

The effect of lower limb alignment on knee joint line orientation

Maarten Mertens MD, Nathalie van Beek PhD, Toon Claes MD, Steven Claes MD PhD, Stijn Bartholomeeusen MD

Introduction

The principle of an open wedge high tibial osteotomy (HTO) is to achieve a neutral or slightly valgus limb alignment, redistributing weight-bearing to the healthy lateral knee compartment. This realignment results in significant alterations in the medial proximal tibial angle (MPTA), subsequently affecting knee joint line orientation (KJLO). However, to date, a direct correlation between these parameters remains elusive. This study seeks to refine the relationship between changes in joint line orientation (Δ KJLO) and correction sizes (Δ MPTA) by examining the influence of foot positioning. The objective is to develop a linear model capable of more accurately predicting postoperative KJLO.

Materials and methods

A retrospective radiographic analysis was conducted on 91 patients who underwent HTO surgery between April 2016 and April 2017. Three investigators conducted a thorough assessment of radiographic measurements on standing X-rays both pre-operatively and three months post-operatively. Two novel radiographic parameters were introduced to assess the realignment of the foot of the operated side to the midline. This involved determining the angle formed by rotating the natural foot position onto the midline, using the center of the hip as a pivot point. Subtracting this angle from the measured knee joint line orientation (KJLO) yielded a new adjusted KJLO (aKJLO).

Results

The mean age of the study participants was 54 years, with an age range of 21 to 82 years. Single-score interclass correlation (ICC) was calculated among all investigators, with authors M.M. and Y.N. showing an ICC of ≥ 0.72 and authors M.M. and S.B. exhibiting an ICC of ≥ 0.78 , indicating good reliability. The Pearson correlation coefficient assessing the reliability of aKJLO was 0.887 (p -value < 0.005). A linear model was developed to predict postoperative KJLO, yielding an R^2 of 0.685 between Δ aKJLO and Δ MPTA. Upon segregating patients into two categories ($>4^\circ$ KJLO and $<4^\circ$ KJLO), our analysis revealed that among individuals with an MPTA exceeding 92° , the proportion with a KJLO surpassing 4° ranged from 55% to 100%. Conversely, this percentage notably declined when the MPTA fell below 92° , with only 10% to 30% exhibiting a KJLO exceeding 4° .

Discussion

Our study highlights the challenge of predicting postoperative KJLO using solely MPTA. The traditional KJLO measurement lacks standardization due to variations in foot positioning, hindering its predictive value. However, by adjusting the KJLO measurement to account for foot positioning, we developed a novel measurement—adjusted KJLO (aKJLO)—which enabled a more accurate prediction of postoperative KJLO relative to MPTA. This method can help

inform surgical decision-making, particularly in choosing between single or double-level osteotomies to prevent excessive postoperative joint line obliquity ($>4^\circ$ KJLO).