



Cost of Headless vs Headed Screw Fixation for Calcaneal Osteotomy and Subtalar Arthrodesis

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Abstract

Background: Screw head prominence in the heel following fixation for calcaneal osteotomy or subtalar arthrodesis has resulted in high rates of symptomatic hardware and screw removal. A cost analysis was performed to determine the financial implications of screw removal. Furthermore, we compared the rate of nonunion following fixation.

Methods: *Current Procedural Terminology* codes were used to identify all patients who had a subtalar arthrodesis or calcaneal osteotomy (with screw fixation) performed between 2010 and 2016. The cohort was divided into 2 groups: 7.0-mm headless screw or 6.7-mm headed screw. The primary outcome measure was the rate of symptomatic screw removal. Secondary outcomes included the rate of nonunion. The expense associated with symptomatic hardware removal was determined by cost analysis.

Results: Seventy-six patients underwent headless screw fixation, and 2 patients (2.6%) required screw removal. Fifty-four patients underwent headed screw fixation and 12 patients (22.2%) required screw removal. Symptomatic hardware removal was performed more frequently in the headed screw group ($P < .001$). There was no difference in the rate of nonunion after subtalar arthrodesis between the 2 groups ($P = .363$). The calcaneal osteotomy united in 100% of patients. There was a \$51 755 cost savings per 100 cases using headless screw fixation.

Conclusion: The rate of symptomatic screw removal was lower with headless screw fixation. The calcaneal osteotomy healed in 100% of patients, and there was no difference in the rate of subtalar nonunion between the 2 groups. Cost analysis demonstrated a significant benefit when the expense of hardware removal was considered.

Level of Evidence: Level III, retrospective cohort study.

Keywords: cost analysis, hardware removal, calcaneal osteotomy, subtalar arthrodesis, nonunion

Introduction

Calcaneal osteotomy and subtalar arthrodesis are common procedures used to treat a variety of hindfoot disorders. Historically, screw prominence in the heel following calcaneal displacement osteotomy and subtalar arthrodesis has led to high rates of symptomatic hardware and subsequent screw removal. The hardware removal rate following calcaneal screw fixation ranges from 11% to 50%.¹⁻⁵ Hardware removal is not without economic impact, increased hospital costs, and risk to the patient for undergoing a subsequent procedure. Lucas et al¹⁰ performed a cost analysis comparing lateral plate fixation vs traditional screw fixation following displacement calcaneal osteotomy. The average cost of screw removal following calcaneal displacement osteotomy was \$10 937.02. There were significant cost savings with the

use of lateral plate fixation following displacement calcaneal osteotomy, secondary to the lower rate of symptomatic hardware removal.¹⁰ To the authors' knowledge, there have not been any reported cost analysis comparing headed screw fixation vs headless screw fixation in calcaneal osteotomies or subtalar arthrodeses in the foot and ankle literature.

Regardless of the fixation method used, high rates of union are reported after calcaneal osteotomy. However,

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nonunion following subtalar arthrodesis occurs more frequently and is reported to vary between 16% and 23%.^{2,6,7} Several risk factors have been identified for nonunion, including smoking, diabetes, worker's compensation, and operative technique.^{6,7} We hypothesized that the higher cost associated with headless screw fixation in the calcaneus could be justified by a significantly lower rate of hardware removal compared with headed screws. We believed a cost analysis would justify the routine use of headless screw fixation for displacement calcaneal osteotomy and subtalar arthrodesis. Secondly, we compared the rate of nonunion following subtalar arthrodesis between the 2 groups. We expected the rate of subtalar nonunion to be similar regardless of the type of screw fixation.

Methods

Current Procedural Terminology (CPT) codes were used to identify all patients who had a subtalar arthrodesis or displacement calcaneal osteotomy (with screw fixation) performed by a single orthopedic foot and ankle surgeon between 2010 and 2016. The cohort was divided into 2 groups by the type of screw fixation: 7.0-mm headless screw (Arthrex, Naples, FL) or 6.7-mm headed screw (Arthrex). Exclusion criteria included <2 years from the index surgery and avascular necrosis of the calcaneus or talus. Retrospective chart review was performed to collect demographic data, complications, and reason for screw removal. The primary outcome measure was the rate of symptomatic screw removal. The hardware was considered to be symptomatic if the patient had pain directly over the screw head site and it interfered with activities of daily living (Figure 1). No screws that were removed because of infection or staged total ankle arthroplasty were included. The secondary outcome measure was the union rate of subtalar arthrodesis as determined by computed tomography (CT) or radiographic review. Successful arthrodesis was defined as >50% fusion mass of the posterior calcaneal facet as determined on 3-mm-cut CT. Radiographic arthrodesis was defined as complete bridging callus or trabeculation across the subtalar joint (Figure 2). All radiographic and CT images were reviewed by the senior author (A.M.V.) and junior author (B.M.S.). The expense associated with symptomatic hardware removal was determined and cost analysis was performed for the 2 groups.

Results

Seventy-six patients underwent headless screw fixation: 32 for subtalar arthrodesis and 44 for calcaneal osteotomy. Two of these patients (2.6%) required screw removal. Fifty-four patients underwent headed calcaneal screw fixation: 22 for subtalar arthrodesis and 32 for calcaneal osteotomy. Twelve of these patients (22.2%) required symptomatic screw removal. Symptomatic hardware removal was performed more frequently in the headed screw group ($P < .001$). There



Figure 1. Lateral Radiograph of a patient with symptomatic hardware after headed screw fixation.



Figure 2. Lateral radiograph demonstrating complete bridging callus across the subtalar joint consistent with union.

Table 1. Actual Costs Associated With Screw Removal Compared Between Private Insurance and Medicare.

