



The effect of tibiofemoral angle changes on the results of dome osteotomy

Kubbe osteotomisinde tibiofemoral açı değişikliklerinin sonuçlar üzerine etkisi

Servet KERIMOGLU, Sonay CAVUSOGLU,¹ Ahmet Ugur TURHAN

Karadeniz Technical University Faculty of Medicine Department of Orthopaedics and Traumatology;
¹Orthopaedics and Traumatology Clinic in Sürmene Government Hospital

Amaç: Diz ekleminde medial kompartman artrozu nedeniyle kubbe osteotomisi uygulanan hastalarda tibiofemoral açı değişimlerinin sonuçlar üzerine etkisi araştırıldı.

Çalışma planı: Medial kompartman osteoartriti nedeniyle 22 hastanın (15 kadın, 7 erkek; ort. yaş 60; dağılım 37-73) 23 dizine kubbe osteotomisi (KO) tipinde yüksek tibial osteotomi (YTO) uygulandı. Eksternal tespit olarak, Charnley tipi eksternal tespitin basit bir modifikasyonu kullanıldı. Ahlback sınıflamasına göre, ameliyat öncesinde 15 dizde evre I, altı dizde evre II, iki dizde evre III osteoartrit vardı. Hastalar ameliyat sonrasında ölçülen tibiofemoral açı değerlerine göre üç gruba ayrıldı: <8° valgus (4 diz), 8°-12° valgus (10 diz), >12° valgus (9 diz). Klinik sonuçlar Amerikan Diz Derneği skoru kullanılarak değerlendirildi. Ortalama takip süresi 5.4 yıl (dağılım 1-10 yıl) idi.

Sonuçlar: Tibiofemoral açı ameliyat öncesinde ortalama 4.4±2.9° (dağılım 0°-10°) varusta iken, ameliyat sonrasında ortalama 11±3.8° (dağılım 5°-18°) valgus olarak ölçüldü. Son değerlendirmelerde ortalama düzeltme kaybı 2.7° bulundu. Ameliyat öncesinde ortalama 37.7±15.8 (dağılım 19-77) olan diz skoru, son değerlendirmede 80.2±9.2'ye (dağılım 51-93); fonksiyonel skor ise 52.3±18.8'den (dağılım 10-80) 75.6±18.5'e (35-100) yükseldi (p<0.001). Tibiofemoral açığa göre üç gruba ayrılan hastalar arasında diz ve fonksiyonel skorlar açısından anlamlı fark bulunmadı (p>0.05).

Çıkarımlar: Bulgularımız, YTO sonrasında elde edilen dizilimin, kabul edilen açılar içerisinde olmak kaydıyla, sonuçlar üzerinde etkili olmadığını göstermektedir.

Anahtar sözcükler: Diz eklemleri/radyografi/cerrahi; osteoartrit, diz/cerrahi; osteotomi/yöntem; tibia/cerrahi.

Objectives: We investigated the effect of tibiofemoral angle changes on the results of dome osteotomy in patients with medial compartment osteoarthritis of the knee.

Methods: The study included 23 knees of 22 patients (15 women, 7 men; mean age 60 years; range 37 to 73 years) who underwent high tibial dome osteotomy for medial compartment osteoarthritis. A simple modified Charnley external fixator was used for stabilization of the osteotomy. Based on the Ahlback classification, 15 knees had grade I, six knees had grade II, and two knees had grade III osteoarthritis. The patients were evaluated in three groups based on the postoperative tibiofemoral angles obtained; hence, a valgus angle of less than 8° (4 knees), 8° to 12° (10 knees), and greater than 12° (9 knees). Clinical evaluations were made using the American Knee Society scoring system. The mean follow-up period was 5.4 years (range 1 to 10 years).

Results: The mean tibiofemoral angle was 4.4±2.9° of varus (range 0° to 10°) preoperatively, and 11±3.8° of valgus (range 5° to 18°) postoperatively. The mean correction loss at final evaluations was 2.7°. The mean preoperative and postoperative knee scores were 37.7±15.8 (range 19 to 77) and 80.2±9.2 (range 51 to 93), respectively (p<0.001). The mean functional score increased from 52.3±18.8 (range 10 to 80) to 75.6±18.5 (range 35 to 100) at final analysis (p<0.001). The knee and functional scores did not differ significantly between three groups of patients having a different range of postoperative tibiofemoral angle (p>0.05).

Conclusion: Our results show that the alignment obtained after high tibial osteotomy does not influence knee and functional scores provided that it is within an acceptable range.

