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A Retrospective Study of the Risk Factors for Postoperative Foot or Ankle Pain in 90 Patients with Varus Osteoarthritis of the Knee who Underwent Total Knee Arthroplasty

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Data Interpretation D
Manuscript Preparation E
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Background: The reasons for foot and ankle pain following total knee arthroplasty (TKA) for knee varus osteoarthritis are unknown. This retrospective study aimed to investigate the risk factors for postoperative foot and ankle pain in patients with varus osteoarthritis of the knee who underwent TKA.

Material/Methods: We enrolled 90 patients who underwent TKA for varus knee osteoarthritis. The visual analog scale (VAS) was used to evaluate patients' foot or ankle pain before and after surgery. The correlation between independent variables (eg, age, sex, body mass index [BMI], ankle osteoarthritis, and varus angle) and foot and ankle pain in patients with osteoarthritis of the knee was measured. Moreover, radiological changes were compared between the groups with and without worsened pain.

Results: No significant difference in VAS was found between patients <60 and ≥60 years of age ($P>0.05$). Male sex and BMI <30 kg/m^2 were weakly correlated with preoperative foot or ankle pain. However, patients with varus of ≥6° and preexisting ankle osteoarthritis had a higher incidence of foot or ankle pain before surgery. Moreover, no significant differences in radiological changes were found between the groups with and without worsened foot or ankle pain after surgery ($P>0.05$).

Conclusions: In male patients with osteoarthritis of the knee, a BMI <30 kg/m^2, varus of <6°, and no preexisting ankle osteoarthritis were protective factors for foot and ankle pain. TKA corrected knee and ankle malalignment. Therefore, postoperative foot and ankle pain was not associated only with TKA surgery.

Keywords: Age Factors • Arthroplasty, Replacement, Knee • Pain

Abbreviations: **TKA** – total knee arthroplasty; **BMI** – body mass index; **HKA** – hip-knee-ankle angle; **LTA** – lateral tibial angle; **TASA** – tibia anterior surface angle; **TTSA** – tibia talar surface angle; **TTA** – talar tilt angle; **GS – angle** between the ground and the upper surface of talus; **MAJS** – medial ankle joint space; **MACS** – medial ankle clear space; **VAS** – visual analog scale

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Background

Total knee arthroplasty (TKA) is an effective surgical method used to treat advanced osteoarthritis of the knee [1,2]. In most patients, joint function can be reestablished and pain can be alleviated through the correction of lower extremity malalignment [3,4]. TKA surgery can achieve normal alignment of the lower extremity in a 3-dimensional plane, including the axial, sagittal, and coronal planes, by the accurate installation of the prosthesis [5]. However, recent studies have shown that a change in the level of knee alignment affects the foot and ankle joints and induces adverse clinical symptoms, such as foot and ankle pain [6,7].

In orthopedic medicine, foot and ankle pain are common clinical symptoms that can influence movement and affect patient quality of life [8-10]. The pain can be further divided into ankle pain, forefoot pain, hindfoot pain, and multiple pain [11]. The common etiologies of foot and ankle pain including ligament injury [12], peroneal tendon disorders [12], neural causes [8], and bony causes [13]. The uncommon causes of foot and ankle pain are infectious tenosynovitis of the tibialis anterior tendon [14], transient osteoporosis [15], and complex regional pain syndrome [16]. In recent years, foot or ankle pain following TKA has received increasing attention from orthopedic specialists worldwide [6,7,17,18]. We hypothesized that, in addition to changes in the lower extremity's mechanical axis after TKA, patient age, sex, body mass index (BMI), genu varus severity, and the presence of preoperative ankle osteoarthritis might also be associated with postoperative foot and ankle pain.

However, the related risk factors of foot and ankle pain following TKA are still not elucidated. Furthermore, there is no consensus concerning the prevention of foot and ankle pain following TKA. It is essential to estimate the related risk indicators of foot and ankle pain following TKA in patients with osteoarthritis of the knee to help with diagnosis, decision making, and pain control. Therefore, this retrospective study aimed to investigate the risk factors for postoperative foot or ankle pain in 90 patients with varus osteoarthritis of the knee who underwent TKA.

Material and Methods

Ethics Approval

Ethics approval for the study was obtained from the Ethics Committee of the Third Hospital of Hebei Medical University. Consent was obtained from all patients.

