RESEARCH ARTICLE

High Tibial Osteotomy Effects on Subtalar Joint in Patients with Genu Varum

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Abstract

Background: osteotomy around the knee is one of the most common corrective surgeries for lower limb deformities. The exact relationship between the effects of these surgeries on the ankle joint is unclear.This study aimed to investigate the effect of HTO on the subtalar joint in patients with genu varum.

Methods: In the case series study33 patients including 27.2% men and 72.7% womenwith an average age of 41.9, with genu varum who underwent corrective surgery of open wedge high tibial osteotomy were studied. the heel alignment angle was determined before and after surgery in 10-months follow-up based on Saltzman view in conventional radiography. The data were then compared.

Results: Average genu varum correction angle was 11.9±1.3˚. Heel alignment degree was 5.9±1.3˚ before HTO surgery, and after the surgery,in final follow-up,it was to 3.4±1.2˚ valgus, this value was statisticallysignificant(p=0.04). Moreover, there was a significant statistical relationship between average correction of Varus deformity and heel alignment anglechanges (P=0.02, r=0.3).

Conclusion: Correcting Varus knee deformity can be effectiveon heel alignment angle in patients undergoing HTO surgery with genu varum. The angle of the subtalar valgus decreases as a result.

Level of evidence: III

Keywords: Genu varum, High TibialOsteotomy, Subtalar Joint, Heel Alignment, HindfootAlignment

Introduction

Genu valgum and genu varum deformities can be induced osteoarthritis in the knee joint. Genu varum can also increase the risk of osteoarthritis by applying forces to the medial surface of the knee joint, compared to other patients. On the other hand, the subtalar joint attempts to correct the balance of forces using implementing some changes in itself. As the result, varus and valgum changes due to knee alignment variationare seen in the subtalar joint (1, 2). In advanced stages, increased pressure on subtalar joints, due to compensation mechanisms, can result in stiffness, progressive pain, fusion, coalition, and progressive osteoarthritis in the subtalar joint (3). Accordingly, correctional surgeries in knee joint disorders, not only improve the joint status but also can be a suitable solution to reduce associated morbidities (3).

High Tibial Osteotomy (HTO) is a common method of surgery for correcting genu varum following osteoarthritis of knee joint medial compartment, especially in younger patients (4). This operation aims to transmit forces from the medial compartment of the knee joint to the lateral compartment. Since the postoperative period of this surgery requires a long-term recovery program, this surgery appliesto patients with sufficient muscle strength and high physical activity. Based on theoretical evidence, using HTO surgery and correcting genu varum, the joints which are related to the osteotomy area, knee, and ankle will positively be affected by this correction (5). Changing the balance of forces in the knee joint will result in changes in the balance of forces in other related joints, including the subtalar joint. Consequently, symptoms, forces, and alignment of the subtalar joint will be different before

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and after the surgery. Few studies have investigated changes in forces applied on the subtalar joint so far; thus this study aimed to investigate the effect of HTO on the subtalar joint in patients with genu varum.

Materials and Methods

In a case series study, 33 patients with primary and secondary genu varum(secondary to trauma depends on the degree of physical damage in childhood period) who visited the orthopedic clinic of Akhtar Hospital, ShahidBeheshti University of Medical Sciences, between 2017 to 2019, and underwent correctional surgery of open wedge high tibial osteotomy were studied the study. The average age of subjects was 41.9±3.8, including 9 (27.3%)men and 24 (72.7%) women.Inclusion criteria included anyone withunilateralosteoarthritis of knee jointmedial surface caused by genu varum with the age of under 65 years of age. All surgeries were done by a single specific surgeon, and all patients were treated using the same technique (open wedge osteotomy). All deformity & correction angles and measurements were performed using software-based alignment view standard radiography. Patients with osteoarthritis in both surfaces (medial and lateral) of the knee joint, patellofemoral osteoarthritis,restriction in motion range of knee joint (arc of motion <100 and flexion contracture >10°), ligament instability, rheumatoid arthritis, previous surgery on theintended lower limb, other structural deformities of lower limb and history of the limb trauma or injury, were all excluded. All subjects were followed up for at least ten months. In this study examinations of angels and required measurements from knee to ankle was done using Anterior-Posterior imaging of the entire length of the lower limb. It was done before the HTO surgery and ten months after the surgery. This imaging included lateral distal femoral angle (LDFA) and medial proximal tibialangle (MPTA), which were measured and compared before and after the treatment. Moreover, to examine the subtalar joint,Saltzman View imaging was used. For imaging,the intended limb will be placed in a standing position on the floor, and the rays will be irradiated in a posterior-anterior direction at the angle of 20 ˚concerning the horizon, and heel alignment angle will be determined.

