RESEARCH ARTICLE

Supracondylar Osteotomy in Valgus Knee: Angle Blade Plate Versus Locking Compression Plate

Seyyed Morteza Kazemi, MD; Reza Minaei, MD; Farshad Safdari, MD; Ali Keipourfard, MD; Rozhin Forghani, MD; Alemeh Mirzapourshafiei, MD

Research performed at Akhtar Hospital, Shahid Beheshti University of Medical Sciences, Tehran, Iran

Received: 12 August 2015 *Accepted: 22 November 2015*

Abstract

Background: There are few studies comparing the biomechanical properties of angled blade plate and locking compression plates in supracondylar osteotomy. In the current randomized study, we prospectively compared the clinical and radiological outcomes of supracondylar osteotomy using these two plates.

Methods: Forty patients with valgus knee malalignment were randomly assigned to two equal numbered groups: angled blade plate and locking compression plates. All of the patients underwent medial closing wedge supracondylar osteotomy and were followed for one year. Before and after the operation the valgus angle and mechanical lateral distal femoral angle were compared between groups. Also, the rate of complications were compared.

Results: After the operation, the mean valgus angle and mechanical lateral distal femoral angle improved significantly in the two groups (P<0.001). Although, the preoperative amount of the valgus angle and mechanical lateral distal femoral angle were the same, at the last visit the valgus angle (5.4±2.1 versus 3.1±1.8; P=0.032) and mechanical lateral distal femoral angle (87.6±2 versus 89.7±3.2; P=0.041) were significantly lower and higher in the angled blade plate group, respectively. Nonunion occurred in four patients (20%) in the locking compression plates group (P=0.35).

Conclusion: Based on having a larger valgus angle and mechanical lateral distal femoral angle correction in the angled blade plate group and considerable rate of nonunion in the locking compression plate group, the authors recommend using the angled blade plate for fixation of medial closing wedge supracondylar osteotomy for patients with valgus malalignment. However, more long-term studies are required.

Keywords: Angle blade plate, Locking compression late, Valgus knee

Introduction

Frontal knee deformities in adults are one of the most important complaints encountered in orthopedic practice. Wedge corrective osteotomy is the standard treatment for angular knee deformities such as valgus malalignment (1). Corrective osteotomy for the genu valgum can be performed either by the supracondylar femoral or high tibial osteotomy based on the location and severity of the deformity. Satisfactory outcomes have been reported after supracondylar osteotomies in several previous studies (2-5). Alignment can be obtained by either the medial closing-wedge technique or lateral opening-wedge technique, each with its advantages and disadvantages. One potential advantage of the medial closing wedge osteotomy is a lower nonunion rate compared to opening wedge osteotomy (6-8). The limitation of the latter is the opposite medial cortex that acts as a hinge, limiting the amount of correction, once its integrity is essential for maintaining stability and attained alignment (9).

Several instruments have been introduced for fixation of the osteotomized bone. In recent years, locking plates have been developed to overcome the problem of a possible opposite cortex breakage (10). Despite favorable biomechanical and clinical outcomes, the use of locking compression plates (LCPs) is not affordable worldwide and so angle blade plates (ABPs) are commonly used due to their lower cost. Some limited studies compared

Corresponding Author: Reza Minaei, Bone Joint and Related Tissue Research Center, Akhtar Hospital, Shahid Beheshti University of Medical Sciences, Tehran, Iran
Email: rezaminaeiortho@gmail.com

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the LCPs and ABPs in the distal femoral region (6, 11). However, to our knowledge, no one compared clinical outcomes of these two devices for fixation of distal femoral osteotomy. In the current prospective study, we compared the rate of correction of valgus deformity and complications of supracondylar osteotomy using the LCP and ABP.

Materials and Methods

Between 2010 and 2014, 40 patients (age: 20-30) with bilateral idiopathic genu valgus deformity underwent a medial closed wedge distal femoral osteotomy in Akhtar Hospital. Patients with ligamentous instability, arthritis, history of surgery or trauma around the knee, neurovascular disease, and other lower limb deformities were not included in the study. Surgical indications included valgus malalignment >12°, the intermalleolar distance >5 cm, decreased lateral joint space, and cosmetic problems. The ethical committee approved the study and patients were asked to sign an informed consent.

Patients were randomly assigned to two equal groups: 1) angled blade plate (ABP) and 2) locking compression plate (LCP) group. Patients' demographics were collected, body mass index (BMI) and medical history were recorded. After undergoing a physical examination, an anteroposterior and lateral weight bearing long leg radiography was taken. On the x-rays, the mechanical medial proximal tibial angle (mMPTA) and mechanical lateral distal femoral angle (mLDFA) were measured using MicroDicom software. Mechanical lateral distal femoral angle was defined as the lateral angle between the femoral mechanical axis and the line tangent to the distal femoral articular surface. Mechanical medial proximal tibial angle was defined as the medial angle between two lines: the tibial mechanical axis and the proximal articular surface line of the tibia. Before the operation, the length of the base of the wedge was calculated based on the tangent of the required correction angle as below:

The tangent of the angle = length of the base of the wedge/diameter of the bone at the level of osteotomy on the anteroposterior x-ray.