Key words: Knee joint/radiography/surgery; osteoarthritis, knee/surgery; osteotomy/methods; tibia/surgery.

With the increasing average age of the population, osteoarthritis, especially of the knees, either cause socioeconomic problems or have become an important disease affecting the daily life of people. According to a study by the World Health Organisation, gonarthrosis is in women the fourth and in men the eighth leading cause of disability.^[1]

The preferential treatment for gonarthrosis consists of conservative methods such as; anti-inflammatory medication; weight loss; physical therapy; and injections into the joints. Despite repeated conservative therapy, especially in patients with deformed alignment, symptoms occur with increasing frequency. In this type of patient, one of the surgical options available is arthroscopic debridement. However, even after arthroscopic debridement, most patients require another surgical procedure. In advanced stages, high tibial osteotomy (HTO), unicompartmental prosthesis and total knee arthroplasty are, in order, available surgical procedures. However, due to the increase of living standards and life expectation, especially in young and active patients, a biological reconstructive method like HTO has become more attractive.^[1,2] HTO is a treatment method which repairs joint pathomechanics, saves the medial section from pressure and may stimulate the regeneration of degenerated cartilage. The aim of the osteotomy is to transfer the load on the knee from the arthritic surface to a more healthy area.^[3-6] The targeted axis angle and the effect of this after a HTO is a subject currently being debated.^[7] It can be seen in the literature that over-correction has been advised or that very changeable values have been given.

In this study, the effect of tibiofemoral angle changes on the results of dome osteotomy (DO) was investigated.

Patients and methods

The study included 23 knees of 22 patients (15 women and 7 men; mean age 60 years; range 37 to 73 years) who underwent high tibial dome osteotomy for medial compartment osteoarthritis. Patients' knees had range of motion over 70° and less than 10° varus. While DO was performed only one leg in four of 5 patients who had problems in both knees, the other patient had operated bilaterally on 2 different occasions.

Before the osteotomy all of the patients, prophylactic medical treatment was undergone more than 1. One

patient who was 73 years of age, as they were still active and a farmer with only medial compartment arthritis opted to have a HTO.

Surgical technique

After a fibula osteotomy on all patients, a DO type HTO was performed with a modification in the technique as defined by Maquet.^[6] Firstly, a 1cm segment was removed from the middle 1/3 of the fibula. After this, under the control of a scopy, 1 cm below the tibia proximal gap and in such a way to stay parallel with the joint gap, a 5 or 6 mm Steinman pin was inserted. Later the osteotomy was performed in a way that its tip is in the proximal of the tuberositas tibia. The distal part was taken external rotation and valgus under x-ray control. In this time, another Steinman pin was inserted from distal of the osteotomy and as a parallel with first pin. As an external fixation, a simple modified of the Charnley external fixator was used. While the legs were held in a suitable position, 2 external fixation bars were positioned on both sides and with light compression on the osteotomy, stabilized. Then, x-ray was used to determine if the correction had been sufficient. If necessary, corrections were made on the external fixations (Figure 1).

In order to determine if the valgus from the surgery was adequate or not, radiography taken of the leg with the patella fully facing the ceiling or images of the femoral head-knee-ankle direction using a scopy with a cautery cable was used. It was determined that the cable passing through the lateral plateau was adequate.

Both active and passive knee movements were started 1 day after the surgery. From the second postoperative day, the patients, with the help of crutches, were walked with as much weight put on the knee as they could tolerate. The extremity was covered with an elastic bandage. Also isometric quadriceps and flexion exercises were actively done. No other rehabilitation programme was performed on the patients. The external fixations were removed in an average of 3 months postoperatively (range 2 to 5.5 months). The average follow up time was 5.4 years (range 1 to 10 years). The patients were postoperatively divided into 3 groups based on the measured tibiofemoral values: < 8 ° valgus (4 knees); 8°-12 ° valgus (10 knees); >12° valgus (9 knees). The clinical results were evaluated using American Knee Society scoring system. In this score system, 100-85 points is excellent; 84-70 is

