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Mobilization after Fixation with Endobutton Device versus Transfixation Screw for Syndesmotic Disruption

Henry Kuechly*, Sarah Kurkowski, John Bonamer, Brian Johnson, Richard Smith, Nihar Shah, Augusto Roca, Jacob Meyer, Richard Laughlin

Department of Orthopedic Surgery and Sports Medicine, University of Cincinnati, Cincinnati, OH, USA

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***Correspondence:**
*Mr. Henry Kuechly, Department of Orthopedic Surgery and Sports Medicine, University of Cincinnati, Cincinnati, OH, USA; Email: kuechlhy@mail.uc.edu

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Abstract

Background: Fitness trackers have been used to measure postoperative mobility following arthroplasty procedures, but there is no published research using fitness tracker data to compare mobilization following screw fixation versus dynamic fixation for syndesmotic ankle injuries. The objective of this study was to measure steps and activity levels following syndesmotic fixation with either endobutton fixation or screw fixation using a wearable fitness tracker.

Methods: Patients that underwent operative management of ankle fractures with syndesmotic disruption using either a transfixation screw or endobutton were provided a Fitbit Inspire to electronically track their steps and activity level.

Results: Patients treated with endobutton fixation device had statistically significantly more mean daily steps and more mean daily very active minutes than patients treated with screw fixation at the 3, 4, 5, and 6-month time points and 4, 5, and 6 month time points respectively ($p<0.05$).

Conclusion: Patients with ankle fractures treated with endobutton device for syndesmotic fixation have earlier and higher levels of mobilization during the first 6 postoperative months than those treated with transfixation screw as measured by a fitness tracker. Fitness trackers are increasing in popularity and the data gathered from these devices contains significant potential for creating patient specific rehabilitation guidelines that may ultimately improve patient functional outcomes postoperatively.

Introduction

Ankle fractures are the most common type of lower extremity fractures, and distal tibiofibular syndesmotic instability is estimated to occur in up to 5%-23% of ankle fractures[1-4]. The distal tibiofibular syndesmosis is composed of 4 ligamentous structures: the anterior tibiofibular ligament, the posterior tibiofibular ligament, the transverse ligament, and the interosseous membrane. Together, the stability provided by these 4 structures is vital for mobility and proper maintenance of the ankle mortise. Full ankle dorsiflexion and eversion places maximal tension on the syndesmosis and therefore leads to a high risk of syndesmotic injury[5]. This mechanism of injury is also commonly associated with both Weber type B and C fractures[6-8]. If left untreated, these injuries can lead to chronic instability, pain, and subsequent osteoarthritis. Because of these complications, surgical fixation is considered the gold standard treatment option. Surgical fixation stabilizes the syndesmosis and promotes optimal recovery by placing the damaged ligaments in their native anatomic positions[8].

Although there is clear consensus that surgical management is best, there is no consensus regarding which fixation technique, screw fixation or dynamic fixation using a suture button construct, is optimal. Previously published literature has compared these two fixation methods using metrics such as patient reported outcomes, postoperative complications, and financial cost of use, but there are no published manuscripts comparing objective mobility measures following these two fixation techniques.

Recent advancements in Global Positioning Systems (GPS) and the incorporation of gyroscopes and accelerometers into both smartphones and wearable fitness trackers has presented a potentially powerful tool for the assessment of patient functional status following surgery. Previous studies in the Arthroplasty literature have explored the use of fitness trackers to quantify daily step count after both knee and hip arthroplasty, but there have been no reports using this technology to compare dynamic vs screw fixation for syndesmotic injuries[9-11].

In this study, we compare postoperative mobilization using wearable fitness trackers in patients who underwent either suture button fixation or screw fixation for the management of their syndesmotic ankle injuries. Through the assessment of postoperative mobilization using a wearable fitness tracker, this study aims to provide a better understanding of screw fixation versus dynamic fixation. Additionally, this study serves as a model for the utility of fitness trackers for documenting objective functional outcomes which can be used to tailor recovery and rehabilitation protocols, ultimately improving patient outcomes.

