Minimally invasive knee arthroplasty

An essay

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Abstract

Reviewing literature revealed that, total knee arthroplasty is gold standard for treatment of knee joint replacement and minimally invasive TKA is rapidly gaining the attention of the orthopedic community. Published data suggest better range of motion, less blood loss, and a shorter length of stay with minimally invasive TKA as compared with standard TKA. The long-term results for these minimally invasive techniques are yet not available.

Key words

Minimally invasive knee arthroplasty

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List of abbreviations

ACL	Anterior collateral ligament
AF	anatomical axis of femur
AKP	Anterior knee pain
AL	Arcuate ligament
AP	antero-posterior
AT	anatomical axis of tibia
BMI	Body mass index
CAD	computer-aided design
CAOS	Computer assisted orthopaedic surgery
CAS	Computer-assisted surgical
CPM	Continuous passive motion
CT	Computed tomography
2D	two dimensions
3D	three dimensions
DVT	Deep venous thrombosis
DRB	dynamic reference body
EM	Electromagnetic
KBL	knee base line
KSS	Knee Society Score
LCL	Lateral collateral ligament
LCS	Low contrast stress
LFC	Lateral femoral condyle
LMWH	Low molecular weight heparin
MAF	mechanical axis of femur
MAT	mechanical axis of tibia
MCL	Medial collateral ligament
MIS	Minimally invasive surgery
MPP	Median parapatellar
MRI	Magnetic resonance imaging
OA	Osteoarthritis
PCA	Patient controlled analgesia
PCL	Posterior collateral ligament
PE	Pulmonary embolism
PFJ	patellofemoral joint
PST	patient-specific templates

PT	Popliteus tendon
QS	Quadriceps saving
RCTs	Randomized controlled trial
ROM	Range of motion
RP	rapid prototyping
SD	standard deviation
TKA	Total knee arthroplasty
UCLA	The University of California Los Angeles
UHMWPE	Ultra-high molecular weight polyethylene
UKA	Unicompartmental knee arthroplasty
USA	United States of America
VMO	Vastus medialis obliquus muscle
WOMAC	Western Ontario and McMaster Universities Osteoarthritis Index

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Introduction

Minimally invasive surgery (MIS) in orthopedics essentially began with the introduction of the arthroscope. Initially, arthroscopy was relatively primitive, with limited goals and time-consuming procedures. It has gradually evolved to become one of the standard of treatment currently used for many orthopedic procedures.

Most total joint arthroplasties have been performed through an extensile approach, with complete visualization of the joint and supporting soft tissue structures. [1]

Several groups are attempting to develop an MIS approach for total knee arthroplasty. The indications for the surgeries remain the same, but the surgical technique has demonstrably changed. MIS techniques approach each joint in a new, modified way that violates fewer muscular structures and surrounding tissues. The length of the surgical incision is not the defining factor. The approaches require modified instruments. The components must be placed in the proper position, similar to conventional approaches. The surgeon must draw on previous clinical experience and knowledge of the local anatomy to support the technique that presents a completely modified view of the joint. The surgical procedures require careful planning and preparation. The incision for the surgery must be properly positioned to permit the required exposure. The learning process is a continuum. The surgical approach can be gradually decreased as the surgeon's experience improves. The potential advantages of MIS techniques include reduced pain, earlier mobilization, shorter hospital stays, quicker rehabilitation, decreased morbidity, and decreased costs. [2]

Initially the MIS technique was applied to unicondylar knee replacement. In the mid-1990s, **Repicci and Eberle** designed a unicondylar knee prosthesis, which was implanted with an MIS approach. The procedure was essentially a freehand technique that used limited instrumentation. **Repicci's** work created great interest in the United States and his follow up reports substantiate good results up to eight years after the surgery. MIS unicondylar arthroplasty has naturally led to the investigation of MIS total knee arthroplasty. [3]

The first step in this transition to decrease the actual incision and perform a mini-TKA. The arthroplasty is performed through a 10- to 14-cm skin incision, with a limited medial parapatellar arthrotomy or midvastus approach. Attention must be given to the local anatomic landmarks to achieve correct component position and alignment. The success with minimal-incision TKA is evolving toward MIS-TKA which requires modification of the instrumentation because the skin incision and arthrotomy are further reduced. As the incision and arthrotomy become smaller, so does the field of view. Computer assisted instruments and navigation may be helpful with this aspect of the knee surgery. [4]

AIM OF THE WORK

This essay will discuss the anatomy, biomechanics of the knee joint and will discuss the alternatives of conventional total knee arthroplasty; minimally invasive techniques in TKA ,unicopartmental knee arthroplasty ,patellofemoral arthroplasty , computer assisted navigation in total knee arthroplasty , advantages and complications of these new techniques.

ANATOMY OF THE KNEE JOINT

The knee joint is the largest and most complicated articulation in the human body. In this joint, three functional spaces exist: the medial femoro-tibial space, the lateral femoro-tibial space, and the patellofemoral space. The knee joint is a synovial joint. It is a modified hinge joint, in addition to flexion and extension, its motion has a rotary component. It is a compound joint that includes two condylar joints between the femur and the tibia and a saddle joint between the patella and the femur. [5]

The stability and mobility of the knee are dependent on complex interactions between: [6]

I- Osseous factors (shape of the articulating surfaces)

II- Soft tissue factors:

-Passive stabilizers (capsule, menisci and ligaments).

-Active stabilizers (muscles).

(I) osseous anatomy:

Femoral part :

The femoral condyles are asymetrical, the larger medial condyle has more symmetrical curviture. the lateral condyle is slightly shorter than the medial. the long axis of the lateral condyle is slightly longer and is placed in am more sagittal plane than the long axis of the medial condyle.

The inter-conylar notch separates the two condyles distally and posteriorly.in knee arthroplasty,The femoral component is aligned parallel to the transepicondylar axis, which passes through the center of the prominence of the lateral epicondyle and the center of the sulcus of the medial epicondyle.[6]

Tibial part :

The tibial articular surfaces are the cartilage clothed condyles; each with a central hollow and peripheral flattened area. the articular surface of the medial tibial condyle is oval and larger with its long axis in the sagittal plane, whereas the articular surface of the lateral condyle is circular,smaller and more convex than the medial condyle. however, the lack of confirmity between the femoral and tibial articular surfaces is more apparent than real.in the intact knee the menisci enlarge the conact and increase the confirmity of the joint surfaces. [7]

Both surfaces have a posterior inclination of approximatly 10 degrees with respect to the shaft of the tibia. On the anterior aspect of the tibia the tuberosity is the most prominant feature and is the attachment site of the patellar tendon. approximately 2 to 3 cm lateral to the tibial tubercle is Gredy's tubercle, which is the insertion site of the iliotibial band (ITB). [6]

patella :

The patella, the largest sesamoid bone in the body sits in the femoral trochlea. it is an asymetrical oval with its apex directed distally.the fibers of the quadriceps tendon envelope it anteriorly and blend with the patellar ligament distally.posterior aspect of the patella is described as possessing seven facets. the medial and lateral facets are divided vertically into approximately equal thirds, whereas the