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RESEARCH ARTICLE

PRELIMINARY REPORT OF ACCURATE PRE-OPERATIVE PLANNING FOR RESTOKNEE SURGERY OF MEDIAL COMPARTMENT OA KNEE

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Abstract

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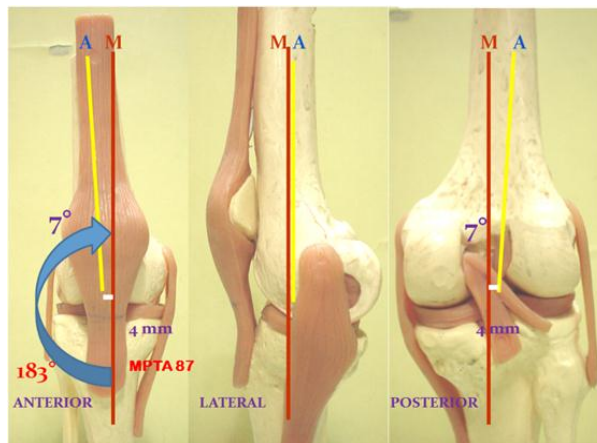
Introduction:-

Considering drawbacks of all procedures of osteoarthritis surgery of knee, we decided to do restoknee surgery for isolated medial compartment osteoarthritis of knee. The procedure is mainly based on the principle of very old and established technique of closed wedge osteoclasis, where we are not using any implants internally.

Stalwart orthopaedic surgeons like Dr. Dror Paley, Dr. J. E. Herzenberg had explained the things in their book on "Deformity correction" for pre-operative assessment for corrective osteotomy. Professor Tomihisa Koshino had shown his assessment in his many papers like 28 years long follow up of osteotomy as well as Dr. Staubli has put his pre-operative assessment in his book on "osteotomy around the knee". Considering all these assessments, routine considerations are as follows:

Anatomy with average angle:

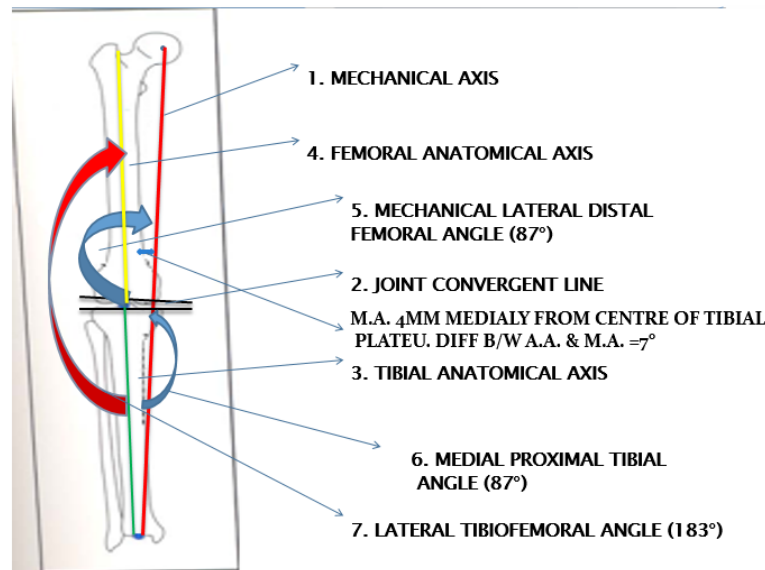
According to mechanical axis and joint convergent angle of fibular and tibial articular surfaces, the medial proximal tibial angle is average 87° (85° - 90°) and distal lateral femoral angle is average 88° (85° - 90°). These two angles are very important for deciding whether tibia is involved or femur is involved or both the bones are involved and the treatment of restoration depends on these angles.



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Natural anatomy and drawing on model:

Because of accentric situation of femur, there is 7° of diff. B/w anatomical and mechanical axis of femur. Mechanical axis passing 4 mm medial to the centre of the knee because of natural 3° of proximal tibial varus. Mpta is 87 and lateral tibio femoral angle is 183.



Femur is having antero-lateral bowing and the situation of femur is accentric and that is why the mechanical axis which is drawn from the center of the head to the center of the ankle joint and the anatomical axis of femur is drawn from tip of the trochanter to the center of the knee joint and that is why there is a 7° difference between mechanical axis and anatomical axis. Considering this fact, mechanical axis is passing 4mm medial to the center of the knee and that is why God has gifted 3° of inclination of tibial articular surface on medial side which is producing 3° of tibia vara and that is why maximum load is passing through the medial compartment and that is the main cause why osteoarthritis starts from medial compartment.

