

Cost analysis of ankle syndesmosis internal fixation



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ABSTRACT

Background: Unstable ankle syndesmosis injuries are common, and the optimal surgical fixation is controversial. The two main options for stabilization of syndesmosis injuries are suture button fixation and screw fixation. Suture button fixation has a higher initial cost, but may have a lower hardware removal rate. The purpose of this study was to compare the costs of syndesmosis fixation.

Methods: A cost analysis was performed at a single university-affiliated hospital. Variables included the number of suture buttons, the number and type of syndesmosis screws used, and the frequency of hardware removal and operative time required for hardware removal. There were four clinical scenarios evaluated: (A) one suture button versus one cortical screw; (B) two suture buttons versus two cortical screws; (C) one suture button versus one locking screw; (D) two suture buttons versus two locking screws. Suture button removal rate was assumed to be 0% in the analysis.

Results: Cost equivalence was achieved at an 18 to 53% syndesmosis screw removal rate depending on the fixation construct used and the amount of time required for hardware removal. When the syndesmosis screws were removed 100% of the time, suture button fixation was more economical by \$85,000–\$194,656 per 100 ankles. When hardware was never removed, suture button fixation was more expensive by \$169,844–\$295,500 per 100 ankles.

Conclusion: This study demonstrates that the costs associated with syndesmosis fixation are more dependent on the rate of hardware removal than the type of hardware utilized. Routine removal of syndesmosis screws is clearly less economical than suture button fixation.

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1. Introduction

Ankle fractures represent a common injury treated by nearly all orthopaedic surgeons, regardless of subspecialty. Outcomes after operatively treated ankle fractures generally have excellent results. Approximately 90% of patients have minimal to no pain or functional limitation at one year.¹ Although less than 1 in 4 ankle fractures require syndesmosis fixation, these injuries have worse outcomes compared to ankle fractures requiring only malleolar fixation.² Furthermore, syndesmosis malreduction has been correlated with worse functional outcomes.³

Controversy currently exists regarding the optimal fixation method once a syndesmosis injury has been identified. The two main methods for fixation include suture button fixation or rigid screw fixation.⁴ Furthermore, there are a wide variety of constructs for rigid screw fixation, although data indicates that 3 versus 4

cortices of fixation show equivalent outcomes.⁵ Additional surgeon-specific preferences include leaving syndesmosis screws in place, while others routinely remove all syndesmosis screws.^{5–8} Proponents for both fixation methods commonly debate fixation method cost, although little literature exists to substantiate cost arguments. Previous cost analyses estimate a cost associated with routine syndesmosis screw removal, but did not calculate a rate of syndesmosis fixation removal to yield cost equivalence.^{9,10} Studies have cited a lower incidence of syndesmosis malreduction with the use of an endobutton, and consequently the potential for a lower rate of return to the OR.¹¹

The purpose of this study was to perform a cost analysis to determine at what point the increased cost of suture button fixation is outweighed by the cost of a return trip to the operating room for removal of hardware. Our hypothesis was that there was a point at which endobutton fixation would become more economical than traditional syndesmosis screw fixation. Secondary assessments included a variety of treatment algorithms to determine whether suture button fixation was more or less cost effective in each of those settings.

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2. Methods

A cost analysis was performed using actual operating room costs at a single university-affiliated hospital. Assumptions were made as to the costs of each surgery. Fixed and variable costs were identified. Actual costs were obtained from the hospital billing department. Multiple scenarios were defined to compare costs. These included varying the number of implants, as well as the frequency with which the implants required removal. Descriptive statistics were then used to calculate cost equivalence between the various scenarios.

Study assumptions are listed in [Table A1](#). These include the following: operative time for syndesmosis screw fixation was equal to that for suture button fixation; all other hardware constructs remained the same; the number of suture buttons needed for fixation would be the same as the number of syndesmosis screws needed for fixation; infection rates were equal between the two groups; operative time for removal of hardware would be 30 min; surgeon and anesthesia charge would be equal regardless of whether suture button or syndesmosis screws were used; and the removal of hardware was performed under local anesthesia and consequently did not require an anesthesia charge.

The following were assumed to be fixed costs regardless of type of fixation used: operating room time, anesthesia charges, fluoroscopy charges, and surgeon charge. Operating room time was charged at \$32.00 per minute. Anesthesia use was charged at \$475.00 per 30 min and \$675.00 per 60 min. Fluoroscopy charge was \$108 for any utilization less than one hour. Actual surgeon charge at our institution for removal of hardware was \$2,102.00, which is billed at four times the current Medicare rate. Variable charges included the following: the number of suture buttons or syndesmosis screws used, which was either one or two for each fixation method; and the frequency of removal of hardware, which varied between never and 100% of the time. Screw fixation cost was calculated using the following cost: \$26.72 per 3.5 mm cortical screw, and \$150.00 per 3.5 mm locking screw. The cost of each suture button was \$1,000.00.

