International Journal of Chemical and Biochemical Sciences
(ISSN 2226-9614)

Journal Home page: www.iscientific.org/Journal.html

Comparison of the Outcome of High Tibial Osteotomy Using Plate versus Mono Lateral External Fixator

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Abstract

High tibial osteotomy (HTO) is a well-known procedure for the correction of knee varus. The aim of the present study was to compare the radiological results and accuracy of deformity correction performed using two different techniques: acute opening wedge correction using a plate and gradual correction with a monolateral external fixator. This was a prospective study of adolescents with genu varus which was conducted at Helwan University hospitals for one year. A sample of 30 children who matched the inclusion and exclusion criteria was included in the study to evaluate the results of the correction of genu varus with the use of monolateral external fixator (15 patients) vs plate (15 patients). Scanogram e x-ray lower limb done for the cases pre and post-operative at the same places so the degree of the correction after operation can be calculated clearly with satisfactory results to the patients. The result of the group A who were operated with plate show more complications such as infection,wound scaring and inability to remodule the wedge and the angles after the operation in comparison to the other group B who was operated with monolateral external fixator those only show pin tract infection and we can easily remodule the wedge and correct the angles even after the operation. In conclusion: Correction of genu varum in adolescent using plate and monolateral external fixator has nearly same good results in genu varum and improvement of MPTA and TFA and correction of MAD after surgical correction but weight bearing was much faster to those who operated by external fixator.

Keywords: High tibial osteotomy; Plate; Monolateral External Fixator ; Deformity Correction

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1. Introduction

Angular deformities of the knee are common during childhood. In most cases, this represents a variation in the normal growth pattern and is an entirely benign condition. Normally developing children undergo a varus phase between birth and 18 to 24 months of age, at which time there is usually a transition in alignment from varus to straight to valgus (knock knees), which will correct to straight or mild valgus throughout adolescence [1].

Angular deformities of the knee alter the biomechanics of the knee by causing a distorted stress distribution on the weight-bearing surface of the knee joint. The deformities of the tibia or femur in the frontal plane lead to mechanical axis deviation of the lower limb and misorientation of the joints above and below the level of deformity. The mechanical axis of the lower extremity is a straight line extending from the center of the femoral head to the center of the ankle. The horizontal distance in millimeters from the center of the knee joint to the mechanical axis is the deviation of the mechanical axis [2].

Correction of deformity around the knee depends on the position of Cora and the degree of deformity. Correction varies according to the age of the patient and position of deformity. Osteotomy is still considered the 'gold standard' by some, but it is associated with increased expenses and morbidities including overcorrection or under-correction, neurovascular risk, hardware healing problems, and recurrent deformity with growth [3].

Genu varum is relatively common in children and can be a frequent cause for parental concern. Numerous conditions can be responsible, and the natural history of the deformity can vary widely, ranging from fairly benign, physiological bowing requiring reassurance and observation only to more complex, pathological causes necessitating early intervention to prevent progressive deformity and disability [1].

The initial varus seen in children up to 2 years is known as 'physiological varus' and is by far the most common cause for genu varum in toddlers. Some children may lie outside the typical curve but still have physiological varus, particularly in early walkers who begin to ambulate before their first

birthday. A positive family history is often present. Physiological varus is typically bilateral and symmetrical [2].

Opening-wedge high tibial osteotomy is a well-established procedure in the management of medial osteoarthritis of the knee and correction of proximal tibia vara. Conventional opening-wedge high tibial osteotomy is associated with complications including implant breakage, lateral cortical fracture, fracture of the lateral tibial plateau, increased posterior tibial slope, delayed union or nonunion, delayed wound healing, and deep infection [4].

Since angle-stable locking plates were introduced, implant-related complications have been reduced considerably [5].

However, soft tissue problems, delayed union or nonunion, and deep infection still are reported to be relatively frequent in a conventional opening-wedge high tibial osteotomy, which may result from extensive soft tissue exposure to protect posterior neurovascular structures or to apply for the plate while maintaining a distractor in place during the surgery [6].

