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Title: Subtalar Joint Compensation using Full-length Standing Lower Extremity Anteroposterior Radiograph after Total Knee Arthroplasty for Varus Osteoarthritis with 2-year Follow-up: A Retrospective Study (Level of evidence III)

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Conflict of Interest

- Nothing to Disclose



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Introduction

- The mechanical axis is conventionally used for evaluating the alignment of the lower extremity during total knee arthroplasty (TKA).
- There is currently no consensus on knee alignment and hindfoot alignment correlation and the changes between them after TKA
- This study aims of comparing pre- and post-TKA measurements up to 2 years follow-up using the conventional mechanical axis to the of hip-to-calcaneus angle (HCA) and using tibia-calcaneus angle (TCA) as a measure of subtalar compensation to see the changes that happens to the subtalar joint over time.



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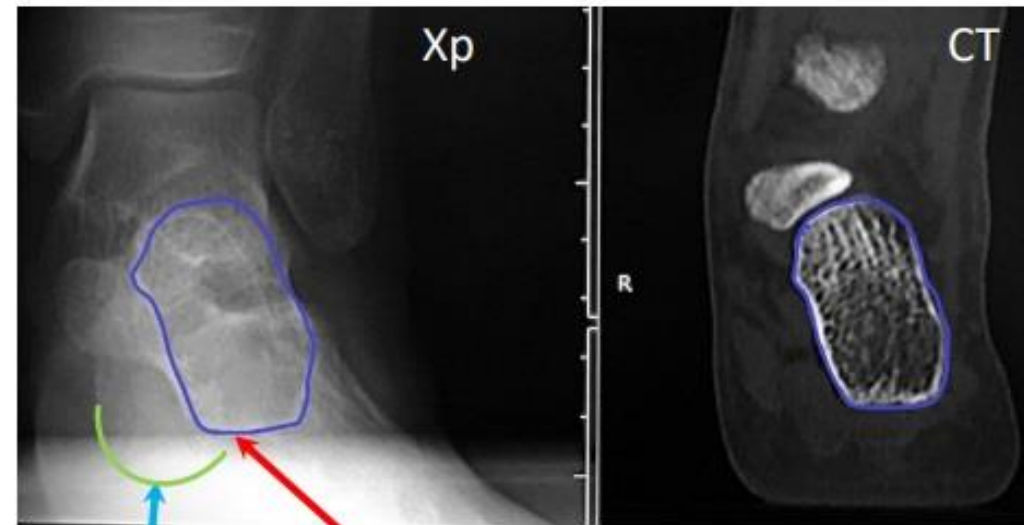
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Objectives

- To determine the compensatory function of subtalar joint to varus knee osteoarthritis pre- and post-total knee arthroplasty by using the clear calcaneal contour as reference point in measuring the HCA and TCA.

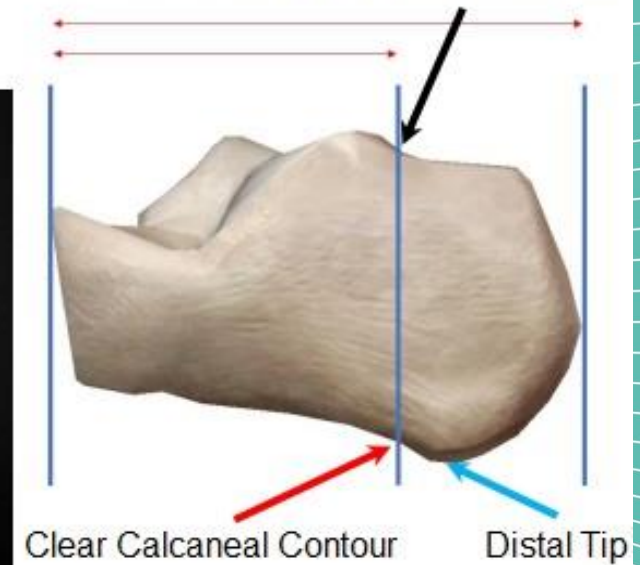
Clear Calcaneal Contour

A clearly defined line in the AP view which indicates the 66% position from anterior which is closer to the tibial axis than the most distal point of calcaneus