Materials and Methods

In this observational prospective study performed at an urban level 1 trauma center, patients aged 18 and older that underwent operative management of ankle fractures with concomitant syndesmotic disruption using either a transfixation screw or endobutton device between the years 2019 and 2022 were enrolled at their two-week postoperative visit. Patients were excluded if they had an additional lower extremity injury that influenced or altered their weightbearing status, if they were non-ambulatory prior to surgery, or sustained a pilon variant type injury. Syndesmosis instability was identified with intraoperative stress fluoroscopic radiographs. External rotation, coronal, sagittal, and axial stress views were obtained. Instability identified on any one of these views was an indication for syndesmotic fixation. The choice between transfixation screw or dynamic fixation using an endobutton device was determined based on surgeon preference. Adequate surgical reduction was assessed via intra-operative comparison of a true lateral X-ray of the injured ankle to the contralateral, uninjured ankle. At the 2-week postoperative visit, eligible patients were provided a Fitbit watch (Fitbit Inspire) to electronically track their steps and activity level. The watch was connected to an application on the patient's smartphone and an online account was created that corresponded to each individual patient. Data was downloaded monthly from each online account for up to one year after surgery. General demographic data was collected retrospectively via electronic medical records.

Patients with insufficient data, due to noncompliance with wearing the Fitbit watch, were excluded from the mobilization data analysis. For the purposes of this study, noncompliance was defined as wearing the Fitbit less than 7 days per month. Moreover, mobilization was defined as the action of the patient moving about their environment while full weight bearing. Days when zero steps were recorded were excluded from data analysis. The patients were divided into two groups based on technique of syndesmotic fixation: transfixation screw versus dynamic fixation using endobutton device. To control for the potential confounding variable of decreased pain sensation secondary to neuropathy in diabetic patients, non-diabetic patient outcomes were compared between treatment groups. In addition, patients ≤ 40 years old theoretically are more active than patients > 40 years old. To control for the effect of age on mobilization ability, outcomes of patients > 40 years old were compared between treatment groups.

Due to a small sample size of study participants, data regarding age, sex, and BMI was gathered from an Institutional Review Board (IRB) approved prospective database of ankle fractures at our institution in patients between 18-65 years old. Our study group demographics were compared to this prospective database of ankle fractures to ensure that our study group was comparable to a large population of ankle fractures at our institution.

Postoperative Protocol and Rehabilitation

Postoperatively, patients were instructed to be non-weight bearing for 2 weeks. Patients were then instructed to begin progressive protected weightbearing as tolerated.

Statistical Analysis

The mean daily steps and mean daily very active minutes (defined by Fitbit as vigorous intensity activity that burns six times as many calories as patient does at rest) for each patient group were calculated and compared against one another using two-sample independent t-tests to determine if there were statistically significant differences. Patient demographic data including age and body mass index (BMI) was analyzed using two-sample independent t-tests to compare data between groups. Sex, fixation type, diabetes mellitus (DM) status, age greater than 40 years, and mechanism of injury analyzed using a chi-squared analysis. All statistics were analyzed using IBM

SPSS statistics software (IBM SPSS Statistics for Windows, version 28.0; IBM, Armonk, NY, USA).

Results

65 patients were enrolled. 17 patients had insufficient data for analysis of their postoperative mobilization due to not wearing the fitness tracker. The mean age of this cohort was 39 ± 11 years. The mean BMI was 33.4 ± 10.5 kg/m^2. 9 of the 17 were male. 7 patients received syndesmotic fixation with transfixation screw, while the remaining 10 patients received syndesmotic fixation with endobutton device. 12% of patients had diabetes mellitus. 41% of patients were 40 years of age or older. 1 of the 7 (14%) patients receiving screw fixation underwent subsequent hardware removal. 0 of the 10 patients receiving the endobutton underwent subsequent hardware removal.

