

# Assessment of the Treatment Outcomes of Dome-shaped Proximal Tibial Osteotomy in Patients with Genu Varum Referred to Razi Hospital

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## Abstract

**Introduction:** The proximal tibial osteotomy is an accepted and commonly used treatment for younger and active patients with medial unicompartmental osteoarthritis of the knee and varus deformity. The aim of this study was to assess the treatment outcomes of dome-shaped proximal tibial osteotomy in patients with genu varum. **Materials and Methods:** In this prospective study, dome-shaped osteotomy was performed in 23 patients (14 males and 9 females) with genu varus deformity that referred to Razi Hospital in Ahvaz in 2016. Patients were followed for 6 months after surgery and were assessed in terms of Modified Hospital for Special Surgery Knee Scoring System (HSSKS), tibiafemoral angle, Insall-Salvati index, and complications. **Results:** The mean tibiofemoral angle changed from  $16.6 \pm 5.01$  varus to  $6.9 \pm 1.48$  valgus degrees ( $P < 0.001$ ). The mean modified HSSKS promoted from  $73.3 \pm 3.01$  to  $82.3 \pm 1.45$  ( $P < 0.001$ ). Furthermore, there was no significant difference in the range of motion and quadriceps strength. Insall-Salvati index was not different significantly after dome-shaped osteotomy, and the mean patellar height index changed from  $1.054 \pm 0.07$  to  $1.057 \pm 0.08$  ( $P = 0.774$ ). The incidence of complication after dome-shaped osteotomy was one case (4.34%) of non-union. **Conclusion:** Results of this study demonstrated that dome-shaped osteotomy of proximal tibial is a simple, safe, and useful treatment which has favorable results in patients with genu varum.

**Key words:** Dome, genu varum, osteotomy, tibia

## INTRODUCTION

Genu varum is a type of deformity of knee joints marked by a change in natural alignment of the limbs such that the center of the knee joints lies outside of the mechanical axis of the limbs. In this deformity, the patient's knees are distanced from each other in the standing position, giving the limbs the appearance of parentheses.<sup>[1]</sup> The existence of this deformity puts patients at risk of many complications such as the increased risk of the injury of patellofemoral joint, osteoarthritis of tibiofemoral joint, also compensatory deformations in leg and ankle joints, and increased risk of stress fractures of the tibia.<sup>[2,3]</sup>

Performing proximal tibial osteotomy is a treatment of choice for young- and middle-aged active patients with progressive and symptomatic genu varum and mild-to-moderate

osteoarthritis which results reduction of the loading of the involved medial compartment of the knee joint.<sup>[4,5]</sup> 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.<sup>[6,7]</sup> Proximal tibial osteotomy is a useful method to relieve pain and restore the knee functionality.<sup>[1]</sup> Proximal tibial osteotomy in patients, who have a significant physical activity or are young, has substantial long-term results and significantly postpones their need for joint replacement.<sup>[8,9]</sup> Proximal tibial osteotomy is performed by a wide range of

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**Received:** 09-09-2017

**Revised:** 20-09-2017

**Accepted:** 25-09-2017

techniques including opening-wedge, closing-wedge, and dome-shaped surgery methods. The dome-shaped proximal tibial osteotomy is a conventional and traditional method for the treatment of osteoarthritis and genu varum deformity.<sup>[5,7]</sup> 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.<sup>[10]</sup> In dome-shaped osteotomy, an external fixator is used.<sup>[7,11]</sup> 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.<sup>[12]</sup> Osteotomy is also inherently stable and does not usually need internal fixation, but pin and plaster or external fixator can be used.<sup>[13]</sup> 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.<sup>[14]</sup> Although there are different treatment methods for the correction of genu varum, detailed assessments before surgery play an important role in the selection of the appropriate treatment and the treatment success. In addition, the treatment outcomes of these patients are also of particular importance. Therefore, this study was conducted with the aim to evaluate the treatment outcomes of patients with osteoarthritis and genu varum after the proximal tibial osteotomy surgery using the dome-shaped method.

## MATERIALS AND METHODS

The current research is an interventional study and was conducted using self-controlled pre- and post-intervention method. In this study, 23 patients (27 knees), who had been admitted to Ahvaz Razi Hospital during 2015-2016 period, diagnosed with medial knee pain, genu varum deformity, and medial unicompartmental osteoarthritis of the knee, and undergone the dome-shaped proximal tibial osteotomy surgery, were assessed.