Recently, surgical approaches using less invasive plate osteosynthesis have been used in various fracture surgeries to diminish soft tissue complications and promote biologic bone healing [7].

The use of a mono lateral external fixator is also advocated in the case of large corrections. No bone graft has to be added to fill the gap. No additional surgery is needed for hardware removal [8].

Moreover, the most important advantage is that the degree of alignment correction can be set accurately on long-standing anteroposterior (AP) lower limb radiograph at fixed intervals, and in case of overcorrection, the wedge can be closed to the desired amount acting on the fixator. On the other hand, major concerns of this technique are pin tract infection and loss of correction [8].

An abnormal biomechanical axis of the lower extremity not only causes damage to the cartilage of the knee but also affects the outcome of knee ligament reconstruction surgery. The degree of pain relief experienced after varus deformity correction depends on the accuracy of deformity correction. Inaccurate correction may cause pain to persist [9].

Therefore, this study aimed to compare the radiological results and accuracy of deformity correction performed using two different techniques: acute opening wedge correction using a plate and gradual correction with a monolateral external fixator.

2. Patients and Methods:

This was a prospective study of children with genu valgus or genu varus which was conducted at Helwan University for one year. A sample of 30 children who matched the inclusion and exclusion criteria was included in the study.

Justification of sample size:

Through using z-score able with 1 confidence interval (95%) with consideration of estimated prevalence ratio of the disease in Egypt and census; 30 patients with genu varus were to be sorted.

Inclusion criteria:

Patients aged from 15 to 19 years. Genu varum having a metaphyseal-diaphyseal angle of more than 11 degrees.

Exclusion criteria:

Genu recurvatum, flexion deformity, pathological conditions (e.g: bone softening diseases), and severe deformities of more than 40 degrees when acute correction may lead to knee instability and nerve injury were excluded.

Ethical Consideration:

An approval of the study was obtained from Helwan University Academic and Ethical Committee. Written informed consent of all the participants was obtained. This work has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

Clinical evaluation:

All children were assessed using:

1- Clinical examination included the evaluation of pain,measurement of the range of flexion, and stability tension of the cruciate and collateral ligaments of the knee.
2- X-rays (weight-bearing anteroposterior, lateral, and full leg alignment films).
3- X-ray scanogram.
4- Serum levels of parathyroid hormone and calcium to exclude any parathyroid gland pathology that may contribute to the deformity

Surgical technique:

The patient is positioned supine on a radiolucent table to make sure that the ipsilateral hip, knee, and ankle joints can be visualized with the image intensifier. The operative extremity is prepared and draped in the usual fashion.

- *Genu varum:*

Fibular osteotomy: skin incision about 1 cm at the junction between middle and distal one third of the fibula and by the aid of C-arm drill bit 4.5 mm is used to make fibular osteotomy.

Placement of the proximal two Schanz screws through two minimal skin incisions on the medial side of proximal tibia under C-arm guide 1s Schanz screw is five or six mm depending on the patient age and placed below the proximal tibial epiphysis parallel to the joint line 2nd Schanz screw is of the same diameter and placed just blow the first Schanz.

Placement of distal two Schanz screws:

*Through minimal two skin incisions 4 cm distal to the proximal clamp

*3rd and 4th Schanz screws are placed in the tibial shaft from medial side to lateral one.

Proximal tibial osteotomy:

Skin incision about 1 to 2 cm length is done 1 cm distal to tibial tuberosity and by the aid of C-arm drill bit 4.5 mm is used to make tibial osteotomy site then we introduce an Osteotome to complete osteotomy (Fig. 1).

