ISAKOS CONGRESS 2025 | MUNICH GERMANY June 8–11

Differences in Coronal Plane Alignment of the Knee (CPAK) measured on Long-Leg Radiographs compared to Computed Tomography for the Patients undergoing Total Knee Arthroplasty

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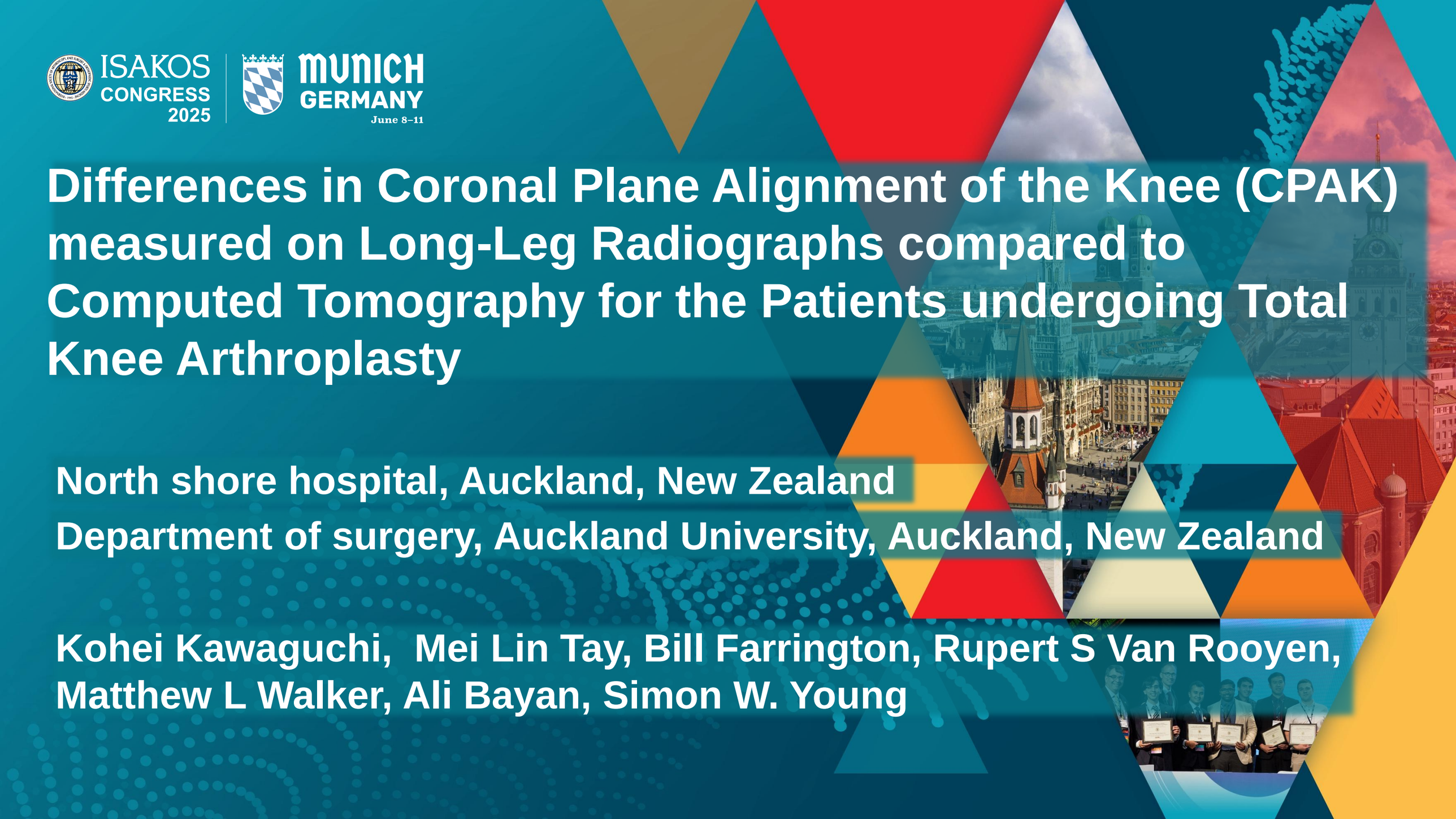

