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Radiographic assessment of knee–ankle alignment after total knee arthroplasty for varus and valgus knee osteoarthritis

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ABSTRACT

Background: There are unanswered questions about knee–ankle alignment after total knee arthroplasty (TKA) for varus and valgus osteoarthritis (OA) of the knee. The aim of this retrospective study was to assess knee–ankle alignment after TKA.
Methods: The study consisted of 149 patients who had undergone TKA due to varus and valgus knee OA. The alignment and angles in the selected knees and ankles were measured on full-length standing anteroposterior radiographs, both pre-operatively and post-operatively. The paired *t*-test and Pearson's correlation tests were used for statistical analysis.
Results: The results showed that ankle alignment correlated with knee alignment both pre-operatively and postoperatively ($P < 0.05$). The pre-operative malalignment of the knee was corrected ($P < 0.05$), and the ankle tilt angle was accordingly improved in the operative side after TKA ($P < 0.05$). In addition, TKA had little effect on knee–ankle alignment on the non-operative side ($P > 0.05$).
Conclusion: These findings indicated that routine TKA could correct the varus or valgus deformity of a knee, and improve the tilt of the ankle. Ankle alignment correlated with knee alignment both pre-operatively and postoperatively. Both pre-operative knee and ankle malalignment can be simultaneously corrected following TKA.
Level of evidence: Level III.

1. Introduction

Total knee arthroplasty (TKA) is a very successful surgical procedure used to treat end-stage osteoarthritis (OA) of the knee so that pain can be relieved and joint function can be restored due to the correction of lower extremity malalignment [1,2]. It is also known that TKA surgery can achieve normal Saxial alignment of the lower extremity in the coronal, sagittal and rotational planes by implanting the prosthesis precisely, contributing to improve long-term survival of the prosthesis [3]. Postoperative lower extremity alignment, measured on anteroposterior radiographs, is an important determinant of long-term outcomes following TKA [4,5]. Several factors such as soft tissue laxity, tibial bone loss, inappropriate bone resection, improper cementation, pre-operative varus deformity of >20°, and femoral bowing of >5° could contribute to malalignment after TKA [6]. Malalignment

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after TKA could cause overloading of the implant bearing and the bone itself, leading to osteolysis, instability and early loosening [7,8], which is one of the major mechanisms leading to early clinical failure and may result in revision surgery [4,9–12]. Moreland pointed out that prosthetic alignment is the most crucial factor affecting the survival of the implant [9]. Other studies have also thought that prosthesis survival following TKA depends on restoration of the mechanical alignment of the operated leg [11,13,14].

Patients with OA knee and requiring TKA commonly present with ankle OA and abnormal ankle alignment; [15] however, whether ankle malalignment is affected after TKA, and/or correlates with knee malalignment pre-operatively and postoperatively, remains uncertain. Few reports are available that assess the association of the abnormal alignment and degenerative changes in the ankle joint with the varus or valgus deformity in the knee. Two studies from different institutions reported inconsistent findings regarding the relationship between ankle and knee malalignment in TKA [15,16]. Indeed, Chandler and Moskal did not find a relationship between knee and hindfoot malalignment before or after TKA [16]. Meanwhile, Tallroth et al. demonstrated that the ankle tilt is pre-operatively associated with deviation in the tibiofemoral angle and mechanical axis [15]. However, few studies have actually used full-length standing anteroposterior radiographs of both lower extremities to assess this issue, and there is no consensus concerning the change of knee–ankle alignment after TKA for varus or valgus OA knee.

The aim of this study was to compare pre-operative and postoperative knee–ankle alignment and angles, using both hip-to-ankle radiographs in the standing position, and assess knee–ankle alignment after primary TKA.

2. Materials and methods

2.1. Patient information

A retrospective study was conducted of patients with symptomatic varus or valgus OA knee who had undergone primary TKA between January and October 2013 in China–Japan Friendship Hospital. During this period, all patients were submitted to routine pre-operative and postoperative full-length standing anteroposterior radiographs of both lower extremities. Exclusion criteria were patients that: lacked full-length pre-operative or postoperative standing anteroposterior radiographs; had unclear radiographs; underwent uni-compartmental knee arthroplasty (UKA), revision TKA or other knee surgeries; had a history of ankle injury and received any type of ankle surgery.

A total of 149 patients were included, with 32 men and 117 women aged 67.2 ± 8.7 years (range: 43 to 86). Mean body mass index (BMI) values of 26.2 ± 12.4 kg/m^2 (range: 18.7 to 35.3) were obtained. From the 149 knees, 24 patients had pre-operative unilateral valgus deformity (range: −30 to −one degree), as measured by the mechanical axis; 82 individuals showed pre-operative unilateral varus deformity (range: one to 24°) and 43 patients had bilateral varus gonarthrosis (range: left one to 30°; right one to 25°). To assess the relationship between knee and ankle alignment before and after TKA, the patients were grouped into two categories: unilateral and simultaneous-bilateral arthroplasty.

The correlation between pre-operative and postoperative knee and ankle alignment was then analyzed on unilateral operative and non-operative sides, as well as bilateral left and right sides. After dividing the patients into the unilateral varus, unilateral valgus, and bilateral varus groups, pre-operative and postoperative knee and ankle alignment were compared within each of the three groups. The perioperative demographic characteristics of the patients are listed in Table 1. The pre-operative and postoperative radiographs that were used in this study were routinely taken before and after TKA, and there were no other experimentations on humans, so ethics was not involved in the study.

2.2. Measurement of alignment and angles

The same surgical technique was performed in all patients. The alignment and angles in the knees and ankles were pre-operatively and postoperatively assessed on full-length standing anteroposterior radiographs. Two experienced orthopedic surgeons (FG and JM) independently measured the selected angles by using the same instrumentation for all radiographs. The images from the included patients were evaluated with Picture Archiving and Communication Systems (PACS) (Carestream Health. Inc., Canada) and were randomly presented to one of the two surgeons by an independent investigator who was unaware of the study design, in order to enhance measurement accuracy. The two surgeons had the same professional qualifications and were trained before the initial measurement. The data extraction and quality assessment were independently performed by two

Table 1
Demographics and baseline characteristics.

Demographics	Unilateral valgus gonarthrosis	Unilateral varus gonarthrosis	Bilateral varus gonarthrosis
n	24	82	43
Gender (male/female)	3/21	18/64	11/32
Age (years)	67.5 ± 8.9	65.8 ± 13.7	68.3 ± 12.5
Height (cm)	162.5 ± 6.7	162.5 ± 6.2	165.1 ± 5.9
Weight (kg)	71.4 ± 10.6	65.5 ± 15.2	72.4 ± 11.3
BMI (kg/m^2)	27.0 ± 5.2	25.1 ± 4.5	26.5 ± 7.3
Anesthesia (ESA/GA)	9/15	31/51	14/29
Anticoagulants (LMWH/R)	19/5	71/11	40/3

BMI, body mass index; ESA, epidural spinal anesthesia; GA, general anesthesia; LMWH, low molecular weight heparin; R, rivaroxaban.

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