Genu varum using plate:

Skin incision about 5-7 cm at the anteromedial surface of proximal tibia. Insertion of k wire at site of osteotomy

directed towards head of fibula. By the aid of C-arm drill bit 4.5 mm is used to make tibial osteotomy site then we introduce an Osteotome to complete osteotomy. Opening of the wedge using help of your assistant to abduct the leg to open the wedge. Place the plate on the anteromedial surface of tibia considering that the proximal 3 holes of plate are proximal to the wedge and other holes distal to the wedge. Closure of subcutaneous and skin and above knee slab is done (Fig. 2).

Statistical Analysis:

Data analyzed using Microsoft Excel software. Data were then imported into Statistical Package for the Social Sciences (SPSS version 20.0) (Statistical Package for the Social Sciences) software for analysis. According to the type of data qualitative represent as number and percentage, quantitative continues group represent by mean ± SD, the following tests were used to test differences for significance; difference and association of qualitative variable by Chi square test (X2). Differences between quantitative independent groups by t test paired by paired t. P value was set at <0.05 for significant results & < 0.001 for high significant result.

3. Results:

The patient ages was distributed as 17.33±1.54 and 17.26±1.57 respectively between Group A & Group B respectively with no significant difference between studied groups, also there was no significant difference regard sex distribution between groups as the group were matched regard sex distribution (Table 1).

There was no significant difference or association regarding side distribution between groups (Figure 3).

There was no significant difference between groups either pre or post but both groups increased significantly from pre to post (Table 2).

There was no significant difference between groups either pre or post but both groups increased significantly from pre to post (Figure 4).

There was no significant difference between groups either pre or post but both groups decreased significantly from pre to post (Table 3).

There was no significant difference between groups regard pain but group A was slightly higher (Figure 5).

Group B was significantly shorter and faster than Group B regard weight bearing (Figure 6).

We found that the average time needed for full weight bearing in patients corrected by monolateral Ex-fix was 8 weeks while in patients corrected by plate was 6 weeks and the average time needed for complete radiological union was 7 weeks in all patients. Two patients had pin tract infection and were treated with oral antibiotics and followed up then improved. Two patients had superficial infection at site of surgery and were treated with injection antibiotic and followed up then improved. One patient had deep infection 14 days after surgery and was re-admitted again for debridement and treated with injection antibiotic according to C&S and followed up then improved. One patient corrected by Ex-Fix had lost correction of the deformity two weeks after surgery, this was discovered during 1st follow up visit, he was re admitted and correction were done again.

4. Discussion

Angular deformities of the knee alter the biomechanics of the knee by causing a distorted stress distribution on the weight-bearing surface of the knee joint. The deformities of the tibia or femur in the frontal plane led to mechanical axis deviation of the lower limb and malorientation of the joints above and below the level of deformity [10].

Treatment of angular deformities around the knee in children is mainly surgical. Surgical treatment in children with morbid obesity is ineffective and usually fails thus weight reduction in those patients is recommended [3].

Angular deformities of the knee can be corrected by several surgical methods, including osteotomy and internal fixation with plate and screws or an osteotomy and external fixation [1].

Osteotomy and internal fixation has many hazards including a longer operative time, more intraoperative bleeding, a higher risk of infection, delayed mobilization of the patient and a long skin scar [4].

Valgus producing high tibial osteotomies are used in the treatment of genu varum. Indications of osteotomies are patients of who are skeletally mature or near skeletal maturity; where there is insufficient growth remaining to benefit from guided growth. An external fixator can also be used, especially when lengthening is required as well [5,6].

Once skeletal age and physeal width have been established, the Green-Anderson growth charts can help predict the timing of epiphysiodesis for angular correction [1,3]. In general, the younger the patient, the more rapid a correction is obtained. In these cases, removal of hardware may need to be performed to avoid over-correction to varus. Since it is a tendency for “rebound” growth, it is recommended to allow over-correction prior to hardware removal. Patients are closely monitored between 4 to 6-month intervals [7,8].