The four clinical scenarios evaluated were: (A) one suture button versus one cortical screw; (B) two suture buttons versus two cortical screws; (C) one suture button versus one locking screw; (D) two suture buttons versus two locking screws. All scenarios were evaluated for a total operative time of 30 and 60 min required for the removal or implantation of hardware.

The first question (at what point is the increased cost of suture button fixation outweighed by the cost of a return trip to the operating room for removal of hardware) was answered by calculating the number of times per 100 ankles that syndesmosis screws would need to be removed in order to make the cost equal between the two groups. The second question (cost effectiveness for suture button fixation) evaluated the extreme scenarios of no screw hardware removal compared to screw hardware removal 100% of the time. Suture button removal rate was assumed to be 0% in all scenarios.

No Institutional Review Board approval was required for this study. All data was collected using Excel (Microsoft Corporation, Redmond, Washington), which was also used for descriptive statistics.

3. Results

For a hardware removal time of 30 min, results are listed in [Table A2](#). In Scenario A30: 1 suture button vs. 1 cortical screw, the number of syndesmosis screw removals per 100 ankles required to make the cost between suture button fixation and syndesmosis screw fixation equal was 27 cases (27%). In Scenario B30: 2 suture buttons vs. 2 cortical screws, 53 cases per 100 ankles (53%) would

need syndesmosis screw removal; for Scenario C30: 1 suture button vs. 1 locking screws, 23 cases per 100 ankles (23%) would need syndesmosis screw removal; and for Scenario D30: 2 suture buttons vs. 2 locking screws, 47 cases per 100 ankles (47%) would need syndesmosis screw removal in order to make the costs equivalent. When syndesmosis screws are assumed to be removed 100% of the time, suture button fixation was more economical by the following amounts per 100 operative ankles: \$267,172.00 for Scenario A30; \$169,844.00 for Scenario B30; \$279,500.00 for Scenario C30; and \$194,500.00 for Scenario D30.

For a hardware removal time of 60 min, results are listed in [Table A3](#) and [Fig. A1](#). For Scenario A60: 1 suture button vs. 1 cortical screw, the number of syndesmosis screw removals per 100 operative ankles to make costs equal between suture button fixation and syndesmosis screw fixation was 20 cases (20%). For Scenario B60: 2 suture buttons vs. 2 cortical screws, 41 cases per 100 ankles (41%) would need syndesmosis screw removal; for Scenario C60: 1 suture button vs. 1 locking screws, 18 cases per 100 ankles (18%) would need syndesmosis screw removal; and for Scenario D60: 2 suture buttons vs. 2 locking screws, 35 cases per 100 ankles (35%) would need syndesmosis screw removal. When the syndesmosis screws are assumed to be removed 100% of the time, suture button fixation was more economical by the following amounts per 100 ankles: \$383,172.00 for Scenario A60; \$285,844.00 for Scenario B60; \$395,500.00 for Scenario C60; and \$310,500.00 for Scenario D60.

When the syndesmosis screw fixation is never removed, suture button fixation was more expensive by the following amounts per 100 ankles regardless of anesthesia cost and operating room time as listed in [Tables A2 and A3](#): \$97328.00 for Scenarios A; \$194656.00 for Scenarios B; \$85000.00 for Scenarios C; and \$170000.00 for Scenarios D.

4. Discussion

The results of this study reveal a low percentage of syndesmosis screw removal required to create cost equivalence between syndesmosis screw and endobutton fixation of syndesmotom injuries. As expected, this percentage increases substantially with doubling the fixation points, decreases slightly with usage of more expensive rigid fixation constructions, and decreases with longer operative times for removal. This crossover point can be calculated for an individual institution, confirming our hypothesis that the increased implant costs associated with endobutton fixation may be balanced out by a decreased rate of repeat operation for removal of hardware when rigid screw fixation is used.

The greatest limitation of this study is that the data may not be generalizable to other institutions, where costs may be slightly different. We have provided the costs at our institution in order to provide comparability to other institutions. Future studies should assess actual implant usage, actual costs per surgery, and the rate of implant removal in each cohort in order to directly compare the costs at our institution. Our study is limited by the assumptions we made for the calculations. The operating time required for suture button placement may be not be equivalent to screw placement, which would alter the costs. There are data to suggest that the hardware removal rate of syndesmotom suture button is not zero.¹¹ In our experience, no syndesmotom suture buttons have required removal; hence we assumed a 0% suture button removal rate for ease of comparison. An extremely low removal rate of suture button is upheld in the literature.^{12,19} If one were to expect a certain rate of suture button removal requirement, this would simply raise the allowable rate of screw fixation removal by an equivalent percentage (assuming equal operative time for hardware removal of either implant, and therefore equal cost of hardware removal for each). It is possible that the operative time required for suture

Table A1
Study Assumptions.

