Management of genu valgum in children

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The Egyptian Orthopedic Journal; 2018 supplement (2), December, 54: 28-35

Abstract

Background
Genu valgum is a frontal plane deformity may pathological or physiological. Aim of correction of valgus deformity to regain normal mechanical axis to avoid stress on ligaments and articular surface and early arthritis we assess in our study degree of correction and complications after we do correction of pathological deformity in our study by two methods of correction acute correction by osteotomy, gradual correction by hemiepiphysiodesis by 8 plate.

Objective
The aim of this study to evaluate degree of corrections and complications done by two methods osteotomy and hemiepiphysiodesis.

Patient and methods
This prospective study involve 15 patient with genu valgum coming to out patient clinic of AL-Azhar university hospital (Al-Hussien and Sayed Galal hospital) between period of December 2015 till July 2017. 8 patient were treated with supracondylar femoral osteotomy and fixation by k wires or plate and screws. 7 patient were treated with guided growth arrest throught hemiepiphysiodesis by 8 plate. These 15 patients prospectively followed up for 6-12 months with average 9 months.

Result
All patient are fully corrected except one case partially corrected, P value of all measurement is significant except medial proximal tibial angle (MPTA) and this may be due to the main pathology in genu valgum is distal femur.

Conclusion
Multiple and repeated osteotomies may be required for managing valgum deformities in growing children. These osteotomies are associated with pain, stiffness, risk of non union, malunion and prolonged period of immobilization. Guided growth using a flexible construct of 8 plate and two screws applied around the physis offers the easy, safe and effective solution for these angular deformity

Key words
Genu valgum, pathological, osteotomy, hemiepiphysiodesis.

Introduction

Genu valgum is a normal physiological process in childern therefore it is critical to differentiate between physiological and pathological process. The distal femur is the most common location of primary pathological genu valgum but can arise from the tibia.[1]

The Physiological coronal changes around knee in childern at first there is a varus then decrease till it is reversed to valgus then increase 10-15º at 4 years then it starts to decrease over another 2 years till it reaches adult level (7ºvalgus) usually bilateral. [2]

The Pathological genu valgum may be unilateral or bilateral. Unilateral may be idiopathic or caused by physical injuries as trauma (proximal metaphyseal tibial fracture, distal femoral physeal fracture), infection, vascular insult and benign tumors as (fibrous dysplasia,osteochondromas and olliers disease) While bilateral maybe idiopathic or caused by renal rickets and skeletal dysplasia as morquio syndrome, spondylo-epiphyseal dysplasia and chondroectodermal dysplasia.[3]

Genu valgum diagnosed clinically and radiologically. Clinically the patient may be obese, pes plannus, lax ligaments, chondromalacia,increase Q angle and +ve Obers test (contracted ilieotibial band contraction especially in paralytic patient).

Radiological evaluation of genu valgum through long plain film x-ray show pelvis and both lower limbs show increase Q angle, decrease tibio femoral angle,

femoral hypoplasia and sky line view show patellar sublaxation.[4]

The treatment of genu valgum may be non operative as Observation in valgum <15 degree in child <6years of age and this the first line of treatment. Bracing in pathological genu valgum usually ineffective.[5]

The operative management which include two choice hemi-epiphysiodesis(staples or screws and plate, screws) and indicated in > 15-20 degree of valgus in child < 10 years of age.[5] Distal femoral varus osteotomy which indicated in insufficient remaining growth for hemiepiphysiodesis but this technique has several complications as Peroneal nerve injury.[6]

Patient and Methods

This prospective study involve 15 patient with genu valgum coming to out patient clinic of AL-Azhar university hospital (Al-Hussien and Sayed Galal hospital) between period of December 2015 till July2017.. In our study we evaluate 15 patient (5-15 y.old) mean age 8.4years old,33% male, 67 % female with different pathology 53 % idiopathic,27% post traumatic,20% post rachitic, 67 % bilateral, 33 % unilateral and corrected by 2 methods osteotomy and fixation by k-wires 40%, plate & screws 13% or hemiepiphysiodesis by eight plate 47%.

Patients included in our study are Child 5-15 years old, Bilateral or unilateral deformity and patient excluded are Child less than 5 or more than 15 years old. Physiological form, Neuromuscular disorders, infectious cases

These 15 patients prospectively followed up for 6-12 months with average 9months Patient selection, preoperative preparation, intraoperative technique, post operative management and results were all assed

Our patient are descriped in following tables to shows distribution of gender table (1),distribution of age table (2), distribution of affected side table(3),distribution of aetiolgy table(4)and distribution of treatment table(5).

