ORIGINAL ARTICLE

Fixator Assisted Plating For Correction Of Genu Valgum Femoral Deformity In Adults

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Abstract

Background: ***Genu valgum, a common orthopedic condition, causes lateral mechanical axis deviation and can lead to knee damage. Distal femur wedge osteotomy with fixator-assisted plating corrects this deformity acutely, letting surgeons assess and maintain correction before final fixation.***

Objective: ***This study evaluates the clinical and radiological outcomes of adults with genu valgum femoral deformity treated with distal femoral osteotomy and fixator-assisted plating. It assesses the benefits, accuracy, functional results, and complications of this technique.***

Materials and Methods: ***A prospective case series study was conducted from July 2023 to July 2024, involving 20 patients treated with fixator-assisted plating.***

Results: ***The study included 20 patients (13 females, 7 males) with a mean age of 22 years (range 14-42). Etiologies included post-rachitic (30%), post-traumatic (25%), and idiopathic (45%) causes. Preoperatively, the mean mLDFA was 78±4.34°, TFA was 15±4.2°, and MAD was 29±5.49 mm. Postoperatively, these values improved to mLDFA 88±1.95°, TFA 6±1.31°, and MAD 5±1.92 mm. Seventeen patients achieved excellent functional outcomes based on the Bostman score, while three had good satisfaction. Complications: Complications included overcorrection in three cases, one case of delayed union, and one case of limited knee flexion that improved with physiotherapy. No cases of nonunion, infection, neurovascular injury, or implant failure were reported.***

Conclusion: ***Fixator-assisted plating of the distal femur is a simple, safe, and low-cost procedure that provides accurate and successful correction of acute deformities, yielding excellent functional outcomes and patient satisfaction.***

Keywords: Fixator-assisted plating distal femur; Distal femur osteotomy in adults; Femoral genu valgum acute correction

1. Introduction

Deformities of the long bones in the lower extremities may arise from a variety of causes, such as sequelae of trauma, metabolic disorders, skeletal dysplasia, infections, and congenital limb deficiencies. Valgus deformities may predispose individuals to discomfort, knee instability, ligamentous injury, and degeneration of cartilage .[1]

Genu valgum is a prevalent orthopedic condition characterized by a lateral deviation of the mechanical axis. This condition may manifest as either physiological or pathological.[2]

The normal anatomical alignment of the knee is approximately 5° to 7° of valgus. Any alterations in the mechanical axis of the knee may result in harm to the knee joint .[3]

In cases of valgus deformity, the excessive pressure is concentrated on the lateral compartment. A distal femur wedge osteotomy may be utilized for the acute correction of this deformity .[4]

The aim of surgical intervention for pathological genu valgum is to restore the normal alignment of the mechanical axis and the orientation of the joint.[5] The advantage of the fixator assisted plating technique is the surgeon maintains control of the osteotomy, and the position may be checked with x-ray, then the fixator adjusted to modify the position as required. Upon achieving optimal alignment, a plate is introduced to keep the position, thereby facilitating the removal of the fixator .[6]

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Fixator-assisted plating is the preferred option for cases with a closed growth plate; however, it is important to acknowledge the complications associated with internal fixation. These complications may include delayed union, implant failure, the necessity for a second major surgical procedure to remove the internal implant, and the possibility of deep infection.[7]

The aim of this study was to evaluate the clinical and radiological outcomes of adults with genu valgum femoral deformity treated with distal femoral osteotomy and fixator-assisted plating. It assesses the benefits, accuracy, functional results, and complications of this technique.

2. Patients and methods

A prospective case series investigation among July 2023 and July 2024, twenty patients with distal femoral genu valgum deformity had treated by fixator assisting plating distal femur (in El Hussein and Sayed Galal university hospitals) thirteen were females and seven were males, the mean age at time of presentation was 22 years range (14-42), according side of deformity 12 were bilateral deformity, five were left sided and three right sided. The cause of the deformity was idiopathic (9 patients), post-rachitic (6 patients), and post-traumatic (5 patients).