Faculty Disclosure Information

- Nothing to disclosure: Kohei Kawaguchi, Mei Lin Tay, Rupert Van Rooyen
- Other disclosures are

Simon W Young

Auckland Orthopaedics Ltd: Stock or stock Options

Axis Sports Medicine: Stock or stock Options

President New Zealand Knee Society: Board or committee member

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Stryker: Paid consultant; Paid presenter or speaker; Research support

Surgical Solutions: Stock or stock Options

Bill Farrington

Lima: Research support

Smith & Nephew: Research support

Stryker: Research support

Ali Bayan

Lima: Paid presenter or speaker

Matthew L Walker

Stryker: Research support

Background

- Coronal alignment is a critical consideration in TKA
- CPAK (coronal plain alignment knee) classification has widely spread

MacDessi BJJ 2020[1]

Coronal parameters in CPAK MacDessi BJJ 2020

MPTA: Medial proximal tibial angle

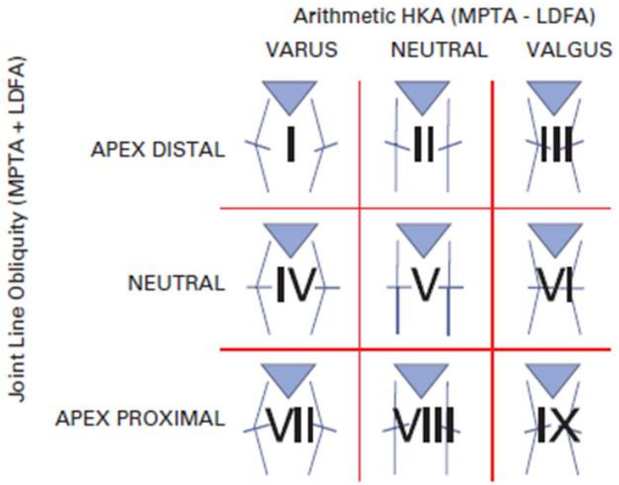
LDFA: Lateral distal femoral angle

aHKA: arithmetic hip knee ankle angle (=MPTA-LDFA)

JLO: Joint line obliquity (=MPTA+LDFA)

CPAK Phenotype

Classify by JLO and aHKA



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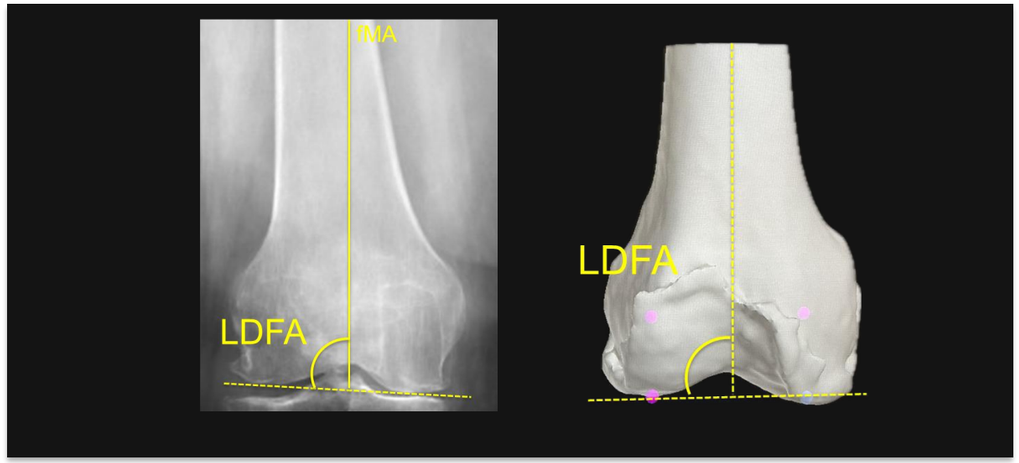
Background

