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# Outcome of Dome-Shaped Proximal Tibial Osteotomy in Infantile Genu Varum

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## ABSTRACT

**Background:** The goals of the proximal tibial osteotomy are correcting the deformity, Hip-knee-ankle angle, and preventing the progress of the destruction of the medial compartment of the knee joint.

**Objectives:** The aim of the work was to evaluate the outcome of children with genu varum after proximal tibial dome shaped osteotomy.

**Patients and Methods:** These randomized clinical trials study included a total of 10 patients with 12 affected knees confirmed with persistent physiologic genu varum, attending at Orthopedic Department, Zagazig University Hospitals, Zagazig, Egypt. All cases were evaluated pre and post-operatively according to Modified Hospital for Special Surgery Knee Scoring System (HSSKS) as shown in appendix I**.** cases were assessed for functional improvement after surgery at 2, 4 months and detection of malunion or delayed union after 3 months.

**Results**: The mean (±SD) pre-operative tibio-femoral angle was 21.7 (±5.6) versus 3.18 (±1.97) post-operatively, pre-operative femoral condyle-tibial shaft angle (FTA) was 16.3 (± 2.8) versus 3.2 (±1.1) post-operatively and pre-operative metaphyseal diaphyseal angle was 15.8 (±2.6) versus 3.6 (±1.2) post-operatively with a statistically significant difference in between ($p < 0.05$). The mean pre-operative HSSKS scores were 70.16±11.3 while the mean post-operative HSSKS scores were 91.4±2.1.

**Conclusion:** It could be concluded that proximal tibial osteotomy using dome-shaped procedure to correct Infantile Genu varum deformity, has favorable treatment outcomes, does not involve any dangerous complications, and can be used as a safe and effective treatment method for the correction of infantile genu varum deformity. In the current study, angles significantly improved, most of legs got full correction and little complications occurred.

**Keywords:** Proximal Tibial Osteotomy; Tibio-femoral angle; Genu Varum.

## INTRODUCTION

Genu varum is a type of deformity of knee joints marked by a change in the center of the knee joint that lies outside the mechanical axis of the limb. In this deformity the patient's knees are distanced from each other in standing position giving the limbs the appearance of parentheses. The existence of the deformity puts the patient at risk of many complications such as the increased risk of the injury of patellofemoral joint, osteoarthritis of tibiofemoral joint, also compensatory deformities in leg and ankle joints, and increased risk of stress fracture of the tibia. Proximal tibial osteotomy is a useful method to relieve pain and restore knee function. It may be performed by a wide range of techniques including opening wedge, closing wedge and dome shaped surgery methods [(1)]**.**

It was felt that a suitable osteotomy should be near the center of rotation of angulation (CORA) with little translation, primarily in cancellous bone to allow rapid healing, and safe the epiphyseal plate and tibial length. In addition to these, the osteotomy site should be stable without the use of internal fixation devices to be able to change the amount of correction obtained on table during postoperative period. To fulfill these requirements and at the same time provide 3-plane correction of the deformity dome shaped tibial osteotomy has been described for realignment of the knee by many authors. Ponseti et al discussed a bilateral dome-shaped osteotomy of the proximal tibia to correct a varus deformity of the knees. Paley et al modified this concept by describing a focal dome osteotomy through the CORA to allow for deformity correction with minimum translation [(2,3)].

Dome shaped proximal tibial osteotomy is a conventional and traditional method for genu varum deformity [(4)].

Dome-shaped osteotomy is performed when a large degree of correction is needed (18-20 mm open or closed, or more than 20° of angular correction). In severe varus deformity cases or Blount’s disease, this method is used. The control of the correction of the tibiofemoral alignment during surgery is performed using radiography and smaller or larger than the required correction is one of the complications that may occur due to inaccuracies of intraoperative radiographies [(4)].

The aim of the current work was to evaluate the outcome of children with genu varum after proximal tibial dome shaped osteotomy.

## PATIENTS AND METHODS

These randomized clinical trials study included a total of 10 patients with 12 affected knees confirmed with persistent physiologic genu varum, attending at Orthopedic Department, Zagazig University Hospitals, Zagazig, Egypt. This study was conducted between March 2019 and May 2020.





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**Inclusion criteria:** Patients presenting with infantile genu varum aged 3 years and above, and persistent physiological genu varum.

