Variations In Femoral Anteversion And Tibial Torsion Influence Knee Alignment In Subjects With Knee Osteoarthritis

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Disclosures:

Introduction: There are mixed views as to whether knee alignment can consistently predict incidence and/or progression of tibiofemoral osteoarthritis (TFOA). Much of the literature on this subject reports knee alignment as either hip-knee-ankle angle (HKA - mechanical axis) or femoral-shaft tibial-shaft angle (FSTS - anatomical axis). This approach fails to take into account subjects where the overall angular deformity between the mechanical and anatomical axis differ. For example, there exists a population of individuals with medial compartment OA (MOA) that have a varus mechanical axis but valgus anatomical axis. If one were to compare the angular deformity to the location of TFOA in such a cohort, two very different outcomes are possible depending on which variable is used as a surrogate for overall knee alignment.

Some of the current inconsistencies in the literature that compare the association of knee alignment to TFOA may be explained by failure to take into account angular orientation of both mechanical and anatomical axes, and also a lack of information regarding additional anatomical variables that may influence such axes. Femoral neck-shaft angle (NSA), femoral anteversion (FA), and tibial torsion (TT) are all likely to influence HKA and FSTS, yet there is little to no information about their association with different patterns of knee alignment or TFOA. Differences in such variables may help explain why there is a difference in anatomical versus mechanical axis in some patients with TFOA. The identification of all variables that influence knee alignment will help to more specifically define combinations that predispose TFOA.

The aims of the current study are: 1) explore the various combinations of mechanical versus anatomical alignment among a cohort of subjects with primary end-stage knee OA, and 2) determine if NSA, FA, and TT are associated with differences in knee alignment.

Methods: This retrospective, observational study reports on 48 subjects (96 hips/knees) with primary end-stage knee OA who presented to a single surgical centre for either total knee arthroplasty (TKA) or medial unilateral knee arthroplasty (UKA). All patients operated on by an author surgeon (TH) between November 2011 and August 2012 were included. Subjects were excluded if radiographic (N=8) or computed tomography (N=8) scans were unavailable.

FA and TT were assessed from computed tomography (CT) imaging by previously defined methods. The HKA, FSTS, and NSA were assessed from full-limb, standing anteroposterior radiographs using Osirix software (Orthopaedic Studio (customized version), Spectronic Medical AB, Helsingborg, Sweden). Both limbs from all patients were included in the analysis.

Individual limbs were categorized based on the combination of angular deformity of both mechanical and anatomical axes. The four possible combinations of mechanical:anatomical axes included: 1) varus:varus, 2) varus:valgus, 3) valgus:varus, and 4) valgus:valgus. Femoral NSA, FA, and TT were then compared independently among the groups via analysis of covariance (ANCOVA), controlling for age, sex, and body mass index (BMI). Additionally, HKA and FSTS were compared to NSA, FA, and TT using Pearson bivariate correlation analysis.

Results: Based on radiographic assessment of 10 subjects, the intra-class correlation coefficient for HKA, FSTS, NSA, FA, and TT were 0.99, 0.99, 0.91, 0.95, and 0.99 respectively. There were 48 knees in varus:varus alignment, 24 knees in varus:valgus alignment, and 10 knees in valgus:valgus alignment. Fourteen knees were unable to be categorized due to subluxation of the femur on the tibia. The ANCOVA analysis showed that between groups there was a significant difference in HKA (p<0.001), FSTS (p<0.001), NSA (p=0.014), and FA (p=0.002) (Table I). Pearson bivariate analysis showed a positive correlation between HKA and FA (r=0.412, p<0.001) and also HKA and TT (r=0.295, p=0.004). Additionally, there was a positive correlation between FSTS and FA (r=0.430, p<0.001) and also FSTS and TT (r=0.322, p=0.003). Therefore, as FA and TT increase, so do HKA and FSTS. An increase in FA was associated with an increase in TT (r=0.254, p=0.013). There was no correlation between NSA and either HKA or FSTS.

Discussion: Our results illustrate the variability between the mechanical and anatomical axis of the knee in subjects with end-stage OA. Even among this smaller cohort of subjects, nearly 30% of knees had mechanical and anatomical axes that differed in the direction of angular deformity. An increase in NSA, FA, and TT was more associated with a valgus:valgus alignment. The varus:valgus group also had an increased FA and TT as compared to the varus:varus group, but there was no difference in NSA between these latter two groups. These findings suggest FA and TT influence the anatomical axis more than the mechanical axis. The Pearson correlations confirm this, showing that FSTS has a stronger positive correlation with FA and TT than does HKA. This study demonstrates that the simple classification of a knee as either “varus” or “valgus” based on a single alignment in one
anatomical plane is inadequate. Continued uses of such surrogates for knee alignment are insufficient to elucidate the true relationship between anatomical alignment and TFOA. This study identifies additional variables that influence alignment - NSA, FA, TT - and further research is being undertaken to explore how such variables relate to incidence and location of TFOA.

**Significance:** This study is significant in identifying previously un-described relationships between anatomical variations and knee alignment. Utilizing such information may help identify patients with predisposing risk factors for TFOA, allowing for earlier intervention strategies to reduce incidence and/or progression of disease.

**Acknowledgments:**

**Table 1. Alignment by mechanical:anatomical axes orientation**

<table>
<thead>
<tr>
<th>Knee orientation (Mechanical:Anatomical) (Mean(SD))</th>
<th>Varus:Varus</th>
<th>Varus:Valgus</th>
<th>Valgus:Valgus</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>HKA</td>
<td>-13.5 (4.3)</td>
<td>-3.5 (1.4)</td>
<td>7.2 (7.4)</td>
<td>p &lt; 0.001</td>
</tr>
<tr>
<td>FSTS</td>
<td>-7.4 (4.5)</td>
<td>2.9 (1.4)</td>
<td>13.1 (7.2)</td>
<td>p &lt; 0.001</td>
</tr>
<tr>
<td>NSA</td>
<td>125.9 (4.5)</td>
<td>125.6 (7.0)</td>
<td>131.4 (8.2)</td>
<td>p = 0.014</td>
</tr>
<tr>
<td>FA</td>
<td>12.7 (9.1)</td>
<td>17.3 (10.9)</td>
<td>27.4 (14.4)</td>
<td>p = 0.002</td>
</tr>
<tr>
<td>TT</td>
<td>24.0 (7.6)</td>
<td>27.4 (10.1)</td>
<td>30.4 (14.2)</td>
<td>NS</td>
</tr>
</tbody>
</table>

References: ORS 2014 Annual Meeting

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