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Original Research

Ankle Arthrodesis: A Retrospective Analysis Comparing Single Column, Locked Anterior Plating to Crossed Lag Screw Technique

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A R T I C L E I N F O

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A B S T R A C T

Ankle arthrodesis is performed to eliminate pain due to end-stage osteoarthritis, regardless of etiology. This procedure remains the reference standard treatment for end-stage ankle arthritis, despite recent advancements in total ankle replacement. The objective of the present study was to retrospectively evaluate the radiographic and clinical fusion rates and time to bony fusion for patients who underwent ankle arthrodesis using an anterior approach with a single column locked plate construct versus crossed lag screws. We identified 358 patients who had undergone ankle arthrodesis from January 2003 to June 2013. Of the 358 patients, 83 (23.2%) met the inclusion criteria for the present study. Of the 83 included patients, 47 received locked anterior (or anterolateral) plate fixation, and 36 received crossed lag screw constructs. The overall nonunion rate was 6.0% (n = 5), with 1 nonunion in the anterior plate group (2.1%) and 4 nonunions in the crossed lag screw group (11.1%; $p = .217$). No differences were identified between the 2 groups for normal talocrural angle [$\chi^2(1) = 0.527$; $p = .468$], normal tibial axis/talar ratio [$\chi^2(1) = 0.004$; $p = .952$], and lateral dorsiflexion angle ($p = .565$). Based on our findings in similar demographic groups, ankle arthrodesis using locked anterior plate fixation is a safe technique with similar complication rates and radiographic outcomes to those of crossed lag screws.

Ankle arthrodesis is performed to eliminate pain due to end-stage osteoarthritis, regardless of etiology. This procedure remains the reference standard treatment for end-stage ankle arthritis, despite recent advancements in total ankle replacement. Ankle arthrodesis is also indicated for failed ankle arthroplasty and revision ankle arthrodesis (1–7). Ankle fusion involves the bony consolidation of the tibiotalar articulation and, in some instances, incorporation of the distal fibula into the construct (2,4–8). Several various fixation techniques and constructs have been historically described. Currently, the most common methods of fixation include internal screws, plate fixation, or a combination of the 2. Additionally, anatomic ankle fusion plates are available that are intended for various surgical approaches. The results of screw versus plate fixation and different types of plates in fusion have been limited in published studies thus far (3,5,7–10). Recently, a biomechanical comparison determined a superior bending stiffness with a locked plate and crossed screw construct compared with either a locked plate or crossed screw construct alone (11). The objective of the present study was to retrospectively evaluate the radiographic and clinical fusion rates and time to bony fusion for patients who underwent ankle arthrodesis using an anterior approach with a single column locked plate construct versus crossed lag screws.

Patients and Methods

After institutional review board approval, a retrospective medical record and radiographic review was performed of all operative patients within a single foot and ankle specialty practice (Orthopedic Foot and Ankle Center, Westerville, OH) from January 2003 to June 2013 who had undergone ankle arthrodesis. The patients were identified using the Current Procedural Terminology (American Medical Association, Chicago, IL) code 27870, ankle arthrodesis. The exclusion criteria were the presence of diabetes or Charcot neuroarthropathy, a lateral or transfibular approach for ankle arthrodesis, presentation for revision ankle arthrodesis, a lack of ≤3 months of follow-up data available, the presence of peripheral neuropathy, concomitant adjacent joint arthrodesis, fixation constructs other than anterior plating or crossed lag screws, and patient age <18 years. All patients identified for the anterior plate group also had ≥1 lag

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screw placed before application of the anterior locking plate. A radiographic review was performed to assess the time in days to union, determined by bony trabeculation about 3 cortices. Additionally, secondary fusion indicators, including the time in days to full weightbearing and time in days to wearing regular shoe gear were recorded. Radiographic measurements were performed at confirmed fusion, including the talocrural angle, tibial axis/talar ratio, and lateral dorsiflexion angle (Fig.) (12–14).

The demographic and clinical characteristics were recorded using the mean ± standard deviation for continuous variables and frequencies and percentages for categorical variables. To assess the differences between patients with plate fixation and patients with lag screws alone, the χ^2 and Fisher's exact test were used to compare categorical variables, and 2-sample *t* tests were used to compare normally distributed continuous variables. The follow-up duration, time to full weightbearing, and time to regular shoe wear between the 2 groups were compared using Wilcoxon rank sum tests. The time to fusion among patients with plate fixation and those with only lag screws were compared using the log-rank test. Statistical significance was defined at the 5% ($p \leq .05$) level.

Results

We identified 358 patients who had undergone ankle arthrodesis from January 2003 to June 2013. Of the 358 patients, 83 (23.2%) met the inclusion criteria for present study. Of the 83 included patients, 47 received locked anterior (or anterolateral) plate fixation, and 36 received crossed lag screw constructs. Of the 36 crossed lag screw constructs, various surgical approaches were used, including anterior (n = 14), mini-open (n = 8), arthroscopic (n = 7), medial (n = 6), and posterior (n = 1). Of the 36 crossed lag screw constructs, 18 patients had 2 screws (50%) and 18 patients had 3 screws (50%). The overall nonunion rate was 6.0% (n = 5), with 1 nonunion in the anterior plate group (2.1%) and 4 nonunions in the crossed lag screw group (11.1%; $p = .217$). Regarding the anterior plate group, hardware removal occurred in 10 patients (21.3%), including 6 screw removals (6 of 47 screws; 12.8%), 2 plate removals (2 of 47 plates; 4.3%) and complete removal of 2 plate and crossed screw constructs (2 of 47; 4.3%). A total plate removal rate of 8.5% (4 of 47) was identified. For the crossed screw group, hardware removal occurred in 25% of patients [9 of 36; χ^2 (1) = 4.20; $p = .041$]. Considering our included sample size for each group with regard to nonunion, we had only 40.8% power to detect a significant difference, with an α of 0.05, because our exclusionary criteria were stringent. A post hoc power analysis was performed assuming the same proportions and α level for nonunion (2.1% versus 11.1%), which concluded 119 patients would be required in each group to obtain 80% power.

