

**“RADIOLOGICAL ASSESSMENT OF THE POSTERIOR TIBIAL SLOPE
AS A RISK FACTOR FOR OSTEOARTHRITIS OF KNEE JOINT ”**

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ABSTRACT

INTRODUCTION:

Osteoarthritis is a chronic degenerative disorder that affects the joints, causing pain and stiffness with a prevalence of 22% to 39% in India. With increasing life span and considering the burden that this can cause to both the individual and society, there is an urgent need to be able to detect early, or predict OA in high risk groups, so that preventive measures can be taken. Osteoarthritis has an important correlation with various risk factors such as weight, genetic factors, sex, previous traumas, occupational factors, physical activity, lifestyle and age. The geometry of an articular surface may be an important risk factor for development of knee osteoarthritis.

The coronal alignment of the knee has been evaluated extensively, but there are only few studies for the sagittal plane alignment. The posterior inclination of the tibial plateau in relation to its longitudinal axis in lateral view is the Posterior Tibial Slope (PTS). Posterior tibial slope is a determinant of altered joint biomechanics. There are no studies correlating the effect of posterior tibial slope angle as a risk factor for OA knee in Indian population. This study was performed to determine the value of, and confirm whether changes in Posterior Tibial Slope on radiographs are associated with Osteoarthritis.

AIMS AND OBJECTIVES :

The aim of the study was to determine the value of Posterior Tibial Slope (PTS) in patients with early osteoarthritis, to establish whether the changes (higher or lower) in the PTS, in comparison to known values in normal patients, are associated with osteoarthritis and to assess the correlation of Posterior tibial slope as a risk factor for osteoarthritis.

MATERIALS AND METHODS:

153 individuals were included in the study as per the inclusion and exclusion criteria. Demographic details, weight, height, co-morbidities and medications were noted. Knee examination findings, VAS scores and WOMAC scores were documented. Standard X-rays of the knee joint were examined. Osteoarthritis was classified by Kellgren-Lawrence grading system. The posterior tibial slope was measured using standardized methods.

RESULTS:

There were 153 individuals in the study with Osteoarthritic (Grade I and II) knees. The mean posterior tibial slope measured in our study was found to be 11.5 with SD of 1.34. The range of PTS in our study was found to be between 7° - 13°. All the observations and measurements of PTS were statistically analysed using SPSS.

CONCLUSION:

In our study, the PTS angle in patients with early osteoarthritis was higher in comparison to known normal values in the Indian population, suggesting an increased PTS in individuals having osteoarthritis. Hence, the PTS can be used as a marker for screening of osteoarthritis, and early interventions can be undertaken.

Key words: Knee Osteoarthritis, Posterior tibial slope, Risk factors.

LIST OF ABBREVIATIONS

PTS	-	Posterior Tibial Slope
OA	-	Osteoarthritis
MRI	-	Magnetic Resonance Imaging
TPAA	-	Tibial Proximal Anatomical Axis
PTC	-	Posterior Tibial Cortex
TSAA	-	Tibial Shaft Anatomical Axis
ATC	-	Anterior Tibial Cortex
FPAA	-	Fibular Proximal Anatomical Axis
FSA	-	Fibular Shaft Axis
TKR	-	Total Knee Replacement
AP	-	Antero - Posterior
VAS	-	Visual Analogue Score
WOMAC	-	Western Ontario and McMaster Universities index
SD	-	Standard Deviation
CT	-	Computed Tomography

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INTRODUCTION

Osteoarthritis is a condition that affects the joints, causing pain and stiffness. It is by far the most common form of joint disease, and the knee is one of the most commonly affected joints. The symptoms of osteoarthritis are pain, stiffness, a grating or grinding sensation when the joint moves (crepitus), swelling (either hard or soft) while the knee may either lock or give way on weight bearing.

A joint is where two or more bones articulate. The joint allows the bones to move freely within limits. The knee is the largest and most complicated joint in the body, strong enough to take our weight and must lock into position so we can stand upright. It also acts as a hinge so we can walk and withstand extreme stresses, twists and turns, such as when we run or play sports. The geometry of the articular surface (e.g., posterior tibial slope)^[1,2] may be an important risk factor for development of knee osteoarthritis. Posterior tibial slope is a determinant of altered joint biomechanics.

The posterior tibial slope is essential for both ligament function and knee kinematics (Cullu et al., 2005).^[1] Comparative studies have shown that it is steepest in most animals and shallowest in humans (Gupte et al., 2007).^[1] Among human fossil species, the angle varies very little. Attempts have been made to discriminate locomotor modes in human species based on the curvature of the tibia condyle with limited success (Organ & Ward, 2006).^[2]

The coronal alignment of the knee has been evaluated extensively, but there are only few studies for the sagittal plane alignment. The posterior inclination of the tibial plateau in relation to its longitudinal axis in lateral view is the Posterior Tibial Slope (PTS). Posterior Tibial Slope is an important factor that influences the sagittal alignment. Hence, an altered posterior slope angle may play a role in knee joint kinematics and influence the risk of injury.^[3] Due to these abnormal biomechanics^[4], it is important to consider the posterior tibial slope as a potential risk factor for knee osteoarthritis. Studies in oriental population in respect to PTS have found different values from that of Caucasians.^[3,4] No prior study has evaluated posterior tibial slope in relation to osteoarthritis in India.

We hypothesized that individuals with greater or lesser posterior tibial slope angles will have greater risk of developing knee osteoarthritis than those with a neutral posterior tibial slope. This study was performed to determine the mean posterior tibial slope (PTS) in early osteoarthritis of knee in Indian population and to assess whether changes (higher or lower) in the PTS are associated with increased risk of Osteoarthritis in comparison to known values in normal patients.

AIMS & OBJECTIVES

The aims and objectives of the study were

1. To determine the value of Posterior Tibial Slope (PTS) in patients with early osteoarthritis.
2. To establish whether the changes (higher or lower) in the PTS, in comparison to known values in normal patients, are associated with osteoarthritis.
3. To assess the correlation of posterior tibial slope as a risk factor for osteoarthritis.

REVIEW OF LITERATURE

APPLIED ANATOMY OF THE KNEE

The knee joint is one of the largest and most complex joints in the body. It is constructed by 4 bones and an extensive network of ligaments and muscles. It is a bi-condylar type of synovial joint, which mainly allows for flexion and extension (and a small degree of medial and lateral rotation).^[5]

The femur, the tibia and the patella articulate through tibiofemoral and patellofemoral joints. These three bones are covered in articular cartilage which is an extremely hard, smooth substance designed to decrease the friction forces. The medial and lateral condyles of the femur articulate with the tibia to form tibiofemoral joint. Similarly, the anterior and distal part of the femur articulate with the patella to form patellofemoral joint. The tibiofemoral joint is the weight bearing joint of the knee. The patella lies in an indentation of the femur known as the intercondylar groove.^[5]

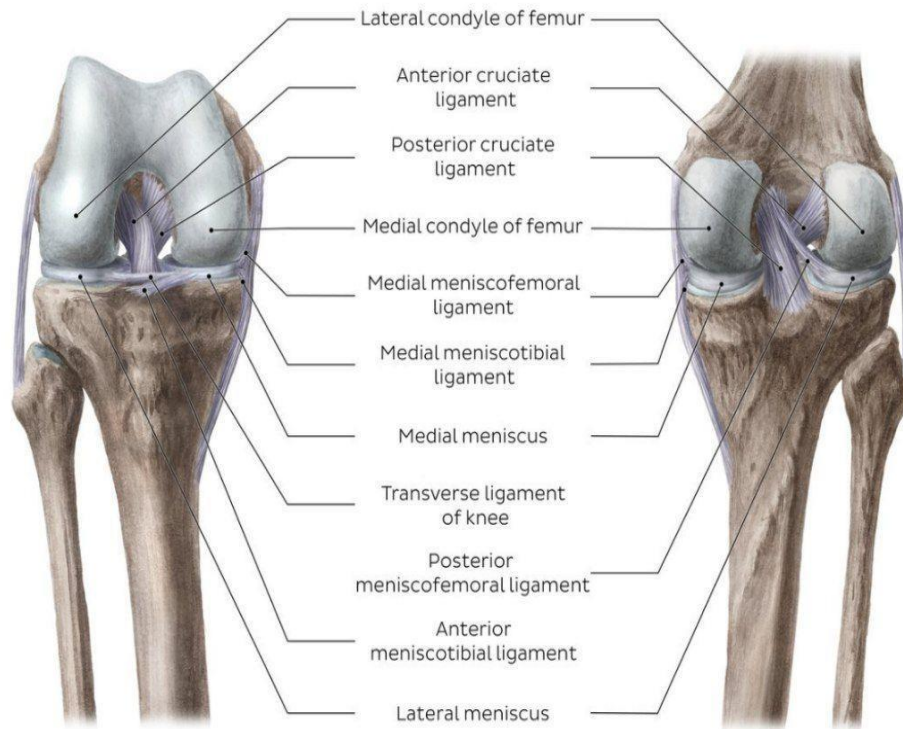


Fig 1. Anterior and Posterior views of the knee joint

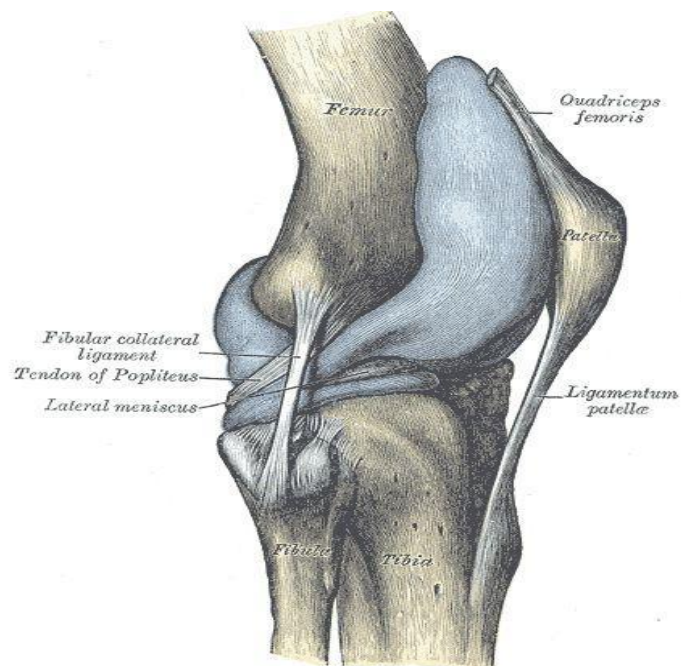


Fig 2. Lateral view of the knee joint

The distal aspect of the femur forms the proximal articulating surface for the knee, which is composed of 2 large condyles, the medial and the lateral. These two condyles are separated inferiorly by the intercondylar notch although they are connected anteriorly by a small shallow groove which is known as either the femoral sulcus or the patella groove or patella surface. This engages the patella in early flexion.

The patella is a triangular, flat bone, situated on the front of the knee joint. It is regarded as a sesamoid bone, developed in the tendon of quadriceps femoris. Its anterior surface is convex and covered by the expansion of the quadriceps femoris tendon.

The posterior surface has a smooth, oval and cartilaginous area. It is divided by a rounded vertical ridge into a larger lateral portion and a smaller, medial portion. Larger lateral portion for articulation with the lateral condyle of the femur and the smaller medial portion, for articulation with the medial condyle of the femur. Below the articular surface is a rough, convex, non-articular area.

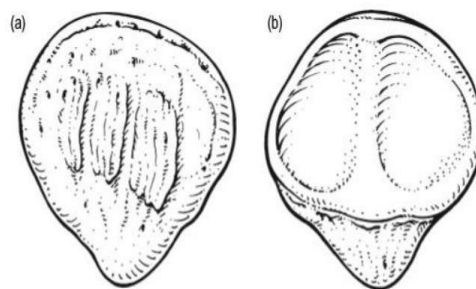


Fig 3. Surfaces of the Patella a) Anterior b) Posterior

The tibia also has 2 asymmetrical condyles (medial and lateral) which are relatively flat. These are also known as the tibial plateau. The medial tibial plateau is much longer than the lateral antero-posteriorly, and the diameter of the proximal tibia is much greater than the shaft posteriorly which is sloped to facilitate flexion of the femoral condyles on the tibia.

