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Comparing Conventional and Navigation-assisted Techniques for Lateral Opening-wedge Femoral Varus Osteotomy

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Objective: The aim of this study was to assess short-term clinical and radiographic results of opening-wedge distal femoral varus osteotomy performed using either the conventional technique or a navigation (NAV)-assisted technique.

Materials and Methods: This study included 25 patients; 12 patients underwent femoral osteotomy with NAV, and 13 patients underwent the conventional procedure.

Results: In the NAV osteotomy group, the mean duration of surgery was 73.69 minutes (SD, 12.53 min), and the mean tourniquet time was 59 minutes. Mean preoperative mechanical alignments were 13.84 degrees in the conventional osteotomy group and 14.4 degrees in the NAV osteotomy group ($P = 0.7432$; 95% confidence interval = 12.8-15.4 degrees), and the final postoperative mechanical alignment varied between −2 and 3 degrees in both groups, with no significant difference between the results obtained using the 2 techniques ($P = 0.1316$; 95% confidence interval = 0.08-1.24 degrees). However, the correlation between initial alignment and postoperative result was strong ($P = -0.68$) in the NAV osteotomy group and weak ($P = -0.07$) in the conventional osteotomy group.

Conclusions: Duration of surgery and tourniquet time were longer in the NAV osteotomy group. The use of NAV for femoral varus osteotomy did not result in any significant difference in final alignment.

Key Words: osteotomy—navigation—femoral—knee—osteoarthritis.

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Osteoarthritis (OA) of the knee is a degenerative, progressive, and universal disease. Its prevalence, which is currently 12% in the United States and 19% in the United Kingdom,[1,2] is expected to gradually rise as life expectancy and obesity rates increase worldwide.

OA has important social and economic impacts because patients affected by this condition may experience temporary and often permanent incapacity to work and to perform sports activities, exclusion from social life, and loss of walking ability.[2]

Changes in femorotibial alignment during the natural course of primary OA of the knee modify the relative distribution of loading between the medial and lateral compartments of the knee. In varus deviation, the load-bearing axis gradually shifts to the medial side, whereas in valgus deviation, this axis shifts to the lateral compartment.

Osteotomy is a surgical treatment option for OA with femorotibial axis deviation, particularly for patients who are <55 years of age, have good joint mobility, and are active.[2] Good results from distal femoral varus osteotomy for lateral OA in valgus knees have been reported.[3]

Final limb alignment after femoral osteotomy remains a challenging issue and is one of the most important factors for achieving good clinical and radiographic results. Certain studies have clearly associated final limb alignment with osteotomy outcome and longevity.[4–6]

Computer-aided orthopedic surgery (CAOS), a term coined in Davos in 2001, has been widely studied and applied in knee and hip arthroplasty. In this procedure, the navigator provides precise data for correctly positioning prosthetic components and consequently achieving adequate alignment of the limbs. The surgeon can therefore intraoperatively confirm the final alignment of the limb, increasing implant longevity and improving long-term outcomes.

In 2007, Lorenz et al[7] presented and discussed the surgical technique of femoral osteotomy with support from a navigation (NAV) system. These researchers provided a step-by-step description of the surgical procedure, from careful preoperative planning, to osteotomy plate fixation.

In 2009, Pearle et al[8] used tomography with three-dimensional reconstruction to examine the reliability and reproducibility of NAV osteotomy in cadavers.

Certain studies have demonstrated that for certain orthopedic procedures, particularly arthroplasty and tibial osteotomy, approaches that use NAV provide advantages relative to conventional techniques.[9–11]

Therefore, the aim of this study was to assess the short-term results of NAV-assisted distal femoral varus osteotomy in patients with lateral unicompartmental OA on the basis of the following parameters:

- duration of surgery;
- tourniquet time;
- preoperative alignment (mechanical); and
- Knee Society Scoring (KSS) System.

Moreover, the results of NAV-assisted surgery were statistically compared with those obtained for distal femoral varus osteotomy using the conventional technique.

