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Research Article

Radiological And Functional Outcomes of Corrective Osteotomy in Genu Valgum Stabilized By K-Wire Fixation in Adolescents Aged 12–18 Years: A Prospective Study

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ABSTRACT

Background: Genu valgum persisting into adolescence can cause altered biomechanics, patellofemoralmal tracking, and predispose to early osteoarthritis. Corrective distal femoral osteotomy is the treatment of choice in near-skeletal maturity. K-wire fixation offers a cost-effective and minimally invasive stabilization method, particularly useful in resource-limited settings.

Objective: To evaluate radiological and functional outcomes of corrective distal femoral osteotomy stabilized by K-wire fixation in adolescents with genu valgum.

Methods: A prospective interventional study was conducted on 27 adolescents (24 females, 3 males; mean age 15.07 years) with tibiofemoral angle (TFA) >15° and intermalleolar distance (IMD) >10 cm (bilateral) or >7 cm (unilateral). All underwent medial closed-wedge distal femoral osteotomy stabilized with cross K-wires and cylindrical cast. Radiological (TFA, lateral distal femoral angle [LDFA]), clinical (IMD), and functional (Böstman score) outcomes were assessed preoperatively and at 6 months. Statistical significance was set at $p<0.05$.

Results: Significant improvements were observed postoperatively: IMD decreased from 11.74 ± 2.36 cm to 5.11 ± 2.08 cm ($p<0.001$); TFA improved from 16.04° ± 2.07° to 7.48° ± 1.45° ($p<0.001$); LDFA increased from 73.48° ± 3.70° to 86.30° ± 1.94° ($p<0.001$). The mean Böstman score rose from 23.41 ± 4.14 to 28.33 ± 1.96 ($p<0.001$). At final follow-up, 74.1% of patients had excellent and 25.9% good functional outcomes. No major complications were noted, and patient satisfaction was universally high.

Conclusion: Distal femoral osteotomy stabilized with K-wires is a safe, effective, and economical option for correcting genu valgum in adolescents, providing significant radiological correction, excellent functional outcomes, and high patient satisfaction with minimal complications.

Keywords*: Genu valgum, corrective osteotomy, K-wire fixation, distal femur, adolescents.*

INTRODUCTION

Coronal plane deformities of the knee, particularly genu valgum, are a frequent cause of orthopedic consultation in pediatric and adolescent populations. While physiological genu valgum often resolves by age 7, persistence into adolescence is pathological and requires intervention. Left untreated, it predisposes to altered biomechanics, patell ofemoralmal tracking, and early-onset osteoarthritis. Corrective osteotomy is the treatment of choice in adolescents nearing skeletal maturity where guided growth is ineffective. Among fixation options, Kirschner wire (K-wire)

stabilization is widely used in resource-constrained settings due to its simplicity, cost-effectiveness, and ease of removal. However, literature on its efficacy in adolescents remains limited. This study evaluates the functional and radiological outcomes of distal femoral osteotomy stabilized by K-wires in patients aged 12–18 years

MATERIALS AND METHODS

Study Design: Prospective interventional study conducted at the Department of Orthopaedics, ESIMC, Basaidarapur, New Delhi, over two years with ethical clearance obtained.

The inclusion criteria were 1) Unilateral or bilateral GV having tibiofemoral angle (TFA) more than 15° and intermalleolar distance (IMD) in standing position, more than 10 cm for bilateral and 7 cm for unilateral deformity 2) Age between 12 to 18 years 3) No active metabolic abnormality. Patients who had Age 18 years, patient not willing for regular follow up, origin of deformity in proximal tibia, patient having femoral condyle dysplasia, no metabolic abnormality. Patients were assessed in out-patient department for lower limb scannogram, calculation of LDFA and TFA and Bostman score included in the study after informed consent. The knee flexion test is done to rule out Genu valgum involving proximal tibia. The preoperative aTFA (anatomical tibio-femoral angle) and LDFA (lateral distal femoral angle) is calculated in scannogram. (Figure 1 and 2)

Figure 1: Clinical photograph of a patient with bilateral genu valgum.