Demographic features of our patients:

Table (1): Distribution of patient sex

Sex	Number	Percentages
Male	5	33 %
Female	10	67 %
Total	15	100

Table (2): Distribution of patient age

	Mean ±SD	Min	Max
Age range (years)	8.4 ± 3.1	5	14

Table (3): Distribution of the affected side of deformity

Side of deformity	Number	Percentages
Unilateral	10	67 %
Bilateral	5	33 %
Total	15	100 %

Table (4): Distribution of etiology

Etiology	Number	Percentages
Idiopathic	8	53 %
Post-traumatic	4	27 %
Post-rachitic	3	20 %
Total	15	100 %

Table (5): Distribution of treatment options of the studied patients

Treatment options	Number	Percentages
Hemiepiphysiodesi By 8 plate	7	47 %
Osteotomy K- wires	6	40 %
Osteotomy Plate-screws	2	13 %
Total	15	100 %

Preoperative evalauation

The patient were managed according to age, severity of deformity, cause of deformity. The patient should be assessed clinically, laboratory and radiologically.

Clinically: examine limb length, deformity (unilateral or bilateral), oigin of deformity (Tibial or femoral or both and another associated deformity as external tibial torsion.

Laboratory: Serum calcium, phosphate, alkaine phosphatase. And urine analysis.

Radiological: Long film x-ray showing from both hips to both ankles, x-ray Scaogram showing angles and mechanical axis deviation.

All theses perpation was done to detect:Cause of deformity.,Severity and degree of deformity (intermalleolar distance – Tibio femoral angle), Site of deformity either femoral or tibial, detect center of rotation angle (CORA) and Planning for managent (hemiepiphysiodesis or corrective osteotomy).

Surgical technique:

Lateral open wedge supracondylar femoral osteotomy:

Incision and exposure:

The lateral aspect of the femur is exposed through a standard straight incision through the skin and the fascia, starting two finger-breadths distally to the epicondyle and extending the incision about 12 cm proximally. The dissection is carried down to the vastus lateralis.

Osteotomy:

An Homan retractor is placed under the posterior aspect of the femoral metaphysis to protect the vessels and to expose the posterolateral aspect of the femur in order to place the plate in the desired position. With the knee in extension and under fluoroscopic control, a guide wire is drilled freehand through the distal femur from lateral to medial. A slightly oblique direction (about 20°) should be maintained from a proximal point on the lateral cortex, three finger breadth above the lateral epicondyle, above the trochlear groove, to a distal point a few millimetres proximal to the medial epicondyle.

The osteotomy is performed keeping the oscillating saw blade proximal and parallel to the cutting guide in order to prevent a possible migration of the osteotomy into the joint. The saw is used to cut only 1 cm in depth of the lateral cortex. A sharp osteotome is used to finish the osteotomy. The surgeon should be certain that the anterior and posterior cortices, as well as all of the cancellous metaphysis, are completely interrupted but should preserve a medial hinge of intact bone (about 1 cm). While performing the osteotomy, it is important to regularly check progress with the fluoroscope to ensure the appropriate depth and direction of the cut.

The osteotomy is easily opened to the desired degree of correction. Before fixing the plate, the mechanical axis is checked by means of the special guide rod or diathermy cabl, long enough to extend from the centre of the femoral head to the centre of the ankle. Under fluoroscopy, the position of the rod over the knee joint is checked. To obtain a neutral mechanical axis it should be approximately in the centre of the tibial plateaus between the tibial spines. (Fig 1)

A

B

Fig 1: A- Preoperative X-ray scanogram and photograph B-Postoperative X-ray and photograph

Epiphysiodesis using eight plate:

Incision and exposure:

The level of the physis on the relevant side and segment (distal femur or proximal tibia) was identified using fluoroscopy. The centre of the physis was estimated by palpating the anterior and posterior margins of the femur or tibia and placing a 2 cm skin incision over this position. The fascia lata was divided longitudinally. The periosteal surface was exposed by blunt lateral view to help for adjusting appropriate site of plate.