The two tibial condyles are separated by the intercondylar tubercles, these are two bony spines which are roughened and their role lies within knee extension. They become lodged in the intercondylar notch of the femur, adding to the stability of the joint. Overall the tibiofemoral joint is a relatively unstable joint as the plateaus are slightly convex anteriorly and posteriorly.

The knee balances in axial compression due to the action of gravity, in nearly all situations. Mobility and stability are the two contrasting qualities of knee and it must resolve these two opposed requirements. The arrangement of ligaments, menisci and tendons are ingenious in the knee and they help to resolve mobility and stability vis, static stability provided by the ligaments and menisci and the muscles and tendons provide dynamic stability. However, the exposure of the knee to external forces makes it vulnerable in several occupations and sports. The primary movements taking place in the knee is flexion– extension; secondarily – internal and external rotations of the tibia in relation to the femur takes place only when the knee is flexed.

Therefore, the knee must be flexed to a right angle in order to measure the extent of internal rotation.

The Articular surfaces

The knee acts as a hinge joint during flexion–extension whereby the articular surfaces of the femur roll and glide over the tibial articular surface. The distal femur is compared with a double wheel, where the medial and lateral condyles are the components and the junction between them is the intercondylar notch.

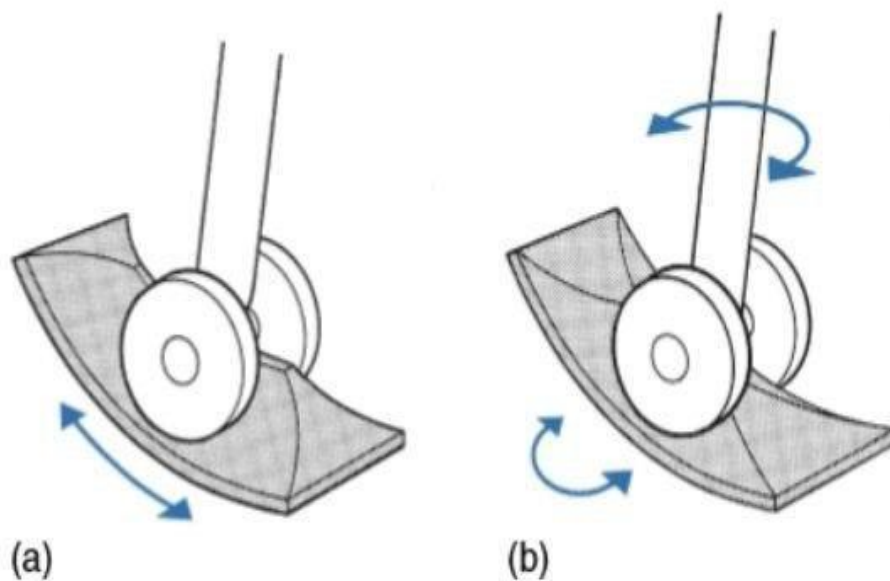


Fig 4. Osteo-kinematics of the knee joint a) The knee as a hinge joint: the femoral condyles (twin wheel) in relation to the tibial and patellar surfaces (rails). b) By flattening the anterior and posterior end of the ‘rail’, rotational movements become possible : the inter condylar spines act as the central pivot.

The condyles are convex in both planes. The lateral femoral condyle is prominent than medial condyle thereby preventing the patella from sliding laterally. The medial condyle extends more distally than the lateral condyle. The upper surface of tibia which is articular has two curved gutters which are separated by an anteroposterior eminence. The gutters are incongruent with the corresponding femoral condyles. However, this lack of compatibility is overcome by the menisci. The femoral intercondylar notch corresponds to anteroposterior elevation between the medial and lateral tibial condyles. The articular surface of the patella is almost congruent with and corresponds to the anterior surfaces of the femoral condyles. The surfaces of the tibial condyles when anteriorly projected will coincide with the articular surface of the patella. Similarly, if the tibial intercondylar eminence is anteriorly projected, its plane will be continuous with the vertical ridge on the patella as much as the femoral intercondylar notch which continues in the central groove of the patellar surface of the femur.

This assembly resembles a twin-wheel rolling on a central rail. The tibia and patella act as one structure during flexion and extension, in relation to the femur. The flatter upper tibial surface in relation to the rounded femoral condyles might give an impression that the femoral condyles roll during flexion–extension. In reality this is not so.

In 1836 the Weber brothers demonstrated that the femoral condyles simultaneously roll and slide, and these movements occur in opposite directions. The femoral condyles roll backwards and slide forwards on the tibia during flexion and they roll forwards and slide backwards during extension. However, the ratio of rolling to sliding changes with the degree of flexion or extension. During the first 30° of flexion the movement is almost entirely rolling and at nearly full flexion the condyles slip along the tibial plateau without rolling.

Thus, the knee joint is primarily a hinge, where the femoral condyles are the wheels gliding and rolling in a twin set of gutters of the tibial and patellar surfaces which are concave and curved. Even though this is a satisfactory concept in terms of flexion and extension the reality of the situation is more complex. The knee not only allows gliding and rotation around a horizontal axis but also allows rotation through a vertical axis, namely internal and external rotation of the tibia in relation to the femur.

The rotation movement of the knee would be precluded if the knee, as described above is considered a hinge joint with the tibial intercondylar eminence gliding between the two femoral condyles. However, rotation becomes possible if the anterior and posterior ends are flattened. The intercondylar spines forming the remaining middle part of the eminence act as the central pivot about which the movements of axial rotation occur.

OSTEOARTHRITIS – AN OVERVIEW

Osteoarthritis is caused when the surfaces within the joints become damaged such that the joint does not move smoothly. The condition is sometimes called arthrosis, osteoarthrosis, degenerative joint disease or wear and tear. When osteoarthritis develops, some of the cartilage covering the ends of the bones gradually wears out and becomes thin. This can happen over the main surface of your knee joint and in the cartilage underneath patella. The bone underneath the cartilage reacts by growing thicker and broader. All the tissues within the joint become more active than normal trying to repair the damage. The bone at the edge of the joint grows outwards, forming bony spurs called osteophytes.^[6,7] This can affect femur, tibia or patella. The synovium swells and produce more fluid, which then causes the joint to swell. This is called as effusion of the knee. The capsule and ligaments may slowly thicken and contract as if they were trying to stabilize the knee joint.

The inflammatory process results in these changes in and around the joint and partly by body's attempt to repair the damage.^[8,9] Mostly the repairs are successful and the changes inside the joint do not cause much pain or rarely mild pain may come and go. However, in many cases, the repair does not work as well and the knee becomes damaged.

This leads to instability as more weight is being put onto other parts of the joint causing symptoms to become gradually worse and more persistent over time.

The major symptom of osteoarthritis is pain and sometimes stiffness. The pain tends to be worse on moving the joint or at the end of the day. Pain may be all around the knee or just in a particular place, most likely at the front and sides along the joint line. Pain may get worse after a particular movement, such as walking up or down stairs. The pain is usually relieved by rest. It's unusual, but in severe osteoarthritis some people have pain that wakes them up at night. There are many factors that increase the risk of osteoarthritis. Often a combination of these leads to the condition.^[10]

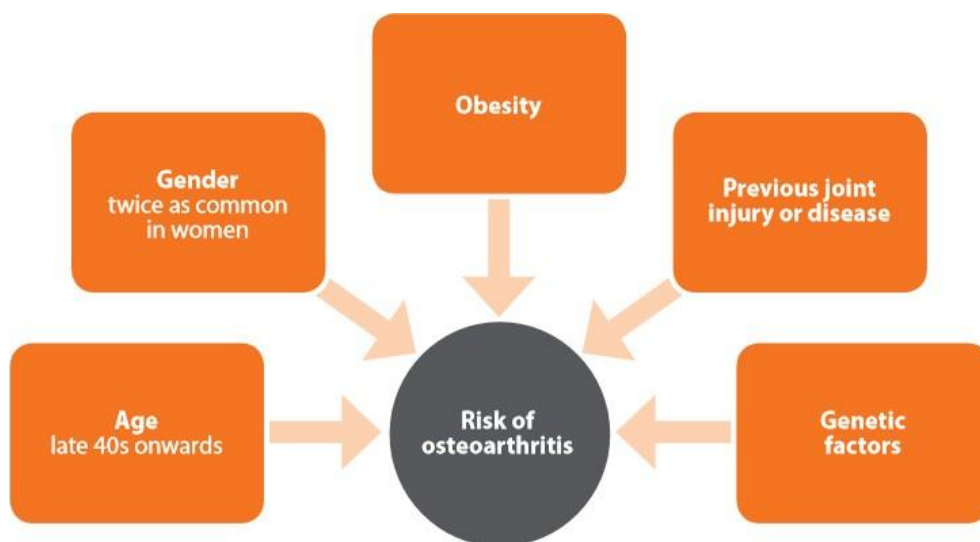


Fig 5. Risk factors of knee osteoarthritis ^[11]

Age – Osteoarthritis usually starts by late 40s onwards. It's occurrence in older people is not well understood, but it might be due to factors such as weakening of the muscles, inability of the body to heal itself or gradual wearing out of the joint with time.

Gender – Osteoarthritis of the knee is twice as common in women as in men. It's most common in women over the age of 50 and it may be directly linked to the menopause. It's often associated with mild arthritis of the interphalangeal joints of the fingers (nodal osteoarthritis).

Obesity – Overweight is an important factor in causing osteoarthritis, especially in the knee. It also increases the chances of progressive worsening of osteoarthritis.

Joint injury – Physically demanding and very hard, repetitive activities can increase the risk of osteoarthritis, although normal activity and exercise don't cause osteoarthritis. Injuries to the knee may lead to osteoarthritis in later life. Often a twisting injury causes a torn meniscus or ligament. A torn meniscus is a common injury in footballers and meniscectomy or repair of cruciate ligaments also increases the risk of developing osteoarthritis in later life.

Genetic factors – Genetic factors play a major role in osteoarthritis of the knee. There are greater chances of developing osteoarthritis if a parent or siblings have knee osteoarthritis. It is proposed that a number of genes will have a small effect rather than one particular gene being responsible.

Other types of joint disease – Sometimes different kinds of rarer joint disease, such as gout, result in damage of articular surface and can cause osteoarthritis.

The outlook

It is impossible to predict the development of osteoarthritis in any person. It can sometimes develop over just a year or two. It can cause a lot of damage to the joint, which may lead to some deformity or disability of the knee. But more often osteoarthritis is a slow process which develops over many years resulting in fairly small changes in few parts of the joint. Although it will be painful, it's less likely to cause severe deformity or disability in initial stages. In severe osteoarthritis the cartilage becomes so thin that it no longer covers the articular surface of the bones. During movement of the joint, the bones rub against each other and eventually wear away. The wear and tear of the joint with loss of cartilage and appearance of the bony spurs alter the shape of the joint, causing mal-alignment of the joint. In addition, the muscles that produce the joint movement gradually weaken and become thin or wasted.

This causes the joint unstable and the knee gives way on weight bearing. Lifestyle changes can greatly reduce the risk of progression of the knee osteoarthritis.

Regular exercise, protecting the joint from injury and maintaining an optimal weight will help. Osteoarthritis of one joint may lead to uneven loading in other joints, resulting in osteoarthritis in those joints.

Diagnosis of osteoarthritis:

There are many different types of arthritis such as primary osteoarthritis, rheumatoid arthritis, gout etc., which require different treatments. Osteoarthritis is usually diagnosed based on the physical signs and symptoms such as:

- tenderness over the joint
- creaking or grating of the joint (crepitus)
- bony swelling
- excess fluid
- restricted movement
- joint instability
- weakness and wasting of thigh muscle.

