Computer Assisted Total Knee Arthroplasty

Thesis

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List of abbreviations

ACL	Anterior cruciate ligament
AP	Anterposterior
CAS	Computer assisted surgery
LCL	Lateral collateral ligament
NSAID	Non Steroidal Antiinflamatory Drug
MCL	Medial collateral ligament
Min	Minutes
Ml	Milliliters
PCL	Posteriro cruciate ligament
RA	Rhumatoid arthritis
TKA	Total knee arthroplasty
TKR	Total knee replacement
USA	United States of America

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INTRODUCTION

Total knee replacement (TKR) is one of the most clinically successful and cost-effective interventions in orthopaedics; and even in all surgical practice. However, implant malalignment is a common cause of failure following total knee replacement. ***Erik J., et al 2007***

S. David et al in 2002 summarized that the success of total knee replacement surgery depends on several factors, including:

1. Proper patient selection.
2. Appropriate implant design.
3. Correct surgical technique.
4. Effective perioperative care.

In their work they also concluded that the outcome of total knee replacement surgery is particularly sensitive to variations in surgical technique. ***David S., et al 2002***

It is now agreed on that the long-term total knee replacement results depend on lower limb realignment, proper implant positioning and sufficient ligament balancing. Improper alignment of the limb, Incorrect positioning or orientation of the implant and ineffective ligament balancing at the end of the surgical procedure can lead to accelerated implant wear and loosening as well as suboptimal functional performance. ***Jacques D., 2008***

A number of studies have suggested that alignment errors of >3° are associated with more rapid failure and less satisfactory functional results after total knee replacement. ***Werner et al., 2005***

Recent studies have also emphasized that the most common cause for revision total knee replacement is error in surgical technique. ***David S., et al 2002***

Trying to investigate this problem a number of studies have examined the accuracy of traditional mechanical alignment guides used for total knee replacement and have demonstrated that while the majority of components are correctly positioned, there are a substantial number of outliers where positioning is outside of the ideal range.

Recently, computer-assisted surgical navigation systems have been developed and employed for total knee replacement. The majority of studies examining computer-assisted surgery have shown more consistent restoration of neutral mechanical alignment, with improved precision of component placement in one or more of the measured anatomic planes, as compared with mechanical guides. In particular, most studies have demonstrated consistently better alignment in the coronal plane, with significantly fewer outliers. Proponents of computer-assisted surgery have argued that the improved consistency of alignment seen in association with computer navigation will improve implant longevity and decrease revision rates. Outcome studies have shown that component alignment in the coronal plane affects both functional success and component longevity. Components placed in a varus or valgus alignment have a higher rate of loosening and revision when compared with components placed in neutral alignment. ***Erik J., et al 2007***

Aim of the Work

The aim of this study is to compare between navigated total knee replacement and conventional TKR.

The objectives are to measure postoperative radiological alignment in each arm of the study.

Also to look at other important parameters, such as blood loss, operative time and complications.

ANATOMICAL CONSIDERATIONS

The knee joint is a modified hinge of synovial joint. It is the largest and most complicated articulation in the human body. It permits mainly flexion and extension movements, and small amount of rotation of the leg in the flexed position of the knee. It is described as a compound joint that includes two condylar joints between the femur and the tibia and a saddle joint between the patella and the femur. ***Chummy S., 1999***

The stability and mobility of the knee are dependent on complex interactions between:

I- Osseous factors (shape of the articulating surfaces)

II- Soft tissue factors:

A-Passive stabilizers (capsule, menisci and ligaments).

B-Active stabilizers (muscles). ***Resnick D. and Niwayama G., 1995***

Fig.1: Anatomic dissection of the anterior knee. *Insall J. and Scott D., 2006*

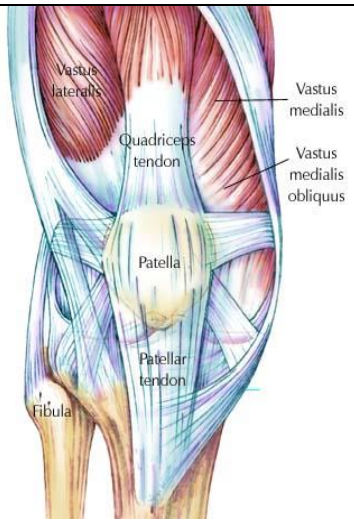

Fig.2: Diagrammatic dissection of the anterior knee*. Insall and J. Scott D., 2006*

[I] Bony Architecture

The osseous structures of the knee consist of three components:

1- The patella.
2- The distal femoral condyles.
3- The proximal tibial plateaus or condyles. ***Robert E., 1988***

1) Patella:

The patella is the largest sesamoid bone in the body and sits in the femoral trochlea. It is asymmetric oval in shape with the apex distally. The fibers of the quadriceps tendon envelop it anteriorly and blend with the patellar ligament distally. The articulation between the patella and femoral trochlea forms the anterior or patellofemoral compartment. ***Philippe S., 1983***

The posterior aspect of the patella is described as possessing seven facets.