History Taking: (Signs And Symptoms Of Patient):**Symptoms:**

1. Age
2. Gender
3. Occupation
4. Pain – severity
5. Analogue scale (from 0 to 10): 0- no pain
6. <5- mild pain
7. >5- moderate pain
8. 10- Severe pain
9. Duration of pain: in days/months/years
10. Site of pain: anteromedial/ posteromedial/ anterolateral/ posterolateral
11. Type of pain: throbbing/ shooting/ burning/ dull aching/ compressive/ other
12. Aggravating factors of pain: standing/ walking/ sitting/ squatting/ floor sitting/ namaz position/ cross legged sitting/ climbing up and down stairs/ claudication distance (after few minutes of walking)
13. Relieving factors of pain: rest/ hot water fomentation/ cold sponging/ medicines/ others
14. Walking distance in meters (without pain)
15. Standing time in minutes (without pain)
16. Morning stiffness
17. Restrictions of routine activities (due to pain) like: walking/ standing time/ stair climbing/ cross legged sitting/ squatting/ floor sitting (rituals)/ namaz position
18. Medical history: Hypertension/ Diabetes Mellitus/ hypo or hyper thyroid/ gout/ rheumatoid arthritis/ vitamin D or calcium deficiency/ menopause age/ others.
19. Surgical history like hysterectomy or any other surgical process undergone in past.

20. Bending of knees upto _____ °.
21. Knee locking: yes / no (if yes- how many times a day/week?) Mac murry's test- +ve/-ve.
22. Other joints involvement: yes / no. (if yes, mention the joints)

Signs:

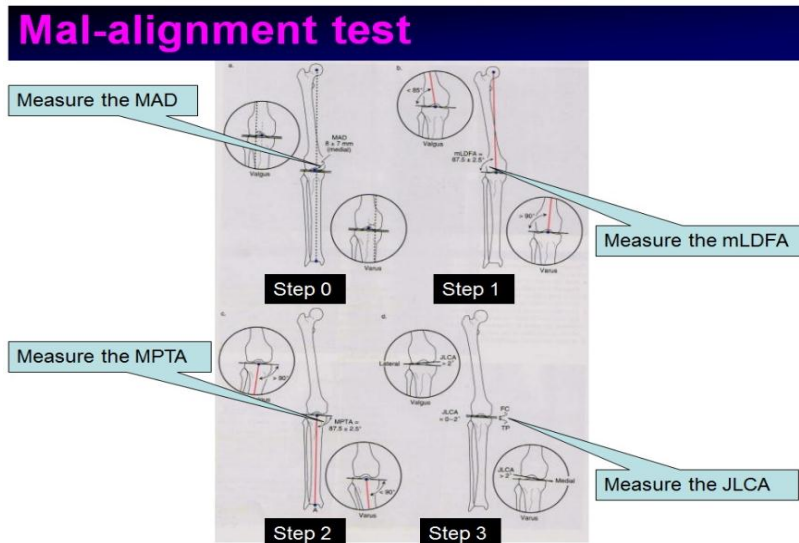
1. Height
2. Weight
3. Swelling: Patellar Tap Test, Cross Fluctuation, Synovitis +nt or not.
4. Tenderness: medial/ lateral/ posterior/ over the joint line.
5. Appearance of bone: bow knee/ knock knee/ tibia vara.
6. Range of motion: in degree by Goniometer- flexion/ extension.
7. END feel- hard/ firm/ soft. (feeling of restricted end range motion)
8. Crepitation- during flexion/ extension/ both/ at what fixed angle.
9. Knee joint laxity- varus/ valgus, anterior/ posterior.
10. Muscle power:
11. by manual muscle testing: grade: 1/-2/+2/-3/+3/-4/+4/5.
12. Hip Joint – Flexor, Extensors, Abductors, Adductors, Internal & External Rotators.
13. Knee Joint ; Flexors, Extensors, Vastus Medialis Oblicus.
14. Ankle Joint : Dorsi Flexors, Planter Flexor. a
15. Extensor lag.
16. Patellar gliding test.
17. Extension stress test.
18. Gait: waddling/ limping on side/ wide base of support.