Distal tip of Calcaneus Clear Calcaneal Contour

Load Line in Lateral View



Ueno, Tanaka et al. Jap Soc of Foot Surgery 2-5-20



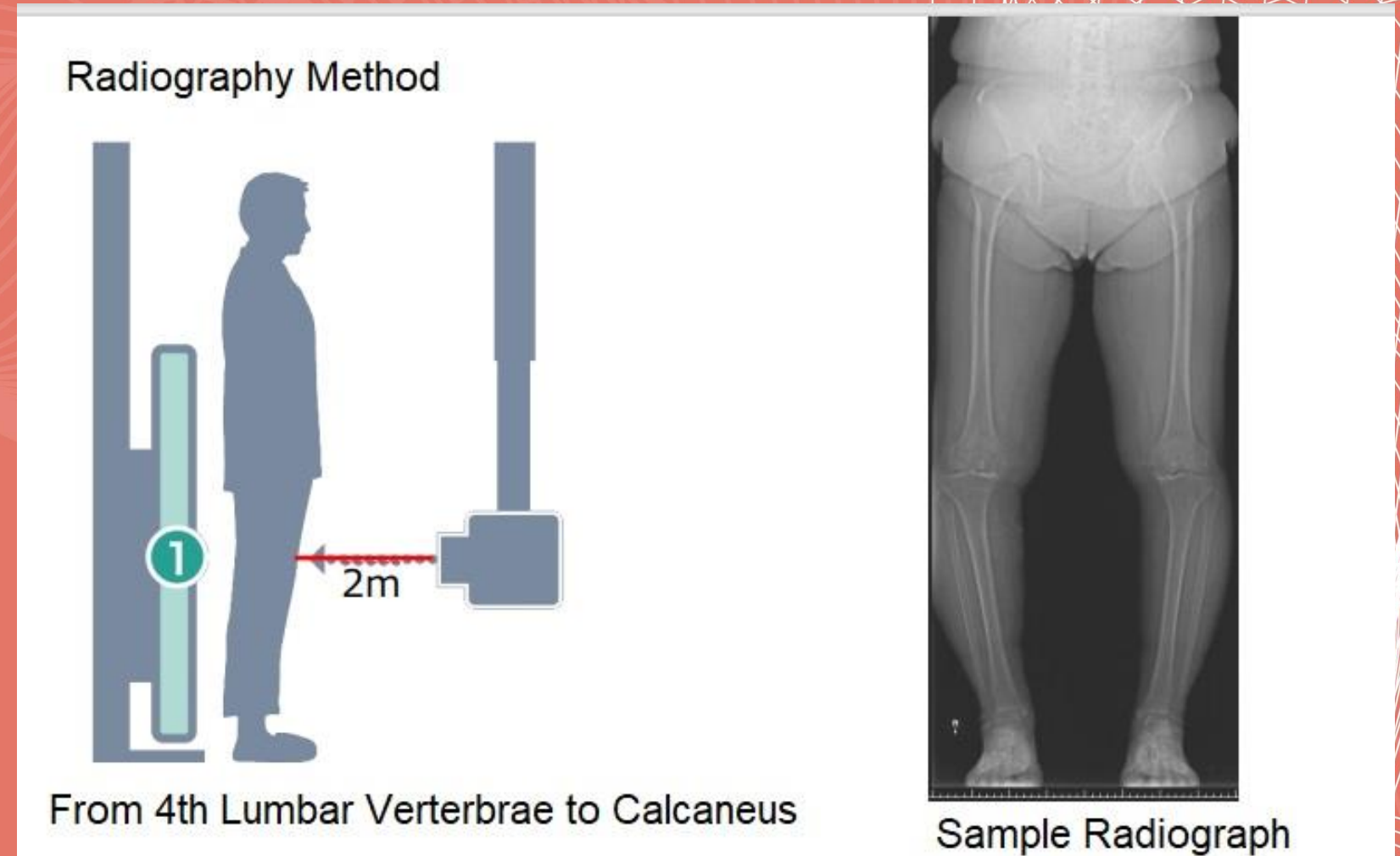
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Study Design and Methods

- Full-length standing lower extremity anteroposterior radiographs were used to define the reference points and determine the mechanical axis (MA) of the lower extremity, hip-to-calcaneus axis (HCA), and tibia-calcaneus angle (TCA) pre-TKA, post-TKA first follow-up, 1-year post-TKA, and 2 years post-TKA.