**Exclusion criteria:** Children presenting with infantile genu varum aged below 3 years, blount disease, and adolescent genu varum.

**Operational design:** Full history taking, clinical and radiological examination including long film x-ray for patient with bilateral infantile genu varum.

**Scoring system:** All cases were evaluated pre and post-operatively according to Modified Hospital for Special Surgery Knee Scoring System (HSSKS) as shown in appendix I.

Surgical technique:

**I. Pre-operative Planning:**

One needs to determine the location of the apex of deformity, i.e., the center of rotation and angulation (CORA), and determine whether it is feasible to perform the correction at that site. The tibial osteotomy is typically made in the metaphysis, distal to the tibial apophysis and insertion of the patellar tendon. The location of the osteotomy being away from the CORA necessitates appropriate lateral and often anterior translation of the distal fragment, in order to realign the anatomic axis of the tibia. Disregarding this principle creates a secondary translational ‘‘dog-leg’’ deformity at the metadiaphysis as well as valgus malorientation of the ankle. In this study, cases requiring proximal tibial osteotomy were corrected based on the osteotomy rule II concept and fixation using k-wires. General anesthesia was done for all infants on whom surgical procedure was performed.

**II. Surgical procedure:**

In the dome-shaped osteotomy, first, the fibula osteotomy was performed by making an incision of about 3 cm. A sub-periosteal excision of 1 cm of fibula was performed through a lateral longitudinal incision at the junction of the middle and distal thirds of the shaft: in the so-called ‘safe zone’ to avoid damage to branches of the peroneal nerve. A direct approach is made to the fibula through the interval between the peroneal muscles and the soleus. Care is taken when performing the subperiosteal dissection as the motor branch to the extensor hallucis longus lies close to the anteromedial border of the fibula. The soft tissue is protected with Hohmann retractors exposing the fibular diaphysis. Multiple drill holes of the fibula is done the completing the osteotomy with osteotome. The fascia is left open, and the skin is closed in layers.

**Postoperative care and follow up:**

Post-operative analgesics: Diclofenac potassium syrup was given when required for 24 hours and antibiotics: Ceftriaxone 500 mg IM twice daily were used for 2-3 days, then oral antibiotics in the form of syrup amoxicillin clavulanic combination (Augmentin 600mg) were used for another 10 days. Post-operative anti-edematous medications were used along with leg elevation. The patient was discharged within 48 hours. At 2 weeks, the plaster cast was changed, and the final position of the osteotomy was adjusted. Dressings were changed as the wound was inspected at the time of recasting. Infants were closely evaluated in outpatient clinic at 2, 4 and 6 weeks postoperatively for early detection of infection, under or overcorrection. The K-wires were removed at 6 weeks in outpatient clinic. The plaster cast was removed when the osteotomy was completely united clinically and radio-graphically. The total time in cast varied with the age of the patient. Full weight bearing was allowed at 6 weeks. Physiotherapy and early postoperative passive, active range of motion were encouraged following cast removal. Then, they were assessed for functional improvement at 2, 4 months and detection of malunion or delayed union after 3 months.

Final evaluation was at 6 months postoperatively. The complications were addressed and managed.

**Ethical approval**

**The study was approved by the Ethical Committee of Zagazig Faculty of Medicine. An informed consent was obtained from all patients in this research. Every patient received an explanation for the purpose of the study. All given data were used for the current medical research only. 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.**

***Statistical analysis***

Data analyzed using windows operating system and the based statistics program (SPSS 20.0) adopting in the outcome the following statistical tests: continuous variables were expressed as means and standard deviation (SD), discrete variables were expressed as frequencies and percentages. Differences would be statistically significant if probability (p value $\leq 0.05$) using appropriate statistical tests.

**RESULT**

Mean age was distributed as 5.91±1.62. 66.7% were males (8 cases) and 33.3% were females (4 cases). Regarding side distribution among the studied population, all cases (12) have bilateral knees deformity (100%) **(Table 1).**

Regarding to pre-operative ligamentous laxity, 8 (66.7%) patients were negative versus 4 (33.3%) patients were positive **(Table 2)**.