Inclusion and Exclusion Criteria

From January 2017 and October 2019, a total of 90 consecutive patients who received TKA surgery in the Third Hospital of Hebei Medical University were retrospectively studied. The inclusion criteria were as follows: (1) radiological findings suggested varus osteoarthritis of the knee; (2) patient was symptomatic due to osteoarthritis of the knee; (3) full-length standing anteroposterior radiographs of bilateral lower extremities were performed before and after surgery; (4) unilateral TKA was performed. The exclusion criteria were as follows: (1) radiological findings were unclear or the patients did not have full-length preoperative or postoperative standing anteroposterior images; (2) patient had undergone previous ankle surgery or had a medical history of ankle injury; (3) patient had received revision TKA, uni-compartmental knee arthroplasty, or other knee surgeries [18].

Pain Evaluation

All patients' visual analog scale (VAS) scores were evaluated before surgery and 1, 3, 6, and 12 months after surgery. A previous study categorized foot and ankle pain into ankle pain, forefoot pain, hindfoot pain, and multiple pain [11]. In this study, we used the term "foot and ankle pain" for any of these types of pain. When there were definite focal tenderness and VAS score ≥1, pain was considered to exist. For instance, hindfoot pain was considered when pain beyond the calcaneus (Achilles insertion sites, plantar fascia, and subtalar joint) with a VAS score of 4. Forefoot pain was considered when there was tenderness about the toes (metatarsal, tarsal bones, and metatarsophalangeal joint) with a VAS score of 3. Ankle pain was considered when there was medial joint line tenderness with a VAS score of 1.

Radiographic Assessment

All patients received the same surgical strategies performed by our corresponding author. Two trained surgeons, who were blinded to the purpose of the study, independently measured the selected angles from the picture archiving and communication system (Beijing Tianjian Yuanda Technology Co., Ltd., China). The 2 surgeons independently performed the quality evaluation and data extraction. If the measured results were consistent, the data were considered valid. However, if the measurement results were inconsistent, the 2 surgeons needed to remeasure the data until a consensus was reached [18].

The center of the femoral head was determined using the Moses circles method [19]. The femur and tibia mechanical axes were defined as a line from the center of the femoral head to the center of the knee and a line from the center of the tibial plateau to the center of the ankle, respectively. Normal

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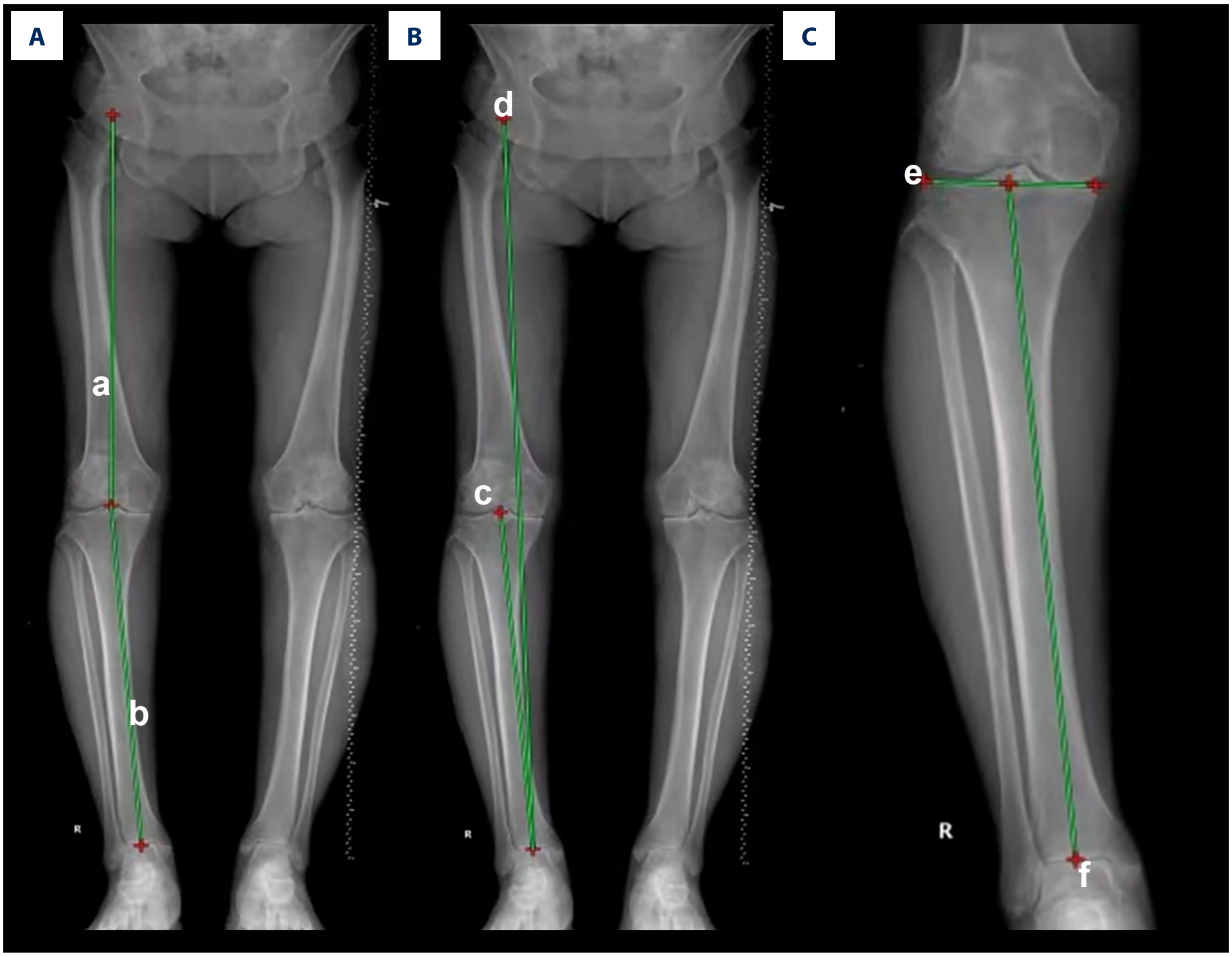