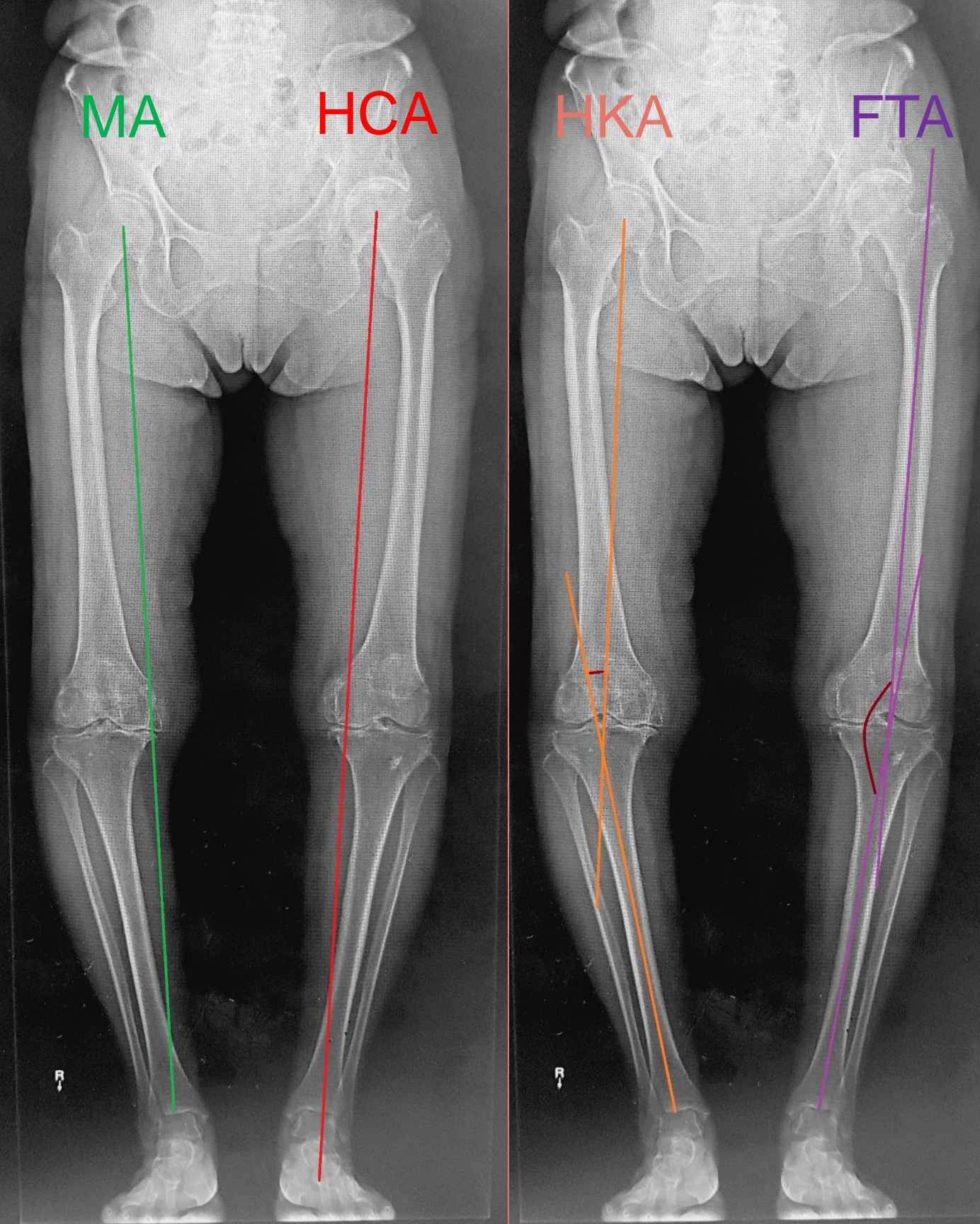


Study Design and Methods

- **Mechanical Axis (MA)**
 - Center of femoral head to center of tibial plafond
- **Hip-to-Calcaneus Axis (HCA)**
 - Center of femoral head to clear calcaneal contour
- **Hip-Knee-Ankle Angle (HKA)**
 - Angle between the mechanical axes of the femur and the tibia
- **Femorotibial Angle (FTA)**
 - Angle formed by the intersection of anatomical axes of the femur and tibia

The distance from lateral tibial plateau to the MA, HCA, and HDC lines bisecting the tibial plateau was recorded and expressed as percentage.

