Distribution and Changes in Lower Limb Alignment Using the Coronal Plane Alignment of the Knee Classification System Before and After Total Hip Arthroplasty

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INTRODUCTION:

Total hip arthroplasty (THA) represents the standard treatment for hip osteoarthritis, however, changes in lower limb alignment following the procedure remain incompletely understood. The coronal plane alignment of the knee (CPAK) classification system has emerged as a valuable tool in knee surgery for comprehensive evaluation of coronal lower limb alignment; as far as we know, its application for evaluating alignment changes following THA has not been explored. This study aimed to investigate the distribution of CPAK classifications among patients with hip osteoarthritis and examine the dynamic changes in coronal lower limb alignment following THA, with particular focus on transitions between CPAK types and their clinical implications.

METHODS: This retrospective cohort study analyzed 110 patients (113 hips) who underwent primary THA for hip osteoarthritis between January 2017 and July 2019 at a single institution. Exclusion criteria included follow-up period of less than 2 years, insufficient medical records or radiographic data, and history of knee surgery on the ipsilateral side of where the THA procedure was performed. Full-length standing anteroposterior X-rays were obtained preoperatively and at 1 year postoperatively. Four key radiographic parameters were measured: mechanical medial proximal tibial angle (mMPTA), mechanical lateral distal femoral angle (mLDFA), arithmetic hip-knee-ankle angle (aHKA), and joint line obliquity (JLO), all used in CPAK classification. Hip center position was evaluated using horizontal and vertical coronal alignments. All THAs were performed using the direct-anterior approach with cementless components, and patients followed a standardized rehabilitation protocol.

RESULTS:

The mean age was 66.5±11.0 years with 19 males and 94 females. Type II CPAK was the predominant classification preoperatively (47.8%), while types I and III were equally distributed (22.1% each). At 1 year postoperatively, dynamic shifts occurred with types I and II becoming equally prevalent (34.5% each), whereas type III decreased to 15.0%. The mLDFA significantly increased from 86.4±2.2° to 87.7±2.2° (p<0.001), and aHKA decreased from -0.2±3.2° to -1.2±3.2° (p<0.001), indicating a trend toward varus alignment. The mMPTA remained unchanged throughout the study period (p>0.05). JLO increased significantly from preoperative to postoperative measurements (p<0.001). Hip center medialization occurred, with horizontal coronal alignment decreasing from 43.6±6.4° to 34.7±4.9° (p<0.001) and vertical coronal alignment decreasing from 30.2±8.8° to 24.5±6.0° (p<0.001). Neutral joint line types (types IV-VI) collectively increased from 7.1% preoperatively to 15.9% at 1 year postoperatively.

DISCUSSION AND CONCLUSION: Japanese patients with hip osteoarthritis exhibit distinct CPAK patterns, with type II representing the predominant classification preoperatively, differing from knee osteoarthritis populations. Following THA, significant lower limb alignment changes occurred, characterized by increased mLDFA and decreased aHKA parameters, primarily attributed to hip center medialization during surgical reconstruction. These alignment changes resulted in a trend toward varus alignment and dynamic shifts in CPAK type distribution over the 1-year follow-up period. Understanding these predictable alignment changes is crucial for surgical planning, implant positioning, and postoperative care, as the tendency toward varus alignment may have implications for long-term knee joint health and patient outcomes.

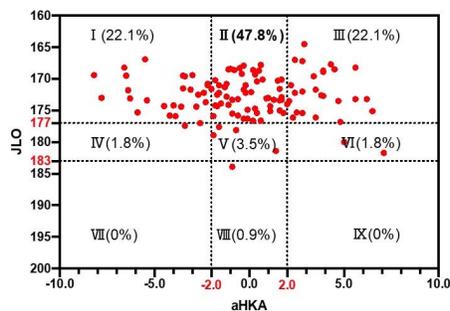Figure 1 Preoperative distribution of CPAK classification types.

Figure 2 Postoperative distribution of CPAK classification types at 1 year.