The data collected from participants is confidential. No participants were identifiable by name in any report or publication related to this investigation. Prior to the participants' admission to this investigation, the investigation's aim, nature, and risk-benefit evaluation have been clarified to them. Informed consent was acquired. Inclusion criteria involved patients managed by distal femur osteotomy and plate fixation, both sexes were included, males aged sixteen years or older, females aged fourteen years or older, a degree of deformity not more than 20 degrees, and all patients available for a minimum of 6-month postoperative follow-up. At the same time, exclusion criteria involved patients who complain of generalized deformity, those who complain of systemic disorder, and patients managed by proximal tibial osteotomy or other methods of fixation.

A complete history was taken include; name, age, sex, residence and telephone number of relative; clinical history of onset, course and duration of complain or associated medical condition to clarify the cause of genu valgum, followed by general and local examinations for the deformity (site, degree), any skin condition, bilateral leg length, range of movement, neurovascular state, and any associated conditions and routine laboratory investigations. After that, a radiological investigation was conducted involving X-ray of the distal femur and knee (AP, LAT) and X-ray scanogram showing mechanical axis deviation and angles.

Operative procedures:

Preoperative preparation and positioning:

All cases received prophylactic antibiotics before the administration of anesthesia. The cases have been positioned supine on a radiolucent table under spinal anesthesia; verify that both lateral and AP views may be acquired by fluoroscopy.

The surgical approach:

Skin Incision: Skin incision along the mid-lateral line of the femoral shaft, curving it anteriorly across the lateral femoral condyle, beginning two fingerbreadths distal to the lateral epicondyle and extending the incision proximally up to twelve centimeters. [Figure 1]

Exposure of the bone: Incise the iliotibial band along the skin incision, then cut the fascia of the vastus lateralis muscle, positioning the incision just anterior to the lateral intramuscular septum, and elevate the muscle fibers of the septum, then retract the vastus lateralis anteromedially. [Figure 1]

Figure 1. skin incision and exposure of the bone

Fixator application in the femur: Type of fixator: Uni-planar design.

In this technique, the external fixator is fixed to the distal third of the femur. Schanz are inserted in the diaphysis, on the anteromedial aspect of the femur under fluoroscopic control. The distal schanz is inserted in the medial condyle about 0.5 cm above the articular cartilage. Proximal Schanz inserted a few centimeters above the palatal proximal end in the diaphysis of the femur. [Figure 2]

Open wedge osteotomy: A guide wire is inserted into the distal femur from lateral to medial with the knee in extension and under fluoroscopic guidance at the site of CORA and through the bisector line, which should be identified preoperatively. The osteotomy is performed by multiple drilling of the lateral cortex parallel to the guide K-wire. A sharp osteotome or saw is utilized to finish the osteotomy across the anterior and posterior cortices. [Figure 2]

Closed wedge osteotomy: A guide wire is inserted into the distal femur from lateral to medial with the knee in extension and under fluoroscopic guidance, where the apex is in the lateral cortex at the site of CORA. Then, according to the bisector and angulation correction axis, which is preoperatively measured, we determine the degree

of angulation of the K wire. The osteotomy is performed by multiple drilling of the lateral cortex parallel to the guide K-wire. A saw or sharp osteotome is used to finish the osteotomy, and we approach the osteotomy end to end. [Figure 2]

After conclusion of the osteotomy, mechanical alignment correction of the leg is carried out utilizing the fixator hinge for adjustments in the frontal plane. The osteotomy is then easily adjusted to the required degree of correction.

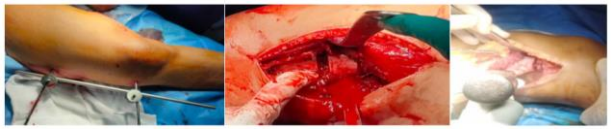

Figure 2. Fixator application in the femur and wedge osteotomy

Mechanical axis assessment: Before fixation, the mechanical axis is assessed utilizing a specialized guide rod or diathermy cable that is sufficiently long to extend from the center of the femoral head to the center of the ankle. The rod's location over the knee joint is verified via fluoroscopy. The neutral mechanical axis should be positioned about at the center point of the tibial plateaus, situated between the tibial spines. [Figure 3]

Figure 3: fluoroscopic images of the assessment of the mechanical axis intraoperatively after osteotomy.