Plate application:

The plate was placed over the physis and provisionally secured with a hypodermic needle through a small central hole in the plate. Satisfactory positioning was confirmed by fluoroscopy. Threaded guide wires were then driven through the centres of the two main holes of the plate, aiming to keep the direction of these wires parallel to the physis. (Fig 2)

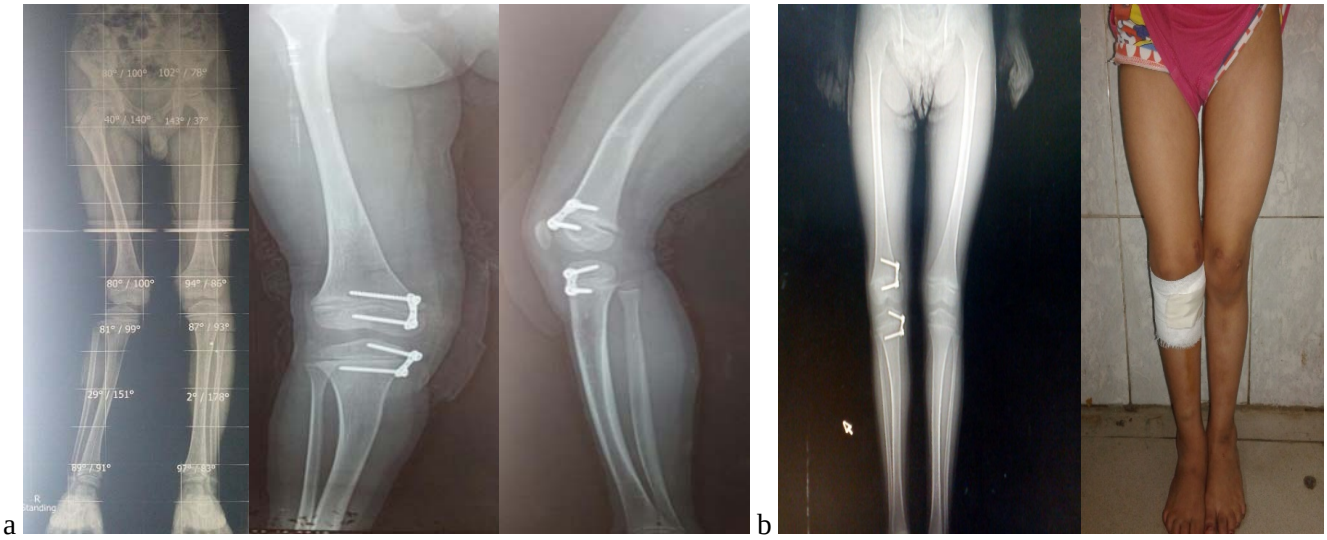

Fig 2: A: Preoperative x-ray and scanogram. B: Postoperative x-ray and photograph after full correction

Result

Between December 2015and July 2017, we evaluated the patients as a single group to assess the effectiveness and complication of different methods of correction.

In our study the mean age group 8.4 years old range (5-14), the mean follow up 9months range (6-12 months), the mean mechanical lateral distal femoral angle (mLDFA)was 77° range(73-83) preoperatively and corrected mean 88.4 degree range (87-90), Mean tibio femoral angle (TFA) preoperative 19.8 degree range (14-24) and corrected mean 5.3degree (2-9),Mean MPTA pre operative 91.3 degree range (87-98) and corrected mean 88.3 range (87-90), Mean mechanical axis deviation (MAD) pre operative 17.8 mm range (9-30mm)and corrected mean 2mm range(0-5 mm) and Mean inter malleolar distance (IMD) 15.4 cm range 12-20cm) and corrected mean 1.5 cm range (0-6 cm).

we reach full correction in all cases either done by osteotomy or by epiphysiodesis except one case partially corrected was done by osteotomy also complications in our study 28% more in osteotomy than epiphysiodesis through more time of immmoblization , pin tract infection around k-wires , swelling from cast, stiffness in knee after removal of cast.

All this data are simplified in demographic tables, comparsion between preoperative measurement and post operative measurments after correction in unilateral cases showen in table (6) . While in bilateral cases showen in table (7). Complications showen in table (8).

Table (6): Comparison between pre-operative measurements and post-operative corrections in unilateral cases.

Groups / Variables	Pre-operative measurements		post-operative corrections		p-value
	Mean	± SD	Mean	± SD	
MAD (mm)	17.8	6.6	2.1	1.6	< **0.001***
IMD (cm)	15.4	2.8	1.5	2.1	< **0.001***
TFA (º)	19.8	4.5	5.3	3.05	< **0.001***
mLDFA (º)	77	3.5	88.4	1.3	< **0.001***
MPTA (º)	91.3	4.7	88.3	1.9	0.08

** p-value < 0.001 is considered highly significant.*

This table shows highly statistical significant difference **(p-value < 0.001)** between pre-operative measurements and post-operative corrections as regard MAD, IMD, TFA and mLDFA in unilateral cases. While there was no statistical significant difference **(p-value > 0.05)** between pre-operative measurements and post-operative corrections as regard MPTA in unilateral cases.

