Coronal Plane Alignment of the Knee (CPAK) classification after Total Knee Arthroplasty (TKA) and Post-Operative Patient Reported Outcomes (PROMs)

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Background

- Arthritic diseases of the knee, such as osteoarthritis, have been shown to significantly impact activities of daily (ADL's) in older adults[1]. Total knee replacements are one of the most common and successful surgeries. The 2021 Annual Joint Replacement Registry documented 1,223,300 primary TKA's between 2012 and 2020[5], while the predicted number of TKA's in the year 2025 is 1,272,000[6].
- It is understood that the most important factor in the durability of a TKA within a surgeons control[3], is the post-operative alignment. One study examined the differences in PROMs between patients who had aligned knees versus patients who had maligned knees following a TKA, with maligned knees denied as knees with an outlying post-operative distal femoral angle (DFA), proximal tibial angle (PTA), and posterior slope angle (PSA). It was determined that there were significant differences in activity levels, satisfaction with ability to perform ADL's, degree of pain relief, and overall knee function between patients with no alignment outliers and patients with one, two or three outliers.
- To provide a more standardized classification system of joint alignment, another study universally applicable new classification system for Coronal Plane Alignment of the Knee (CPAK)[7]. Two variables were used for classification: arithmetic hip-knee-ankle (HKA) angle and joint line obliquity (JLO). The arithmetic HKA was determined by the following equation: medial proximal tibial angle (MPTA) – lateral distal femoral angle (LDFA). The JLO was determined by the following equation: medial proximal tibial angle (MPTA) + lateral distal femoral angle (LDFA). Based on these calculations, the arithmetic HKA was divided into varus (less than -2°), neutral (0±2°), and valgus (greater than +2°). The JLO was divided into apex distal (less than 177°), neutral (180±3°), and apex proximal (greater than 183°). The combination of these categories comprises the nine CPAK classifications.
- Additionally, this study explored the relation of CPAK categories to two alignment techniques: mechanical alignment (MA) and kinematic alignment (KA). Of the two alignment techniques, KA favors 'the recreation of a patient's constitutional (prearthritic) alignment'[7], while MA is generally viewed as less individualized. The study found that more CPAK types benefited from the KA approach over the MA, although the sample size was relatively small
- Our research seeks to further explore and quantify the long-term surgical benefits of maintaining a patients CPAK classification post-operatively, to better inform surgical expectations and improve patient reported outcomes (PROMs)

Methods

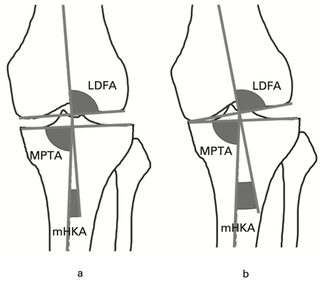

Figure 1. Lateral Distal Femoral Angle (LDFA) and Medial Proximal Tibial Angle (MPTA) measurement acquisition[6]

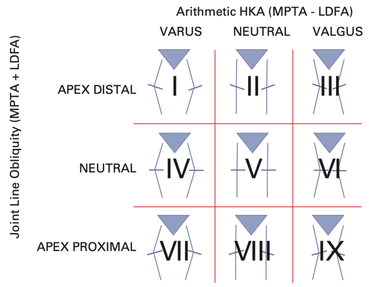

Figure 2. CPAK Classification[6]

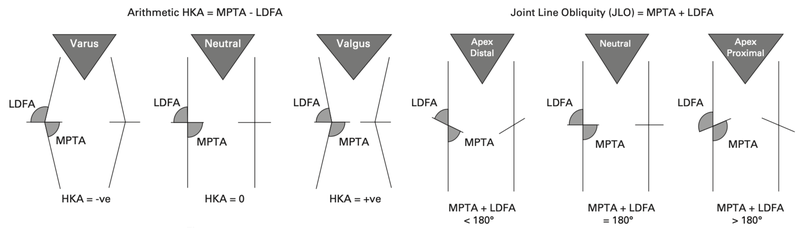

Figure 3. Classification of Arithmetic HKA and Joint Line Obliquity[6]

- Patients were selected that matched the following criteria: Primary TKA performed between 10/2014 and 08/09/2022 at DHMC, with one or two year PROMS
- Using patient pre-operative scans, determine the LDFA and MPTA (as pictured in figure one). These values are then used to calculate the Arithmetic HKA and Joint Line Obliquity (Figure Two). These values are then used to classify the patient pre-operatively into one of the nine possible CPAK classifications- this process is then repeated for the post-operative scans.
- The patient reported outcomes to be used are as follows: PROMIS-10 Physical, PROMIS-10 Mental, KOOS Jr, Modified Sane (Knee). For pre-TKA PROMs, the lowest values within a year of the operation will be used. For Post-TKA PROMs, all recorded values will be used

Results

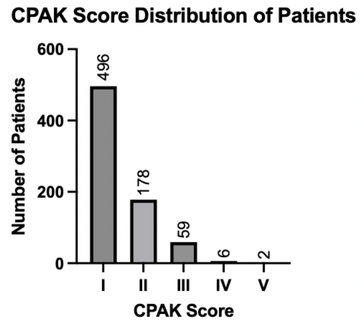

Figure 4. CPAK Score Distribution of Patients Of the 1033 patients in the sample, 741 have currently been assigned a CPAK score for their pre-operative scans following the described methodologies. The patients are distributed amongst classes I-V, with the overwhelming majority (66.94 percent of patients) following in the I class, followed by class II (24.02 percent of patients).

Next Steps

- Finish the CPAK classifications of the remaining patients, compare pre and post-operative CPAK classifications, and submit for statistical correlation and analysis in relation to patient reported outcomes
- Manuscript formulation and submission

Citations

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