CHAPTER 31

Superior Peroneal Retinacular Injuries in Calcaneal Fractures

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INTRODUCTION

Calcaneal fractures are devastating injuries with historically poor outcomes. Accounting for approximately 2% of all fractures, it is the most commonly fractured tarsal bone (1). This injury, resulting in an axial force being applied to the foot driving the talus into the calcaneus is most commonly seen in males in the industrial sector and motor vehicle accidents (2). As this occurs, it can result in injury of the superior peroneal retinaculum with subsequent displacement of the peroneal tendons (3). Acute dislocation of the peroneal tendons are relatively rare injuries with a reported incidence of approximately 0.5% (4). The mechanism of these retinacular injuries and dislocations has been elucidated but not in the setting of these fractures (5). In addition to the blowout that occurs with the fracture, the reduction in height generates slack in the tendons that could excarbate subluxation especially in the presence of a flat or convex peroneal groove (2).

We report the incidence of these retinacular injuries and tendinous subluxation and, or dislocations and demonstrate whether there was any association with specific fracture patterns. We also emphasize the dynamic nature of this pathology and the clinical technique of diagnosis.

PATIENTS AND METHODS

After institutional board review approval, patients were identified by reviewing all operative procedures performed by the primary author (JJF) from January 2006 to December 2012 abstracted from the medical records. Additional searches by the Current Procedural Terminology (CPT) code 28415 were performed, representing open treatment of calcaneal fracture. We initially identified 130 consecutive calcaneal fractures that were repaired by the primary author (JJF). All the operative notes were subsequently performed by the other authors to determine the presence or absence of peroneal injury. In order to reduce the likelihood of missing any potential repairs, the following additional CPT searches were performed: CPT 27675 representing repair of dislocating peroneal tendons without fibular osteotomy, and CPT 27676 representing repair of dislocating peroneal tendons with fibular osteotomy. These searches were cross-referenced with CPT 28415. Our inclusion criteria comprised of patients who acutely sustained intraarticular calcaneal fractures, had preoperative computed tomography (CT) images, and underwent open reduction and internal fixation. Exclusion criteria included calcaneal fractures that underwent primary fusion, patients with calcaneal fractures treated definitively with external fixation, patients younger than 18 years, patients who did not have CT images available for retroactive review, and fractures without subtalar joint involvement. There were 10 isolated tuberosity avulsion fractures (7.69%) without subtalar joint involvement, 16 fractures (12.31%) that underwent primary subtalar joint arthrodesis, 3 fractures isolated to the anterior process of the calcaneus (2.31%), 3 patients who kept their preoperative CTs and could not be reached (2.31%), and 2 (1.54%) fractures primary treated with external fixation. Following application of our exclusion criteria, there remained 90 patients (78.26%) with 97 calcaneal fractures (74.61%).

All available diagnostic images were reviewed, including CTs and radiographs, by physicians who participated in the operations and were not blinded to the outcome of the study. Each fracture was classified according to the classification system described by Sanders et al (6).

The morphology and position of the peroneal tendons on the axial CT reconstruction were reviewed to determine any abnormality. Following this, we reviewed each accompanying CT report to determine if the radiologist noted any abnormality with the peroneal tendons or the superior peroneal retinaculum. Finally, we reviewed every operative report in these 97 cases to determine whether the superior peroneal retinaculum or tendons were compromised clinically requiring surgical intervention. We followed this very specific order in order to reduce identification bias and to demonstrate that even among skilled musculoskeletal radiologists, it is rarely mentioned.

Data were collected and stored in a password protected computer for subsequent analysis. Descriptive data were presented in terms of the frequency and percentatge. Additionally, a 2 x 2 contigency table and subsequent chi-square test was performed to determine if a specific fracture pattern type carried a higher assocated for peroneal tendon and retinacular injury.

Technique

In order to inspect the integrity of the superior retinaculum, the blunt end of a Freer elevator was inserted in the caudal direction posterior to the fibular within the peroneal sheath (Figures 1, 2). The Freer elevator was then utilized to inspect for the presence of resistance confered by an intact superior retinaculum. The ability to simulate the subluxion/dislocation of the tendons with the Freer elevator from

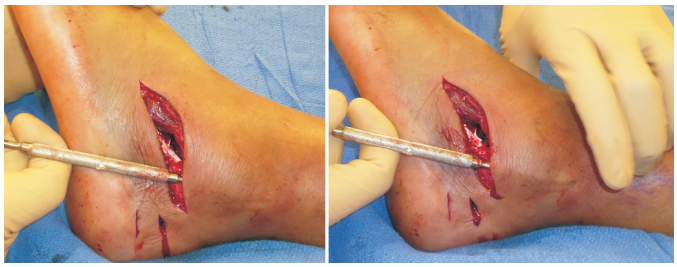

Figure 1. The orientation of the Freer elevator inserted within an intact peroneal sheath.