Figure 2: Antero-posterior radiograph of bilateral hip, knee and ankle showing different angle measurements. Line AB = Mechanical axis of the lower limb; AC = Mechanical axis of femur; DE = Articular surface of distal femur; FG = Anatomical axis of femur; HI = Anatomical axis of tibia. Tibiofemoral angle = Angle between line FG and line HI; lateral distal femoral angle = Angle between line AC and DE

Description of clinical grading scale of Bostman:

Variable	Points
Range of movement (ROM)	
Full extension and the ROM >120° or within 10°	6
of the normal side	3
Full extension, movement 90° to 120°	
Pain	
None to 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 10 cm proximal to the patella	
<12 mm	4
12-25 mm	2
>25 mm	0
Assistance in walking	
None	4
Cane part of the time	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

LDFA is calculated by angle formed between line drawing through mechanical axis of femur and line parallel to joint orientation line while TFA is calculated by angle between anatomical axis of femur and tibia (Figure 1 and 2).

The outcome was evaluated regarding corrective changes in TFA and LDFA postoperatively. Also for functional outcome postoperative Bostman Score is calculated.

Operative Procedure

Surgical Technique and procedural steps:1)The patient was laid supine on the operation table. Appropriate anaesthesia, either general or spinal, was administered. 2) The surgical site was painted and draped aseptically. 3)A 4–5 cm long incision was made on the medial side of the knee intended for genu valgum correction. 4)The deep fascia was identified and incised, and the underlying muscles were carefully retracted. 5)Two K-wires were inserted—one parallel to the joint line and the other obliquely at the site of deformity in the femur or tibia, as determined by the knee flexion test—to form a wedge. 6)Osteotomy of the bone was performed, and the appropriate-sized wedge was removed. 7)The osteotomy site was confirmed under C-arm imaging, and the deformity was corrected using a gentle varus force. The wedge site was fixed using two K-wires (preferably of >3mm) in a cross configuration. 8)The tourniquet was removed, hemostasis was achieved, and the wound was closed in layers. 9)Finally, a cylindrical cast was applied.

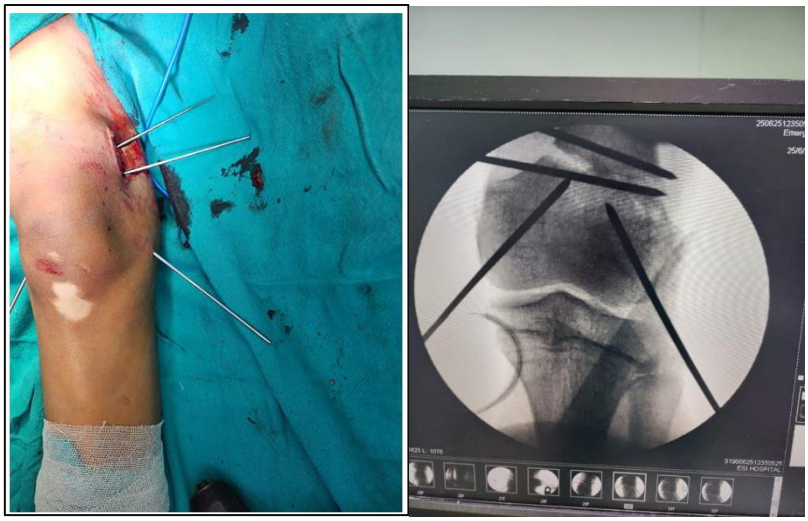

Figure 3: Intraoperative clinical photographs and c-arm images

Postoperative protocol

1)The first postoperative aseptic dressing was done after 48 hours and static quadriceps strengthening exercises started. 2) Patients were discharged accordingly and advised to follow up in the outpatient department after 2 weeks for suture removal. 3) K-wires were removed at 6 weeks, and the cast was reapplied until union of the osteotomy site was observed. 4) During this period, the patient was allowed partial weight-bearing ambulation with the aid of walker. 5) The cast was continued till 8 weeks, as radiological analysis confirmed union during follow-up. Thereafter, gradual full weight-bearing was permitted. Patients were followed quarterly and assessed clinically. 6) At the final follow-up at 6 months, IMD, clinical and radiological TFA, and LDFA were calculated. 7) Patients were also evaluated using the Bostman knee score, where scores between 28 and 30 were considered excellent, scores between 20 and 27 were considered good, and scores below 20 were classified as unsatisfactory. Subjective parental satisfaction was also recorded.