Table (7): Comparison between pre-operative measurements and post-operative corrections in bilateral cases.

Groups / Variables		pre-operative measurements		post-operative corrections		p-value
		Mean	± SD	Mean	± SD	
MAD (mm)	**Rt.**	16	3.3	1.8	1.3	< **0.001***
	Lt.	14.8	3.4	0.8	0.4	< **0.001***
IMD (cm)		18.8	0.83	2.4	1.5	< **0.001***
TFA (º)	**Rt.**	17.8	1.9	5.6	1.3	< **0.001***
	Lt.	16.8	1.9	4.6	1.6	< **0.001**
mLDFA (º)	**Rt.**	77.4	1.6	88	1.2	< **0.001***
	Lt.	78.8	0.8	89	0.7	< **0.001***
MPTA (º)	**Rt.**	90.4	2.8	88.8	1.3	0.2
	Lt.	90	3	88	1	0.2

**: p-value < 0.001 is considered highly significant.*

This table shows highly statistical significant difference **(p-value < 0.001)** between pre-operative measurements and post-operative corrections as regard MAD, IMD, TFA and mLDFA in bilateral cases. While there was no statistical significant difference **(p-value > 0.05)** between pre-operative measurements and post-operative corrections as regard MPTA in bilateral cases.

Table (8): Distribution of post-operative complications occurred in studied cases.

Post-operative complications	Number	Percentages
Pin track infection-soakage of cast	1	7%
Oedema of foot	1	7%
Limited extension of knee	1	7%
Superfacial infection	1	7%
No complications	11	72%

This table shows post-operative complication in all studied cases. Each of pin track infection-soakage of cast, oedema of foot and collapse, limited extension of knee and superfacial infection occurred in single case (7%) while no complications was reported in 11 cases (72%).

Discussion

Genu valgum deformity alter the biomechanics of the knee by causing a distorted stress distribution on the weight-bearing surface of the knee joint, and various methods have been proposed to address this problem .

Corrective osteotomy is the gold standard for treatment of severe angular deformity, but is a major surgical intervention with operative site morbidity, postoperative pain and prolonged therapy that requires internal or external fixation and restricted weight-bearing that are the main drawbacks of this surgery. Osteotomies, especially of the proximal tibia, are high-risk surgeries, with a small but significant incidence of compartment syndrome, neurovascular injury, overcorrection or under-correction, delayed union or non union [7].

The purposes of this study were to determine the accuracy of partial hemiepiphysiodesis and supracondylar femoral osteotomy in correction of genu valgum deformity by evaluating radiological outcome comparing the preoperative and postoperative measurements, the descriptive data on time spent with plate, mean correction time, and determine the safety of the use of both methods by reviewing the complications.

We done in our study both methods for correction of deformity by supracondylar femoral osteotomy and hemiepiphysiodesis by eight plate. Our study was done on 15 patient 10 female (67%), 5 male (33%),10 unilateral (67%), 5 bilateral(33%) ,3 cases post rachitic(20%) , 4 post traumatic(27%) ,8 idiopathic correction(53%)done by osteotomy on 8 patient, hemiepiphysiodesis on 7 cases.

In our study the mean age group 8.4 years old range (5-14), the mean follow up 9months range (6-12 months), the mean mLDFA was 77° range(73-83) preoperatively and corrected mean 88.4 degree range (87-90), Mean TFA preoperative 19.8 degree range (14-24) and corrected mean 5.3degree (2-9),Mean MPTA pre operative 91.3 degree range (87-98) and corrected mean 88.3 range (87-90), Mean MAD pre operative 17.8 mm range (9-30mm)and corrected mean 2mm range(0-5 mm) and Mean IMD 15.4 cm range 12-20cm) and corrected mean 1.5 cm range (0-6 cm). P value is significant in all measurments except MPTA and this explain main pathology of genu valgum deformity more femoral than tibial . we reach full correction in all cases either done by osteotomy or by epiphysiodesis except one case partially corrected wasdone by osteotomy also complications more in osteotomy than epiphysiodesis through more time of immmoblization , pin tract infection around k-wires , swelling from cast, stiffness in knee after removal of cast.