Surgical technique

On the lateral aspect of the knee, a direct longitudinal incision was made 10 cm proximal to the joint line. While the knee was fully extended, under C-arm visualization, a guide pin was inserted parallel to the joint line in the distal of the femur at the level of the superior pole of the patella [Figure 1]. The osteotomy was initiated from the lateral cortex of the femur and a medially base wedge of bone was removed. Finally, the femur was aligned in all desired directions (axial, coronal, and sagittal) and fixated using the ABP or LCP.

The limb was immobilized for two weeks using commercial knee splints. Weight bearing was not allowed for six weeks. At the end of the second postoperative week, range of motion (ROM) exercises were started. Partial weight bearing was allowed after six weeks and gradual full weight-bearing as tolerated. Patients were followed for one year and x-rays were taken every 3 months. Lack of union after nine months was defined as nonunion. At the last x-rays, the mLDFA and tibiofemoral angle were measured.

The statistical analysis was performed using SPSS statistical software (version 15.0; SPSS, Chicago, IL). The pre- and post-operative angles were compared using the paired t-test. The quantitative and qualitative variables were compared between the two groups using the independent samples t-test and Chi square test, respectively. $P<0.05$ was considered significant.

Results

The demographic characteristics of the patients are compared in Table 1. There was no statistically significant difference between the two groups in terms of age, gender and body mass index. The mMPTA averaged 88.5±1.7 degrees (range: 85-91), showing none of the patients required correction of the proximal tibial bone. As shown in Table 2 the mean valgus angle and mLDFA improved significantly after the operation in the two groups. Although the valgus angle and mLDFA were the same preoperatively, the postoperative differences between the two groups were statistically significant ($P<0.05$) [Table 2].

All of the femurs united in the ABP group within the postoperative nine months [Figure 2, 3 and 4] and there were four cases with nonunion in the LCP group ($P=0.35$). [Figure 5] The LCP was removed in these patients and the osteotomy site was fixated with ABP and autologous bone graft was used in these cases. There were no other major complications such as infection, neurovascular injury, or device failure.

Table 1. Comparison of demographic characteristics between two groups

Group		LCP(n=20)	ABP(n=20)	*P* value
Age (year)		24±3.3 (20-30)	25.5±3 (20-30)	0.163
gender	Male	7	9	0.519
	Female	13	11	
BMI (kg/m^2)		24.6±1.9 (22.6-27.5)	25.2±0.9 (23.1-27.7)	0.318

Table 2. Comparison of pre- and post-operative mLDFA and valgus angle between two groups

Group		LCP(n=20)	ABP(n=20)	*P*
Valgus angle (degree)	Preoperative	14.6±3.2 (12.3-24)	15.3±3.7 (12-22.5)	0.538
	postoperative	5.4±2.1 (1.5-7.6)	3.1±1.8 (1.4-6.5)	0.032
mLDFA (degree)	Preoperative	79.9±1.7 (77-82)	80.5±2.2 (78-82)	0.525
	postoperative	87.6±2 (82-90)	89.7±3.2 (83-92)	0.041

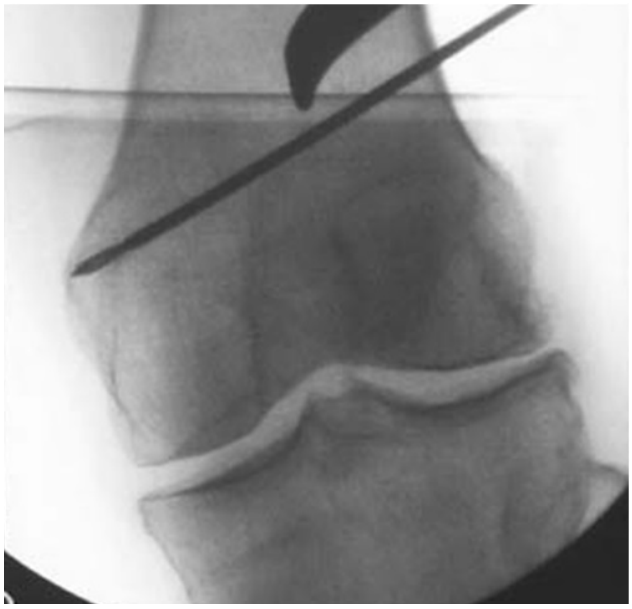

Figure 1. A guide pin was inserted parallel to the joint line in the distal of the femur at the level of the superior pole of the patella.