Fugisawa point:

The center of the knee to the lateral cortex is considered as a lateral compartment and it is divided from 0% to 100%. Now the area between 30% to 40% is considered as 'fugisawa point'.

Restoration chart: (Post operative):

1. No medial articular surface lost= mechanical axis is passing through the centre of the knee.
2. 1/3rd articular surface lost= mechanical axis should pass through 30% of 'Fugisawa'.
3. 2/3rd articular surface involved= mechanical axis should pass through the 'Fugisawa' point actually. (35%)
4. More than 2/3rd articular surface is involved= mechanical axis should pass through 40% of 'Fugisawa' point.

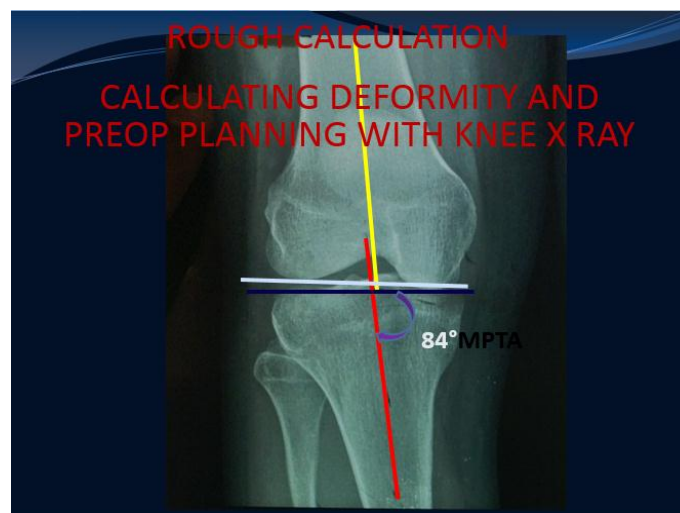
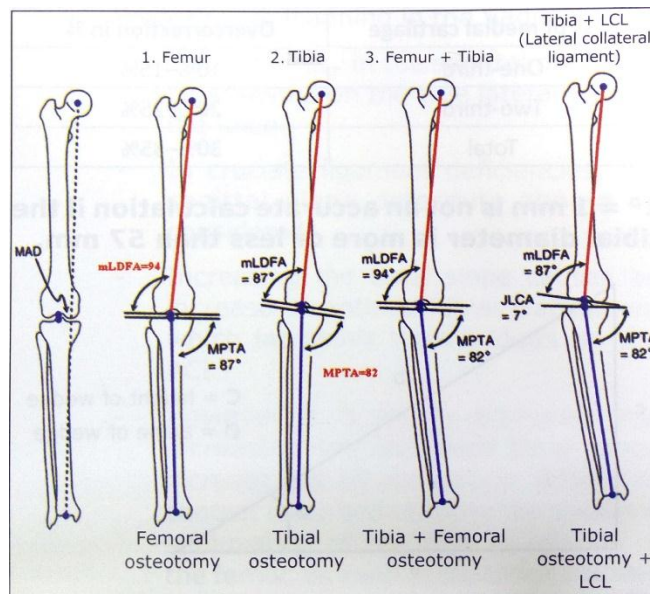
Mal alignment test:

1. Step 0: Draw a joint convergent line of femur and tibia.

2. Step 1: Draw a mechanical axis of femur from the center of the head of femur to the center of the knee joint and measure mechanical lateral distal femoral angle, which is on an average 88° .
3. Step 2: Draw a mechanical axis of the tibia from the center of the knee to center of the ankle and measure medial proximal tibial angle, which is on an average 87° .
4. Step 3: measure the angle between joint convergent line of femur and tibia which is on an average upto 2° .

Involvement Of Bones In Deformity:

1. When MLDF angle is less or more than 88° , then femur is involved in the deformity.
2. When MTPA is less or more than 87° , tibia is involved.
3. If both the angles- distal lateral femoral angle and medial proximal tibial angle are changed than average angle, then both the bones (femur and tibia) are involved.
4. When tibia is involved and joint convergent line are grossly differ, then there is possibility of involvement of ligaments [LCL].