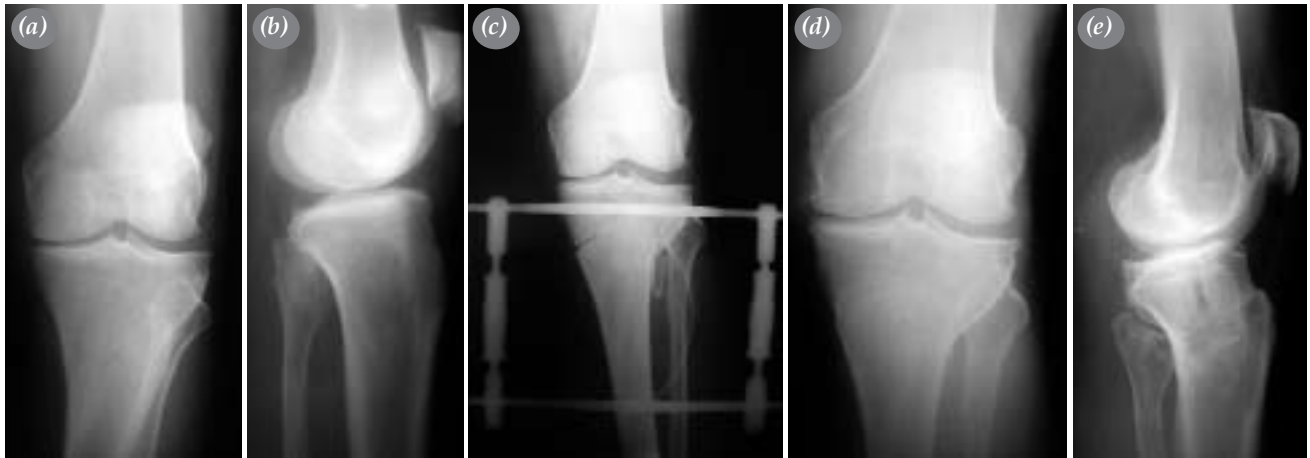


Figure 1. Radiographs of left knee with gonarthrosis in 60-year-old man. (a) Anteroposterior radiography. (b) Lateral radiography. (c) Early postoperative radiography. (d) Anteroposterior radiography 6 years after HTO. (e) Lateral radiography 6 years after HTO.

good; 69-60 is fair and under 60 is considered bad.

For pre and postoperative radiographic evaluations, graphics were taken with the patient standing (putting weight) from the front-back and side of the knee on 30X40 cm X-ray cassette. The tibiofemoral angle was measured from these graphics. Preoperative osteoarthritis staging was made according to Ahlback measurements.^[9]

Statistical evaluation was made using the Kruskal-Wallis variance analysis; a value of $p < 0.05$ was considered as statistically significant.

Results

While the preoperative tibiofemoral angle was on an average of $4.4 \pm 2.9^\circ$ (range 0° to 10°) in varus, postoperatively the average was $11 \pm 3.8^\circ$ (range 5° to 18°) measured as valgus. At the time of the last

follow up, the average loss of correction was found to be 2.7°

The preoperative average Knee score of 37.7 ± 15.8 (range 19 to 77) at the last evaluation had risen to 80.2 ± 9.2 (range 51 to 93) ($p < 0.001$). The average Functional score of 52.3 ± 18.8 (range 10 to 80) at the last evaluation had risen to 75.6 ± 18.5 (range 35 to 100) ($p < 0.001$).

Between the 3 groups of patients divided according to tibiofemoral angle measurements, both pre and postoperatively, in Knee and Functional scores there was no statistical difference (Pre and postoperative Knee scores were $p = 0.523$ and $p = 0.352$, respectively. For Function, they were $p = 0.912$ and $p = 0.306$, respectively). The results for the 3 groups formed according to the tibiofemoral angle measurements are shown in Table 1.

Table 1. The results of 3 groups according to tibiofemoral angle

	Tibiofemoral açı						p	Total	
	<8°		8°-12°		>12°			Mean.±SD (Range)	
	Mean.±SD	(Range)	Mean.±SD	(Range)	Mean.±SD	(Range)		Mean.±SD	(Range)
Knee Score									
Preoperative	28.5±5.8	21-34	39.9±15.7	23-73	39.5±18.6	19-77	0.523	37.7±15.8	19-77
Postoperative	83.5±4.3	79-89	76.8±11.3	51-89	82.4±7.7	73-93	0.352	80.2±9.2	51-93
Functional Score									
Preoperative	51.2±11.8	35-60	53.0±25.0	10-80	52.2±14.8	35-70	0.912	52.3±18.8	10-80
Postoperative	87.5±9.5	80-100	71.5±19.3	35-100	75.0±20.0	35-100	0.306	75.6±18.5	35-100
Tibiofemoral angle									
Preoperative (Varus)	5.5±3.3	2-10	6.1±2.6	3-10	2.2±1.7	0-5		4.4±2.9	0-10
Postoperative (Valgus)	5.7±0.9	5-7	9.5±1.5	8-12	15.0±1.8	13-18		11.0±3.8	5-18

According to the Ahlback classification, while preoperatively 15 knees were Stage I, 6 knees were Stage II and 2 knees were Stage III, at the last follow up 12 knees were Stage I, 6 knees were Stage II, 3 knees were Stage III and 2 knees were Stage IV.