- CPAK measurement algorism has been introduced into CT images, when they performed CT based robotic assisted TKA



Clark JOA 2023[2] Tarassoli KSSTA 2023[3]

Objectives

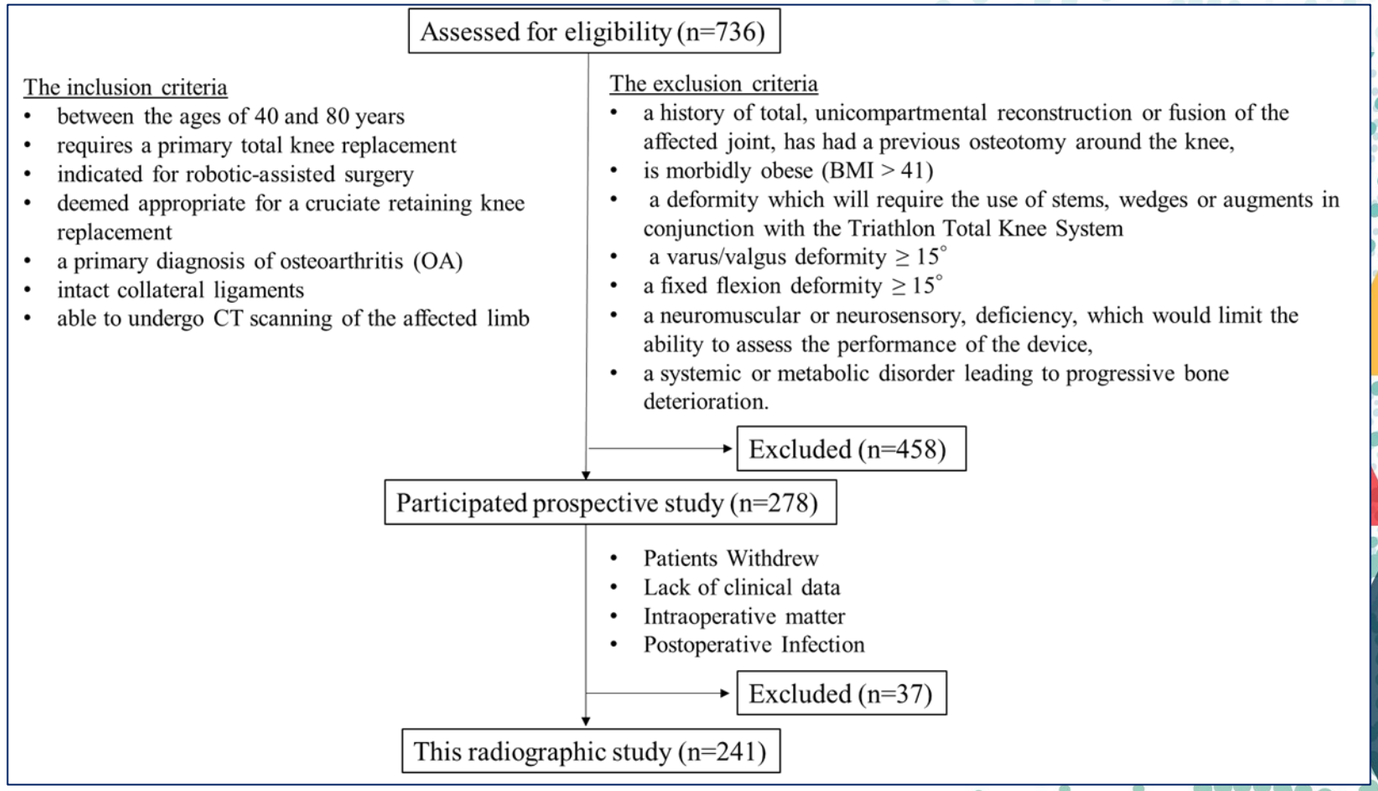
The aims of this study were to compare measurements of CPAK coronal alignment parameters and phenotype distributions using LLR compared with CT in TKA, and to identify reasons for any discrepancies in the CPAK parameters.

