your request and approved your study titled **"*Analysis of components alignment in total* knee replacement using traditional jigs and its relationship to the functional outcome" No.31052015.**

The following members of Ethics Committee were present in the meeting held *on 12.05.2015 conducted at Madras Medical College, Chennai-3.*

1. Prof.C.Rajendran, M.D., : Chairperson
2. Prof.R.Vimala, M.D., Dean, MMC, Ch-3 : Deputy Chairperson
3. Prof.B.Kalaiselvi, M.D., Vice-Principal, MMC, Ch-3 : Member Secretary
4. Prof.B.Vasanthi, M.D., Prof. of Pharmacology, MMC : Member
5. Prof.P.Ragumani, M.S., Professor of Surgery, MMC : Member
6. Prof.Saraswathy, M.D., Director, Pathology, MMC, Ch-3 : Member
7. Prof.K.Srinivasagalu, M.D.,Director, I.I.M. MMC, Ch-3 : Member
8. Thiru S.Rameshkumar, B.Com., MBA : Lay Person
9. Thiru S.Govindasamy, B.A., B.L., : Lawyer
10. Tmt.Arnold Saulina, M.A., MSW., : Social Scientist

We approve the proposal to be conducted in its presented form.

The Institutional Ethics Committee expects to be informed about the progress of the study and SAE occurring in the course of the study, any changes in the protocol and patients information/informed consent and asks to be provided a *copy of the final report.*

13/5/15

Member Secretary, Ethics Committee

MEMBER SECRETARY
INSTITUTIONAL ETHICS COMMITTEE
MADRAS MEDICAL COLLEGE
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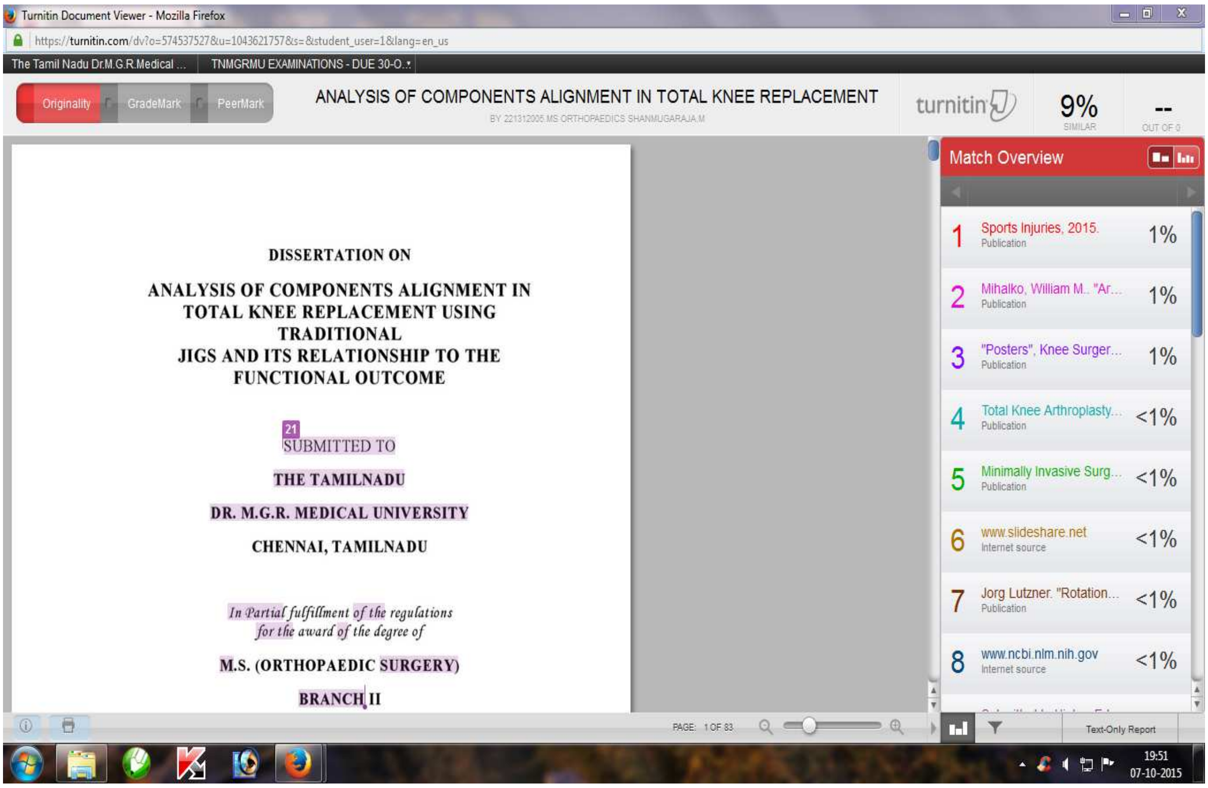
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DISSERTATION ON
ANALYSIS OF COMPONENTS ALIGNMENT IN TOTAL KNEE REPLACEMENT USING TRADITIONAL JIGS AND ITS RELATIONSHIP TO THE FUNCTIONAL OUTCOME
21
SUBMITTED TO
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DR. M.G.R. MEDICAL UNIVERSITY
CHENNAI, TAMILNADU
In Partial fulfillment of the regulations for the award of the degree of
M.S. (ORTHOPAEDIC SURGERY)
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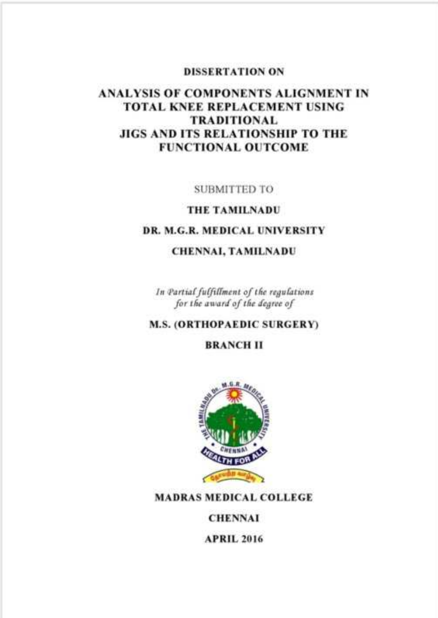