When comparing the 2 groups, no statistically significant differences were identified in gender [χ^2 (1) = 0.756; $p = .385$], age at surgery ($t = 0.86$, df = 81; $p = .391$), body mass index ($t = -0.35$, df = 81; $p = .725$), tobacco use ($p = .318$), workers' compensation ($p > .999$), history of rheumatoid arthritis ($p > .999$), operative side [χ^2 (1) = 0.207; $p = .649$], biologic augmentation [χ^2 (1) = 1.396; $p = .238$], overall incidence of hardware removal [χ^2 (1) = 0.160; $p = .689$], infection ($p = .971$), need for revision ($p > .999$), or neurosensory disturbance ($p = .945$). Between the 2 groups, we found no statistically significant differences in the median interval to the follow-up examination (plate fixation, median 240.0 days, range 92.0 to 1087.0; lag screw, median 239.5 days, range 92.0 to 3534.0; $p = .989$), time to fusion [χ^2 (1) = 0.600; $p = .439$), median interval to full weightbearing (plate fixation, median 49.0 days, range 9.0 to 97.0; lag screw, median 48.0 days, range 8.0 to 97.0; $p = .606$) or interval to regular shoe wear (plate fixation, median 97.0 days, range 55.0 to 498.0; lag screw, median 101.0 days, range 62.0 to 238.0; $p = .097$; Table 1).

A postoperative radiographic review was performed for radiographic union and radiographic measurements at fusion, including the talocrural angle, tibial axis/talar ratio, and lateral dorsiflexion angle. No differences were identified between the 2 groups for the normal talocrural angle [χ^2 (1) = 0.527; $p = .468$], normal tibial axis/talar ratio [χ^2 (1) = 0.004; $p = .952$], and lateral dorsiflexion angle ($p = .565$; Table 2).

Discussion

The purpose of our study was to evaluate the fusion rate, time to bony union, radiographic alignment, and incidence of complications after ankle arthrodesis when comparing 2 different fixation constructs. Against the current body of published data, our cohort of single column anterior locked plate fixation represents one of the largest reported series. Anticipated concerns about this technique, such as an increased incidence of neurosensory disturbance or a more frequent requirement of hardware removal when using plate fixation, were simply unfounded compared with our crossed lag screw cohort. Also, the incidence of plate removal was significantly lower than the rate of hardware removal in the crossed lag screw group. Also, the radiographic position of the ankle fusion was similar between the 2 groups. Concern could be postulated for a tendency for anterior translation of the talus using plate fixation to

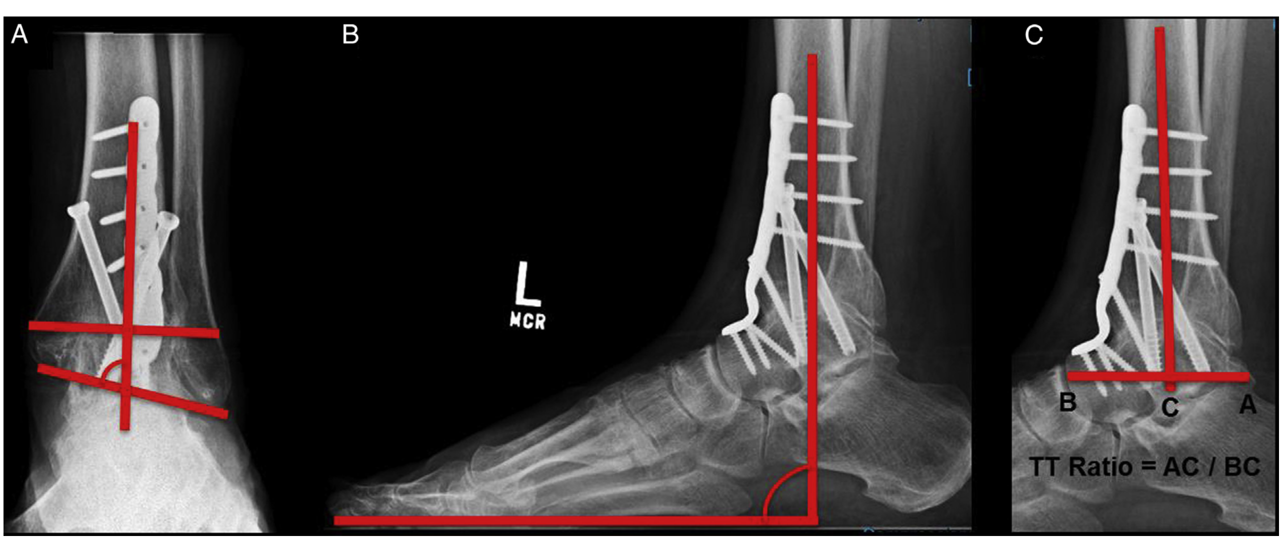

Fig.. Radiographic images demonstrating the measurements used to confirm fusion: (*A*) talocrural angle, (*B*) lateral dorsiflexion angle, and (*C*) tibial axis/talar ratio.