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Study Design and Methods

- Tibia-Calcaneus Angle (TCA)

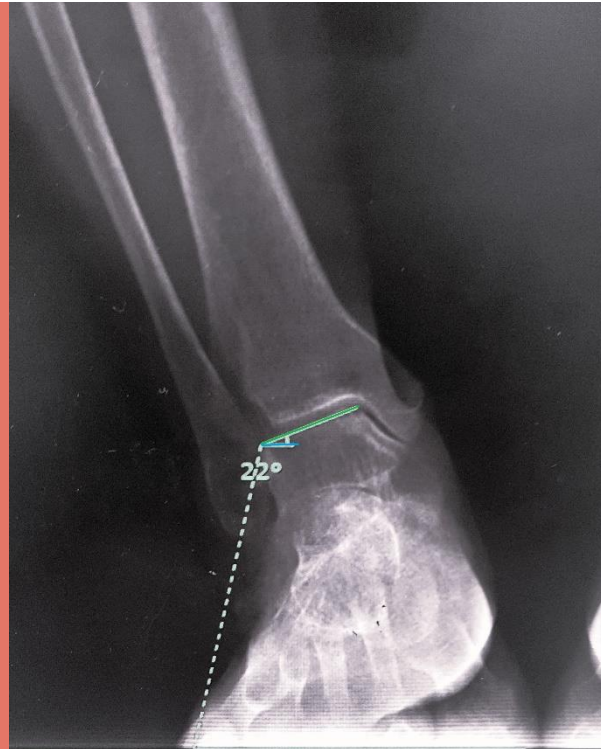
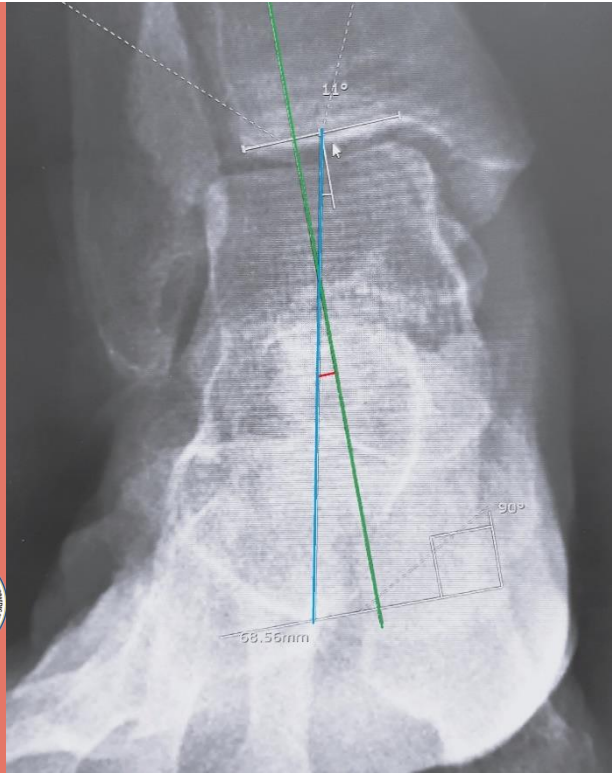
Angle formed from the anatomic tibial axis line bisecting the line from the center of tibial plafond to the clear calcaneal contour

- Ankle Joint Line Orientation (AJLO)

Angle between the tangent to the subchondral plate of the talus and the horizontal grid line on radiographs

- Talar Tilt (TT)

Angle between the talus and the distal tibia



Inclusion Criteria

Patients diagnosed with varus osteoarthritis of the knee (Kellgren-Lawrence grade III to IV)

Patients with full-length standing lower extremity anteroposterior (AP) radiographs

Patients that underwent TKA in Nara Medical University Hospital from year 2016-2020 under one Orthopaedic surgeon (more than 20 years experience in doing TKA)

Patients with at least 2 years follow-up

Exclusion Criteria

Excluded:

61 Patients (61 Knees)
Previous Hip surgery (7)
Previous Knee surgery (1)
Previous Ankle surgery (3)
Revision TKA (5)
Rheumatoid Arthritis (10)
Valgus Knee (14)
Incomplete Data (21)

