Shafa Ortho J. 2017 August; 4(3):e11547. doi: 10.5812/soj.11547.

Published online 2017 July 30. **Research Article**

Proximal Tibial Osteotomy in Patients with Varus Knee Deformity Using M-W Technique: Evaluation of Results

Farshid Bagheri,[1] Mohamad Gharehdaghi,[1] Azra Izanloo,[2] Hassan Rahimi,[1] and Masoud Mirkazemi[3,*]

[1]Orthopedic Research Center, Mashhad University of Medical Sciences, Mashhad, Iran
[2]Razavi Cancer Research Center, Razavi Hospital, Imam Reza International University, Mashhad, Iran
[3]Bone and Joint Reconstruction Research Center, Shafa Orthopedic Hospital, Iran University of Medical Sciences, Tehran, IR Iran

[*]*Corresponding author*: Masoud Mirkazemi, Bone and Joint Reconstruction Research Center, Shafa Orthopedic Hospital, Iran University of Medical Sciences, Tehran, IR Iran. Fax: +98-5136004359, E-mail: masoud_dr2003@yahoo.com

Received 2017 March 27; **Revised** 2017 June 18; **Accepted** 2017 July 06.

Abstract

Background: Genovarum is the most common knee deformity for which a variety of surgical techniques have been proposed.
Objectives: We decided to share our experiences through a detailed presentation of a new and simple method called proximal tibia osteotomy using M-W method.
Methods: In this study, 68 patients (128 knees) with proximal tibia osteotomy with an average age of 34 years, who had undergone W-M osteotomy surgery in a community hospital during 2001 and 2014, were studied using knee society score (KSS) and functional KSS questionnaires, and their clinical results were analyzed.
Results: No significant difference was obtained between patients undergoing surgery by this method in KSS before (78.8) and after (89.6) the surgery. Although the mean score was improved, functional KSS improved significantly after surgery. None of the patients had peroneal nerve complication, infection, osteomyelitis, or postoperative nonunion. Moreover, no recurrence was detected in a mean of 2.7 years follow-up.
Conclusions: Considering the advantages of this method, it is recommended that knee varus deformity be treated using this method, as its rate of complications is low. However, further studies should be conducted on the effectiveness of this method in the future.

Keywords: Knee, Osteotomy, Tibia, Varus Deformity

1. Background

The most common deformity of the knee is genovarum. 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 (1, 2).

High tibia osteotomy was first proposed by Jackson in 1958 for treatment and prophylaxis of medial compartment osteoarthritis of the knee (3). Valgus osteotomy of proximal of tibia is still used as a common method to reduce pressures on the medial compartment of the knee. This clinical method is mostly used for young and active patients, who are affected by premature medial osteoarthritis of the knee (3). In this osteotomy, the mechanical axis of the knee is shifted to the lateral compartment, and therefore the pressure to medial compartment is reduced.

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 (4).

Each of these methods has its own advantages and disadvantages. In medial open-wedge osteotomy, a wedge-like segment of the proximal part of tibia bone is opened and corrected on the medial side of the affected knee. This method needs internal fixation. The main benefit of open-wedge method is that the lateral cortex remains intact and fibula osteotomy is not needed, thus no complications associated with fibular osteotomy such as peroneal nerve palsy were reported. On the other hand, limb shortening did not occur in this technique.

However, the disadvantages of this method include the possibility of delayed union, patella Baja at the site of osteotomy, and infection (5).

Another osteotomy technique, which is based on fibula osteotomy, is lateral closed-wedge high tibia osteotomy. In this method, a wedge- like segment of proximal tibia is removed from the lateral side of the tibia. The benefits of this method, compared with open wedge, are a better control on posterior tibia slope and a more rapid union. Non-rigid fixation devices are used in classic closed-wedge method (Coventry technique). In addition, if the patella Baja is created as a result of increased length of patella tendon before surgery, this problem would be corrected (4, 6).

Considering the aging of the population and the rising rate of knee osteoarthritis, which in turn burdens enormous costs on the health system, finding a surgical method to prevent or treat this disease would be of paramount importance. Thus, we decided to implement a detailed evaluation of our experiences on proximal tibia osteotomy through W-M technique. A similar technique was explained in blunt disease in shaft of tibia in 1995 (7).

2. Objectives

The present study aimed at explaining M-W osteotomy technique and evaluating the radiographic and clinical results and complications of this method in patients with genovarum deformity, who underwent surgery in a referral community hospital in Mashhad, Iran.