1. Equivalent patient demographics and fracture patterns
2. Otherwise identical fixation constructs for ankle fixation prior to syndesmotic fixation
3. Equal number of syndesmotic fixation points (one screw equals one suture button)
4. Equal operative time for syndesmotic fixation with screw or suture button
5. Equivalent intraoperative care costs (anesthesia cost, surgeon cost)
6. Equivalent preoperative and postoperative care costs (e.g. immobilization, rehabilitation)
7. Equivalent complication rates (e.g. infection, arthritis, neuropraxia)
8. Suture button fixation removal rate of 0%

Study Assumptions. This table explains the eight study assumptions that underlie the cost-benefit calculations.

Table A2
Scenario analysis with operative time ≤ 30 min.

		Cost difference per 100 cases with:	
Scenario	Need to Equal ^a	All Syndesmosis Screws removed	No Syndesmosis Screws Removed
A ₃₀ : 1 suture button vs. 1 cortical screw	27	–\$267172.00	\$97328.00
B ₃₀ : 2 suture buttons vs. 2 cortical screws	53	–\$169844.00	\$194656.00
C ₃₀ : 1 suture button vs. 1 locking screws	23	–\$279500.00	\$85000.00
D ₃₀ : 2 suture buttons vs. 2 locking screws	47	–\$194500.00	\$170000.00

Scenario analysis with operative time ≤ 30 min. This table shows (1) the cost benefit associated with the use of suture buttons for syndesmotic fixation when compared to 100 cases where all syndesmosis screws are removed, (2) the excess cost associated with the use of suture buttons for syndesmotic fixation when compared to 100 cases where no syndesmosis screws are removed, and (3) the number of syndesmosis screws that need to be removed in a series of 100 cases for the use of suture buttons for syndesmotic fixation to equal the cost of syndesmosis screws used for syndesmotic fixation.

(–) favors suture button placement.

^a The number of syndesmosis screws needed to be removed to equal the cost of suture button fixation.

Table A3
Scenario analysis with operative time ≤ 60 min.

		Cost difference per 100 cases with:	
Scenario	Need to Equal ^a	All Syndesmosis Screws removed	No Syndesmosis Screws Removed
A ₆₀ : 1 suture button vs. 1 cortical screw	20	–\$383172.00	\$97328.00
B ₆₀ : 2 suture buttons vs. 2 cortical screws	41	–\$285844.00	\$194656.00
C ₆₀ : 1 suture button vs. 1 locking screws	18	–\$395500.00	\$85000.00
D ₆₀ : 2 suture buttons vs. 2 locking screws	35	–\$310500.00	\$170000.00

Scenario analysis with operative time ≤ 60 min. This table shows (1) the cost benefit associated with the use of suture buttons for syndesmotic fixation when compared to 100 cases where all syndesmosis screws are removed, (2) the excess cost associated with the use of suture buttons for syndesmotic fixation when compared to 100 cases where no syndesmosis screws are removed, and (3) the number of syndesmosis screws that need to be removed in a series of 100 cases for the use of suture buttons for syndesmotic fixation to equal the cost of syndesmosis screws used for syndesmotic fixation.

(–) favors suture button placement.

^a The number of syndesmosis screws needed to be removed to equal the cost of suture button fixation.

button removal may differ from the time required for screw removal, but any difference in time is likely to be negligible. Another assumption is in equivalent preoperative and postoperative care for screw and suture button fixation. In our experience, the driving force behind immobilization time and need for physical therapy is the type of injury and patient characteristics, not the specific syndesmotic fixation utilized. The economics of time off from work and quality of life degradation by weight-bearing restrictions was not included in this study. We also assume equal complication rates for the two fixation methods. Some data show decreased complication rates with suture button fixation of the syndesmosis, but most show equivalent rates.^{4,12,13}

Presently there are only three previous cost analysis examining suture button fixation versus syndesmotic screw fixation. One study, the authors utilized cost data from their institution in Queensland, Australia. They determined a universal same-day admission cost of \$1190.50, which covered the cost of operating room time, pre-and postoperative care, as well as anesthesia and surgeon care. This price was independent of operative time. The only other costs were for the implants used for each procedure.