This was similar to Ghasemi et al. [11] study which studied 43 patients with plates and 36 patients with external fixators with moderate uniplanar varus deformities and revealed statistically significant correction of MPTA from 83.9º to 90.9º with p-value 0.001 and significant improvement of MAD from 23.6 mm medial to midline to 6.9 mm lateral to midline with p-value <0.001 which was similar to our study.

Lim et al. [12] previously evaluated surgical correction of proximal tibia deformity in small children using monolateral external fixator and found statistically significant increase of MPTA from 73º to 90º in varus tibia and from 104º to 89º in valgus tibia, also MDA improved from 19º to 0º in varus tibia and from -25º to 2º in valgus tibia.

In the present study; characteristics of patients with genu varum; with male predominance (53.0%), and female (47.0%) with male to female ratio 1.14:1. with median age of 17 years range between 15 to 19 years. There is a statistically significant increase of angle TFA, MPTA and MAD after surgical correction of genu varum among the included children with p-value=0.001. This goes in run with Pandya et al. [13] study which was performed for 17 consecutive patients with surgically corrected Blount disease using multiple axial correction (MAC) with statistically significant decrease of mechanical axial deviation (MAD)), TFA, an increase of median proximal tibial angle (MPTA) with p-value 0.001.

Another study by Özkul et al. [14] was conducted for 25 patients with genu varum with male predominance (60%), which revealed statistically significant decrease of MAD from 37.6 mm to 8.4mm with p-value <0.05, and statistically significant increase of MPTA from 76º to 89º with p-value <0.05.

