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Closing-wedge low femoral osteotomy: Functional outcomes of 47 cases after 6.5 years follow-up in a low-income country

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Abstract
Introduction: Distal femoral varus osteotomy (DVO) allows for the surgical management of uni-compartmental femoral-tibial gonarthrosis on knee valgum after failure of medical treatment.
The aim of this study was to evaluate the functional results of this therapeutic approach at the Saint Jean de Dieu Hospital in Afagnan.
Patients and Method: This is a retrospective, single-center study conducted from January 2006 to December 2018 on patients who presented with gonarthrosis with disabling knee valgum. Osteosynthesis was performed using AO blade-plates bent at 90°. The patients were reviewed and the evolution and complications were recorded.
Results: Forty-seven patients had been treated surgically by the medial closure varus femoral osteotomy technique. They were 32 women and 14 men with an average age of 55.45 years (25-72 years). Twenty-six patients had AHLBACK stage III femorotibial gonarthrosis and 5 patients had stage IV. Twenty-six patients also had associated patellofemoral osteoarthritis. All patients consolidated with a mean time of 95 days (90-125). No pseudarthrosis or postoperative infection was observed. We recorded one case of osteosynthesis failure (material rupture) resumed by a dynamic DCS compression screw.
Conclusion: Femoral varus osteotomy by medial closure remains today an alternative of choice in the management of gonarthrosis with associated knee valgum in our context.

Keywords: gonarthrosis, knee valgum, osteotomy, medial closure

Introduction
Distal femoral varus osteotomy (FVO) has long been the procedure of choice for the surgical treatment of valgus gonarthrosis after failure of medical treatment [1-3] . It allows correction of the axis of the lower limb in the distal femoral metaphysis. It allows correction of the axis of the lower limb in the distal femoral metaphysis. Its biomechanical principle and good medium-term results have been reported in the literature, regardless of the type of technique used [4-7]. However, this surgery seems to have been relegated to the background with the progress of unicompartmental and total arthroplasty [8, 9]. It still remains an alternative in our context of low-income countries. It was performed without fluoroscopic control. The aim of this study was to evaluate the clinical and radiological results of this therapeutic approach at an average follow-up of 6.5 years.

Patients and Method
The Series
This was a single-center retrospective study including all patients operated on for disabling knee valgum gonarthrosis between 2006 and 2018. We did not include in this study Patients treated surgically with a technique other than distal femoral varus osteotomy. A poorly mobile knee was a contraindication.
A total of 47 patients (47 knees, including one bilateral) were operated on by the same surgeon: 29 right and 18 left knees. They were 32 women and 14 men, with a mean age of 55.45 years (25 to 72 years).

The average height of the patients was 164 cm (147 to 178 cm) and an average weight of 69 kg for an average body mass index (BMI) of 28.63 (25.6 - 34.2). The reason for consultation was pain in all patients. The etiology was mainly degenerative gonarthrosis (Fig. 1a). The distribution of the radiological stages of femorotibial osteoarthritis showed, according to the modified Ahlbäck classification [10]: stage 1 (n=3), stage 2 (n=13), stage 3 (n=26), stage 4 (n=5). Patellofemoral osteoarthritis was assessed according to the Iwano classification [11]. It was stage 1 (n=15), stage 2 (n=10), stage 3 (n=1). Twenty-one patients (21Genoux) had no radiological abnormalities. All patients had pangonometry:

The mean preoperative mechanical femoral-tibial angle (HKA) of the limb was 185. 3° (182-199°), the mean femoral mechanical angle (FMA) was 94.3° (92°-108°), and the tibial mechanical angle (TMA) was 89.8° (89°- 95°). Knee flexion averaged 127.7° (95°- 140°) and extension averaged -1.25° (-15- 0°); medial laxity was found (n=2).

The mean International Knee Society (IKS11) "knee" score was 58.4 points (40- 95) and the mean IKS function score was 60.4 points (10- 100).

Therapeutic Protocol

All surgeries were performed under locoregional anesthesia, through an internal skin approach. The goal was to achieve normocorrection or 2° hypercorrection with an HKA angle between 180 and 182°.

Patients were positioned supine on a regular table with a first counterbearing under the homolateral buttock to prevent the limb from falling in external rotation. A log was placed under the thigh to be operated on to maintain the knee in 40° flexion if necessary during the procedure. A pneumatic tourniquet was placed at the root of the limb but was not mandatory.

The approach was medial longitudinal, starting at the joint space and ascending 15-20 cm proximally. Planning data were used to perform the distal femoral osteotomies by internal closure without fluoroscopic control.

An 18/10 guide wire was placed in the femorotibial joint parallel to the joint space. A second 20/10 dia-condylar wire was placed 2 cm above the joint space and parallel to the first wire. It was used as a guide to prepare the bed of the blade with a conductive chisel.

A third wire was placed at the proximal border of the femoral trochlea cartilage and oriented obliquely from medial to lateral, and 2.5 cm from the second wire and parallel to the other two wires (Fig. 2).

