RESEARCH ARTICLE

Evaluation of Changes in the Tibiotalar joint after High Tibial Osteotomy

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Abstract

Background: There are limited studies regarding the effects of high tibial osteotomy (HTO) on other areas of lower extremity. In current study, we investigated the changes of tibiotalar joint following HTO.

Methods: A total of 39 patients with genu varum requiring HTO were enrolled in this before and after study. The genu varus, joint diversion (JDA), lateral distal tibial (LDTA) and lateral distal tibial-ground surface (LDT-GSA) angles were measured before the operation and compared with 6 months after the surgery.

Results: Twenty threeout of39 patients (59%) were females. The genu varus angle decreased significantly ($13^0 \pm 1.7^0$versus $0.6^0 \pm 1^0$). No significant changes were seen in JDA (*P=0.45*) and LDTA (*P=0.071*). LDT-GSA changed significantly (*P=0.011*) from $8.1^0 \pm 1^0$ in varus to $-0.3^0 \pm 0.5^0$ in valgus.

Conclusion: Although HTO did not change the JDA and LDTA, however, significant change in LDT-GSAindicates that HTO can significantly decrease the shearing forces exerted on the ankle joint.

Keywords: Ankle joint, Genu varum, High tibial osteotomy, Lateral distal tibial angle, Lower extremity, Joint diversion angle, Tibiotalar joint

Introduction

Tibia and fibula deformities are common. Genu varum (also called bow-leg or bow-leggedness) is one of the most common knee deformities (1-4). It can be grounds for developing knee medial compartment osteoarthritis (3). Although many studies have shown desirable short and medium term results for proximal tibia osteotomy, it has special limitations (5).

Medial opening wedge high tibial osteotomy as the last method has many applications owing to its lower risks and side effects (5, 6).Proximal tibial osteotomy is a surgical procedure to correct genu varum through modification of proximal tibia alignment (7). Some studies have verified the effect of re-alignment on reduction of the load exerted on knee medial compartment (8, 9).

One of the most common complications of proximal tibia osteotomy for correction of genu varus knees is Uribe joint line (10). Uribe joint line is along with the increase of shear forces on the articular surfaces. In this state the load of body weight is non-uniformly distributed in the knee, leading to the progression of osteoarthritis (10). One of the key points to be taken into account while performing HTO is that while bearing the burden of body weight, lower limb is counted as a closed kinematic chain and any change in any of the components will affect other areas as well (11, 12).

Considering the fact that few studies have been carried out to investigate the effect of HTO and changing the organ alignment on proximal joints and distal knee, this study was designed to examine the changes of tibiotalar joint alignment after HTO in the patients with genu varum.

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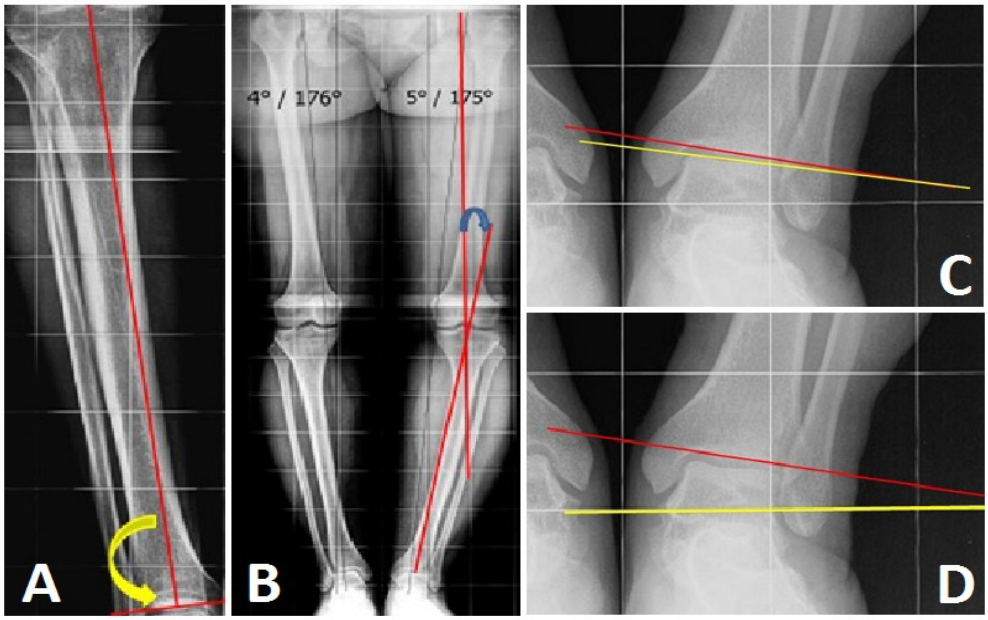

Figure 1. Representative radiographic images used for measuring lower extremity angles: (A) Lateral distal tibial angle (LDTA); (B) Genu varum angle; (C) Joint diversion angle (JDA); (D) Lateral distal tibial-ground surface angle (LDT-GSA).

Materials and Methods

A total of 39 patients who were referred to the orthopedic clinic at Akhtar hospital, Tehran, Iran, between May 2014 and December 2015with primary and secondary genu varum and undergone tibial osteotomy (HTO) were enrolled in this before and after study.

The genu varus angle, joint diversion angle (JDA), lateral distal tibial angle (LDTA) and lateral distal tibial-ground surface angle (LDT-GSA) were measured and compared in all patients before and 6 months after high tibial osteotomy.

Patients complaining from knee deformities were initially undergone lower limb long radiography. The feet were aligned completely close to each other with the patella bent forward, keeping the patients' rotation rate constant.