Figure 1. Measurement of hip-knee-ankle angle (HKA) and ankle parameters based on full-leg standing anteroposterior radiographs. HKA was defined as the medial angle between (a) and (b) (**A**). Lateral tibial angle was defined as the medial angle between (c) and (d) (**B**). Medial angle of the proximal tibia was defined as the lateral angle between (d) and (f) (**C**).

alignment of the lower limb was considered when the mechanical axis passed through the hip, knee, and ankle midpoints in a straight line. The midpoint of the knee was represented by the center of the femoral condyle at the top of the intercondylar notch. The center of the ankle was defined as the midpoint of the talus joint surface [20]. The hip-knee-ankle angle (HKA) (**Figure 1A**), lateral tibial angle (LTA) (**Figure 1B**), medial angle of the proximal tibia (MAPT) (**Figure 1C**), tibia anterior surface angle (TASA) (**Figure 2A**), tibia talar surface angle (TTSA) **(Figure 2B**), talar tilt angle (TTA) (**Figure 2C**), the angle between the ground and the upper surface of talus (GS) (**Figure 2D**), medial ankle joint space (MAJS) (**Figure 2E**), and medial ankle clear space (MACS) (**Figure 2F**) were measured.

Varus deformity severity was estimated by the HKA, with an HKA of ≥3° considered varus knee deformity [21-23]. The HKA was calculated using the angle between the mechanical axes of the tibia and femur. The tibiotalar joint alignment was assessed with the TTSA [22,23] and was measured through the angle between the talus upper surface and tibia anatomical axis. Moreover, the TTA, GS, MAJS, and MACS were used to evaluate the ankle changes before and after surgery.

Grouping Design

Subgroups were determined using the following demographic and radiographic factors: age at surgery (<60 years, ≥60 years), sex (female, male), BMI (BMI <25 kg/m^2, BMI 25-30 kg/m^2, BMI ≥30 kg/m^2), varus (<6°, 6-10°, ≥10°), and preexisting ankle osteoarthritis (yes or no). Subsequently, the preoperative foot or ankle pain of patients with osteoarthritis of the knee was compared within each of 5 groups. Following TKA, the groups with and without worsened foot or ankle pain were established to investigate the correlation between ankle radiological changes and foot or ankle pain. Changes before and after surgery were calculated as follows: Δ radiological changes=preoperative angle–postoperative angle. For example, Δ HKA=preoperatively HKA–postoperative HKA. All data,