The objective of this study was to determine the advantages of the NAV-aided approach relative to the conventional technique for distal femoral varus osteotomy, particularly with respect to lower limb alignment, given the importance of this parameter to the longevity of the surgical outcome.

MATERIALS AND METHODS

The present study was conducted at the General Hospital of Pedreira OSS and the outpatient clinic of the Jardins dos

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The authors declare that they have nothing to disclose.

For reprint requests, or additional information and guidance on the techniques described in the article, please contact Sergio R. da Costa, MD, at drsergiorcosta@gmail.com or by mail at st dr diogo de faria, 1077, ap 82, 04037003, São Paulo, Brazil. You may inquire whether the author(s) will agree to phone conferences and/or visits with regard to these techniques.

Prados and was approved by the Ethics Committee for the Analysis of Research Projects (CAPPesq) of the Hospital das Clínicas of the Faculty of Medicine, University of São Paulo (no. 0265/09).

This investigation included 25 patients (age <55 y) with lateral knee OA classified as Ahlback Grade 3 or lower, who complained of pain, without knee joint instability, having an ROM higher than 100 degrees, and a valgus deformity >9 degrees. After undergoing clinical examination, these patients were divided into the following 2 groups.

The study group included 13 patients who received osteotomy with NAV. The control group included 12 patients with the same clinical features as patients in the study group who received conventional osteotomy (without NAV).

In the NAV group, before the osteotomy was to be performed, the procedure used was as follows. One device (tracker) was fixed in the femur shaft (about 20 cm) above the articular line, and another tracker was fixed in the tibial shaft (about 10 cm) below the articular line. These trackers send infrared signals to the NAV system. Some points (medial and lateral malleoli, articular surface, medial and lateral epicondyles) were informed by the pointer, and the range of motion was informed by moving the limb. With thise information in hand, the NAV system provides us the initial alignment of the limb.

When the NAV system informed the alignment to be 0 degree, the osteotomy was fixed.

All the patients completed the KSS questionnaire before the surgery and 1 year after the surgery.

These patients underwent lateral opening-wedge femoral varus osteotomy supported by a fixed-angle plate with locking screws (Fig. 1), as described by Puddu.[12,13] The goal of the surgical procedure was to achieve 0 degree in the mechanical axis (coronal plane).

The Mann-Whitney test was used to compare the results of conventional and NAV-assisted surgery. The following variables were statistically compared between the 2 groups: age, duration of surgery, tourniquet time, limb alignment, and KSS.

All patients were followed-up and assessed in the orthopedics department of the specialty outpatient clinic of the General Hospital of Pedreira.

RESULTS

A total of 25 patients (48% male and 52% female) were examined. Patients' ages ranged from 39 to 55 years (mean, 50.08 y; SD, 3.93 y).

The duration of surgery significantly differed for the 2 tested approaches ($P=0.0046$), with mean times of 73.69 minutes (SD, 12.53 min) and 92.75 minutes (SD=, 6.49 min) for the conventional and NAV-assisted techniques, respectively. Consequently, the pneumatic tourniquet time also significantly differed between the 2 groups ($P=0.0237$), as indicated in Figure 1.

Absolute mean preoperative mechanical alignments were 13.84 degrees in the conventional osteotomy group and 14.4 degrees in the NAV osteotomy group ($P=0.7432$; 95% confidence interval, 12.8-15.4 degrees). Mean postoperative alignment did not statistically differ between the 2 groups ($P=0.1316$).

Spearman correlation coefficient was used to determine the correlation between initial alignment and postoperative result. This correlation was strong (0.68) for the group that underwent the NAV-assisted procedure ($P=0.0143$), suggesting that, for any value of initial alignment, the best possible (closest to zero) result with respect to final alignment was achieved. In contrast, the correlation coefficient for the conventional technique was −0.07 ($P=0.8310$), as indicated in Table 1.