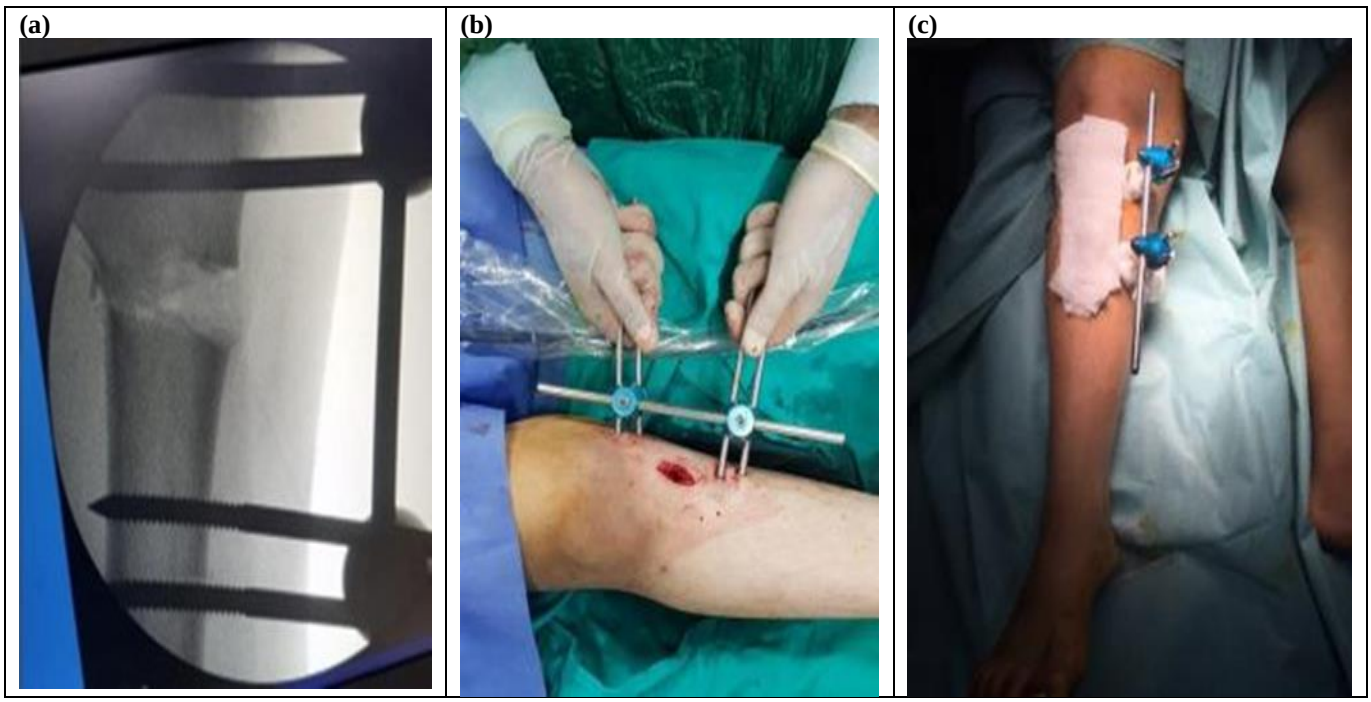

Figure (1): (a) Proximal tibial osteotomy ; (b,c) Clinical photo postoperative of HTO using monolateral EX Fix.

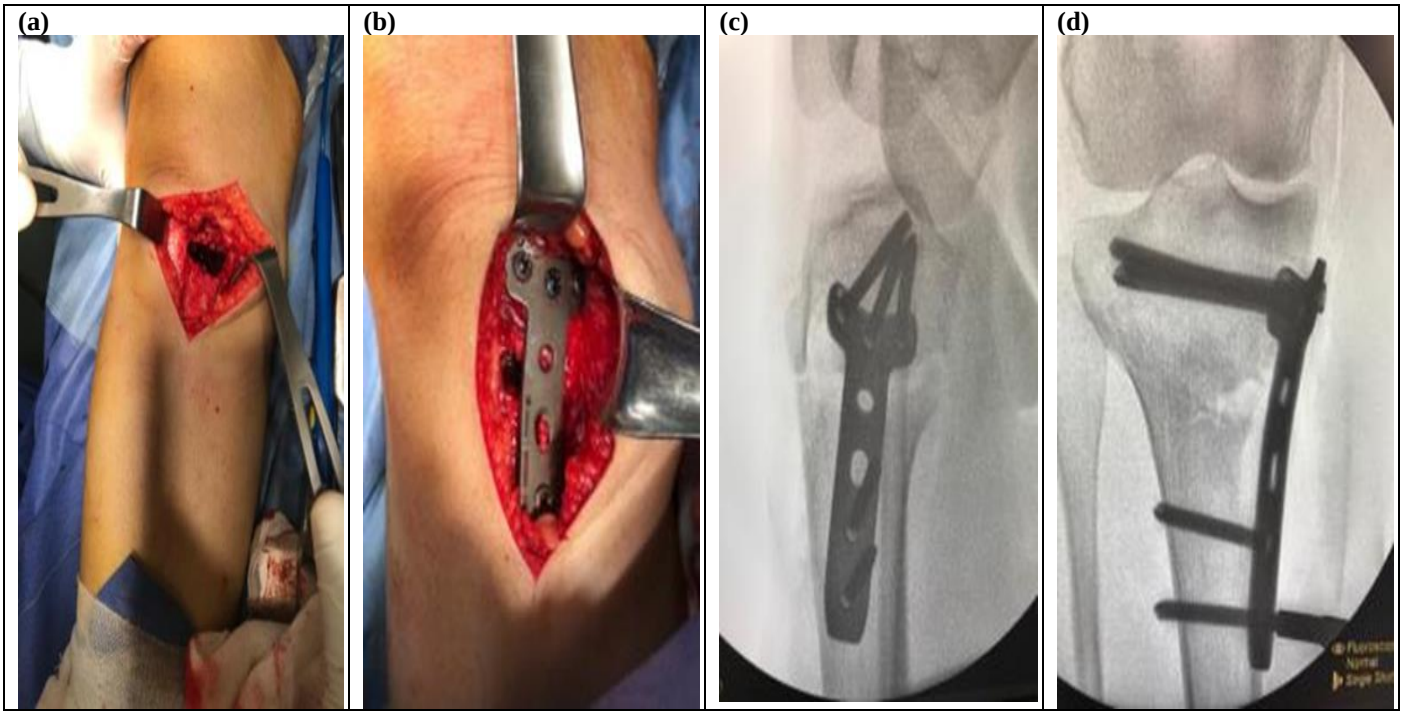

Figure (2): (a) Site of osteotomy; (b-d) placement of the plate.

