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Treatment of Genu Valgum in Adolescents by Distal Femoral Dome Osteotomy

Khaled Mohamed Saad*; Mohamed Mustafa Elmenawy; Mahmoud Mohamed El Said

Department of Orthopedic Surgery, Damietta Faculty of Medicine, Al-Azhar University, Damietta, Egypt.

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*Corresponding author

Email: dr.khaledsaad9010@yahoo.com

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Abstract

Background: Coronal plane knee deformities are common in daily orthopedic practice. It is more prevalent in adolescents. The treatment aim is to restore normal mechanical axis, permitting avoidance of stress on ligaments, articular surface and development of early arthritis.

The aim of the work: This study aimed to evaluate the correction degree and outcomes after surgical correction of genu valgum deformity in adolescents by distal femoral dome osteotomy.

Patients and Methods: This prospective study involves 25 patients with genu valgum coming to outpatient clinic of the Damietta Faculty of Medicine, Al-Azhar University. All were submitted to preoperative evaluation [history, examination, radiological and lab investigation]. Then underwent distal femoral dome osteotomy and followed up for at least 6 months, with outcome assessment on the clinical, radiological and functional basis.

Results: All patients showed full correction except in one case, where undercorrection was recorded. There was a significant reduction of mechanical axis deviation [MAD] and intermalleolar distances [IMDs] postoperatively when compared to preoperative values [18.8±6.2, 14.8±2.5 vs 2.3±1.5 and 1.3±2.2, respectively]. In addition, the postoperative measurements showed significant reduction of tibiofemoral angle [TFA], while mechanical lateral distal femoral angle [mLDFA] showed significant increase after intervention than preoperative values [89.2±1.2 vs 75.0±3.7]. The post-operative complications were in the form of foot edema, limited extension of the knee, superficial wound infection and undercorrection in 12.0%, 8.0%, 4.0% and 4.0% respectively. No complications were reported among 18 subjects [72.0%].

Conclusion: Distal femoral dome osteotomy is a viable and safe treatment option for genu valgum correction with early restoration of knee motion and function, early union with no leg length discrepancy.

Keywords: Femur; Genu Valgum; Osteotomy.

INTRODUCTION

Genu valgum is described as medial angulation of the knee associated with outward deviation of the tibial and femoral longitudinal axes. In adolescents, the persistent genu valgum induces abnormal disturbances for the gait and overall function [this includes difficult running, knee discomfort, malalignment and lateral instability of the patella, and ligamentous instability] [1]. The Physiological genu valgum begins at age of 2 years old characterized by a tibiofemoral angle less than 15º, bilateral and spontaneous resolve at age of 6 years old. management for mild cases through Observation, correct general condition, vitamin- D, Bracing, and Physiotherapy [2]. The condition may be uni- or bi-lateral. Unilateral Genu valgum is usually of idiopathic etiology. However, it may be due to physical injuries, infection, vascular injury, benign tumors or fibrous dysplasia. The traumatic causes may include metaphyseal fracture of the proximal tibia, distal physeal fracture of the femur. On the other side, the bilateral condition may be idiopathic or due to skeletal dysplasia, renal rickets, provided that the tibiofemoral angle is > 15º in children younger than 10 years of age [3].

Genu valgum usually initiated from the distal femur, and can be confirmed by different angle measurements on the standing radiographs of both lower limbs [LL] including hips, knees and ankles. The operative intervention for pathological genu valgum aimed to restore the normal mechanical-axis alignment and joint orientation [4]. The literature has reported various kinds of distal femur osteotomies for correcting genu valgum. These include medial closing wedge osteotomy of the tibia, lateral opening wedge osteotomy of the femur, medial closing wedge osteotomy of the femur, dome osteotomy and "V" osteotomy [5]. These osteotomies can fix deformities in the alignment of the knee, either, it was due to congenital or traumatic causes. Lateral femoral open wedge osteotomy causes lengthening of the limb, delayed union with more restricted weight bearing and may be need graft. Disadvantages of distal femoral medial closing wedge osteotomy are long healing time, injury of popliteal vessels [6]. Dome osteotomy leads to full axial realignment without limb length change or translation of osteotomy components. It is picked over a wedge osteotomy in order to avoid limb shortening, good bony contact and better stability [7].

