Distal femoral rotational axes of knees in an elderly Indian population

A Dissertation submitted in partial fulfillment of M.D

Radiodiagnosis (Branch VIII) examination of

The TAMIL NADU Dr M.G.R MEDICAL UNIVERSITY,

CHENNAI,

to be held in April, 2016.

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This is to certify that the dissertation entitled “Distal femoral rotational axes of knees in an elderly Indian population” is a bonafide original work of Dr. Jayavelu Hariram Prasad D, submitted in partial fulfillment of the requirement for M.D Radiodiagnosis (Branch-VIII) Degree Examination of The Tamil Nadu Dr M.G.R Medical University, Chennai, to be conducted in April, 2016.

Guide:

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Department of Radio Diagnosis,
Christian Medical College,
Vellore.

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Principal:

Dr. Alfred Job Daniel, D.Ortho, MS Ortho, DNB
Principal,
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Vellore.

DECLARATION

I, Dr. Jayavelu Hariram Prasad D, hereby declare that this dissertation entitled "Distal femoral rotational axes of knees in an elderly Indian population" is an original work done by me in partial fulfillment of the requirement for M.D Radiodiagnosis (Branch- VIII) Degree Examination of The Tamil Nadu Dr M.G.R Medical University, Chennai to be conducted in April, 2016.

Candidate:

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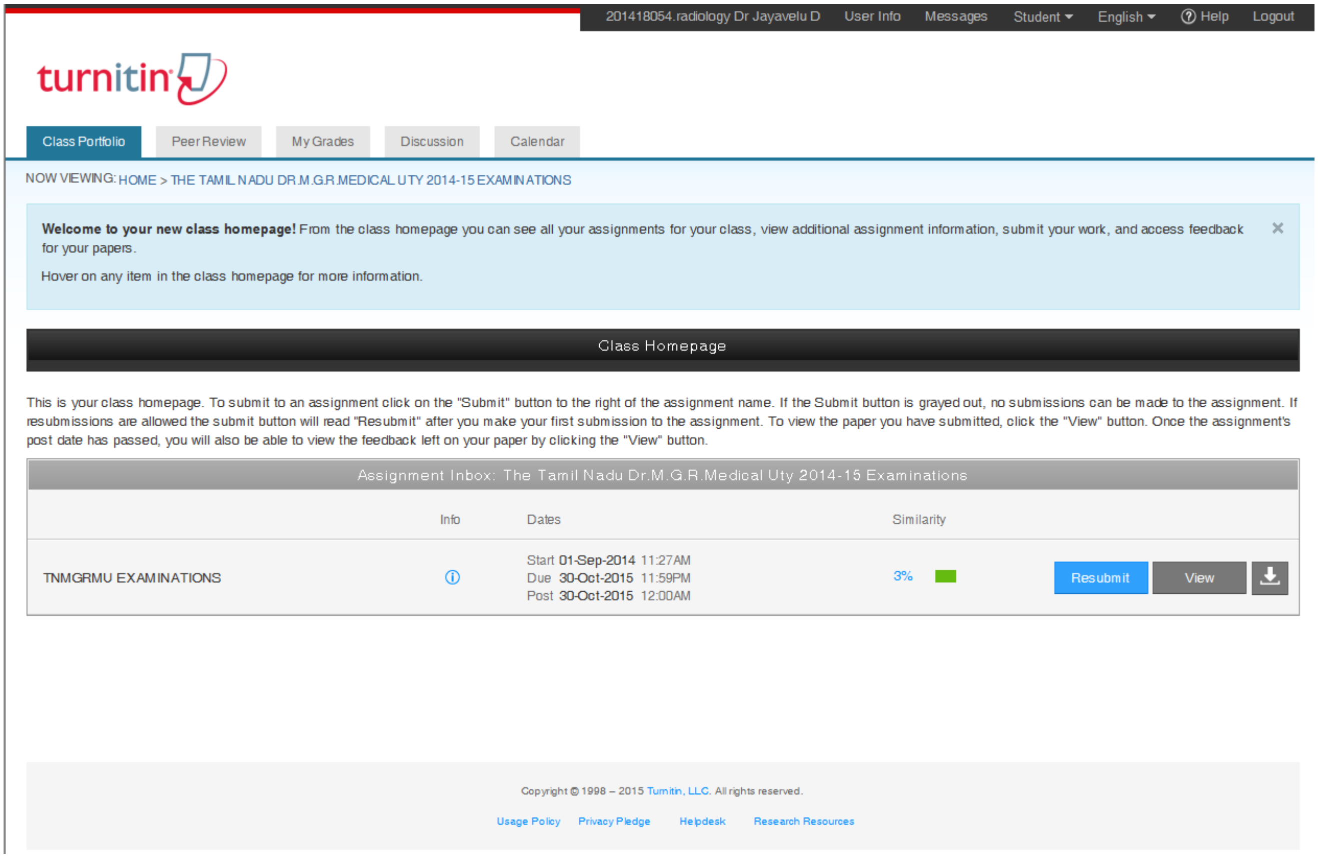
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September 23, 2015

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Sub: **Fluid Research Grant NEW PROPOSAL:**
Distal femoral rotational axes of knees in an elderly Indian population
Dr. Jayavelu Hariram Prasad D (Employment Number: 29007), Radiology, Dr. Jyoti PanwarEmployment Number: 31535, Radiology, Dr. Pradeep Poonnoose, (Emp No: 13033), Orthopaedics

Ref: IRB Min No: 9573 [OBSERVE] dated 05.08.2015

Dear Dr. Jayavelu Hariram Prasad D,
The Institutional Review Board (Blue, Research and Ethics Committee) of the Christian Medical College, Vellore, reviewed and discussed your project titled "Distal femoral rotational axes of knees in an elderly Indian population" on August 05th 2015.

The Committee raised the following documents
1. IRB Application format.
2. Cvs of Drs. Jayavelu Hariram Prasad, Jyoti Panwar
3. No of documents 1 - 4

The following Institutional Review Board (Blue, Research & Ethics Committee) members were present at the meeting held on August 05th 2015 in the CREST/SACN Conference Room, Christian Medical College, Bagayam, Vellore 632002.

Name	Qualification	Designation	Affiliation
Dr. B. J. Prashantham	MA(Counseling Psychology), MA(Theology), Dr. Min(Clinical Counselling)	Chairperson, Ethics Committee, IRB. Director, Christian Counseling Centre, Vellore	External, Social Scientist

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Deputy Chairperson
Secretary, Ethics Committee, IRB
Additional Vice Principal (Research)

Dr. Nihal Thomas	MD, MNAMS, DNB(Endo), FRACP (Endo) FRCP(Edin) FRCP (Glasg)	Professor & Head, Endocrinology. Additional Vice Principal (Research), Deputy Chairperson (Research Committee), Member Secretary (Ethics Committee), IRB, CMC, Vellore	Internal, Clinician
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Rev. Joseph Devaraj	BSc, BD	Chaplaincy Department, CMC, Vellore	Internal, Social Scientist
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Dr. Anup Ramachandran	PhD	The Wellcome Trust Research Laboratory Gastrointestinal Sciences, CMC, Vellore	Internal, Basic Medical Scientist

We approve the project to be conducted as presented.

Kindly provide the total number of patients enrolled in your study and the total number of withdrawals for the study entitled: "Distal femoral rotational axes of knees in an elderly Indian population" on a monthly basis. Please send copies of this to the Research Office (research@cmcvellore.ac.in)

Fluid Grant Allocation:

A sum of 5,000/- INR (Rupees Five Thousand) will be granted for 6 months.

Yours sincerely

Dr. NIHAL THOMAS
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Vice - Principal (Research) - Reg. No. 43983
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Ms. Mythily Vandana, for her constant help, guidance, encouragement and support.

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My family, friends and colleagues for their love, constant support and encouragement.

Above all, I thank the Lord for his abundant grace and mercy.

CONTENTS

ABSTRACT

TITLE: Distal femoral rotational axes of knees in an elderly Indian population.

DEPARTMENT: Department of Radiodiagnosis, CMC, Vellore.

NAME OF THE CANDIDATE: Dr. Jayavelu Hariram Prasad D.

DEGREEE AND SUBJECT: MD Radiodiagnosis.

NAME OF THE GUIDE: Dr. Jyoti Panwar

AIMS AND OBJECTIVES: To define the angular relationships of the distal femoral rotational axes in an Indian population aged between 50 and 75 years using Magnetic Resonance Imaging (MRI) scans of the knee joint.

MATERIALS AND METHODS: Institutional Review Board approved retrospective study of 300 MRI knees of patients aged between 50 and 75 years to define the Posterior Condylar Angle (PCA) and Whiteside's Epicondylar Angle (W-EP). The results were compared with pre-existing literature to assess whether knowing these values in this age group may help in bringing about changes in the design of TKA implants for the elderly Indian population.

RESULTS: Total number of knees studied was 300 (147 left and 153 right, in 144 men and 156 women). Mean age of patients was 56.7 years (SD 6.3 years), range – 50 to 75 years. The mean PCA and W-EP were 5.5º (SD, 1.2º; range, 2.2º–8.8º), 92.5º (SD, 2º; range, 90º - 99.4º), respectively.

CONCLUSIONS: Differences have been noted in the distal femoral rotational axes between various races. Mean PCA and W-EP angles in the Indian population are similar to other Asian races such as the Chinese and Japanese in that they are more externally rotated but dissimilar when compared the Western population. Hence using fixed values to describe the angles between the axes can lead to femoral component malrotation. Therefore knowledge of the racial differences is important when implants for the Indian population are designed.

Keywords: Elderly Indian knee, Whiteside’s line, Posterior condylar axis, Transeipcondylar axis, Rotational malalignment.

INTRODUCTION

Osteoarthritis is a disease of the joints. It is the most common joint disorder in the world. It is also known as **degenerative arthritis**, **degenerative joint disease**, or **osteoarthrosis.** It occurs due to breakdown of joint cartilage and underlying bone. It specifically affects the joints unlike other arthiritis such as rheumatoid arthritis and systemic lupus erythematosus which affect other organs of the body also. It frequently causes pain, los of function and disability in adults. By the age of 65 years, majority of people show radiographic evidence of OA, and by 75 years it rises up to 80 % of the group.

Multiple factors such as female gender, obesity, old age, heredity, athletics, metabolic disorders and repetitive stress injuries have been thought to contribute in the development of OA. Occupational activity such as kneeling, squatting, or lifting heavy weights are also thought to contribute to the development of osteoarthritis.

The diagnosis of knee osteoarthritis includes a physical exam, family history of osteoarthritis, a detailed medical history, X-rays, MRI and blood investigations to rule out other conditions and to confirm the diagnosis.

Knee arthroplasty is the final treatment for osteoarthritis of the knee. This requires proper diagnostic workup, especially with cross-sectional imaging such as Computed tomography or Magnetic Resonance Imaging to study the anatomy of the knee joint and the various axes and angles. These axes and angles help in planning the correct resection techniques so that the correct implant is chosen and that any event of implant failure can be prevented.

The various reference landmarks that have been described in literature to study the femoral component rotation in knee arthroplasty are the posterior condylar axis, the transepicondylar axis, the Whiteside's anteroposterior line, the posterior condylar angle and the Whiteside's epicondylar angle.

The aim of our study is to define these various axes and angles in the elderly Indian population aged between 50 and 75 years using MRI images of the knee joint.

AIM:

To define the angular relationships of the distal femoral rotational axes in an Indian population aged between 50 and 75 years using Magnetic Resonance Imaging (MRI) scans of the knee joint.

OBJECTIVES:

1. To measure the posterior condylar angle (PCA) of the distal femur in patients aged between 50 and 75 years.

2. To measure the Whiteside's epicondylar angle (W-EP) of the distal femur in patients aged between 50 and 75 years.

3. To compare the results of this study and previously known literature and determine whether it may help in bringing about changes in the design of TKA implants for the elderly Indian population.

LITERATURE REVIEW

ANATOMY OF THE KNEE JOINT:

The knee joint is the largest joint of the body. It is a complex joint joining the lower end of femur and upper end of tibia. The patella (also known as kneecap) and fibula are other bones that are involved in the knee joint. The fibula is not directly involved in the formation of the knee joint. The knee joint is a synovial hinge joint which allows mainly flexion and extension and a minimal amount of internal and external rotations.

The knee joint consists of 2 articulations: first between the femur and tibia and second between the patella and femur. The articulation between the femur and tibia forms the tibiofemoral joint and articulation between patella and femur forms the patellofemoral joint.

The soft tissues that are involved in the knee joint are muscles, tendons, ligaments and menisci. Tendons connect bones that are involved in the knee joint to the leg muscles so that movement occurs at the knee joint. Ligaments join bones that are involved in the knee joint and help in providing stability to the knee joint.

The various ligaments that are involved with the knee joint are

- The anterior cruciate ligament
- The posterior cruciate ligament
- The medial and lateral collateral ligaments

Menisci: Menisci are 2 'C-shaped' pieces of cartilage located on the medial and lateral tibial plateaus. The 2 menisci are the medial and lateral menisci. Their function is to absorb the shock between the femur and tibia.

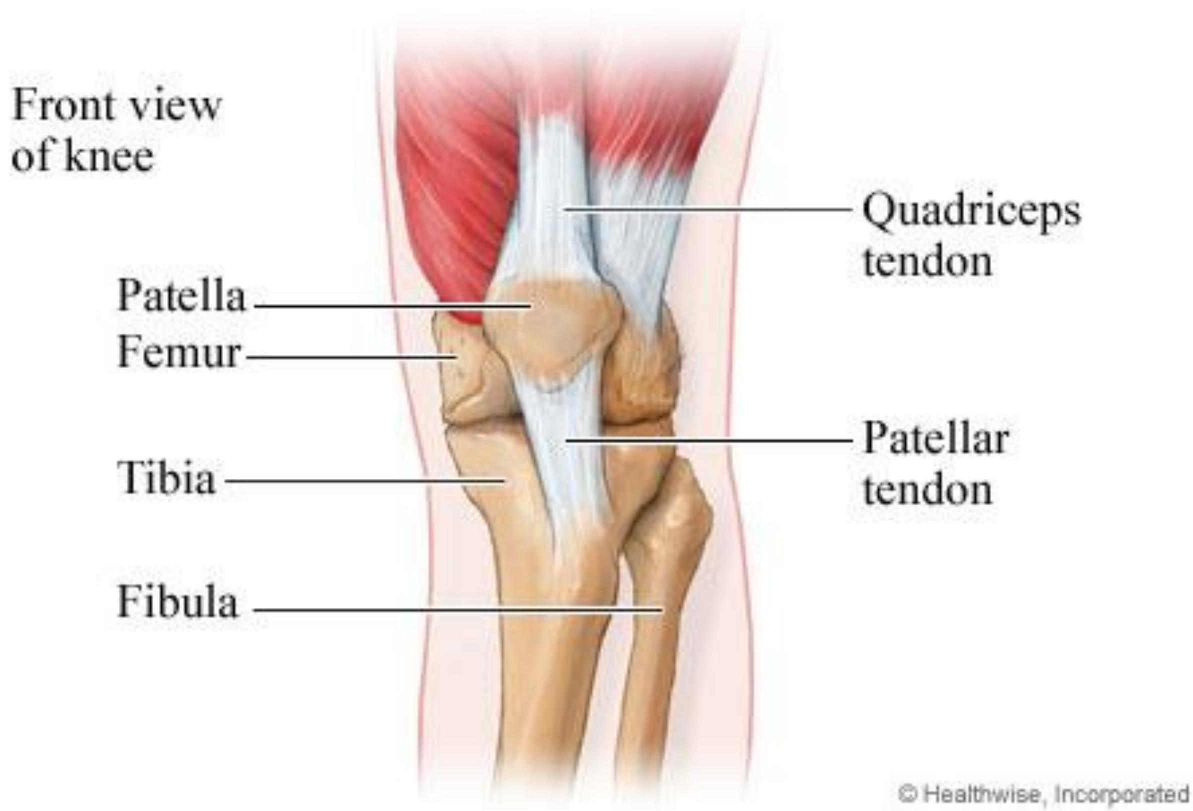


Figure 1. Anterior view of the knee

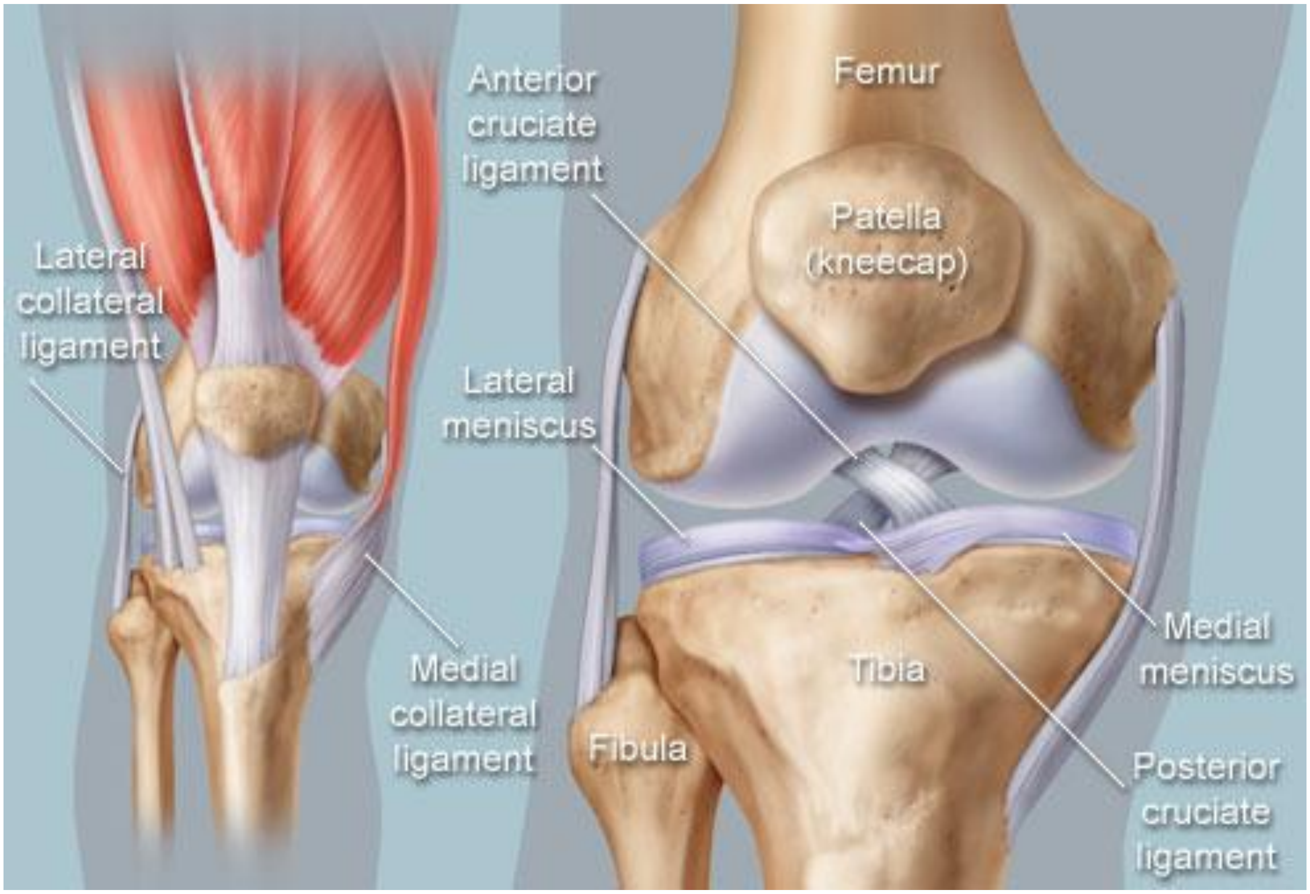


Figure 2. Anterior view of Menisci & Ligaments of the knee joint

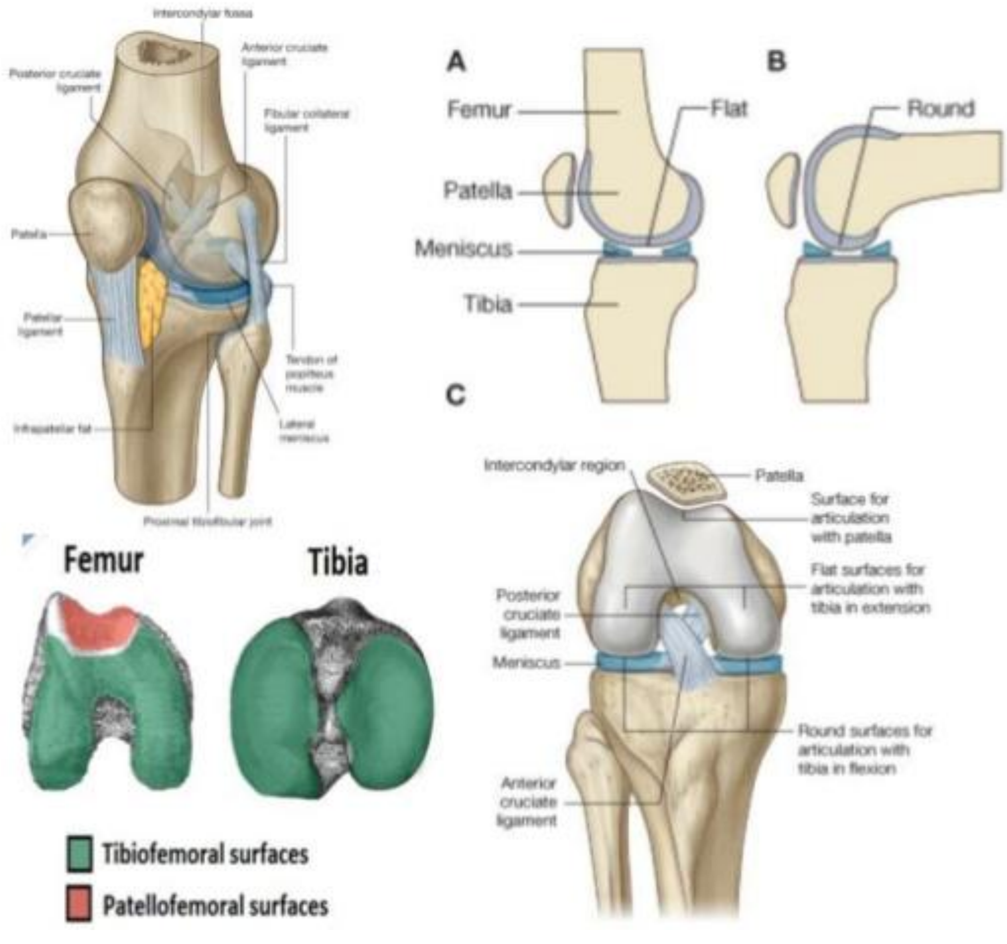


Figure 3. Articular surfaces of the knee joint

ANATOMY OF THE DISTAL FEMUR:

The femur is the strongest and longest bone in the entire human body. The proximal end forms the head of the femur, which articulates with the acetabulum of the pelvis to form the hip joint. The distal end forms 2 condyles and hence is wider. The distal end articulates with the proximal end of the tibia forming the knee joint.

The 2 condyles of the distal end of femur are - the medial and lateral condyles. These condyles articulate with the tibia and patella. The medial femoral condyle articulates with the medial tibial condyle and lateral femoral condyle articulates with lateral tibial condyle. The patella articulates posteriorly with the distal femur in the region of the patellofemoral fossa (also known as the trochlear groove).

The medial and lateral condyles have corresponding epicondyles which are bony elevations located in areas of non-articulation on the condyles. Some muscles and the collateral ligaments which provide stability to the knee joint are attached in these areas. The medial collateral ligament attaches to the medial epicondyle and the lateral collateral ligament attaches to the lateral epicondyle.

The intercondylar fossa is a depression located on the posterior aspect of the femur, between the 2 femoral condyles. It contains 2 facets for the attachment of the anterior and posterior cruciate ligaments.