Discussion

The aim of SCO in adults is to restore normal and optimal joint symmetry to prevent disability of the knee and osteoarthritis. Supracondylar osteotomy has been used for several decades to correct the deformities of the distal femur in all three planes (12). Although, initially, some surgeons tended to correct the valgus knee by high tibial osteotomy, subsequent unsatisfactory outcomes have caused the surgeons to consider the osteotomies proximal to the knee joint in patients with substantial valgus deformity mainly located in the femoral bone (13, 14). For valgus deformities >12 degrees or when the joint direction is deviated >10 degrees on the horizontal plane, a SCO should be performed (4, 15).

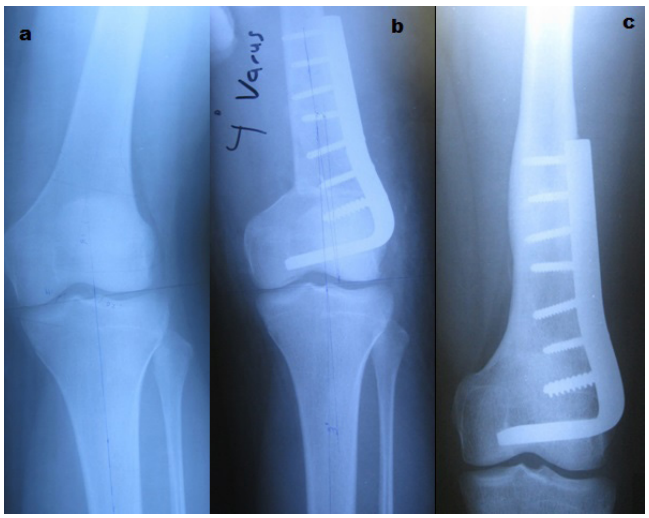

Figure 3. a) Preoperative anteroposterior radiographs of a valgus knee. b) Four months after supracondylar osteotomy using angled blade plate and c) one year post-operative anteroposterior radiographs showing complete union of the osteotomized bone.

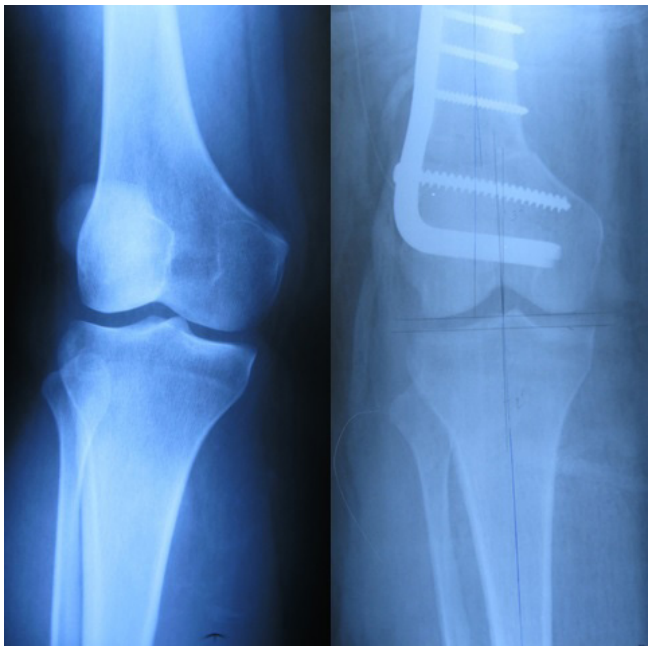

Figure 2. Pre- and one year post-operatively anteroposterior radiographs of a valgus knee that underwent supracondylar osteotomy using the angled blade plate.

Supracondylar osteotomy is currently used all over the world with good outcomes for the treatment of patients with gonarthrosis of the lateral knee compartment and primary genu valgum (2-7, 16-18). There are several factors affecting the results of the surgery. The method of fixation, especially stability of the plate and osteotomy construct, is one of these factors considerably influence the final results of the osteotomy (19, 20).

Angled blade plate has been used widely for the fixation

Figure 4. Anteroposterior radiographs after the angled blade plate (ABP) removal.