Tests available:

There's no specific blood test for osteoarthritis, although basic investigations may help rule out other types of arthritis. X-rays are taken to assess the severity of the damage caused by osteoarthritis, such as bony spurs or narrowing of the joint space where the cartilage has worn thin or any calcium deposits within the joint. Rarely, a magnetic resonance imaging (MRI) scan of the knee can be helpful. This will show changes in the soft tissues such as cartilage, tendons, muscles and also changes in the bone that are not seen on a standard x-ray.

In considering osteoarthritis as a “whole joint” disease, it is essential to recognize the contribution of bone to the pathogenesis of the disease, in addition to cartilage and synovium. Radiographic features of OA, such as bony sclerosis and osteophyte formation that are helpful in diagnosis of OA are thought to be results of the disease process as such rather the cause. OA certainly causes changes in bone, but conversely, changes in biology and architecture of bone may also contribute to the development of OA. The quality of bone in part determines the distribution of biomechanical forces across the joint and so, the changes in bone itself may contribute to the development of OA. Here, we highlight the emerging evidence that bone plays a key role in the pathogenesis of OA.

POSTERIOR TIBIAL SLOPE

Superior surface of the upper end of tibia, commonly known as tibial plateau, bears a slope directed posteriorly and inferiorly relative to the longitudinal axis of the tibial shaft. Slope of medial and lateral plateau may differ significantly. The posterior tibial slope is an important factor in knee biomechanics, modification of radiological techniques and surgeries such as high tibial osteotomy for genu recurvatum deformity, tibiofemoral osteoarthritis and knee arthroplasty.

The coronal alignment of the knee has been evaluated extensively, but there are only few studies for the sagittal plane alignment. Posterior Tibial Slope is an important factor that influences the sagittal alignment.^[6] The posterior inclination of the tibial plateau in relation to its longitudinal axis in lateral view is the Posterior Tibial Slope (PTS). PTS was defined as the angle formed by two lines in the lateral knee radiograph. The first line was the line perpendicular to the anatomical axis of the tibia. The second line was formed by joining the most proximal points on the tibia plateau on the lateral radiograph as defined by Massin et al, avoiding osteophytes. Although, there was no previous consensus on the ideal anatomical axis to measure PTS, the tibial proximal anatomical axis, i.e. the line connecting midpoints of outer cortical diameter at 5 and 15cm distal to the knee joint is now recommended because it is most parallel to the sagittal mechanical axis -Yoo et al.

Also, Brazier et al described the different anatomical axes against which the PTS could be measured. The lines included the Tibial Proximal Anatomical Axis (TPAA); Tibial Shaft Anatomical Axis (TSAA); Posterior Tibial Cortex (PTC); Anterior Tibial Cortex (ATC); Fibular Proximal Anatomical Axis (FPAA) and Fibular Shaft Axis (FSA). They concluded that among the proximal axes, the TPAA and PTC gave higher reliability.

PTS plays a very important role in the kinematics and biomechanics of knee joint.^[11] Cullu et al.,(2005) stated in their study that the function of posterior tibial slope in knee biomechanics was evident in cruciate ligament injuries and also the site of collapse of the weight bearing area of the tibial plateau in osteoarthritis.^[12,13] They also mentioned that the tibial slope can be measured securely in most cases with mild to moderate osteoarthritis, but in cases with severe osteoarthritis it might be difficult and unreliable to measure tibial slope because of advanced hypertrophic changes or erosions on both limits of the medial tibial plateau.

PTS in normal knees has found to be different in different studies, with variations depending on factors like age, gender, ethnicity as well as the methods and modalities used for measurements. In a study done by V. Thirunarayan et al,^[14] they have measured PTS of normal knees with values of 9.690. Chiu et al., also has measured PTS of both Normal and osteoarthritic knees with values for the normal knees being 10.80.

Studies done on normal knees by Yoo et al.,^[15] gave values of 10.6 while Yoga et al. gave values of 10.1. Didia et al., had done a study on normal knees with values of PTS as 12.3. The highest values for Asians has been shown as 13.65 by the study done by Khattak et al.^[16]

Now various studies have come with contrasting results i.e. while some have shown the slope to increase with osteoarthritic degeneration, others have shown that it decreases. Matsuda et al.,(1999) evaluated the posterior tibial slope in 30 normal and 30 varus knees using magnetic resonance imaging in one of the earliest studies on PTS. The mean tibial posterior slope in the medial plateau was 10.7 degrees in the normal knees and 9.9 degrees in the varus knees. The mean tibial posterior slope in the lateral plateau was 7.2 degrees in the normal knees and 6 degrees in the varus knees. JM Muthuuri et al.,^[17]conducted a study in an African population. They found that the mean posterior tibial slope among the African population is about 7°. The control group had a mean of 6.8° while the arthritic group had a mean of 6.1°. This study has concluded that the slope decreases with Osteoarthritic degeneration.

Similarly, the increase in PTS with osteoarthritic degeneration has been shown in many studies.^[18] Chiu et al., studied the posterior tibial slope of Chinese cadaveric tibia. They measured posterior slope of lateral tibial plateau of both Normal and osteoarthritic knees with values of 10.80 and 13.10 and concluded that osteoarthritis increases the slope by two to three degrees.

Dehghan M et al., (2014) in their study examined the posterior tibial slope in two groups with knee osteoarthritis and healthy knee; they reported that PTS values in patients with osteoarthritis were significantly higher than in healthy subjects. But their study is based on entirely different groups, the diseased and healthy ones.

Studies in oriental population in respect to PTS have found different values though, from that of Caucasians.^[19,20] Further studies were hence required to understand the variations among Indian populations. Qidwai et al.,^[21] conducted a study on patients with relation to the habit of squatting, and was aimed at measuring PTS in the north Indian population. The mean values were found to be 10.74°, with those of non squatters found to be 9.25. Here, the posterior tibial cortex was used as a reference line to measure the PTS. A study done by V Thirunarayan et al., found the mean PTS in normal knees to be 9.69. Here the TPAA was used as the reference axis. Praganesh Kumar et al.,^[22] conducted a study on patients with healthy knees, with mean values of PTS of medial and lateral slope being 8.60 and 7.94 respectively.

Mohanty SS et al.,(2013) conducted a study in the Indian population using X-Rays where the PTS was measured using tibial anatomical axis as reference line. The study was done on patients with Ahlback grade 4 and 5 osteoarthrosis of knee and PTS was found to have a mean value of 11.64.

Medda S et al., (2017) in their study to estimate the posterior tibial slope in the adult Eastern Indian population, found the mean values to be 13.6° with subjects including those with normal and osteoarthritic knees. Nekkanti S et al.,^[23] studied the posterior tibial slope in the South Indian population where the subjects included patients with minor knee injuries, but importantly excluded those with advanced OA. It was found to have a mean value of 10.37° .

In addition to the above, optimum intra-operative PTS is crucial in achieving good postoperative range of movements after Total knee replacement (TKR).^[24,25] Total knee Replacement is one of the most successful surgeries with an average survival of more than 90% at 15 years. In the Indian population, people require flexion greater than 105° for kneeling, squatting and during activities of daily living and religious activities. Generally, we require an average of 67° - 93° of knee flexion for swing phase of gait, climbing stairs, descending stairs and to rise from a seated position. Among the numerous factors affecting the post operative flexion in a total knee replacement, posterior tibial slope (PTS) is important which decides about sagittal alignment of knee. The posterior tibial slope is an important factor to preserve during knee replacement. Appropriate slope aids in achieving the amount of flexion and ensures the knee will be loose on flexion. One of the factors determining the outcome of total knee replacement is proper placement of the prosthesis.^[26]

It is a well-known fact that there is a significant correlation between a well-positioned prosthesis and good clinical results. The tibial component when positioned horizontally in the lateral view, performs best. This position however, does not represent the normal tibial slope. Whiteside suggested that the tibial cut should be made at a 0° to 3° posterior slope.^[27] Even with most modern TKR designs, some degree of posterior slope is now recommended when cutting the tibial plateau.

METHODOLOGY

This study is a hospital based observational study done at our Institution. Measurement of PTS was done on patients who came to the OPD and were diagnosed with Osteoarthritis of the knee (Grade I and II) at the KLE'S DR. PRABHAKAR KORE HOSPITAL AND MEDICAL RESEARCH CENTRE AND CHARITABLE HOSPITAL, BELAGAVI in between 1st January 2021 to 31st December 2021, over a period of one year, after obtaining proper informed consent.

- A total of 153 patients were a part of this study who were examined thoroughly and basic investigations were done.
- Then the patients who were being assessed were explained in detail about the study and informed written consent was taken for those who wished to participate.
- Patients were then asked to get X Rays of the Knee joint in both AP and True Lateral views using standardized technique,^[28,29] following which measurement of the Posterior Tibial Slope was done.
- The reports of all said investigations were then documented, compiled and analysed.

The selection criteria for the study were as follows:

INCLUSION CRITERIA:

- All patients who gave their willful consent to participate in the study.
- Patients over the age of 30 years and above with complaints of knee pain along with early osteoarthritis (Grade 1 and 2) changes radiologically.

EXCLUSION CRITERIA :

- Previous fractures/surgeries of knee/around the knee or the lower limb affecting biomechanics of walking or muscle strength.
- Ligamentous injuries of the knee
- Tumours
- Rheumatoid Arthritis, Severe Osteoporosis
- Patients under the age of 30
- Advanced OA (Grade 3 and 4)
- Paralysis
- Congenital Deformities
- Patients on long term medications – steroids
- Skeletally immature knees

STANDARDIZED X-RAY TECHNIQUE

Participant position

The participants were made to stand on their bare feet with both knees facing away from the film cassette in an erect Bucky or film holder. They were made to stand such that their knees were at, or near, a 10 degrees angle (caudal) to the film. The position of the tibio-femoral joint space was identified by locating the inferior border of the patella and the superior margin of the tibial tuberosity; and this line was traced around to the side of the knee and markings done over the skin. The feet were externally rotated at an angle of about 10 degrees.



Fig 6. Proper patient positioning and beam angulation for radiography of the knee.

Criteria for assessing AP image quality

Superposition of the posterior and anterior edges of the tibial plateau in the PA view was required to accurately demonstrate the joint space. If the edge of the tibial plateau nearly touched or overlapped the distal femoral condyle on either knee, as it would become unacceptable, the x-rays were repeated with the beam angled at 5 degrees and then at 15 degrees. Correct contrast/exposure was achieved by ensuring that medial and lateral sides of the knee joint were well visualized.