Methods

- This was a retrospective subanalysis using data from a prospective randomised controlled trial

Young Trials 2023[4] Young JOA 2025[5]

- All patients (241 knees) underwent robotic-arm assisted TKA using a cruciate-retaining Triathlon knee system (Stryker) at a single institution between November 2020 and December 2022

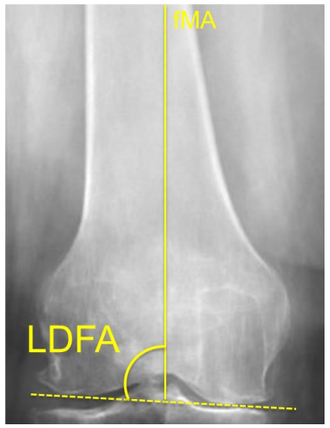


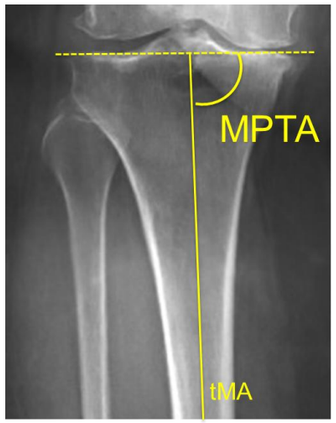
Radiographic study protocol

Radiographic measurement parameters of patients' coronal alignment and classification into the CPAK phenotypes were performed as per MacDessi BJJ 2020[1]

MPTA and LDFA were first measured in both LLR and CT. JLO and aHKA were calculated as JLO = MPTA + LDFA, aHKA = MPTA – LDFA. Knees were classified into CPAK phenotypes I~IX according to the aHKA and JLO values, with phenotype cutoffs of ± 2º in aHKA and ± 3º in JLO

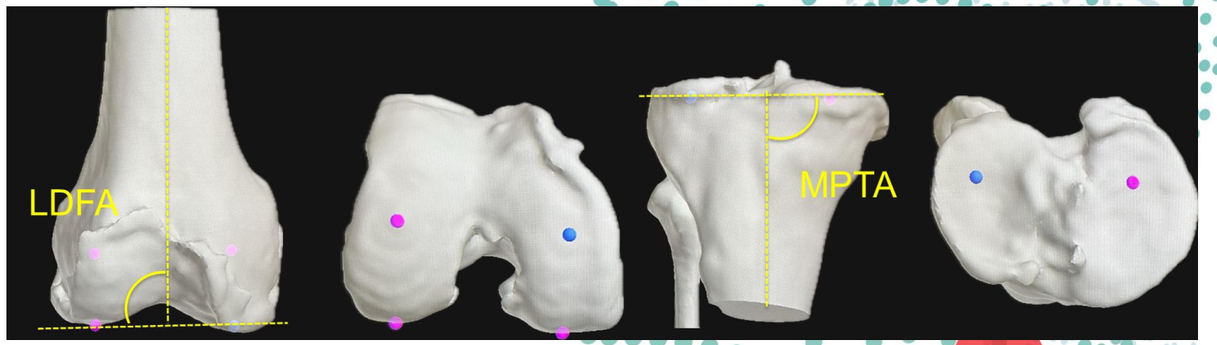
Measurement in LLR





- LDFA was defined as the lateral angle formed between the femoral mechanical axis and the joint line of the distal femur
- MPTA was defined as the medial angle formed between the tibial mechanical axis and the joint line of the proximal tibia

Measurement in CT



- Femoral condylar landmarks were set at the most distal surface of each condyle
- Tibial landmarks, a point two-thirds posterior from the anterior cortex of each plateau (the "66% point") was selected
- MPTA, LDFA were measured using the landmarks and mechanical axis

