Talar Coronal Malalignment as a Consequence after High Tibial Osteotomy in Osteoarthritic Knee Patients

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Background: *Medial opening wedge high tibial osteotomy (MOWHTO) is an effective treatment for varus osteoarthritic knee. Alteration of knee alignment after MOWHTO may affect ankle biomechanics.*
Objective: *To evaluate the coronal alignment change of the ankle after MOWHTO.*
Material and Method: *Thirty-five patients who underwent 40 MOWHTO procedures were retrospectively reviewed. Pre-operative and 6 to 12 month postoperative standing hip-to-ankle films were assessed. Differences in the anatomical femorotibial angle (FTA) and the talar tilt angle (TTA) were measured and the correlations were analyzed.*
Results: *The mean differences in FTA and TTA were 14.06±4.89 degrees and 0.48±1.27 degrees, respectively. Increased FTA difference was found to correlate with increased TTA ($p<0.001$). According to ROC analysis, an FTA correction of more than 14 degrees results in a 50% chance of altering ankle coronal alignment.*
Conclusion: *An FTA correction of more than 14 degrees may alter ankle coronal alignment. Other factors may affect talar tilt; therefore, further study is required.*

Keywords: *Ankle coronal alignment, High tibial osteotomy*

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Osteoarthritis (OA) is the most common arthritis and an important cause of musculoskeletal pain that often results in disability in elderly patients. Forty-percent of elderly patients suffer from knee or hip OA[1,2]. Osteoarthritis of the knee usually develops a varus angulation deformity, knee pain, and decreased knee range of motion[3]. For cases of knee OA with unicompartmental (medial compartmental) osteo-arthritis, corrective osteotomy is an effective treatment that alters knee mechanics and subsequently shifts the weight-bearing point[3,4]. The osteotomy procedure results in regeneration of damaged cartilage, according to reports of arthroscopic findings of fibrocartilaginous repair in patients who underwent high tibial osteotomy. From a/the Virolainen et al study, 75% of patients who underwent osteotomy could use their own knees for as long as/at least10 years[5].

The goal for correction in high tibial osteotomy is now referred to as the Fujisawa point, which is defined as 62% of the entire width and measured from the medial border of the tibial plateau. Koshino et al followed osteoarthritic knee patients after high tibial osteotomy for 28 years. That study found that the surgery resulted in an excellent Hospital for Special Surgery (HSS) knee score when the postoperative valgus angulation was 6-15 degrees[6].

Most of the patients with knee osteoarthritis had no ankle complaint. However, ankle pain or deformity may occur after tibial surgery. Olerud et al reported pronation of the foot as the cause of ankle pain from tibial deformity[7]. In another study of patients with ipsilateral knee and ankle osteoarthritis, the authors performed the valgus closing wedge high tibial osteotomy and found ankle pain improvement with decreased talar tilt[8]. Michal et al found that subtalar joint kinematics change as a result of ankle osteo-arthritis[10]. However, there is no study reporting ankle pain or deformity after tibial osteotomy.

Purpose

The purpose of the present study is to evaluate the effect of high tibial osteotomy on talar coronal alignment in osteoarthritic knee patients.

Material and Method

The present study population included

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osteoarthritic knee patients who underwent medial open wedge high tibial osteotomy at Siriraj Hospital between January 2005 and June 2011. Exclusion criteria were secondary OA knee, metabolic bone disease resulting in knee deformity, ankle deformities, and patients who were lost to follow-up.

For surgical technique, all patients were operated upon in the supine position. Fluoroscopy was used for evaluating osteotomy direction and desired angle correction. Our principal investigator was the only surgeon in the presented study. Open wedge high tibial osteotomy and Tomofix® plate fixation without bone grafting was performed. Postoperative protocol included range of motion (ROM) exercises and weight-bearing ambulation, as tolerated with walker or crutches within two or three days after surgery. Full weight-bearing ambulation was initiated after 6 weeks and walking aid was used unless the patient had no knee pain. Postoperative radiographs were scheduled at 6 weeks, 3 months, and 6 months, postoperatively, for radiographic signs of union and an alignment assessment.

Data collection included demographic data (e.g. sex, age, and BMI). Three independent investigators performed pre-operative angle measurements and a 6-month postoperative standing AP teleoroent-

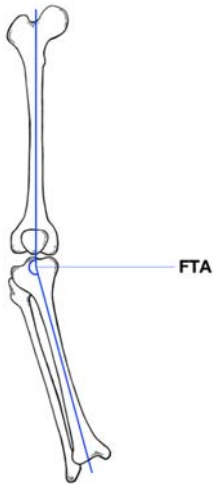

Fig. 1 Anatomical femorotibial angle (the lateral angle between the line of the anatomical axis of the femur and the line of the anatomical axis of the tibia).

