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Role of Full-Length Lower Limb Scanogram in Pre-Operative Radiological Assessment for Total Knee Arthroplasty

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Abstract
Total knee arthroplasty (TKA) is a surgical procedure performed in patients with severe osteoarthritis to relieve pain and restore function. The success of the procedure depends on correct planning and implant selection for which full length radiograph or scanogram of the knee is performed. Various axes and angles are measured which help in decision making. Hence it is important for the radiologists to have an in-depth knowledge of these measurements which are crucial for the fellow orthopedic surgeons.

Keywords: Full-Length x-ray, Scanogram, Total Knee Arthroplasty

1. Introduction

Total knee arthroplasty (TKA) is a surgical procedure used to relieve pain, restore function and mobility in patients with severe osteoarthritis. The long-term success of this operative procedure depends on correct planning, which relies on various factors including patient selection, surgical technique, implant design, positioning and balancing which affects the outcome of TKA. Deviations from the mechanical axis (MA) that is the line from femoral head to the center of knee and ankle joints leads to an increase in the risk of implant loosening and load on the knee joints. Improper positioning of the implant will lead to acceleration of prosthesis wear and tear and resultant poor clinical outcome.

Conventional radiographs are most frequently used imaging modality for this purpose. Preoperative imaging for TKA has several indications such as assessment of the severity of osteoarthritic disease, to annulus there is a bone tissue, to review the relevant anatomy, and to decide which implant and surgical approach will be applied. This article aims to present the necessary radiological evaluation and measurements to be made before TKA procedure is ordered in order to achieve good clinical outcomes [1].

2. Technique

Standing weight-bearing scanogram / radiographs of the lower extremity are done with bare foot subject standing with the patella facing forwards. To achieve this position of patella, 8–10° lateral rotation of the feet is usually needed. However, as seen in torsional deformities there can be medialization or lateralization of the patella. In these cases, the correct position is obtained through the internal or external rotation of the lower leg until the patella is centred amongst the femoral condyles [2].

Both lower extremities are included in the scanogram. 3 joint views of 52-inch cassettee are used. A metallic ball marker of standard size (6 inch in our institution) iss also adhered to patient's thigh to serve as a scale for measurement. Standing AP view of the lower extremities are taken from hip to ankle (Fig 1). Scanogram are also used to evaluate anatomic leg length and to calculate leg length discrepancies (Fig 2A) [3].

Weight bearing standing scanogram / radiographs of the lower extremity with the patella facing forwards. 3 joint views of 52-inch cassettee are used. A metallic ball marker of standard size (6 inch in our institution) is also adhered to patient's thigh to serve as a scale for measurement.

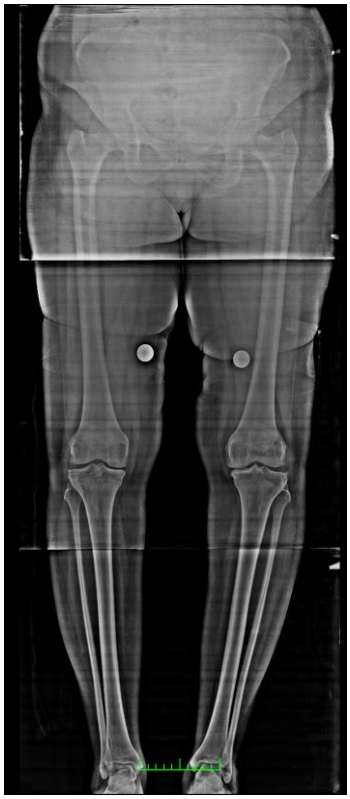

Fig 1

3. Discussion

The role of radiology in TKA is crucial and, one should have an understanding of axes of the lower limbs associated with the knee, the angles between the axes and their direct radiography positions.

Lower limb axes associated with the knee for TKA [1, 4, 5]:

1. Femoral anatomical axis: Line connecting the mid-femoral diaphysis and midpoint of the intercondylar notch of the femur.
2. Tibial anatomical axis: Line connecting the midpoint of tibial eminences and the midpoint of talus dome.
3. Femoral mechanical axis: Line connecting the center of the femoral head to the intercondylar notch of the femur.
4. Tibial mechanical axis: Same as the tibial anatomical axis.
5. Lower limb anatomical axis: Line connecting the tibial and femoral anatomical axes.
6. Lower limb mechanical axis: Line connecting the center of the femoral head and the center of the ankle. This is the load bearing axis (Fig 2B).
7. Transtibial axis: Line drawn tangentially to the medial and lateral tibial plateaus.
8. Transcondylar axis: Line drawn tangentially to the ends of the medial and lateral condyles of the femur in the knee joint.