This study aimed to assess the correction degree and outcomes after genu valgum deformity correction by distal femoral dome osteotomy in adolescents.

PATIENTS AND METHODS

This was prospective case-series research done at the orthopedic surgery departments of Al-Azhar University in Damietta. This research was done on 25 cases.

Inclusion criteria: Adolescent patients [10-19 years], patients with tibiofemoral angle >15 degree or intermalleolar distance > 10 cm were included and the origin of deformity is femur.

Exclusion criteria: paralytic patients or patients with severe instability of collateral ligaments, subluxation and sagittal plane deformity more than 15º or genu valgum due to tibial deformity.

Methods:

Preoperative evaluation: It included full history taking [personal data, present history and complaint] and physical examination [general and local examinations]. The local examination included inspection, palpation, movement, special tests and neurological examination [motor and sensory]. The radiological investigation included long film x-ray provided that it showed from both hips to both ankles. In addition, X-ray scanogram showed the angles and mechanical axis deviation, furthermore, the routine laboratory workup was performed and involved complete blood count [CBC], international normalization ratio [INR], serum calcium, phosphorus, and alkaline phosphatase. In cases of rickets, parathyroid hormone and vitamin D level were involved.

Surgical technique: Operative Assessment:

The surgical intervention was performed under general or spinal anesthesia in the supine position of the table. The C-arm of an image intensifier was set up on the opposite side of the surgeon. First, the tourniquet was inflated, then the patient was completely draped from umbilicus downwards, with exposure of the femoral lateral aspect. A standard straight incision was performed through the skin and the fascia. It typically started two-fingers breadth distal to the lateral epicondyle. The incision was then extended about 12 cm in proximal direction. The dissection was then carried out downwards to reach the vastus lateralis muscle. The must was retracted from the posterolateral intermuscular septum by a special retractor [Homan retractor] placed ventrally. Then, exposure of the lateral cortex was achieved and the procedure was facilitated by the knee flexion. The osteotomy line was a dome-shaped, circular with superior convexity. It was marked on the distal femur, and included the metaphyseal area [e.g., future plate placement for osteotomy fixation]. Then, the deformity was corrected and the overall limb was aligned and check by an electrocautery cord. This cord was used from the marker of femoral head to the mid-ankle markers. The knee was imaged under the C-arm to confirm the alignment [the line was corrected to the center of the knee or just lateral to the medial tibial spine]. After achievement of full correction and fixation we put suction drain in wound and closured the wound in layers' iliotibial band, subcutaneous and skin, in our patients we fixed osteotomy by k-wires and above knee cast.

Post-operative evaluation: The patients are following up in outpatient clinics one week after discharge from hospital to change dressing and clean the wound, in 2nd week we remove sutures and the exercise program begin to start through passive motion of knee for one-week, next week begin active motion and exercise for the knee when one-month complete post-operative the patient can able to fully flexed his knee. After 6 weeks, the partial weight bearing was permitted. The full weight bearing was not permitted before it normally becomes possible [e.g., after eight or nine weeks provided there was a sure radiographic evidence of sufficient bone healing]. A repeat X-ray scanogram was done at six months postoperatively. Radiological parameters like mechanical axis deviation [MAD], mechanical lateral distal femoral angle [mLDFA], clinical or radiological [tibiofemoral angles], and intermalleolar distances [IMDs] were measured to determine the degree of deformity correction.

Statistical Analysis: Data collection Serial clinical examination and radiological assessment Computer software IBM SPSS [V.23; Chicago, IL, USA] Statistical tests ANOVA test and a T test were used for the outcome measures. For qualitative variables, the data were reported as numbers & percentages, whereas for quantitative ones, they were expressed as means and standard deviations [SD]. The mean of the arithmetic values and the standard deviation [SD] were utilized to summarize the data. Methods such as the student t-test, the Mann-Whitney test, the Chi-square test [X2], the Z-test for percentage, and the odds ratio [OR] were utilized in the comparison. In terms of its level of significance, a significance level [P-value] of 5% was chosen as the cutoff for all of the statistical tests described in the previous paragraph.

