Radiologic Assessment of Distal Femur Cutting Angle in Varus Knee Candidates for Total Knee Arthroplasty

Abstract

**Background:** In a total knee arthroplasty surgery the goal is to produce 90 degree angle between the knee articular surface and the mechanical femoral line. Most orthopedic surgeons usually utilize a 5 to 7 degree for distal femoral cutting angle. In this study we will aim at clearing this question, that whether the “five-seven degree” distal femoral cutting angle supposed to be an equable spectrum?

**Method:** In this three year course of study, 123 candidate patients for knee arthroplasty with varus knee deformities underwent pre operator radiologic assessment before joint replacement surgery. The femoral bowing angle, distal femoral cutting angle, neck shaft angle, angle between knee articular line and mechanical femoral angle were assessed and statistically analyzed.

**Results:** The mean varus angle was in 13.71±4.34 in male and 16.41±7.87 in female. The mean distal femoral cutting angle (DFCA) was 6.50±1.09 in male and 7.38±1.75 in female. In 48 patients (%39) the female DFCA was out of 507 degree range. In 32 (26%) of patients the DFCA was 7-9 degrees and in 8 (%6) it was over 9 degrees, and in 8 (%6) was less than 5. The angle differences had no sex-related variation. There was a good co-relation between DFCA and bowing angle (r=0.769). The co-relation between DFCA and NSA was moderator (r=0.523). The co-relation between DFCA and DFA (r=0.11) and varus angle with LDFA (r=0.28) was low. LDFA was also related to NSA (r=0.15). Therefore, the candidates for knee replacement who have varus deformity may need a distal femoral cutting angle over 7 degrees. Based on these results, the distal femoral cutting angle in patients in need of a knee arthroplasty and varus deformity might be more than seven degrees.

**Conclusion:** The distal femoral cutting angle in knee arthroplasty in face of severe varus does not have a constant value and maybe over 7 degrees. A long standing radiograph is needed to measure the mechanical and correlate with axis the anatomic axis of distal third of femur. When the bowing angle is high the DFCA will need to be higher.

**Keywords:** Knee, Arthroplasty, Replacement

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Introduction

Creating a suitable mechanical femoral axis in the lower body is an important factor in the longevity of knee arthroplasty surgery\(^1,2\). After knee arthroplasty surgery, the mechanical axis must pass through knee joint to prevent prosthetic loosening and abrasion\(^3\). In order to have the best possible longevity results in knee arthroplasty surgery based on mechanical theory, the angle between mechanical femoral axis and the knee articular lobe must be 90 degrees. This angle is acquired by equalizing the femoral cutting angle and the angle between the mechanical femoral axis and the one third of distal femoral anatomical axis\(^4\).

In spite of the femoral cutting angle being generally between five-seven degrees, it has been shown that in 30 percent of patients, this angle is either more or less than the aforementioned values\(^5,6\). This research is based on the hypothesis that the femoral cutting angle of patients with varus knee deformity that will undergo knee arthroplasty surgery, might be out of the five-seven range mentioned before. While several studies have been done in different countries and on different races, performing three joint alignment view before the surgery is still a controversy. In addition, such researches have also been done on Iranian patients with varus deformities.
Methods

In this research, case studies have been done with confirmation from the research development center of Taleghani Hospital. Between the years 2015 to 2017 a total of 123 patients (34 males and 89 females) with lower body varus deformity who had been chosen for knee arthroplasty surgery, entered the research. All the patients went under standard full-length radiography for a three joint alignment view in the same radiology center. Exclusion criteria of the research included: congenital deformities, steatumatitis in upper femoral joints, upper femoral joint prosthesis on the same side, surgical history on the same limb (from upper femoral joint up to knee joint), normal femoral mechanical axis or valgus in the limb and femoral fracture in the same limb. The radiography results showed that in all the cases the limb was in normal rotation. The varus angle, femoral bowing angle, distal femoral cutting angle, neck shaft angle (NSA) and lateral distal femoral angle (LDFA) were measured (Figure 1).

The varus angle is the angle between femoral mechanical axis (the line between distal femoral joint plan and the line connecting the femoral head center to the point between femoral Condyles) and tibia (the line between proximal tibia joint plan and the line connecting the center of knee joint to the center of heel). The line that connects the femoral head center to knee center is named femoral mechanical axis; and the line connecting the center of proximal tibia center to the ankle center is tibia axis. In addition the distal femoral cutting angle is considered the angle between the mechanical axis and the one-third of distal femoral anatomical axis.

In order to determine the femoral bowing angle, three pints were chosen: The femoral center point near Lesser Trochanter, the femoral center point 10cm above knee joint and the point in the center of the previous two points. The angle between these three points is called the femoral bowing angle.

In order to measure the angles and decrease the inter-observer error, two orthopedic surgeons measured the angles with the same tool (orthopedic ruler) at different times; and in the case of major difference between the two measurements, a third measurement was done in the presence of both surgeons. It should be noted that before measuring the case studies, radiographic measurements of five out of study patients were done in the presence of both surgeons. All the angles were measured in coronal, axial and sagittal plans before surgery. No measurement was done during and after the surgery. It should be noted that this study was done using only the radiographic data of the patients and the surgical techniques were not part of the study. The ethical code of the study is: IR.SBMU.REC.1396.75

Survey evaluation

The 20th version of SPSS software was used for this evaluation. The correlation between distal femoral cutting angle and the varus angle with other angles was measured using Pearson correlation coefficient. It was decided that correlation coefficient values 0.9 to 1 would be Very good, 0.7 to 0.89 would be good, 0.5 to 0.69 would be medium, 0.25 to 0.49 would be bad and 0 to 0.24 would be very bad. The T-test was used to compare countable data.