Regarding radiological assessment, the mean (±SD) pre-operative tibio-femoral angle was 21.7(±5.6) versus 3.18 (±1.97) post-operatively with a statistically significant difference in between ($p < 0.05$) **(Figure 1)**. The mean (±SD) pre-operative femoral condyle-tibial shaft angle (FTA) was 16.3 (± 2.8) versus 3.2 (±1.1) post-operatively with a statistically significant difference in between ($p < 0.05$) **(Figure 2)**. The mean (±SD) pre-operative metaphyseal diaphyseal angle was

15.8 (±2.6) versus 3.6 (±1.2) post-operatively with a statistically significant difference in between ($p < 0.05$) **(Figure 3)**.

Regarding outcomes, (83.3%) knees had full correction of deformity while 1 knee (8.3%) had under correction and 1 knee (8.3%) showed over-correction of deformity **(Table 3)**.

The mean pre-operative HSSKS scores were 70.16±11.3 while the mean post-operative HSSKS scores were 91.4±2.1. The subjects HSSKS results were improved from pre- to post-operatively with a statistically significant difference between them **(Table 4)**.

Regarding post-operative complications, 3 cases (25%) had superficial skin infection and 2 cases had post-operative edema. All complications were addressed and managed conservatively **(Table 5)**.

**Table (1): Demographic distribution among studied group (N=12)**

| | | Age (years) | |
|---|---|---|---|
| Mean± SD | | 5.91±1.62 | |
| Median (Range) | | 5.5 (4-9) | |
| | | N | % |
| Sex | Male | 8 | 66.7 |
| | Female | 4 | 33.3 |
| | Total | 12 | 100 |
| Side | Bilateral | 12 | 100.0 |
| | Total | 12 | 100.0 |
| Pre-operative pain | No pain | 12 | 100 |
| | Total | 12 | 100 |

**Table (2): Pre-operative ligamentous laxity distribution among studied knees (N=12).**

| | | N | % |
|---|---|---|---|
| Pre-operative ligamentous laxity | -VE | 8 | 66.7 |
| | +VE | 4 | 33.3 |
| | Total | 12 | 100.0 |