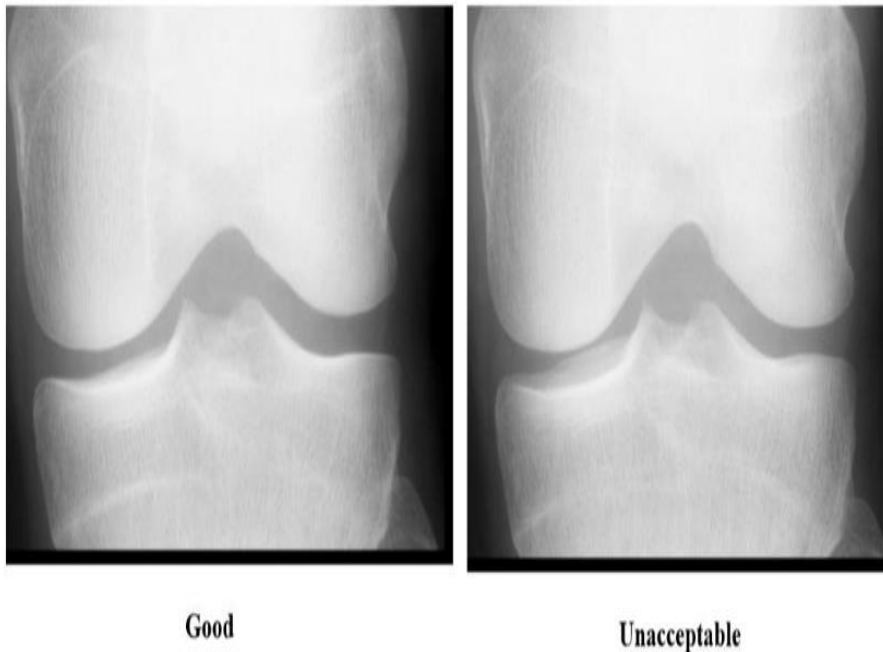


Fig 7. Xray AP view of Knee - a) Correct and b) Incorrect

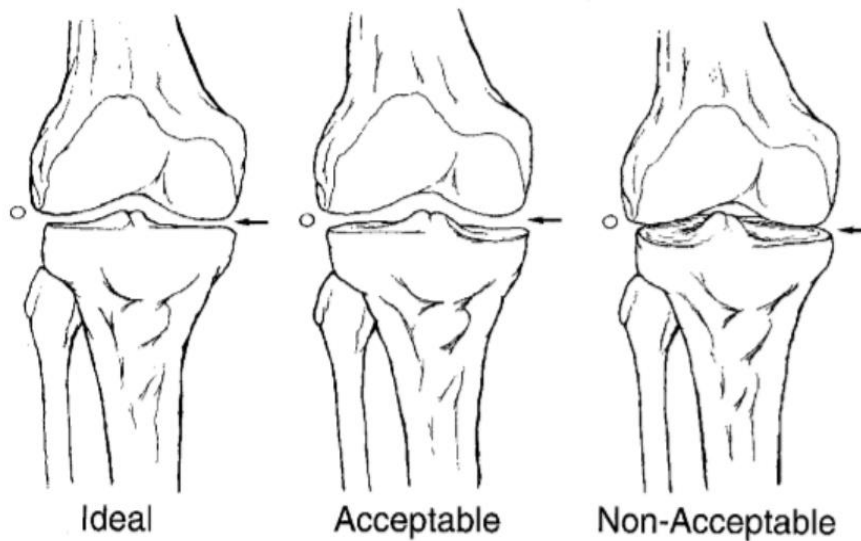


Fig 8. Figurative description of acceptable X-Ray of AP view of knee

Criteria for assessing Lateral image quality

The following structures were fully visualized, in order for the x-rays to be acceptable, which were the tibial tubercle (where patellar tendon inserts), the upper border of patella, the anterior aspect of patella and the upper end of fibula. The positioning was considered as correct, when the contours of the front edge of the medial and lateral femoral condyles would nearly overlie one another or be superimposed.



Fig 9. X-ray Lateral view of Knee - **Acceptable**



Fig 10. X-ray Lateral view of Knee - **Unacceptable**

AP view of the knee was taken to grade the level of osteoarthritis of the knee joint as per the Kellgren Lawrence classification,^[31] while the measurement of PTS was done on Lateral view of the affected knees. The Kellgren Lawrence classification grades knee osteoarthritis from Grade 0 to Grade 4, in the increasing order of severity, and is as follows :

Grade	Radiologic Findings
0	No radiological findings of osteoarthritis
I	Doubtful narrowing of joint space and possible osteophytic lipping
II	Definite osteophytes and possible narrowing of joint space
III	Moderate multiple osteophytes, definite narrowing of joint space, small pseudocystic areas with sclerotic walls and possible deformity of bone contour
IV	Large osteophytes, marked narrowing of joint space, severe sclerosis and definite deformity of bone contour

Table 1 : Kellgren Lawrence Classification of Knee Osteoarthritis

Kellgren and Lawrence (KL) Grading System



Fig 11. Radiological images of Kellgren Lawrence Classification

Measurement of the PTS

PTS was defined as the angle formed by two lines in the lateral knee radiograph. The first line was the line perpendicular to the anatomical axis of the tibia. The second line formed by joining the most proximal points on the tibia plateau on the lateral radiograph as defined by Massin et al,^[32] avoiding osteophytes. Although, there was no previous consensus on the ideal anatomical axis to measure PTS, the tibial proximal anatomical axis, i.e. the line connecting midpoints of outer cortical diameter at 5 and 15cm distal to the knee joint is now recommended because it is most parallel to the sagittal mechanical axis -Yoo et al. ^[33] This axis was assumed to be the anatomical axis in our study also. The study broadly included patients without any complaints in knee as normal group and patients with osteoarthritis as osteoarthritic group.

Measurement of the PTS required primarily three lines. Firstly, the line connecting midpoints of outer cortical diameter at 5 and 15 cm distal to the knee joint (anatomical axis of tibia). Then the line drawn perpendicular to the anatomical axis of the tibia. The third line formed by joining the most proximal points on the tibia plateau on the lateral radiograph. The angle formed between the lines 2 & 3 was taken as measurements of the posterior tibial slope (PTS).

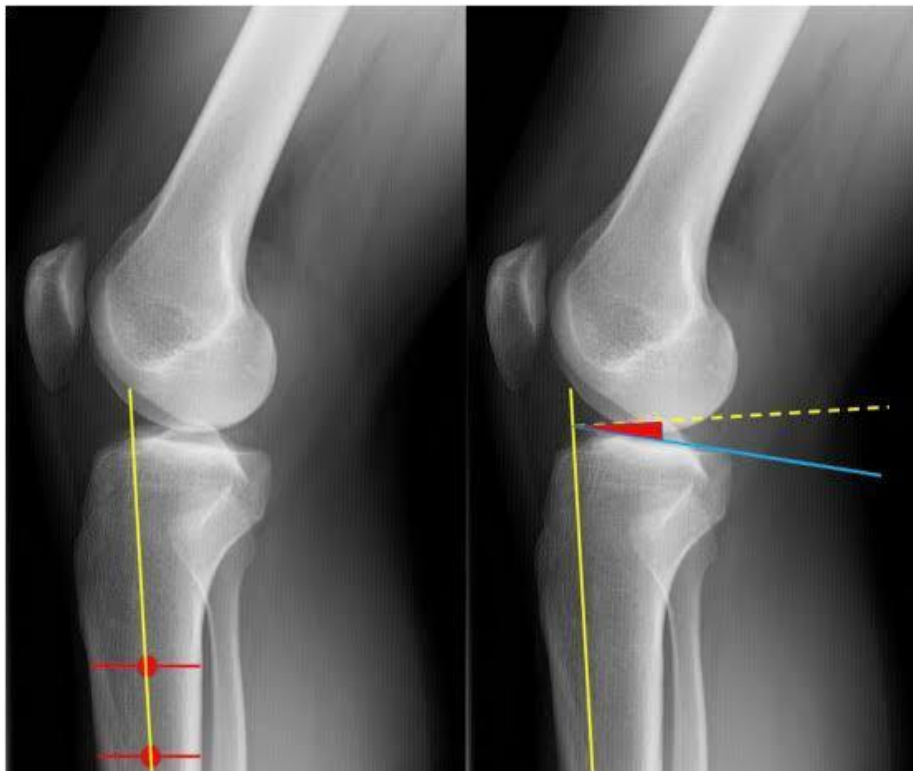


Fig 12. Measurement of the Posterior Tibial Slope



Fig 13 : X-ray lateral view of knee shows Posterior tibial slope angle(PTS)

RESULTS

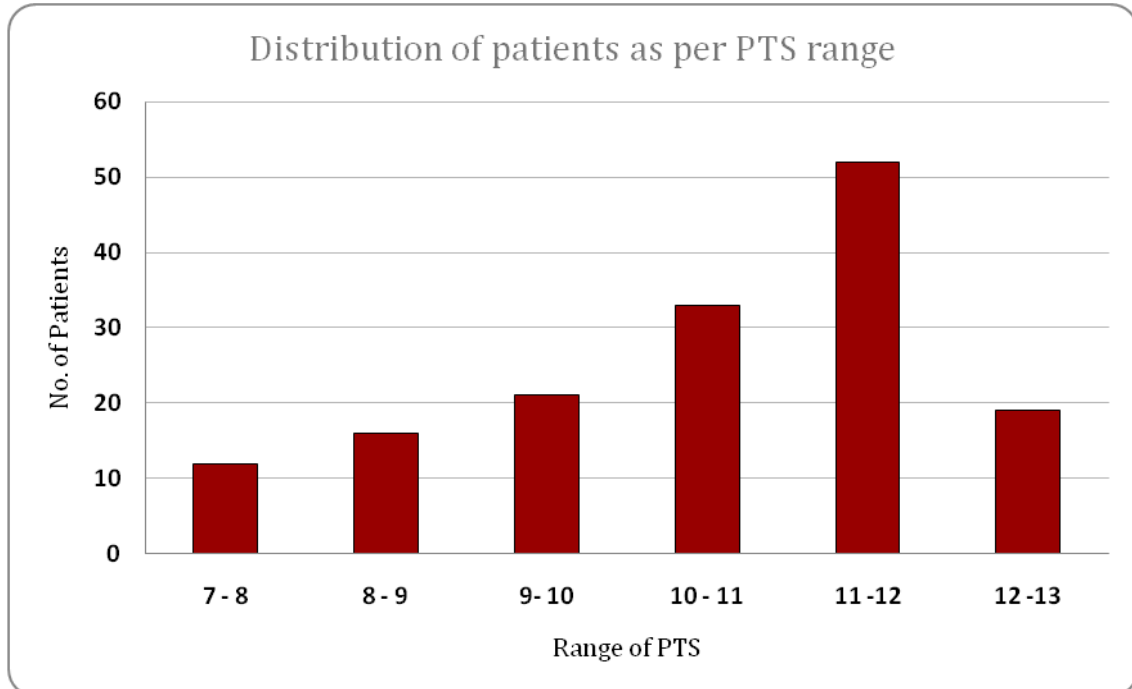
All the observations and measurements of PTS were statistically analysed using SPSS (Statistical Package for social sciences) . There were 153 patients with knee osteoarthritis (grade I & II) as part of the study. All clinical parameters - age, sex, weight, height, co-morbidities and medications were documented. Knee examination findings, VAS scale (Visual Analogue Score) for pain and WOMAC (Western Ontario and McMaster Universities index) scores were noted. Routine blood investigations related to OA were done. The measurement of the posterior tibial slope were done using X Rays of the Knee joint.

The mean posterior tibial slope measured in our study was found to be 11.5 with SD of 1.34. The range of PTS in our study was found to be between 7° - 13°.

Table 2: Distribution of patients as per PTS

PTS	NUMBER	%
7 - 8	12	7.84
8 - 9	16	10.46
9- 10	21	13.73
10 - 11	33	21.57
11 -12	52	33.99
12 -13	19	12.42
TOTAL	153	100.00

Graph 1: Distribution of patients as per PTS range

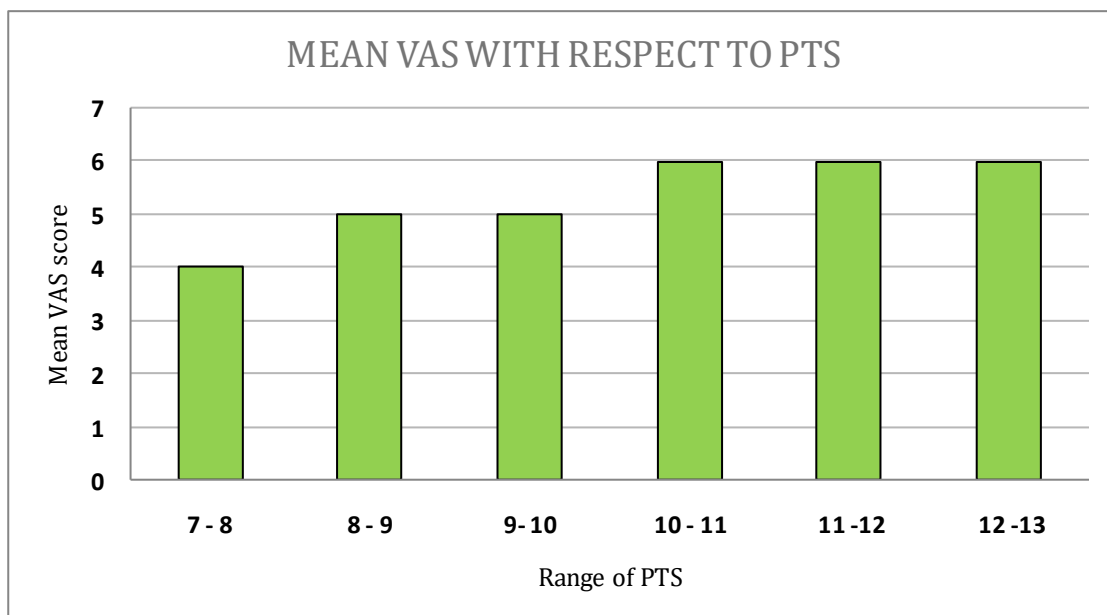


The patients were having a PTS within a range of 7-13. The highest percentage of these patients with grade I and II osteoarthritis were within the ranges of 10-11 and 11-12 of PTS with percentage of patients in each group 21.57 % and 33.9 % respectively