Table 1. Age and sex distribution between studied groups

			Group A	Group B	t	P
Age			17.33±1.54	17.26±1.57	0.117	0.908
Sex	**Female**	**N**	7	7		
		%	46.7%	46.7%		
	Male	**N**	8	8	0.0	1.0
		%	53.3%	53.3%		
Total		**N**	15	15		
		%	100.0%	100.0%		

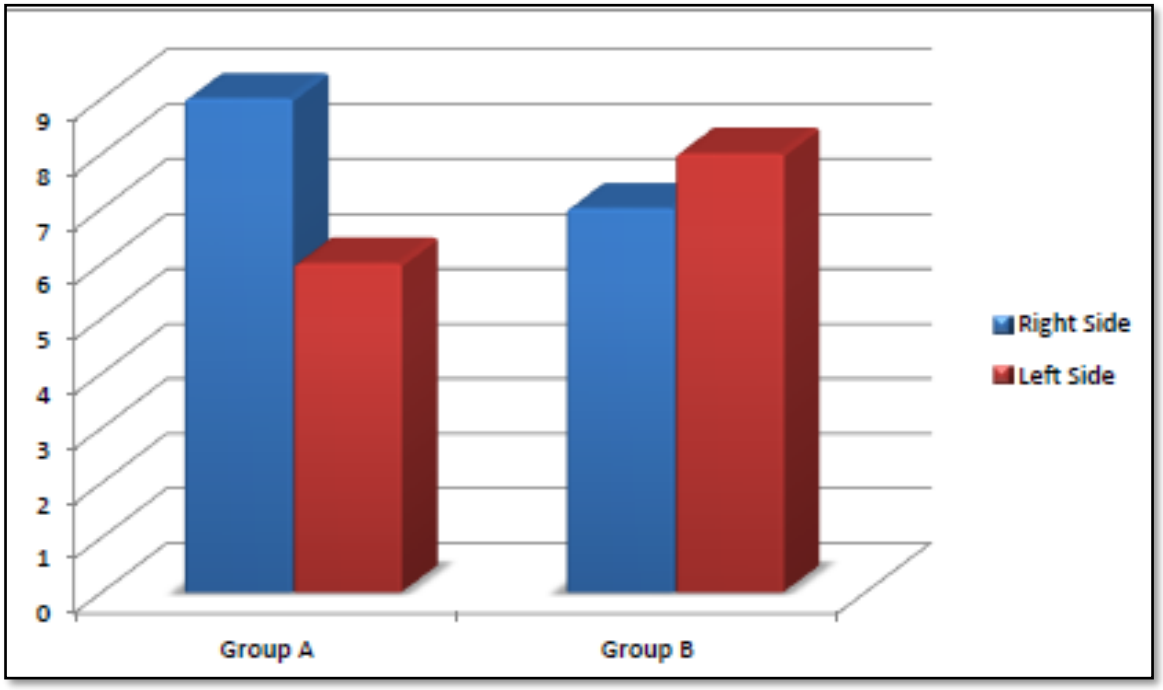

Figure 3. Side distribution between studied groups

Table 2. TFA distribution between studied groups pre and post-operative

	Group A	Group B	t	P
TFA pre	3.12±.54	3.62±0.86	1.887	0.070
TFA post	6.75±0.42	6.69±1.01	0.215	0.831
P	0.00**	0.00**		