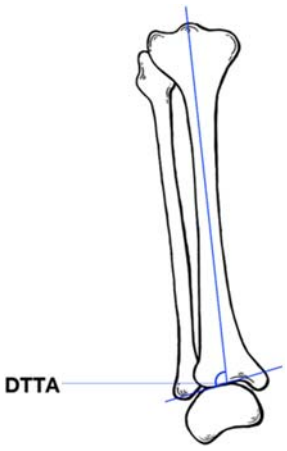

Fig. 2 Distal tibial-talar angle (the lateral angle between the line of the anatomical axis of the tibia and the line parallel to the talar dome).

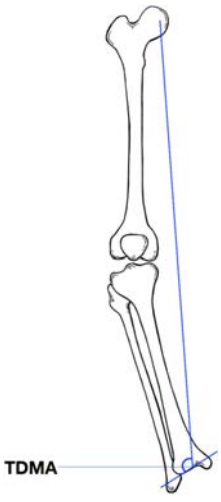

Fig. 3 Talar dome to mechanical axis angle (the lateral angle between the line of mechanical axis and the line parallel to the talar dome).

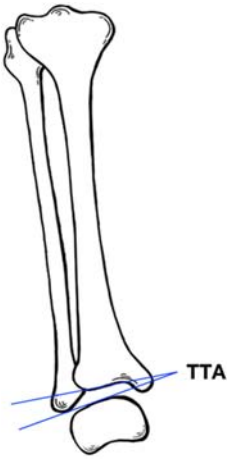

Fig. 4 Talar tilt angle (the lateral angle between the line parallel to the tibial plafond and the line parallel to the talar dome).

genogram, 3 times. Angle measurements included the anatomical femorotibial angle (FTA), the distal tibial-talar angle (DTTA), the talar dome to mechanical axis angle (TDMA), and the talar tilt angle (TTA).

Data analysis

Our data were analyzed using SPSS version 13.0. The quantitative data were analyzed using the Student's t-test and qualitative data were analyzed using the Chi-square test. For the correlation of 2 variables, the data was analyzed using Spearman's rank correlation coefficient and ROC analysis. Differences between the correlation coefficients of 2 variables were analyzed using the Fisher r to z transformation. A *p*-value of less than 0.05 was considered statistically significant.

Results

Thirty-three females and one male, aged 40-62 years, were included in this study. BMI range was 23.5-39.4 kg/m^2. Sites of affected knees were 21 right knees and 19 left knees. Angle measurements are summarized in Table 1.

The correlation of variables using Spearman's rank correlation coefficient between FTA and DTTA and TDMA and TTA were non-significant. The intraclass correlation coefficient for the interobserver was 0.8. The incidence of increased TTA was 11 of 40 knees (27.5%). Patients with increased TTA had an FTA difference of 17.36±2.08 degrees, but the patients with decreased/unchanged TTA had an FTA difference of 12.81±5.09 degrees. The correlation of increased and decreased TTA to FTA difference by t-test for equality of means was found to be statistically significant (p<0.001).

The recipient operator curve (ROC) analysis of increased and decreased TTA to FTA difference was 0.803 as shown in Fig. 5. The cut point value of the FTA difference that resulted in increased TTA was 14.5 degrees. If the FTA difference was more than 14 degrees, 11 of 22 affected knees had increased TTA. At the same time, affected knees with an FTA difference of less than or equal to 14 degrees had unchanged or decreased TTA.

Discussion

Osteoarthritic knee is one of the major causes of disability in elderly patients. Management of medial compartmental osteoarthritic knee consists of both conservative treatment and operative treatment. Surgical treatments include debridement, osteochondral transplantation, corrective osteotomy, and arthroplasty. Corrective osteotomy is an effective surgical treatment for medial compartmental osteoarthritic knee. The goal of corrective osteotomy is to shift the weight-bearing point to the lateral femorotibial compartment and to permit reparation of the damaged cartilage. However, there is limited knowledge in the assessment of ankle alignment after corrective osteotomy.

In the present study, most of the patients were middle-aged females with obesity. The sides of the affected knees were nearly equal (21 right knees vs. 19 left knees). Most patients presented with pre-operative talar tilt without ankle complaint. Mean differences in FTA, DTTA, TDMA and TTA were 14.06±4.89°, 0.53±4.88°, 7.16±3.53°, and 0.48±1.27°, respectively.