Table 3 : Average VAS score with respect to PTS

PTS	AVERAGE VAS SCORE
7 - 8	4
8 - 9	5
9- 10	5
10 - 11	6
11 -12	6
12 -13	6

Graph 2 :Mean VAS scores with respect to PTS

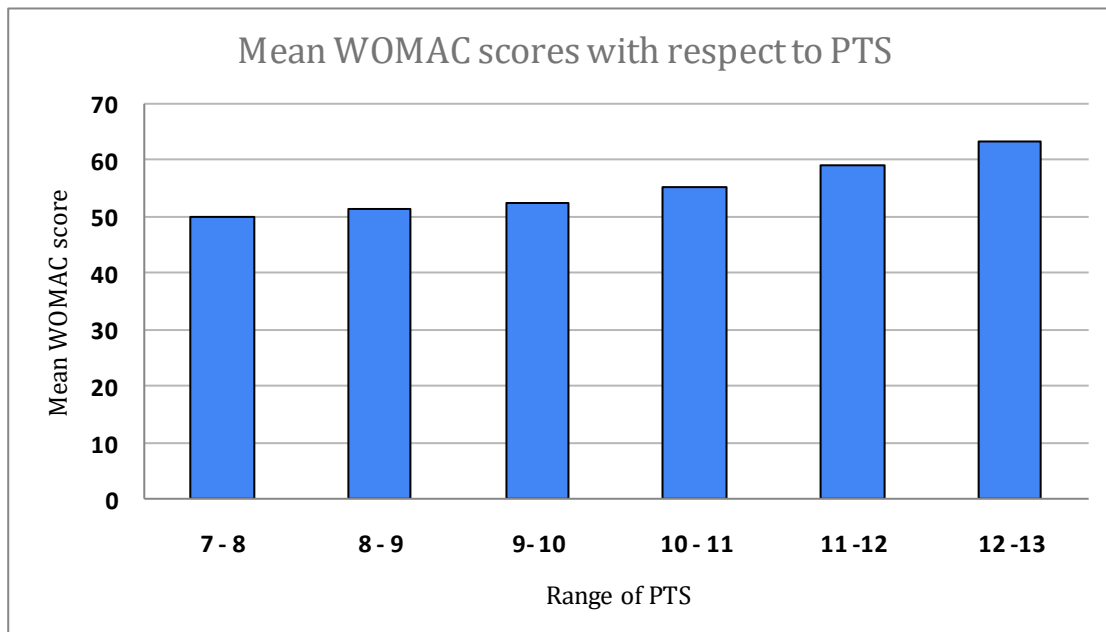


On analysis of the mean VAS scores with respect to the PTS, it was shown that the mean VAS scores increased with an increase in the Posterior Tibial Slope with highest value of VAS scores in our study (score of 6) seen in the range of PTS between 10-13.

Table 4 : Average WOMAC scores with respect to PTS

PTS	AVERAGE WOMAC SCORE
7 - 8	50.11
8 - 9	51.48
9- 10	52.36
10 - 11	55.31
11 -12	59.12
12 -13	63.22

Graph 3 :Mean WOMAC scores with respect to PTS

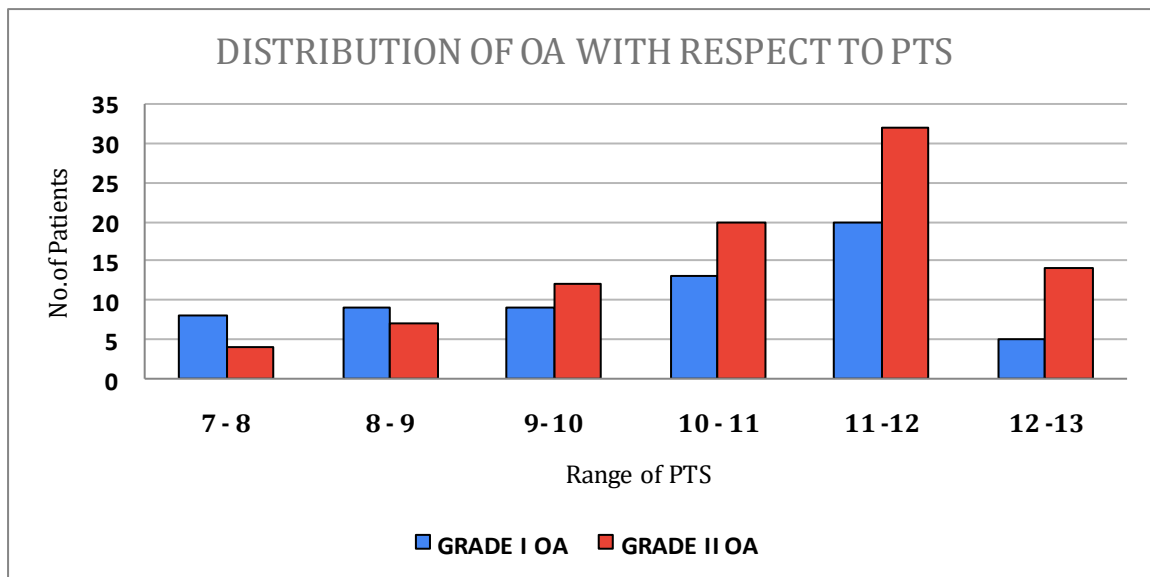


The WOMAC scores ranged between 49-66, and on correlating the mean scores with respect to the PTS, it was observed that the average WOMAC scores increased with an increase in the range of PTS. The lowest average of 50.11 was observed to be in the PTS range of 7-8 while the highest average score of 63.22 was in the range of 12-13.

Table 5 : Distribution of OA with respect to PTS

PTS	GRADE I OA	GRADE II OA
7 - 8	8	4
8 - 9	9	7
9- 10	9	12
10 - 11	13	20
11 -12	20	32
12 -13	5	14
TOTAL	64	89

Graph 4 : Distribution of OA with respect to PTS

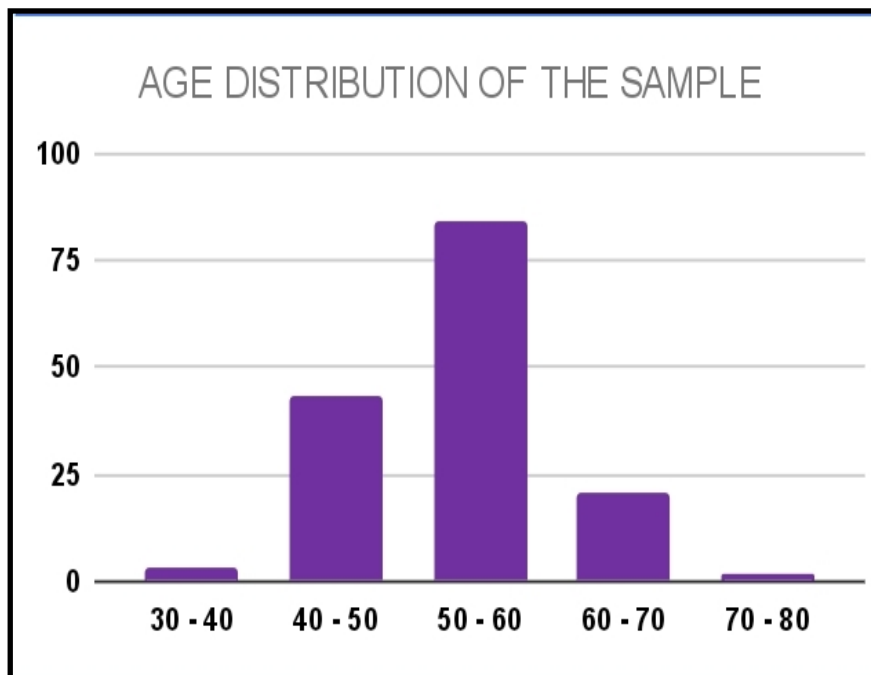


The total number of patients with grade I osteoarthritis was 64 while there 89 patients with grade II osteoarthritis. It was observed that the PTS range of 11-12 had the maximum number of patients in both groups with number of patients in grade I and II osteoarthritis being 20 and 32 respectively.

Table 6 : Analysis of age distribution with osteoarthritis in the study

AGE	NUMBER	%
30 - 40	3	1.96
40 - 50	43	28.10
50 - 60	84	54.90
60 - 70	21	13.73
70 - 80	2	1.31
TOTAL	153	100.00

Graph 5 : Age distribution of the sample

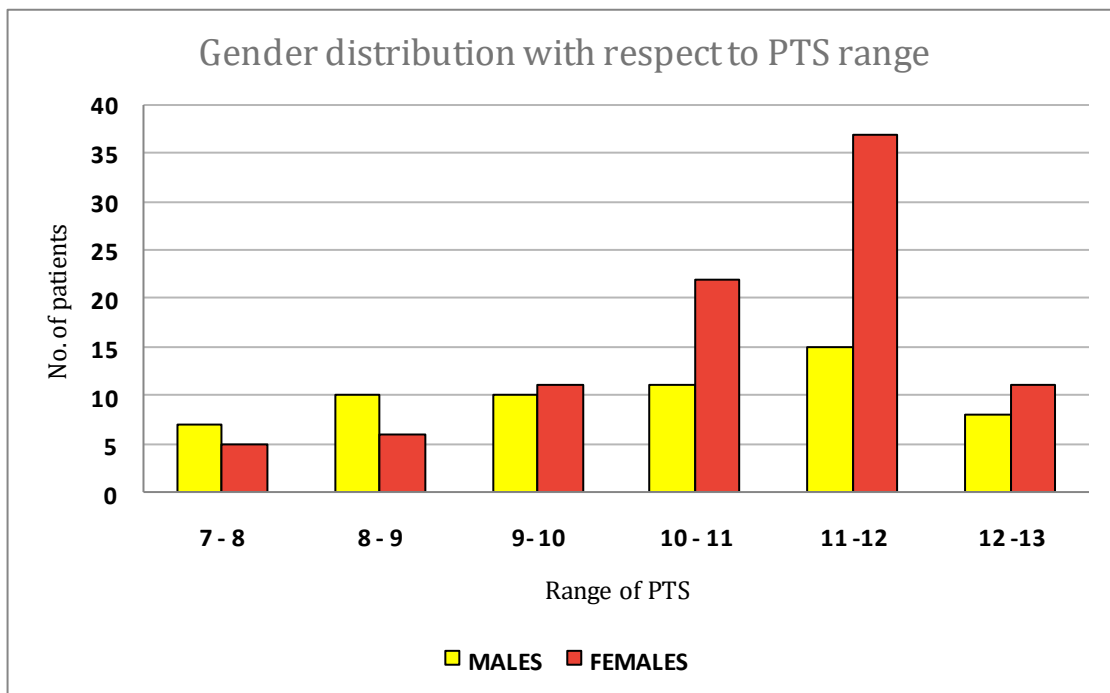


The analysis of age distribution among our study group shows that, the age group 50-60 years are more affected with grade I and II kneeosteoarthritis with this group having 54.9 % of the patients in the study with a mean age of 53.92 years.