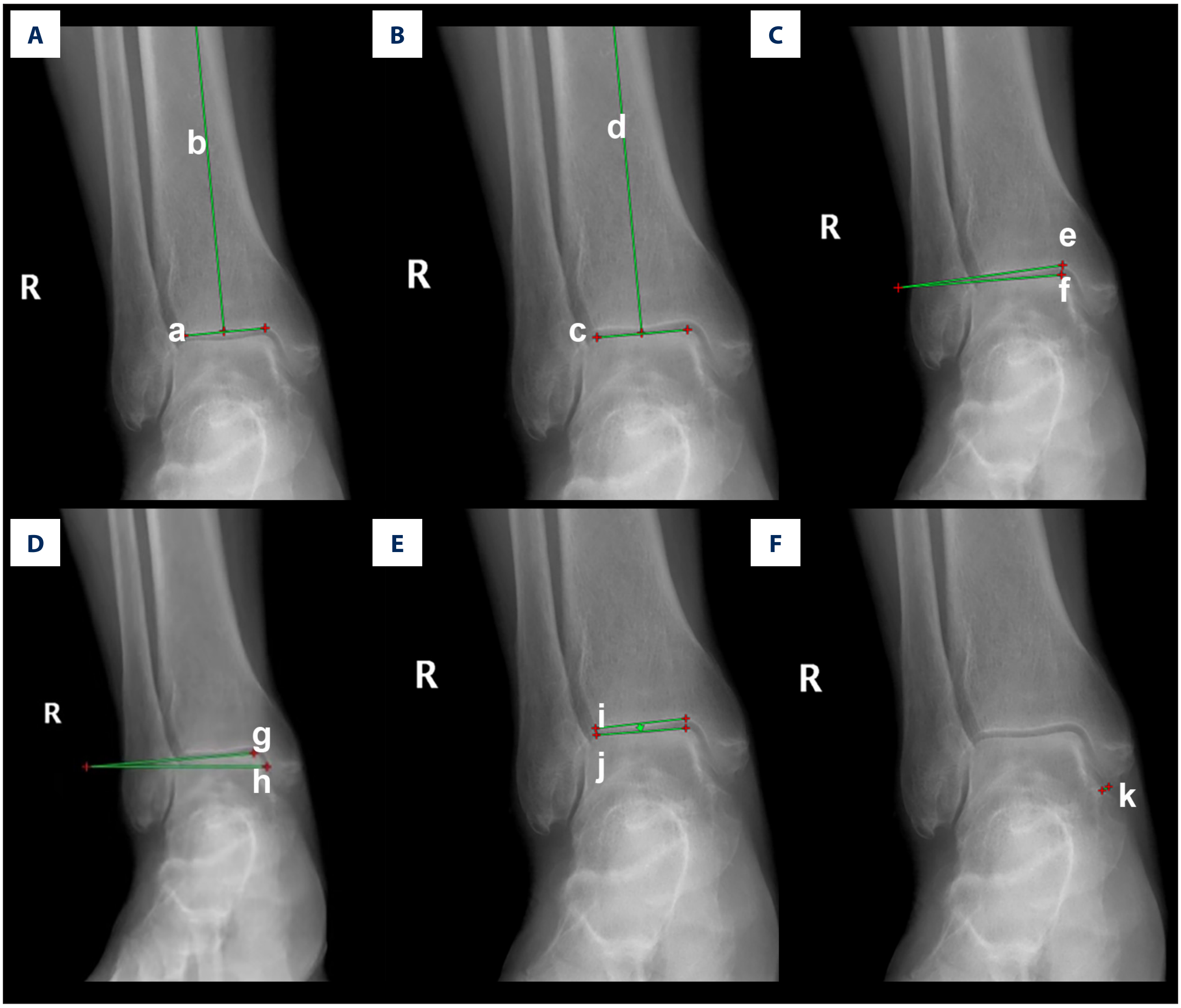

Figure 2. The tibia anterior surface angle was defined as the angle between (a) and (b) (**A**). The tibia talar surface angle was formed by the angles between (c) and (d) (**B**). Angle between the ground and the upper surface of talus was defined as the angle between (e) and (f) (**C**). The talar tilt angle was defined as the angles between (g) and (h) (**D**). The medial ankle joint space was defined as the medial angles between (i) and (j) (**E**). Moreover, medial ankle clear space was defined as the line k from the medial malleolus to the lateral malleolus (**F**).

including age, sex, BMI, varus angle, and whether patients had preexisting ankle osteoarthritis, were collected from clinical records and radiograph findings (**Table 1**).