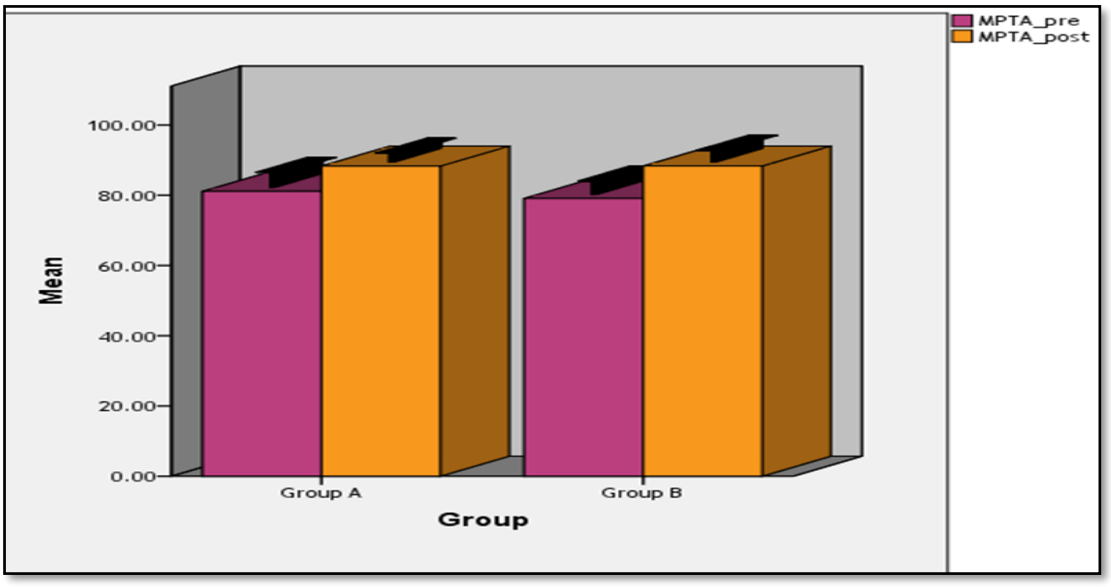

Figure 4. MPTA distribution between studied groups pre and post-operative

Table 3. MAD distribution between studied groups pre and post-operative

	Group A	Group B	t	P
MAD pre	31.25±5.25	30.90±4.44	0.196	0.846
MAD post	6.45±2.24	6.60±2.31	0.113	0.911
P	0.00**	0.00**		