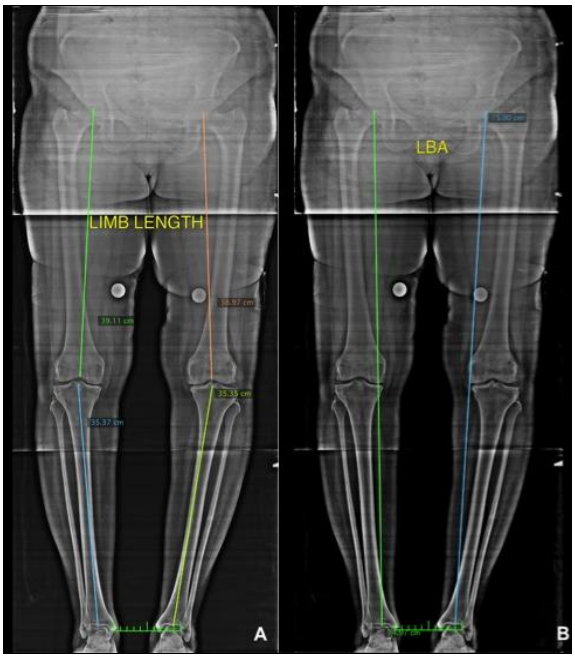

Fig 2: A) Standing AP view of the lower extremities is taken from hip to ankle, used to evaluate anatomic leg length and to calculate leg length discrepancies B) Load bearing axis - Line connecting the center of the femoral head and the center of the ankle.

Angles of knee associated with TKA [1, 5, 6, 7]

1. Hip-knee-ankle (HKA) angle: The angle between the femoral and the tibial mechanical axes. The angle is normally 180°. It is above 180° in the case of a valgus, and less than 180° in the case of a varus deformity.
2. Lateral distal femoral angle (LDFA): The lateral angle between the line drawn tangentially to the ends of the medial and lateral condyles of the femur in the knee joint (transcondylar axis) and the femoral mechanical axis (Fig 3A). This angle is normally 87±2°.
3. Medial proximal tibial angle (MPTA): The medial angle between the line drawn tangentially to the tibial plateaus and the tibial mechanical axis (Fig 3B). This angle is normally 87±2°.
4. Tibiofemoral divergence: The angle between the line drawn tangentially to the ends of the medial and lateral condyles of the femur in the knee joint (transcondylar axis) and the line drawn tangentially to the tibial plateaus (transtibial axis). This is also the joint congurence (Fig 3C). Normally, these two lines converge medially. An angle between 0.4°–3° is considered to be normal. Its mean value is 1.7°.

Fig 3: A) Lateral distal femoral angle (LDFA): The lateral angle between the line drawn tangentially to the ends of the medial and lateral condyles of the femur in the knee joint (transcondylar axis) and the femoral mechanical axis. B) Medial proximal tibial angle (MPTA): The medial angle between the line drawn tangentially to the tibial plateaus and the tibial mechanical axis. C) Joint congurence: The angle between the line drawn tangentially to the ends of the medial and lateral condyles of the femur in the knee joint (transcondylar axis) and the line drawn tangentially to the tibial plateaus (transtibial axis).

Role of standing anteroposterior radiographs:

Standing anteroposterior radiographs are also used to determine whether there will be significant bone loss during surgery and to decide whether such bone loss will need to be compensated. To determine the bone loss, a vertical horizontal line is drawn from the unaffected plateau region to the long axis of the tibia. No specific action will be required if maximal bone loss did not reduce the height of the affected plateau above 15 mm compared with a normal plateau. Standing radiographs also allow for the measurement of the amount of subluxation and ligamentous laxity. They also allow for the determination of the sizes and locations of the osteophytes that need to be removed while reconstructing the anatomical contours of the knee during surgical procedure [1].

4. Conclusion

Preoperative radiographs allow for the accurate decision making of the size and position of the implants when preparing for TKA surgery to maintain good joint mechanics. Accurately sized implants help maintain the soft tissue balance and also maintain even load transmission on the joint. With in- depth knowledge of joint axes and mechanics, a radiologist plays an important role in planning of TKA surgery.

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