Ballal et al. reported 13 patients (28 physes) with genu valgum deformity of mean age of 11.6 years. Patients were treated with the extra-periosteal application of 8 plates. The mean plate time of guided growth was 9.1 months (range 8–16 months).Femoral genu varum deformity (mLDFA) corrected within 5^{o}of their normal mean values, while in tibial genu varum MPTA corrected within 2^{o} of their normal mean values, Correction was faster if the child was under 10 years of age .[8]

Burghardt et al. reviewed guided growth in 10 patients (17 physes) with genu valgum deformity of mean age of 9.7 years using 8 plates. The mean guided growth time as 8.5 months (range, 6-15 months). Sites of correction were 3 limbs with both distal femur and proximal tibia deformities, 11 limbs with distal femur deformities.Femoral deformity (mLDFA) corrected within 3^{o} of their normal mean values, while MPTA corrected within 2^{o} of their normal mean values with exclusion of 2 patients which failure of correction occur in both of them.[9]

Casteneda et al. reviewed guided growth in 24 patients (52 physes) with genu valgum deformity of mean age of 11.9 years using staples. Site of correction was 18 limbs with both distal femur and proximal tibia deformities, 7 limbs with distal femoral deformities and 9 limbs with proximal tibial deformities. Femoral deformity (mLDFA) corrected within 6^o of their normal mean values, while MPTA corrected within 3^o of their normal mean values with exclusion of 5 patients which failure of correction occur. [10]

Cho et al. reviewed guided growth in 3 patients (4 knees) with genu valgum deformity of mean age of 11.4 years using staples. Site of correction was distal femoral deformities, rebound valgus deformity occur in one patient.[11]

Nouh et al. reviewed guided growth in 9 patients with genu valgum deformity of mean age of 12.7 years using percutaneous transphyseal screw and failure of correction occur in one patient.[12]

Shin et al. reviewed guided growth in19 (43 physis) patients with genu valgum deformity of mean age of 12.1 years for boys and 10.4 years for girls using staples. Site of correction was distal femur deformities, rebound deformity occur in three distal femoral physis.[13]

In our series we have one case with superfacial infection that managed by debridement , one case with limited knee flexion that respond well to physiotherapy and exercise , limited flexion of knee joint explained by delayed early mobilization .one case with oedema of foot and managed by release of cast all complication occurred with cases corrected by osteotomy.

Ballal et al. reviewed one patient with plate and screw migration and one patient with deep infection who have surgical debridement but no permanent physeal tethers were encountered after follow up patients between 6 and 32 months after plate removal [8], while **Burghardt et al.** reviewed failure of correction occur in two patients because of no enough growth remaining in the physes.[9]

Casteneda et al. reviewed failure of correction occur in 5 patients, 5 patients with staple back out and one patient with superficial infection [10], while **Cho et al.** reviewed rebound tibial varus deformity occur in one patient.[11]

Nouh et al. reviewed failure of correction occur in one patient [12], while **Shin et al.** reviewed rebound deformity occur in three distal femoral physes, arrested physes in one patient and staple extrusion from one distal femoral physes. [13]

Howard et al. reviewed osteotomy in 66 guided patients with genu varum deformity of both femoral and tibial. The mean age was 14.1 years. Evidence of neurological change due to ischaemia observed in two patients, three patients had delayed union, one patient had non union and one patient had peroneal nerve injury.[14]

Schroerlucke et al. reviewed osyeotomy in 50 patient with genu valgum deformity of femoral origin. The mean age 13.5years. correction achieved in all cases expect 2 cases not fully corrected as wedge not sufficient to achieve full correction. And delayed union observed in 5 patients, stiff knee observed in 6 patients.[15]

The logic behind eight-plate concept lies in the placement of non rigid extra-periosteal plate and screws, serving as a focal hinge at the perimeter of the physis, because the fulcrum of the plate falls outside the physis, it has longer moment arm does not exert a relative compression effect on the physis without limiting the growth potential.[16]

This study presents our preliminary results with small sample size. Additional studies are needed to be conducted with larger sample size and longer follow up to determine whether the results from this study can be validated and to determine maximum degrees of angular deformity that can be corrected.

Furthermore, osteotomy and acute correction of deformities carry a risk of complications such as compartment syndrome , non union, potential hardware irritation, a high rate of plate removal, malunion, or nonunion with the possible need for bone grafting, malcorrection, contracture, intra-articular fracture, breach of medial cortex, and neurovascular injury.

Conclusion

Multiple and repeated osteotomies may be required for managing angular deformities in growing children. These osteotomies are associated with pain, stiffness, risk of non union, malunion and prolonged period of immobilization. Guided growth using a flexible construct of 8 plate and two screws applied around the physis offers the easy, safe and effective solution for genu valgum deformities.

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