Table 7 : Analysis of gender distribution with PTS

PTS	MALES	FEMALES
7 - 8	7	5
8 - 9	10	6
9- 10	10	11
10 - 11	11	22
11 -12	15	37
12 -13	8	11
TOTAL	61	92

Graph 6 : Gender distribution with respect to PTS

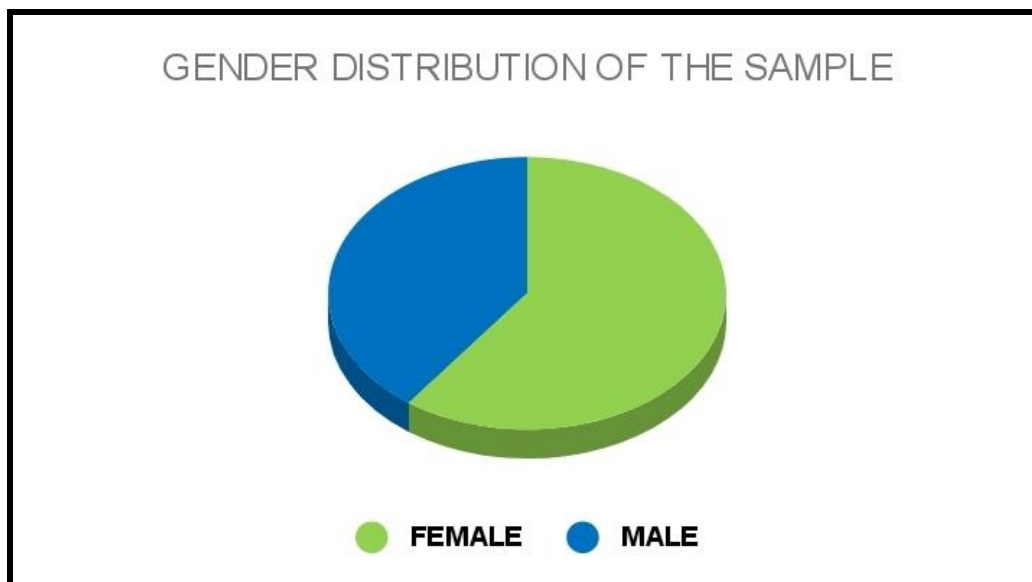


range

Table 8 : Analysis of gender distribution with knee osteoarthritis in the study

GENDER	NUMBER	%
FEMALE	92	60.13
MALE	61	39.87
TOTAL	153	100.00

Graph 7 : Gender distribution of the sample



The sex distribution in our study reveals there is a slightly increased prevalence of knee osteoarthritis arthritis among the female population, with 92 females and 61 males as part of our study with percentage of patients as females and males being 60.13 % and 39.87 % respectively. In case of females, maximum number of patients were within the PTS range of 11-12 with 37 patients in number, while the majority of male patients were also in the PTS range of 11-12 with 15 patients.

Table 9 :Distribution of patients with respect to VAS score

VAS SCORE	NUMBER OF PATIENTS	%
4	16	10.46
5	54	35.29
6	62	40.52
7	21	13.73
TOTAL	153	100.00

Graph 8 :Distribution of patients with respect to VAS score

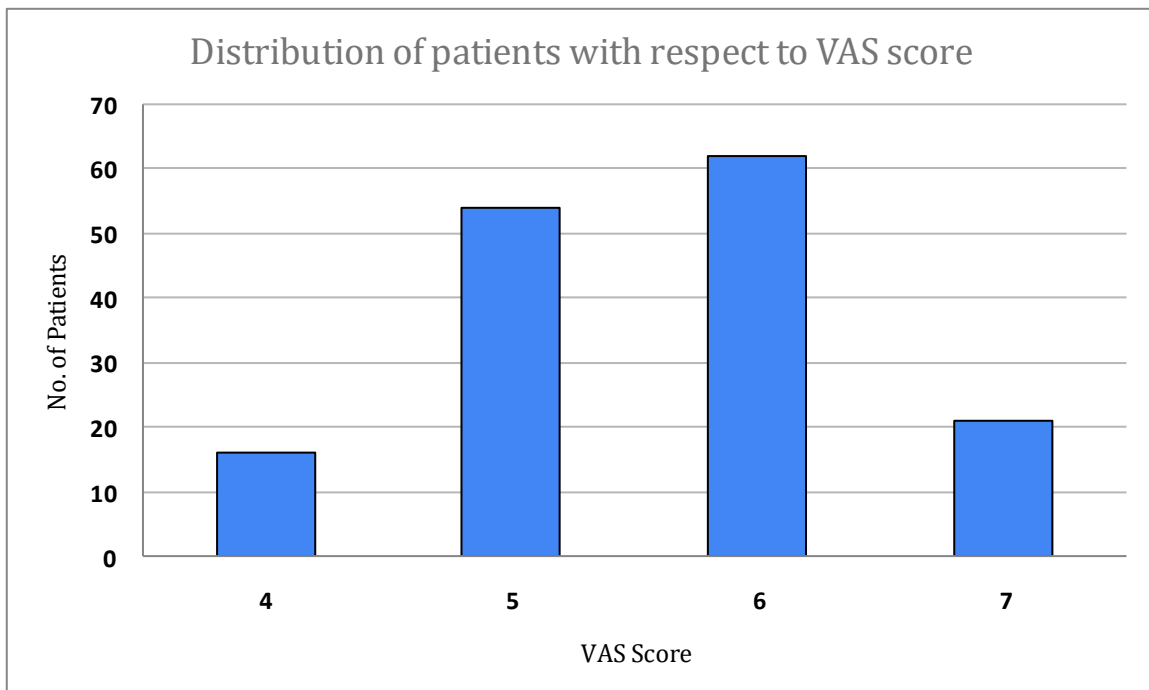
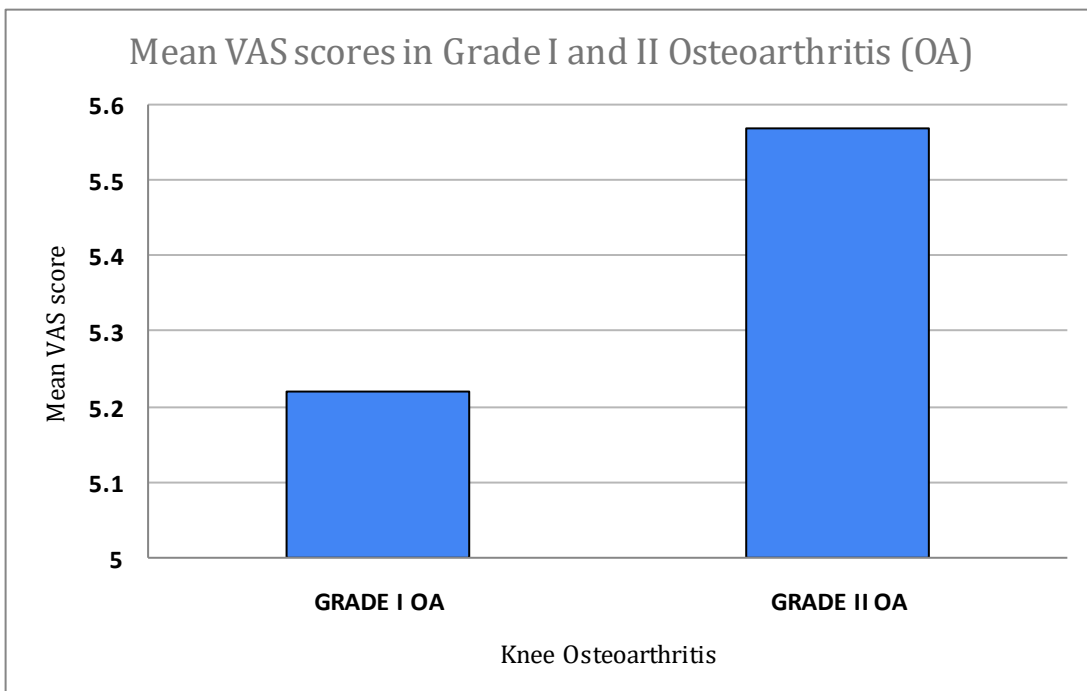


Table 10 :Mean values of VAS score with respect to osteoarthritis

	GRADE I OA	GRADE II OA
Mean VAS score	5.22	5.57

Graph 9 :Mean VAS scores in Grade I and II Osteoarthritis

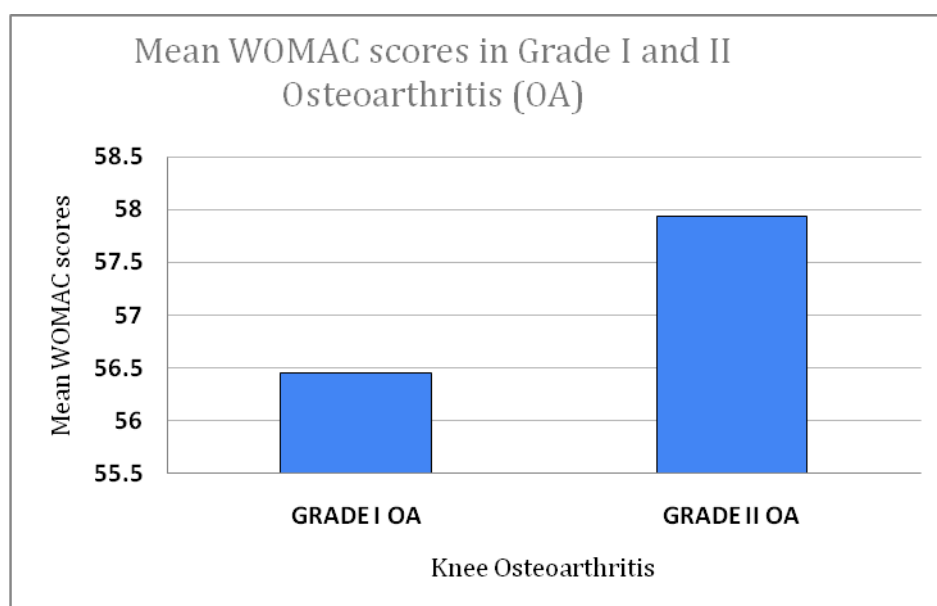


The mean VAS scores in our study was found to be 5.38 with 0.93 as SD and range of 4 – 7. It was found the VAS score increased with an increase in severity of knee osteoarthritis. The mean VAS scores in grade I and grade II osteoarthritis was found to be 5.22 and 5.57 with SD of 0.82 and 1.19 respectively. Highest percentage of patients had a VAS score of 6 with 40.52 % followed by a VAS score of 5 with percentage of patients being 35.29 %.

Table 11 : Mean values of WOMAC score with respect to Osteoarthritis

	GRADE I OA	GRADE II OA
Mean WOMAC score	56.45	57.94

Graph 10 :Mean WOMAC scores in Grade I and II Osteoarthritis



The WOMAC scores had their mean as 57.12 with SD of 7.86 and a range between 49 – 66. It was found that in addition to an increasing WOMAC score being associated with an increase in the value of PTS, the average WOMAC scores also increased with an increase in the grade (severity) of knee osteoarthritis. The mean WOMAC scores in grade I and II osteoarthritis was 56.45 and 57.94 with SD of 6.83 and 9.25 respectively.

DISCUSSION

The PTS has been assessed using various methods ranging from direct cadaveric measurements to X-rays, computed tomography (CT), and magnetic resonance imaging (MRI) scans. The ideal way to measure the PTS by X-ray is against the anatomical axis of tibia. Both CT and MRI are useful in measuring the medial and lateral slopes separately.^[34,35] The age- and gender-specific PTS have not been fully mapped out for all populations. PTS in normal knees has found to be different in different studies, with variations depending on factors like age, gender, ethnicity^[36] as well as the methods and modalities used for measurements. In a study done by V. Thirunarayan et al, they have measured PTS of normal knees with values of 9.690. Chiu et al.,^[37] also has measured PTS of both Normal and osteoarthritic knees with values for the normal knees being 10.80. Studies done on normal knees by Yoo et al., gave values of 10.6 while Yoga et al. gave values of 10.1. Didia et al., had done a study on normal knees with values of PTS as 12.3. The highest values for Asians has been shown as 13.65 by the study done by Khattak et al.

Now various studies have come with contrasting results i.e. while some have shown the slope to increase with osteoarthritic degeneration, others have shown that it decreases. Matsuda et al.,(1999) evaluated the posterior tibial slope in 30 normal and 30 varus knees using magnetic resonance imaging in one of the earliest studies on PTS.