Using a 3.2 mm diameter drill bit, three holes were made at the level of the second wire, and the chisel was then introduced through these holes on the medial condyle towards the lateral hinge in order to prepare the bed for the blade-plate.

The axes of the osteotomy cuts were marked with the electric scalpel. The size of the medial-based subtraction wedge was decided preoperatively during planning using the tracing method. Fixation was performed with a 90° blade-plate.

In case of associated advanced patellofemoral osteoarthritis, a partial vertical patellectomy was performed.

Retention of the medial collateral ligament was sometimes necessary.

Knee rehabilitation was initiated after removal of the drain on Day 2. It consisted of passive and active mobilization in flexion and extension without limitation of amplitude.

The postoperative protocol included short-term antibiotic therapy for 5 days and anticoagulation with low-molecular-weight heparin for 21 days.

Support was allowed at day 90.

Evaluation Method

Data were collected from the medical records, then in consultation. At the last follow-up, the patients were evaluated clinically and radiologically by the operator. The occurrence of complications was recorded. All patients had preoperative and postoperative pangonometry as well as radiographs of the knee (front and side views and a 30° patellofemoral pathway), which made it possible to analyze the mechanical axis of the lower limb preoperatively and at the last follow-up. This HKA angle was calculated by tracing the mechanical axis of the femur from the center of the femoral head to the center of the intercondylar fossa of the femur, and the mechanical axis of the tibia from the center of the tibial spines to the proximal center of the articular surface of the talus. The International Knee Society (IKS) [12] scores were used for outcome assessment: the knee score items were: (pain relief, improved mobility, and stability); and those for the function score: improved walking perimeter and stair climbing. The overall IKS score was considered excellent for a score between 85 and 100, good between 70 and 84, average between 60 and 69 and poor for a score below 60. A complementary subjective evaluation, using a satisfaction questionnaire was used. The scale had three items: very satisfied, satisfied, disappointed, or dissatisfied.

Results

Clinical

Thirty-eight patients were very satisfied or satisfied with the result, two found the result disappointing.

The mean knee IKS score (Table 1) was 88.4 points (60 to 100) and the function score (Table 2) was 78.7 points (65 to 100).

Radiological findings

All osteotomies consolidated within a mean time of 95 days (90 to 125 days). The preoperative goal was achieved: thirty-six patients had a correction between 0-4° (Fig. 1b) and four others exceeded 4° of varus.

The mean HKA angle was 180.2° (179-185°). Four (4) patients had an overcorrection postoperatively and ended up with an HKA angle less than 180 (Fig. 3).

Thirty-six (36) patients had an HKA angle between 180-182°.

The mean MFA was 90.5° (88 - 94°) and the mean LMA was 89.2° (88 - 92).

Complications

No pseudoarthrosis was observed. Two patients died unrelated to surgery and 5 were lost to follow-up. One case of failed osteosynthesis was resumed with a dynamic DCS compression screw. Forty patients out of 47 were analyzed. The mean follow-up was 6.5 years (1-12 years).

Discussion

We evaluated the results of a series of 47 femoral varus osteotomies at a mean follow-up of 6.5 years.

The mean BMI of our series was 28.63 (25.6-34.2) with 24 overweight and 16 obese patients. These data were superior to those of Buda *et al*,13 who found a mean BMI of 25.3+/- 5.1. These authors took into account the contraindication to osteotomy for patients with a BMI greater than 30. In our study, obese and overweight patients were put on a weight-loss diet at least 3 months before the procedure but could not lose the weight to reach a BMI below 30. However, they were

eligible because of disabling pain, which was the main reason for consultation for all these patients.

The results of VFOs depend on the stage of evolution of the osteoarthritis. According to the study by Antonescu *et al.* [14], the results were better in early uni-compartmental stage 1 and 2 gonarthrosis, with 85% good and very good results, compared with only 42% for advanced gonarthrosis. However, in advanced gonarthrosis, limitation of joint movement and the existence of laxity were poor prognostic factors. Significant wear and ligament distension were a source of failure to correct and recurrence of the deformity4,15. In our series, 29 of 47 knees had stage 2 and 3 osteoarthritis. All our patients had satisfactory knee mobility, making them eligible for distal femoral varus osteotomy. According to some authors, OFV should be contraindicated in cases of flexion less than 90° and flessum greater than 15°. Other authors16-19 contraindicated distal femoral osteotomy in cases of associated patellofemoral osteoarthritis because of poorer pain outcomes.

Zarrouk *et al.* [20] and Wang *et al.* [21] demonstrated in their study that the results of osteotomy were not modified when there was associated patellofemoral osteoarthritis. In the absence of another therapeutic alternative related to the technical platform, the presence in our series of patellofemoral osteoarthritis was not an exclusion criterion. To minimize patellofemoral pain, a partial vertical patellectomy was performed (Fig. 4a, 4b).