Plate insertion: The appropriate length plate for the osteotomy is determined. The distal femur locked plate is secured by matching the contour of the plate with the distal segment of the lateral femur, then inserting appropriate length cancellous locking screws into the metaphysis distal to the osteotomy site and cortical screws into the diaphysis proximal to the osteotomy site. [Figure 4]

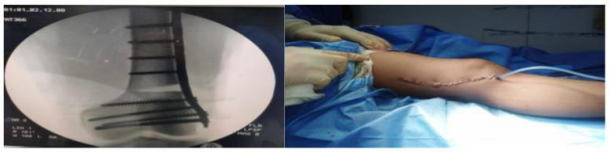

Figure 4. Fluoroscopic image after fixing osteotomy by plate and photographic image after closure of the wound.

Postoperative management:

The case's vital signs have been monitored. Limb elevation has been maintained for one week postoperatively, and the drain has been checked. Antibiotics have been administered according to the hospital policy. Analgesics have been administered according to the case's compliance. Blood transfusion has been administered based on the preoperative general status and intraoperative bleeding.

Patients may do knee flexion and extension starting from the second postoperative day.

Partial weight bearing is permitted following six weeks. Full weight-bearing is typically achievable following eight to nine weeks, depending on radiographic confirmation of adequate bone healing.

Patient satisfaction

Bostman's score examines cases through follow-up. 8

The outcome is excellent if the case scored 28-30, good if scored 20-27, and poor if scored less than 20.

Table 1. Bostman's score. [8]

VARIABLE	POINTS
RANGE OF MOVEMENT (ROM):	
FULL EXTENSION AND THE ROM>120° OR WITHIN 10° OF THE NORMAL SIDE	6
FULL EXTENSION, MOVEMENT 90° TO 120°	3
PAIN:	
NON OR MINIMAL ON EXERTION	6
MODERATE ON EXERTION	3
IN DAILY ACTIVITY	0
WORK:	
ORIGINAL JOB	4
DIFFERENT JOB	2
CANNOT WORK	0
ATROPHY, DIFFERENCE OF CIRCUMFERENCE OF THIGH TEN CENTIMETER PROXIMAL TO PATELLA :	
< TWELVE MILLIMETER	4
TWELVE TO TWENTY FIVE MILLIMETER	2
> TWENTY FIVE MILLIMETER	0
ASSISTANCE IN WALKING:	
NONE	4
CANE PART OF THE TINE	2
CANE ALL THE TIME	0
EFFUSION:	
NONE	2
REPORTED TO BE PRESENT	1
PRESENT	0
GIVING WAY:	
NONE	2
SOMETIMES	1
IN DAILY LIFE	0
STAIR-CLIMBING:	
NORMAL	2
DISTURBING	1
DISABLING	0
TOTAL SCORE:	
EXCELLENT	30 to 28
GOOD	27 to 20
UNSATISFACTORY	<20

Statistical analysis: The statistical analysis has been done utilizing the SPSS 22.0 application for Windows (Chicago, IL, USA, 2007). While continues (quantitative) variables are presented

such mean SD, categorical (qualitative) variables are displayed as percentages. Additionally, the variance analysis test [paired t-test] compared continuous variables, whereas the Chi-square test analyzed categorical variables between groups.

3. Results

Our study was done on twenty patient 13 female (65%) and 7 male (35%), 8 unilateral (40%) and 12 bilateral (60%), 6 cases post rachitic (30%), 5 post traumatic (25%) and 9 idiopathic (45%), the mean age group 22 years old range (14-42), we had 12 patients managed by open wedge osteotomy whereas 8 patients managed by closed wedge osteotomy, the mean operative time was 125 min ranged (90-150). The mean time for full radiological union was 6 months ranged (4-9). One patient had bone grafting at the time of surgery witch had autogenetic bone graft.

Mechanical axis evaluation:

Table 2. Comparison among pre-operative and post-operative mechanical axis deviation (mm)

		STUDIED PATIENTS(N= 20)							LCOXON SIGNEDRANKS TEST	
		Mean	±SD	Median	IQR		Range			P- VALUE
MAD	Preoperative	29.55	±5.49	26.00	22.60	32.1	18.0	45.0		
	POSTOPERATIVE	5.67	±1.92	6.25	3.25	7.4	2.6	9.0	920	<0.001

P value less than 0.05 is significant, P value less than 0.01 is highly significant, SD: Standard deviation.