The mean tibial posterior slope in the medial plateau was 10.7 degrees in the normal knees and 9.9 degrees in the varus knees. The mean tibial posterior slope in the lateral plateau was 7.2 degrees in the normal knees and 6 degrees in the varus knees. JM Muthuuri et al., (2014) conducted a study in an African population. They found that the mean posterior tibial slope among the African population is about 7°. The control group had a mean of 6.8° while the arthritic group had a mean of 6.1°. This study has concluded that the slope decreases with Osteoarthritic degeneration.

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In our study, we have measured PTS of osteoarthritic knees with values of 11.5° with a range of 7° to 13° . Our study also confirms that PTS increases with osteoarthritic degeneration, upon comparison with known values from previous studies. In our study, we have not included post-TKR patients, so the actual clinical significance of PTS, with respect to post TKR, has not been done in our study. As per Yoga et al. who have studied the preoperative and postoperative TKR PTS, they have suggested that patients with higher preoperative PTS end up with higher postoperative PTS, which may increase the range of flexion, but these patients may not achieve full extension, which is not desirable.

They also suggest that in patients with high preoperative PTS, when tibial cut is parallel to the surface, it exhibits 40% greater load-carrying capacity and 70% greater stiffness than paired tibiae cut perpendicular to long axis.^[42,43,44,45] In this condition, to achieve full range of extension, an excess resection of proximal tibia needs to be taken.

There were certain limitations to the study such as variations in the medial and lateral tibial slope of the knee joint in the same patient. A larger sample size could have helped in reducing the margin of error, and increasing the precision of the results. Also, previous studies have shown that computed tomography scan is the most accurate method in measuring PTS and preferred over X-rays.

CONCLUSION

Our study finds that the posterior tibial slope in patients with early osteoarthritis was higher in comparison to known values among patients with normal knees in the Indian population, suggestive of increased posterior tibial slope in individuals having osteoarthritic degeneration. Hence, the posterior tibial slope can be used as a marker for screening of osteoarthritis, and early interventions can be undertaken.

Further studies are required with more samples to validate PTS as an arthritic marker and its statistical significance in terms of sensitivity and specificity, to study gender- and age-related changes of PTS and its statistical significance to study the slope changes with progression of arthritis, and to further evaluate the significance of PTS with respect to TKR.

SUMMARY

Osteoarthritis is a chronic degenerative disorder that affects the joints, causing pain and stiffness with a prevalence of 22% to 39% in India. It has an important correlation with various risk factors such as weight, genetic factors, sex, previous traumas, occupational factors, physical activity, lifestyle and age. The geometry of an articular surface may be an important risk factor for development of knee osteoarthritis. This study was performed to determine the value of, and confirm whether changes in Posterior Tibial Slope on radiographs are associated with Osteoarthritis.

As part of the study, 153 individuals were selected among the patients visiting the outpatient department as per the inclusion and exclusion criteria. X-rays of the knee joint of patients with Early OA (Grade I and II) with AP and lateral views were examined.

The posterior tibial slope was obtained through measuring the angle between the tangent to the tibial plateau and the perpendicular direction to Tibial Proximal Anatomical Axis (TPAA). The mean posterior tibial slope measured in our study was found to be 11.5 with SD of 1.34. The range of PTS in our study was found to be between 7° - 13°. All the observations and measurements of PTS were statistically analysed using SPSS (Statistical package for social sciences).

The study finds that the posterior tibial slope in patients with early osteoarthritis was higher in comparison to known values among patients with normal knees in the Indian population, suggestive of increased posterior tibial slope in individuals having osteoarthritic degeneration. Hence, the posterior tibial slope can be used as a marker for screening of osteoarthritis of the knee joint, and earlier interventions can help in improving the management of knee osteoarthritis.

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ANNEXURE I

INFORMED CONSENT

TITLE OF THE STUDY :“RADIOLOGICAL ASSESSMENT OF THE POSTERIOR TIBIAL SLOPE AS A RISK FACTOR FOR OSTEOARTHRITIS OF KNEE JOINT “

PRINCIPAL INVESTIGATOR: Reg No. BL0120005

GUIDE: Associate Professor

INTRODUCTION AND PURPOSE:

Osteoarthritis of the knee is a degenerative disorder which cause significant morbidity in patients. It has a multifactorial etiology affecting both the rich and poor population with potentially no cure and drastically affecting the quality of living. Degenerative arthritis has shown a raising trend and contributes to the major chunk of chronic orthopaedic patients presenting with pain and inability to carry out daily activities. Early preventive measures and newer, more sensitive screening tools can go a long way in reducing the burden of OA on both the individual and society.

The purpose of this study is to determine the posterior tibial slope in patients with Early Osteoarthritis, and to find whether there is any association which can be used as evidence to start early interventional measures in such patients.

PROCEDURE :

If you consent to be in this study, the relevant data is collected as per the proforma, and the final diagnosis is confirmed after correlating both clinical and radiological evidences, and the posterior tibial slope is measured using the Lateral view X-rays of the Knee.

RISKS AND BENEFITS :

There are no risks associated with this study.

VOLUNTARY PARTICIPATION / WITHDRAWAL:

Taking part in this study is voluntary. I may choose not to take part in this study, or if I decide to take part I can later change my mind and withdraw from the study. My decision will not change the present or future health care or other services that I receive. The investigator or the sponsor may stop my participation in this study. I will tell of any important new findings that may change my willingness to continue to take part. If I choose not to take part in the study, I will receive the standard treatment for patients with my condition.

COMPENSATION :

As the subject will be voluntarily giving consent to be a part of the study, no compensation shall be given.

COSTS OF PARTICIPATION :

The cost of investigations namely X-ray will be borne by the patient.

CONFIDENTIALITY :

All information collected about the subject during the course of the study will be kept confidential to the extent permitted by the law. The code numbers will identify the subject in this research record. Information and/or photographs taken from this study may be presented but the subject's identity will be confidential in any publication. If any enquiries in the future or in case of study related injury or illness, you may contact following persons :

Reg No. BL0120005
Post-graduate Student,
Department of Orthopaedics,
J.N. Medical College,
KAHER, Belagavi 10.

Associate Professor,
Department of Orthopaedics,
J.N. Medical College,
KAHER, Belagavi 10.

CHAIRPERSON

DR. HARSHA HEGDE

CHAIRPERSON,
JAWAHARLAL NEHRU MEDICAL COLLEGE,
IEC AND SCIENTIST D,
ICMR, NATIONAL INSTITUTE OF TRADITIONAL MEDICINE,
BELAGAVI-590010

CONSENT TO PARTICIPATE IN THE STUDY

I Mr./Ms. _____ have been explained about the research study, the need of the study, the intervention, their risks, benefits and alternatives available in my own vernacular language.

I voluntarily agree to participate in this study by signing up this form below. I understand that I may withdraw at any time from this study. I have been given adequate time to clarify my doubts about the study and my rights as a study participant.

My signature/thumb impression below indicates that I have read or information in the consent been read to me including the risks and benefits and have cleared my doubts.

Name of participant:

Signature/LTI:

**Name of legally authorized
Representative (if applicable):
Relationship with participant:**

Signature/LTI:

Name of witness:

Signature:

Name of investigator:

Signature:

Date:

Place:

ANNEXURE II

PROFORMA

“RADIOLOGICAL ASSESSMENT OF THE POSTERIOR TIBIAL SLOPE AS A RISK FACTOR FOR OSTEOARTHRITIS OF KNEE JOINT”

Serial NO. _____ OP/IP NO. _____

NAME: _____

AGE: _____ YRS SEX: _____

ADDRESS: _____

OCCUPATION: _____

DOA: _____

DOS: _____

DOD: _____

CHIEF COMPLAINTS:

PRESENTING COMPLAINTS:

Pain

Swelling

Disability

Wound

ROM

Deformity

HISTORY OF PRESENT ILLNESS:

SIGNIFICANT PAST HISTORY:

- a. History of Diabetes Mellitus, Hypertension, Asthma, Rheumatoid Arthritis, Tuberculosis and other chronic illness
 - 1. Yes
 - 2. No

- b. Previous history of Fractures. If yes, elaborate.
 - 1. Yes
 - 2. No

- c. Previous history of any medication received/surgery

PERSONAL HISTORY :

Diet : Veg/ Mixed/ Nonveg
Appetite : Increased or Decreased
Habits : Smoking/ Alcohol /others
Bowel & Bladder Habits : Normal or Abnormal

FAMILY HISTORY :

GENERAL PHYSICAL EXAMINATION :

Build : Well/Moderate/Poor
Height Weight
Temperature Pulse
Blood Pressure Respiratory Rate
Pallor
Cyanosis
Icterus
Clubbing
Pedal edema
Lymphadenopathy

SYSTEMIC EXAMINATION :

Cardiovascular System Examination :

Respiratory System Examination :

Per Abdomen Examination :

Central Nervous System Examination :

LOCAL EXAMINATION :

INSPECTION :

RIGHT

LEFT

Knee Involved

Attitude

Skin: Blebs / Ecchymosis / Avulsed / Bruise

Swelling

Deformity

PALPATION :

Tenderness

Crepitus

Abnormal mobility

Deformity

Loss of transmitted movements and continuity of bone

Peripheral Pulses : Radial / Brachial

Neurovascular Deficits : (Tingling, numbness, Power)

1. Yes

2. No

Presence of any associated injury :

1. Yes

2. No

If Yes specify

RANGE OF MOVEMENTS :

RIGHT

LEFT

Knee joint movement

MEASUREMENTS :

Length of the segment

WOMAC Score:

The test questions are scored on a scale of 0-4, which correspond to: None (0), Mild (1), Moderate (2), Severe (3), and Extreme (4). The scores for each subscale are summed up, with a possible score range of 0-20 for Pain, 0-8 for Stiffness and 0-68 for Physical Function.

Your Full Name: _____ Today's Date: _____
 _____/_____/_____ Month Day Year

WOMAC OSTEOARTHRITIS INDEX

1. The following questions concern the amount of pain you are currently experiencing in your knees. For each situation, please enter the amount of pain you have experienced in the past 48 hours.

	None	mild	moderate	severe	extreme
A. Walking on a flat surface	A. <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
B. Going up or down stairs	B. <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
C. At night while in bed	C. <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
D. Sitting or lying	D. <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
E. Standing upright	E. <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

2. Please describe the level of pain you have experienced in the past 48 hours for each one of your knees.

	None	mild	moderate	severe	extreme
A. Right knee	A. <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
B. Left knee	B. <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

3. How severe is your stiffness after first awakening in the morning?

None	mild	moderate	severe	extreme
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

4. How severe is your stiffness after sitting, lying, or resting later in the day?

None	mild	moderate	severe	extreme
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

5. The following questions concern your physical function. By this we mean your ability to move around and to look after yourself. For each of the following activities, please indicate the degree of difficulty you have experienced in the last 48 hours, in your knees.