48 patients had sufficient data up to six months postoperatively and were included in the postoperative mobilization analysis. The mean age of the study cohort was 37.9 ± 12.7 years. The mean BMI was 32.6 ± 7.7 kg/m^2. 46% of the patients were male. 28 (58%) patients received syndesmotic fixation with transfixation screw, while the remaining 20 (42%) patients received syndesmotic fixation with endobutton device. 15% of patients had diabetes mellitus. 42% of patients were older than 40 years. 8 of the 28 (29%) patients receiving screw fixation underwent subsequent hardware removal. 7 of the 8 hardware removals were due to painful hardware while the remaining 1 was due to infection. 1 of the 20 (5%) patients receiving the endobutton underwent subsequent hardware removal. In this case, the removal was secondary to infection.

The above statistics are summarized in Table 1 along with mechanism of injury for the included and excluded patients. There were no statistically significant differences between the included and excluded patients (p>0.05) (Table 1).

Data from 125 patients enrolled in our IRB approved prospective database on ankle fractures was gathered and calculated. 44% of patients were male and 56% female. The mean age was 45.3 ± 13.2 and the mean BMI was 30.1 ± 6.5 kg/m^2 (Table 2).

Endobutton vs Screw Fixation

Patients treated with endobutton fixation device were recorded having more mean daily steps than patients treated with screw fixation at all time points except 2

Table 2: Prospective Ankle Fracture Cohort.

Variable	
Age (years)	
mean	45.3 ± 13.2
BMI (kg/m²)	
mean	30.1 ± 6.5
Sex	
Male	44%
Female	56%

Table 1: Patient Demographic data.

Variable	**Category**	**Fitbit**	**No Fitbit**	***p value***
Age (years)				
mean		37.9 ± 12.7	39.9 ± 11.3	0.57
BMI (kg/m²)				
mean		32.6 ± 7.7	33.4 ± 10.5	0.75
Sex	Male	22	9	0.78
	Female	26	8	
Fixation	Endobutton	20	10	0.27
	Screw	28	7	
Diabetes	yes	7	2	1.00
	no	41	15	
Age	>40	20	7	0.78
	<40	28	10	
Mechanism of Injury	Motor Vehicle Collision	4	3	0.43
	Ground Level Fall	32	11	
	Motorcycle Collision	4	2	
	Trampoline	2	0	
	Assault	2	0	
	Fall from Height	4	0	
	Crush Injury	0	1	

months (1259.0 vs 1094.1 at 1 month, 1886.1 vs 1966.9 at 2 months, 3039.8 vs 2278.8 at 3 months, 3710.3 vs 2455.5 at 4 months, 3836.3 vs 2537.2 at 5 months, and 3349.3 vs 2124.1 at 6 months); the difference was statistically significant at the 3, 4, 5, and 6-month time points ($p<0.05$). Patients treated with endobutton fixation device were recorded having more mean daily very active minutes at 1, 4, 5, and 6 months postop (3.4 vs 2.6 at 1 month, 2.4 vs 3.5 at 2 months, 5.6 vs 5.6 at 3 months, 8.3 vs 4.6 at 4 months, 8.8 vs 1.5 at 5 months, 7.4 vs 0.9 at 6 months); the difference was statistically significant at the 4, 5, and 6-month time points ($p<0.05$) (Table 3).

No DM: Endobutton vs Screw Fixation

When comparing endobutton vs screw fixation in patients without DM, patients with endobutton fixation were recorded to have more mean daily steps at all time points (913.3 vs 640.8 at 1 month, 2233.2 vs 1435.7 at 2 months, 2850.8 vs 1067.2 at 3 months, 2685.5 vs 774.6 at 4 months, 2148.8 vs 635.6 at 5 months, and 1417.4 vs 545.3 at 6 months). The difference was statistically significant at 2, 3, 4, 5, and 6 months postop ($p<0.05$). As for mean daily very active minutes, patients treated with endobutton were recorded to have more mean daily very active minutes than patients treated with screw fixation at all time points (2.7 vs 1.7 at 1 month, 2.5 vs 2.1 at 2 months, 4.8 vs 4.3 at 3 months, 5.7 vs 1.4 at 4 months, 5.0 vs 0.2 at 5 months, and 3.2 vs 0.2 at 6 months); the difference was statistically significant at the 4, 5, and 6 month time points ($p< 0.05$) (Table 4).