During the postoperative period, it was observed that 1 patient had delayed union, 6 patients had superficial pin tract infection, and that 1 patient had a deep infection. Superficial pin tract infections generally appeared within the first postoperative month and were followed up with a 10-day course of antibiotics and dressings at the around of the pin. Deep infection healed after treatment with parenteral antibiotics and dressings.

Peroneal nerve lesions in 2 patients and extensor hallucis longus dysfunction in 1 patient were observed. Both complications healed in the postoperative first and second month respectively.

Pulmonary embolism in 1 patient and deep vein thrombosis in another patient were observed and these were treated with help from the relevant departments.

Discussion

Even if many types of osteotomy have been described for medial compartment arthritis, dome type and wedge (closed, open or combined) type osteotomies made from the tibia proximal are preferred more. The important advantages of dome osteotomy is that it can remedy large angular deformities; with rigid external fixations it can allow for early movement and load bearing; it provides decompression of the patellofemoral joint and also allows for postoperative corrections.^[4] In the commonly used dome osteotomy technique, the osteotomy line is implemented from the proximal of the tibia and is fixed with external fixation devices. Although this modification was first defined by Blaimont, as it was made common with the biomechanic basics by Maquet, it is known as the Maquet type HTO.^[5,6]

Long term results of dome osteotomy have been put forward in many studies. Krempe and Silver^[10] obtained good-very good results in 84 % of 40 cases. With Sundaram et al^[11] although they only obtained the necessary mechanic correction in 18 out of 105 cases using staples, they reported that a good level of pain control was achieved for over five years in

most of the cases and that good-very good results were obtained in 75 % of the cases. According to the results of the researchers, contrary to widely accepted results, neither the correction of the deformity is seen as a certainty for pain control nor can the best results be obtained from the best cases.

The targeted axis degree and its resulting effect after a HTO is currently a debated subject. It can be seen in the literature that either an overcorrection is advised or that variable values are given about this. Coventry^[7] reported that the normal angle was 5°- 8° valgus and that the aim of an osteotomy was to add 5° to this to obtain a 10°-13° valgus. Sprenger and Doerzbacher^[12] came to the conclusion that patients with a valgus degree of between 8-16 ° in the first postoperative year may have a “well-being” period of more than 10 years. In the same study, it was clarified that the reason for defining the upper limit for a successful valgus correction as 16° was due to the fact that a valgus degree over this, especially in women, could lead to the knee cosmetically looking bad.^[12] Yasuda et al.^[13] determined that to have good long term results the postoperative valgus needed to be between 12°-16°. The generally accepted correction rates are upper and lower limits of between 5°-15° and these are also cosmetically suitable.^[14] On the other hand, there are researchers who claim that alignment obtained after osteotomy are not very effect on results.^[15,16]

In our study, when the patients were evaluated in 3 groups according to postoperative axis degree, there was no statistical difference between the groups in either Knee or Function score.

Besides the advantage of external fixing of the DO, there are also some problems such as superficial pin tract infection. Geiger et al.^[17] compared the results of HTO where different types of fixations had been used. Pin tract infection was observed in 25 % of patients (38/154); however none had osteomyelitis. Extensor hallucis longus weakness in 8 patients (5 %) and nerve paralysis in 19 patients (12 %) developed. In the same study, it was determined that biplane fixations should be preferred over single plane for the reason that it gives greater stability.^[17] Weale et al.^[18] observed that medial compartment osteoarthritis progressed more than lateral in the radiographic evaluation of 76 cases where dynamic axial external fixation was used. Approximately 36 % (28) of the patients developed a superficial pin tract infection and in

1 patient chronic osteomyelitis developed.^[18] Kodkani^[19] reported that as a result of external fixation after DO, superficial pin tract infection developed at a rate of 15 % and that in 1 patient proximal pin migration in the osteotomy line was observed. The most frequently observed complication involved in HTO which was performed using external fixators is a superficial pin tract infection and that is not transform into chronic osteomyelitis in the majority of patients. In our study, superficial pin tract infections developed in 6 knees (26.1 %).