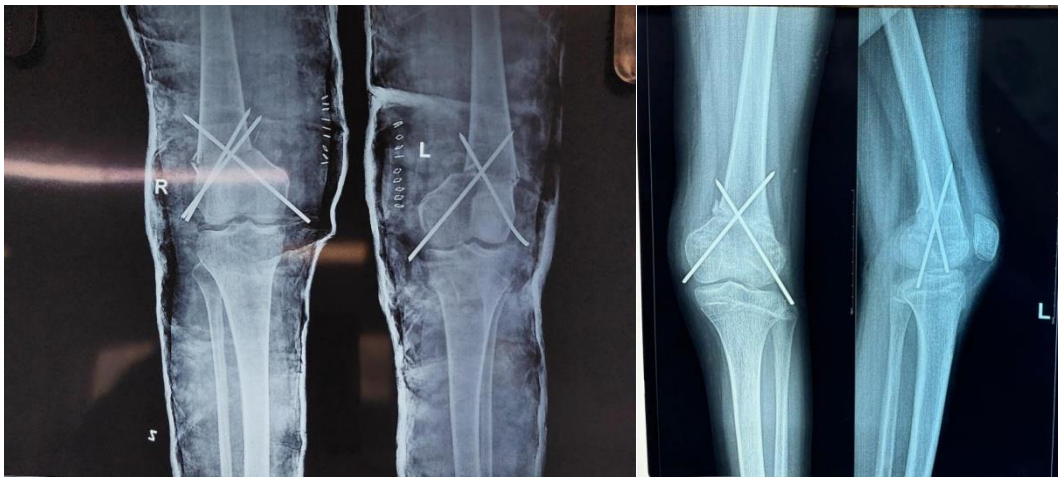

Figure 3: post operative x rays of follow up cases

Sample Size: Based on Smith et al. (2018) with 92.6% good outcome, sample size was calculated as 27.

Outcome Measures: Clinical (IMD, TFA), radiological (TFA, LDFA), and functional (Böstman score) assessments were performed preoperatively and at 6 months. Statistical analysis was performed with paired t-tests and Wilcoxon signed rank test; $p<0.05$ was significant.

RESULTS AND OBSERVATIONS;

Twenty-seven patients (24 females, 3 males) with a mean age of 15.07 years were included. Significant improvements were recorded across clinical, radiological, and functional parameters.

Table 2 presents the descriptive statistics for the age of patients included in the study.

	N (%)	Mean (SD)	Median (Min-max)	Mode
Total patients	27 (100%)	15.07 (1.75)	15 (13-18)	13
Male	3 (11.1%)	15.08 (1.77)	15 (13-18)	13
Female	24 (88.9%)	15 (2)	15 (13-17)	13

All patients were had undergone corrective osteotomy for genu valgum using K-wire fixation. None of the patients had any pre-existing medical conditions at the time of surgery.

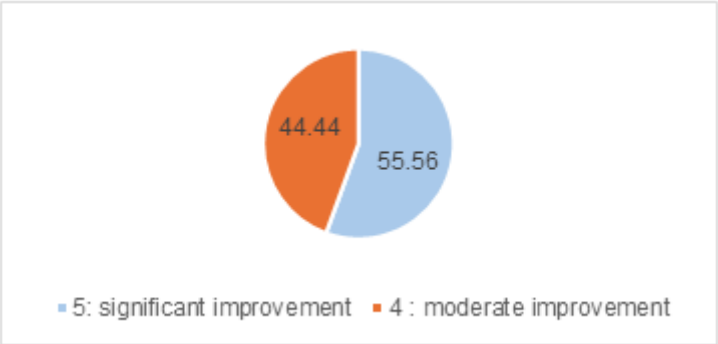

Figure 3: Long-Term Functional Outcomes with the Surgical Process

significant improvement (score 5) in their musculoskeletal function following corrective osteotomy with K-wire fixation. The remaining 44.44% experienced moderate improvement (score 4). Notably, no patients reported slight improvement, no change, or deterioration, suggesting that the surgical intervention yielded consistently favorable long-term functional outcomes.

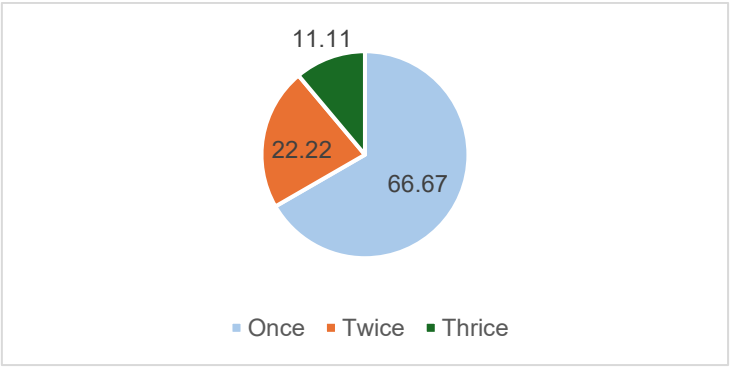

Figure 4: Frequency of Pain with the Surgical Process

Among those reporting postoperative pain, the majority experienced it only once (66.67%), followed by 22.22% who experienced it twice, and 11.11% who reported pain on three occasions. These findings suggest that in most cases, pain was transient and self-limiting, with only a few patients requiring repeated attention.