106 Patients
(116 knees)

45 Patients
(55 Knees)
included



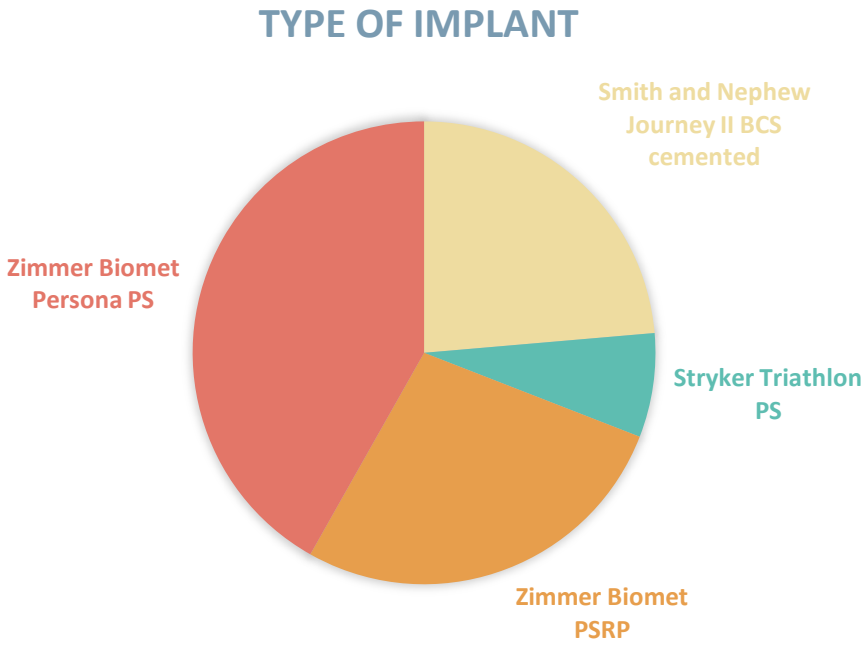
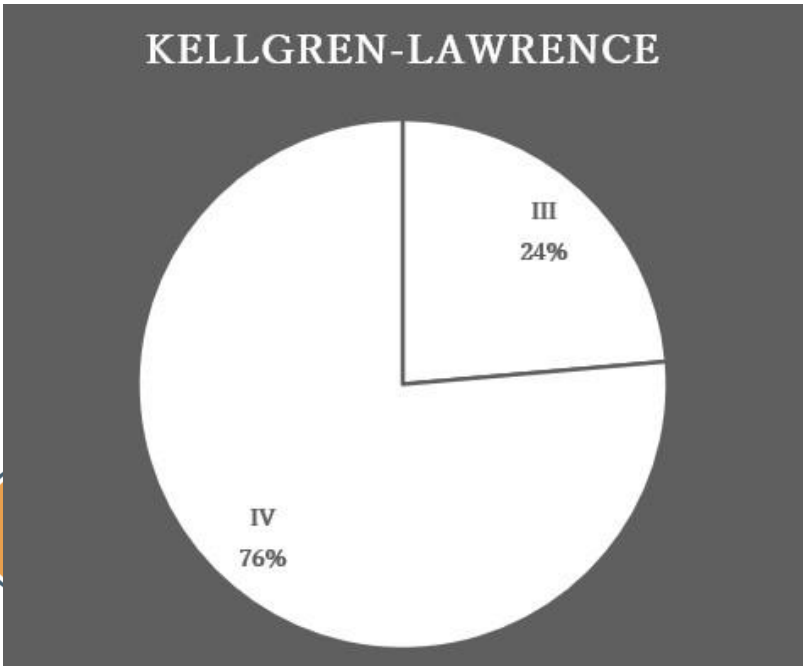
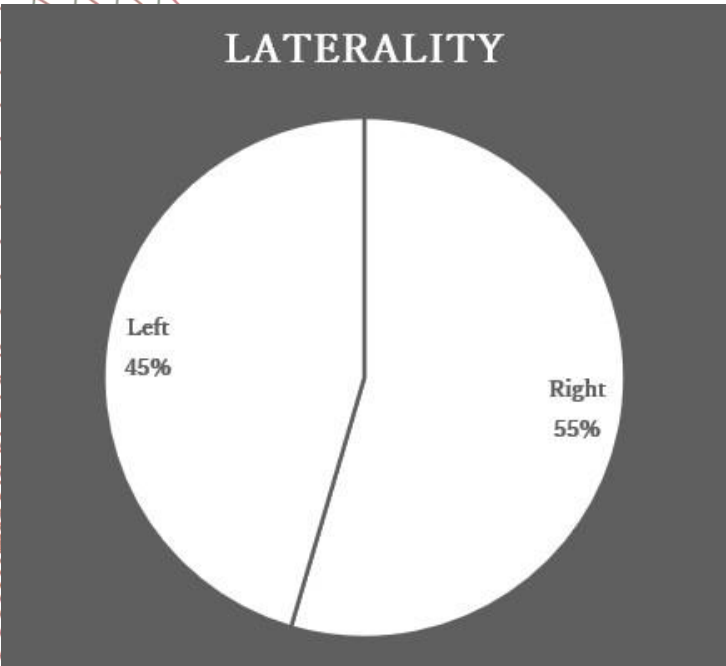
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Results: Demographic Data