Results

Numerical results

A number of 123 patients (34 males and 89 females) with varus deformity who needed knee arthroplasty surgery entered the study as shown in table 1. The average age of the patients was 64.85 ± 7.51 years. There was no significant difference between the two genders from age point of view. All the patients had varus deformity. The average of varus angle in men was 13.71 ± 4.34 and in women it was 16.41 ± 7.87. The average distal femoral cutting angle in the male gender was 6.5 ± 1.09 and in the female gender it
was 7.38 ± 1.75. In 48 patients (39%), the distal femoral cutting angle was out of five to seven degree range. In 32 patients (26%), it was between seven to nine degrees, in eight patients (six percent) it was more than nine degrees and in eight other patients the angle was below five degrees. The angles did not have any correlation with the patient’s gender however there was a significant correlation between the distal femoral cutting angle (IMA) and the femoral bowing angle (r=0.76)(Diagram 1). In addition, there was a medium correlation between the distal femoral cutting angle and the NSA (r=0.523). The correlation between varus angle and LDFA was bad (r=0.28) and finally the correlation between the cutting angle and the LDFA and between LDFA and NSA according to what has been said up to now was very bad (r=0.11, r=0.15).

Table 1. Measured angles in patients including both genders with varus deformity in the years between 2015-2017

<table>
<thead>
<tr>
<th>Index</th>
<th>gender</th>
<th>Mean value</th>
<th>Deviation</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>NSA (neck shaft angle)</td>
<td>Male</td>
<td>137.79</td>
<td>4.995</td>
<td>0.074</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>132.65</td>
<td>5.57</td>
<td></td>
</tr>
<tr>
<td>Distal femoral cutting angle</td>
<td>Male</td>
<td>6.5</td>
<td>1.019</td>
<td>0.086</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>7.38</td>
<td>1.758</td>
<td></td>
</tr>
<tr>
<td>VA (varus angle)</td>
<td>Male</td>
<td>13.71</td>
<td>4.340</td>
<td>0.24</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>16.41</td>
<td>7.970</td>
<td></td>
</tr>
<tr>
<td>CA (calf angle)</td>
<td>Male</td>
<td>6.21</td>
<td>3.577</td>
<td>0.48</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>6.85</td>
<td>2.463</td>
<td></td>
</tr>
<tr>
<td>Angle between femoral mechanical axis and joint axis</td>
<td>female</td>
<td>90.21</td>
<td>5.309</td>
<td>0.597</td>
</tr>
<tr>
<td>Angle between tibia mechanical axis and joint axis</td>
<td>Male</td>
<td>83.71</td>
<td>4.598</td>
<td>0.533</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>82.74</td>
<td>5.023</td>
<td></td>
</tr>
<tr>
<td>Bowing angle</td>
<td>Male</td>
<td>3.43</td>
<td>3.275</td>
<td>0.232</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>5.09</td>
<td>4.660</td>
<td></td>
</tr>
</tbody>
</table>

Graph 1. The relation between IMA and femoral bowing

Discussion

The results show that it is possible for the femoral distal cutting angle in patients with varus deformity and in need of knee arthroplasty to be more than seven degrees. In 26% of the patients, the angle was between seven to nine degrees and in six percent it was more than nine degrees. According to Mullaji et al., choosing the same femoral distal cutting angle for all the patients is a mistake. This angle is different for everyone (10). The patients in Drexler’s study (11) were all of Caucasian descent and their average varus angle was 5.7 degrees while all our patients suffered from severe varus deformity.

In knee arthroplasty, proper positioning of the prosthesis, and finding the right axis in coronal, sagittal and axial plans have a major role in the longevity of the prosthesis (12). The best position for the femoral prosthesis is for it to be perpendicular to the mechanical axis. If the surgeon decides to do so, he or she must equalize the femoral distal cutting angle to the angle between the mechanical axis and the one-third of distal femoral anatomical axis (13). Although it has been proved that a suitable axis in coronal plan is of great importance; but there are studies that show it is not the only effective factor in the longevity of the prosthesis and various factors have a role in it (14,15). It has been shown in a study that some patients despite having a suitable coronal axis, still suffer from prosthetic loosening (16). For this reason, many surgeons still choose a femoral distal cutting angle between five to seven degrees and do not use standard full-length radiography for a three joint alignment view before surgery. Kharvadkar et al. showed in their research that for 83 patients in need of knee arthroplasty, the average femoral distal cutting angle has been 5.4 ± 0.9 (between 3.3 to 7.6 degrees). They suggested that a femoral distal cutting angle between five to seven degrees is a good angle for simple knee arthroplasties (17). Similarly, the cutting angle for all the 80 patients in the study performed by McGory et al. was between five to eight degrees and there was no need for a bigger or smaller angle (18). Despite all the results from above, in the present study, 32% of the patients with severe varus deformity had femoral distal cutting angles more than seven degrees. In the study performed by Drexler et al. (11), the patient's height is introduced as an independent factor affecting femoral distal...
cutting angle. In addition the work done by Mullaji et al. showed that age and gender of the patient have no effect on this angle and the effect of the patient’s height is insignificant. Because of the limitations of the present work, the relation between the femoral distal cutting angle and the age and gender and height of the patients was not studied. Also only one plan has been studied and the two others need to be examined. In addition, it is necessary to do research during and after the surgery as well.

References


Conclusion

The size of the femoral distal cutting angle in patients with severe varus deformity is not constant and may be more than seven degrees. For this reason, it is best to have a standard full-length radiography in these patients and to determine the angle between the mechanical axis and the one-third of distal femoral anatomical axis.