Determiningthe heel alignment angle in Saltzman view is done by this technique. The hindfoot alignment is defined as the mid-diaphyseal axis of the tibia by bisecting the tibia into two mid-diaphyseal points. The mid-diaphyseal axis of the calcaneus is defined by a line through two points in the calcaneus. At a distance of 7 mm from the most distal part of the calcaneus, a horizontal line near to calcaneal tuberosity is divided into a 40%:60% ratio, where the length of the 40% line is measured from the lateral side. A second line near tocalcaneal sustentaculum is drawn horizontally, 20 mm from the most distal part of thecalcaneus The calcaneus axis is drawn by connecting the 40% on the lateral side and 60% on the medial side. Finally, the angle at the intersection of the two axes of the tibia and calcaneus is measured as a hindfoot aliment angle (6) [figure 1,2].

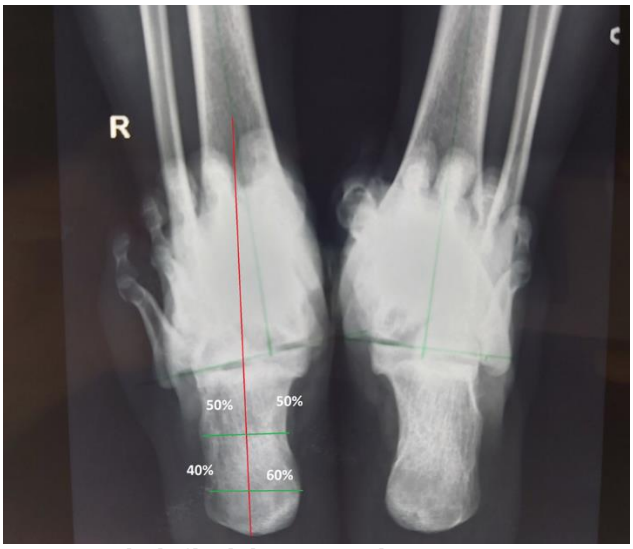

Figure1. Method of heel alignment angle measurement.

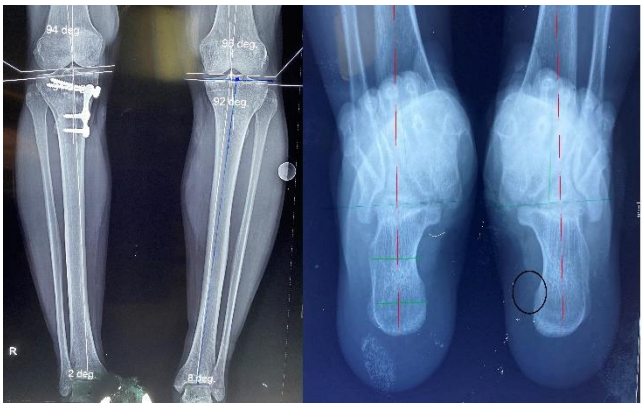

Figure 2. Standing alignment view in patients under HTO osteotomy and heel alignment angle.

The study was approved by the Ethics Committee of ShahidBeheshtiUniversity of Medical Sciences. Descriptive statistical methods have been used for statistical analysis.The Wilcoxon statistical test was used to compare changes before and after treatment.The association between deformity correction and heel alignment angle has been calculated using Spearman's correlation test.SPSS16/win statistical software was used to analyze the data and P-value of 0.05 or less were considered to be significant.