Statistical Analysis

The chi-squared test was used for comparison between groups. Logistic regression analysis was used to determine the connection between ankle pain following TKA and the independent variables. Changes in HKA, LTA, MPTA, TASA, TTSA, TTA, GS, MAJS, and MACS were compared using a paired *t* test. SPSS (version 23.0, IBM Corp, Armonk, NY, USA) was used to analyze the data. A *P* value of less than 0.05 was defined as statistically significant.

Results

Ninety patients were included, with 16 men and 74 women aged 66.3±6.3 years (range, 51 to 82 years). Mean BMI values of 27.7±3.2 kg/m^2 (range, 18.99 to 37.04 kg/m^2) were obtained. The mean follow-up duration was 23 months.

The chi-squared test results revealed no significant difference between patients <60 years and ≥60 years ($P>0.05$); however, patients with female sex, high BMI, varus of ≥6°, and preexisting ankle osteoarthritis had a higher incidence of foot or ankle pain (**Table 1**). Moreover, the logistic regression results showed that male sex (odds ratio [OR] 0.131, 95% confidence interval [CI] 0.020-0.874) and BMI <30 kg/m^2 (OR 5.351, 95% CI

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Table 1. Incidence of foot or ankle pain and associated risk factors were evaluated before surgery.

	Number of patients	Number of FAP	Incidence (%)	χ^2	p
Age				0.000	1.000
<60	8	2	25.00		
≥60	82	20	24.39		
Sex				9.079	0.003
Female	53	19	35.85		
Male	37	3	8.11		
BMI				15.456	<0.001
<25	33	1	3.03		
25-30	34	10	29.41		
>30	23	11	47.83		
Genu varus (°)				11.982	0.003
<6	30	1	3.33		
≥6 & <6	22	6	27.27		
≥10	38	15	39.47		
Pre-existing ankle OA				9.215	0.002
No	73	13	17.81		
Yes	17	9	52.94		

p<0.05 was defined as a statistically significant difference. FAP was foot and ankle pain; OA indicates osteoarthritis; BMI suggests body mass index.

Table 2. The logistic regression analysis of foot or ankle pain and its potential explanatory variables.

	OR	95% CI	p
Sex	1		
Female			
Male	0.131	0.020~0.874	0.036
BMI			
<25	1		
25-30	5.351	0.417~68.738	0.198
>30	28.937	2.155~388.478	0.011
Genu varus (°)			
<6	1		
≥6 & <6	23.176	1.411~380.753	0.028
≥10	27.716	2.125~361.525	0.011
Pre-existing ankle OA			
No			
Yes	9.279	1.780~48.353	0.008

p<0.05 was defined as a statistically significant difference. OA indicates osteoarthritis; BMI suggests body mass index.

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Table 3. Lower limb alignments on the operated side were compared before and after total knee arthroplasty using full-length standing anteroposterior radiographs.

Parameters	TKA pre-	TKA post-	Surgical improvement	Statistic (Z/t)	P value
HKA	12.1±5.5	2.4 (1.1,3.9)	-9.3±4.8	-8.219#	<0.001*
LTA	6.5 (4.4, 8.7)	1.3±1.4	-5.3 (-7.4, -3.3)	-8.193#	<0.001
MAPT	83.7 (81.3,85.6)	89.8±51.6	6.0 (4.1, 8.5)	-8.180#	<0.001*
TASA	91.0±3.8	90.5±3.3	-0.5±3.1	1.552	0.124
TTSA	89.8±4.0	90.0±3.6	-0.2±3.3	-0.477	0.635
GS	9.5±4.9	4.3±3.6	-5.2±3.8	13.142	<0.001*
TTA	1.0 (0.1, 2.2)	0.5±1.6	-0.6 (-1.4, 0.4)	-2.944#	0.003
MAJS (mm)	2.8 (2.5, 3.0)	2.9 (2.6, 3.1)	0.1±0.3	-3.020#	0.003
MACS (mm)	2.4 (2.4, 2.9)	2.5±0.5	0.03±0.5	-0.431#	0.666

# Indicates that the statistic was Z, and the rest was t; pre- and post- suggest preoperatively and postoperatively, respectively; p<0.05 was defined as a statistically significant difference. HKA represents the hip-knee-ankle angle, LTA indicates the lateral tibial angle, MAPT is the medial angle of proximal tibia, TASA represents tibia anterior surface angle, TTSA indicates tibia talar surface angle, TTA is the talar tilt angle, GS is formed by angle between the Ground and the upper Surface of talus, MAJS indicates the medial ankle joint space, MACS represents and the medial ankle clear space.