	N	Frequency
Once	18	66.67
Twice	6	22.22
Thrice	3	11.11
Total	27	100

Intermalleolar Distance was reduced from 11.74 ± 2.36 cm to 5.11 ± 2.08 cm ($p<0.001$).

Table 4: comparison of intermalleolar distance among patients (pre and post)

	Mean	Std. Deviation	Std. Error Mean
Pre	11.741	2.3631	.4548
Post	5.11	2.082	.401

Paired t test, level of significance set at $p < 0.05$

Table 5 presents the comparison of tibiofemoral angle (TFA) in degrees among patients before and after the intervention. The mean TFA reduced markedly from 16.04° (SD = 2.07) pre-intervention to 7.48° (SD = 1.45) post-intervention. The paired t-test showed a mean difference of 8.56° (SD = 0.89), with a standard error of 0.17. The 95% confidence interval for this difference ranged from 8.20° to 8.91°, indicating a consistent and substantial change. The t-value was 49.863 with 26 degrees of freedom, and the p-value was .0001, which is highly significant ($p < 0.05$). These findings confirm that the intervention led to a statistically significant correction in the tibiofemoral angle, indicating improved lower limb alignment.

Table 5: comparison of TFA (degree) among patients (pre and post)

	Mean	Std. Deviation	Std. Error Mean
Pre	16.037	2.0659	.3976
Post	7.48	1.451	.279

Paired t test, level of significance set at $p < 0.05$

Table 6: presents a comparison of the Bostman total scores among patients before and after the intervention, reflecting functional outcomes. The mean pre-intervention score was 23.41 (SD = 4.14), which significantly improved to 28.33 (SD = 1.96) post-intervention, indicating enhanced knee function and recovery. The analysis was performed using the Wilcoxon signed-rank test due to the ordinal nature of the score and possible non-normal distribution of data.

Table 6: comparison of Bostman total score among patients (pre and post)

	Mean	Std. Deviation	Std. Error Mean
Pre	23.407	4.1441	.7975
Post	28.333	1.9612	.3774

Wilcoxon signed rank test, level of significance set at $p < 0.05$

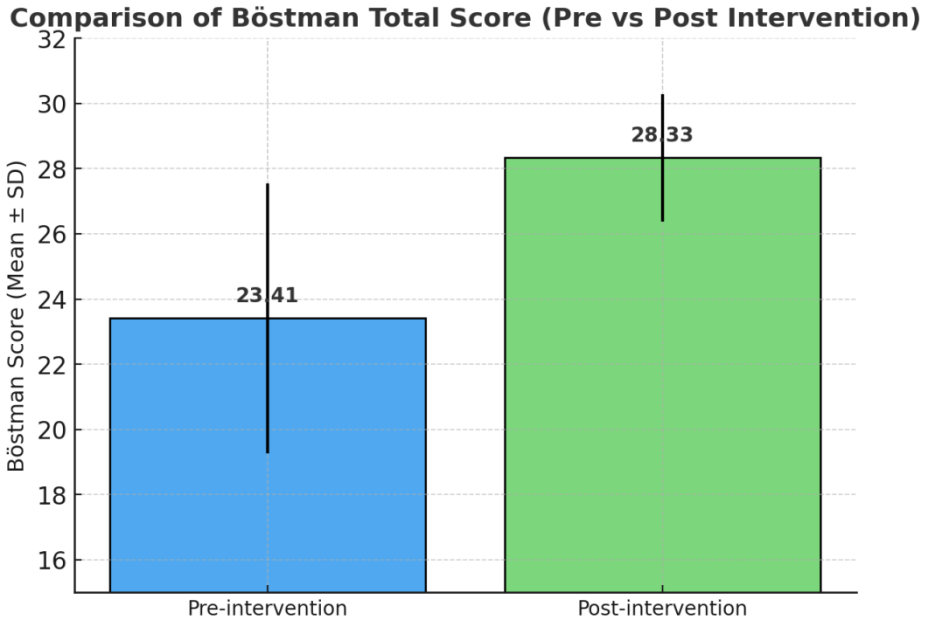

Figure 5: comparison of Bostman total score among patients (pre and post)

Before the intervention, 18.52% (5 out of 27) of patients had an unsatisfactory score, which reduced to 0% post-intervention. The proportion of patients rated as having an "excellent" outcome increased significantly from 11.11% (3 patients) to 74.07% (20 patients), while those in the "good" category decreased from 70.37% to 25.93%. This shift in the distribution clearly indicates that the intervention led to a significant enhancement in functional outcomes, with most patients achieving excellent postoperative results.