Age >40: Endobutton vs Screw Fixation

When comparing endobutton vs screw fixation in patients >40 years old, patients with endobutton fixation were recorded to have statistically significantly more mean daily steps at 1, 2, and 3 months postop (1111.4 vs 591.6 at 1 month, 3281.0 vs 1633.1 at 2 months, 3169.3 vs 904.9 at 3 months) ($p<0.05$) and statistically significantly more mean daily very active minutes at 1, 2, and 3 months postop (5.0 vs 0.9 at 1 month, 6.1 vs 1.8 at 2 months, 8.6 vs 0.6 at 3 months) ($p<0.05$) (Table 4). Data was not available for a comparison at 4, 5, and 6 months.

Discussion

The results of this study demonstrate that endobutton fixation of ankle fractures with syndesmotic disruption leads to greater mobilization during the first 6 months than screw fixation as measured by a fitness tracker. Prior research has compared patient reported outcomes as well as complications between suture button fixation and screw fixation, but to the best of our knowledge, this is

Table 3: Mean daily steps and average daily very active minutes for Endobutton vs Screw Fixation.

	Endobutton vs Screw Fixation								
	Months	**Endobutton**	**Screw Fixation**	**p value**		**Months**	**Endobutton**	**Screw Fixation**	**p value**
Mean Daily Steps (steps)	1	1259	1094.1	0.19	Mean Daily Very Active Minute (minutes)	1	3.4	2.6	0.41
	2	1886.1	1966.9	0.45		2	2.4	3.5	0.09
	3	3039.8	2278.8	<0.01*		3	5.6	5.6	0.98
	4	3710.3	2455.5	<0.01*		4	8.3	4.6	0.03*
	5	3836.3	2537.2	<0.01*		5	8.8	1.5	<0.01*
	6	3349.3	2124.1	<0.01*		6	7.4	0.9	<0.01*

*statistical significance

Table 4: Bottom- Mean daily steps and average daily very active minutes for patients >40 - Endobutton vs Screw Fixation.

	No Diabetes Mellitus: Endobutton vs Screw Fixation								
Mean Daily Steps (steps)	Months	Endobutton	Screw Fixation	p value	Mean Daily Very Active Minutes (minutes)	Months	Endobutton	Screw Fixation	p value
	1	913.3	640.7	0.08		1	2.7	1.7	0.18
	2	2233.2	1435.7	<0.01*		2	2.5	2.1	0.39
	3	2850.8	1067.2	<0.01*		3	4.8	4.3	0.66
	4	2685.5	774.6	<0.01*		4	5.7	1.4	<0.01*
	5	2148.8	635.6	<0.01*		5	5	0.2	<0.01*
	6	1417.4	545.3	<0.01*		6	3.2	0.2	<0.01*
	Age >40: Endobutton vs Screw Fixation								
Mean Daily Steps (steps)	Months	Endobutton	Screw Fixation	P value	Mean Daily Very Active Minutes (minutes)	Months	Endobutton	Screw Fixation	p value
	1	1111.4	591.6	<0.01*		1	5	0.9	<0.01*
	2	3281	1633.1	<0.01*		2	6.1	1.8	<0.01*
	3	3169.3	904.9	<0.01*		3	8.6	0.6	<0.01*

*statistical significance

the first study which has attempted to objectively quantify mobilization using a wearable fitness tracker following these two fixation techniques.