The patients were enrolled in the research based on the pain induced by medial compartment osteoarthritis of the knee, evidence of degenerative arthritis of the medial compartment of the knee in standing radiographs, painful genu varus, the ability of the patient to use crutches, and the proper vascular condition of limbs, and with written informed consent. The exclusion criteria were as follows: Lateral knee compartment space narrowing, lateral tibial subluxation over 1 cm, the loss of bone in the medial compartment of more than 2-3 mm, knee flexion contracture over 15°, knee bent <90°, needed correction of more than 20°, and rheumatoid arthritis patients. After obtaining patient's history, examination, and asking for the required radiographs and explaining the surgical procedures, its complications and also post-operative cares

and follow-ups patients underwent surgery. Before surgical operation and 6 months after surgery, the Modified Hospital for Special Surgery Knee Scoring System (HSSKS) was completed and patients were asked about the severity of the pain using direct interview method. Furthermore, the amount of pain, tibiofemoral angle, patellar height (based on Insall-Salvati index), and range of motion and quadriceps muscle power were also assessed and recorded. The HSSKS scores were graded in four categories of excellent (90-100), good (80-89), medium (70-79), and weak (<70). To measure the length of diagonal patella, the lateral radiography of the knee, bent 30°, was performed. Insall-Salvati index is  $1 \pm 0.2$  (in the range of 0.8-1.2) in normal conditions. Index values <0.8 and more than 1.2 were considered as an indication of Patella Baja and Patella Alta, respectively.

To assess treatment outcomes, patients were recalled again 6 months after the surgery and were evaluated with regard to all the abovementioned variables. Patients were also assessed with regard to various surgical complications during post-operative examinations.

## The method of operation

In the dome-shaped osteotomy, first, the fibula osteotomy was performed by making an incision of about 3 cm on fibula at the confluence of the middle-third and distal third of fibula, and the distal section of fibula was completely displaced to the medial section. Then, under the tibia tuberosity, a cut between 1 and 1.5 inch in the midline at the central section of the tibia was made, and after the exposure of proximal tibia under and around patella tendon, several dome-shaped holes were made in proximal tibia using special drills, and osteotomy was completed using narrow 5-mm osteotome for joining holes, and finally, by applying valgus force between the distal and proximal sections, action was taken to correct the deformity. The amount of correction was controlled using cautery wire and fluoroscopy. Pin and plaster was applied for the fixation of osteotomy. It should be noted that all surgical procedures were performed by a single person to eliminate the impact of the difference in the skills of the performer of the surgery on treatment outcomes.

## Data analysis

In the end, the SPSS version 22 was used to perform statistical analyses. The data obtained through paired *t*-test and Chi-square statistical tests were analyzed. The significance level of these tests was set at 0.05.

## RESULTS

In the present study, 9 women (39.13%) and 14 men (60.87%) participated. All participants were in the age range of 10-35 and in average were  $70.7 \pm 21.43$  years old.

The results of the present study showed that the amount of pain was significantly reduced after surgery compared to before the surgery ( $P = 0.002$ ). So that after surgery, no pain was reported in 17.52% of patients (12 people) [Figure 1].

The results showed a significant improvement in the knee scoring index of HSSKS after surgery ( $P = 0.002$ ) [Table 1]. The HSSKS score after tibial osteotomy using dome-shaped method was between 80 and 85 for all cases, which is indicative of good knee function, whereas before the surgery, this score was in the range of 68-77 (weak-to-moderate performance). The mean tibiofemoral angle was significantly reduced after the surgery compared with before the surgery ( $P < 0.001$ ) [Table 1].

The patellar height showed no significant difference before and after surgery based on Insall-Salvati index ( $P = 0.774$ ). In all cases, the amount of the index was between 0.98 and 1.2, which is indicative of the absence of Patella Alta and Patella Baja, respectively. Furthermore, by comparing the data before and after surgery, no significant difference was observed with regard to the range of motion and quadriceps muscle power ( $P > 0.05$ ) [Table 1].

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. Only in one case

(4.34%), non-union existed, which underwent surgery and plaque fixation again.