DISSERTATION ON

ANALYSIS OF COMPONENTS ALIGNMENT IN TOTAL KNEE REPLACEMENT USING TRADITIONAL JIGS AND ITS RELATIONSHIP TO THE FUNCTIONAL OUTCOME

SUBMITTED TO

THE TAMILNADU

DR. M.G.R. MEDICAL UNIVERSITY

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In Partial fulfillment of the regulations for the award of the degree of

M.S. (ORTHOPAEDIC SURGERY)

BRANCH II

MADRAS MEDICAL COLLEGE

CHENNAI

APRIL 2016

MASTER CHART

S No	Name	Age	IP no	Side	Diagnois	Deformity		Knee flexion		Knee society score				PCO		PTS		Post op Femoral component alignment		Post op Tibial component alignment	
										KCS		KFS									
						Valgus	Varus	Pre op	Post op	Pre op	Post op	Pre op	Post op	Pre op	Post op	Pre op	Post op	valgus	Rotation	Tibial axis	Rotation
1	Vasantha	60/F	53624	L	OA		8	80	105	26	92	45	70	24	26	7	5	7	3	90	18
2	Radha Krishnan	58/M	54241	R	OA		14	70	115	31	92	20	80	26	28	7	4	8	4	92	16
3	Machakalai	65/M	50213	L	OA		10	85	95	17	80	30	60	22	26	8	4	7	2.6	84	17
4	Ponnan	59/M	44206	L	OA		12	90	115	39	97	30	80	20	24	6	3	6	2.8	86	20
5	Ibrahim	57/M	44161	L	OA	6		80	110	27	97	45	90	30	34	9	4	7	3	90	17
6	Loganathan	60/M	45624	R	OA		8	70	110	20	97	30	80	24	26	8	3	6	3.2	90	18
7	Muniammal	68/F	36375	L	OA	10		75	105	22	98	30	90	22	26	7	3	9	2.4	92	16
8	Krishnamoorthi	65/M	29762	R	OA		14	95	120	39	99	50	90	28	32	9	4	8	3	90	16
9	Chandra	62/F	11878	R	OA		6	60	100	17	80	30	80	26	30	8	5	2	2.8	88	18
10	Jayalakshmi	54/F	16104	L	OA		8	100	125	38	98	50	90	30	32	7	2	6	2.6	87	19
11	Shanthi	40/F	11579	R	RA	8		80	110	25	97	45	90	24	26	6	4	5	2.2	90	20
12	Rangan	46/M	12266	L	RA		6	75	110	26	98	45	80	22	24	5	3	6	3	92	18
13	Ramesh	42/M	13331	R	RA	10		75	110	21	97	45	90	20	24	7	4	6	1.8	92	16
14	Allimuthu	62/M	24810	L	OA		14	105	125	38	98	50	90	22	26	8	5	7	2.0	92	19
15	Sulochana	60/F	46188	R	OA	6		100	120	36	99	50	90	20	24	6	3	8	2.2	88	18