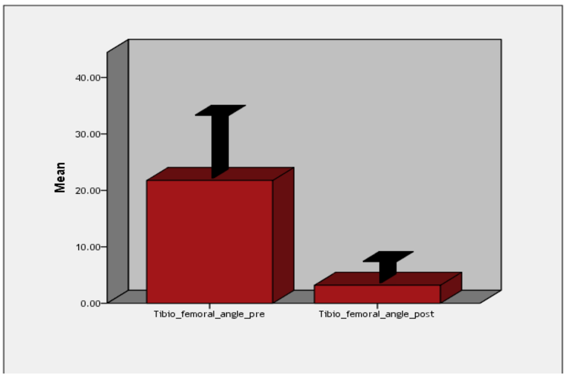


**Figure (1): Mean of radiological assessment for tibio-femoral angle pre and post-operatively.**

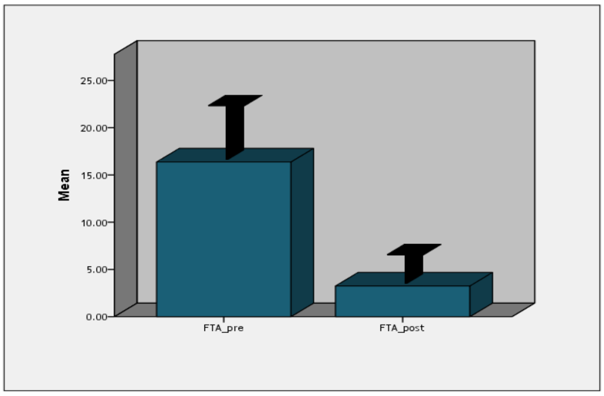


**Figure (2):** Mean radiological assessment for femoral condyle-tibial shaft angle pre and post-operatively.

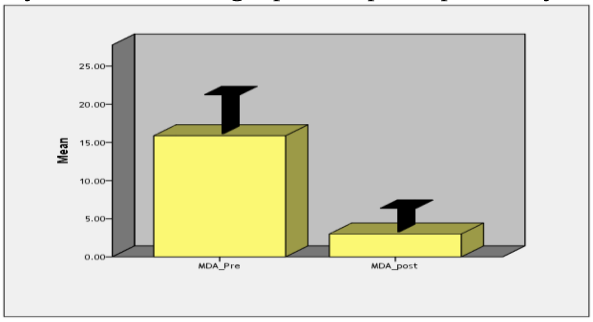


**Figure (3):** Mean radiological assessment for metaphyseal diaphyseal angle pre and post-operatively.

**Table (3): Outcome distribution regarding under, full and over-correction of deformity among studied legs (N=12).**

| | | N | % |
|---|---|---|---|
| Outcome | Full | 10 | 83.4 |
| | Under | 1 | 8.3 |
| | Over | 1 | 8.3 |
| | Total | 12 | 100.0 |

**Table (4): showing pre- and post-operative Modified Hospital for Special Surgery Knee Scoring System (HSSKS).**

| | Pre | Post | P |
|---|---|---|---|
| Special Surgery Knee Scoring System | 70.16± 11.3 | 91.4± 2.1 | <0.05 ** |

**Table (5): Showing post-operative complications.**

| | | N=12 | % |
|---|---|---|---|
| Post-operative complications | Infection | 3 | 25 |
| | Edema | 2 | 16.6 |
| | No complications | 7 | 58.3 |

## DISCUSSION

The most common deformity of the knee in children is infantile genu varum. As a result of unbalanced distribution of weight on knees, this deformity leads to increased pressure on medial compartment of the knee, and thus damages the articular cartilage, which finally causes osteoarthritis [5]. Genu varum is a type of deformity of knee joints marked by a change in the center of the knee joint that lies outside the mechanical axis of the limb. In this deformity the patient's knees are distanced from each other in standing position giving the limbs the appearance of parentheses [1].

Performing proximal tibial osteotomy is a treatment of choice for young and middle aged active patients with progressive and symptomatic genu varum resulting in reduction of the loading of the involved medial compartment of the knee joint [6].

The goals of the proximal tibial osteotomy are correcting the deformity, hip-knee-ankle angle and preventing the progression of destruction of the medial compartment of the knee joint [7].

The surgical correction of persisting, significant deformity can be achieved by a variety of methods ranging from manipulation of physeal growth by temporary physeal stapling, or hemiepiphysiodesis to many types of valgus osteotomies such as the incomplete lateral closing wedge osteotomy, an oblique tibial osteotomy, and the intra-epiphyseal, or trans-epiphyseal tibial osteotomy. In these osteotomies, the mechanical axis of the knee is shifted to the lateral compartment, and therefore the pressure to medial compartment is reduced [8,9].

Several methods have been suggested and evaluated for proximal tibia osteotomy including closed-wedge osteotomy, open-wedge osteotomy, and dome-shape osteotomy. Increased quality of life and reduced pain in daily functions have been reported in all the above methods. Each of these methods has its own advantages and dis-advantages [10].

The dome-shaped proximal tibial osteotomy is a conventional and traditional method for the treatment genu varum deformity [11].

Dome-shaped osteotomy is performed when a large degree of correction is needed (18-20 mm open or closed, or more than 20° of angular correction). In severe varus deformity cases or Blount's disease, this method is used [12].

The control of the correction of the tibiofemoral alignment during surgery is performed using radiography and smaller or larger than the required correction is one of the complications that may occur due to inaccuracies of intraoperative radiographies. Therefore, one of the advantages of dome-shaped osteotomy method is its capability in achieving the required correction after the surgery [13].

Osteotomy is also inherently stable and does not usually need internal fixation, but pin and plaster or external fixator can be used. Some of the disadvantages of this method are the difficulty of the surgical technique, incidence of intra-articular fractures, and scarring around the patellofemoral extensor mechanism [14].

The aim of our study was to improve functional outcomes of the children with genu varum after the proximal tibial osteotomy surgery using dome shaped osteotomy.

The study was conducted at the Department of Orthopedic Surgery and Traumatology, Zagazig University hospital. Ten patients with 12 affected knees were included in the study.

As a regard to age and sex distribution among studied group of patients, the mean age was 5.91±1.62, ranged (4-9) years. 8 (66.7%) of them were males and the rest 4 (33.3%) were females.

In a study of **Nadeem *et al.*** [3] the mean age at surgery 10.25 years (range 4.0–15.25 years), and from 31 patients included in that study 18 patients were males and the rest 13 patients were females.