Statistical analysis

- Paired t-tests were used to assess differences between LLR and CT in MPTA, LDFA, aHKA and JLO

- Correlation of these coronal alignment parameters between LLR and CT was quantified using Pearson's correlation coefficient

- Repeated analysis of variance (ANOVA) was used to assess the parameters among three groups and a Bonferroni correction was applied to correct for multiple testing with an adjusted p value for each comparison

All data and graphical representations were performed using SPSS version 26 (IBM Corp, Armonk, NY, USA), Statistical significance was taken at the 5% level ($P < .05$).

Results

Comparison between LLR and CT in Parameters in CPAK

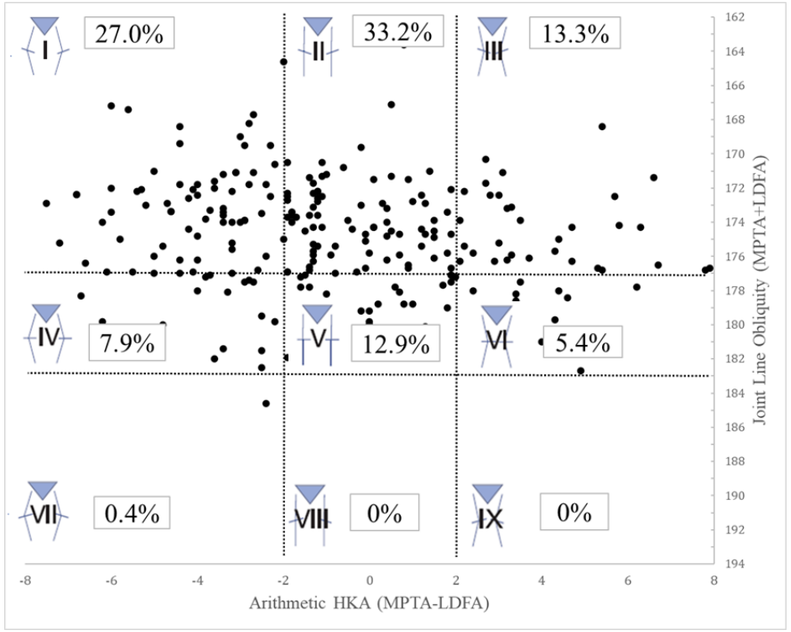
	LLR	CT	P value
MPTA (º)	87.1 ± 2.5	86.7 ± 2.1	<0.01*
LDFA (º)	87.8 ± 2.2	87.2 ± 2.1	<0.01*
aHKA (º)	-0.7 ± 3.3	-0.5 ± 2.7	0.05
JLO (º)	174.9 ± 3.4	173.9 ± 3.1	<0.01*

Average ± S.D.

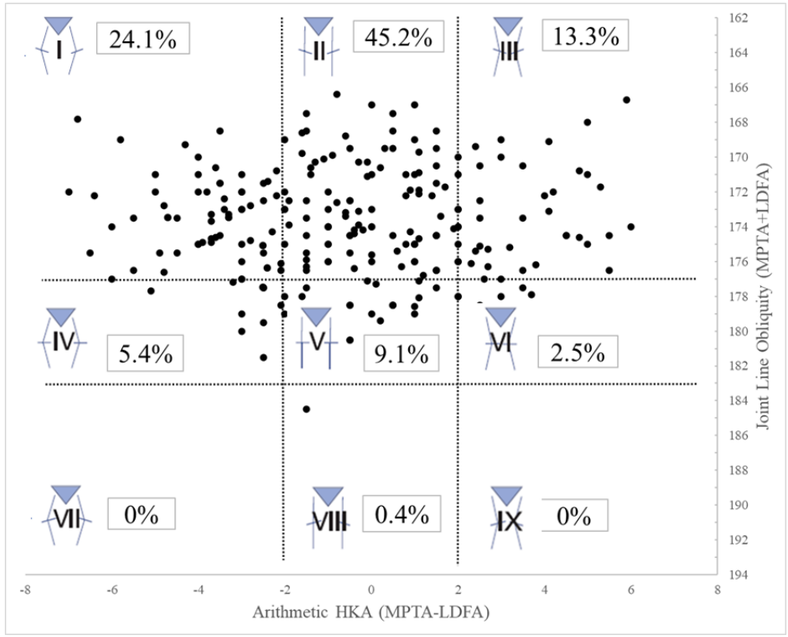
MPTA, LDFA and JLO in LLR were larger than CT