Different angels were measured using radiography software (INFINITT PACS). Diversion of crossing of the organ's mechanical axis through the knee center (>20mm from the knee center) was defined as the criterion for varus knee in this study. The acute angel between the femur and tibia axes was measured. The joint diversion angel (JDA) is the angel between the tangent line to the tibia and femur articular surface. The angel between the horizon and the articular surface of distal tibia with the positive values were considered as varus and the negative values as valgus.

Arthritis after trauma, rheumatoid arthritis (RA), neurovascular disease, history of previous open surgery, and fractures of lower limbs were the exclusion criteria.

This study was approved by the research ethics committee of the Shahid Beheshti University of Medical Sciences. All patients were provided written voluntary informed consent. SPSS 18.0 (SPSS Inc, Chicago, IL, USA) was used for statistical analysis and a $P<0.05$ was considered as statistically significant.

Results

A total of 39 patients were investigated; 23 (59%) were females and 16 (41%) were males; and the mean age was 37.5±11.7 years (21-60 years).A comparison of the angles before and after surgery is presented in Figure 2.

The genu varus angle decreased significantly ($P<0.001$) after surgical correction; where as LDTA and JDA remained the same. However, LDT-GSA changed significantly from 8.1±1 in varus to -0.3±0.5 in valgus ($P=0.011$).

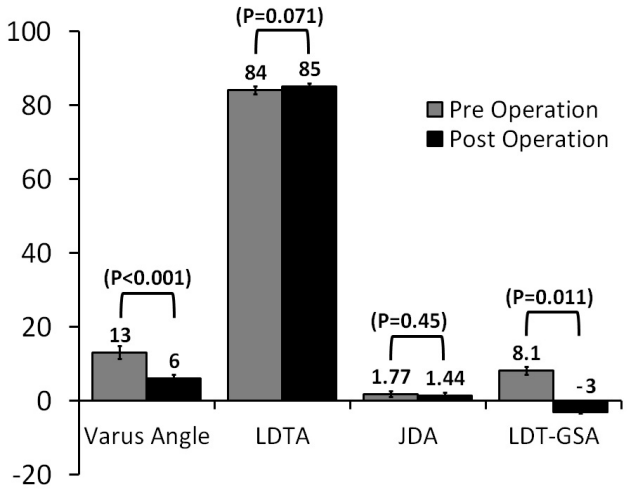

Figure 2. comparison of the angles before and after surgery.

Discussion

The most important finding of this study was that HTO has no influence on JDA and LDTA, but it can have a determining role in the reduction of shearing forces exerted on the tibiotalar joint by reducing LDT-GSA.

A study on possible effects of varus knee on hip and ankle joints in 315 lower limb organs afflicted by varus gonarthrosis revealed an increase in the mean mechanical lateral distal femoral angle (mL DFA) in patients with varus knee, leading the distal femur direction to valgus to a lower extent (2). In addition, they manifested that the effect of mL DFA on the mechanical angle of tibia femoral is similar to the effect of medial proximal tibial angle; and a significant relationship was observed between the lateral distal tibial angle and the medial neck shaft angle. It can be concluded that the distal femur articular surface in such people is less common in valgus and this causes or contributes to deformity (2). Additionally, exerting abnormal forces on the ankle can cause collapse of metaphyseal distal lateral tibia and a reduction in LDTA in patients with varus knee. Medial neck shaft angle can also decrease in patients with varus knee due to abnormal loading angles (2). Weidenhielm et al discussed the changes in loading and adduction moment in the knee and two hip joints as well as the ankle of the same part in 9 patients after HTO and compared the results with 10 normal people at the same age and weight. Forces and torques around the joints were measured through kistler force platform 6-12 months after surgery (13). The results revealed that adduction moment in the hip and knee is significantly higher in patient group than in the normal one. The adduction moment reduced to less than normal in the knee and normal in the hype after surgery. Neither deformity nor HTP had effect on the torques around the ankle (12). The radiographic and clinical results of OA treatment of knee and ankle using HTO was investigated in a study in 2008 (14);in which 16 organs of 10 patients with bilateral varus knee due to OA of the internal compartment of knee were examined. Eight years follow up showed an increase in the mean HHS from 54 to 91, as well as AOFAS from 54 to 86. In addition, the knee alignment changed from 6 to 12 degrees. The tibial inclination angle changed from $10^0$to outer part into $2^0$to inner part and the talar tilt angle decreased from 18^0 to 6^0; hence, recovering the congruity of the joint ankle (14). Examining 104 knees being operated due to OA by Tallroth et al. also revealed ankle joint affection by OA in 30 knees (15). The results revealed that the more the ankle jointtilt, the more generative changes and the ankle alignment will get through knee alignment modification. The study of Tallroth et al. showed a relationship between osteoarthritis of the knee, ankle and joint alignment (15). Tarr et al. showed that distal leg deformity can probably be along with some changes in the ankle joint contact area (13).

Although our findings are inconsistent with some of the previous studies, they reconfirm the results of previous studies that HTO can have a determining role in reduction of shear forces exerted on ankle joint through a considerable change in LDT-GSA.

This study verifies the biomechanical relationship between HTO, angle and loading of tibiotalar joint in most studies.

Limited sample size, follow-up duration, and number of variables as well as lack of tests examining the role of muscles and other soft tissues are the limitations of this study. As patients in this study were in static state, examining the state of joints while walking and comparing the results are suggested in future studies. More prospective studies in this area are also proposed.

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