Association between Prosthetic Component Malalignment and Post-Total Knee Arthroplasty Pain

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1. Background

Osteoarthritis of the knee is an increasingly common condition, and the final line of management, after the exhaustion of conservative treatment, is **total knee arthroplasty** (TKA)[1,2].
20% of those who undergo TKA are **dissatisfied**, often due to ongoing pain[3]. Some degree of this pain is thought to be attributable to component malalignment, which can be investigated on **computed tomography (CT) scans or X-Ray**. Current UK guidelines suggest CT may be used for extra detail, as adjunct[4]. There is a dearth of studies considering the **prevalence of malalignment in patients with pain following TKA.**
Given the **difficult and often complex nature of revision TKA**[3] there is value in knowing **to what extent** component alignment is responsible for pain following TKA, as this may **inform clinical decision making** and establish the value or lack thereof for CT imaging in these patients.

2. Aims

- Evaluate the association between malalignment of prosthetic components and ongoing pain in patients following TKA

- Analyse CT scans of symptomatic patients to evaluate prosthetic malalignment and compare alignment to normal ranges in three axes

- Determine the association between specific types of prosthetic component malalignment and both pain and rates of revision surgery

- Assess the validity and usefulness of current normative values for implant position / alignment in predicting post-operative pain

	Study Cohort [mean (SD)]	Normative [midpoint (range)]	p-value[i]
Tibial Component Rotation (⁰)	21.0 (9.3)	18.0 (-)	0.002*
Patellar Tilt (⁰)	3.7 (4.4)	5.0 (-)	0.003*
Insall-Salvati ratio	0.94 (0.19)	1.0 (0.8 – 1.2)	0.003*
Blackburne-Peel ratio	0.51 (0.14)	0.8 (0.54 – 1.06)	<0.001*
Caton-Deschamps ratio	0.63 (0.16)	0.95 (0.6 – 1.3)	<0.001*

Table 1: Significant Differences from Normative Values on CT (one-sample student's t-test)

4. Results

On X-Ray the **femoral component** was found to be significantly malaligned (3.8⁰ ± 3.3⁰ **flexion**, p=0.014) and on CT the **tibial component** was found to be significantly malrotated (21⁰ ± 9.3⁰ **internal rotation** relative to tibial tuberosity, p=0.002) in the cohort relative to normal values. Measures of **patellar height were significantly low**, though only one mean reached patellar baja: Blackburne-Peel on CT (0.51 ± 0.14, p<0.001).
Between those who did and did not undergo revision surgery, **only one** measurement showed a significant difference: **sagittal femoral angle**, measured on lateral X-Ray (p=0.044).
A significant difference was found between patients who underwent revision (mean 90 months) to patients who were unrevised (mean 61 months) in the **time between their primary TKA and presentation to tertiary knee clinic** (p=0.025).
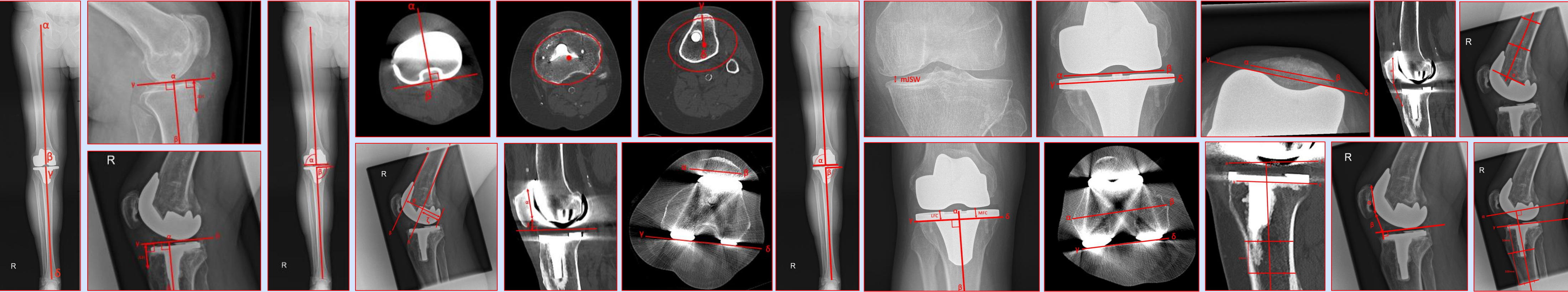

Figure 1: Images of sample Radiological Measurements

3. Methods

A cohort of **107 cases** of **painful primary TKA** was selected from a specialist knee clinic.
These patients were investigated for component malalignment using **CT scans and a standardised series of plain radiographs**.
Images were assessed using a range of established and validated measurements, on CT in **3 axes** and on X-Ray in **2 axes**.
Patients underwent blood tests and had comorbidity scores including ASA and Charlson Comorbidity Index calculated.
Results were compared to **established normative ranges**. Analysis was also conducted comparing patients who underwent revision TKA surgery and those who were unrevised. A sample of measurements used are illustrated in Figure 1.

A total of **24 measurements** for each case were compared to normative values, with **26 measurements** compared between revised and unrevised groups.