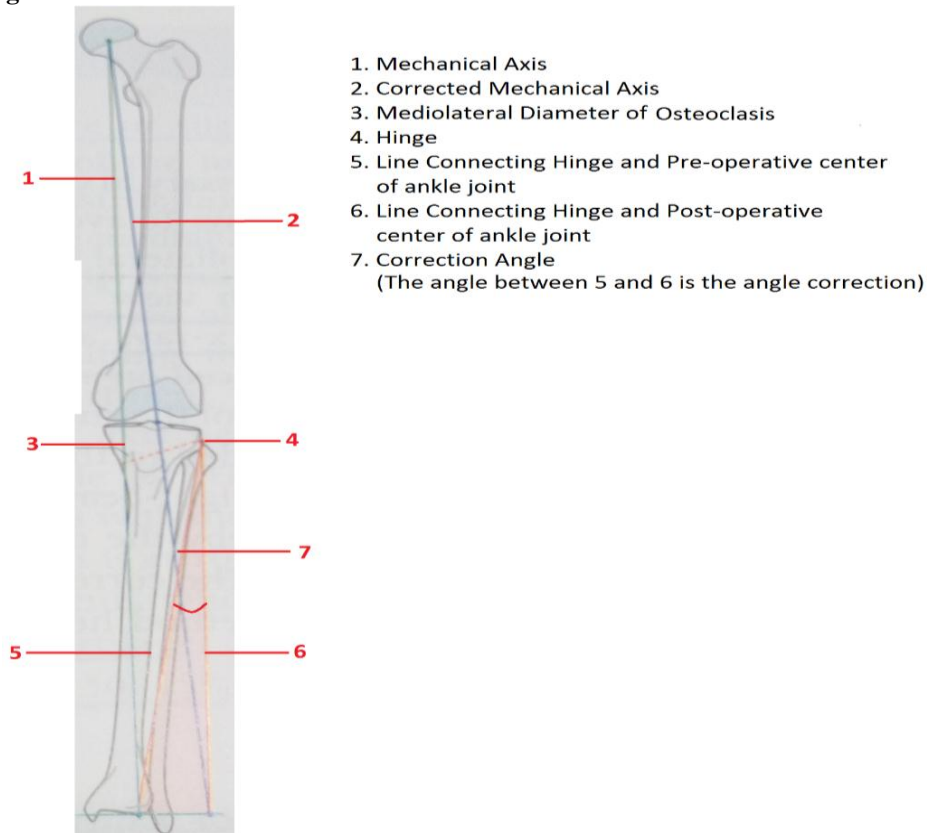


Measurement with calculation:

1. Ideal AP view with weight bearing following are the criteria the person should on single leg with patella face forward, for which you have to catch patella between index finger and thumb and camera must be 305 cms away from knee joint. One has to rotate the foot externally or internally in such a way that patella face forward and camera should be parallel to knee joint and then tilt 5° downward inclination will give correct AP view.

2. If 57 mm is the diameter of tibial articular surface, then $1^\circ=1$ mm is the rough calculation. But if the diameter is less/more than 57 mm, then Pythagoras theorem has to be applied.
3. Draw a joint convergent line of tibia and mechanical axis of tibia drawn on x-ray then measure medial proximal tibial angle. E.g. here it is 84° , then $87^\circ-84^\circ=3^\circ$, 3° of deformity + 7° (valgus over correction) = 10° (total correction needed).
4. $10^\circ=10$ mm, so we have to take 10 mm wedge. $1^\circ=1$ mm is not an accurate calculation if the tibial diameter is more or less than 57 mm. If the diameter is more or less than 57 mm, then calculation is to be made by Pythagoras theorem. $c^2 = a^2 + b^2 - 2ab \times \cos \theta$.

From Long Leg Film:



There are three methods of pre-operative planning in the frontal plane: Miniaci method, Dugdale and Noyes method, Coventry method.

About Curis Data Science:

The Restoknee has collaborated with the “Curis Data Science”, LLC based in Louisville, KY, USA (specializes in 3D reconstruction and printing of body organs) to 3D print models of the patient’s knee joint prior to surgery for accurate surgical planning which also serves as excellent resource for patient education. This collaboration maybe one of the first instance in India where surgical planning and patient education is carried out by way of 3D printing the actual body organ.

In the era of information science, ‘CURIS’ is committed to provide precise and meaningful clinical data science services to its clients so they can achieve their goals in clinical and outcomes research, clinical quality improvement, clinical data analytics and academic medicine.