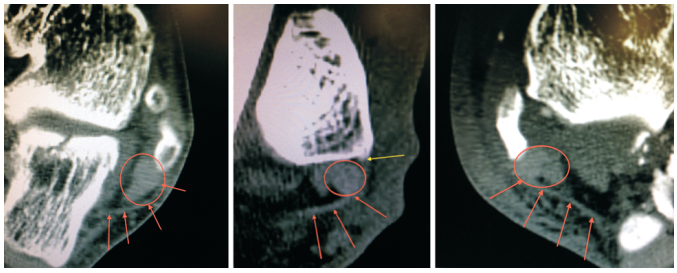

Figure 2. Intact superior retinaculum identified by orange arrows, intact tendons identified by the orange oval. The yellow arrow identifies the intact fibrocartilagenous spike in the middle image.

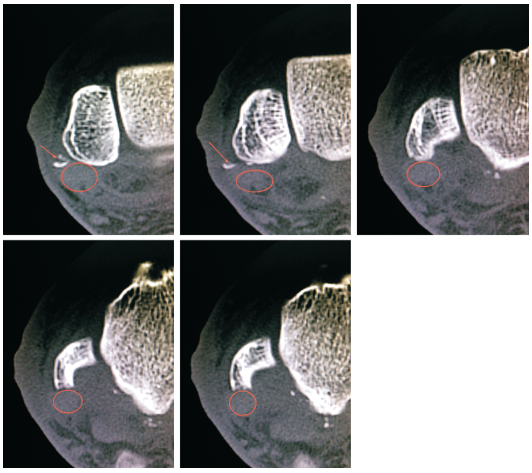

Figure 3. Avulsion (orange arrow) with subluxation and indistinctness of the injured peroneal tendons with blood within sheath (orange oval).

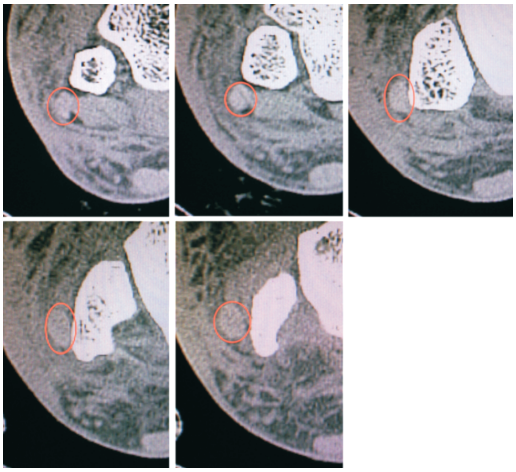

Figure 4. Grossly subluxed peroneal tendon traced by the orange oval along its course.

posterior to the lateral aspect of the fibula while within the sheath was a grossly positive finding that occurred either as a result of an osseous avulsion of the superior retinaculum at its fibula insertion, the avulsion of the fibrocartilagenous spike, or a full rupture of the superior retinaculum. The ability to visualize the tenting of the Freer elevator on the surface of the skin during this examination was evidence of redundancy of the superior retinaculum. We defined all these as clinically positive findings that were repaired. In the absence of these findings without clinical suspicion of pathology and negative CT findings, the peroneal tendons were not visually inspected. The superior peroneal retinaculum was approached with a 3 cm linear incision just posterior to the fibula. Following subcutaneous dissection, the redundant superior peroneal retinaculum was identified and primarily repaired with # 2.0 fiberwire suture in a pants-over-vest technique. Larger osseous avulsions underwent primary internal fixation with 2.0 or 3.0 cannulated screws. Small osseous avulsions were debrided, the superior peroneal retinaculum advanced over the lateral roughened fibular border to facilitate adherence, and fixated with 2.0 bone anchors.