ANTERIOR VIEW

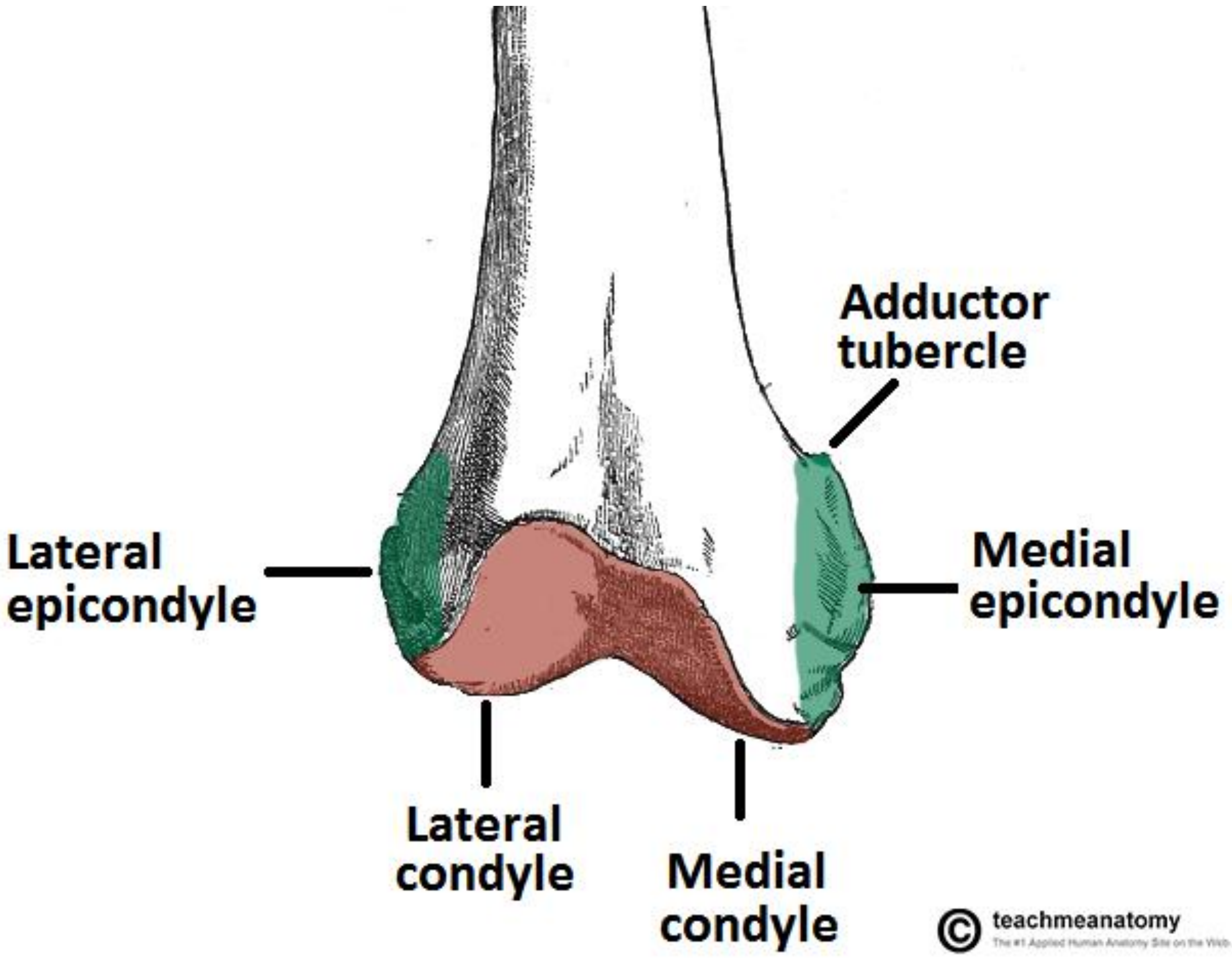


Figure 4. Diagrammatic representation of the anterior view of the distal femur

POSTERIOR VIEW

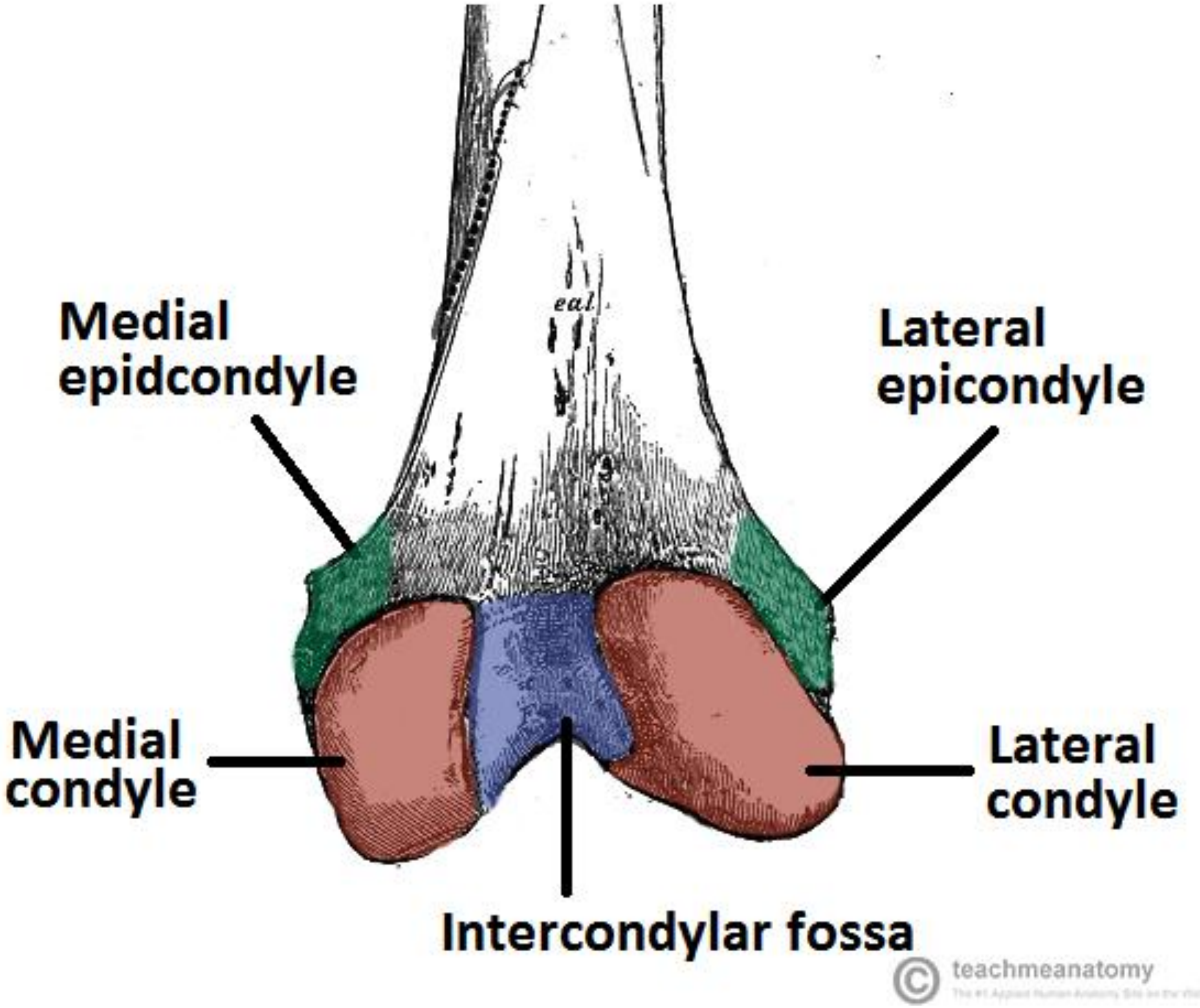


Figure 5. Diagrammatic representation of the posterior view of the distal femur

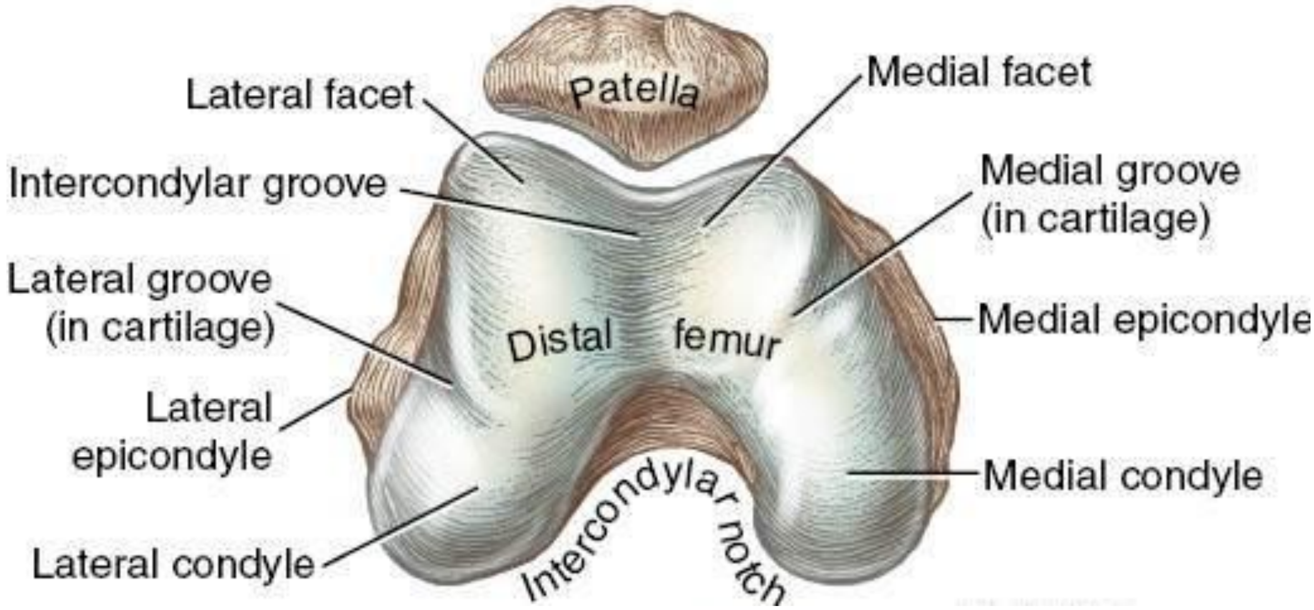


Figure 6. Diagrammatic representation of the anatomy of the distal femur

OSTEOARTHRITIS OF THE KNEE

The knee joint is susceptible to both acute and chronic injury. A number of pathological conditions affect the knee joint. They are osteoarthritis, chondromalacia patella, knee effusion, meniscal tear, ACL strain or tear, PCL strain or tear, patellar subluxation, patellar tendonitis, rheumatoid arthritis, gout, pseudogout and septic arthritis.

The various symptoms of knee osteoarthritis are joint pain, limitation of movement, tenderness, locking of the knee, crepitus and joint effusion.

Symptomatic OA of the knee occurs in 10% of men and 13% of women of 60 years of age or older. This number is likely to increase due to the constantly aging population and the epidemic of obesity.(1)

Epidemiology: Felson et al. reported that 1/3rd of adults have signs of OA on radiological studies, although Andrianakos et al., found clinically significant osteoarthritis of the knee, in only 8.9% of the adult population. The likelihood of developing osteoarthritis increases with age.(2) Studies have shown that the right knee is more commonly involved (23%) than the left (16.3%) in men aged 60 to 64 years. But in women it seems to be more evenly balanced (right knee - 24.2%; left knee- 24.7%) The prevalence of knee osteoarthritis is higher among 70- to 74-year-olds, rising as high as 40%.(3)

In India the prevalence of osteoarthritis of the knee is estimated to be higher in the urban (5.5%) than the rural community (3.3%). A study conducted in Bangalore, India by Nisha et al found a prevalence of 17% and 5.6% in the adult population and 54.1% and 16.4% in the elderly.(4)

Treatment: The primary aims of treating osteoarthritis of the knee are to relieve pain and increase mobility. The treatment algorithm usually includes a combination of exercise, weight loss, anlagesics & anti-inflammatory drugs, steroids or hyaluronic acid injections into the knees and topical therapies. Knee braces, physiotherapy and occupational therapy have also been used. Surgery is often resorted to only when symptomatic treatment options fail.

The common surgical options are scopy of the joint (arthroscopy), resection of bone (osteotomy), and joint replacement surgery (arthroplasty). Arthroplasty is an operation in which the joint surfaces are replaced with metal or plastic parts. The replacement could be partial or total. Commonly knee arthroplasty is reserved for patients above 50 years of age and with severe osteoarthritis.

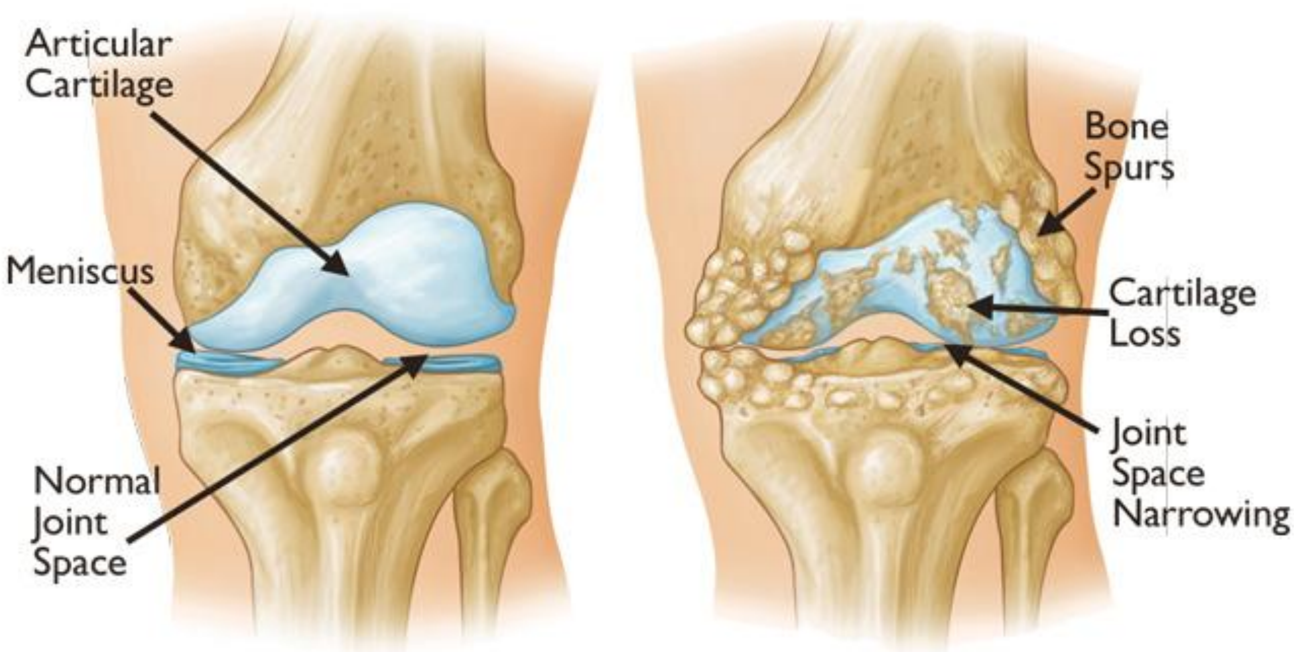
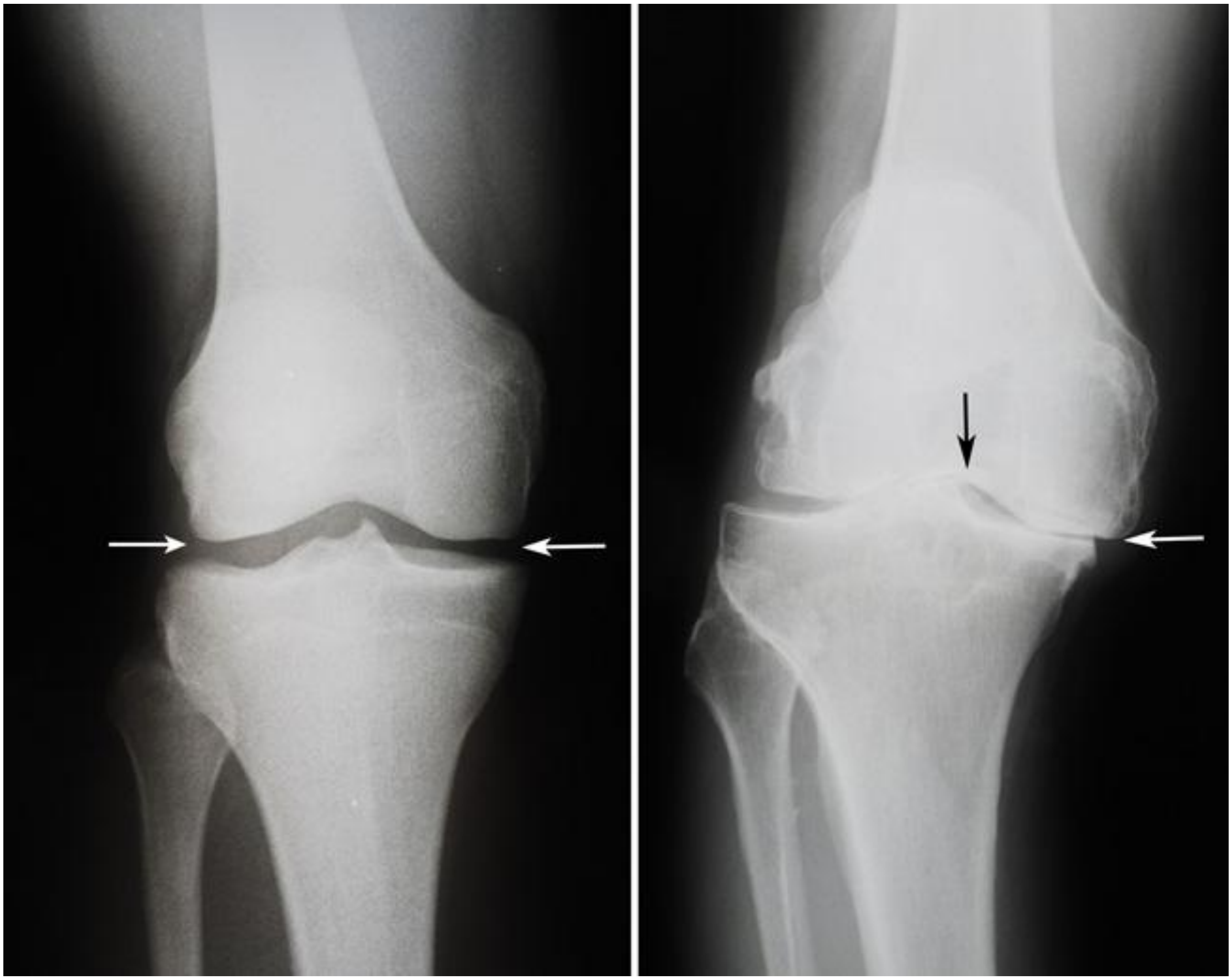