3. Methods

From 2001 to 2014, we evaluated 74 patients of proximal tibia osteotomy, of whom 4 were prepubertal with congenital diseases and rickets and 70 (42 females and 28 males) were pubertal, with a mean age of 34 years. Of these patients, 2 had patellofemoral osteoarthritis, and therefore were excluded from the study. Thus, 68 patients underwent high tibia M-W osteotomy (8 underwent unilateral osteotomy and others had bilateral in a 2-stage surgery). All patients were physically examined before the surgery to assess their knee condition. In this study, 68 patients had a completely stable knee without any contracture or limitation in range of motion, and no patient with varus trust was included in this study. All patients filled out an informed consent form.

The degree of varus angulation was measured before the surgery and at least after a 2-year follow-up. X-ray imaging of the knee was performed before and after the surgery, moreover, the degree of deformity correction after the surgery and the recurrence of deformity at least after 2 years were assessed.

The angles were determined using the mechanical and anatomical axis of the lower extremity, which in normal cases is about 6 to 8 degrees of valgus. In patients with medial compartment osteoarthritis of the knee and varus deformity, the deformity was corrected up to 6 to 8 degree valgus as a normal knee.

The knee society score (KSS) and functional knee society score (F-KSS) forms were completed for all patients to evaluate the knee function (8). We evaluated patients for peroneal nerve complications, union, and infection after the surgery and follow- up. Statistical analysis was performed using IBM SPSS for windows, Version 21. Paired t test was used to evaluate patients' satisfaction and functional ability before and after surgery. P value < 0.05 was considered as significant.

This study was approved by the ethical committee of Mashhad University of Medical Sciences, Mashhad, Iran.

3.1. Operation Technique

Preoperative evaluation consists of anteroposterior and lateral knee radiography; and standing alignment view and correction angle were measured before the surgery.

Surgery was performed with the patients in the supine position using a tourniquet. C-arm was set up at the opposite site of the surgeon. A curved oblique incision was made extending from the tip of the fibula to the tibia tuberosity anteriorly before descending for approximately 5 centimeters along the lateral border of the tibia tuberosity. The anterior compartment musculature was taken down by a large periostal elevator to expose the lateral proximal tibia metaphysis and cortex. Fibula osteotomy was done first at proximal part 4 centimeter below the articular surface in a safe zone. A Bennett tibia retractor was placed posterior to the proximal tibia to protect the posterior structures during the osteotomy. Similarly, a right angle retractor was placed posterior to the patellar tendon to protect it during osteotomy. Osteotomy was then performed using a 2.5 cm-wide thin osteotomy or a 10 mm-wide power oscillating aw as follows. First-osteotomy was started from the anterior of tibia metaphysis, 10 millimeters proximal to tibia tuberosity, and continued 15 millimeters distal and posterior to the tuberosity. Then, the second route of osteotomy with the guide of C-arm was started from this point at a 30- degree angle and extended to the proximal and posterior of the starting point (20 mm to the articular surface of knee). The third osteotomy was then performed in parallel with the first osteotomy, and the forth osteotomy was implemented parallel to the second osteotomy up to the posterior cortex of tibia proximal metaphysis, 2 cm to the articular surface. Medial cortex osteotomy is not essential in pubertal age. However, it is better to perform osteotomy of the medial cortex in post-pubertal years due to the rigidity of the medial cortex. A valgus load was then slowly applied using a large reduction clamp on the lateral side to close the osteotomy (impaction). The amount of necessary impaction was different, depending on the required angle for correction. The goal was to reach a final appropriate valgus angle, which was evaluated using clinical and fluoroscopic aid. In older ages, given the resistance to impaction, it is continued in the distal end of V osteotomy up to 10 mm so that the osteotomy would resemble a Y (Figure 1).

Figure 1. The Site of Osteotomy Started in proximal insertion of Patellar Tendon on the Tuberosity of Tibia and Below the Articular Surface

4. Results

This study was performed on 68 patients (128 knees), with a mean age of 34 (in the range of 16 to 60) and a mean BMI (body mass index) 23.4 $\pm$ 6.3. In bilateral cases, the mean time between the 2 surgeries was 8.3 $\pm$ 2.8 months. The mean varus angle between tibia and femur in the standing X-ray was 12.25 $\pm$ 6.42 before the surgery. After the surgery, the mean valgus angle in the standing X-ray caused by the M-W osteotomy, was 6.37 $\pm$ 3.13. The patients were followed- up for 2 to 4 years after the surgery (mean = 2.7 years), and a recurrence rate of about 1.9 degree varus was found in these patients, which was very low. Peroneal nerve complications were not observed in any of the patients, and neither in infection, osteomyelitis, and non-union.