In our study, we concluded that the alignment obtained after HTO does not influence knee and functional scores provided within an acceptable range. We believe that factors like the age of the patient and pre-operative osteoarthritis have more of an effect on the results. It also should not be forgotten that with the external fixations of DO, superficial pin tract infections is a potential problem.

References

1. Baydar ML. Gonartrozda risk faktörleri ve patogenezi. In: Tandoğan RN, editör. Gonartrozda artroplastisi dışı tedavi yöntemleri. Ankara: Spor Yaralanmaları Artroskopisi ve Diz Cerrahisi Derneği; 2003; s. 1-8.
2. Şen C, Kocaoglu M, Bilen E, Dikici F, Hepgur G. Comparison of two different techniques for high tibial osteotomy: internal fixation vs circular external fixator. [Article in Turkish] *Acta Orthop Traumatol Turc* 2001;35:382-9.
3. Sarpel Y, Özsoy MH. Varus gonartrozda YTO endikasyonları ve hasta seçimi. In: Tandoğan RN, editör. Gonartrozda artroplastisi dışı tedavi yöntemleri. İzmir: Türk Spor Yaralanmaları Artroskopisi ve Diz Cerrahisi Derneği; 2003; s. 61-8.
4. Aynaci O, Aydın H, Turhan AU. High tibial osteotomy in the treatment of varus gonarthrosis. [Article in Turkish] *Acta Orthop Traumatol Turc* 2001;35:342-6.
5. Aydoğdu S. Varus gonartrozda kubbe (dome) osteotomisi. In: Tandoğan RN, editör. Gonartrozda artroplastisi dışı tedavi yöntemleri. Ankara: Spor Yaralanmaları Artroskopisi ve Diz Cerrahisi Derneği; 2003; s. 111-20.
6. Maquet PG. Biomechanics of the knee. 2nd ed. New York: Springer; 1984.
7. Coventry MB. Upper tibial osteotomy for gonarthrosis. The evolution of the operation in the last 18 years and long term results. *Orthop Clin North Am* 1979;10:191-210.
8. Insall JN, Dorr LD, Scott RD, Scott WN. Rationale of the Knee Society clinical rating system. *Clin Orthop Relat Res* 1989;(248):13-4.
9. Ahlback S. Osteoarthritis of the knee. A radiographic investigation. *Acta Radiol Diagn* 1968;Suppl 277:7-72.
10. Krempen JF, Silver RA. Experience with the Maquet barrel-vault osteotomy. *Clin Orthop Relat Res* 1982;(168):86-96.
11. Sundaram NA, Hallett JP, Sullivan MF. Dome osteotomy of the tibia for osteoarthritis of the knee. *J Bone Joint Surg [Br]* 1986;68:782-6.
12. Sprenger TR, Doerzbacher JF. Tibial osteotomy for the treatment of varus gonarthrosis. Survival and failure analysis to twenty-two years. *J Bone Joint Surg [Am]* 2003;85:469-74.
13. Yasuda K, Majima T, Tsuchida T, Kaneda K. A 10- to 15-year follow-up observation of high tibial osteotomy in medial compartment osteoarthritis. *Clin Orthop Relat Res* 1992;(282):186-95.
14. Taşer Ö. Gonartrozda artroplastisi dışında tedavi yöntemleri. In: Tandoğan RN, Alpaslan AM, editörler. Diz cerrahisi. Ankara: Haberal Eğitim Vakfı; 1999. s. 299-320.
15. Rinonapoli E, Mancini GB, Corvaglia A, Musiello S. Tibial osteotomy for varus gonarthrosis. A 10- to 21-year follow-up study. *Clin Orthop Relat Res* 1998;(353):185-93.
16. Insall JN, Joseph DM, Msika C. High tibial osteotomy for varus gonarthrosis. A long-term follow-up study. *J Bone Joint Surg [Am]* 1984;66:1040-8.
17. Geiger F, Schneider U, Lukoschek M, Ewerbeck V. External fixation in proximal tibial osteotomy: a comparison of three methods. *Int Orthop* 1999;23:160-3.
18. Weale AE, Lee AS, MacEachern AG. High tibial osteotomy using a dynamic axial external fixator. *Clin Orthop Relat Res* 2001;(382):154-67.
19. Kodkani PS. Dome osteotomy of the proximal tibia for genu varum treated with a new fixation device. *J Knee Surg* 2007;20:111-9.