Figure 5. An anteroposterior radiograph of a valgus knee that underwent supracondylar osteotomy using the locking compression plate showing nonunion 10 months after the surgery.

of the osteotomy site in recent decades. Conventionally, these plates were utilized to fix the bone fragments in the osteotomy site while the surgeon was able to change the bone direction in three planes (12). Wang et al. found satisfactory outcomes in 83% of their patients who underwent SCO for valgus gonarthrosis using the 90 degree ABP (21). Aglietti and Menchettie evaluated the outcomes of SCO fixed with ABP to treat patients with osteoarthritis of the lateral knee compartment and after nine years they found that valgus angle decreased from 17.5 to 6 degrees. The results were good or excellent in 77% of the patients (2). Recently, when comparing the results of SCO with the ABP or casting, Makhmalbaf et al. found that tibiofemoral angle was corrected significantly after two years (from 32±6 degrees to 7±3 degrees). The results were satisfactory; however, the complication rate was lower in the ABP group (5). In a study by Kosashvili et a.l, 33 SCOs using the ABP were followed with a minimum of ten years. The failure rate was 48.5% (16 SCOs) after 15.6 years. Of the remaining 17 SCOs, good or excellent outcomes were achieved in 10 SCOs (58.8%) (4).

Despite its several advantages and good outcomes, fixation of the SCO using the ABP is technically demanding and requires more experience and expertise (19). In addition, Learmonth, Marti et al., McDermott et al., Miniaci et al. and Stahelin et al. pointed out some complications such as hardware failure, nonunion and loss of correction in SCO with the ABP (22-24).

Locking compression plates were introduced to provide the rigidity for fixation of osteoporotic bone or comminuted periarticular fractures with easier application than ABPs (6, 11). Furthermore, LCPs afford multiple points of fixed-angle contact (25, 26). However, despite acceptable outcomes, these plates may be associated with some complications such as union problems (27-31).

Nowadays, LCPs and ABPs are used routinely for fixation of SCO, but to our knowledge, there is no study comparing the clinical results of SCO for valgus knee using the ABP and LCP. However, some authors compared the biomechanical properties of these implants in the fixation of SCO. Brinkman et al. compared the stability of five different plates and osteotomy configurations and found that the least amount of motion and highest stiffness was achieved with medial oblique closing-wedge osteotomy using the ABP. They showed that the LCP had no superiority over the ABP in SCO (19). Vallier and Immler in 2012, compared the outcomes of internal fixation of distal femoral fractures utilizing the ABP (32 fractures) and LCP (39 fractures). In their study, malunion occurred in 11% of the LCP group and 3.4% of the group. Also, nonunion developed in 16% of the LCP group and 3.4% of the ABP group, respectively. They found that complications were more frequent in the LCP group (35% versus 10%) (11).

Before discussing our results, it seems necessary to explain the osteotomy technique that has been used in the current study. Clearly, the medial closing wedge osteotomy is more stable than the lateral opening wedge osteotomy due to the contact between the two osteotomized bones. However, we performed the medial closing wedge osteotomy through the lateral approach due to convenience and concerns about the injury to several important neurovascular structures located in the lateral aspect of the distal femur. Furthermore, since the lateral aspect of the femur is the tension side of the bone, we performed the lateral plating and did not encounter any biomechanical problems. In our study, we compared the clinical and radiological outcomes of SCO fixated with the ABP or LCP. We did not find any other study that similarly investigated the effects of type of implant on the outcomes of medial closing wedge SCO. The current study showed that valgus angle decreased significantly in the two groups with a statistically greater amount in the ABP group. Also, the amount of mLDFA correction was significantly greater in the ABP group. Although, one might assume that this difference has no important clinical effect, you should know that the most important finding of the current study was the considerable number of nonunions that occurred in the LCP group (20%). The difference between the two groups was not statistically significant, however, it seems that the difference could be significant if there were more patients enrolled into the current study. The authors think that the cause of nonunion with LCPs is

the lack of contour accordance between the plate and osteotomy site contours after surgery and correction of the deformity. This mismatch between implant-bone construct results in increased tension on the construct and disturbed union of the bone. In addition to lower union complications, ABPs are cheaper and more economical than LCPs which is an important aspect for selecting the appropriate treatment option (6, 11).

The current study was limited with the relatively small sample size. Also, we did not compare the long-term outcomes of the SCO between the two groups. More future studies are required to investigate and compare the effects of implant type on long-term clinical, functional, and radiological outcomes of SCO.

Supracondylar osteotomy fixated using the ABP or LCP is an efficient surgical procedure to correct the genu valgum. However, regarding the rate of nonunion, it seems that ABPs are more reliable instruments for the fixation of the osteotomized bone. Furthermore, the amount of correction of the valgus angle and mLDFA was significantly greater in the ABP group encouraging the use of these implants.

Seyyed Morteza Kazemi MD
Reza Minaei MD
Farshad Safdari MD
Rozhin Forghani MD
Bone Joint and Related Tissue Research Center, Akhtar Hospital, Shahid Beheshti University of Medical Sciences, Tehran, Iran

Ali Keipourfard MD
Akhtar Hospital, Shahid Beheshti University of Medical Sciences, Tehran, Iran

Alemeh Mirzapourshafiei MD
Clinical Research Development Center, Babol University of Medical Sciences, Babol, Iran

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