	Single	Bilateral	Total
Patients, n (%)	35 (89)	10 (11)	45 (100)
Age, mean (SD)	74 (7)	77 (6)	75 (7)
Female, n (%)	28 (80)	8 (80)	36 (80)
Height (m), mean (SD)	1.53 (0.08)	1.55 (0.05)	1.54 (0.07)
Weight (kg), mean (SD)	63.61 (12.85)	60.09 (7.33)	62.39 (11.21)
BMI, mean (SD)	26.94 (4.55)	24.86 (2.61)	26.18 (4.06)

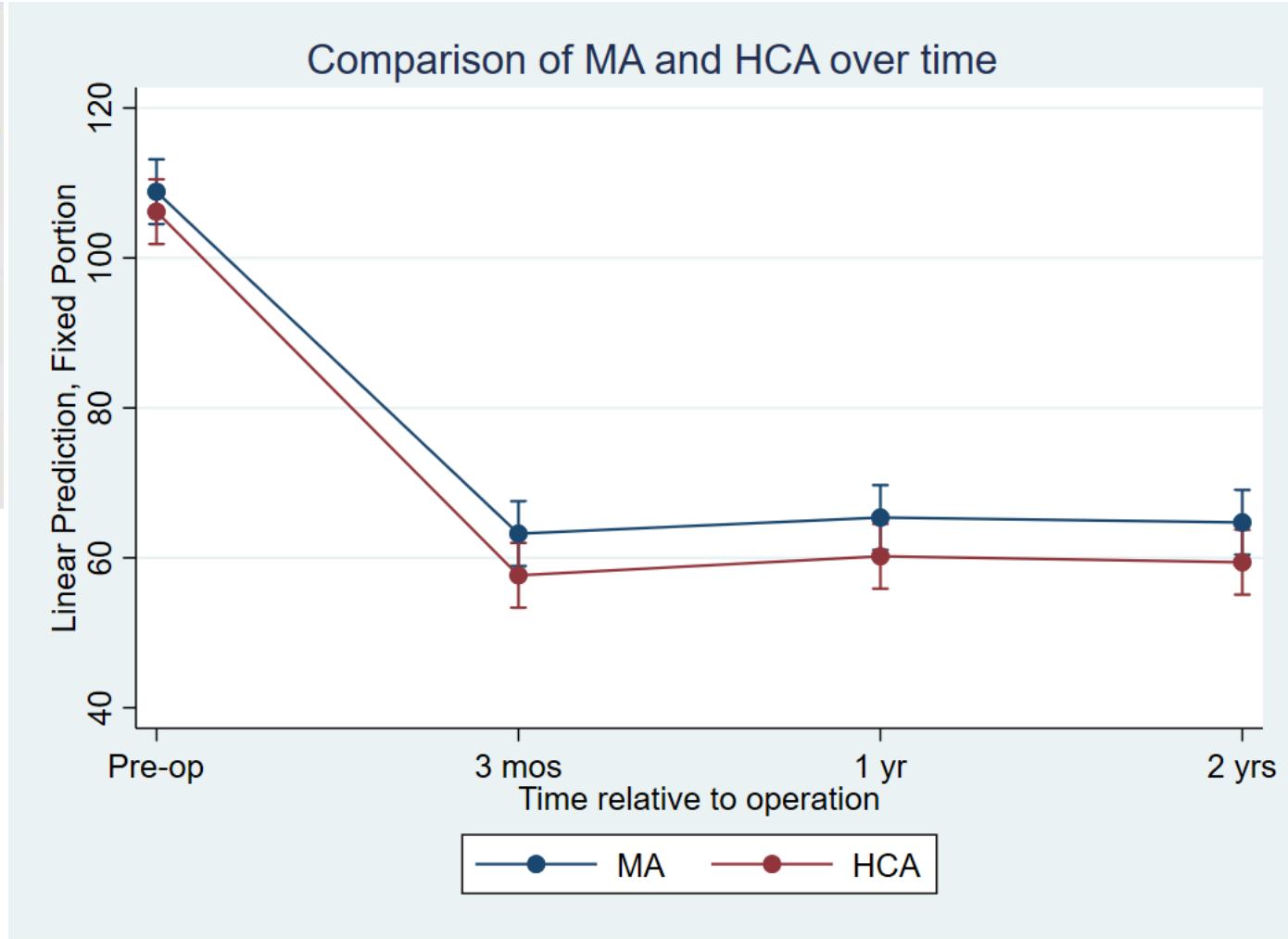
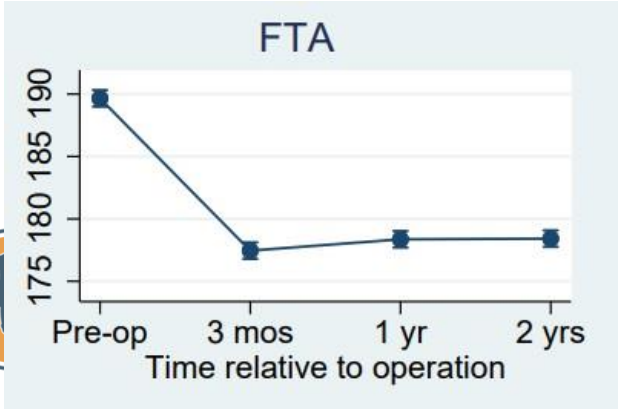
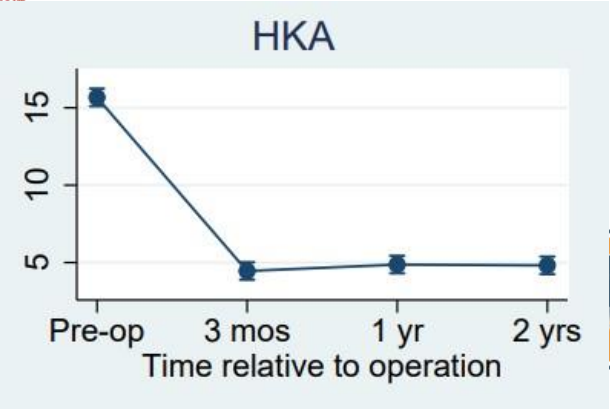


