Changes in the Weight Bearing Line After Total Ankle Arthroplasty for Osteoarthritis of the Ankle

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INTRODUCTION:

Total ankle arthroplasty (TAA) has become a standard surgery for treating end-stage ankle osteoarthritis and improved mobility compared to ankle arthrodesis[1]. However, achieving optimal postoperative outcomes requires precise alignment of the ankle joint. Severe preoperative varus alignment or residual varus alignment postoperatively has been suggested as a risk factor for postoperative failure of TAA [2, 3]. Residual malalignment after TAA has been suggested to increase the peak contact pressure at the bone-implant interface, leading to bone damage, implant loosening, or subsidence [4]. Good clinical outcomes have been reported even in cases of severe preoperative varus deformity when alignment is corrected, highlighting the critical importance of intraoperative alignment correction[5]. However, few studies have tracked the temporal changes in alignment postoperatively. While research has focused on the alignment of the ankle joint, studies on the alignment of the entire lower limb are lacking. Therefore, in this study, we evaluated the alignment of the entire lower limb after TAA and assessed the changes in the alignment over time. Additionally, we examined the factors contributing to changes in the alignment.

METHODS:

A total of 40 ankles from 36 patients who underwent TAA at our institution from December 2015 to August 2019 were included in this study. The ethical approval for this study was obtain from the institutional review board (IRB #B190002). The surgery was performed using the TNK ankle (Kyocera, Kyoto, Japan) through an anterior approach. Preoperative and postoperative imaging evaluations included full-length standing posteroanterior radiographs that includes the calcaneus (hip-to-calcaneus view: HC-view) taken at preoperative, 3 months postoperative, and at 1, 2, 3, 4, and 5 years postoperative. Exclusion criteria were as follows: absence of imaging evaluation at the postoperative assessment (n=5), cases with valgus deformity (n=3), and cases that underwent ipsilateral lower limb joint replacement surgery during the follow-up period. (n=1). Consequently, a total of 31 ankles from 28 patients were analyzed for this study. We investigated demographic data such as age, sex, and Body Mass Index (BMI), as well as the preoperative etiology and the presence or absence of revision surgery. The weight bearing line (WBL) passing point was evaluated using the HC-view according to the method reported by Haraguchi et al [6], as shown in Figure 1.

Statistical evaluation

Fisher's exact test, Student's t-test, and analysis of variance (ANOVA) were employed for statistical analysis, with a significance level set at 5%.

RESULTS:

The changes of the WBL after TAA is shown in Figure 2. Significant improvement in the WBL passing point was observed between the preoperative period and 3 months postoperatively ($p<0.01$); however, no significant changes were noted over time at the postoperative evaluation points. The etiology of TAA included 16 cases classified as Takakura-Tanaka stage 3b, 13 cases as stage 4, and 2 cases of rheumatoid arthritis (RA). The results of comparing the WBL passing point between the two groups, the stage 3b and the stage 4 (+ RA), are shown in Table 2 and figure 1. There were no significant differences in patient background between the two groups; however, the WBL passing point at 2, 3, and 4 years postoperatively was significantly more medial in the stage 3b group. All four cases that required revision were in the stage 3b group, but there was no significant difference.

DISCUSSION:

The most important finding of this study is that the WBL passing point is significantly corrected laterally after TAA. While there have been studies focusing on ankle joint alignment and component alignment, no studies have been reported changes in the WBL after TAA using full-length standing radiographs. Although there was no significant difference, it was suggested that the WBL may shift medially over time postoperatively. Furthermore, at 2, 3, and 4 years postoperatively, the WBL passing point in the stage 3b passed significantly more medially compared to the stage 4 (+ RA). In the stage 3b, four revision cases were observed, where the WBL continued to pass medially postoperatively, resulting in concentrated stress on the medial side of the implant and an increased likelihood of revision. If the WBL shifts medially over time postoperatively, additional treatments such as insoles or other orthotic devices may need to be considered.

SIGNIFICANCE / CLINICAL RELEVANCE:

Assessing the changes of the entire lower extremity alignment after TAA may help predict postoperative TAA failure.

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IMAGES AND TABLES:

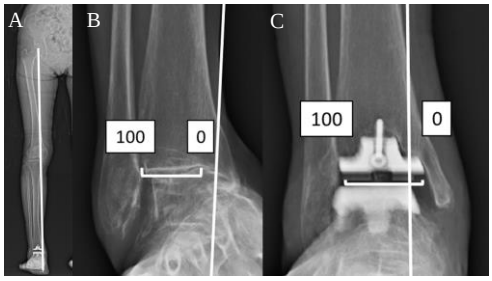

Figure 1: The method for evaluating the weight-bearing line (WBL) passing point. A line is drawn from the center of the femoral head to the lowest point of the calcaneus (A). The point where the WBL passes through the tibial plafond of the ankle joint is expressed as the ratio of the distance from the medial corner of the plafond to the passing point relative to the total length of the plafond. Preoperatively, the medial edge of the plafond was defined as 0% and the lateral edge as 100% (B). Postoperatively, the medial edge of the tibial component was defined as 0% and the lateral edge as 100% (C).

Table 1. Comparison of demographic data between Stage 3b and Stage 4 (+ RA).

	Stage 3b（n=16）	Stage 4+RA (n=15)	P value
Age	69.19±5.22	69.87±5.76	0.73
Sex (female, male)	12, 4	9, 6	0.46
BMI	22.45±2.82	22.9±2.84	0.68
revision	4	0	0.10

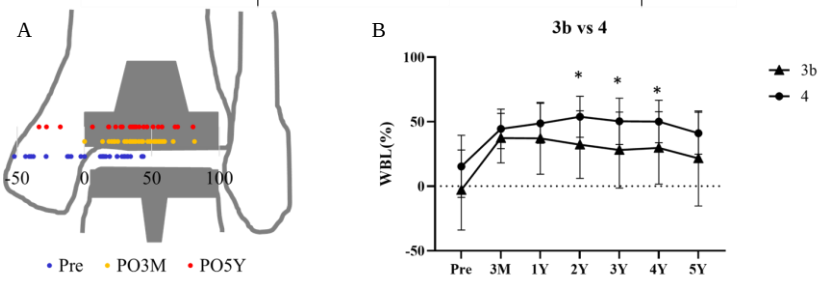

Figure 2: Changes in the WBL preoperatively, 3 months postoperatively, and 5 years postoperatively (A). Comparison of WBL between Stage 3b and Stage 4 (B). In Stage 3b, the WBL was significantly more medial at 2 years, 3 years, and 4 years postoperatively.