Figure 7. OSTEOARTHRITIS OF KNEE – DIAGRAMMATIC REPRESENTATION



NORMAL RIGHT KNEE JOINT

OSTEOARTHRITIS RIGHT KNEE

Figure 8. A-P RADIOGRAPH OF NORMAL KNEE JOINT AND OSTEOARTHRITIS OF KNEE JOINT

IMAGING ANATOMY OF THE KNEE JOINT

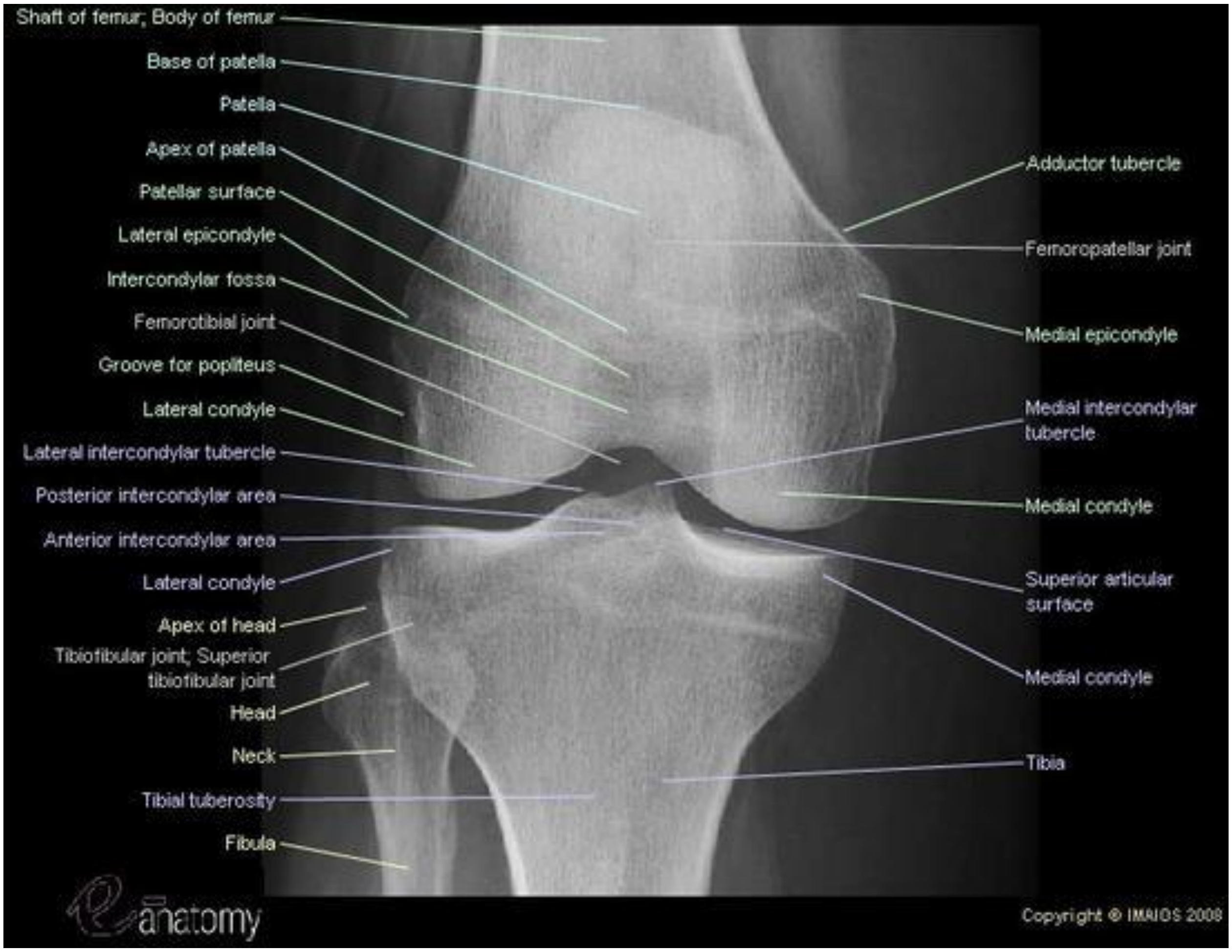


Figure 9. A-P RADIOGRAPH OF NORMAL RIGHT KNEE JOINT

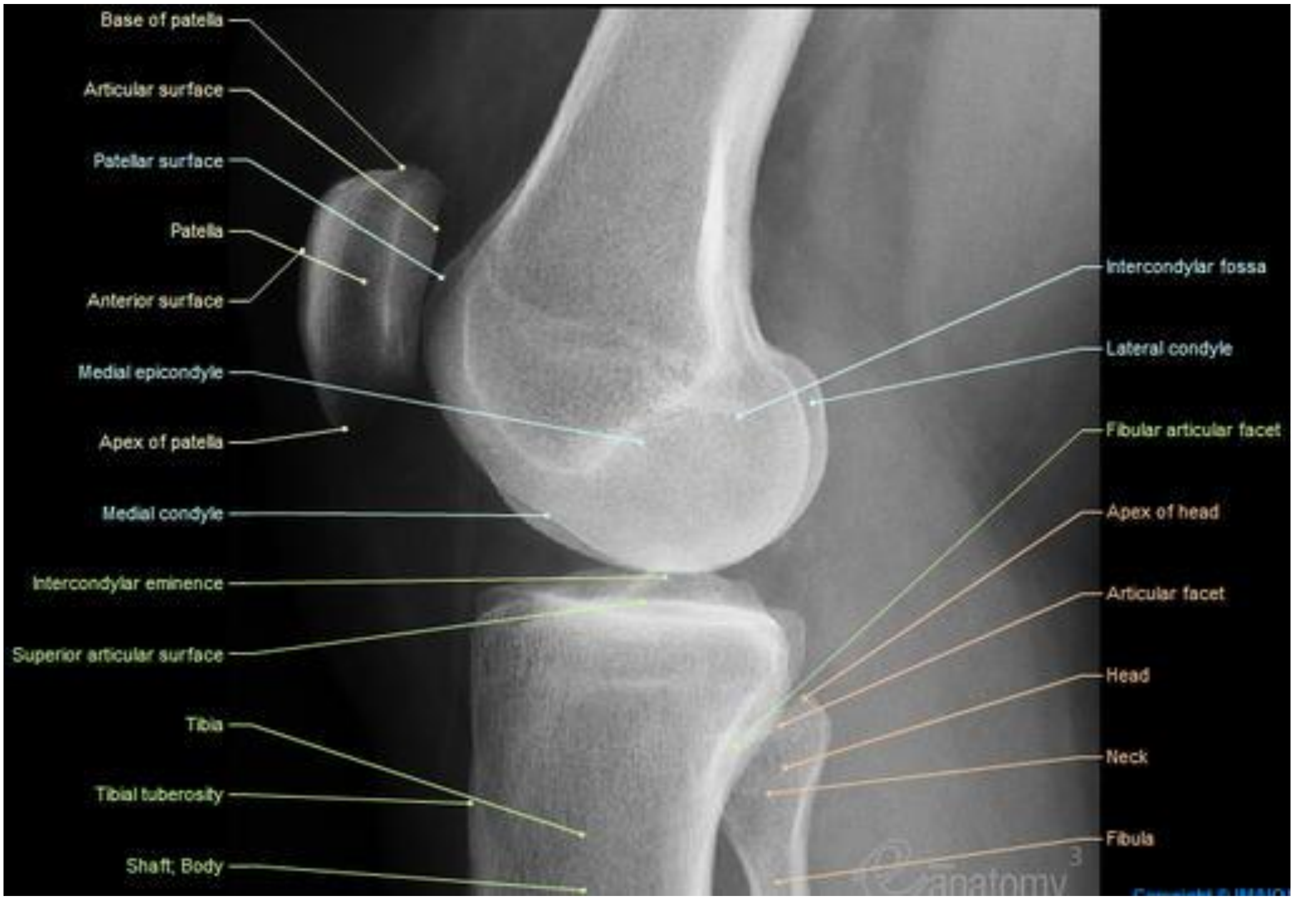
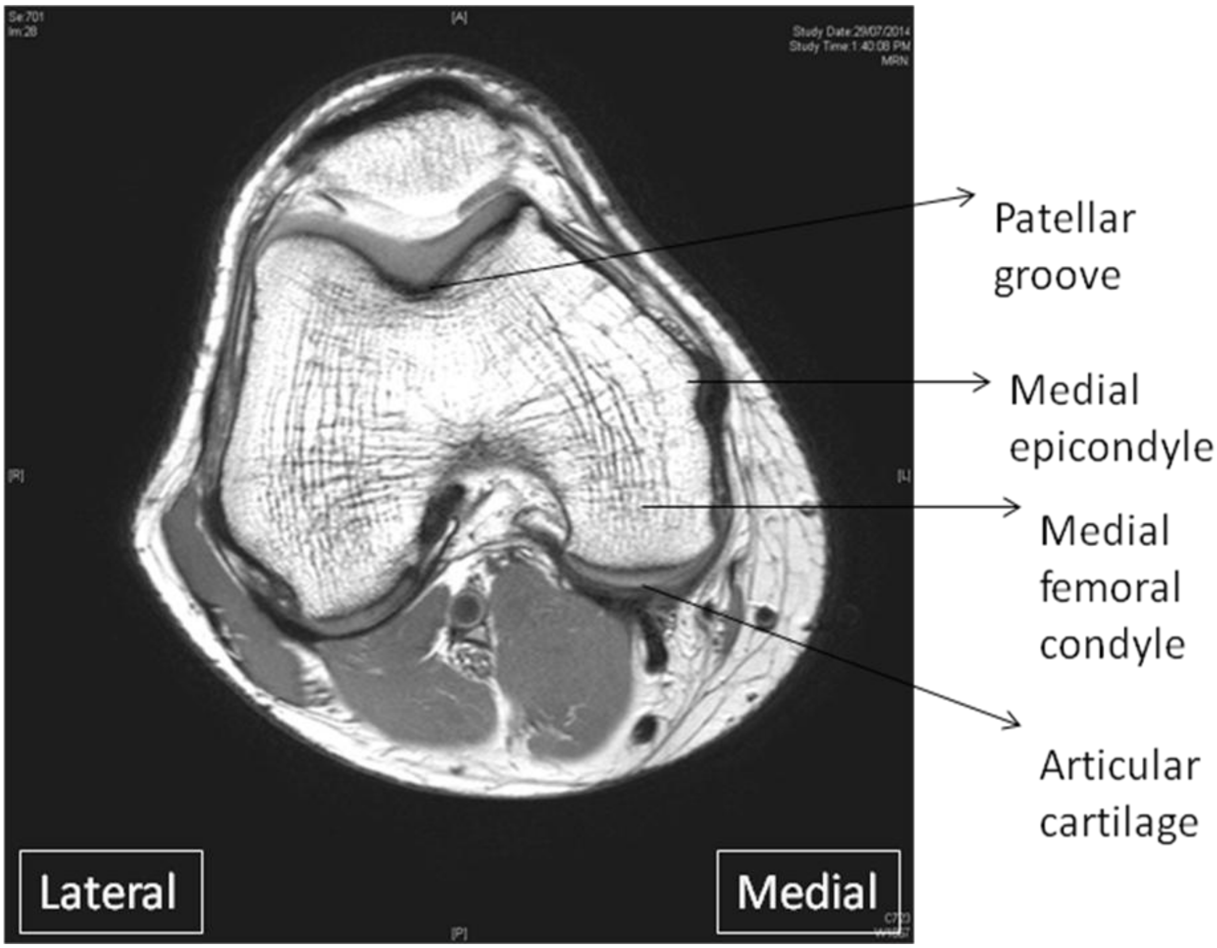
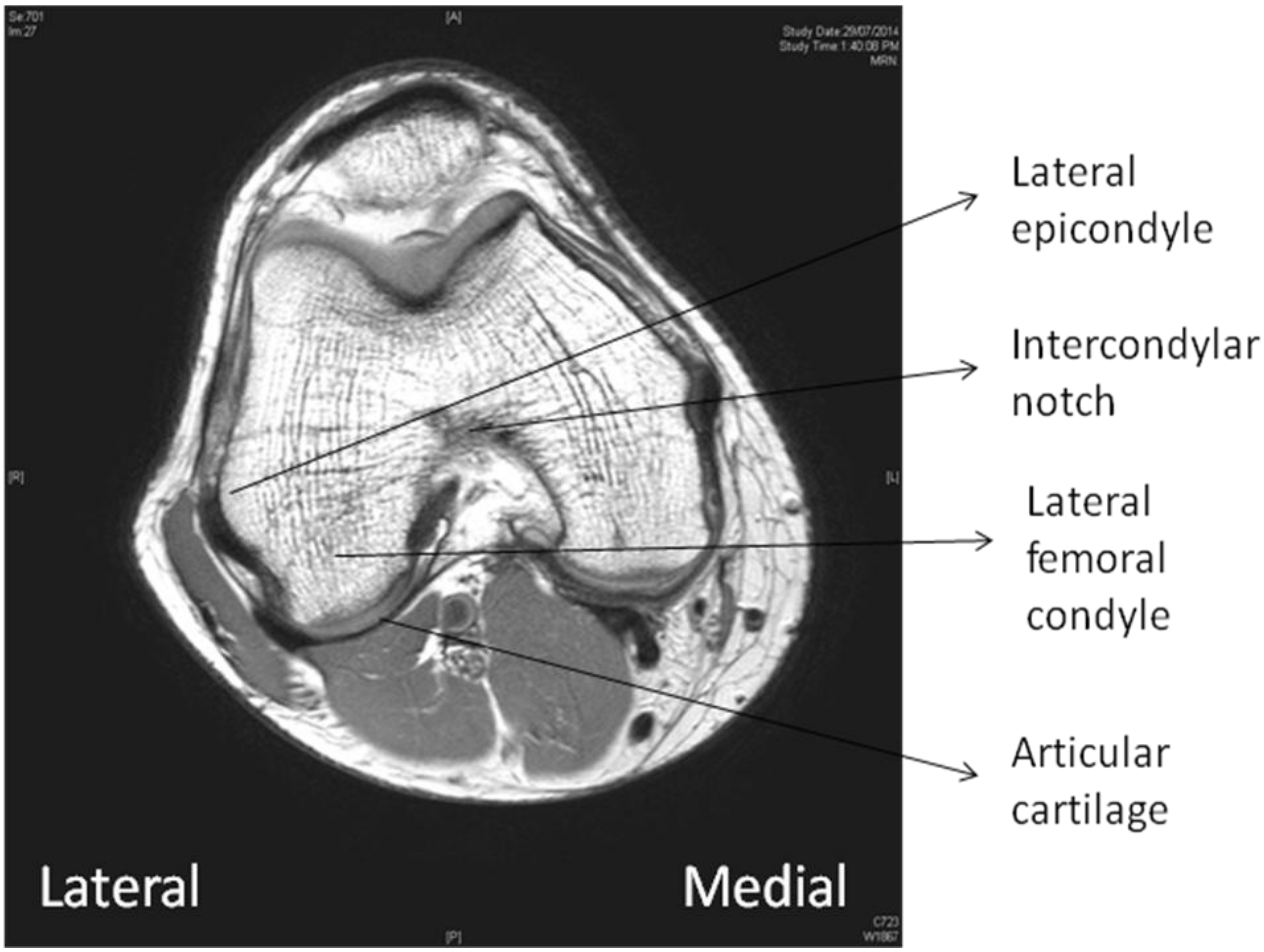


Figure 10. LATERAL RADIOGRAPH OF NORMAL RIGHT KNEE JOINT

RELEVANT NORMAL MRI ANATOMY

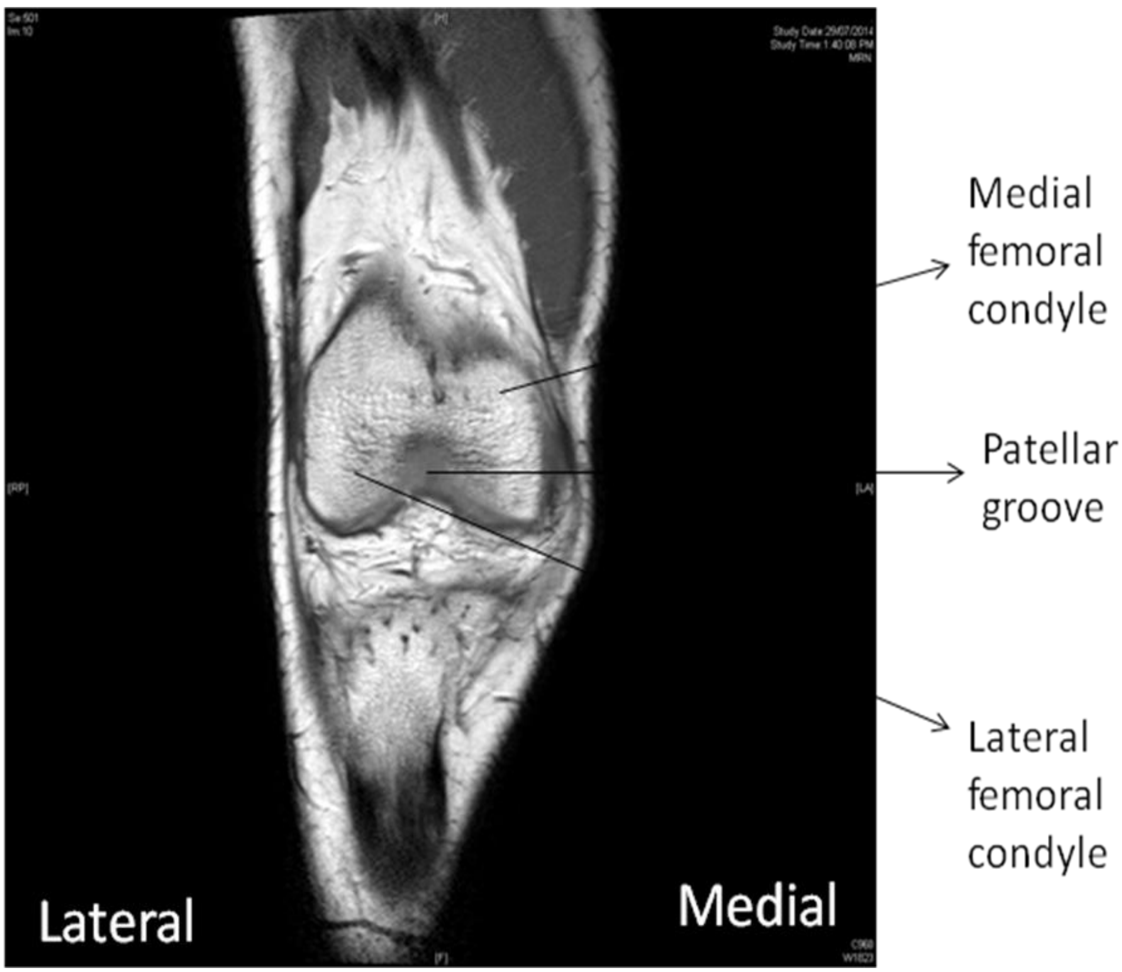
Proton Density Images of Right Knee (Axial sections)

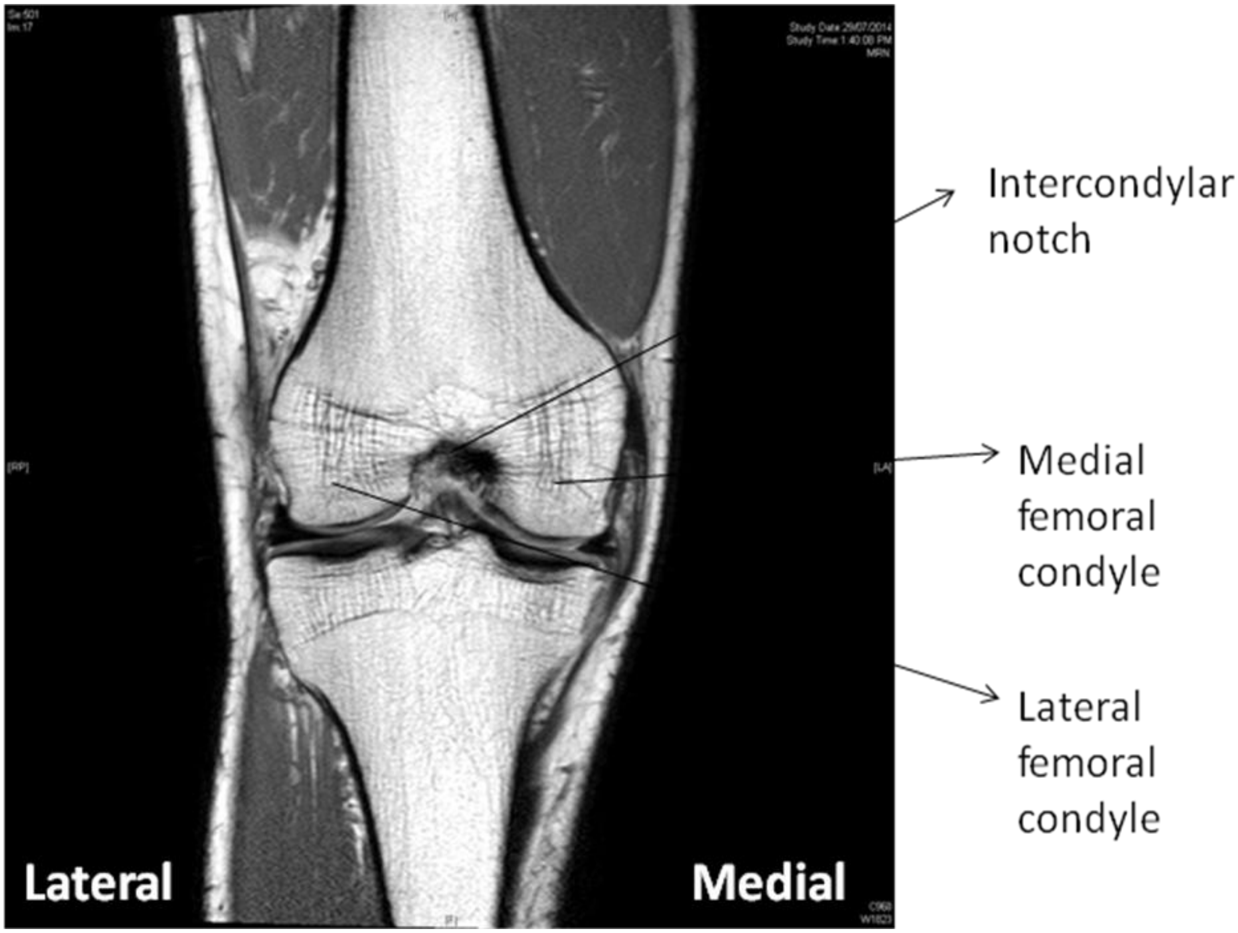


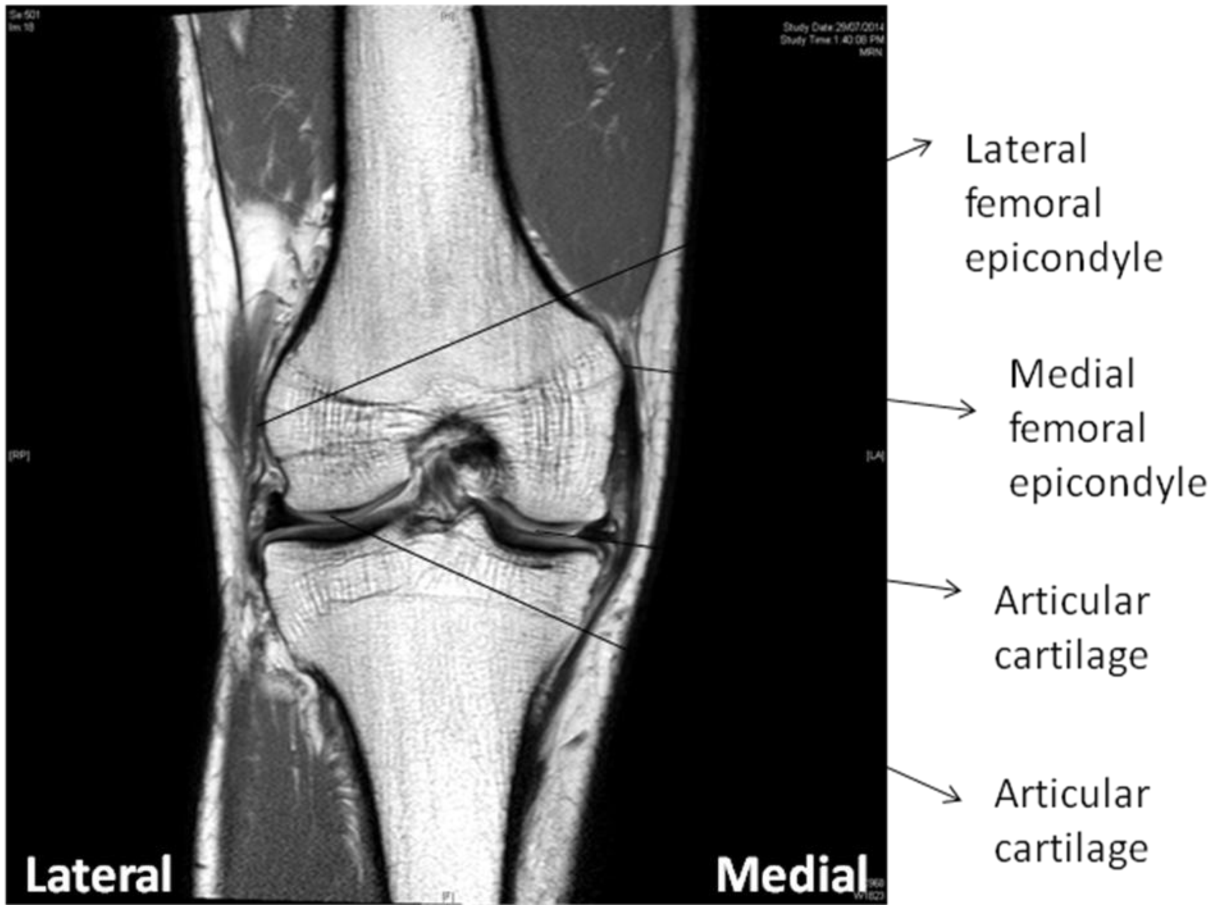


Lateral epicondyle
Intercondylar notch
Lateral femoral condyle
Articular cartilage
Lateral
Medial

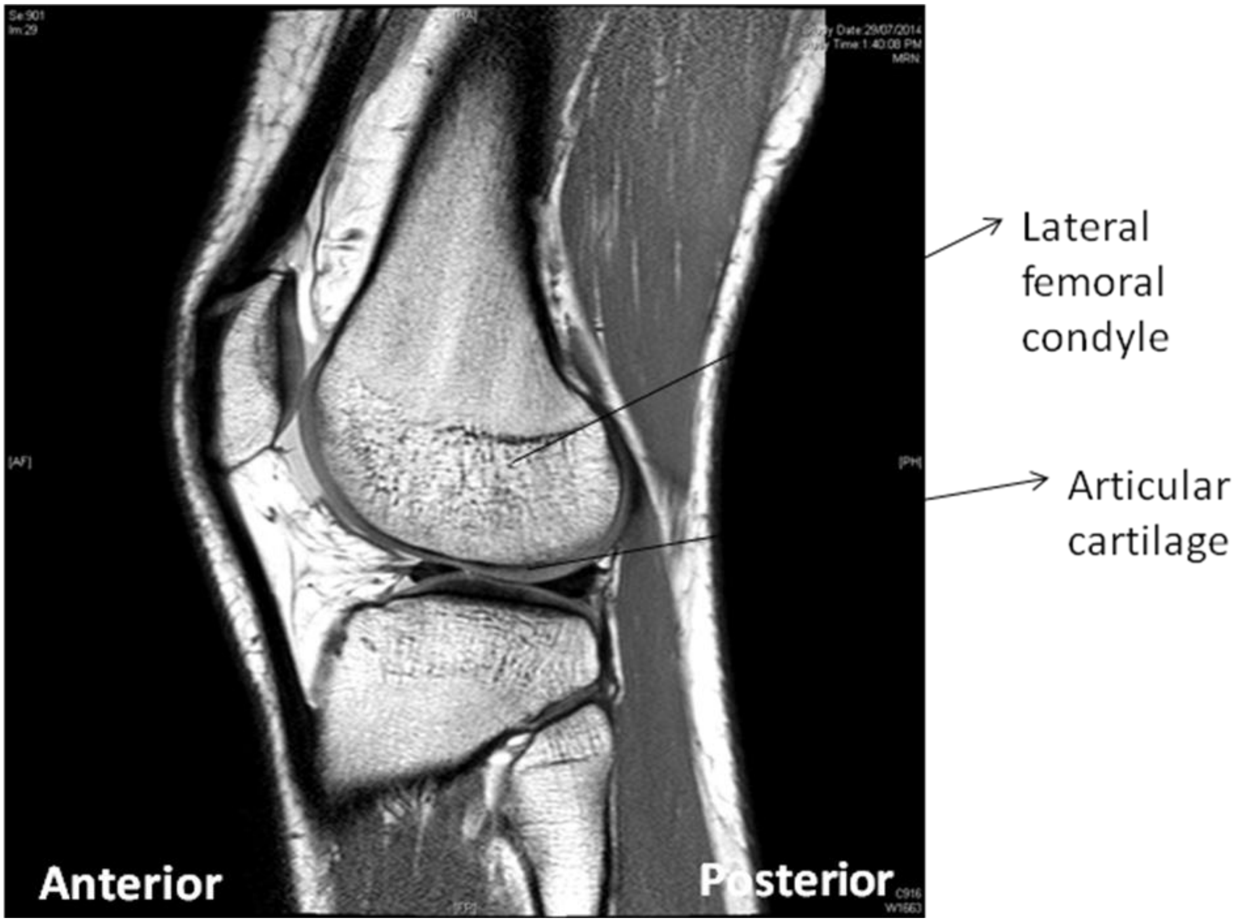
Proton Density Images of Right Knee (Coronal sections)