	Study Cohort [mean (SD)]	Normative [midpoint (range)]	p-value[i]
Mechanical Axis Deviation (⁰)	1.7 (1.6)	0.0 (-)	<0.001*
Preoperative Joint Space Width (mm)	3.0 (1.3)	1.0 (-)	<0.001*
Figgie Joint Line Height Change (mm)	2.4 (3.5)	8.0 (-)	<0.001*
IJLCM Joint Line Height Change (mm)	1.8 (2.9)	8.0 (-)	<0.001*
Sagittal Femoral Angle (⁰)	3.8 (3.3)	3.0 (-)	0.014*
Blackburne-Peel ratio	0.61 (0.14)	0.8 (0.54 – 1.06)	<0.001*
Caton-Deschamps ratio	0.64 (0.16)	0.95 (0.6 – 1.3)	<0.001*

Table 2: Significant Differences from Normative Values on X-Ray (one sample student's t test)
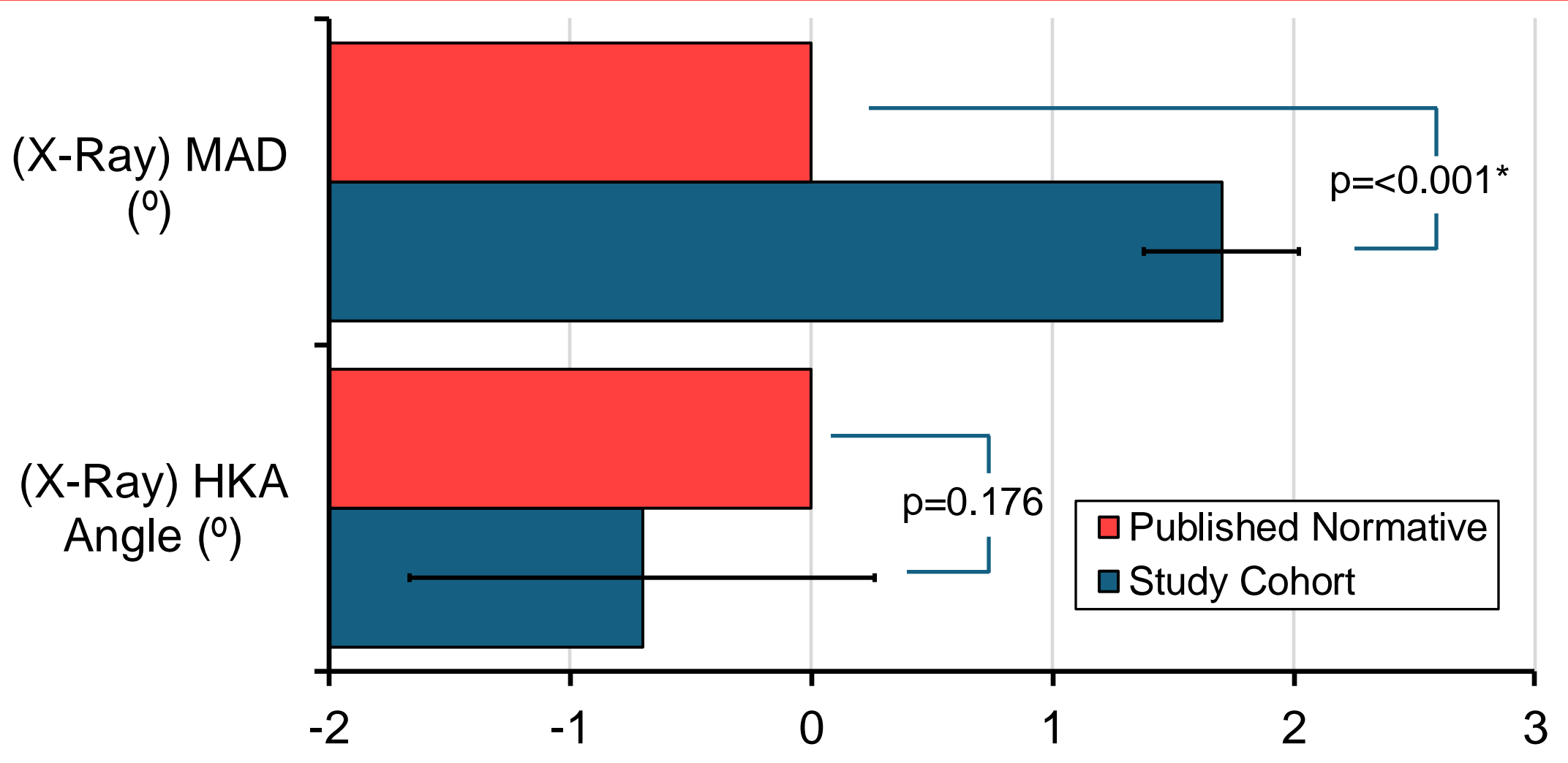

Figure 2: Mean Hip Knee Ankle (HKA) angle and Mechanical Axis Deviation (MAD) compared to Normative Values (95% confidence intervals shown). One-sample student's t-test.

5. Conclusions

- Sagittal femoral angle (*excessive flexion*), tibial component rotation (*excessive internal rotation*) and patellar height (*baja*) are the most significant malalignment variables in patients with pain following TKA.

- CT imaging **and** a standardised series of radiographs (long leg alignment, lateral and skyline) are required to adequately evaluate the radiological measures found significantly malaligned from normal values.

- Sagittal femoral angle (excessively flexed femoral component position) was significantly different in patients who underwent revision TKA surgery as compared to those who were unrevised.

- Further refinement is required for normative ranges of most measures of malalignment in TKA.

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