What degree of difficulty do you have with:

	None	mild	moderate	severe	extreme
A. Descending (going down) stairs	A. <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
B. Ascending (going up) stairs	B. <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
C. Rising from sitting	C. <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
D. Standing	D. <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
E. Bending to floor	E. <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
F. Walking on a flat surface	F. <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
G. Getting in/out of car	G. <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
H. Going shopping	H. <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I. Putting on socks/stockings	I. <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
J. Rising from bed	J. <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
K. Taking off socks/stockings	K. <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
L. Lying in bed	L. <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
M. Getting in/out of bath	M. <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
N. Sitting	N. <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
O. Getting on/off toilet	O. <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
P. Heavy domestic duties (mowing the lawn, lifting heavy grocery bags)	P. <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q. Light domestic duties (such as tidying a room, dusting, cooking)	Q. <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

RELEVANT INVESTIGATIONS :

- a) X-Ray of the affected Knee AP view
- b) X-Ray of affected Knee True Lateral view
- c) Blood - Hb%, TLC, DLC, ESR
- d) Urine - Albumin, Sugar, Microscopy
- e) FBS, RBS
- f) Serum Creatinine, Serum Uric acid, Blood Urea
- g) ECG

DIAGNOSIS :

POSTERIOR TIBIAL SLOPE value :

TREATMENT :

ANNEXURE III

PHOTOGRAPHS



Photograph 1



Photograph 2

Photographs 1 & 2 : Photographs of the X-ray machine along with the Bucky stand and Cassette



Photograph 3

Photograph 3: Clinical examination of the knee joint of the patient
in the OPD



Photograph 4

**Photograph 4 : X-ray imaging of the knee joint of the patient
in AP view**



Photograph 5

**Photograph 5 : X-ray imaging of the knee joint of the patient
in Lateral view**



Photograph 6



Photograph 7

Photographs 6 & 7 : X-ray films of the knee joint in both the AP and Lateral views for the diagnosis of Osteoarthritis



Photograph 8



Photograph 9

Photographs 8 & 9 : Measurement of the Posterior Tibial Slope on the X-ray lateral view of knee joint

ANNEXURE IV

MASTER CHART

Serial No.	Patient Number	Age	Sex	Diagnosis	VAS score	Posterior Tibial Slope	WOMAC score
1	948292	55	M	Gr.1 Knee OA	6	12.5	36
2	955013	53	F	Gr.2 Knee OA	5	12.7	42
3	957218	62	M	Gr.1 Knee OA	4	13.0	54
4	961957	39	M	Gr.1 Knee OA	5	9.5	28
5	962753	38	F	Gr.2 Knee OA	6	8.5	43
6	1052648	39	M	Gr.2 Knee OA	5	13.0	36
7	962256	40	F	Gr.1 Knee OA	6	7.0	38
8	1092416	60	F	Gr.1 Knee OA	4	9.6	51
9	963732	70	F	Gr.1 Knee OA	5	12.4	34
10	967234	66	F	Gr.2 Knee OA	7	12.7	32
11	965476	67	F	Gr.1 Knee OA	5	12.6	29
12	967546	67	M	Gr.1 Knee OA	5	11.7	39
13	969180	64	M	Gr.1 Knee OA	5	12.2	48
14	969247	68	F	Gr.1 Knee OA	5	12.2	43
15	969910	69	F	Gr.2 Knee OA	5	11.7	46
16	969675	70	M	Gr.1 Knee OA	5	12.7	32
17	975085	62	F	Gr.1 Knee OA	5	9.7	38
18	976059	65	F	Gr.1 Knee OA	6	13.0	45
19	977142	65	F	Gr.1 Knee OA	4	13.0	42
20	977605	68	M	Gr.1 Knee OA	6	12.7	39
21	978872	62	M	Gr.1 Knee OA	5	13.0	32
22	980906	65	F	Gr.2 Knee OA	7	12.2	29
23	980896	69	M	Gr.2 Knee OA	5	13.0	46
24	986829	62	M	Gr.2 Knee OA	5	12.2	30

25	988626	65	M	Gr.2 Knee OA	4	13.0	34
26	990699	61	F	Gr.2 Knee OA	6	12.9	36
27	987222	62	F	Gr.2 Knee OA	4	13.0	48
28	992188	65	F	Gr.2 Knee OA	5	9.2	43
29	993337	68	M	Gr.2 Knee OA	7	9.6	36
30	993730	58	M	Gr.2 Knee OA	5	11.7	43
31	1000130	45	F	Gr.2 Knee OA	6	11.0	37
32	1000458	46	F	Gr.2 Knee OA	5	9.7	29
33	1000708	58	F	Gr.2 Knee OA	4	8.8	36
34	1003424	45	M	Gr.2 Knee OA	5	12.2	32
35	1003739	48	M	Gr.2 Knee OA	6	12.7	28
36	995859	43	M	Gr.2 Knee OA	5	12.7	36
37	1004991	45	F	Gr.2 Knee OA	6	11.4	45
38	1008044	45	F	Gr.2 Knee OA	4	13.0	45
39	1008552	46	F	Gr.2 Knee OA	5	10.7	42
40	1014254	54	F	Gr.2 Knee OA	7	11.7	32
41	1014401	53	M	Gr.2 Knee OA	5	13.0	36
42	1015115	59	F	Gr.2 Knee OA	5	11.7	42
43	1015608	51	F	Gr.2 Knee OA	5	12.2	39
44	1018136	57	F	Gr.2 Knee OA	5	12.7	44
45	1019512	55	M	Gr.2 Knee OA	5	13.0	46
46	1039929	55	F	Gr.2 Knee OA	5	9.2	43
47	978526	59	F	Gr.2 Knee OA	5	13.0	48
48	1055923	55	F	Gr.2 Knee OA	6	13.0	42
49	1059099	45	M	Gr.2 Knee OA	4	8.2	39
50	1063129	47	F	Gr.2 Knee OA	6	9.2	37
51	593462	55	M	Gr.2 Knee OA	5	9.2	43
52	1066219	57	F	Gr.1 Knee OA	7	11.4	44
53	1066312	45	M	Gr.1 Knee OA	5	11.6	43
54	1065868	48	F	Gr.1 Knee OA	5	10.6	49
55	1633495	55	M	Gr.1 Knee OA	4	11.0	42
56	1063653	55	F	Gr.1 Knee OA	6	12.4	46
57	1062980	58	F	Gr.1 Knee OA	4	12.7	39
58	1068717	50	F	Gr.1 Knee OA	5	10.8	35
59	1071104	59	M	Gr.1 Knee OA	7	12.7	38

60	1071528	55	F	Gr.2 Knee OA	5	13.0	36
61	907547	51	M	Gr.2 Knee OA	6	13.0	38
62	1053085	45	M	Gr.2 Knee OA	5	12.9	39
63	976059	49	M	Gr.2 Knee OA	4	11.7	34
64	977142	47	M	Gr.2 Knee OA	5	13.0	36
65	977605	42	F	Gr.1 Knee OA	6	9.1	36
66	978872	46	M	Gr.1 Knee OA	5	9.6	35
67	980906	55	F	Gr.1 Knee OA	6	8.3	39
68	980896	59	M	Gr.1 Knee OA	4	9.6	34
69	986829	56	F	Gr.1 Knee OA	5	9.7	29
70	988626	53	M	Gr.1 Knee OA	7	12.7	35
71	990699	56	F	Gr.1 Knee OA	5	12.4	49
72	987222	54	F	Gr.1 Knee OA	5	12.5	43
73	992188	57	F	Gr.2 Knee OA	5	11.7	47
74	993337	52	M	Gr.2 Knee OA	5	10.6	49
75	993730	57	F	Gr.2 Knee OA	5	10.7	42
76	1000130	58	M	Gr.2 Knee OA	5	13.0	35
77	1000458	54	F	Gr.2 Knee OA	5	12.7	38
78	1000708	59	F	Gr.1 Knee OA	6	11.7	39
79	1003424	55	M	Gr.1 Knee OA	4	13.0	34
80	1003739	54	M	Gr.1 Knee OA	6	11.7	35
81	995859	45	F	Gr.1 Knee OA	5	11.2	36
82	1004991	48	F	Gr.1 Knee OA	7	10.6	36
83	1008044	57	F	Gr.1 Knee OA	5	9.7	35
84	1008552	59	F	Gr.1 Knee OA	5	10.7	32
85	1014254	56	M	Gr.1 Knee OA	4	13.0	31
86	1014401	55	F	Gr.1 Knee OA	6	12.7	39
87	1015115	54	M	Gr.1 Knee OA	4	12.2	36
88	1015608	53	F	Gr.1 Knee OA	5	13.0	33
89	1018136	55	F	Gr.1 Knee OA	7	11.8	36
90	1019512	56	M	Gr.1 Knee OA	5	10.7	42
91	1039929	55	M	Gr.1 Knee OA	6	10.2	29
92	639856	59	F	Gr.1 Knee OA	5	11.2	39
93	1055923	54	F	Gr.1 Knee OA	4	11.2	35
94	1059099	55	M	Gr.1 Knee OA	5	12.2	34

95	1063129	51	M	Gr.1 Knee OA	6	13.0	35
96	964326	55	F	Gr.1 Knee OA	5	13.0	35
97	1066219	57	M	Gr.1 Knee OA	6	12.7	39
98	1066312	55	M	Gr.1 Knee OA	4	11.4	34
99	1065868	59	F	Gr.1 Knee OA	5	10.6	39
100	654395	57	F	Gr.1 Knee OA	7	9.7	35
101	5326985	54	F	Gr.1 Knee OA	5	10.7	38
102	1062980	55	M	Gr.1 Knee OA	5	9.2	35
103	1068717	56	F	Gr.1 Knee OA	5	10.2	39
104	1071104	55	F	Gr.1 Knee OA	5	10.7	32
105	1071528	59	F	Gr.1 Knee OA	5	10.7	29
106	1023457	55	F	Gr.1 Knee OA	5	9.2	36
107	975085	54	F	Gr.1 Knee OA	5	11.2	38
108	976059	45	M	Gr.1 Knee OA	6	11.7	39
109	977142	57	F	Gr.1 Knee OA	4	11.2	34
110	977605	46	M	Gr.1 Knee OA	6	12.7	32
111	978872	48	F	Gr.1 Knee OA	5	10.7	36
112	980906	43	M	Gr.1 Knee OA	7	11.2	36
113	980896	45	M	Gr.1 Knee OA	5	11.7	32
114	986829	49	F	Gr.1 Knee OA	5	12.2	29
115	988626	54	F	Gr.1 Knee OA	4	12.7	36
116	990699	55	M	Gr.1 Knee OA	6	10.7	42
117	987222	58	F	Gr.1 Knee OA	4	11.2	45
118	992188	54	F	Gr.1 Knee OA	5	12.7	43
119	993337	55	F	Gr.2 Knee OA	7	13.0	46
120	993730	48	M	Gr.2 Knee OA	5	12.2	42
121	1000130	45	F	Gr.2 Knee OA	6	12.7	36
122	1000458	47	M	Gr.2 Knee OA	5	12.7	36
123	1000708	45	M	Gr.2 Knee OA	4	11.7	33
124	1003424	55	F	Gr.1 Knee OA	5	12.2	36
125	1003739	54	F	Gr.1 Knee OA	6	12.2	36
126	995859	52	F	Gr.1 Knee OA	5	13.0	34
127	1004991	49	F	Gr.1 Knee OA	6	12.2	38
128	1008044	54	F	Gr.1 Knee OA	4	12.7	36
129	1008552	57	M	Gr.1 Knee OA	5	11.2	29

130	1014254	55	F	Gr.1 Knee OA	7	10.7	42
131	1014401	54	F	Gr.1 Knee OA	5	9.7	44
132	1015115	59	F	Gr.2 Knee OA	5	9.2	39
133	1015608	54	M	Gr.2 Knee OA	5	11.2	36
134	1018136	55	F	Gr.2 Knee OA	5	10.7	36
135	1019512	45	F	Gr.2 Knee OA	5	10.7	34
136	1039929	43	F	Gr.2 Knee OA	5	12.2	36
137	906323	44	M	Gr.1 Knee OA	5	12.7	39
138	1055923	47	M	Gr.1 Knee OA	6	11.2	34
139	1059099	46	F	Gr.1 Knee OA	4	10.7	35
140	1063129	45	F	Gr.1 Knee OA	6	10.2	36
141	965319	48	F	Gr.1 Knee OA	5	9.9	35
142	1066219	58	M	Gr.1 Knee OA	7	10.2	39
143	1066312	54	F	Gr.1 Knee OA	5	10.2	35
144	1065868	46	F	Gr.1 Knee OA	5	12.2	34
145	966336	45	M	Gr.1 Knee OA	4	13.0	35
146	943265	58	M	Gr.2 Knee OA	6	11.7	36
147	1062980	45	M	Gr.2 Knee OA	4	11.2	35
148	1068717	46	M	Gr.2 Knee OA	5	12.7	42
149	1071104	56	F	Gr.2 Knee OA	7	11.7	43
150	1071528	55	F	Gr.2 Knee OA	5	12.5	44
151	963265	58	F	Gr.1 Knee OA	7	12.7	42
152	1063298	59	F	Gr.1 Knee OA	8	12.2	43
153	1052232	45	F	Gr.1 Knee OA	6	11.2	32