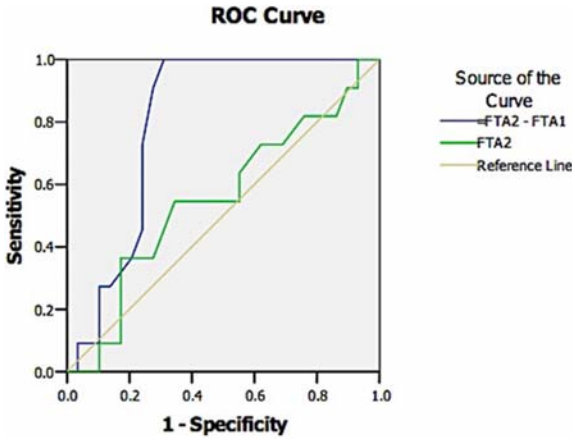

Fig. 5 ROC curve: FTA1 = preoperative FTA; FTA2 = postoperative FTA; FTA2 minus FTA1 = FTA difference.

Table 1. Preoperative and postoperative angle measurements and difference

	Preoperative (degrees)	Postoperative (degrees)	Difference (degrees)
FTA	185.03±3.61	170.97±3.93	14.06±4.90
DTTA	88.23±4.59	88.76±4.56	0.53±4.88
TDMA	94.35±4.16	87.20±5.12	7.16±3.53
TTA	2.09±1.96	1.62±1.76	0.48±1.27

Increased TTA was associated with a higher FTA difference (p<0.001). Using ROC analysis, there was found to be a 50% chance of increased talar tilt when the FTA difference was more than 14 degrees. The authors of this study conclude that open wedge high tibial osteotomy results in ankle coronal alignment change in most patients. Increased talar tilt may alter tibiotalar mechanics and may produce tibiotalar symptoms in the postoperative period. From a previous study of the presented senior staff, a medial proximal tibial angle (MPTA) of at least 95 degrees is necessary to prevent recurrent varus knee deformity[11]. Therefore, the optimal angle for a successful MOWHTO procedure comprises an MPTA of at least 95 degrees and an FTA correction $\leq$14 degrees. However, further study is required for elucidation.

Limitations of the present study included no evaluation of postoperative ankle pain or its correlation to ankle malalignment. The effects of leg length and leg length proportion were not assessed. The present study also may have selection bias and other uncontrolled factors, such as shoe modification.

Conclusion

An FTA correction of more than 14 degrees results in a 50% chance of altering ankle coronal alignment. As a result, the corrected FTA angle needs to be evaluated and determined pre-operatively. Other factors may affect talar tilt; thus, further study is required.

Potential conflicts of interest

None.

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การเอียงตัวของข้อเท้าเป็นผลสืบเนื่องจากการผ่าตัด high tibial osteotomy ในผู้ป่วยโรคข้อเข่าเสื่อม

ธเนศ อริยะวัตรกุล, จตุรงค์ พรรัตนมณีวงศ์, ระพีพัฒน์ นาคบุญนำ, กีรติ เจริญชลวานิช

วัตถุประสงค์: ศึกษาความเปลี่ยนแปลงของการเอียงตัวของข้อเท้าหลังการผ่าตัด open wedge high tibial osteotomy ในผู้ป่วยข้อเข่าเสื่อมและศึกษาความสัมพันธ์ของความเปลี่ยนแปลงของการเอียงตัวของข้อเท้า และความแตกต่างของมุมระหว่างกระดูกต้นขาและกระดูกหน้าแข้ง

วัสดุและวิธีการ: ศึกษามุมการเอียงตัวของข้อเท้าและมุมระหว่างกระดูกต้นขาและกระดูกหน้าแข้ง โดยทำการวัดมุมจากภาพถ่ายรังสี teleoroentgenogram ของผู้ป่วยโรคข้อเข่าเสื่อมก่อนและหลังการผ่าตัด open wedge high tibial osteotomy

ผลการศึกษา: ค่าเฉลี่ยของความเปลี่ยนแปลงของ femorotibial angle และ talar tilt เป็น 14.06±4.89 องศา และ 0.48 ±1.27 องศา ตามลำดับ ความเปลี่ยนแปลงของ femorotibial angle ที่สูงขึ้นมีความสัมพันธ์กับ talar tilt ที่เพิ่มขึ้น โดย femorotibial angle ที่เปลี่ยนแปลงมากกว่า 14 องศา มีโอกาสเกิด talar tilt เพิ่มขึ้นร้อยละ 50

สรุป: femorotibial angle ที่เปลี่ยนแปลงมากกว่า 14 องศา อาจเป็นปัจจัยหนึ่งที่ส่งผลให้ข้อเท้ามีการเอียงตัวเพิ่มขึ้น