According to this table the mean MAD pre-operative 29±5.49 mm range (18-45) and after correction the mean was 5±1.92 mm range (2.6-9) which show complete restoration of normal mechanical axis deviation in all cases that indicate radiological improvement of all cases according to mechanical and functional outcome.

Table 3. Comparison between pre-operative and post-operative tibio- femoral angle (degree).

		STUDIED PATIENTS (N= 20)							REPEATED T TEST	
		Mean	±SD	Median	IQR		Range		T	P- VALUE
TFA	Preoperative	15.10	±4.20	14.50	12.00	18.50	10.0	23.0		
	POSTOPERATIVE	6.13	±1.31	6.00	5.00	7.0	4.0	8.0	12.15	<0.001

P value< 0.05 is significant, P value< 0.01 is highly significant, SD: Standard deviation.

According to this table the mean TFA preoperative 15±4.2-degree range (10-23) and after correction the mean was 6±1.31-degree range (4-8) which show complete restoration of TFA in all cases that indicate clinical improvement of all cases according to cosmetic and functional outcome.

Table 4. Comparison between pre-operative and post-operative mechanical mLDFA (degree).

		STUDIED PATIENTS (N= 20)							REPEATED T TEST	
		Mean	±SD	Median	IQR		Range		T	P-VALUE
MLDFA	Preoperative	78.20	±4.34	77.75	76.00	79.5	73.0	81.0		
	POSTOPERATIVE	87.95	±1.95	88.50	86.50	89.5	85.0	93.0	6.971	<0.001

P value less than 0.05 is significant, P value less than 0.01 is highly significant, SD: Standard deviation.

According to this table the mean mLDFA was 78±4.34-degree range (73-81) preoperatively and after correction the mean was 88±1.95 range (85-93) this show complete restoration of mLDFA in 17 cases and 3 cases had mild over correction which compensated the tibial source deformity.

Complications: [Figure 5]

Three cases had over correction as they had proximal tibial mild degree of genu valgum witch compensated by distal femur mild over correction, one case of delayed union detected with open wedge osteotomy without graft and one case with limited flexion of the knee that responds well to exercise and physiotherapy, no case of nonunion, infection, neurovascular injury or implant failure was detected in our study.

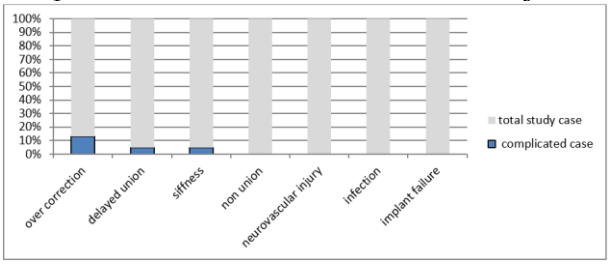

Figure 5. Complications

Patient satisfaction:

Evaluation had done 6 months after surgery using the bostman's score; 17 cases had excellent score, 3 cases were good and no cases with poor satisfaction were detected in our study.

4. Discussion

Genu valgum deformity is defined as lateral mechanical axis deviation, distal femur wedge osteotomy could be utilized for acute improvement of the deformity. [4]

Corrective osteotomy is the gold standard for the management of acute correction in adults However, it is a significant surgical procedure associated with operative site morbidity, postoperative pain, and extended therapy necessitating internal or external fixation and limited weight-bearing, which are the primary disadvantages of this surgery .[9]

Osteotomies are high-risk procedures, associated with a minor yet notable occurrence of compartment syndrome, neurovascular damage, overcorrection or under-correction, and delayed union or nonunion (10). Fixator-assisted plating of the distal femur is applicable for accurate and efficient acute deformity repair. This technique's advantage lies in its ability to utilize the optimal aspects of both internal and exterior fixations. [6]

In our investigation we determined the accuracy of the fixator assisted plating in the correction of genu valgum femoral deformity and evaluated radiological and clinical outcomes comparing the preoperative and postoperative measurements and detected the safety of the utilization of the method by reviewing the problems.