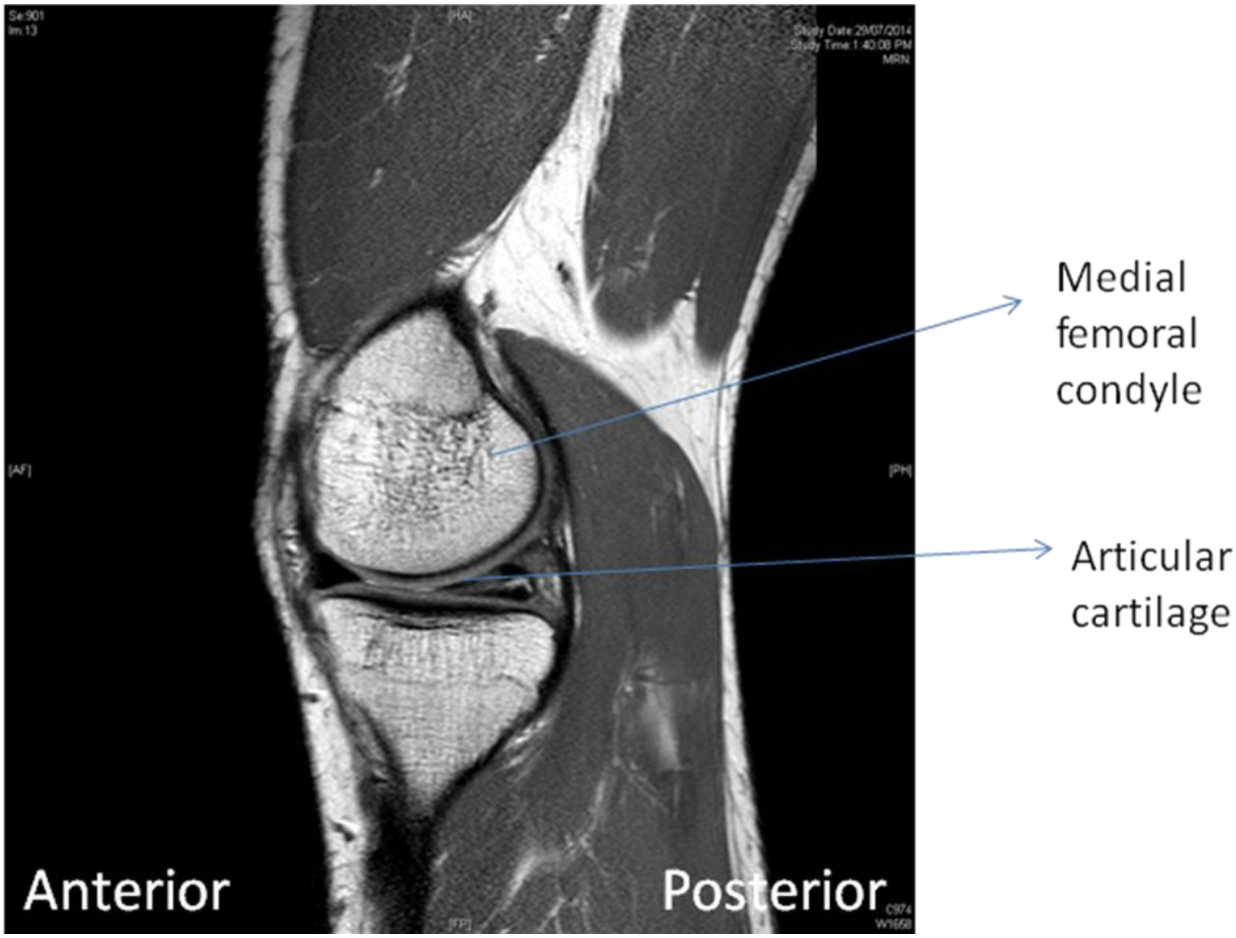



Intercondylar notch
Medial femoral condyle
Lateral femoral condyle
Lateral
Medial


Lateral
Medial
Lateral femoral epicondyle
Medial femoral epicondyle
Articular cartilage
Articular cartilage

Proton Density Images of Right Knee (Sagittal sections)




Medial
femoral
condyle
Articular
cartilage
Anterior
Posterior

TOTAL KNEE ARTHROPLASTY (TKA)

Knee arthroplasty (also known as knee replacement) is an operation done to replace the articular surfaces of the femoral condyles and tibial condyles. It is performed to relieve pain and disability. The most common indication for knee arthroplasty is Osteoarthritis. Other indications include Rheumatoid arthritis and Psoriatic arthritis. Osteoarthritis is a condition most commonly seen in the elderly wherein the articular surfaces of the knee joint undergo damage causing joint narrowing and debilitating pain.

Figure 11. Osteoarthritis of knee – Before and After Total Knee Arthroplasty

Knee arthroplasty can be of 2 types - partial or total. The procedure consists of replacing the damaged joint surfaces of the femoral and tibial condyles with metal and plastic components. The implants are shaped in such a way that they permit normal motion of the knee joint.

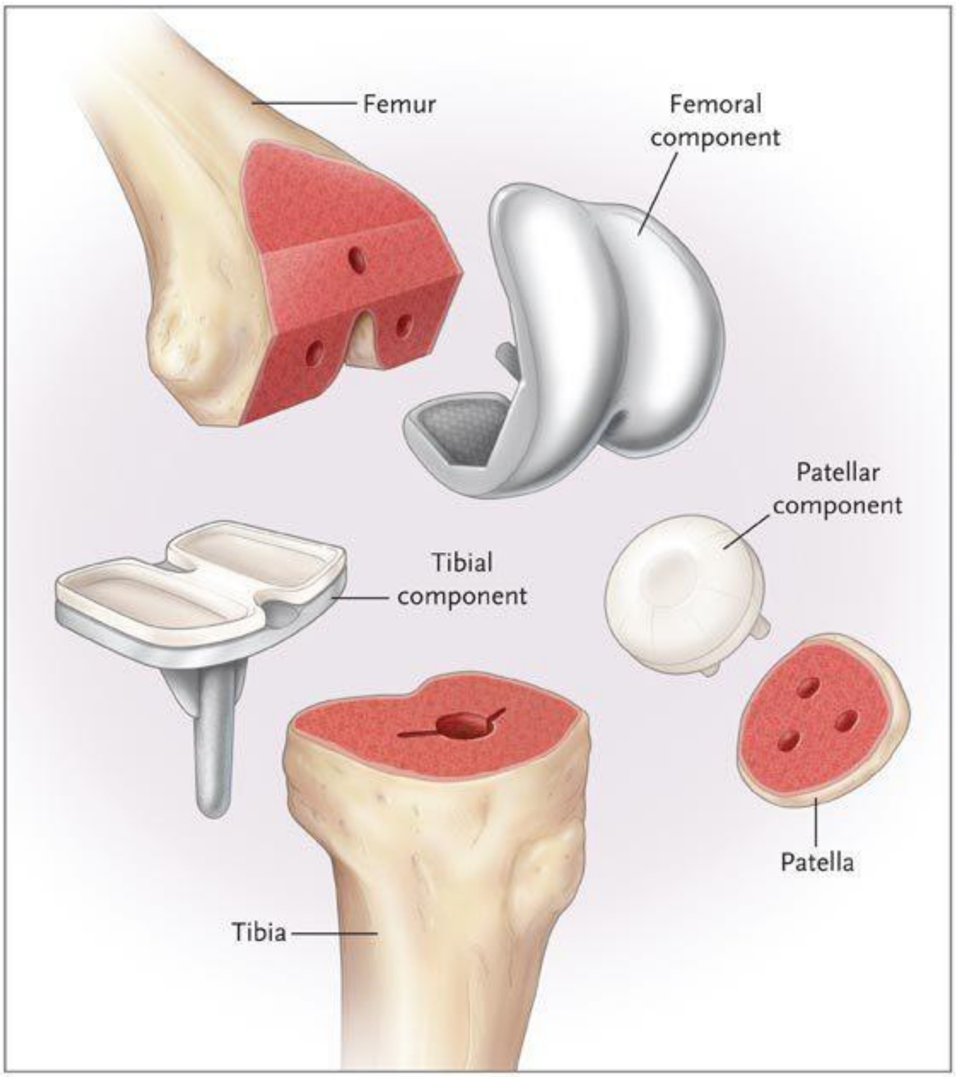


Figure 12. Components of Total Knee Arthroplasty


FEMORAL COMPONENT
Metal
INSERT
Plastic
TIBIAL BASEPLATE
Metal

Figure 13. KNEE RADIOGRAPH – POST TOTAL ARTHROPLASTY

ROTATIONAL ALIGNMENT IN TKA

In TKA, "rotational alignment'' is defined as the positioning of the implants in the axial plane. The accuracy of rotation of the femoral component in TKA affects soft tissue balancing i.e. medio-lateral stability during knee flexion, patello-femoral tracking(5–7), rotational alignment of the tibia in extension and also prevents anterior femoral notching. Polyethylene wear in the patellar component is affected by external rotation and may cause anterior knee pain after TKA(8).

The distal femur anatomy has an important role in the normal movements of the knee joint, i.e. its biomechanics. Therefore it is pertinent to understand the distal femoral condylar anatomy for the treatment of knee osteoarthritis.

The three commonly used axes for determining the rotational alignment of the femoral component in TKA are – the **posterior condylar axis,** the **transepicondylar axis (TEA)** and the **anteroposterior axis (Whiteside's line)**.

The **posterior condylar axis** is a line joining both the femoral condyles, touching its posterior articular surface.

The **transepicondylar axis** is a line joining the most prominent part of the lateral and the medial epicondyles.

The **anteroposterior axis (Whiteside's line)** is drawn by joining the deepest point of the patellar groove to the midpoint of the intercondylar notch.

Various studies have proved that there is a wide variation in these axes among different racial groups.

Various studies have also proved that measured resection technique based on a single angle or axis as the sole reference is often inaccurate in determining the femoral component rotation in TKA.

Mullaji et al had done a study on 100 normal non-arthritic knees among 42 men and 8 women. They used Computed tomography images of the lower end of femur for the measurement of angles formed by the distal femoral rotational axes. They had concluded that, in knees with severe valgus deformity, using the posterior condylar axis alone as the reference axis could result in malrotation due to a pre-existing lateral femoral condylar hypoplasia(9).

Boisgard et al aimed at assessing the reliability of the posterior condylar axis as a reference for the control of femoral implant rotation and at measuring the posterior condylar angle. They prospectively studied 103 arthritic knees (81 varus, 22 valgus) before a TKA was performed in 103 patients (75 women, 28 men). They used CT images of the distal femur for the assessment of the PCA. The mean PCA value obtained for all the patients was 2.65 degrees (range 0 to 7 degrees). The PCA was significantly increased in the valgus knees. The results obtained indicated a marked variability in the PCA value. Hence they concluded that if the posterior condylar axis was being used as a guide for rotation, the PCA had to be calculated individually for each patient using adjustable jigs based on the value that was obtained(10).

Two types of transepicondylar axes have been described in literature. They are - the surgical axis and the clinical axis. The surgical axis is drawn between the lateral epicondyle and the centre of the medial epicondylar sulcus. The clinical axis is drawn between the most prominent part of the lateral and medial epicondyles(10,11).

Yoshino et al studied 48 patients who were posted for Total Knee Arthroplasty to describe the surgical epicondylar axis and the clinical epicondylar axis. They performed CT images of both knees and measured the posterior condylar angle. They were able to detect the medial epicondylar sulcus in the CT scan images in only 33 knees. The degree of difficulty in detecting the medial epicondylar sulcus was dependent on the severity of osteoarthritis. But they were able to detect the most prominent point of medial epicondyle in all knees. They had opined that it may be difficult to define the transepicondylar axis because of difficulty in finding the most prominent point or the sulcus of the medial epicondyle(12). Hence they recommended the use of the clinical transepicondylar axis in selective planning for TKA.

Tanavalee et al also evaluated the differences and reliability between the two epicondylar axes using Computerized tomography. CT scans of the distal femur were done in 55 osteoarthritic knees. 32 knees had a varus deformity and 23 knees were neutral in alignment. Axes for rotational alignment of the femoral component were lined including posterior condylar (PC), anteroposterior (AP), anatomic or clinical epicondylar, and surgical epicondylar axes. They also concluded that the clinical epicondylar axis was more reliable for femoral rotational alignment than the surgical epicondylar axis as it was easier to define and using the surgical epicondylar axis could lead to patellofemoral tracking problems in TKA(13).

Berger et al(11) studied 75 embalmed femurs to identify a secondary anatomic axis other than the posterior condylar axis to determine the rotational alignment of the femoral component when the posterior condylar surfaces could not be used. The surgical epicondylar axis was defined as the line connecting the lateral epicondylar prominence and the sulcus of the medial epicondyle. The posterior condylar angle (PCA) was measured as the angle between the posterior condylar surfaces and the surgical epicondylar axis. The PCA measured using the surgical epicondylar axis as the reference yielded a mean value of 3.5 degrees (+/- 1.2 degrees) of internal rotation for males and a mean value of 0.3 degree (+/- 1.2 degrees) of internal rotation for females. Therefore they concluded that rotational alignment of the femoral component can be accurately estimated using the PCA.

Hence they regarded the surgical axis to be more reliable in measuring the PCA even though it was more difficult to define it clinically[6].

Nagamine et al assessed how reliable were the anteroposterior and posterior condylar axes for determining femoral component rotational alignment in TKA. They performed CT scans of 84 knees (27 varus knees with medial tibiofemoral osteoarthritis in 26 patients, 17 knees with patellofemoral arthritis in 14 patients, and 40 normal knees in 40 volunteers). They found consistent values of the posterior condylar angle in both osteoarthritic and normal knees but there were significant differences in the Whiteside's epicondylar angle between the medial tibiofemoral osteoarthritis knees and normal knees

Therefore they opined that defining the Whiteside's line or the anteroposterior line may be difficult in deformed knees due to erosive changes involving the anterior portion of the lateral femoral or medial femoral condyles(14).

Arima J et al studied 30 cadaveric femora to identify the anteroposterior axis, the posterior condylar axis, and the transepicondylar axis and to determine the reliability and the usefulness of each axis in total knee arthroplasty. The mean posterior condylar angle that was measured was 4 degrees. It was difficult to accurately defined the transepicondylar axis. Hence they concluded that the anteroposterior axis was a reliable landmark for rotational alignment of the femoral component in a valgus knee(6).

Hence, when determining rotational alignment of the femoral component in total knee arthroplasty, it becomes important to take into consideration all the relevant axes.

Few studies have been done in normal subjects aged below 40 years who had no evidence of osteoarthritis using CT and few studies using MRI. But only few studies have been done in Osteoarthritic knees, that too using only CT.

The aim of our study is to define the angular relationships of these axes in an Indian population aged between 50 and 75 years using Magnetic Resonance Images (MRI) of the knee. Knowing these values in this age group may help in bringing about changes in the design of TKA implants for the elderly Indian population.

MATERIALS AND METHODS

The study protocol was approved by our Institutional Review Board (IRB).

Diagrammatic Algorithm of the study:

A search was performed in the Radiology PACS database for all MRI knees done from August 1995 and August 2015 of patients aged between 50 and 75 years

↓

The MRI scans were assessed for any evidence of distal femur fracture, acute or chronic infection or tumor of the distal femur and if any were present those scans were excluded from the study.

↓

300 MRI studies of patients aging between 50 and 75 years met the eligibility criteria

↓

In the 300 MRI knees that met the eligibility criteria, a PDW axial MRI image in which the femoral epicondyles were most prominent was chosen for drawing the axes and measurement of angles.

↓

The posterior condylar axis was drawn as a line joining both the femoral condyles, touching its posterior articular surface.

↓

The transepicondylar axis was drawn as a line joining the most prominent part of the lateral and the medial epicondyles.

↓

The Whiteside’s line (anteroposterior axis) was drawn by joining the deepest point of the patellar groove to the midpoint of the intercondylar notch.

↓

The angle between the posterior condylar axis and the transepicondylar axis was measured as the posterior condylar angle (PCA) (Figure 14).

↓

The angle between the Whiteside’s line and the transepicondylar axis was measured as the Whiteside-epicondylar angle (W-EP angle) (Figure 15).

↓

Results and Conclusions

SCAN PROTOCOL:

MRI of the Knee:

The following sequences were acquired:

i. Proton density sagittal images

ii. Proton density axial images

iii. Proton density coronal images

iv. T1W axial images

v. T2W sagittal SPAIR images

vi. T2W coronal SPAIR images

vii. T2W axial SPAIR images

METHODOLOGY

The MRI images were analysed in a Picture Archiving & Communication System [PACS] monitor using GE Centricity software (Version 3.1.1.2). A Proton Density weighted axial MRI image, in which the femoral epicondyles were most prominent, was used for measurement of the various angles.

The **posterior condylar axis** is a line joining both the femoral condyles, touching its posterior articular surface.

The **transepicondylar axis** is the line joining the most prominent part of the lateral and the medial epicondyles.

The **anteroposterior axis (Whiteside's line)** is drawn by joining the deepest point of the patellar groove to the midpoint of the intercondylar notch.

The angle between the posterior condylar axis and the transepicondylar axis was defined as the **posterior condylar angle (PCA)** (Figure 14).

The angle between the Whiteside's line and the transepicondylar axis was defined as the **Whiteside-epicondylar angle (W-EP angle)** (Figure 15).

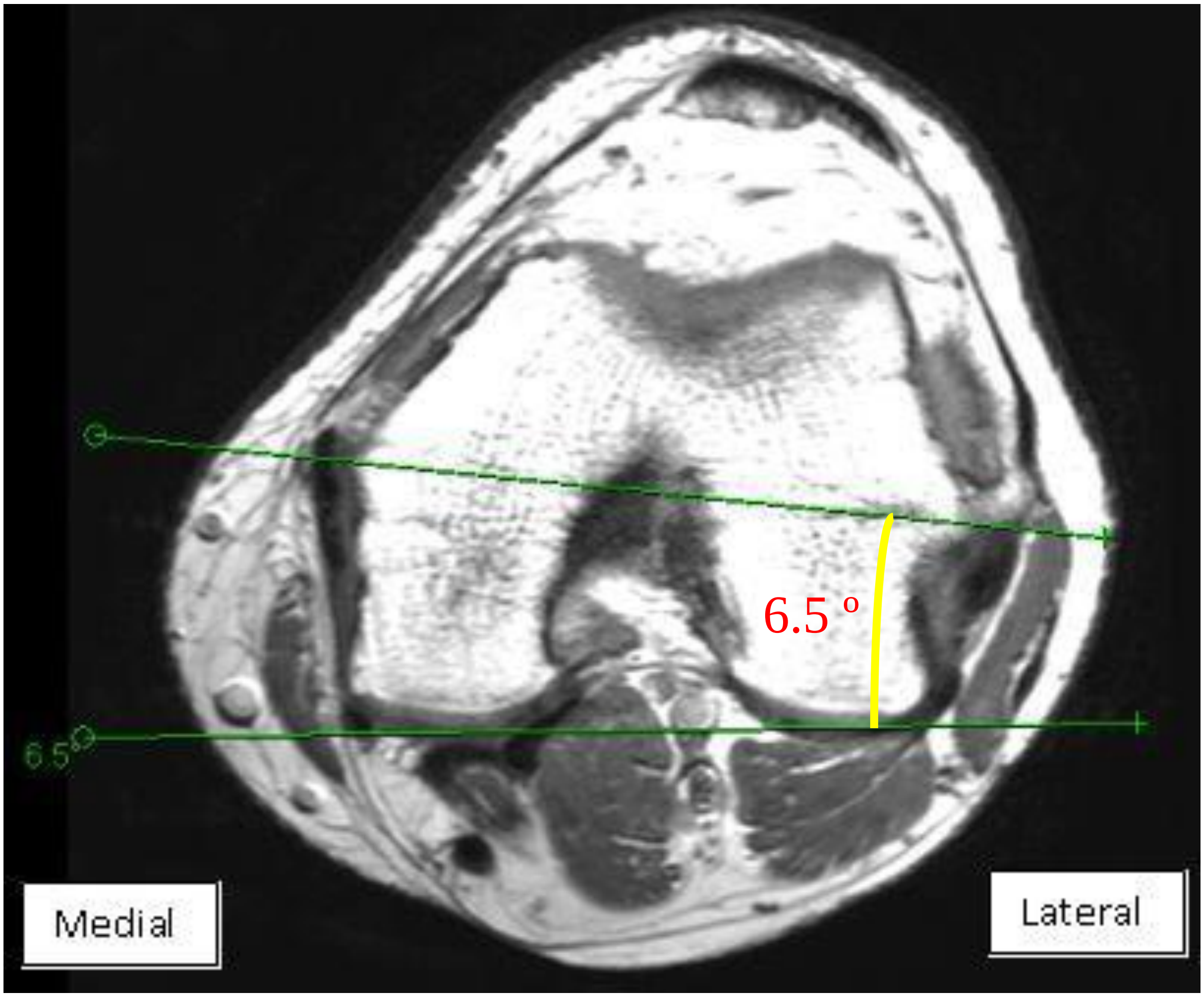


Figure 14 – Measurement of Posterior Condylar angle

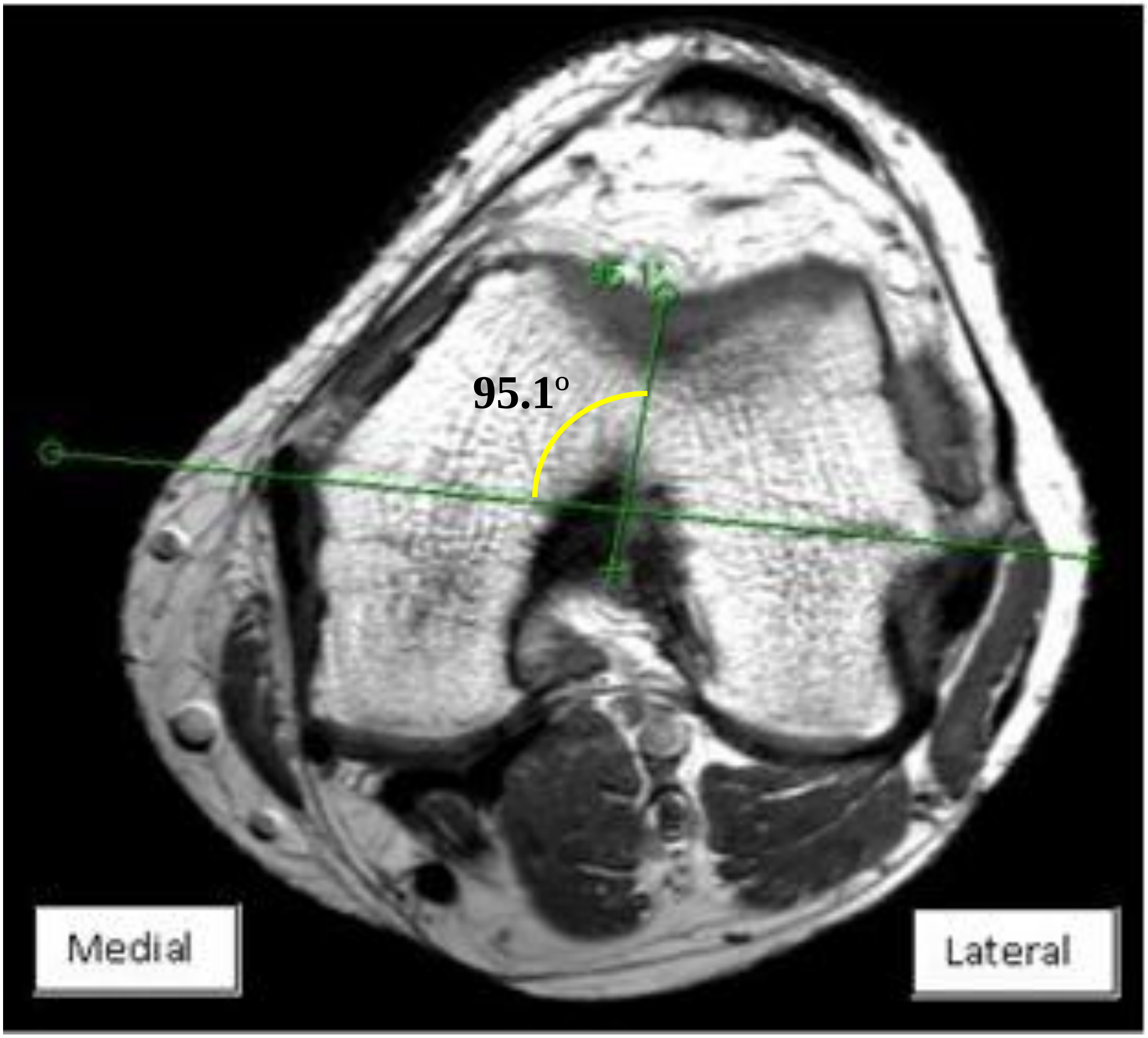


Figure 15 – Measurement of Whiteside's Epicondylar angle

The Mean and Standard deviation for age, Posterior condylar angle, Whiteside's Epicondylar angle were calculated using SPSS software (Version 17.0).