Table 4. The Δ radiological factors changes were compared in the groups with and without worsened foot or ankle pain.

Parameters	No FAP worsened group	FAP worsened group	t/Z	P-value
ΔHKA	8.73±4.94	10.94±3.82	-1.925	0.057*
ΔLTA	5.15 (3.05, 7.15)	5.70 (4.30, 7.80)	1.564	0.118#
ΔMAPT	-5.90 (-8.40, -3.95)	-6.05 (-8.50, -4.80)	0.418	0.676#
ΔTASA	0.47±3.21	0.61±2.80	-0.175	0.861*
ΔTTSA	-0.15 (-1.65, 1.60)	0.60 (-2.20, 2.20)	0.582	0.560#
ΔGS	5.23±3.83	5.17±3.65	0.064	0.949*
ΔTTA	0.50 (-0.40, 1.20)	0.65 (-0.70, 1.80)	0.728	0.467#
ΔMAJS	-0.10±0.31	-0.11±0.33	0.061	0.951*
ΔMACS	-0.02±0.52	-0.03±0.57	0.023	0.982*

* t test, # Wilcoxon signed-rank test, Δ radiological changes=preoperatively angle–postoperative angele, p<0.05 was defined as a statistically significant difference. HKA represents the hip-knee-ankle angle, LTA indicates the lateral tibial angle, MAPT is the medial angle of proximal tibia, TASA represents tibia anterior surface angle, TTSA indicates tibia talar surface angle, TTA is the talar tilt angle, GS is formed by angle between the Ground and the upper Surface of talus, MAJS indicates the medial ankle joint space, MACS represents and the medial ankle clear space.

0.417-68.738) were weakly correlated with foot or ankle pain. However, varus of ≥6° (OR 23.176, 95% CI 1.411-380.753) and preexisting ankle osteoarthritis (OR 9.279, 95% CI 1.780-48.353) were strongly correlated with foot or ankle pain (**Table 2**).

There were no significant differences in TASA, TTSA, and MACS before and after surgery (*P*>0.05); however, the HKA, MPTA, MAJS, and MACS showed significant improvement after surgery (*P*<0.05) (**Table 3**). From all samples, the HKA decreased from 12.1±5.5 before surgery to 2.4 (1.1, 3.9) after surgery (*P*<0.001); the LTA decreased from 6.5 (4.4, 8.7) before surgery to 1.3±1.4 after surgery (*P*<0.001); the MPTA decreased from 83.7 (81.3, 85.6) before surgery to 89.8±51.6 after surgery (*P*<0.001); the GS improved from 9.5±4.9 before surgery to 4.3±3.6 after surgery (*P*<0.001); and the TTA and MAJS were 1.0 (0.1, 2.2) and 2.8 (2.5, 3.0) before surgery, and improved to 0.5±1.6 and 2.9 (2.6, 3.1) after surgery, respectively (*P*<0.05). However, no significant differences in changes in radiological

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factors were found between the groups with and without worsened foot or ankle pain (P>0.05) (**Table 4**).

Discussion

The present findings indicated that knee preoperative malalignment was corrected significantly, whereby the MAJS and MACS were improved on the operated side following TKA. An essential finding in the current study was that various risk factors, including female sex, high BMI, varus of ≥6°, and preexisting ankle osteoarthritis, increased the incidence of foot and ankle pain in patients with osteoarthritis of the knee. Several previous studies have described the association between knee and ankle malalignment after TKA [2,6,11,17,18,24-26]. Nonetheless, few authors have investigated the risk factors associated with foot or ankle pain in patients with osteoarthritis of the knee, to the best of our knowledge. Misdiagnosis and mistreatment of foot or ankle pain can lead to serious complications and impair physical function. Accordingly, understanding the relationships between risk factors and foot and ankle pain is essential to prevent postoperative surgical complications. We hypothesized that risk factors, including surgical age, sex, BMI, varus severity, and preexisting ankle osteoarthritis, might be associated with foot and ankle pain following TKA. Herein, we retrospectively studied 90 patients to evaluate the risk indicators of foot or ankle pain following TKA in patients with osteoarthritis of the knee to help with diagnosis, decision making, and pain control.