Two weeks after the surgery, patients had an X-ray, which was not corrected in 8 cases, with femurotibial angle remaining at 0 degree. In these cases, correction was implemented using gipsotomy, and all patients reached an 8 degree valgus. No recurrence was detected in the next follow- up.

On the other hand, 4 patients had over correction, which was corrected with gipsotomy, but 2 patients had a recurrence of valgus knee in the next follow- up.

To evaluate patients' satisfaction, they were asked to fill the KSS form before and after the surgery. The mean score after the surgery was 89.6 $\pm$ 8.2, with a minimal and maximal score of 54 and 92, respectively, which was higher than a mean score of 78.8 $\pm$ 6.9 before the surgery. However, the difference was not significant among patients (P value $>$ 0.05).

KSS Functional Score was also calculated for patients before and after surgery to assess the knee function. The mean score of 95.4 $\pm$ 5.384 after the surgery indicated appropriate knee motions and function after the surgery (P value $<$ 0.05). The difference was significant among patients. Even those patients with a severe varus and aesthetics complaints before surgery were satisfied with the results of the surgery (Table 1).

5. Discussion

Pressure on the medial compartment of the knee induced by genovarum leads to articular cartilage degeneration at the articular surface and the development of knee osteoarthritis, particularly at the medial surface (9). Proximal tibial osteotomy is an appropriate surgical treatment for preventing the medial compartment osteoarthritis of knee (10). Some studies have shown that patients managed with high tibial osteotomy reported satisfactory outcomes (knee society score $>$ 80) after a mean follow-up of 8 years (11). Consistent with the literature, the results of this study showed the effectiveness of the surgery.

Coventry reported the outcome of 213 knee surgeries and found that 60% of patients had no pain after 10 years and had appropriate function (12). The most common complication was recurrence of the deformity. He also noted that the overcorrection increased the risk of recurrence (13).

Recently, proximal tibia osteotomy by medial open-wedge technique has also been the subject of considerable attention due to its less neurologic complications such as peroneal nerve paresis and possibility of internal fixation without casting (5).

In this study, surgery was performed according to the method Staheli (14) and Khermosh (15). M-W osteotomy, which is a kind of proximal tibial osteotomy and is used to correct varus deformity, has been introduced. Our experience showed that this technique was a relatively simple surgical technique, which unlike open-wedge technique, did not require fixation device, and thus did not pose any risk of device infections or the need for a second surgery to remove the hardware. It also allows angle correction after

Table 1. Characteristics and Clinical Status of Patients Before and After Surgery

Variable under study	Mean	Minimum	Maximum
Age (year)	34.34	16	60
BMI	23.4	20.2	30.4
Varus size before surgery	12.25	2	30°
The size of knee valgus after surgery	6.37	0	12°
Recurrence of knee angle after one year	1.9	0	5°
KSS before surgery	78.8	58	98°
KSS after surgery	89.6	54	92°
Functional KSS before surgery	89.2	74	96°
Functional KSS after surgery	95.4	80	100

Abbreviations: BMI, Body Mass Index; KSS, Knee Society Score.

the surgery with gipsotomy, which is one of its important advantages.

Because in M-W osteotomy, the bone wedge is not removed and the cut of osteotomy engage to each other, it allows improved controlling of the posterior slope of tibia compared to Coventry-closed wedge technique or open wedge osteotomy (16).

Smith et al. in their meta-analysis of several studies reported no significant difference in the outcomes of open-wedge and closed-wedge proximal tibia osteotomy (4).

However, Bland found that in open-wedge osteotomy, the posterior tibial slope and the mean correction was obviously higher. It also indicated that the patella Baja complication was more prevalent in this technique (17).

Moreover, the study of Van Egmond et al., reported the progress of patellar Baja in open-wedge high tibial osteotomy technique (18); we did not have this complication in our study.

One disadvantage of W-M technique is fibula osteotomy, which theoretically increases the risk of peroneal nerve paresis. In this study, however, we did not have any patients with this complication (Figure 2).

Considering all the above, we came to this conclusion that the M-W osteotomy is a very helpful technique for the correction of varus in patients who have not been yet affected by the knee osteoarthritis and varus trust or are at the early stages. Given the fact that complications are trivial in this technique, patient's satisfaction of surgery is high, the cost of surgery is low, and angle correction is available after surgery, we can recommend M-W high proximal tibia osteotomy as a technique for osteotomy in selected patients.