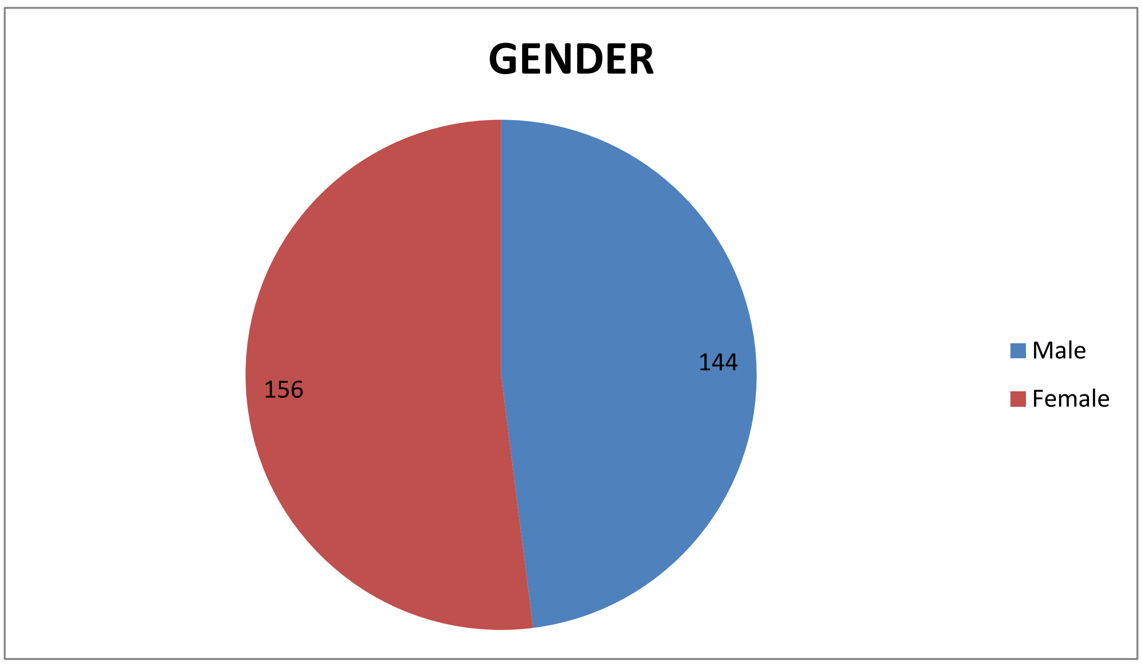
Differences between genders and sides were compared using Student's *t*-test and paired *t*-test, respectively. A p value of <0.05 was considered significant.

RESULTS

GENDER DISTRIBUTION

1. The total number of patients was 300, of which 144 were men and 156 were women), as depicted in Figure 16.

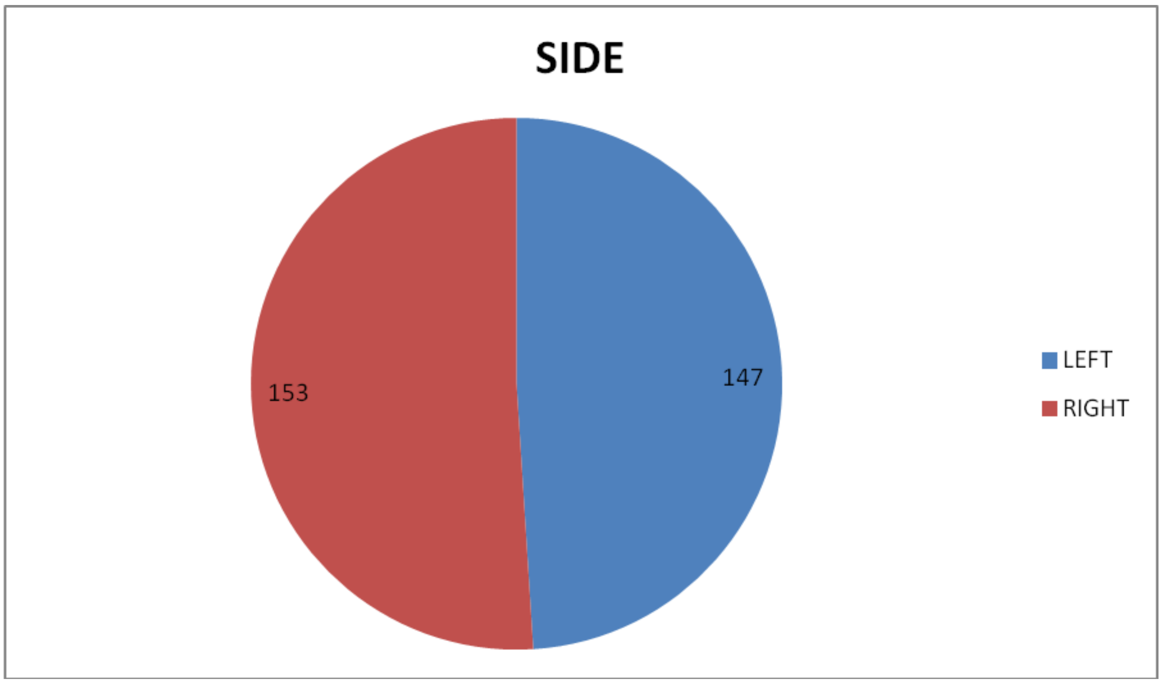
Figure 16.



SIDE DISTRIBUTION

2. A total of 300 knees were analyzed of which 147 were of the left side and 153 were of the right side, as depicted in Figure 17.

Figure 17.



AGE DISTRIBUTION

3. The mean age of patients whose MRI knee images were analyzed was 56.7 years (SD 6.3 years), range – 50 to 75 years, as depicted in **Table 1.**

TABLE 1

Total number	300
Mean age	56.7 years
SD	6.3 years
Minimum age	50 years
Maximum age	75 years

POSTERIOR CONDYLAR ANGLE & WHITESIDE'S EPICONDYLAR ANGLE

4. The overall mean PCA and W-EP were 5.5º (SD, 1.2º; range, 2.2º–8.8º), 92.5º (SD, 2º; range, 90º - 99.4º), respectively. **(Table 2)**

TABLE 2

	PCA	W-EP
Total number	300	300
Mean	5.5 º	92.5 º
SD	1.2 º	2 º
Minimum	2.2 º	90 º
Maximum	8.8 º	99.4 º

POSTERIOR CONDYLAR ANGLE (PCA)

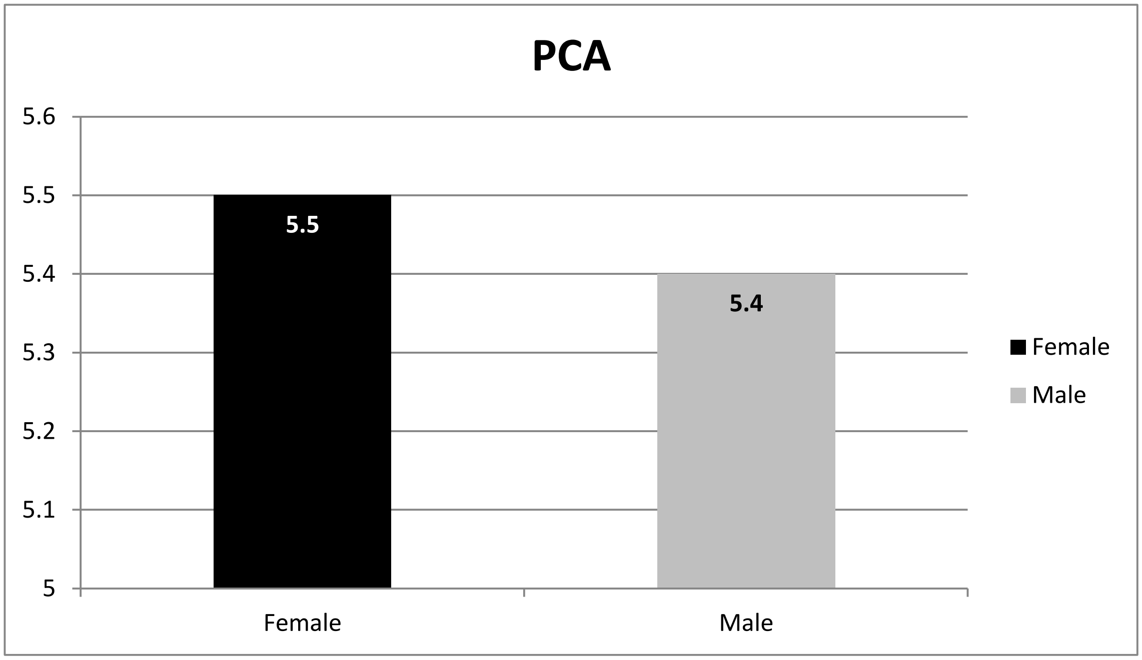
GENDER DISTRIBUTION

5. The mean PCA in the men was 5.4º and in the women was 5.5º, as depicted in **Table 3 & Figure 18.** There was no significant difference between the genders (p – 0.84)

TABLE 3

Gender	Total number	Mean	SD
Female	156	5.5 º	1.2 º
Male	144	5.4 º	1.2 º

FIGURE 18



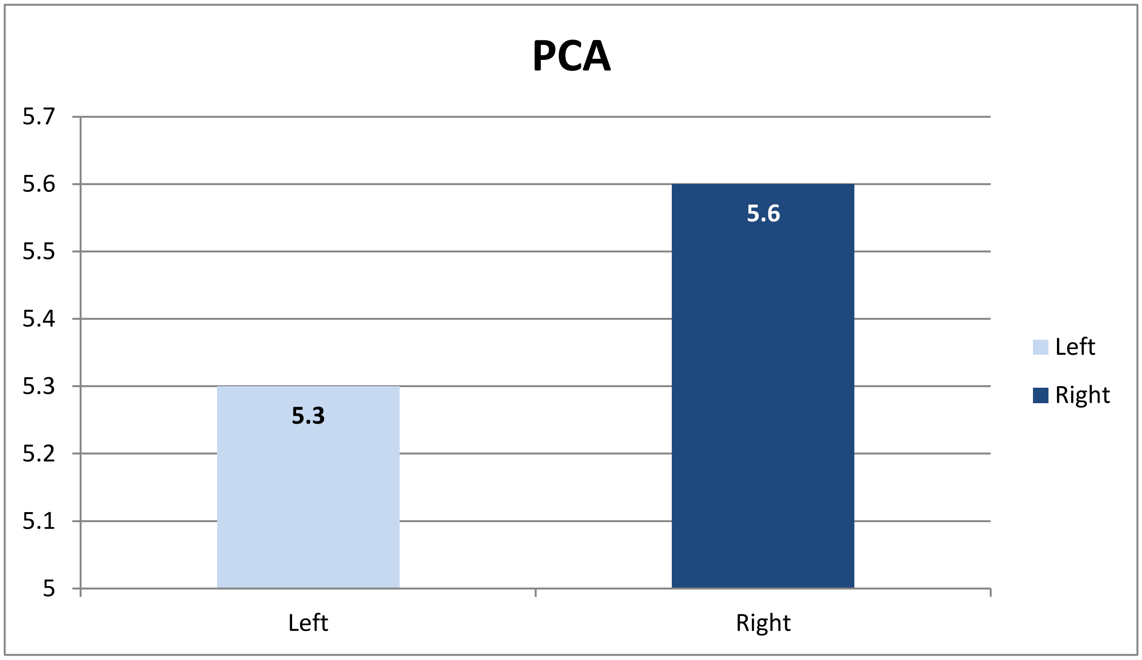
SIDE DISTRIBUTION

6. The mean PCA in the left knees was 5.3º and in the right knees was 5.6º, as depicted in **Table 4 & Figure 19.** There was no significant difference between the sides (p - 0.06)

TABLE 4

Side	Total number	Mean	SD
Left	147	5.3 º	1.2
Right	153	5.6 º	1.2

FIGURE 19



WHITESIDE'S EPICONDYLAR ANGLE (W-EP)

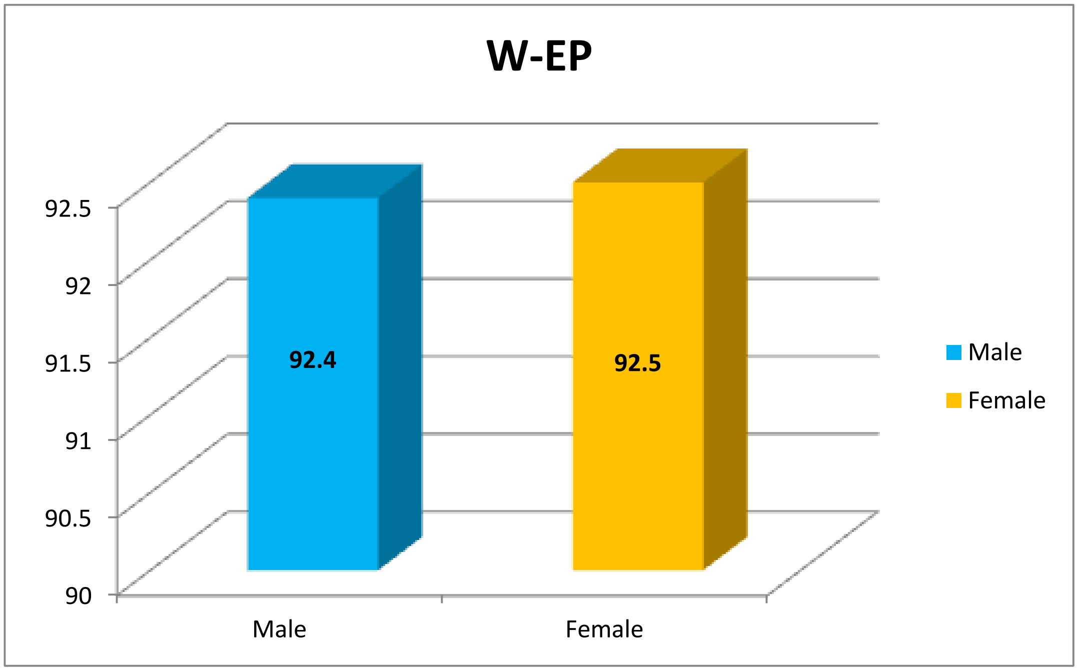
GENDER DISTRIBUTION

7. The mean W-EP in the men was 92.4º and in the women was 92.5º, as depicted in **Table 5** and **Figure 20**. There was no significant difference between the genders (p – 0.44).

TABLE 5

Gender	Mean	Number	SD	Minimum	Maximum
Female	92.5º	156	1.9	90 º	98.7 º
Male	92.4º	144	2	90 º	99.4 º

FIGURE 20

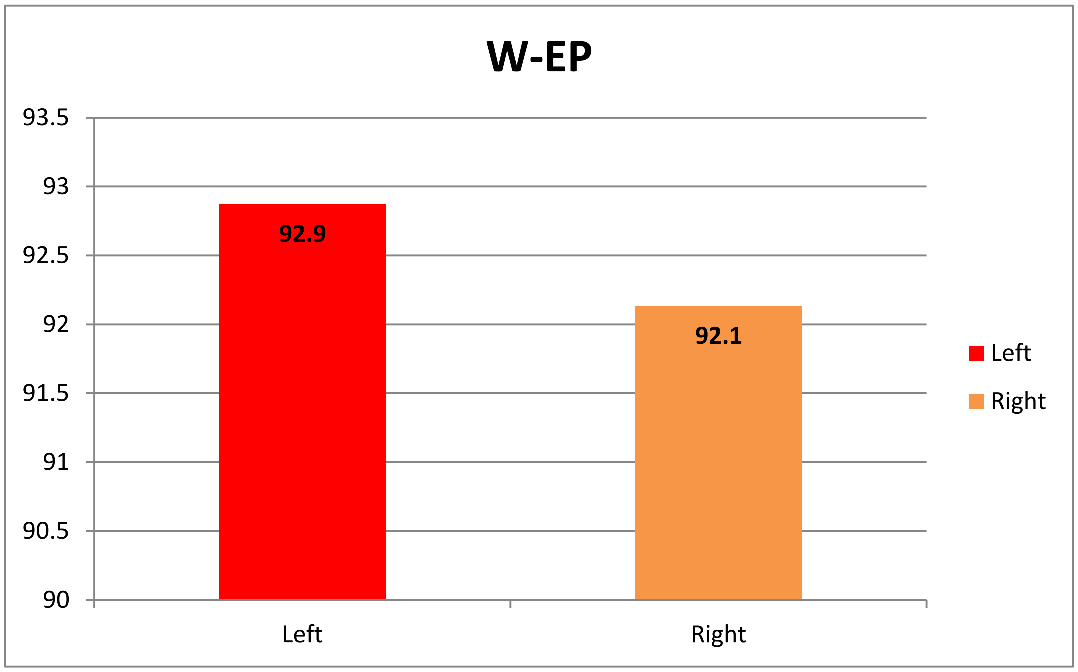


8. The mean W-EP in the left knees was 92.9º and in the right knees was 92.1º, as depicted in **Table 6 and Figure 21**. There was significant difference between the sides (p - 0.001).

TABLE 6

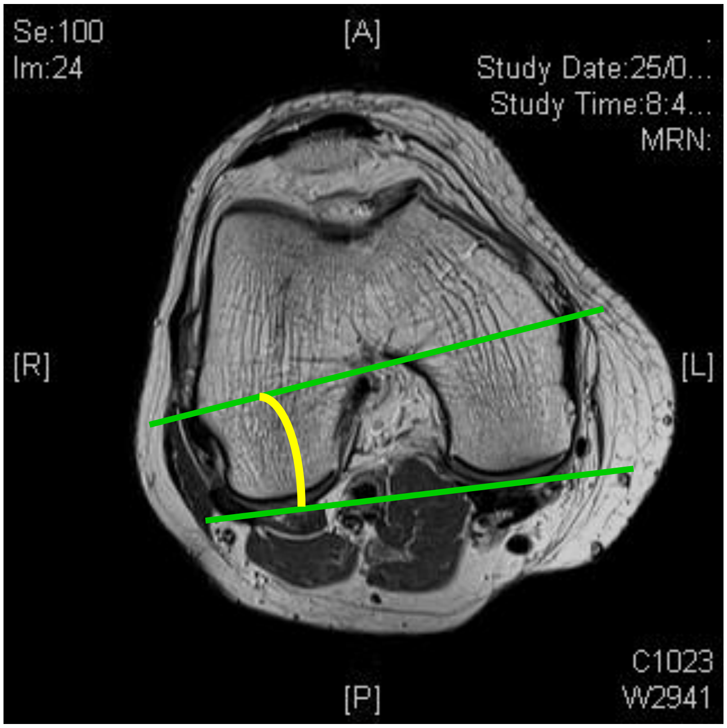
Side	Mean	Number	SD	Minimum	Maximum
Left	92.9 º	147	2.1	90 º	99 º
Right	92.1 º	153	1.8	90 º	99.4 º

FIGURE 21

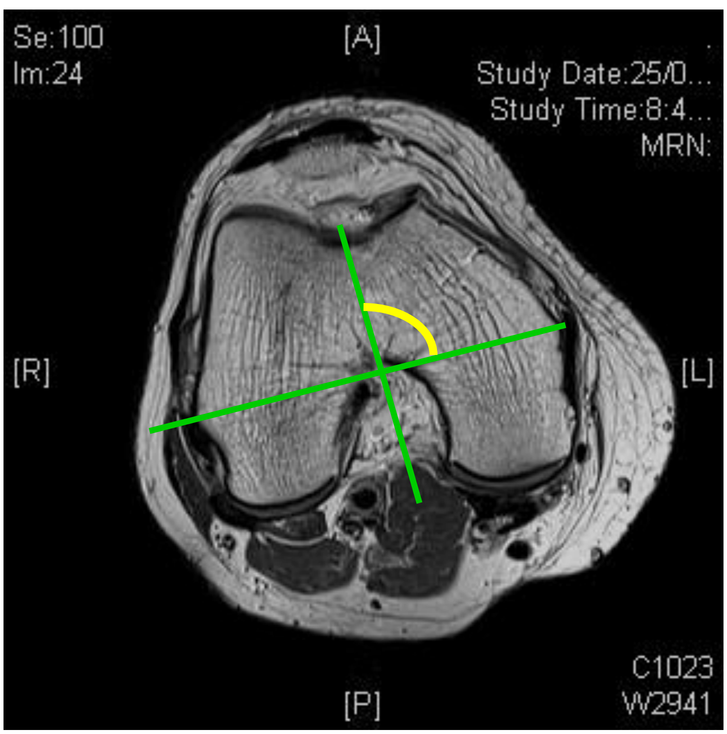


STUDY CASES – REPRESENTATIVE SAMPLES

Case 1:

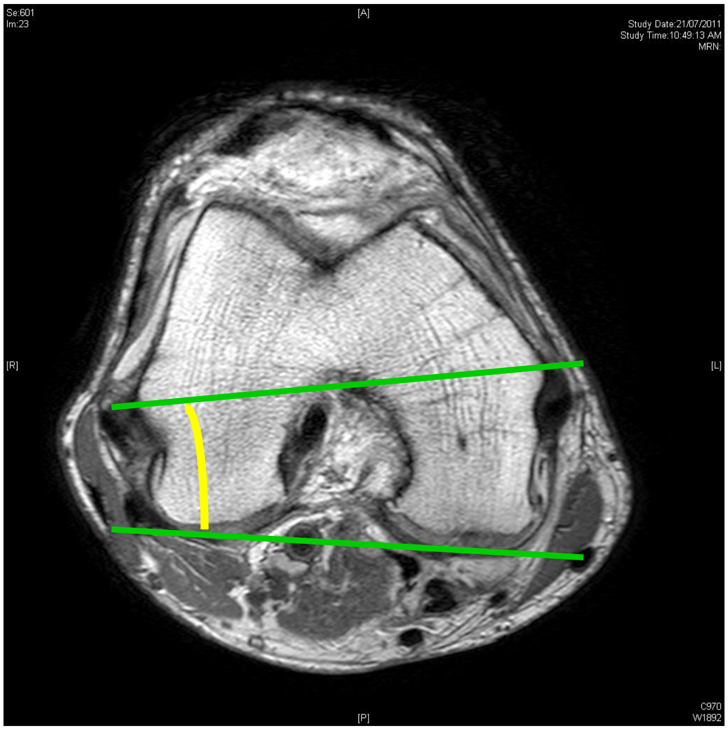


PCA = 8.8º

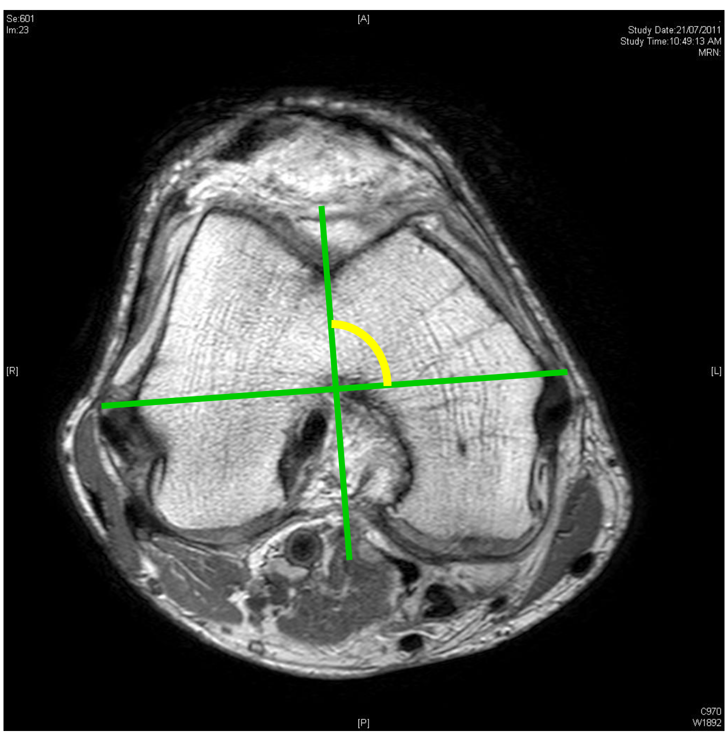


W-EP = 90.3º

Case 2:

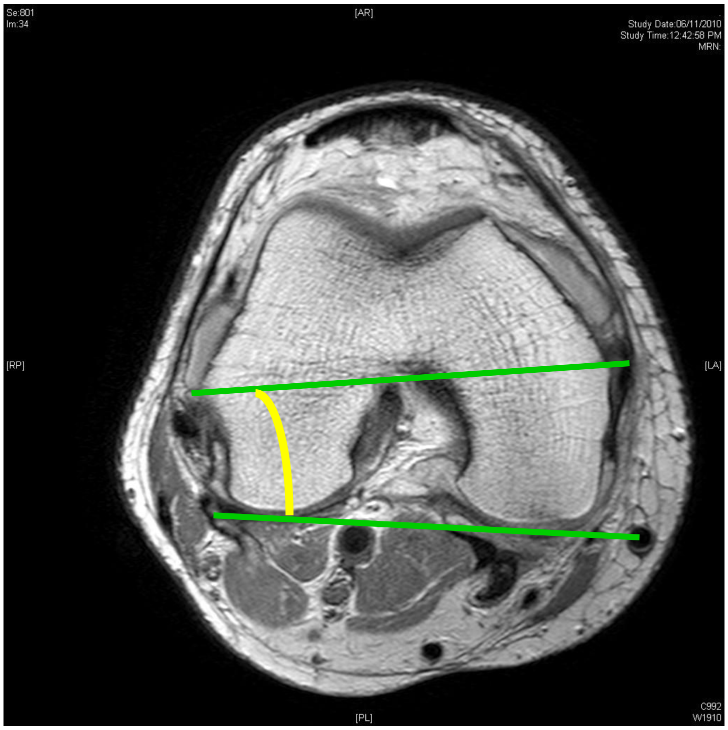


PCA = 7.6º

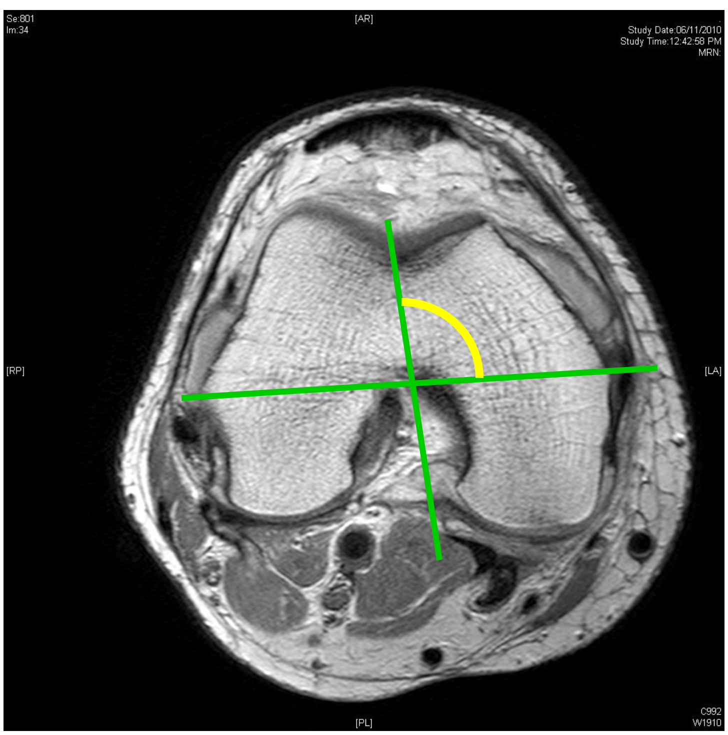


W-EP = 90.5º

Case 3:



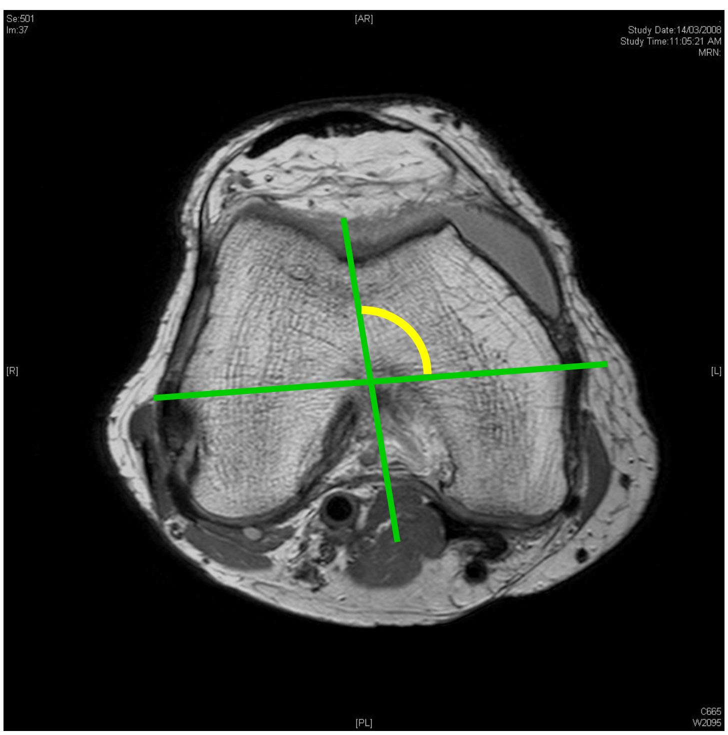
PCA = 8.5º



W-EP = 95.3º

Case 4:

PCA = 4.3º



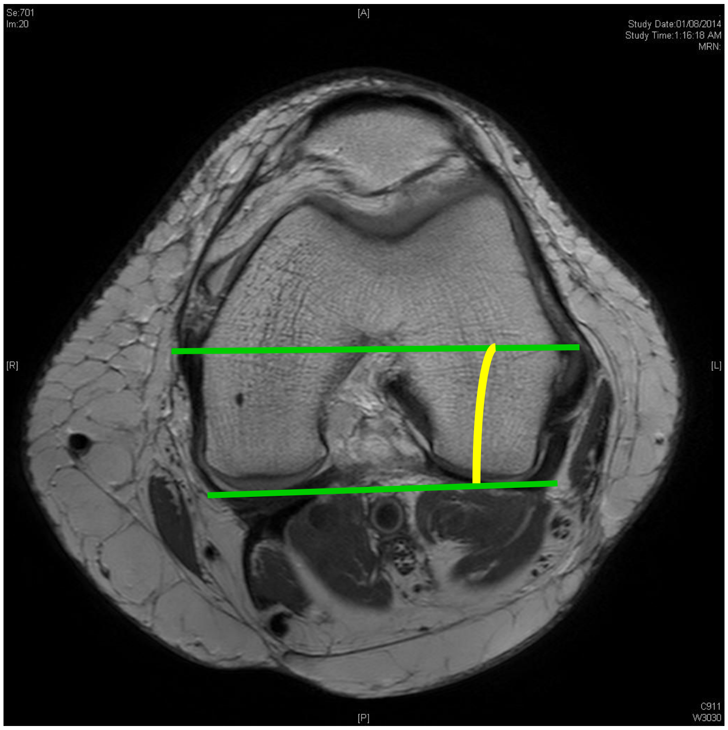
W-EP = 93.3º

Case 5:

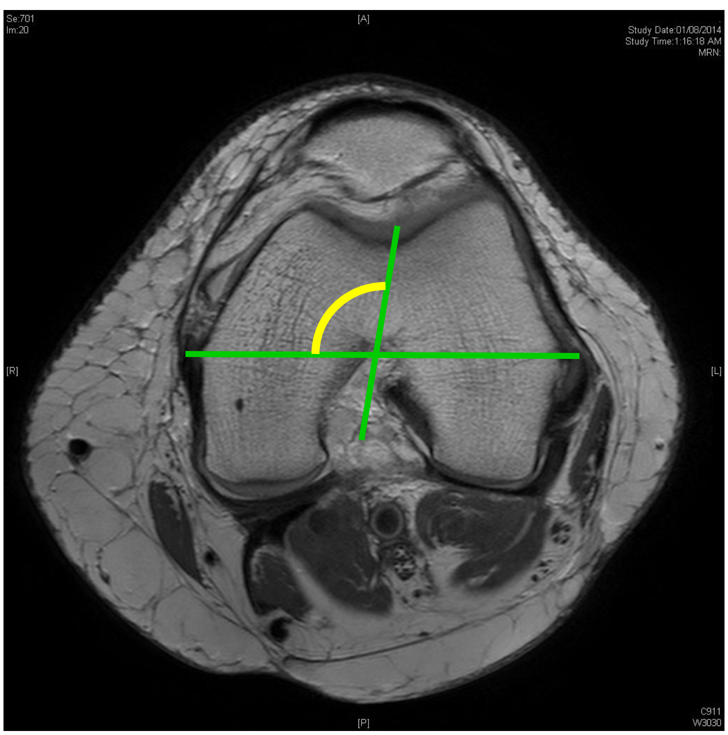
PCA = 4.4º

W-EP= 94.4º

Case 6:

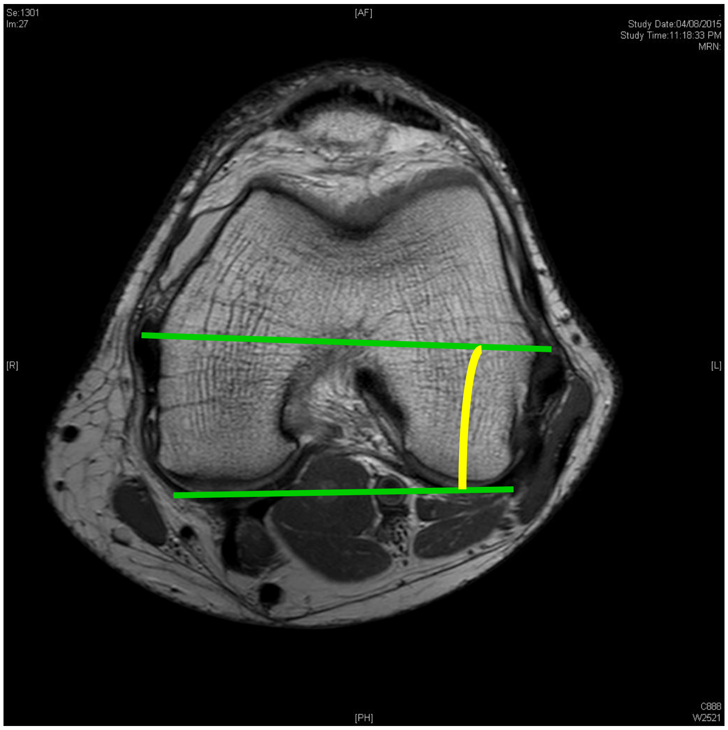


PCA = 5.8º



W-EP = 93.3º

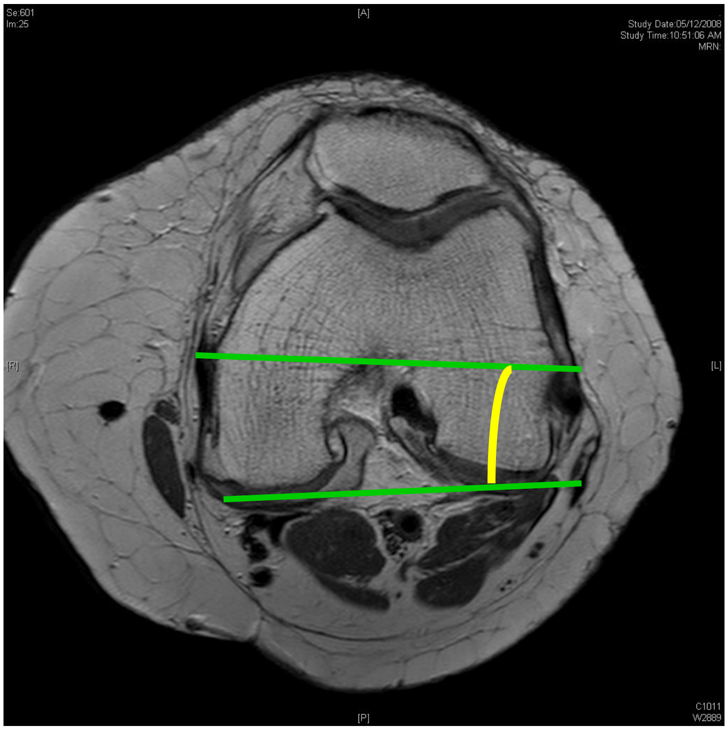
Case 7:



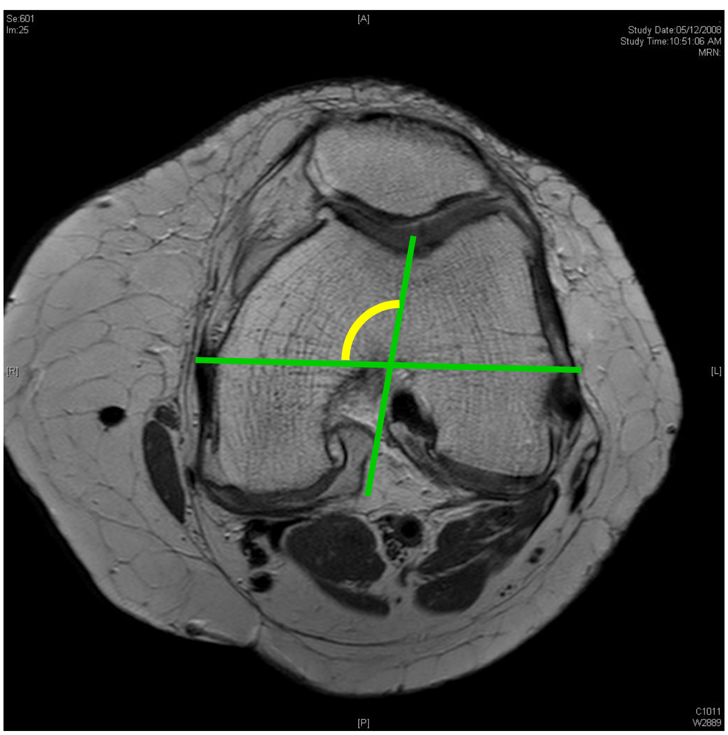
PCA = 3º

W-EP = 99º

Case 8:

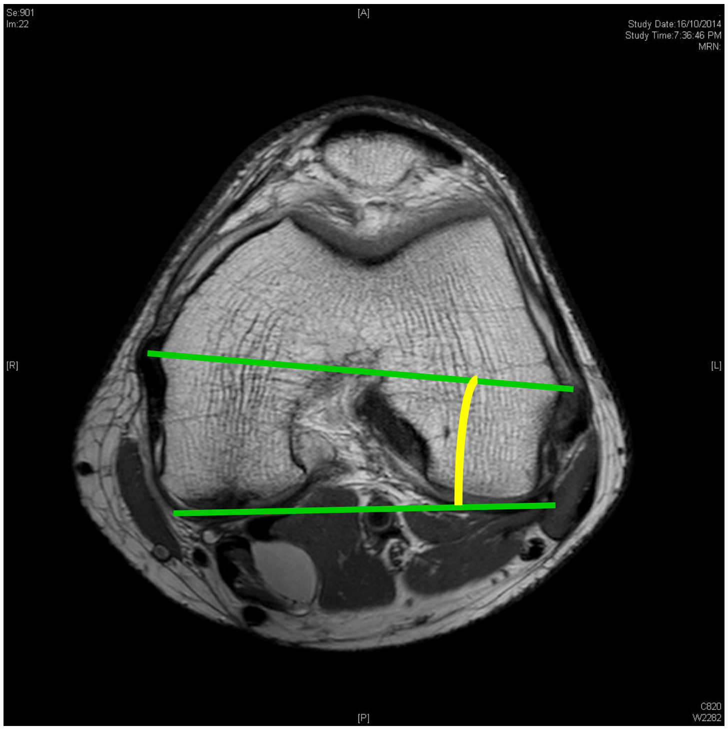


PCA = 6º

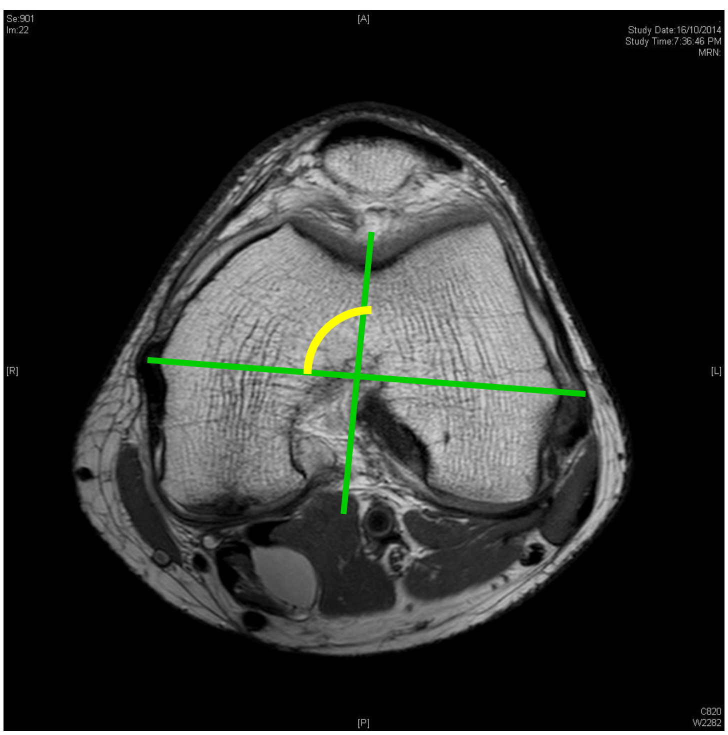


W-EP = 94.5º

Case 9:

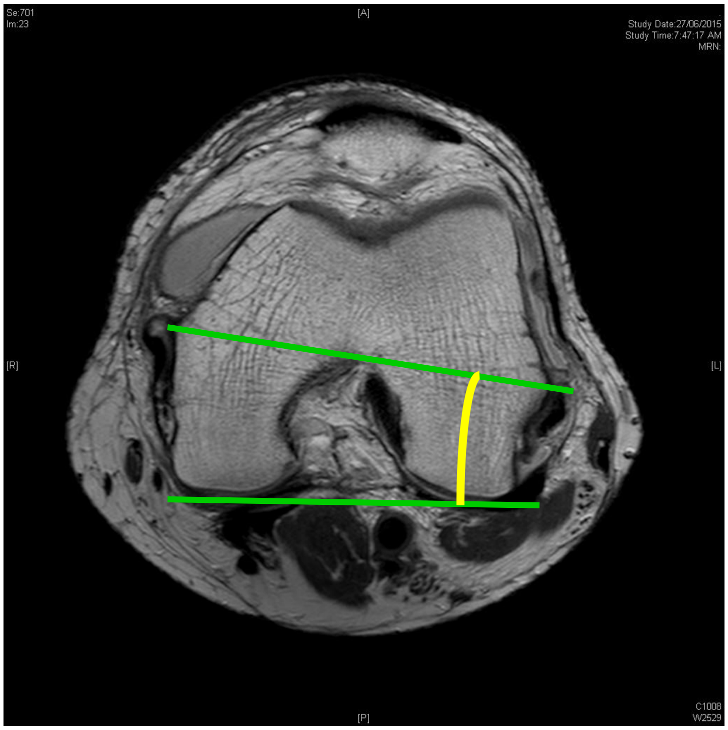


PCA = 4.8º

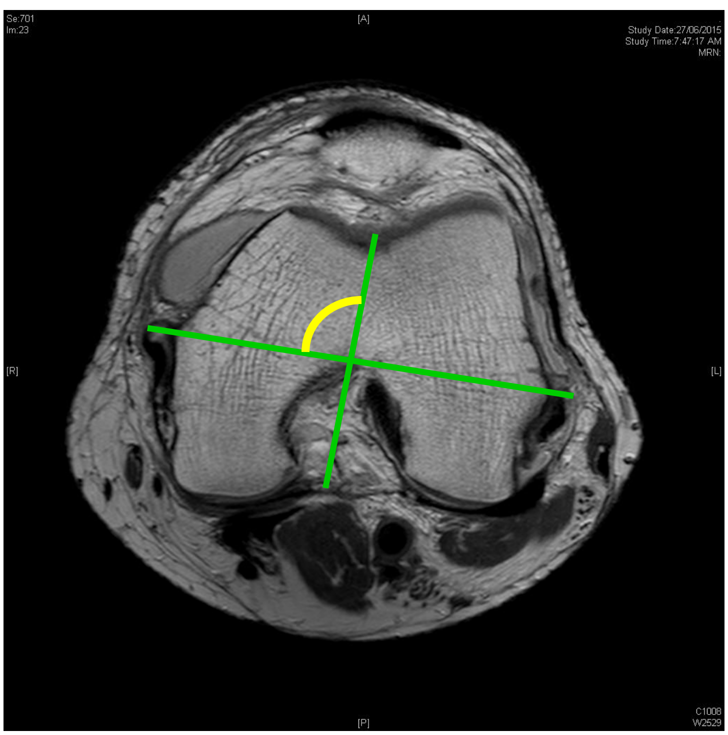


W-EP = 90.5º

Case 10:

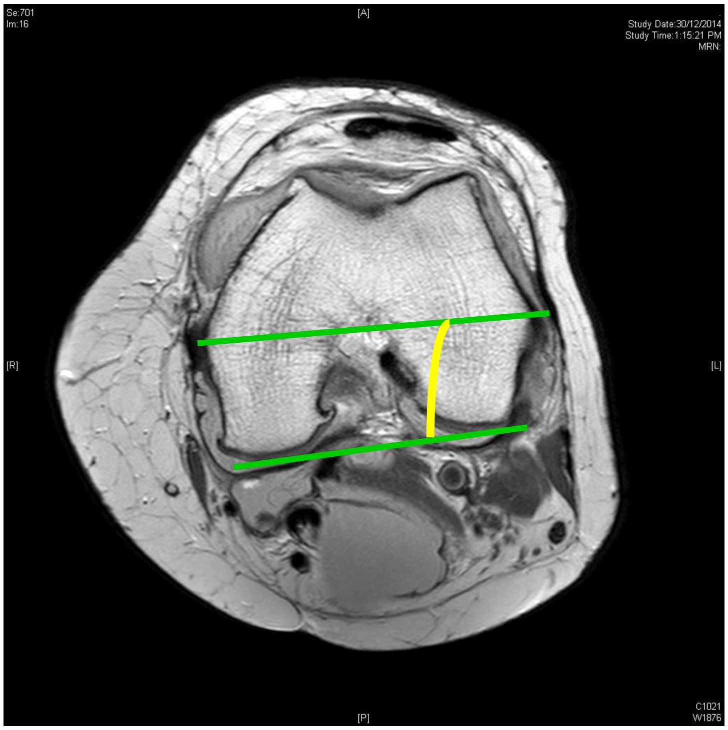


PCA = 6.9º

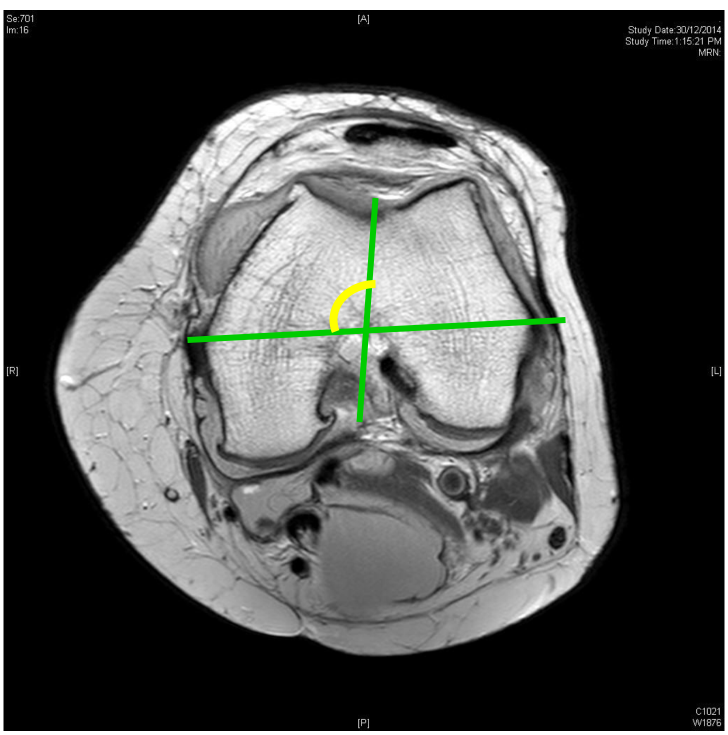


W-EP = 91.8º

Case 11:

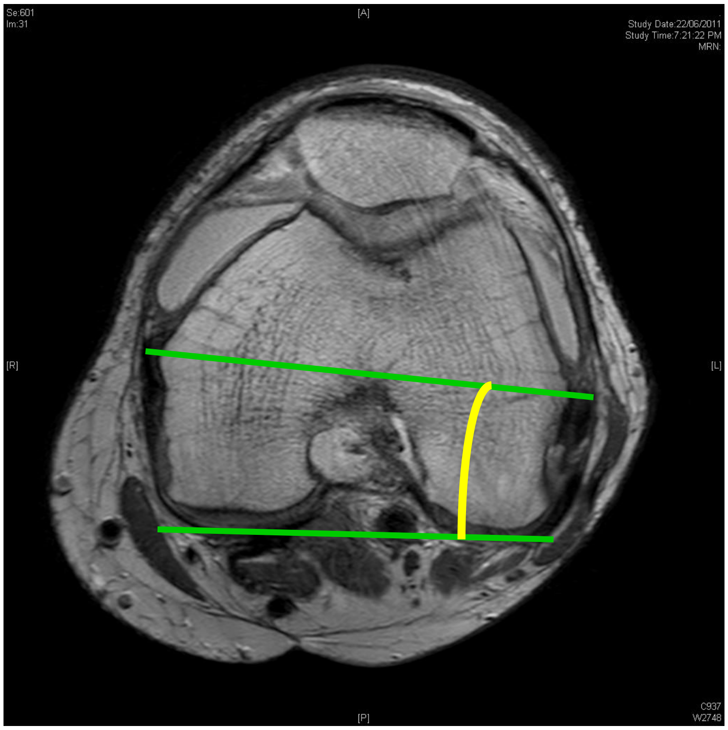


W-EP = 3.5º

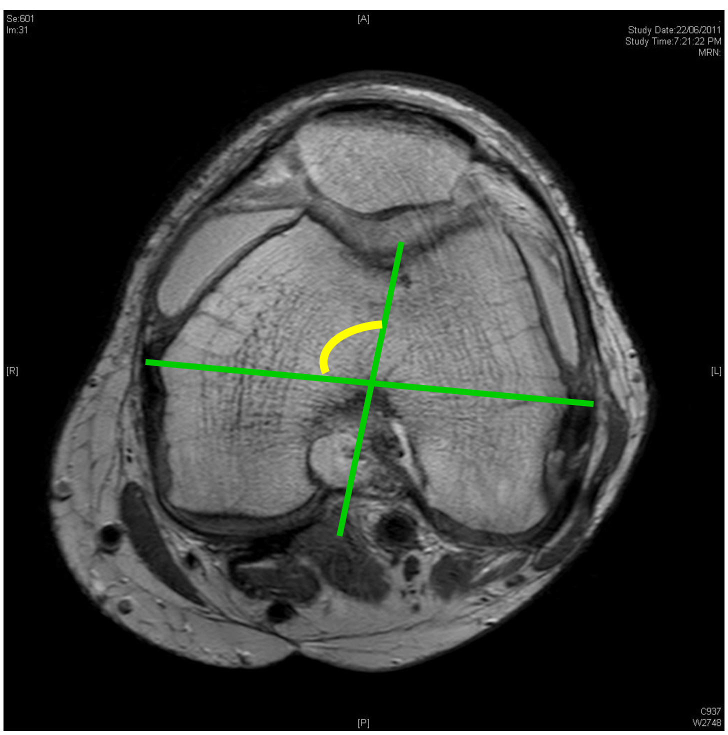


W-EP = 93.4º

Case 12:

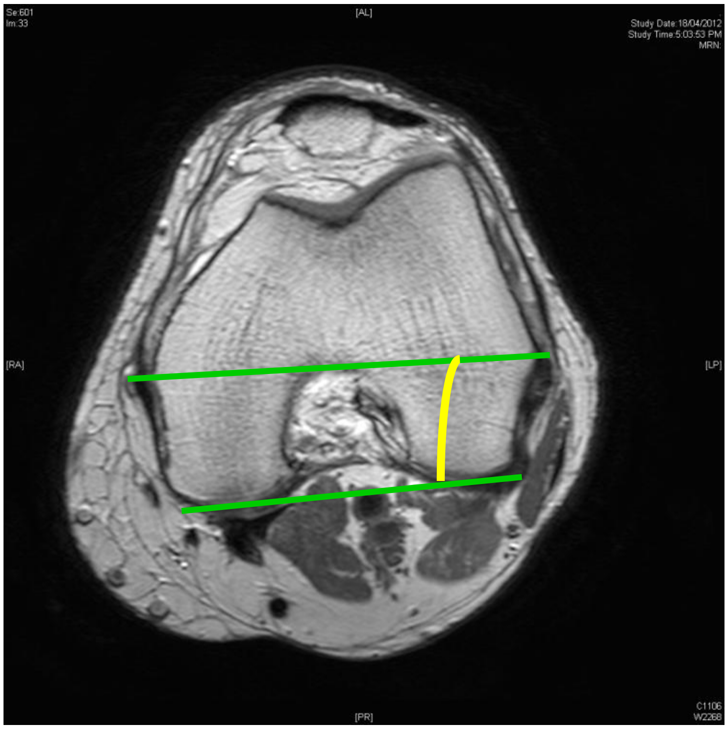


PCA = 3.9º

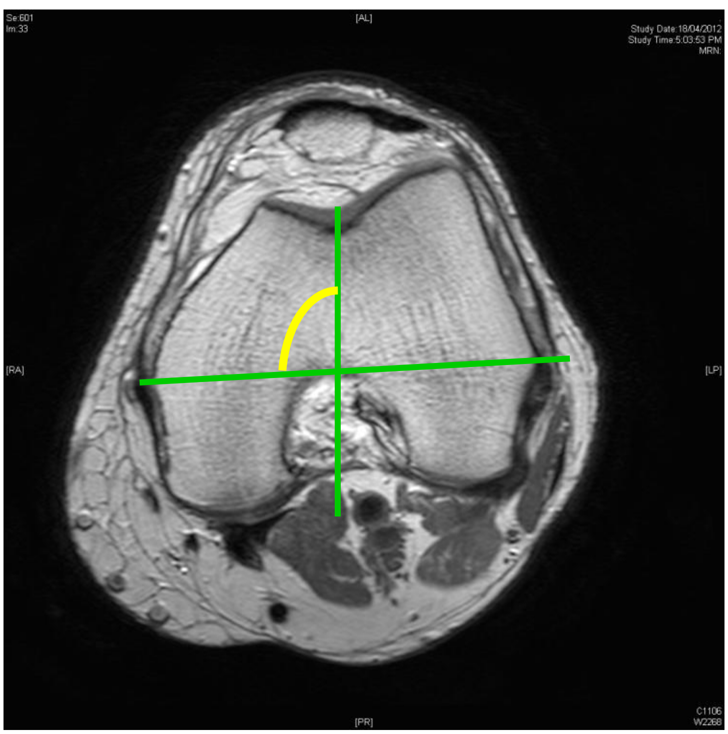


W-EP = 97.6º

Case 13:

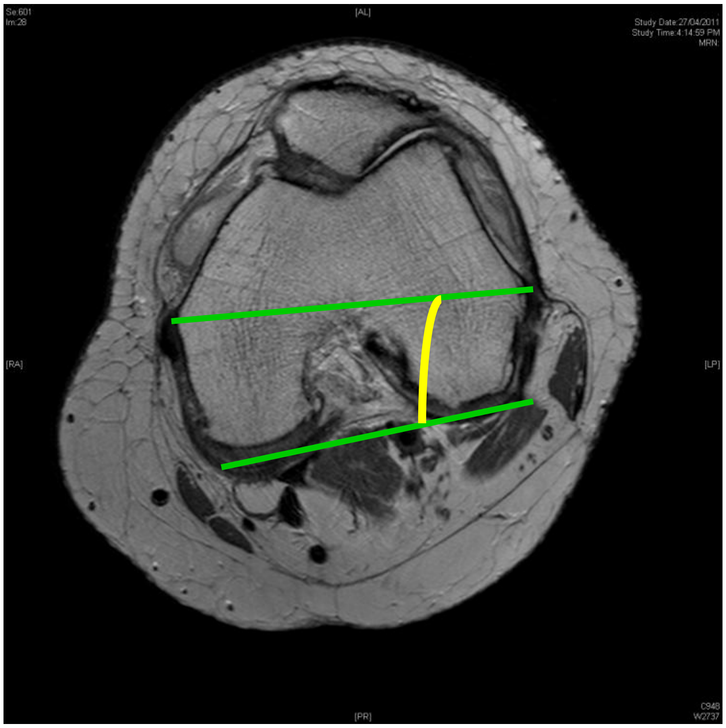


PCA = 3.6º



W-EP = 90.1º

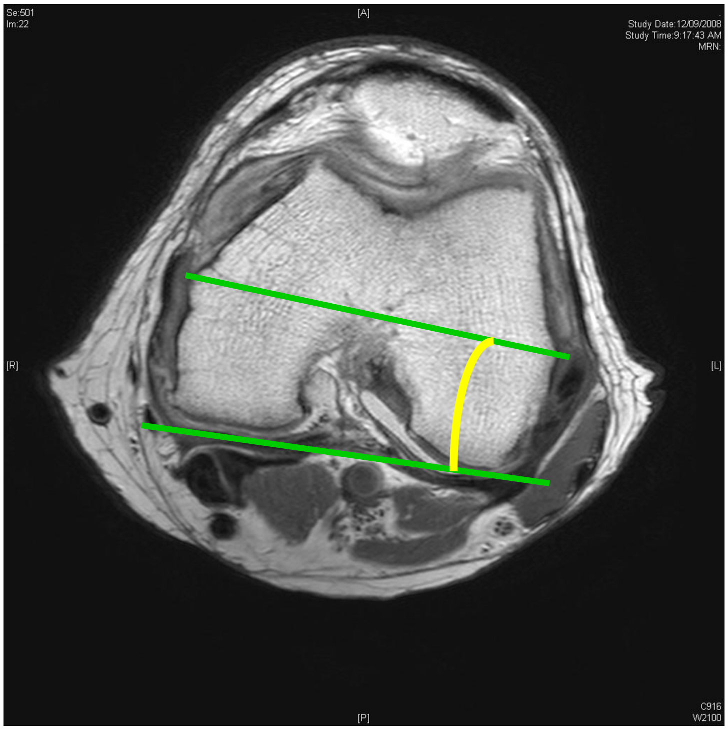
Case 14:



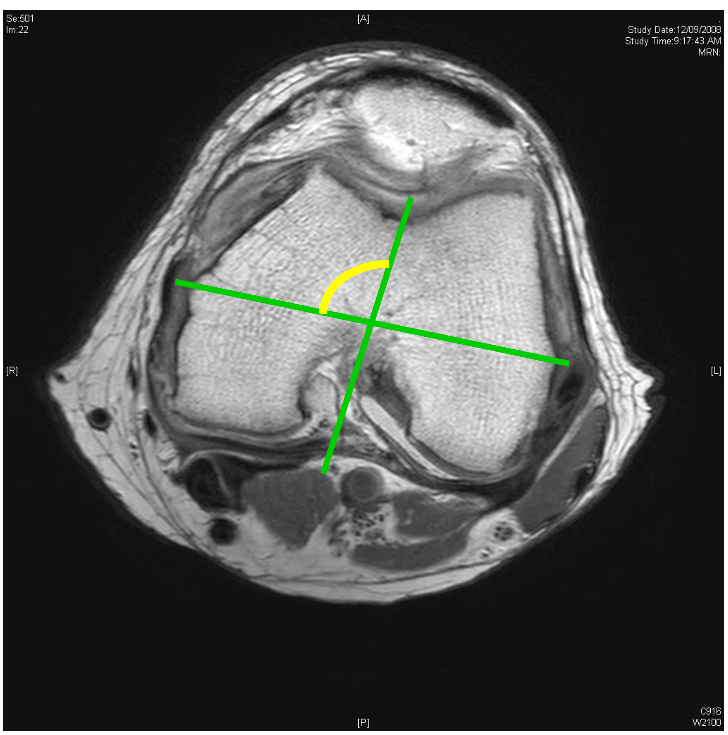
PCA = 5º

W-EP = 92.8º

Case 15:

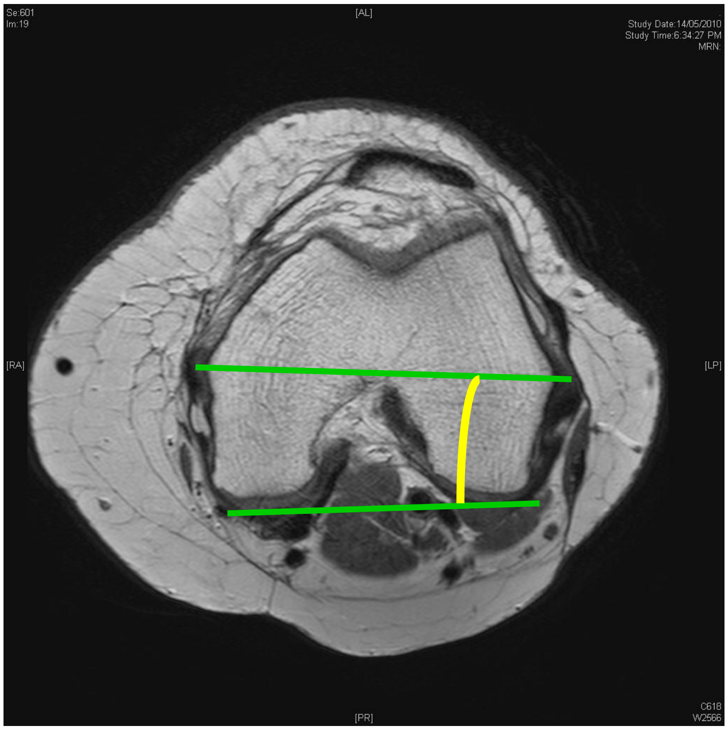


PCA = 7.3º



W-EP = 94.3º

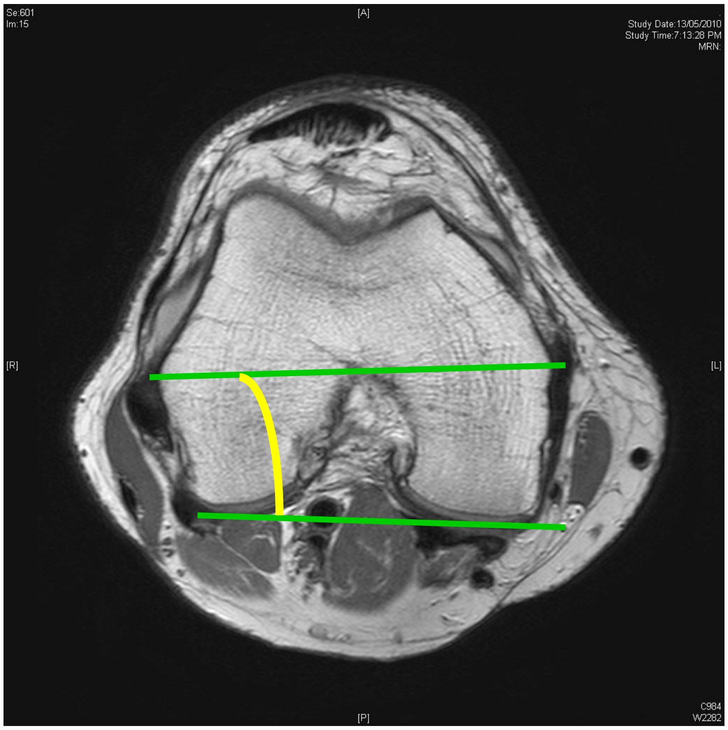
Case 16:



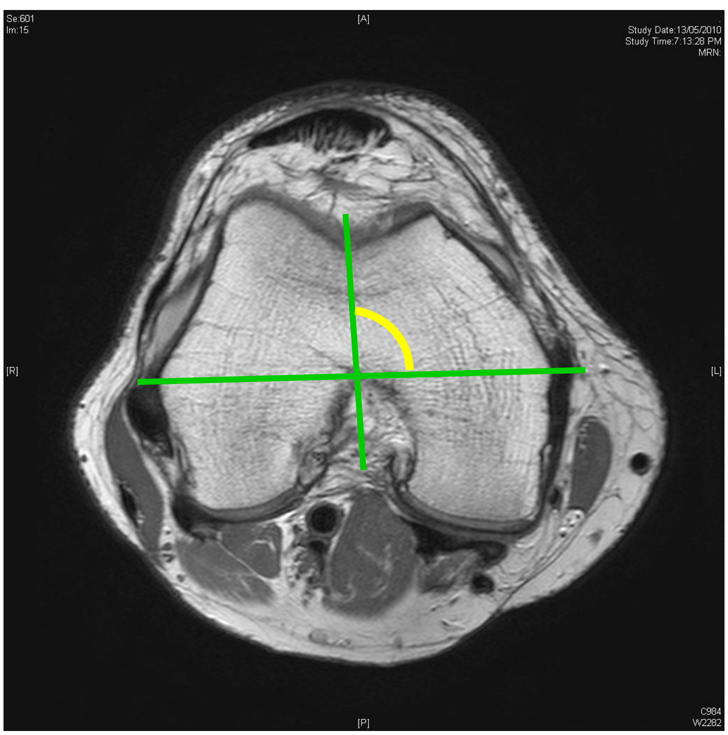
PCA = 4.1º

W-EP = 94º

Case 17:

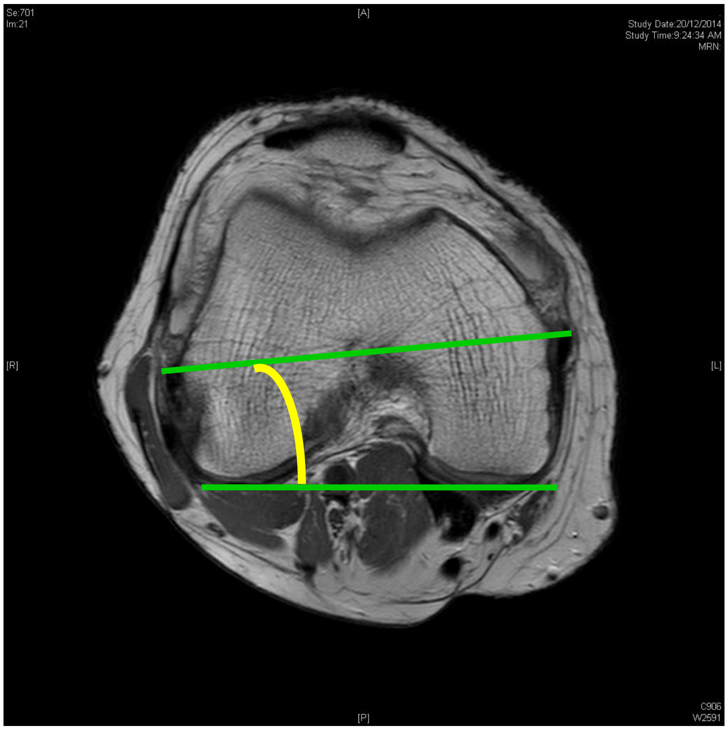


PCA = 4º

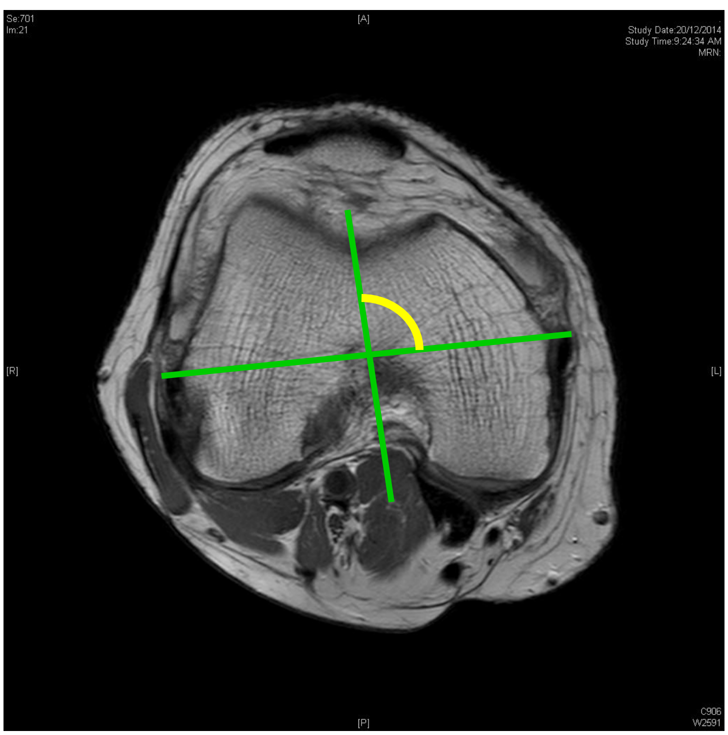


W-EP = 92º

Case 18:



PCA = 6.9º



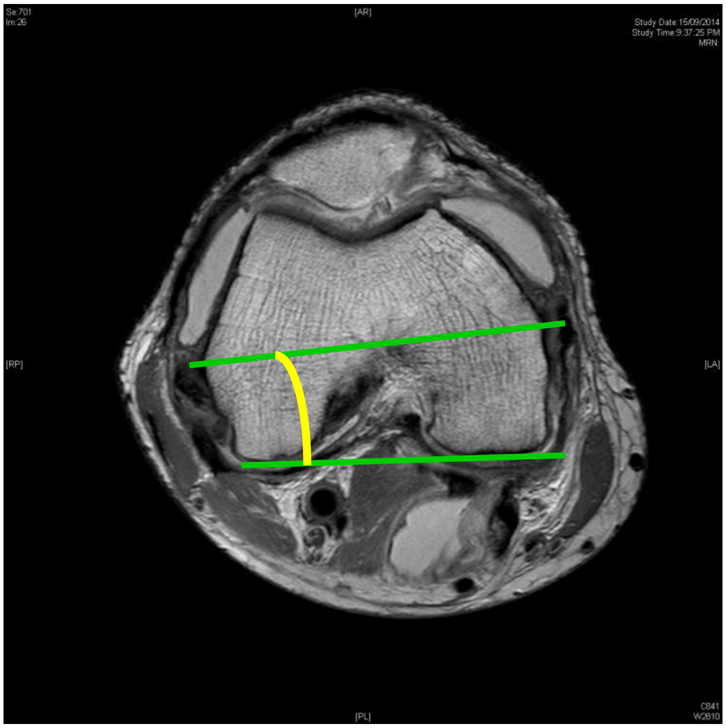
W-EP = 91.6º

Case 19:

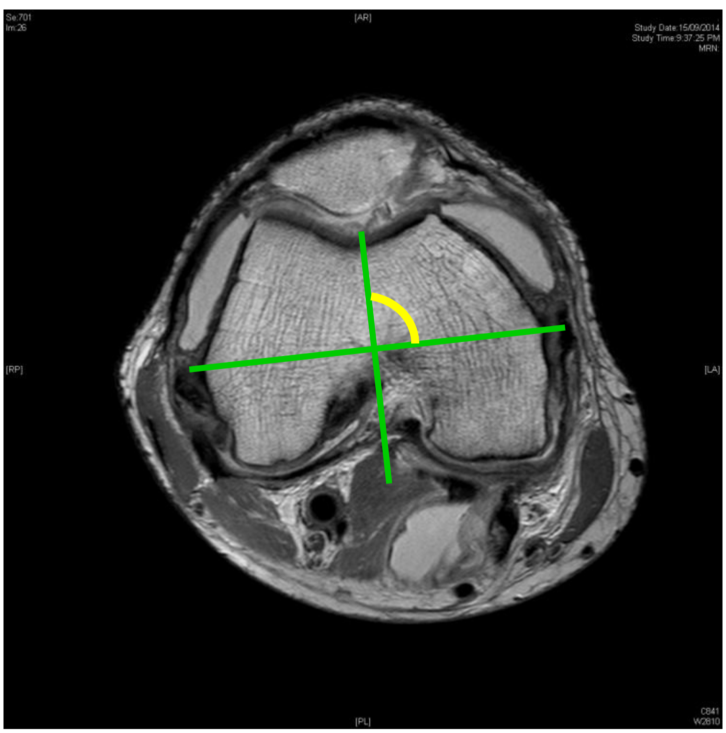
PCA = 8.3º

W-EP = 91.8º

Case 20:



W-EP = 5.3º



W-EP = 90.1º

DISCUSSION

Posterior Condylar Angle (PCA):

The Posterior condylar angle is about 3 degrees according to Western studies – [Boisgard et al 2.65°(10), Griffin et al - 3.11°(15), Berger- 3.5°(11)]. Most proprietary jigs used in total knee arthroplasty employing the measured resection technique place the anterior and posterior cuts at 3 degrees external rotation to the PCA.