Suture button fixation has gained significant support as an alternative to syndesmotic screw fixation due to fewer postoperative complications and re-operations[12-14]. For example, prior studies have reported hardware removal rates ranging between 22.4%-40.2% following screw fixation and 3.7%-6.0% following dynamic fixation[14,15]. Data from our Fitbit cohort follows a similar trend as evidenced by a 28% rate of screw removal and a 5% rate of dynamic fixation removal. In addition to fewer complications, suture button fixation has also been shown to be associated with higher patient reported outcome scores as measured by scores such as the American Orthopedic Foot and Ankle Society Ankle-Hindfoot (AOFAS) score and Olerud-Molander ankle (OMA) score. However, although the improved functional outcomes are promising, the AOFAS and OMA have not been validated for ankle fracture treatment. Therefore, the conclusions drawn from these scoring systems are less descriptive on their own and must be taken into context.

In light of this, we set out to better understand functional status using objective data from a wearable fitness tracker. The two primary measures of mobilization in this study were mean daily steps and mean daily very active minutes. Together, our data supports previous literature demonstrating suture button fixation allows for greater mobility and earlier return to functional activity[16-18]. These findings are likely attributable to suture button fixation allowing for anatomic healing of the syndesmosis while maintaining the reduction[12-14]. Interestingly, however, the increased mobility of suture button fixation does not appear to be appreciable until 2-3 months postoperatively. The significance of this time point is unclear, but may be partially explained by the change in weightbearing status around this time. The increased mobility associated with endobutton fixation was also seen between the two treatment groups when looking at patients without DM and patients > 40 years old.

This study attempted to measure the impact of diabetes mellitus (DM) on mobilization following these two fixation techniques. Unfortunately, however, there was an insufficient number of patients in the endobutton group with DM for a statistically adequate comparison to be made. Therefore, no comparison could be made between patients with DM who received transfixation vs endobutton.

Fitness trackers and GPS equipped smartphones are becoming increasingly prevalent in today's society. About 65% of Americans over the age of 35 carry smartphones on a daily basis, and in 2019 21% of Americans said they regularly used a smart watch or fitness tracker[19-21]. The potential for these devices to monitor surgical patient's mobility habits is exemplified by previous research which has validated the accuracy and reliability of data gathered from fitness trackers such as step counts, walking distance, and stair climbing[22-24]. Moreover, prior studies assessing arthroplasty patients have shown that fitness trackers can be used to provide objective data regarding patient mobilization post-surgery[9-11,25]. Considering the continued emphasis on a value-based healthcare system, orthopedic surgeons must explore tools that can objectively quantify patient progress postoperatively and therefore provide actionable data to tailor specific rehabilitation protocols to individual patients. This study can serve as a rudimentary template from which future studies can build upon in order to elucidate the potential uses for fitness trackers.

There were several limitations to our study. First and foremost was the lack of patient participation and the small sample size. Of the 65 patients enrolled in the study, only 48 had sufficient data after 6 months. Furthermore, because of the unblinded nature of this study, patients were aware of the reason for their involvement in the study. Therefore, the patients with adequate data after 6 months may not be representative of the larger cohort due to healthy user bias. We attempted to address this by demonstrating no statistically significant difference between the included and excluded patients in regards to age, BMI, sex, mechanism of injury, and diabetes status. Moreover, we compared the age, BMI, and sex of the study cohort to the same variables from a prospective database of ankle fractures at our institution. This comparison demonstrated overlap of the mean and standard deviation between the age and BMI of prospective cohort and the study cohort, therefore bolstering the generalizability of our findings. Nevertheless, we acknowledge the small sample size presents a barrier to the generalization of our findings. As fitness trackers continue to increase in popularity and use, it is reasonable to expect greater patient compliance in similarly designed studies in the future. An additional limitation is the accuracy of the gathered data, especially at low or high walking speeds. Fitness trackers and the technology used to gather data continue to improve, but questions remain as to how reliable each tracker may be.

Conclusion

Patients with ankle fractures treated with endobutton device for syndesmotic fixation have earlier and higher levels of mobilization during the first 6 postoperative months than those treated with transfixation screw as measured by a fitness tracker. Fitness trackers are increasing in popularity and the data gathered from these devices contains significant potential for creating patient specific rehabilitation guidelines that may ultimately improve patient functional outcomes postoperatively.

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