CPAK Phenotype distribution

LLR

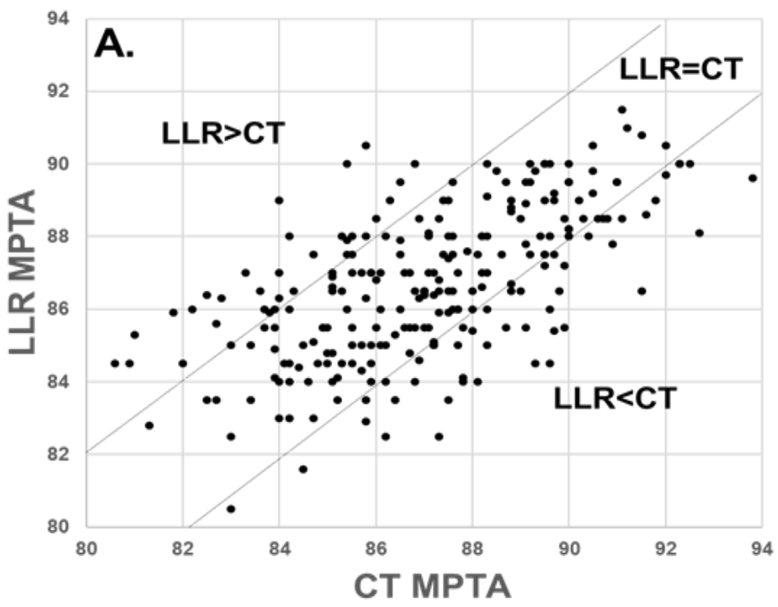


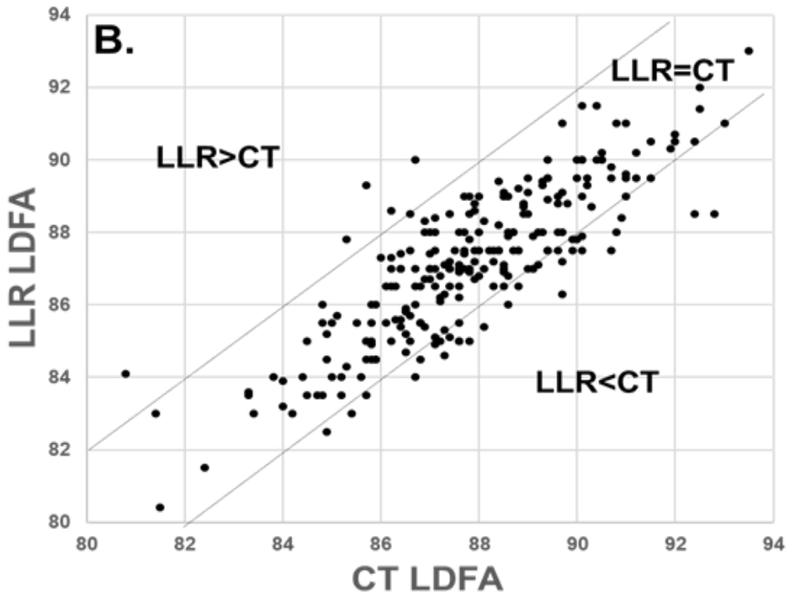
CT



CPAK phenotype	LLR	CT	p value
Apex distal JLO % (n)	73.8 (177)	82.6 (199)	0.01*
Type I % (n)	27.0 (65)	24.1 (58)	0.46
TypeII % (n)	33.2 (80)	45.2 (109)	<0.01*
TypeIII % (n)	13.3 (32)	13.3 (32)	1.00
Neutral JLO % (n)	25.8 (63)	17.0 (41)	0.01*
Type IV % (n)	7.9 (19)	5.4 (13)	0.27
Type V % (n)	12.9 (31)	9.1 (22)	0.19
Type VI % (n)	5.4 (13)	2.5 (6)	0.10
Apex proximal JLO % (n)	0.4 (1)	0.4 (1)	1.00
Type VII % (n)	0.4 (1)	0 (0)	0.31
Type VIII % (n)	0 (0)	0.4 (1)	0.31
Type IX % (n)	0 (0)	0 (0)	—

Results





LLR, long-leg radiograph

CT, computed tomography

A: Plot of medial proximal tibial angle (MPTA) in long leg radiograph (LLR) and computed tomography (CT). LLR=CT area shows the difference within 2°, LLR>CT area shows LLR value was more than 2° larger than CT value, CT>LLR area shows CT value was more than 2° larger than LLR value in MPTA.

B: Plot of lateral distal femoral angle (LDFA) in long leg radiograph (LLR) and computed tomography (CT). LLR=CT area shows the difference within 2°, LLR>CT area shows LLR value was more than 2° larger than CT value, CT>LLR area shows CT value was more than 2° larger than LLR value in LDFA.

Characteristics of three groups according to difference between long-leg radiograph (LLR) and computed tomography (CT) in medial proximal tibial angle (MPTA)

MPTA	LLR > CT	LLR = CT	LLR < CT	p value
Knees	52 (21.6%)	159 (66.0%)	30 (12.4%)	
LLR MPTA	89.0 ±2.2*†	87.0 ±2.2*‡	84.0 ± 1.7†‡	<0.01*†‡
CT MPTA	86.0 ± 2.3*†	86.8 ±2.0*	87.1± 1.6†	0.02*†
age	66.5± 7.7	67.9± 6.7	67.2 ± 9.2	0.45
BMI	31.9 ±4.7	30.8 ±4.7	31.9 ±4.9	0.27