In our study, the PCA in the Indian knee in the 50 to 75 years age group is about 5.5°- which is slightly lesser than the Japanese(14) (5.8°) and Chinese females (5.8°) but greater than in Chinese males (5.1°)(8) and the Western knees [Boisgard et al 2.65°(10), Griffin et al - 3.11°(15), Berger- 3.5°(11)].

Tul et al described a PCA of 4.7°(16) and so did Mullaji et al who described a PCA of 5 degrees in Indian knees(9) (**Table 7**). This means that the implantation of standard femoral jigs with 3° inbuilt external rotation with reference to the PCA in TKA can result in femoral component internal rotation in the Indian knees.

Table 7:

Population	**Mean PCA**
Indian – Our study	5.5°
Indian (Tul et al)	4.7°
Indian (Mullaji et al)	5°
Western	3.11°, 3.5°, 2.65°
Japanese	5.8°
Chinese	5.1° (males) and 5.8° (females)

Whiteside –Epicondylar angle:

The mean Whiteside-Epicondylar angle was seen to be more externally rotated in our study (92.5°). This was similar to other studies done on Indian knees (Tul et al - 92.7°(16) and Mullaji et al – 90.8°(9)) and the Chinese population. However this was not the case in the Western and Japanese population (**Table 8**). The Japanese population[3] was similar in age characteristics to our study group (mean age of 50.2 years vs 56.7 years) whereas cadavers were used in the Western study(8). The implication of this is that if we take a tangent to the Whiteside's line as the reference while performing total knee arthroplasty it would cause external rotation of the femoral component.

Table 8:

Population	**Mean W-EP angle**
Indian – Our study	92.5°
Indian (Tul et al)	92.7°
Indian (Mullaji et al)	90.8°
Western	<90°
Japanese	87.7°
Chinese	91.7°

The externally rotated W-EP angles have a significant bearing on the total knee arthroplasties done in the Indian knees. When in case the posterior condylar cuts are made parallel to the epicondylar axis, it may lead to a narrower and thinner lateral condyle when compared to the medial condyle being broader and thicker. To describe this phenomenon Yip referred to the analogy of the “mountain and molehill” (the medial femoral condyle being “the mountain’’ and the lateral femoral condyle “the molehill’’). This could reassure the orthopedic surgeon that proper rotational alignment has been achieved[4].

Akagi et al noted that if the implant is externally rotated with respect to the posterior condylar axis revision rate for lateral release is significantly less(7). But this has its own limitations. Excessive externally rotation of the implant can result in anterolateral femoral notching, patellar maltracking, compromised cover for the tibia and rotational malalignment of the tibia. It has therefore been postulated that using implants with inbuilt rotations could help prevent the occurrence of such complications.

CONCLUSION

Our study confirms the findings of Mullaji et al[6] and Tul et al that the PCA in the Indian knee is more externally rotated than in the Western knees. Like the Chinese knees, the mean W-EP angle in Indian knees is also more externally rotated.

Mullaji et al had used Computerized tomography scans for the measurements and had proposed that using MRI scans would yield a better assessment; as the cartilaginous joint surfaces are not assessed in CT scans[6]. Our study is the first one to assess these angular measurements in the elderly age group of 50 to 75 years using MRI of the knees.

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ANNEXURE

DATA SHEET

PATIENT ID	AGE	PCA	W-EP	SEX	SIDE
196710G	75	2.5	90.4	MALE	LEFT
153636	75	4.3	93.3	MALE	LEFT
153636	75	4.4	93.4	MALE	RIGHT
734484D	75	6	90	MALE	LEFT
27779	70	8.8	90.3	MALE	RIGHT
45016	69	6.7	91.6	FEMALE	LEFT
956033D	68	3.9	90.7	FEMALE	LEFT
708037D	67	5.9	92.9	MALE	RIGHT
620026	67	6.1	90.2	FEMALE	RIGHT
2370C	66	4.3	98.6	MALE	LEFT
028405C	66	7.6	90.5	MALE	RIGHT
205002D	65	7.8	91.2	FEMALE	RIGHT
215116F	64	3.8	93.4	FEMALE	LEFT
704177A	63	3.6	93.6	FEMALE	RIGHT
170413D	62	5.5	91	MALE	RIGHT
093154G	62	5.4	94.5	MALE	LEFT
158112C	62	5.8	93.8	MALE	LEFT
652181C	62	4.3	92.6	MALE	RIGHT
357393F	61	6	90.7	FEMALE	LEFT
078403F	61	6.4	90.4	FEMALE	RIGHT
839742F	60	5.3	90.1	MALE	RIGHT
695169D	59	4.5	94.1	MALE	RIGHT
260300A	59	6	92.7	MALE	RIGHT
980711D	59	6.6	90.4	FEMALE	RIGHT
522711	58	5.7	91.7	MALE	LEFT
1037	57	4.9	90.6	FEMALE	LEFT
667390A	57	3.9	90.2	FEMALE	RIGHT
624790D	56	5.2	90.6	MALE	RIGHT
692374D	56	4.1	94	FEMALE	LEFT
073802G	56	7.6	91.9	MALE	LEFT
487540F	56	5	90	FEMALE	RIGHT
132193A	52	5.7	90.7	MALE	RIGHT
294766C	56	7.7	90.9	MALE	RIGHT
675113B	55	7.3	94.3	MALE	LEFT
029802A	55	8.5	95.3	MALE	RIGHT
443342B	55	2.6	93.9	MALE	LEFT
451607D	55	2.5	92.9	FEMALE	LEFT
551105A	55	2.6	90	MALE	RIGHT

364488D	55	7.9	91.4	FEMALE	RIGHT
721411	54	7.7	91.3	FEMALE	LEFT
893889F	54	5.5	92.9	FEMALE	LEFT
074822G	54	5.1	92.6	MALE	RIGHT
084217F	54	6.5	90	MALE	RIGHT
198423D	53	6.8	92.2	FEMALE	RIGHT
331315D	53	5.4	92.1	MALE	LEFT
822037B	53	7.1	92.3	MALE	RIGHT
478942C	53	5.6	91	FEMALE	RIGHT
478942C	53	3.5	93.4	FEMALE	LEFT
238256A	53	5.1	91.1	FEMALE	RIGHT
551105A	53	4.2	93.4	MALE	LEFT
822251C	53	6.6	90.5	FEMALE	LEFT
697234D	53	4	92	MALE	RIGHT
538250D	52	5.4	91.3	FEMALE	RIGHT
204507D	52	6.1	90.6	MALE	LEFT
229041D	52	6.2	93.1	MALE	LEFT
623205D	52	4.9	93.7	FEMALE	LEFT
558372A	52	5	91.6	MALE	RIGHT
558372A	52	3.6	90.1	MALE	LEFT
389354C	52	5.2	91.1	MALE	LEFT
080052D	52	6.5	90.4	MALE	RIGHT
186745D	52	6.8	91.6	FEMALE	RIGHT
186745D	52	3.6	92.1	FEMALE	LEFT
563065D	52	4.5	92.1	MALE	RIGHT
701002A	52	6.9	91.6	MALE	RIGHT
317927D	52	3.7	92.3	FEMALE	LEFT
831978D	52	8.3	91.8	FEMALE	RIGHT
736456C	52	4.1	91.4	FEMALE	LEFT
919936	51	7.5	90.8	FEMALE	RIGHT
302799A	51	7.6	91.8	MALE	LEFT
324961D	51	7.6	91.6	MALE	LEFT
030963D	51	6.8	91.2	FEMALE	RIGHT
833019C	51	3.2	98.2	FEMALE	LEFT
821771F	51	4.2	92.2	MALE	RIGHT
821771F	51	4.7	90.8	MALE	LEFT
900114A	51	6.5	96	MALE	RIGHT
900114A	51	8.1	92.3	MALE	LEFT
363822F	51	8.6	90.2	MALE	RIGHT
048097F	51	4	92.9	MALE	RIGHT
262891A	51	6	90.7	FEMALE	LEFT
066875B	50	6.6	91.7	FEMALE	RIGHT
796299C	50	6	90.2	FEMALE	LEFT

375458C	50	6	94.5	MALE	LEFT
387161C	50	6.3	94.2	MALE	LEFT
666983C	50	6	92.4	MALE	LEFT
636349C	50	6.3	91.6	MALE	RIGHT
267849D	50	7.2	93.5	FEMALE	RIGHT
227866G	50	2.2	96.5	FEMALE	RIGHT
080374G	50	4.5	92.1	MALE	RIGHT
700929A	50	4.6	95.3	FEMALE	LEFT
307722F	50	3.6	95.9	FEMALE	LEFT
474674D	50	5.2	91.9	FEMALE	RIGHT
086575F	50	4.9	91.7	MALE	LEFT
922192D	75	2.5	94.2	FEMALE	LEFT
220800F	75	4.9	92.2	FEMALE	LEFT
399384C	71	5.5	91.9	MALE	LEFT
477346	70	5.4	91.1	FEMALE	LEFT
257320D	67	4.4	91.2	FEMALE	LEFT
535199B	66	5.6	92.2	FEMALE	LEFT
376494	66	7.5	91.7	FEMALE	LEFT
573400D	66	6.1	92.4	MALE	LEFT
894222B	66	3.3	92.1	FEMALE	LEFT
162219A	66	5.8	93.3	MALE	LEFT
421831	65	7.7	91.5	FEMALE	LEFT
421831	65	7.4	91.5	FEMALE	LEFT
686012C	65	4.6	91.7	MALE	LEFT
599645C	63	7.7	93.8	FEMALE	LEFT
302888D	63	4.4	93.6	MALE	LEFT
137604F	63	5.1	91.6	MALE	LEFT
815638D	63	7.4	93.8	MALE	LEFT
133890C	63	4.2	91.4	FEMALE	LEFT
034622A	62	4.8	90.2	MALE	LEFT
782493B	62	4.2	96.4	FEMALE	LEFT
122007F	62	5.5	90.9	FEMALE	LEFT
726626C	61	4.6	95.3	MALE	LEFT
476125	61	3.4	96.1	MALE	LEFT
192730C	61	4.8	90.2	FEMALE	LEFT
476022A	61	6.9	91.8	MALE	LEFT
725302	60	5.8	90	FEMALE	LEFT
119835C	60	6.7	90.9	MALE	LEFT
310486A	60	6	92.2	FEMALE	LEFT
585197D	60	7.1	91.7	FEMALE	LEFT
122071C	59	3.4	92.5	MALE	LEFT
892997D	59	4.8	96.5	FEMALE	LEFT
795701A	59	6.4	96.8	FEMALE	LEFT

700592A	58	5.3	97.5	MALE	LEFT
895243B	58	5.2	96.2	FEMALE	LEFT
388038B	58	4.5	90.9	MALE	LEFT
876241	58	4.5	93.7	FEMALE	LEFT
716734F	58	5.3	91.4	MALE	LEFT
863616F	58	5.4	93.4	MALE	LEFT
494342C	57	4.6	92.2	FEMALE	LEFT
489379D	57	5.8	91	FEMALE	LEFT
652175D	57	5	92.8	FEMALE	LEFT
011120G	57	5.4	93.3	MALE	LEFT
297585D	56	4	90.9	FEMALE	LEFT
055641B	56	5.4	93.8	FEMALE	LEFT
805705	56	7.6	94.1	FEMALE	LEFT
523797B	56	5.1	97	FEMALE	LEFT
876241	56	4.6	93.3	FEMALE	LEFT
756121D	55	4.4	98.7	FEMALE	LEFT
637390C	55	4.7	94.4	FEMALE	LEFT
508864D	55	3.9	97.6	MALE	LEFT
073029A	55	5.5	92.7	MALE	LEFT
767661F	55	3.4	90.9	MALE	LEFT
920488	55	5.1	94.7	MALE	LEFT
036966D	55	6	92.5	FEMALE	LEFT
446867F	55	4.8	90.5	MALE	LEFT
887907	55	5.8	91.8	MALE	LEFT
262938G	55	5.7	91.4	MALE	LEFT
383171D	54	6.2	96.2	FEMALE	LEFT
726515C	54	6.1	90.5	MALE	LEFT
260559A	54	6.5	90.5	FEMALE	LEFT
239824C	54	5	90.1	MALE	LEFT
470302D	54	6.5	92.9	FEMALE	LEFT
644964D	56	5.8	94.3	FEMALE	LEFT
730193D	54	5.1	93.6	FEMALE	LEFT
969470D	54	5	94.8	MALE	LEFT
568662C	53	5.1	95.1	FEMALE	LEFT
971673D	53	6	91.8	FEMALE	LEFT
000398F	53	5.7	91.1	FEMALE	LEFT
659595B	53	5.8	90.8	MALE	LEFT
223457F	53	4.8	93.9	FEMALE	LEFT
726719A	53	5.6	91.7	MALE	LEFT
087533B	53	6.2	93	MALE	LEFT
319079A	53	5.9	97.6	FEMALE	LEFT
885174F	53	5	95	MALE	LEFT
757424A	52	6.8	91.3	MALE	LEFT

570084C	52	4.2	97.8	MALE	LEFT
724224	52	6.2	93.7	MALE	LEFT
130281D	52	4.5	95.2	MALE	LEFT
875968C	52	4.1	92.7	FEMALE	LEFT
110785G	52	6.4	95.6	FEMALE	LEFT
174328G	52	5.5	94.4	FEMALE	LEFT
574241C	51	6	93	FEMALE	LEFT
277958D	51	6.5	92.6	FEMALE	LEFT
030967F	51	6.3	91.4	FEMALE	LEFT
917361D	51	4.9	90.5	FEMALE	LEFT
067001F	51	6.3	90.3	MALE	LEFT
105571C	51	5.6	97.6	MALE	LEFT
860818F	51	4.1	91.7	FEMALE	LEFT
277162G	51	3	99	MALE	LEFT
311460D	50	6.6	92.2	MALE	LEFT
554283B	50	5.7	90.1	MALE	LEFT
154803D	50	4.5	91.2	MALE	LEFT
720922D	50	5.5	92.9	MALE	LEFT
307421A	50	6.4	93.5	FEMALE	LEFT
124421F	50	5	92.4	MALE	LEFT
712156F	50	5.1	94.2	FEMALE	LEFT
995528D	50	5.2	92	FEMALE	LEFT
018262G	50	5.7	92.9	MALE	LEFT
688274C	50	5.9	93.3	FEMALE	LEFT
435096D	50	5.6	91.1	FEMALE	LEFT
305219G	50	5.6	90.9	FEMALE	LEFT
504924D	50	6.7	90.6	MALE	LEFT
657965D	50	4.2	92.3	FEMALE	LEFT
889413D	75	5.1	91.8	MALE	RIGHT
602407D	75	7.5	93.2	MALE	RIGHT
477346	74	6	91.2	FEMALE	RIGHT
965122C	73	3.4	96.1	MALE	RIGHT
892671D	72	5.7	92.9	FEMALE	RIGHT
619956	70	6	90.2	FEMALE	RIGHT
015204D	69	7.2	92.1	FEMALE	RIGHT
236691D	68	7.5	90.9	FEMALE	RIGHT
701256A	68	7.1	92.9	MALE	RIGHT
261441D	67	5.5	92.1	FEMALE	RIGHT
640286A	67	6.9	91.5	FEMALE	RIGHT
258869F	67	6.1	93.6	FEMALE	RIGHT
039974G	67	6.6	91.9	MALE	RIGHT
111302F	65	4.9	91	MALE	RIGHT
809395D	65	4.8	92.7	FEMALE	RIGHT

790322	64	5.8	96.9	FEMALE	RIGHT
495575F	64	5	95	FEMALE	RIGHT
782493B	62	5.1	91.3	FEMALE	RIGHT
370316B	63	6.1	90.9	MALE	RIGHT
774803A	63	3.4	91.6	MALE	RIGHT
809799B	62	4.6	90.4	MALE	RIGHT
373268D	62	4.2	90.2	FEMALE	RIGHT
782493B	62	6.5	90.1	FEMALE	RIGHT
876359D	62	5	93.4	FEMALE	RIGHT
083041F	62	5.3	90.6	MALE	RIGHT
001140D	62	4.9	92.6	FEMALE	RIGHT
273454F	62	4.3	90.6	FEMALE	RIGHT
079559G	62	7.7	90.2	FEMALE	RIGHT
855818A	61	4.3	90.4	MALE	RIGHT
088129D	61	5.8	90.7	MALE	RIGHT
550156	61	4.5	91	FEMALE	RIGHT
273690G	61	3.6	90.4	MALE	RIGHT
180365D	60	4.5	91.7	MALE	RIGHT
725302	60	7.1	91.9	FEMALE	RIGHT
058370D	60	5.2	94.6	MALE	RIGHT
369223B	60	6.7	90.4	MALE	RIGHT
257030D	60	5	93.3	MALE	RIGHT
310486A	60	7	91	FEMALE	RIGHT
196815D	59	5.4	90.1	MALE	RIGHT
164297D	59	5.5	93.2	MALE	RIGHT
100737F	59	5	90.9	MALE	RIGHT
908938C	58	4	95	FEMALE	RIGHT
879390D	58	4.5	94.8	FEMALE	RIGHT
001943G	58	4.3	93.2	MALE	RIGHT
153339B	58	5.6	94.4	FEMALE	RIGHT
990335C	57	4.3	91.4	MALE	RIGHT
489379D	57	6.1	93.9	FEMALE	RIGHT
989771D	57	4.9	92.7	FEMALE	RIGHT
970355C	57	5.4	94.3	FEMALE	RIGHT
710577F	57	5.1	95.7	MALE	RIGHT
87127	56	5.2	91.2	MALE	RIGHT
644964D	56	7.7	91.2	FEMALE	RIGHT
985806D	56	6.4	92.5	MALE	RIGHT
022832F	56	4.1	93.2	MALE	RIGHT
716197F	56	4.3	90.3	MALE	RIGHT
701686A	56	5.3	95.1	MALE	RIGHT
517009B	56	5.2	95	FEMALE	RIGHT
863297C	55	6.1	91.4	MALE	RIGHT

264614F	55	5.1	92.5	MALE	RIGHT
340036F	55	3.8	90.2	FEMALE	RIGHT
568666A	55	6.7	94	FEMALE	RIGHT
067001F	51	6.8	91.4	MALE	RIGHT
917131B	55	6	91.3	FEMALE	RIGHT
036966D	55	6	95.3	FEMALE	RIGHT
240482G	55	4.1	99.4	MALE	RIGHT
199296F	54	5.6	92.1	MALE	RIGHT
138081C	54	6.5	91.4	FEMALE	RIGHT
761584F	54	6.8	90.1	FEMALE	RIGHT
046210G	54	6.6	94	FEMALE	RIGHT
791510C	53	4.5	90.2	MALE	RIGHT
268438B	53	6.9	92.9	FEMALE	RIGHT
959806D	53	6.9	91	FEMALE	RIGHT
726719A	53	6.3	94.3	MALE	RIGHT
433374F	53	6.3	90	FEMALE	RIGHT
800159D	53	5.9	90.9	MALE	RIGHT
730193D	53	3.8	93.2	FEMALE	RIGHT
784474D	53	4.9	94.1	MALE	RIGHT
396288D	52	4.3	92.7	FEMALE	RIGHT
637949D	52	4.1	90.4	MALE	RIGHT
106926F	52	6	92.8	MALE	RIGHT
101929A	52	6.2	92	FEMALE	RIGHT
534147A	52	5.9	92.6	FEMALE	RIGHT
852096	51	3.6	95.2	MALE	RIGHT
100860D	51	3.6	92.1	FEMALE	RIGHT
089981D	51	6	90.7	FEMALE	RIGHT
866332D	51	5.8	92.1	FEMALE	RIGHT
917361D	51	4.1	92.5	FEMALE	RIGHT
214526F	51	5.6	90.1	FEMALE	RIGHT
351035F	51	4.1	92.4	FEMALE	RIGHT
435365F	51	3.9	90.2	FEMALE	RIGHT
840835D	51	5.4	94.4	FEMALE	RIGHT
542875B	50	6.7	92.8	MALE	RIGHT
141929D	50	5.5	91.3	FEMALE	RIGHT
526156C	50	5.7	91.4	MALE	RIGHT
926709D	50	3.6	97.7	FEMALE	RIGHT
518418A	50	5.4	92.8	FEMALE	RIGHT
657965D	50	4.2	91.4	FEMALE	RIGHT
684631A	50	6.3	91.2	FEMALE	RIGHT
420675F	50	5.7	90.1	MALE	RIGHT
749268F	50	7.1	90.7	MALE	RIGHT
049369G	50	6.6	94.1	FEMALE	RIGHT

688274C	50	6.2	93.5	FEMALE	RIGHT
397580D	50	6.3	91.4	MALE	RIGHT
070974D	50	6	90	MALE	RIGHT
307421A	50	6.1	91.5	FEMALE	RIGHT