This document outlining certain measurements from the 3D model of the knee joints is provided per your request. The 3D models were generated based on the CT scan images received. The computer model and the printed model which have already been provided are the most accurate source of measurements. Please refer to the table below for measurements of each patients.

All the measurements are in Millimeters. Patient names are provided as initials to secure privacy. Patient date of model creation and laterality of limb are not provided to secure privacy.

No.	pt	Thickness of Articular Cartilage Medially	Thickness of Articular Cartilage Laterally	Medial to Lateral Diameter Tibia
1	GS	-	8	63
2	bk	2	2	66
3	bd	-	4	73
4	prb	-	6	69
5	hs	1	3	67
6	rps	1	8	73
7	ks	-	3	79

[Here is a table from 'Curis Data Science' of our short series of seven cases of pre-operative assessment]

The femoral medullary canal was approximately 13-18 millimeters proximal to the femoral articular surface. The measurement of medullary canal is an estimate and actual measurement and position may vary. Clinical coordination is required for accuracy. We have gone in more details by doing pre-operative high resolution CT scan of knee which was sent to "Curis data science", USA for preparing genuine model of knee and other details, which



3D model AP view



3D model lateral view

are as follows:

1. Diameter of tibial articular surface
2. Thickness of articular surface in medial and lateral compartment and its involvement
3. Depth of femoral medullary canal in lower end.
4. Condition of articular surface of femur and tibia.

These all data were done for perfection.

1. When tibial diameter is 57 mm, then our calculation is $1^\circ = 1$ mm height of the wedge; but when diameter is less than 57 mm, then with rough calculation one will get over correction and if the diameter is more than 57 mm, then with rough calculation one will get under correction. So measurement of diameter of tibial articular surface differs, then we have to calculate by Pythagoras theorem.
2. Thinning out of articular surface in medial compartment is to be confirmed and measured thickness to look for improvement after surgery. How much articular surface becomes thick due to restoration surgery at the end of six months and one year after surgery, which really shows improvement due to restoknee surgery.
3. To know the end of medullary canal of femur to decide for lateral cut in the femoral cortex to decompress intra medullary pressure. When we do this cut, a fluid comes out from the cut portion of the femur which suggest that patient is going to improve from throbbing pain of arthritis.

4. The decision should be taken for putting lateral cut on lateral cortex of femur depends on this findings. Because when we put cut, it should open out medullary canal of femur to decompress for increased intramedullary pressure so proper end of medullary canal is very important. At times when you open out medullary canal, some fluid comes out which suggests that canal is nicely decompressed and throbbing pain is post-operatively relieved.
5. To know the condition of articular surface and its changes following surgery, there will be unknown vascularity improvement which suggests healing of the damaged articular surface and for shifting M.A. towards lateral side in Fugisawa point.
6. The condition of articular surface of tibia and femur are confirmed. This finding is more important in post-operative period to confirm the changes produced due to unknown vascular changes after restoration surgery. This will improve healing of damaged articular surface.
7. By enlarge, when case is complicated then we use to perform surgery on prepared 3D model as shown in above figures.

Conclusion:-

After getting accurate Curis Data, the perfection in our restoknee surgery is much increased. The exact site of the end of femoral medullary canal is 1.3 to 1.8 cm from articular surface and we are doing perforation of femur from lateral cortex 1 cm proximal to intercondylar notch so we are never missing the madulary canal and because of proper perforation, it always decompress. The exact diameter of tibial articular surface in actual size, so when we are counting by Pythagorus Theorum, we get proper height of wedge so there will be perfect removal of wedge from subchondral bone, so you will get exact thickness of articular surface in medial compartment as well as involvement of articular surface 0, 1/3rd, 2/3rd or more than 2/3rd will be prior to surgery you come to know. So you can perform surgery as such that mechanical axis will pass through the ‘Fugisawa Point’. Pain totally disappears and medial articular surface is devoid of load and it regrows well. Roughly speaking and according to Professor Koshino in 1½ years post-operatively, the articular surface will become 1½ times thicker than pre-operative status. So when you repeat the Curis Data after 1 or 1½ years, you will get exact thickening of articular surface which clearly suggest improvement.

So Curis data will give 100% proof of benefit of restoknee surgery when it is done pre and post-operatively.

Preliminary report of patients operated after receiving data from ‘Curis data science’ : (photographs)





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