Preoperative Extension angle	6.1± 9.5	4.3± 5.4*	8.3 ± 5.3*	0.03*
Preoperative Flexion angle	130.3 ±8.6	129.4± 13.1	126.9± 13.4	0.35
mHKA	179.7± 6.9*†	175.1± 5.1*‡	171.5 ± 4.7†‡	<0.01*†
LLR LFDA	87.3 ± 2.1	88.0 ± 2.1	87.7 ± 2.3	0.11
CT LDFA	86.6 ± 2.0	87.2± 2.1	87.4 ±2.0	0.12

Average ± S.D., *†‡: significant difference (p<0.05)

Coronal knee alignment and flexion contracture were risk factors in the discrepancy between CT and LLR in MPTA

Discussion

- use of either LLR or CT led to differences in measurement of CPAK coronal alignment parameters and phenotype distributions

Tarassoli et al[3]. reported that MPTA was larger when measured using LLR compared with CT, which is comparable to this study

However the proportion of knees where LLR >CT MPTA was only 21.6% and the proportion of knees where LLR < CT MPTA was 12.5%

This suggests that when comparing differences in alignment measurements, these measurements should not only focus on aggregate differences between LLR and CT in MPTA.

- Preoperative coronal knee alignment and knee flexion contracture were identified as reasons for the MPTA discrepancies between LLR and CT

We recommend that surgeons should pay attention to discrepancies between LLR and CT for patients who have moderate coronal knee deformity or knee flexion contracture when evaluating coronal knee alignment using MPTA

Conclusions

- Differences in the CPAK parameters and the CPAK phenotype distributions were found when comparing measurements performed using LLR versus CT.
- Coronal knee alignment and knee flexion contracture were associated with differences in MPTA measurements

References

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