The results of this study led us to reach the following conclusions about the advantages and disadvantages of this procedure, which are as follow: not needing to place a graft at the osteotomy site and having no concern about the possibility of opposite cortex fracture, which is a main problem in the open-wedge technique. Limb length discrepancy was not observed in this method. One of the disadvantages of this method is the need for fibular osteotomy, which increases the risk of peroneal nerve injury and modification of the patella disorders. Another disadvantage of this technique is that it is not useful in patients with varus trust, and in such a case, medial open wedge osteotomy is strongly recommended. More accurate evaluations and more series comparisons with open wedge osteotomy and other techniques are suggested for future studies.

One main concern in this method is the possibility and extension of osteotomy into the knee joint, which may be catastrophic. However, this complication was not observed in any of the patients treated with this technique.

This study had several limitations including a small sample size and lack of a control group for comparison. Thus, it is recommended to conduct similar studies with a larger sample size and long-term follow-up. Also, using a control group (other surgical procedures) can help obtain more reliable clinical results.

Footnote

Authors' Contribution: Masoud Mirkazemi, Farshid Bagheri, design of the study and supervision; Azra Izanloo, analyzing the data and editing the manuscript; Farshid Bagheri, Masoud Mirkazemi, Hassan Rahimi, Mohamad Gharehdaghi, Azra Izanloo, drafting and critical revision of the manuscript.

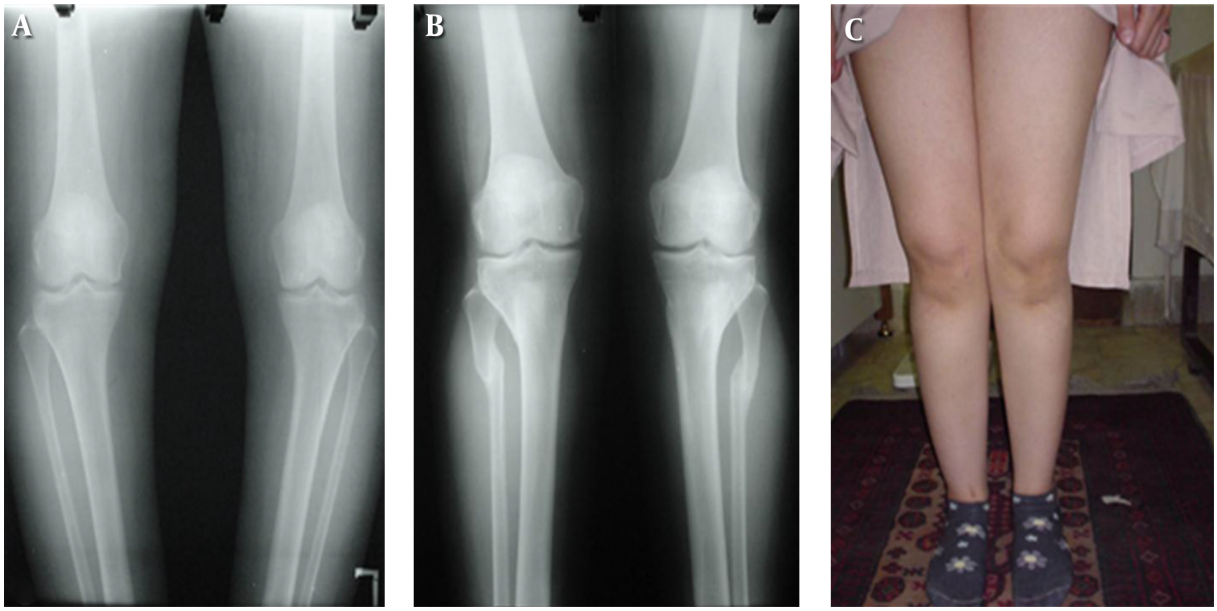

Figure 2. Preoperative Radiograph (A), Postoperative Radiograph with Perfect Union (B) and Clinical Image of Bilateral Genu Varus Correction in Two Lower Limbs of Patients with Clinical Union (C)