Our investigation has been done on 20 case 13 female (65%), 7 males (35%), 8 unilateral (40%), 12 bilateral (60%), 6 cases post rachitic (30%), 5 post traumatic (25%) and 9 idiopathic corrections (45%). In our study the mean age group 22 years old range (14-42), the mean follow up 6 months ranged (4-9).

The mean mLDFA was 78±4.34 degree range (73-81) preoperatively and after correction the mean was 88±1.95 range (85-93), the Mean TFA preoperative 15±4.2 degree range (10-23) and After correction the mean was 6±1.31 degree range (4-8), the Mean MAD pre-operative 29±5.49 mm range (18-45) and after correction the mean was 5±1.92 mm range (2.6-9).

In agreement with our study, Eidelman M et al,[10] describe the procedure of fixator-assisted plating utilizing a supracondylar locking plate over a span of three years, during which six cases (seven femurs) with distal femoral valgus deformities of various etiologies have been treated. All cases attained repair of the abnormalities and started full weight bearing, with radiographic evidence of union observed six weeks' post-correction, we had almost the same results as we achieved normal mechanical axis alignment in all cases and all cases started full weight six weeks after correction.

Similarly, S. Robert Rozbruch[11] study evaluated thirty-six extremities in twenty-seven cases by using fixator-assisted plating of the distal femur and their results show pre-operative MAD 34 mm lateral (8-83) and post-operative 8 (2-14) The average preoperative mLDFA was 805 (78-82) and the average postoperative mLDFA was 895 (83-94), which show approximately the same results to our study where we achieved normal mechanical axis alignment in all patients.

In our series we have one case with limited flexion of knee that responds well to physiotherapy, two cases with edema of foot and managed by limb elevation and anti-inflammatory, one case of delayed union detected with open wedge osteotomy without graft, three case with over correction were detected due to presence of mild tibial genu valgum in this cases witch compensated by femoral over correction for restoration normal mechanical axis. No case with under correction, nonunion, infection, neurovascular injury or implant failure was detected in our study.

Mathews et al.[12] Twenty-one patients with valgus deformity of the knee had distal femoral supracondylar osteotomy and had rigid internal fixation with plate. Fifty-seven percent had a significant problems, involving severe knee stiffness requiring manipulation under anesthesia (forty eight percent), nonunion/delayed union (nineteen percent), infection (ten percent), and fixation failure (5%), this study shows more complications than our results as we had only one case of delayed union but we don't have any cases of nonunion, infection, neurovascular injury or implant failure was detected in our study so that the fixator play role in decrease post-operative complication as it gave stability to osteotomy site that help the surgeon to determine the type and the position of the plate.

S. Robert Rozbruch,[11] study evaluated 36 extremities in 27 patients, their results show 32 cases reach fully correction with 2 cases under correction and 2 cases with over correction, in our study we had 3 cases with overcorrection where distal femur over correction was detected due to presence of mild tibial genu valgum.

Also, Puddu et al.[4] The researchers investigated various types of osteotomies to determine the most effective treatment for valgus deformity, concluding that distal femoral osteotomy alone is preferred in cases of moderate to severe tibiofemoral angles, at the same to our study we did 5 cases with high degree of genu valgum deformity with closed wedge osteotomy and we had reached fully correction without any complications.

We should focus, especially in the first six months, because neglect is a major cause of early and late difficulties in both other studies and our one.

Strength And Limitation: The over hand of our study that we used the external fixator in the femur that facilitate the surgery and plate insertion and give more ability to control the correction angle. We did the medial closed wedge of distal femur by make incision over lateral aspect of thigh which is safer and more favorable in case with sever angle deviation. There are limitations in our study due to the sample size limited to 20 cases, we didn't utilize a standard functional test or score.

4. Conclusion

Osteotomies can be necessary for the treatment of valgum abnormalities in adults. Fixator-assisted plating of the distal femur is a simple, secure, and cost-effective method utilized for accurate and successful acute deformity correction, resulting in consistently favorable outcomes. This technique's advantage lies in its ability to utilize the optimal aspects of both internal and external fixations. Correction of deformity may be accomplished during the surgeon retains control over the osteotomy position. This approach serves as an alternative to external fixation and offers the advantage of eliminating the need for the case to wear a frame for three months.

Disclosure

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