Hip Length Misrepresents Overall Limb length in up to One in Three Patients

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INTRODUCTION: Post operative leg length discrepancy can be a devastating complication for today's discerning patient as well as to surgeons as it is a litigated complication. Hip length is most routinely used intra-operatively to assess and match the length of the contralateral limb to the operative limb during pre-operative templating, or intra-operatively with the use of technology or imaging. However, hip length does not account for variance in the full limb into consideration. We hypothesize that accurate hip length restoration still results in overall leg length discrepancy in some patients.

METHODS: A commercial joint registry containing annotated CTs for pre-operative THA planning was reviewed. This dataset includes pelvis, knee and ankle bilaterally in all patients. Hip Length (HL) was measured as the perpendicular distance between the pelvic teardrop axis and the corresponding lesser trochanter, projected to the CT Coronal plane (Figure 1). Limb Length (LL) was measured in 3D, through summation of the distance from the pelvic teardrops to knee epicondylar center (femur length), and this point to ankle malleolar center (tibia length). Bilateral discrepancies (HLD/LLD) were calculated as operative minus contralateral (negative=operative short). These measurements were compared across the database, including Pearson correlations to assess for association. For both HL and LL measurements, patients were computationally re-aligned to correct for pelvic skew (transverse/coronal), and femur abduction/adduction, extension/flexion and rotation (Figure 1).

RESULTS: In total, 18,232 patients (53.1% female, mean age: 63.5±11.8, surgeries: Oct-2020 to Apr-2025) met the inclusion criteria with all required 3D landmarks available, and no existing THA/TKA implants confirmed present. Computational alignment of the Pelvis/Femurs resulted in less than 1mm change in HL in 72% of patients, but 2.4% and 0.5% had greater than 3mm and 5mm difference respectively.

Across the cohort, mean HLD and LLD were -2.7±5.4mm and -2.3±7.5mm respectively. LLD was strongly correlated with HLD (Pearson ρ: 0.64 (Figure 2)). Deviations larger than 5mm and 10mm were found between LLD and HLD in 33.4% and 6.5% of patients respectively indicating that correcting for HLD in isolation may leave large limb length discrepancies in a significant number of patients.

DISCUSSION AND CONCLUSION: Measurement of hip length without consideration of overall limb length results in one in three patients with a 5mm or greater functional leg length discrepancy post-operatively, and nearly one in fifteen patients with a 10mm or greater discrepancy. While most patients are well aligned in CT, variance in both HLD and LLD measurements were shown to increase considerably in patients with large misalignments of the pelvis and femurs with 2.4% having greater than 3mm change in HLD after re-alignment. Where a large misalignment is present, the impact on these measurements and whether to utilise a re-alignment algorithm should be carefully considered. A more personalised understanding of the patient's overall limb lengths should be considered when performing THA.

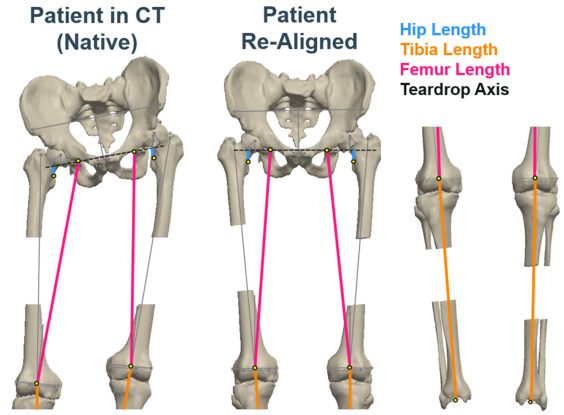

Figure 1: Measurement definitions for Hip, Femur and Tibia lengths, showing patient before and after alignment correction algorithm applied.

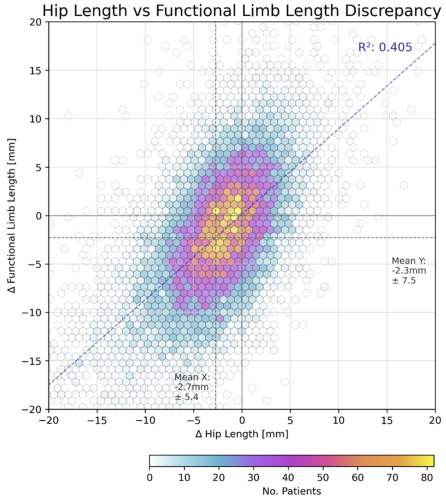

Figure 2: Hip Length vs Limb Length Discrepancies