A P value of > 0.05 shows that the findings are not significant, while a P value of 0.05 reveals that the findings are significant**.** The results are considered to have more significance the lower the P value that was achieved.

RESULTS

The current work included 25 patients, 10 [40.0%] were males and 60.0% were females. Their age ranged between 10 and 19 years [14.8±2.5 years]. The deformity was unilateral in the majority of patients [18 patients; 72.0%], while 25.0% of subjects had bilateral deformity. The majority of deformities were idiopathic [60.0%], followed by the post-rachitic and finally post-traumatic etiology [24% and 16.0% respectively]. The treatment option was osteotomy with plate-screws in 80.0% and K-wires in 20.0%.

The results of the current work showed progressive and significant reduction of MAD and IMD postoperatively when compared to preoperative values [18.8±6.2, 14.8±2.5 vs 2.3±1.5 and 1.3±2.2, respectively]. In addition, the postoperative measurements showed significant reduction of TFA, while mLDFA showed significant increase after intervention than preoperative values [89.2±1.2 vs 75.0±3.7]. However, the difference regarding MPTA showed non-significant difference [Table 2]. The post-operative complications were in the form of foot edema, limited extension of the knee, superficial wound infection and undercorrection in 12.0%, 8.0%, 4.0% and 4.0% respectively. No complications were reported among 18 subjects [72.0%] [Table 3].

Table [1]: Patient characteristics, clinical features and treatment options among study groups

		Statistics [n=25]
Gender [n,%]	Male	10 [40.0%]
	Female	15 [60.0%]
Age [years]	Mean±SD	14.8±2.5
	Min. – Max.	10- 19
Side of deformity [n,%]	Unilateral	18 [72.0%]
	Bilateral	7 [25.0%]
Etiology [n,%]	Idiopathic	15 [60.0%]
	Post-rachitic	6 [24.0%]
	Post-traumatic	4 [16.0%]
Treatment options	Osteotomy Plate- screws	20 [80.0%]
	Osteotomy K- wires	5 [20.0%]

Table [2]: Pre-and postoperative measurements and corrections among study group

	Preoperative values	Postoperative values	P value
MAD [mm]	18.8±6.2	2.3±1.5	<0.001*
IMD [cm]	14.8±2.5	1.3±2.2	<0.001*
TFA [o]	18.6±4.2	4.9±3.04	<0.001*
mLDFA [o]	75.0±3.7	89.2±1.2	<0.001*
MPTA [o]	90.3±4.6	88.2±1.8	0.08

Table [3]: Postoperative complications among study group

	Number	Percentages
Oedema of foot	3	12%
Limited extension of knee	2	8%
Superficial wound infection	1	4%
Under corrected	1	4%
No complications	18	72%

Case presentation

The following figures showed pre- and post-operative x-rays of a female patients, 17 years' old who was presented with bilateral idiopathic genu valgum and treated by osteotomy with plate and screws.

Figure [1]: Pre-operative scanogram

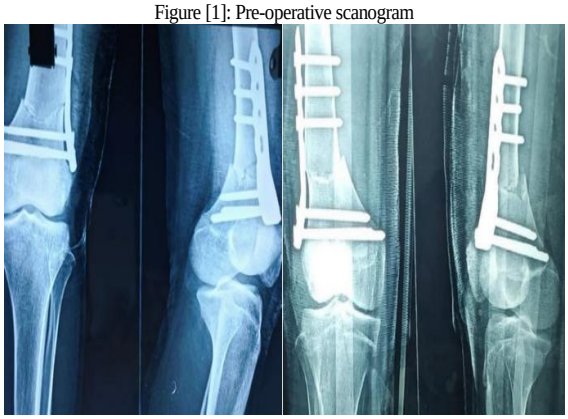

Figure [2]: Immediate post-operative X-ray

Figure [3]: After 6 months

DISCUSSION

Genu valgum deformity is defined as lateral mechanical axis deviation that may be physiological or pathological. Deformity appears in early or late adolescence as a fluctuation of lower extremity growth over the child's life. It showed rapid growth in infancy, followed by a plateau in early childhood, and a second phase of rapid acceleration in adolescence. Persistent genu valgum is presented clinically by abnormal