References

1. Heidari B. Knee osteoarthritis prevalence, risk factors, pathogenesis and features: Part I. *Caspian J Intern Med.* 2011;**2**(2):205–12. [PubMed: 24024017].
2. Hasan M, Shuckett R. Clinical features and pathogenetic mechanisms of osteoarthritis of the hip and knee. *BC Med J.* 2010;**52**(8):393–8.
3. Warme BA, Aalderink K, Amendola A. Is there a role for high tibial osteotomies in the athlete? *Sports Health.* 2011;**3**(1):59–69. doi: 10.1177/1941738109358380. [PubMed: 23015992].
4. Smith TO, Sexton D, Mitchell P, Hing CB. Opening- or closing-wedged high tibial osteotomy: a meta-analysis of clinical and radiological outcomes. *Knee.* 2011;**18**(6):361–8. doi: 10.1016/j.knee.2010.10.001. [PubMed: 21036048].
5. Lee DC, Byun SJ. High tibial osteotomy. *Knee Surg Relat Res.* 2012;**24**(2):61–9. doi: 10.5792/ksrr.2012.24.2.61. [PubMed: 22708105].
6. Gaasbeek RD, Welsing RT, Verdonschot N, Rijnberg WJ, van Loon CJ, van Kampen A. Accuracy and initial stability of open- and closed-wedge high tibial osteotomy: a cadaveric RSA study. *Knee Surg Sports Traumatol Arthrosc.* 2005;**13**(8):689–94. doi: 10.1007/s00167-004-0599-0. [PubMed: 15702355].
7. Hayek S, Segev E, Ezra E, Lokiec F, Wientroub S. Serrated W/M osteotomy. Results using a new technique for the correction of infantile tibia vara. *J Bone Joint Surg Br.* 2000;**82**(7):1026–9. doi: 10.1302/0301-620X.82B7.10507. [PubMed: 11041595].
8. Scuderi GR, Bourne RB, Noble PC, Benjamin JB, Lonner JH, Scott WN. The new Knee Society Knee Scoring System. *Clin Orthop Relat Res.* 2012;**470**(1):3–19. doi: 10.1007/s11999-011-2135-0. [PubMed: 22045067].
9. Sharma L. The role of varus and valgus alignment in knee osteoarthritis. *Arthritis Rheum.* 2007;**56**(4):1044–7. doi: 10.1002/art.22514. [PubMed: 17393411].
10. Herman BV, Giffin JR. High tibial osteotomy in the ACL-deficient knee with medial compartment osteoarthritis. *J Orthop Traumatol.* 2016;**17**(3):277–85. doi: 10.1007/s10195-016-0413-z. [PubMed: 27358200].
11. Karim AR, Cherian JJ, Jauregui JJ, Pierce T, Mont MA. Osteonecrosis of the knee: review. *Ann Transl Med.* 2015;**3**(1):6. doi: 10.3978/j.issn.2305-5839.2014.11.13. [PubMed: 25705638].
12. Miura H, Kawamura H, Nagamine R, Urabe K, Iwamoto Y. Is patellar height really lower after high tibial osteotomy? *Fukuoka Igaku Zasshi.* 1997;**88**(6):261–6. [PubMed: 9248144].
13. Stuart MJ, Grace JN, Ilstrup DM, Kelly CM, Adams RA, Morrey BF. Late recurrence of varus deformity after proximal tibial osteotomy. *Clin Orthop Relat Res.* 1990(260):61–5. [PubMed: 2225645].
14. Staheli LT. In: Pediatric orthopaedics. 3rd ed. Morrissy RT , editor. Philadelphia: JB Lippincott; 1990. pp. 741–66.The lower limb.
15. Khermosh O, Wientroub S. Serrated (W/M) osteotomy: a new technique for simultaneous correction of angular and torsional deformity of the lower limb in children. *J Pediatr Orthop B.* 1995;**4**(2):204–8. [PubMed: 7670991].
16. El-Azab H, Halawa A, Anetzberger H, Imhoff AB, Hinterwimmer S. The effect of closed- and open-wedge high tibial osteotomy on tibial slope: a retrospective radiological review of 120 cases. *J Bone Joint Surg Br.* 2008;**90**(9):1193–7. doi: 10.1302/0301-620X.90B9.20688. [PubMed: 18757959].
17. Bland M. Introduction to medical statistics. Oxford: Oxford University Press; 2006.
18. van Egmond N, van Grinsven S, van Loon CJ, Gaasbeek RD, van Kampen A. Better clinical results after closed- compared to open-wedge high tibial osteotomy in patients with medial knee osteoarthritis and varus leg alignment. *Knee Surg Sports Traumatol Arthrosc.* 2016;**24**(1):34–41. doi: 10.1007/s00167-014-3303-z. [PubMed: 25217316].