Line graph comparing MA and HCA over time

Mixed model regression analysis showed that HCA had similar trend in the line graph with preoperative values of HCA (107%) compared to MA (109%) and had HCA values (58%, 61%, 60%) compared to values of MA (64%, 66%, 65%) post-op, 1st year, and 2nd year post-op respectively.

These findings coincide with the results of HKA from pre-op value of 15.67 varus which significantly dropped to post-op 4.45 varus with slight increase to 4.87 varus at 1st year post-op and plateaus at 4.82 varus 2nd year post-op. A similar trend was also seen from the results of FTA from pre-op value of 189.65 varus which significantly dropped to 177.45 varus with slight increase to 178.36 varus at 1st year post-op and plateaus at 178.42 varus at 2nd year post-op.

	Pre-op	Post-op	1st year	2 nd year	p-value
	Mean	Mean	Mean	Mean	
MA	109	64	66	65	<0.001
HCA	107	58	61	60	<0.001
HKA	15.67	4.45	4.87	4.82	<0.001
FTA	189.65	177.45	178.36	178.42	<0.001



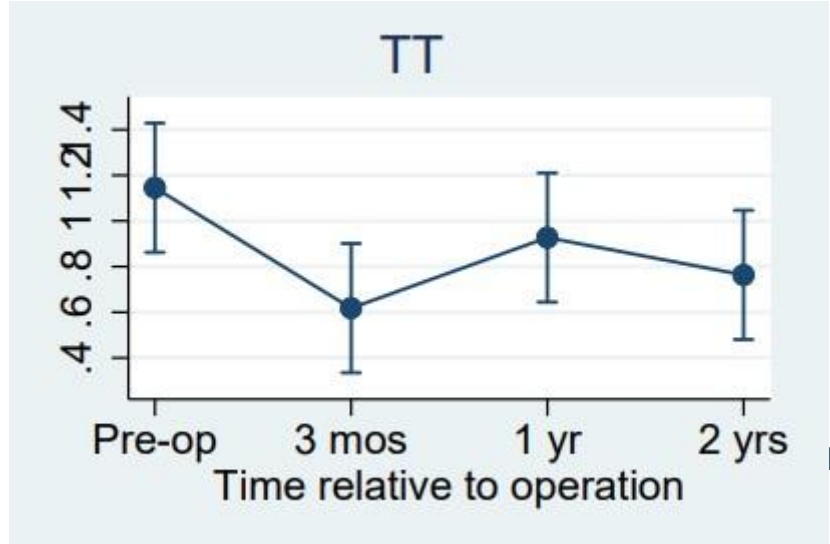
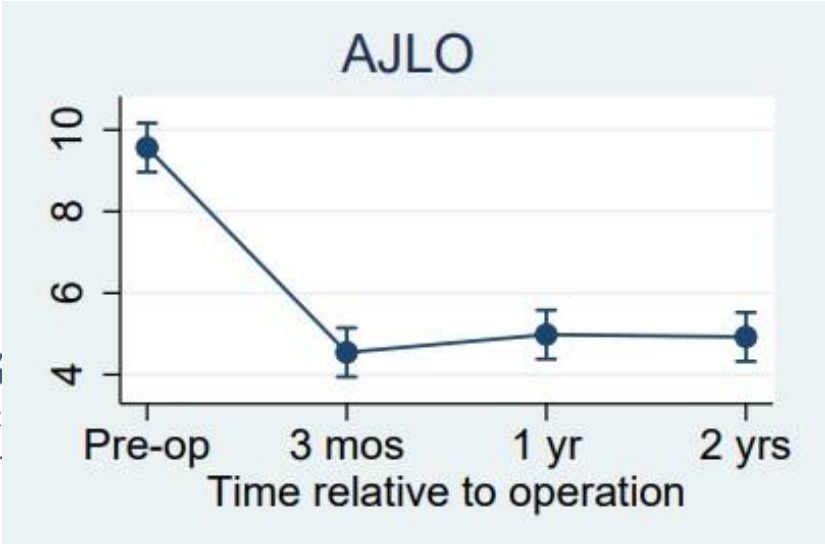
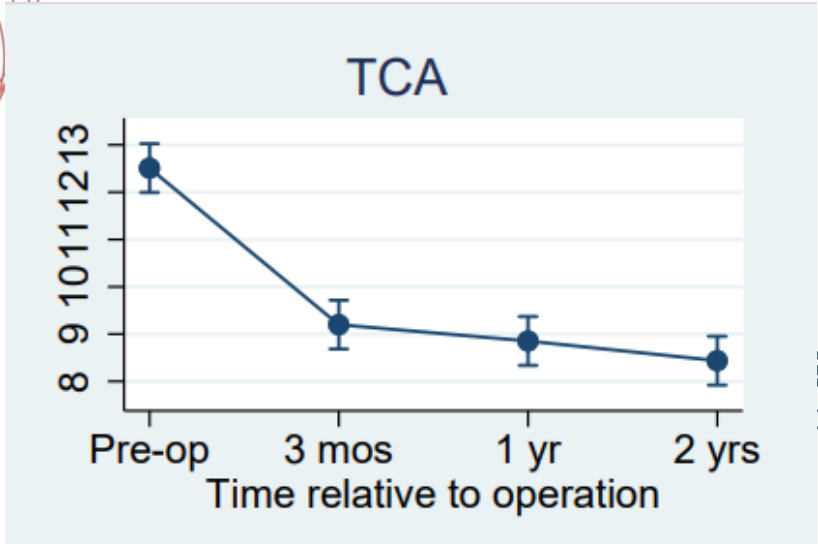
Line Graph showing trend of TCA, AJLO, and TT over time

Results showed mean pre-op TCA of 12.51 degrees which significantly decreased to 9.20 degrees post-op and continued to decrease to 8.85 degrees at 1st year post-op and 8.44 degrees at 2nd year post-op. (9.8 ± 4.1 unpublished data)

Mean pre-op AJLO was 9.56 degrees varus which significantly dropped to 4.55 degrees post-op and had a slight increase to 4.98 degrees at 1st year post-op, and plateaus at 4.93 degrees varus at 2nd year varus post-op.