Results

The mean genu varum correction angle in patients was 11.09±1.3°.The mean MPTA angle was 79.4±1.9° before surgery and 89.8±0.8° after the surgery; which there was a significant statistical difference (P <0.001) in this term.Comparison of LDFA before and after the surgery did not show a statistically significant difference, as it was 90.2±1.4°.the heel alignment angle was measured as 5.9±1.3° valgus before HTO surgery, and after the surgery, in final follow-up, it was 3.4±1.2° valgus, which

this value wasstatistically different. So that,valgus degreedecreased in subtalar alignment after 10-month after the operation (p=0.04) [figure 3,4]. Moreover,based on performed correlation test, there was a significant statistical relationship between average varus deformity correction and the heel alignment angle valgus increased (P=0.02, r=0.3).

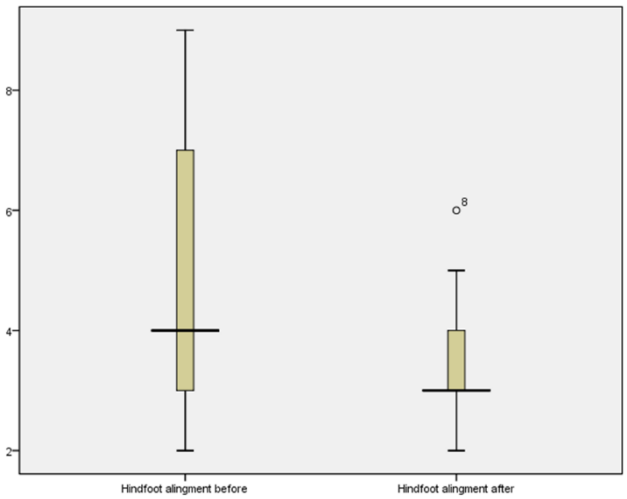

Figure 3. Comparison of heel alignment before and after high tibial osteotomy.

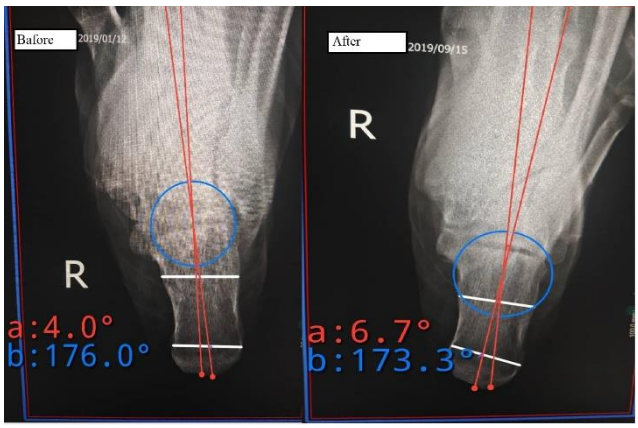

Figure 4. Saltzman view, before and follow up period in a patient under knee varus correction.

Discussion

Any kind of deformity in knee and ankle joints plays an important role in determining the overall alignment of lower limbs. It seems that there is a compensation mechanism between the knee and ankle joints (7).The subtalar joint is unique, and the subtalar joint can compensate supramalleolar and knee deformities (7).Chandler et al., have reported changes in hindfoot alignment after the total knee arthroplasty (TKA) for the first time. However, they did not specifically explain this relationship (8). Mullaji et al., have suggested a significant relationship between knee varus deformity and hindfoot valgus (9).Similarly, Norton et al.,in a study on 402 knees in 324 Knee OA patients have reported a strong association between knee varus deformity and hindfoot valgus (10). Findings of a study by Jeong et al., on patients undergoing TKA, showed a significant change in talar tilt so that correcting varus knee deformity was associated with a valgus deformity in the ankle joint (11). In this studypatients who underwent total knee arthroplasty (TKA) to correct knee varus deformity were investigated before surgery and then six months after the surgery. The average varusdeformity correction was 10.8±4.1°.Moreover, talar tilt and ground-talar dome angles significantly changed from 0.4±1.9° to 0.1±1.8°, and from 6.5±3.1° to 0.2±2.1° respectively. No correlation was observed between the before and after deformity correction on variance in the mechanical axis of the lower extremity and talar tilt. Also, it was observed that the talar tiltand hindfootindex was changed toward varus. So, it was concluded that changes for correcting knee deformitiesnot only can affect the ankle and subtalar joints but also it can induce compensatory changes in the entire leg (11).The findings of Jeong et al. showedthat in the patients with TKA the significant valgus change in subtalar tilt after knee Varus deformity correction (11).