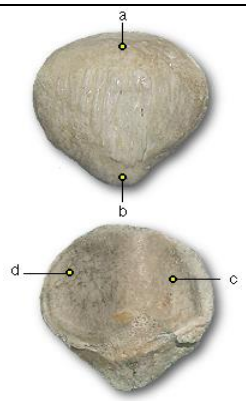

Fig.3: Patella, anterior surface a: base, b: apex, posterior surface c: med facet, d: lat facet. ***Insall and J. Scott D., 2006***

The main biomechanical function of the patella is to increase the moment arm of the quadriceps mechanism. ***Moore K., 2002***

Patello-femoral articulation:

The articulation between the patella and the femoral trochlea forms the anterior or patellofemoral compartment. The medial facet is smaller and slightly convex. The facets are covered by the thickest hyaline cartilage in the body, which may measure up to 6.5 mm in thickness. The femoral trochlea is separated from the medial and lateral femoral condyles by indistinct ridges; the lateral ridge is more prominent. The patella fits in the trochlea imperfectly, and the contact patch between the patella and femur varies with position as the patella sweeps across the femoral

condyles. The main function of the patella is to increase the moment arm of the quadriceps mechanism. ***Eckhoff D. et al., 1996***

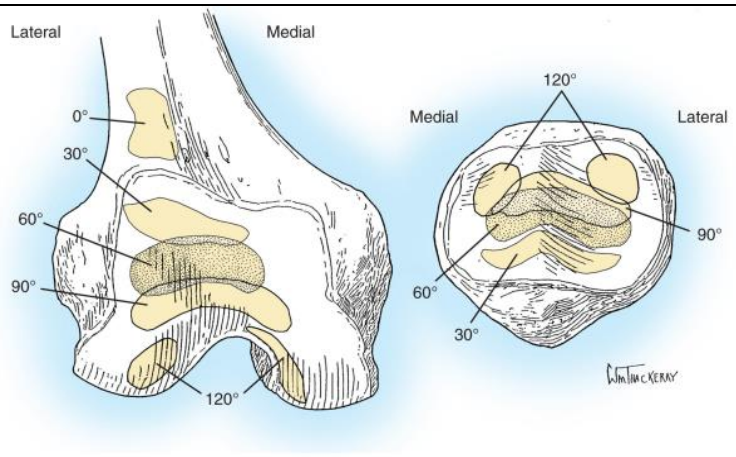

Fig. 4: Patellofemoral contact zones change with knee flexion. *Aglietti P., et al 1975*

2) Femur:

In shape and dimensions, the femoral condyles are asymmetric, with the larger medial condyle having a more symmetric curvature. The lateral condyle viewed from the side has a sharply increasing curvature posteriorly. The femoral condyles viewed from the surface articulating with the tibia show that the lateral condyle is slightly shorter than the medial. The long axis of the lateral condyle is slightly longer than the long axis of the medial condyle and is placed in a more sagittal plane, while the medial is placed at an angle of about 22 degrees on average. The width of the lateral condyle is slightly greater than that of the medial condyle at the center of the intercondylar notch. The lateral condyle has a short groove just proximal to the articular margin, in which lies the tendinous origin of the

popliteus muscle. This groove separates the lateral epicondyle from the joint line.

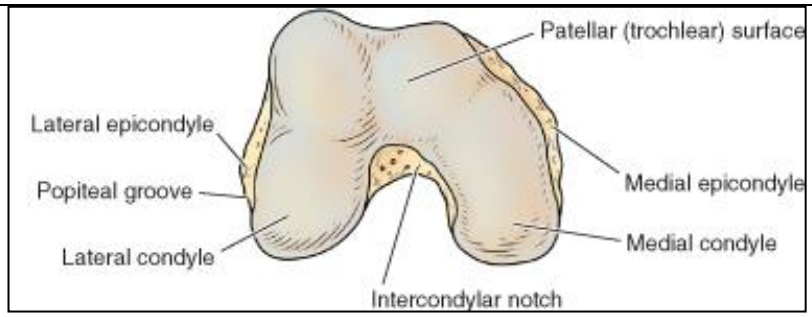

Fig. 5 : Femur, distal end. ***Insall J. and Scott D., 2006***

The lateral epicondyle is a small but distinct prominence to which attaches the lateral (fibular) collateral ligament. On the medial condyle, the prominent adductor tubercle is the insertion site of the adductor magnus. The medial epicondyle lies anteriorly and distally to the adductor tubercle and is a C-shaped ridge with a central depression or sulcus. Rather than originating from the ridge, the medial collateral ligament (MCL) originates from the sulcus. ***Henry D. et al., 2006***

Anteriorly, the condyles are somewhat flattened which provides a greater surface for contact and weight transmission. The condyles project very little in front of the femoral shaft but markedly so behind. ***Verdi V et al., 1999***

Both condyles blend anteriorly to create a shallow concave trochlear groove. Posteriorly, the condyles are separated by the intercondylar notch. ***Dodds J et al., 1994***

The trochlea is located on the anterior distal end of the femur. There is an anteroposterior groove at the middle of the trochlea that divides it into two facets; the lateral