All our patients consolidated (Fig. 1b) within a mean time of 95 days (90 to 125).

This was a long time compared with the consolidation time of 6 to 8 weeks found by Marti *et al.*22 who used a medial closure varus osteotomy as their surgical technique. No explanation was given, but we believe that delayed weight-bearing could account for this delay in consolidation. However, Omidi-Kashani *et al.* [23] and Wang *et al.* [21] reported delays of 4.1 months (2-6 months) and 4.7 months (3-9 months), respectively, which are comparable to our study.

In this study, we used the IKS score, which represents one of the most reliable and reproducible scores in the evaluation of knee function. It is also the most widely used score in previous publications, which facilitates the comparative study.24 Our clinical results were improved, especially the results of the IKS.

Our clinical results were improved, particularly the IKS knee and function scores, which increased from 58.4 to 88.4 and from 60.4 to 78.7, respectively, postoperatively. These results are comparable to those of Zarrouk *et al.* [20] and Sherman G *et al.* [25]. Furthermore, the angle of correction necessary for lasting relief of lateral tibiofemoral gonarthrosis remains controversial. According to the literature, this angle varied between 6° of varus and 10° of valgus [16, 20]. Some authors advocate a hypo-correction and maintain a knee valgum. According to Coventry *et al*, [26, 27] the objective of correction is to place the knee in internal constraints. The results show that the target is between 0° and 4° of varus. Beyond this range, there is hypercorrection, which is responsible for a rapid deterioration of the good initial result by rapid decompensation of the medial compartment. Our correction goal was achieved in 36 patients.

The average HKA angle postoperatively was 180.2° (179 - 185°). Thirty-six patients had a correction between 0-4° and four (4) patients had an excessive correction postoperatively and ended up with an HKA angle of less than 180 (Fig. 3).

The complications reported in the literature in the treatment of gonarthrosis were failed osteosynthesis, pseudarthrosis, and surgical site infections [2, 4, 28]. In our study, no pseudarthrosis or infection was observed, apart from one revision for material failure.

Our study had several strengths: The patients were operated on using the same surgical procedure and by the same surgeon. It also had limitations. It was a retrospective study, but all patients were examined by the same surgeon, which may present some bias. This series was statistically insufficient to make comparisons by statistical tests,

Table 1: Distribution of patients according to the IKS Knee postoperative score

Knee IKS score	Effective	Percentage
Excellent	34	85
Good	5	12.5
Average	1	2.5
Bad	0	0%
Total	40	100%

Table 2: Distribution of patients according to IKS score Postoperative function

Knee IKS function score	Effective	Percentage
Excellent	12	30
Good	19	47.5
Average	9	22.5
Bad	0	0%
Total	40	100%

Fig 1b: Control radiograph showing consolidation and axial correction.

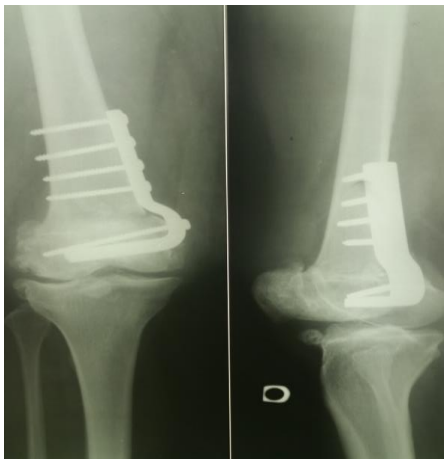

Fig 1a: X-ray of the knee of a patient in Ahlbäck stage 4.

Fig 2: Preparation of the slide-plate bed with the various reference pins.

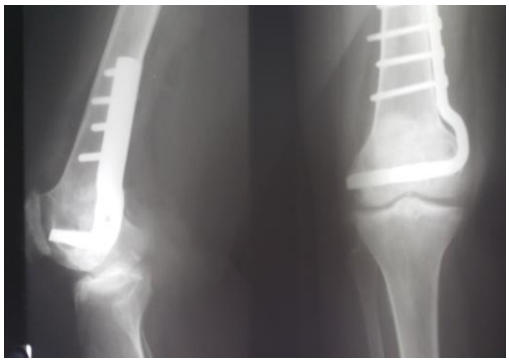

Fig 3: X-ray of the knee showing overcorrection

Fig 4a: Patient seen as a follow-up: bilateral distal femoral osteotomy with varization associated with a vertical partial patellectomy.

Fig 4b: Functional result after a distal femoral varisation osteotomy combined with a vertical partial patelectomy.

Conclusion

The FVO is a difficult procedure to regulate precisely in our context. However, its role in the management of femorotibial gonarthrosis is undeniable. The majority of patients were very satisfied or satisfied with their results at a mean follow-up of 6.5 years, despite the fact that we did not take into account the advanced stage of the gonarthrosis associated or not with patellofemoral osteoarthritis when recruiting our patients.

The main objective was to relieve the patients' pain and thus improve their quality of life and defer their knee arthroplasty surgery.

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