- Tibiofemoral Angle: Improved from 16.04° ± 2.07° to 7.48° ± 1.45° ($p<0.001$).
- Lateral Distal Femoral Angle: Increased from 73.48° ± 3.70° to 86.30° ± 1.94° ($p<0.001$).
- Böstman Score: Increased from 23.4 ± 4.1 to 28.3 ± 2.0 ($p<0.001$).

Functional outcomes were excellent in 74.1% and good in 25.9%. No major complications were noted. Patient satisfaction was high, with all patients recommending the procedure.

DISCUSSION

The present study evaluated the radiological and functional outcomes of corrective distal femoral osteotomy stabilized with K-wire fixation in adolescents aged 12–18 years with genu valgum. Our results demonstrated significant improvements in intermalleolar distance (IMD), tibiofemoral angle (TFA), lateral distal femoral angle (LDFA), and Böstman scores at 6 months follow-up, confirming the efficacy of this technique in restoring normal alignment and improving function.

The correction achieved in our cohort (mean TFA reduced from 16.04° to 7.48°) is comparable to findings in previous literature. Khandelwal et al. (2022) [21] reported good to excellent outcomes in 92.6% of patients under 18 years treated with distal femoral osteotomy stabilized by K-wires. Similarly, Sidhu et al. (2022) [22] demonstrated that wedgelessdistal femoral osteotomy with K-wire fixation yielded significant correction with minimal complications. Our

findings reinforce these results, suggesting that K-wire fixation provides reliable stability during bone healing in adolescents.

The improvement in LDFA from 73.5° to 86.3° in our study aligns with data from Avhad et al. (2024) [20], who compared K-wire fixation with plate osteosynthesis and reported comparable radiological corrections in late adolescents. While plate fixation provides rigid stability, it involves higher implant cost, soft tissue dissection, and hardware removal surgery [12,14]. In contrast, K-wires are economical, minimally invasive, and easy to remove without a second major procedure, making them especially suitable in low-resource settings [11].

Functional outcomes were excellent in 74.1% and good in 25.9% of our patients, consistent with systematic reviews on adolescent osteotomies that reported high rates of satisfactory outcomes following valgus correction [16]. Improvement in Böstman scores from 23.4 to 28.3 in our study reflects better pain relief, knee stability, and patient-reported satisfaction. These outcomes support the functional relevance of restoring normal coronal alignment, as altered biomechanics due to valgus deformity predispose to patellofemoralmaltracking, lateral compartment overload, and early degenerative changes if left untreated [7,17,18].

The safety of K-wire fixation in adolescents has been a subject of discussion. Schneidmueller et al. (2022) [11] highlighted the ongoing debate regarding whether to bury or leave K-wires exposed, noting that superficial placement may carry a risk of infection but simplifies removal. In our study, no major complications such as deep infections, implant migration, or nonunion were observed. Pain was generally mild and transient, resolving within the early postoperative period.

Our study also highlights the demographic predominance of genu valgum in females (88.9%). Previous studies have reported similar trends, with higher prevalence of valgus deformity in adolescent girls, possibly due to hormonal influences on growth plate physiology and pelvic width adaptation [6,19].

While the results are encouraging, some limitations must be acknowledged. The small sample size (n=27) and short follow-up (6 months) may not capture long-term outcomes, including recurrence of deformity or development of osteoarthritis. Moreover, our cohort predominantly consisted of females, which may limit generalizability. Future multicentric studies with larger samples and long-term follow-up are warranted to assess durability of correction, joint preservation, and quality-of-life outcomes [15].

CONCLUSION

Our study concludes that Genu valgum patients can be managed with medial closed wedge osteotomy fixed with 2-3 medial k-wires followed by cylindrical cast till radiological union achieved. It is a safe, simple, minimal implants and low cost procedure to correct valgum deformity. Minimal wound complications and avoidance of 2nd surgery. K-wire removal is also safe and easy and not require another surgery. This procedure gives good result clinically and radiologically.

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