Few studies were done regarding patients undergoing HTO andits relationship with heel alignment changes. Kazemi et al in a study on 39 patients who underwent HTO surgery have not observed significant changes in the tibiotalar joint after the surgery; it seems that compensatory changesdo not occur in the tibiotalar region. But based on their findings HTO can significantly decrease the shearing forces exerted on the ankle joint (12). In two studies by Hara et al. and Takenaka et al. a significant improvement was seen in subtalar joint alignment in patients with subtalar valgus; it was changed from 80.5±3.1° to 78.6±3.7° after three weeks of TKA surgery (13,14).Similarly, after one-year post-surgery it was changed to approximately 77.1±2.7°, which indicates the significant effect of knee deformity correction on the subtalar joint; However, unlike the tibiotalar joint in a patient with subtalar varus, no significant improvement was observed (13,14).

In a study by Cho et al., great improvements were seen in hindfoot valgus, in patients with severevarus deformity in a way that in patients with varus above 10° more improvement in hindfoot valgus was observed (15). Moreover, in patients whose mechanical axis angle was changed from 13.9±3.7° to 2.6±3.5° varusmore improvement was noticed; this, in turn, resulted in hindfoot valgus improvement from 6.5±3.8° to 2.5±4.1° valgus (15).In similar findings in our study, there was a significant statistical relationship between the amount of deformity correction and heel alignment angle in six months after the surgery. Likewise, Yoshimoto et al., have concluded that subtalar joint valgus alignment will improve in terms of varus knee deformity after TKA or HTO surgeries; subtalar joint angle has no change after correctional surgery of the valgus knee or ankle deformity even if the deformity was severe (16).

In our study, the amount of knee varus deformity correction had a significant positive relationship with changes in heel alignment angle, and it seems that the compensatory change is effective onthe subtalar joint.Besides, in a study by Choi et al., hindfoot alignment

changes after HTO and low tibialosteotomy (LTO) were examined (17). Indicators used to evaluate hindfoot alignment includedhindfoot alignment view angle (HAVA), hindfoot alignment ratio (HAR), and hindfoot moment arm (HMA) (17). In patients who underwent HTO, HAVA and HMA indicators were increased significantly after 12 months. In the HTO group, the HAR indicator changed from 0.23 to 0.44 in 12 months. In subjects who underwent tibial osteotomy, theHAVA, HAR, and HMA indicators have decreased significantly,which indicates valgus changes after knee valgus deformity correction (17). Besides, after tibial osteotomies, the hindfoot will change the valgus. These changes can affect symptoms related to the ankle joint (17).Also, they evaluated the hindfoot alignment after high tibial that the preoperative degree of hindfoot valgus deviation (7.8◦ valgus) changes in times with decreased progressively 3months, 6 months, and 12 months after HTO (4.0◦, 3.4◦, and2.3◦ valgus, respectively). Based on our findings we observed subtalar valgus improvement on thefollow-up period based on the compensatory mechanism in the knee and subtalar joint similar to Che et al. findings (17). Also,especially in the high degree of subtalar valgus decrease of valgus is more than in the neutral or low degree of subtalar valgus.

Correcting varus knee deformity is effective on heel alignment angle in patients undergoing HTO surgery, and it can decrease subtalar valgus created by compensatory mechanism.

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Conflict of interests: There is no conflict of interest to be reported.

Ethical Issues

The study was confirmed by the Ethics Committee of Shahid Beheshti University of Medical Sciences.

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