	Private Insurance		Medicare	
	Billed	Paid	Billed	Paid
Surgeon fee	\$2589.02	\$551.16	\$2466	\$468.03
Surgery facility	\$8285.00	\$8284.81	\$15 320	\$1950
Anesthesia	\$900	\$270	\$900	\$160
Radiographs	\$99	\$99	\$99	\$99
Total	\$11 873.02	\$9204.97	\$18 785.00	\$2677.03

was no difference in the rate of nonunion after subtalar arthrodesis between the 2 groups ($P = .363$). The calcaneal osteotomy healed in 100% of patients in both groups. The actual costs associated with isolated screw removal for private insurance and Medicare at an outpatient surgery center was \$9204.97 and \$2677.03, respectively (Table 1). The average cost for screw removal for private insurance and Medicare is \$5941. For the purposes of cost analysis, the average price for screw removal was multiplied by the rate of screw removal and added to the cost per implant for 100 cases (Table 2). There was a \$51 755 cost saving per 100 cases using headless screw fixation compared with headed screw fixation.

Table 2. Cost Analysis Per 100 Cases Using the Average Actual Cost Between Private Insurance and Medicare.

No. of Cases	Implant Costs	Implant Costs per 100 cases	Symptomatic Rate	# of Revision Cases	Removal Costs per Case	Total Removal Costs	Total
100	993	\$99 300	2.60%	2.6	\$5941	\$15 447	\$114 747
100	358	\$35 800	22%	22	\$5941	\$130 702	\$166 502

Discussion

It is well demonstrated in the literature that symptomatic hardware is a common complication after calcaneal screw fixation. A variety of fixation methods have been evaluated in an attempt to decrease cost associated with implant removal. Lucas et al¹⁰ demonstrated that lateral locked compression plating was more economical given the high cost associated with screw removal even though the initial implant is more expensive.⁵ Abbasian et al¹ compared 3 methods of fixation, headed screws, headless screws, and lateral locked compression plates. They found a removal rate of 47%, 11%, and 6%, respectively, which is consistent with the literature.⁸ The traditional method of headed screws necessitates screw removal in 11% to 50% of cases.¹⁻⁵ The screw removal rate in our headed screw group was 22.2% (12/54), which is consistent with the recent literature. The screw removal rate in our headless group was 2.6% (2/76), which is significantly lower.

Cost analysis was performed for associated screw removal for private insurance and Medicare at an outpatient surgery center. The list cost of the headless screw was 2.8 times more expensive than the headed screw (\$993.00 vs \$358.00). The actual cost associated with isolated screw removal for private insurance and Medicare at an outpatient surgery center was \$9204.97 and \$2677.03, respectively. This accounts for surgeon, facility, anesthesia, and radiology fees (Table 1). Assuming a 50:50 distribution of Medicare to privately insured patients, the aggregate cost of screw removal is estimated to be 8.5 times greater with the use of headed screw fixation, with a \$51 755 cost savings per 100 cases using headless screw fixation (Table 2). Overall, there were substantial savings with headless screw design. The initial cost for a headless screw is significantly higher compared to a headed screw however the cost associated with removal and increased removal rates make the headless screw a more economical choice.

Secondarily, there was no difference in the rate of nonunion after subtalar arthrodesis with either headed or headless screws. Previously, subtalar arthrodesis had a reported union rate of nearly 100%.^{9,10} Recently, evidence has linked several risk factors that contribute to nonunion. Easley et al⁵ evaluated union rates in 184 subtalar arthrodesis procedures performed in 174 patients and factors that may be associated with nonunion. They reported a 16% nonunion rate with significantly diminished rates in patients who were smokers, had evidence of

avascular necrosis, or a previous failed subtalar arthrodesis. There was no correlation between nonunion and the number of screws used.²

There are a limited number of studies evaluating nonunion rates based on different implant types.^{2,3} Haskell et al evaluated 101 subtalar arthrodesis procedures performed with a single 7.0-mm cannulated lag screw and had a reported union rate of 98% suggesting that, as long as there is adequate compression and rigidity across the subtalar joint, additional screws are unlikely to augment fixation.⁶ DeCarbo et al³ compared fusion rates in 113 patients who underwent subtalar arthrodesis with either single or double screw fixation. They found no significant difference in fusion rates between the 2 groups.¹¹ The senior surgeon prefers to have at least 2 screw fixations to prevent derotation of the arthrodesis. We did not find a statistical difference in the nonunion rate between the headed and headless screw groups suggesting screw type may not be a factor related to nonunion as long as adequate compression across the subtalar joint is achieved.

This study has several limitations. The patients were not randomized between headed or headless screw fixation groups prior to the study, and selection bias may have played a role as to which implant was selected, based on other patient factors or variables unknown to the authors at the time. The secondary assessment of subtalar nonunion is underpowered; however, our results did not demonstrate a statistical difference between nonunion rate. We propose that implant type does not affect the rate of nonunion as much as previously identified patient factors; however, additional studies are necessary.

Conclusion

The rate of symptomatic screw removal following calcaneal osteotomy or subtalar arthrodesis was lower with headless screw fixation compared to headed screw fixation. Although the headless screw implant was more expensive, cost analysis demonstrated a significant benefit when the expense of hardware removal was considered. Headless screw fixation was a more economical choice for calcaneal osteotomy or subtalar arthrodesis. As a secondary outcome, there was no significant difference in nonunion rates between headed and headless screws.

Ethical Approval

Ethical approval was not sought for the present study because it involved the use of existing data and no items of information would enable identification of any subject.



Declaration of Conflicting Interests

The authors report grants from Arthrex, during the conduct of the study. In addition, Anand Vora, MD, has a patent Headless Screw with royalties paid. ICMJE forms for all authors are available online.

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