In this study, we found that age did not significantly influence foot or ankle pain in patients with osteoarthritis of the knee (**Table 1**). To date, it has not been established whether age is a risk factor for foot or ankle pain after TKA. As a risk factor of advanced knee osteoarthritis, age could affect patient satisfaction with TKA, according to previous studies [27,28]. The patient-reported dissatisfaction rate of TKA has ranged from 11% to 25% in past decades [29,30]. At present, the relationship between age and pain is controversial. Numerous authors believe that elderly patients have a high pain threshold, especially women [31,32]. Moreover, elderly patients are believed to be less susceptible to the experience of pain because the somatosensory pain system and immune system change with age [33]. Lautenbacher et al [34] suggested that aging can reduce pain sensitivity for lower pain intensities. However, Molton et al [35] reported that age could bring various pains, such as musculoskeletal, chronic joint, osteoarthritic back, and peripheral neuropathic pain. Therefore, in our view, clinicians should fully consider the risk factors of foot and ankle pain in patients with osteoarthritis. Mullaji et al [24] reported that age is not a risk factor for postoperative limb mechanical axis malalignment, suggesting that age is not associated with postoperative foot and ankle pain. In the present study, elderly patients had a higher incidence of foot or ankle pain in osteoarthritis of the knee (P>0.05). Although the difference was not statistically significant, providing active perioperative pain management for elderly patients remains essential.

Regarding patient sex, we found that women were more likely to have a foot or ankle pain than were men (35.85% vs 8.11%, P<0.05) (**Table 2**). Authors have mentioned the issue of FAF after TKA [26], but few studies have analyzed the influence of sex on ankle pain after TKA. Xie et al [36] found there is a negative correlation between the HKA and TTA in women, while there is a positive correlation between knee alignment and TASA in women; however, they indicated that men did not have compensatory changes in the ankle alignment and TTA to knee alignment. Our findings were supported by Xie et al [36]. Moreover, female sex is a critical risk factor of advanced and symptomatic knee osteoarthritis [37,38]. Women have a greater risk of osteoporosis than do men, particularly among the elderly population [39,40], and osteoporosis is also a risk factor for foot and ankle pain [15]. Therefore, we believe that performing a careful preoperative examination for ankle deformities with knee osteoarthritis, especially in women, is necessary.

Obesity is considered a global public health crisis [41-43]. China has the largest affected population globally, with approximately 46% of adults and 15% of children with overweight or obesity [43]. Obesity is also a demographic factor that is increasingly common in patients undergoing TKA [44]. No significant difference was found between the BMI <24 kg/m^2 group and the 24≤ BMI <30 kg/m^2 group (P>0.05) in the present study. However, the BMI ≥30 kg/m^2 group had a higher incidence of foot or ankle pain (P<0.05) (**Table 2**). In our opinion, this result can be explained by an increased BMI having a considerable impact on postoperative mechanical axis alignment following TKA [45]. Malalignment of the lower limb can induce harmful symptoms in the hindfoot and ankle joint, especially in patients with ankle osteoarthritis [26]. Moreover, Butterworth et al [46] reported that fat mass is related to foot pain in men. Furthermore, in addition to foot or ankle pain, various surgical complications related to obesity following TKA have been reported, including a decreased postoperative range of motion, increased rates of wound complications, prosthesis loosening, medial collateral ligament avulsion, TKA failure, and even revision surgery [47-50]. We believe the joint forces may be greater in patients with obesity (BMI ≥30 kg/m^2) than in patients without obesity (BMI <30 kg/m^2), and this view is consistent with that of Estes et al [45]. Further, obesity can lead to poor postoperative alignment due to the large soft tissue around the knee, which increases the difficulty of exposure, blurs bone landmarks around the knee and ankle, and interferes with the precise installation of the cutting guidelines [45]. Berend et al [51] found that a BMI of >33.7 kg/m^2

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is an important contributor to the failure of TKA. In the present study, we found that a BMI of >30 kg/m^2 presented more risk for foot or ankle pain following TKA. Although Berend et al evaluated the relationship between BMI and TKA surgical failure, and we evaluated the relationship between BMI and foot or ankle pain after TKA, we formed similar conclusions that a high BMI may increase the incidence of postoperative complications after TKA. Thus, in patients with obesity, clinicians should consider that patients with BMI >30 kg/m^2 are more likely to have foot or ankle pain and should implement preventive strategies in advance.