Rigid syndesmotic fixation was obtained with a single 4.5 cortical screw of 50–65 mm length at a cost of \$50.00. Suture button fixation was obtained with Arthrex Tightrope[®] Plus, at a cost of \$589.00. With the total operative cost calculated as \$2431.00 for rigid fixation (assuming 100% reoperation for removal) and a cost of \$1779.50 for suture button fixation (assuming 0% reoperation), the authors calculated a potential savings of \$651.50 per patient treated with suture button fixation. The studied hospital center performed 33 cases of syndesmotic screw removal over a one-year period, allowing the authors to estimate a potential \$21499.50 annual savings with usage of suture button fixation in place of rigid fixation. Another study retrospectively reviewed the cost of syndesmotic screw removal.¹⁰ The authors identified 56 patients over 6 years treated with rigid syndesmotic fixation that was subsequently removed within 6 months of fixation. Average operative cost for removal was \$3579. A cost-effectiveness comparison of suture button fixation versus syndesmotic screw fixation in unstable supination external rotation IV ankle fractures found that syndesmotic screw fixation was more cost-effective only if syndesmotic screw removal was less than 10% or when the

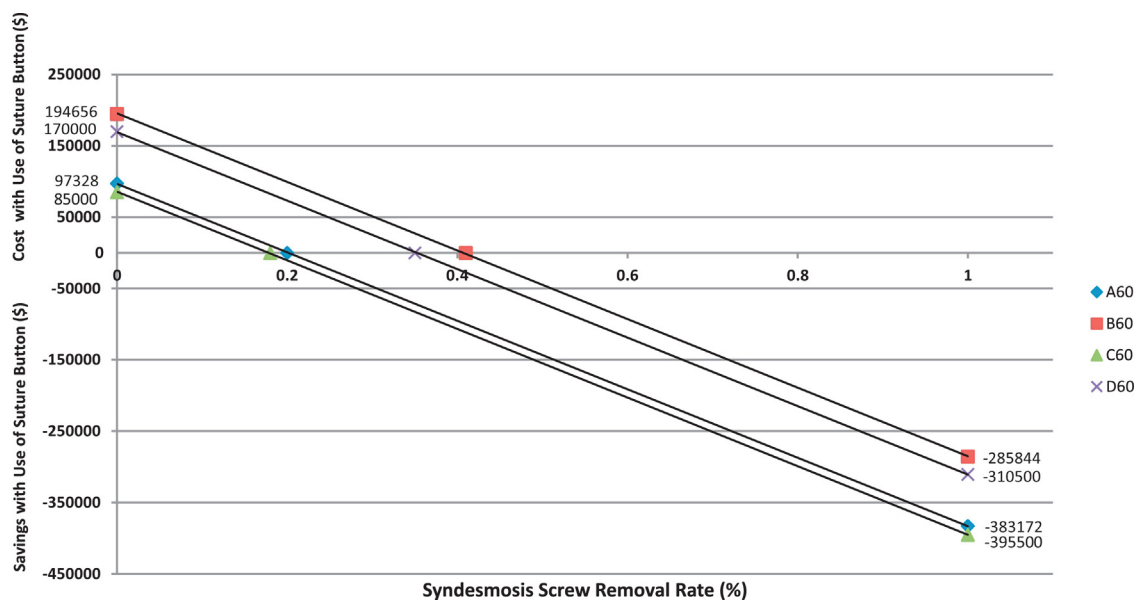


Fig. A1. Graphical representation of cost comparison between each scenario. This is for the scenario <60 min. Note the point at which the lines cross “0” represent the point of cost equivalence.

suture button costs exceeded \$2000.¹⁸ Our study confirms what is reported in these prior studies: removal of syndesmotic screws results in a cost burden to the patient and medical system.

Syndesmotic fixation method remains a controversial topic. The preferred fixation method remains variable between clinicians. Even within rigid fixation, physicians have differing opinions on hardware removal rates and indications.⁷ Some surgeons recommend routine screw removal before weight-bearing to prevent screw breakage. However, data exist to show no clinical outcome difference with rigid fixation maintenance instead of removal.^{6,8} Other data show that the rate of suture button fixation removal is as high as 10%,¹¹ although this is not consistently reproduced.¹² Suture buttons are typically only removed due to implant irritation or concern for infection. A review of several studies showed the average rate of removal for suture buttons was only 3.7% compared to 40.2% for screw removal among surgeons who do not routinely remove screws.¹⁹

Neither rigid screw fixation nor syndesmotic fixation perfectly reproduces the biomechanics of the injured syndesmosis.^{2,14–16} However, in comparing suture button techniques to rigid fixation, biomechanical studies of suture button fixation have proven to be non-inferior to rigid fixation.^{14–17} In some clinical studies, suture button fixation has shown no difference in long term outcomes compared to rigid fixation.^{11,12} Indeed, some evidence suggests improved early outcome scores and faster returns to work with suture button fixation.^{4,12,13}

5. Conclusion

This study demonstrates that the costs associated with syndesmosis fixation are more dependent on the rate of hardware removal than the type of hardware utilized. Routine removal of syndesmosis screws is clearly less economical than suture button fixation.

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Conflict of interest

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Appendix A.

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