Mean pre-op Talar tilt was 1.15 degrees which improved and became more horizontal to the ground with values of 0.62, 0.93 and 0.76 degrees post-op, 1st year post-op, and 2nd year post-op respectively but did not reach statistical significance.

	Pre-op	Post-op	1st year	2 nd year	p-value
	Mean	Mean	Mean	Mean	
TCA	12.51	9.20	8.85	8.44	<0.001
AJLO	9.56	4.55	4.98	4.93	<0.001
TT	1.15	0.62	0.93	0.76	0.06



Conclusion

- The findings of this study showed a similar trend in the improvement of MA and HCA with a significant decrease on first follow-up with a slight increase at 1-year post-TKA then plateaus at 2-year post-TKA, these findings also coincided with the improvement of HKA and FTA over time.
- The TCA had a significant improvement from pre-TKA to post-TKA then plateaus on the succeeding years signifying subtalar joint compensation. Once the varus knee is corrected by TKA, the subtalar joint compensates with the deformity and is corrected. These findings are consistent with previous reports.
- The subtalar joint can be measured on the same full-length standing lower extremity anteroposterior radiograph suggesting that it may be useful for evaluating the lower extremity alignment, including the calcaneal loading area.



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Recommendation

- Further prospective study with a greater number of patients is needed to validate the findings of this study on the clear calcaneal contour as reference point in the measurement of lower extremity alignment with interobserver variability.
- It might be better to also include 3D imaging in order to fine tune the radiographic procedure in future studies.

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