The mean preoperative score (KSS) of the patients by the conventional technique was 56.25, and the mean postoperative score of this group was 82.08 ($P=0.7476$). The mean preoperative and postoperative scores of the NAV group were 55 and 84.58, respectively ($P=0.4638$). After the operation, levels of activity, pain, and instability improved; however, there were no significant differences between the 2 groups.

FIGURE 1. Postoperative aspect and x-ray. full color online

TABLE 1. Demographics and Results

	NAV ($n = 36$)	Conventional ($n = 33$)	*P*
Sex (F/M)	6/6	7/6	
Age (y)	50.66 ± 3.79	64.88 ± 6.78	0.5280
Surgery time	92.75 ± 16.49	73.69 ± 12.53	0.0046
Tourniquet time	68.16 ± 10.88	59.00 ± 7.02	0.0237
KSS (pre)	55.01 ± 10.87	56.25 ± 12.27	0.7476
KSS (post)	84.58 ± 8.64	82.08 ± 7.82	0.4638
Preoperative alignment (deg.)	14.4 ± 2.97	13.84 ± 3.44	0.7432
Postoperative alignment	0.25 ± 1.14	1.08 ± 1.5	0.1316

F indicates female; KSS, Knee Society Score; M, male; NAV, navigation.

DISCUSSION

Accurate mechanical alignment after orthopedic surgery is regarded as extremely important for the success of a procedure, regardless of whether the surgery in question is total arthroplasty of the knee, osteotomy, or osteosynthesis of the femur, tibia, or ankle.[13]

Osteotomy is recognized as a difficult surgical procedure. Small errors in indication, execution, and/or rehabilitation can cause numerous complications and an unsatisfactory result. These complications include intra-articular fracture, loosening or breakage of the prosthetic material, cortical bone fracture, instability, infection, pseudarthrosis, thrombosis, paresthesia, undercorrection or overcorrection of the deformity angle, and reduced range of motion and flexion attitude of the knee.[14–16]

High tibial osteotomy, medial closed-wedge osteotomy of the distal femur, and lateral opening-wedge distal femoral osteotomy are the options for valgus arthritic knees. Tibial osteotomies lead to inclination of the joint line, and femoral closure osteotomies have the correction determined by the size of the wedge, while opening wedge allows progressive and controlled correction of the desired angle.[17,18]

This study used Stryker Howmedica 4.0 NAV software to measure variations, and it indicates them in the mechanical axis in the coronal plane during the surgical procedure.

The main objective of the NAV is to help the surgeon achieve accurate positioning of prosthetic components and adequate mechanical alignment in osteotomy, and thereby ensure that procedures are precise, errors are reduced, and relatively reliable results are obtained.

The conventional osteotomy and NAV osteotomy groups did not significantly differ with respect to preoperative or postoperative alignment. However, there was a stronger correlation between preoperative and postoperative alignment, in the NAV osteotomy group, because the results were more homogeneous, with fewer outliers. When the alignment results were assessed by group, 50% of the cases in the conventional osteotomy group were outside the +2 degrees margin of error for final mechanical alignment, whereas only 16.7% of cases in the NAV osteotomy group fell outside this margin. The fact that the NAV osteotomy group produced results that were closer to the ideal mechanical axis (0 degrees) is evidence of an advantage of NAV-assisted surgery relative to conventional surgery.[16]

The utility of NAV in orthopedics is undisputed for both arthroplasty and osteotomy. Several authors have demonstrated that the quantity of new real-time information obtained in the operating theater via the use of NAV facilitates the surgeon's task by reducing the time required for preoperative planning and minimizing malalignment in cases involving major deformity.[17]

CONCLUSIONS

Duration of surgery and tourniquet time were longer for the NAV osteotomy group than for the conventional osteotomy group. Final alignments obtained using conventional and NAV-assisted techniques for femoral varus osteotomy did not significantly differ. There were no statistical differences in pre-KSS and post-KSS score between the 2 groups.

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