gait, functional disturbances, arthritis, pain of the anterior knee, patella-femoral subluxation, and difficulties in running [1]. The aim of treatment is torestor the limb alignment and thus prevent subsequent joint degeneration. The current work aimed to determine the accuracy of the dome osteotomy of the distal femur in genu valgum deformity correction. It was based on the radiological and clinical data.

The results of the current work showed satisfactory outcome, with lower rate of complications. The reported complications were mild and treated conservatively. In the line with the results of the current work, **Watanabe *et al.*** [8] reported that, the difference in the centers of deformity and osteotomy in the surgery of dome osteotomy led to unsatisfactory correction. Our results on contrast, showed that, the execution of a dome osteotomy with center of rotation or angulation [CORA] at the knee and restoring of mechanical axis alignment to the center of the knee can lead to a satisfactory correction of deformity, even with internal fixation of osteotomy. **Paley and Tetsoworth** [9] described a cylindrical osteotomy with corresponding cuts of the bone, which rotated around the central axis of the circle. When the central axis corresponded to the CORA and deformity correction was achieved without bone axis translation. In our work, the preoperative planning on the radiographic basis showed that, the CORA must be at the knee joint or the femoral condyle level in all studies subjects. Using this CORA to guide the center of a circle, the planned dome was created on the center of this circle. Full correction was achieved with minimal distal bone fragment translation.

The lateral approach was used and the quadriceps was retracted from the intermuscular septum. This was associated with prevention of the possible injury to the quadriceps or its later attachment at the site of the osteotomy. The quadriceps injury was avoided by firm internal fixation and early postoperative knee movement. This was reported in the previous work by **Gautam *et al.*** [7]. The dome osteotomy was preferred than the wedge osteotomy as it prevents the shortening of the limb in closing wedge corrections. In addition, it prevents a slow union with more limitation of the weight-bearing in the opening wedge corrections [as there was no bone contact]. In addition, the dome has a large surface that promotes healing with no discrepancies in the length of the limb. Multiple drill holes followed by a low-energy osteotomy lead to creation of small bone spikes, which interlock the osteotomy after the correction of the deformity. This can be squeezed for more stability, reducing the motion of bone segment during fixation of osteotomy and decreasing the stress on the plates and screws. This permits early partial weight-bearing [10]. **Gugenheim and Brinker** [11] fixed the osteotomy by a retrograde femoral nail. However, we preferred the use of internal fixation as it was easily contoured. **Schroerlucke *et al.*** [12] reviewed the outcome of osteotomy in 50 subjects presented with femoral genu valgum deformity. Their mean age was 13.5 years [comparable to the current work]. The full correction was reported for all cases except 2 subjects who had under correction. The undercorrection was explained by insufficient wedge to achieve the full correction. In addition, the delayed union was recorded for 5 patients and stiff knee in 6 patients [fortunately, the latter two complications were not registered in the current work]. **Howard *et al.*** [13] reported the results of osteotomy for 66 patients with genu varum deformity [or femoral and/or tibial origin]. The mean age was 14.1 years [comparable to ours]. They recorded an evidence of neurological changes due to ischemia in two patients, delayed union in three, nonunion in one and one patient had peroneal nerve injury. These complications are quite different than the current study. This could be explained by different inclusion criteria and number of included subjects.

Conclusion: Distal femur dome osteotomy is a good treatment for genu valgum deformity of distal femoral origin that causes symptoms. It improves the clinical, radiological, and functional results. However, more research is required to compare it with other osteotomy methods with more patients and longer follow-up durations.

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