## DISCUSSION

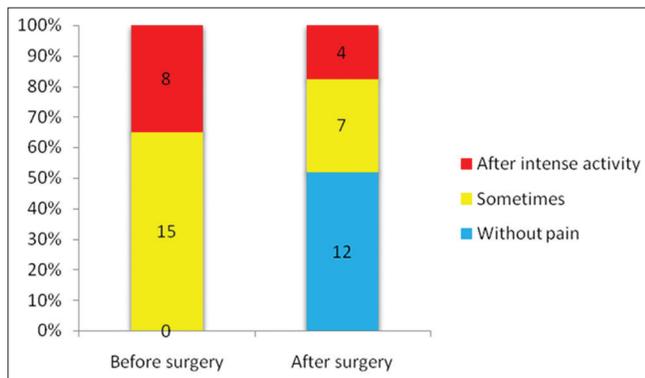
Upper tibial osteotomy is considered an effective treatment to correct knee deformity, but there still exists contradictions about how to perform osteotomy and the selection of patients for each existing surgical method.<sup>[15]</sup> Among the various methods of surgery, dome-shaped osteotomy provides good results through precise angular correction.<sup>[16]</sup> Therefore, this study examines the results of dome-shaped osteotomy surgery for genu varum correction.

The results of the current study showed the pain of patients decreased significantly after surgery compared with that of before the surgery. The results of Pourfeiz *et al.* (2014) study, like the present study, indicated improved performance as well as pain reduction after the dome-shaped osteotomy.<sup>[5]</sup>

In this study, significant improvement in post-operative knee function score (HSSKS) was obtained. Furthermore, the amount of this index in all patients was between 80 and 85, which is indicative of good knee performance.

In the study by Kodkani, the results of dome-shaped proximal tibial osteotomy in the treatment of genu varum showed that the mean score of knee performance increased significantly compared with before the surgery, and at the end of the 2<sup>nd</sup> month after surgery, it was 88.96. Patients held these scores up until the 2-year follow-up.<sup>[17]</sup> In another study, Chiang *et al.* showed that the score of knee performance before the surgery was  $68 \pm 6$  and it was  $88 \pm 9$  5 years after the surgery, and they reported excellent or good performance in 94.73% of the knees, which underwent dome-shaped proximal osteotomy surgery.<sup>[7]</sup> These results correspond with the results of the current study.

In the present study, patellar height based on Insall-Salvati index showed no significant difference before and after the treatment. The results also indicate the absence of Patella Alta and patella Baja. In the study of Pourfeiz *et al.* (2013) like the



**Figure 1:** Amount of pain before and after proximal tibial osteotomy using dome-shaped method

**Table 1:** Comparison of the performance of knee before and after proximal tibial osteotomy using dome-shaped method

Variable	Knee function		P
	Pre-operative	Post-operative	
HSSKS score	73.3±3.01	82.3±1.45	0.0001
Patellar height	1.054±0.07	1.057±0.08	0.774
Tibiofemoral angle	16.5±5.01 varus degrees	6.9±1.48 valgus degrees	0.0001
Motion range of the knee	127.7±4.05	127.7±3.35	0.785
Quadriceps muscle power	27 cases: 5.5	3 cases: 4.5 24 cases: 5.5	0.083

HSSKS: Special Surgery Knee Scoring System

current study, there was no difference in the Insall-Salvati index before and after the dome-shaped osteotomy, and no change in patellar position in patients undergoing this type of osteotomy was observed.<sup>[5]</sup> In the study of Chiang *et al.*, the Insall-Salvati index before the dome-shaped osteotomy was  $88.0 \pm 15.0$ , and it was  $90.0 \pm 19.0$  5 years after the surgery. This difference was not significant, indicating limited changes in patellar position.<sup>[7]</sup> In another study by Rezaeizadeh, the results showed that Patella Baja did not exist in patients treated with dome-shaped osteotomy.<sup>[18]</sup> These results are consistent with the findings of this study.

In their study, Backstein and Meisami have mentioned the lack of patellar position as one of the advantages of dome-shaped osteotomy, which this factor is the reason for the absence of post-arthroplasty complication in the knee.<sup>[19]</sup> However, in open wedge method, performed in the study of Lee *et al.*<sup>[20]</sup> and Mobarakeh *et al.*,<sup>[21]</sup> there is a significant difference in Insall-Salvati index before and after the surgery, and the open wedge osteotomy method had a significant impact on patellar position, which is different from this study and numerous studies mentioned before.