Preexisting ankle osteoarthritis is frequently found on X-ray fluoroscopic for some patients with knee osteoarthritis who are symptomatic. However, ankle osteoarthritis prevalence is lower than that of knee osteoarthritis. In the present study, 17 of 90 (19%) patients had both knee and ankle osteoarthritis (**Table 1**), a finding that was similar to that of 4, who reported that one-third of patients experienced both knee and ankle osteoarthritis. Numerous authors have reported that osteoarthritis of the knee is a common factor inducing pain and disability in the elderly population [53,54]. However, studies evaluating the correlation between foot and ankle pain and preexisting ankle osteoarthritis are scarce. In the present study, the preexisting ankle osteoarthritis group had a higher level of foot or ankle pain than did the group without preexisting ankle osteoarthritis (P<0.05). Gao et al [18] reported ankle alignment can be simultaneously corrected following TKA, suggesting a favorable result for the ankle. However, they did not mention whether the study participants had preexisting ankle osteoarthritis. However, Norton et al reported that the ankle symptoms might not be relieved or can even worsen following TKA in patients who also have stiff subtalar joints due to the inability of the ankle joint to realign after TKA [6,26]. In our opinion, aggravated ankle pain should be evaluated when counseling patients before TKA.

The severity of preoperative knee deformity in relation to the ankle and foot stability after TKA has received increasing attention. Numerous reasons for foot or ankle pain following TKA have been reported, including overcorrecting the tilt of the distal tibia plafond and ankle alignment [25], residual varus in the knee [2], and unbalanced lower extremities with genu varum [11]. Nevertheless, retrospective studies of the influence of varus angle on foot and ankle pain after TKA are extremely uncommon. In the present study, the varus of ≥6° group had a higher incidence of foot or ankle pain than did the varus of <6° group (P<0.05). We believe this may be related to poor ankle alignment after TKA in severe deformities. Moreover, Okamoto et al [7] reported that patients with severe deformities had persistent hindfoot pain postoperatively. Furthermore, Cho et al [55] found that a stable improvement in hindfoot pain can be achieved 6 weeks after TKA, but no further improvement can be expected. In our opinion, surgeons should perform evaluations on patients with severe varus deformities before TKA, give careful attention to the correction of knee alignment during operation, and advocate active treatment within 6 weeks after TKA.

The issues concerning preoperative and postoperative radiological factor changes and whether TKA can cause foot or ankle pain are hot topics in orthopedic medicine. We found that HKA was significantly improved after surgery, compared with before surgery (P<0.05) (**Table 3**), indicating TKA was an effective procedure for osteoarthritis of the knee, as was found by many authors [13,18,28,36]. However, we also observed no differences in Δ radiological changes (ΔHKA, ΔLTA, ΔMPTA, ΔTASA, ΔTTSA, ΔTTA, ΔGS, ΔMAJS, and ΔMACS) between the groups with and without worsened foot or ankle pain (P>0.05) (**Table 4**), suggesting that postoperative foot and ankle pain were not related to TKA. Therefore, we recommend that when analyzing the etiology of foot or ankle pain after TKA, physicians should not focus on the TKA operation itself but should pay attention to the patient's demographic characteristics and changes in the mechanical axis of the lower limbs after TKA.

Although the risk factors for foot or ankle pain following TKA were evaluated objectively, comprehensively, and scientifically in this study, the study still has many limitations. First, this was a was a single-center retrospective study with a small sample size, and the proportion of men and women in the study participants was not equal. These factors may have led to bias in the study results. Therefore, multi-center randomized controlled trials with a similar sex ratio and a larger sample size should be conducted. Second, the results may not be applicable to other populations, owing to racial differences. Third, the participants in this study were patients with osteoarthritis of the knee with genu varus. Consequently, the results may not be applicable to genu valgus. Finally, individuals differ in their sensitivity to pain, while VAS scores are primarily based on individual subjective feelings. Therefore, there may be errors in the VAS score.

Conclusions

The findings of this study showed that in male patients with osteoarthritis of the knee, a BMI <30 kg/m^2, varus of <6°, and no preexisting ankle osteoarthritis were protective factors for foot and ankle pain. TKA corrected knee and ankle malalignment. Therefore, postoperative foot or ankle pain was not associated only with TKA surgery.

Declaration of Figures Authenticity

All figures submitted have been created by the authors, who confirm that the images are original with no duplication and have not been previously published in whole or in part.

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