However, in a study presented by **Ahmed and Abdullah** [15] the mean age was 4.02 ± 0.84 and ranged (3–6) years. 58.3 % of them were males and the rest 41.7% were females which is comparable to our patient's characters.

As regard to side distribution among studied group all cases 12 children (100%) have bilateral deformity.

In the study of **Nadeem *et al.*** [3] the right side was affected in six (35.3%), whereas the left side was affected in four (16.7%), and seven (41.2%) were bilaterally affected which is comparable to our patient's demographic characteristics.

As regard to pre-operative pain among our studied population, the condition was painless in all cases (100%).

In the study of **Kandil** [16] no pain was noted preoperative in all patients which comes with disagreement with our results.

In the study of **Nadeem *et al.*** [3] they concluded that pain was found only in 24% of patients included in that study, which is less than our recorded percentage.

Regarding pre-operative ligamentous laxity among the studied legs, 4 (33.3%) of the patients had positive testing for pre-operative ligamentous laxity.

In the study of **Ahmed and Abdullah** [15] they reported that 41% of children included in that study had pre-operative ligamentous laxity which was agreed with our results.

As regard to radiological angles assessment and distribution pre and post intervention. Tibiofemoral angle: preoperative was 21.75±5.65, while postoperative was 3.18±1.97 (P< 0.00**). Femoral condyle-tibial shaft (FTA): preoperative was 16.37±2.89, while postoperative was 3.25±1.12, Paired t 16.842 (p<0.00**). Metaphyseal diaphyseal angle (MDA): Preoperative was 15.875±2.6, versus 3.62±1.23 postoperatively, Paired t 16.409 (P<0.00**). All angles decreased from pre- to post-operatively among the studied legs with a statistically significant difference. As regard to outcome distribution among the studied legs, 10 legs (83.3%) legs had full correction while 1 leg (8.3%) had under correction with 1 leg has been (8.3%) overcorrected.

In the study of **Tabatabaei *et al.*** [12] they concluded that the mean tibiofemoral angle was significantly reduced after the surgery compared with before the surgery (P < 0.001), which is consistent with our results. In the study of **Rezaeizadeh *et al.*** [17] the average varus angle changes from 17.5 to 5.5 valgus degrees after proximal tibial osteotomy using dome-shaped method.

In a study of **Geith and El Naggar**[8]**,** they showed that the mean tibiofemoral angle reached from 19° (between 19 and 26 varus degrees) before proximal tibial osteotomy to a mean of 2° (5° valgus-15° varus) after dome-shaped osteotomy.

The results of all studies mentioned were agreed to our current study results, indicating that the effectiveness of this technique is in the correction of the tibiofemoral angle.

In the study of **Ahmed and Abdullah**[15] the mean thigh-foot angle was much improved from −7.83±2.84° (5–15 in internal rotation) preoperatively to a postoperative value of 2.08±1.74° (0–5 in external rotation).

The radiological parameters (tibiofemoral angle, mechanical axis deviation, and metaphyseal-diaphyseal angle) showed a significant improvement in the postoperative mean values when compared with the preoperative mean values.

As regard to post-operative complications among the studied legs, 2 cases (16.6%) had post-operative swelling and superficial infection was founded among 3 (25%) cases. All complications were addressed and managed conservatively during early post-operative follow up.

In the study of **Tabatabaei *et al.*** [12] they reported that, in none of the patients, post-operative complications such as peroneal nerve damage, infection, compartment syndrome, venous thrombosis, fractures, lack of complete correction, and over-correction were observed.

In the study of **Chiang *et al.*** [7] they reported excellent or good performance in 94.73% of the knees, which underwent dome-shaped proximal osteotomy surgery for correction of geno-varum, which is consistent with our results.

In the study of **Geith and El Naggar** [8] they reported that, at a mean time of 30-months of follow-up, all patients had a good clinical and radiological correction of deformity with improvement of preoperative symptoms, which comes in agreement of our results.

In the study of **Pourfeiz *et al.*** [4] they indicated improved performance as well as pain reduction after the dome-shaped osteotomy.

Upper tibial osteotomy is considered an effective treatment to correct knee deformity, but there still exists contradictions about how to perform osteotomy and the selection of patients for each existing surgical method. Among the various methods of surgery, dome-shaped osteotomy provides good results through precise angular correction [18].