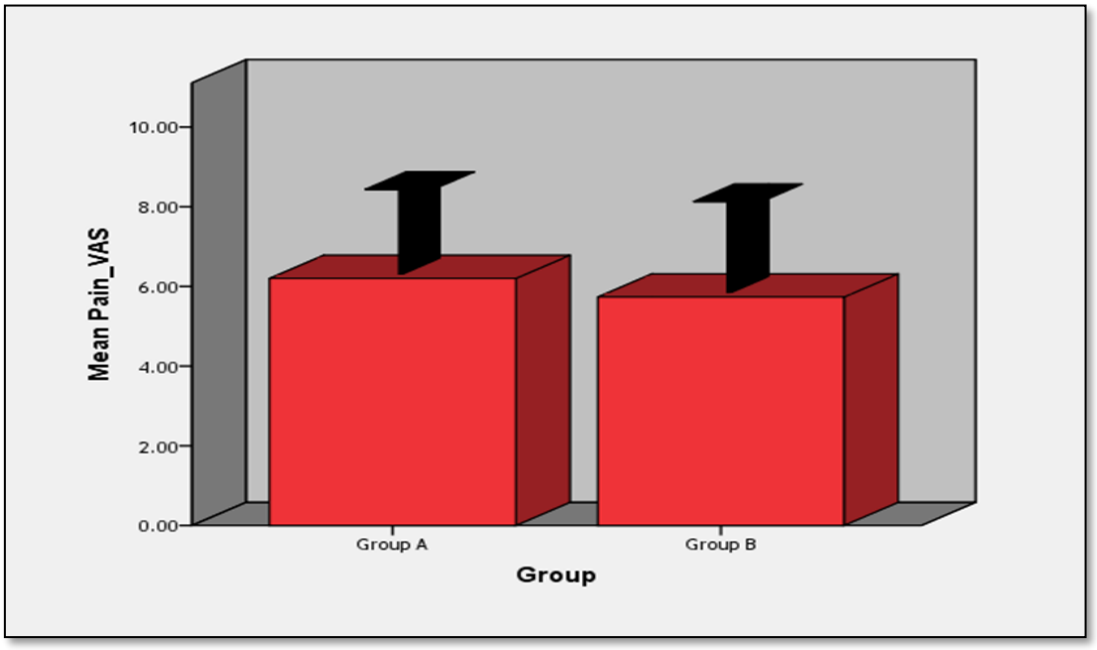

Figure 5. VAS distribution between studied groups

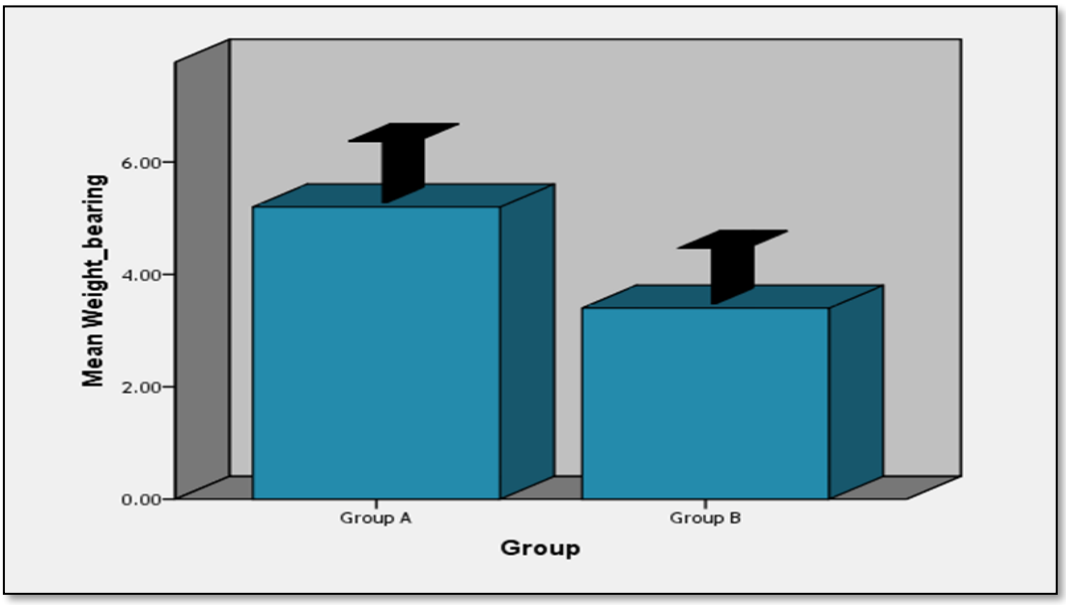

Figure 6. Weight bearing distribution between studied groups

5. Conclusions

Correction of genu varum in adolescent using plate and monolateral external fixator has nearly same good results in genu varum and improvement of MPTA and TFA and correction of MAD after surgical correction but weight bearing was much faster to those who operated by external fixator.

Complications such as infection was less in group operated by external fixator.With same good result, less complications and less invasive operation we can use monolateral external fixator in high tibial osteotomy.

Further studies with large sample size are needed for better estimation of the effect of monolateral external fixator and plate in correction of genu varum deformity.

Further evaluation of complications related to surgical correction of deformities around knee is needed.

- **Availability of data and materials:** All data are available on request.
- **Competing interests:** The authors declare that they have no competing interests.
- **Funding:** Self-funding.

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