In this study, a significant difference in the tibiofemoral angle was observed before and after surgery. There are contradictions in various studies on the amount of the correction of the valgus angle. Insall *et al.* report that an amount of post-operative valgus correction between  $5^\circ$  and  $14^\circ$  is acceptable [22], and in the study of Coventry and Bowman, the rate of angular correction of up to  $5^\circ$  will improve the treatment in the long run.<sup>[23]</sup> The results of the study by Pourfeiz *et al.* (2013) showed that tibiofemoral angle in dome-shaped osteotomy reduced significantly and reached from  $12.7 \pm 3.7$  before surgery to  $4.2 \pm 0.8$  after surgery.<sup>[5]</sup> Furthermore, in the study of Rezaeizadeh (2006), the average varus angle changes from  $17.5$  to  $5.5$  valgus degrees after proximal tibial osteotomy using dome-shaped method.<sup>[18]</sup>

The results of Kodkani study showed all patients, who underwent dome-shaped proximal tibial osteotomy achieved optimal bone corrections, except one case that had  $5^\circ$  undercorrection due to having pre-operative posterolateral corner laxity.<sup>[17]</sup> Furthermore, the study results of Geith and Nagggar showed that the mean tibiofemoral angle reached from  $19^\circ$  (between  $19$  and  $26$  varus degrees) before proximal tibial osteotomy to a mean of  $2^\circ$  ( $5^\circ$  valgus- $15^\circ$  varus) after dome-shaped osteotomy.<sup>[24]</sup> The results of all studies mentioned, similar to the current study, indicate that the effectiveness of this technique is in the correction of the tibiofemoral angle.

In the present study, no significant difference with regard to the range of motion and quadriceps muscle power before and after the surgery was observed. In the study of Pourfeiz *et al.* (2013) and also the study of Chiang *et al.*, patients treated with dome-shaped osteotomy did not have a significant difference before and after surgery.<sup>[5,7]</sup> These results correspond with the results of this study. In this study,

the post-operative complication was only one (4.35%) case of non-union, which went under surgery and plaque fixation again. In the study conducted by Pourfeiz *et al.* (2013), complications of dome-shaped proximal tibial osteotomy for treating genu varum were observed in four cases (7.26%) of patients. Furthermore, limb length discrepancy and surgical site infection was not observed in any patient. However, there was one case of hypostasis on the dorsal surface of the patient's leg that was disappeared after the follow-up period. In two cases, in the 6-month follow-up, the alignment of the limb was not corrected completely and had a varus of  $2-4^\circ$ . Furthermore, in one case, there was a non-union at the location of osteotomy in the 6-month follow-up, which went under internal fixation and bone grafting.<sup>[5]</sup> To some extent, these results correspond to the findings of the present study, but the rate of complications was lower in the present study. One of the prevalent complications in patients treated with dome-shaped osteotomy is the incidence of impermanent palsy in peroneal nerve and/or temporary paralysis of the extensor hallucis longus muscle, which causes dissatisfaction of patients treated with this method of osteotomy.<sup>[19]</sup> In this study, this complication was not observed in any patient.

In the study of Kodkani, the superficial pin tract infection in three cases of patients who underwent dome-shaped proximal tibial osteotomy was observed. Furthermore, all osteotomies fused in 6-8 weeks without any complications.<sup>[17]</sup> These findings do not correspond with the findings of the present study. The reason for this may be related to the skill and experience of the surgeon, or the type of fixation device used. In the study conducted by Chiang *et al.*, an immediate complication after dome-shaped proximal tibial osteotomy operation that involved the loss of fixation in one knee was observed and required a second surgery. Infection, peroneal nerve paralysis, compartment syndrome, and thrombophlebitis were not observed in any patients.<sup>[17]</sup> These results correspond with the results of this study as well.

## CONCLUSION

Eventually, the present study showed that proximal tibial osteotomy using dome-shaped procedure 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 genu varum deformity. However, attention must be paid to the point that for further and more accurate assessment, there is a need for long-term follow-up.

## ACKNOWLEDGMENTS

This study was financially supported by the Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran (Grant.No.: U-96007).

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**Source of Support:** Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran (U-96007). **Conflict of Interest:** None declared.