## CONCLUSION

It could be concluded that proximal tibial osteotomy using dome-shaped procedure to correct Infantile Genu varum deformity, has favorable treatment outcomes, does not involve any dangerous complications, and can be used as a safe and effective treatment method for the correction of infantile genu varum deformity. In our study, angles significantly improved, most of legs got full correction and little complications occurred.

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## REFERENCES

1. **Canale S, Beaty J (2008):** Campbell's Operative Orthopaedics. 11th ed. Philadelphia, PA: Mosby Elsevier. https://www.worldcat.org/title/campbells-operative-orthopaedics/oclc/70929249
2. **Paley D, Tetsworth K (1992):** Mechanical axis deviation of the lower limbs. Preoperative planning of multiapical frontal plane angular and bowing deformities of the tibia or femur. Clin Orthop Relat Res., 280:65.
3. **Nadeem R, Quick T, Eastwood D (2005):** Focal dome osteotomy for the correction of tibial deformity in children. Journal of Pediatric Orthopaedics B., 14(5): 340-346.
4. **Pourfeiz H, Soleimanpour J, Sales J *et al.* (2014):** Comparison of the short time outcomes of geno varum correcting surgery between the open wedge and dome shape high tibial osteotomies. Med J Tabriz Univ Med Sci Health Serv., 35: 32-7.
5. **Heidari B (2011):** Knee osteoarthritis prevalence, risk factors, pathogenesis and features: Part I. Caspian J Intern Med., 2(2): 205-212.
6. **Amendola A, Bonasia D (2010):** Results of high tibial osteotomy: Review of the literature. Int Orthop., 34:155-60.
7. **Chiang H, Hsu H, Jiang C (2006):** Dome-shaped high tibial osteotomy: A long-term follow-up study. J Formos Med Assoc., 105:214-9.
8. **Geith M, Naggar A (2016):** Modified dome shaped proximal tibial osteotomy for treatment of infantile tibia vara. Int J Res Orthop., 2:394-9.
9. **Warme B, Aalderink K, Amendola A (2011):** Is there a role for high tibial osteotomies in the athlete? Sports Health, 3(1):59–69.
10. **Bagheri F, Gharehdaghi M, Izanloo A *et al.* (2017):** Proximal tibial osteotomy in patients with varus knee deformity using MW technique: Evaluation of results. Journal of Research in Orthopedic Science, 4(3: 0-0.
11. **Rosso F, Margheritini F (2014):** Distal femoral osteotomy. Curr Rev Musculoskelet Med., 7:302-11.
12. **Tabatabaei S, Narimani A, Mehramiri S (2017):** Assessment of the Treatment Outcomes of Dome-shaped Proximal Tibial Osteotomy in Patients with Genu Varum Referred to Razi Hospital. Asian Journal of Pharmaceutics, 11(3): S667-S671.
13. **Madadi F, Eajazi A, Madadi F *et al.* (2010):** Clinical results of reversed V-shaped high tibial corticotomy with minimally invasive surgery without internal fixation devices. Orthopedics, 33:388-492.
14. **Schröter S, Konstantinidis L, Kraus T *et al.* (2013):** Open wedge re-correction high tibial osteotomy in an elderly patient with a varus angulated non-united dome-shaped high tibial osteotomy. J Zhejiang Univ Sci B., 14:1054-8.
15. **Ahmed A, Abdullah E (2018):** Anteroposterior inverted-U proximal tibial osteotomy without internal fixation for correction of angular and torsional deformities in children with infantile tibia vara. The Egyptian Orthopaedic Journal, 53(4): 373-377.
16. **Kandil H (2001):** Valgus rotational-dome shaped-tibial osteotomy in treatment of tibia vara. The Egyptian Journal of Hospital Medicine, 4(1): 52-58.
17. **Rezaeizadeh A (2006):** High tibial dome shape osteotomy for symptomatic geno-varum in young adults. Res J Math Stat., 12:77-84.
18. **Tabrizi A, Soleimanpour J, Sadighi A *et al.* (2013):** Short time following of geno varum correcting surgery using open and closed wedge high tibial osteotomy. Malays Orthop J., 7:7-12.