RESULTS

There were 62 men (68.88%) and 28 women (31.11%) with a cumulative mean age of 43.39 years (range 19-72 years). The mean follow up was 13.54 months (range 8.5-26 months). There were 51 type II fractures (52.57%), 17 (33.3%) of which demonstrated the A fracture line, 20 (39.21%) with the B fracture line, and 14 (27.45%) with the C fracture line. Of the 25 type III fractures (25.51%), 10 (40%) demonstrated the AB fracture lines, 7 (28%) AC fracture lines, and 8 (32%) demonstrated the BC fracture lines. There were an additional 21 type IV fractures (21.43%). Of the 97 cases, 13 (13.4%) required repair of the superior peroneal retinaculum. Six of these repairs (46.12%) were the result of frank avulsions of the superior retinaculum from the fibula with unconstrained peroneal tendons (Figure 3). This was seen in 2 II-A fractures (33.3%), 2 III-AB fractures (33.3%), 1 II-C fracture (16.6%), and 1 type IV fracture (16.6%). The remaining 7 (53.85%) presented with clinical subluxation/dislocation and redundancy without avulsion or fracture of the fibula (Figure 4). This was seen in 4 type IV fractures (57.14%), 1 III-AB fracture (14.28%), 1 III-BC fracture (14.28%), and 1 III-AC fractures (14.28%).

Of the 6 avulsion, all of which were visualized on CT by the study investigators, 2 (33.3%) were not reported by the radiologist preoperatively. Of the 7 cases with clinical subluxation and redundancy requiring repair, only 2 (25%) were reported as such by the radiologist, and 5 (71.43%) were visualized on CT by the investigators.

When considering specific fracture type, and assuming all type IV fractures demonstrated the Sanders A fracture line, we observed a total of 55 fractures with the type A fracture line. Eleven of these 55 (20%) was associated with superior peroneal retinacular injury with peroneal tendon dislocation requiring operative repair. We observed 42 fractures that did not demonstrate a type A fracture line with 2 (4.76%) associated with superior peroneal retinacular injury with peroneal tendon dislocation requiring operative repair. A two-tailed chi-square test demonstrated a statistically significant difference (P = 0.0291; chi-square 4.765) with fractures involving a type A fracture line having an increased rate of associated peroneal injury.

Equally important were instances where a positive CT finding did not necessarily correlate with a clinically postive finding. Of the 97 cases, there were 6 (6.18%) additional cases with evidence of peroneal tendons posterolateral to the posterolateral border of the fibula with suspicion of superior retinacular redundancy according to the investigators on CT, 4 (66.7%) of which were also reported preoperatively by the musculoskeletal radiologist. However, the superior peroneal retinaculum was clinically intact in all these cases. Similarly, there were 6 additional cases (6.18%) with avulsion fractures visible on CT at the fibular insertion of the superior peroneal retinaculum, none of which were reported by the radiologist. Again, none of these cases were associated with positive intraoperative finding of instability.

DISCUSSION

Calcaneal fractures are devastating injuries with relatively poor outcomes depending on the fracture pattern. Combined in the setting of the missed traumatic superior peroneal retinacular injury with subluxation, the morbidity can be significant (7-9). Poor outcomes specifically pertaining to this have been reported specifically relating to the inability to resist inversion due to peroneal tenosynovitis, which can be a source of significant disability (3). Peroneal tendinopathy must be ruled out from subtalar joint pathology along the lateral course of the tendons.

It was our desire to elucidate the acute and specific findings to help in the identification of this pathology. Because of the relatively little attention it has received, this pathology is scarcely suspected, even among skilled musculoskeletal radiologists, as our findings demonstrated and as such without a high index of suspicion, it is easily missed. This was evident in instances where pathology was visualized on the CT by the study investigators without a comment from the radiologist. The reverse did not occur. Interestingly, there were instances where avulsion type fractures of the fibula at the peroneal insertion were noted on the CT, however did not clinically correlate with instability, highlighting the dynamic nature of this pathology. The ability to easily trace the peroneal tendons on CT along the entire posterior course along the fibula reduces the likelihood of identifying pathology clinically and intraoperatively. Conversely, indistinctness of the peroneal tendons may be the prodrome of injury as a result of hematoma within the peroneal sheath.

Ebraheim et al (10) reported that 8 of 21 intraarticular calcaneal fractures presented with peroneal subluxation or dislocation (10). The study investigators further added that there was no inherent advantage of a magnetic resonance image because of the dynamic nature of this pathology, a finding that corroborated with ours.

Based on our exclusion criteria, the inclusion of those fractures that underwent primary repair may have increased the incidence further highlighting the importance of inspecting for this pathology. However, we suspected no clinical benefit of addressing the peroneal injury where the subtalar joint was fused.

We observed an association between the type A fracture line and superior peroneal retinaculum injuries with peroneal tendon dislocation requiring repair. This is an interesting finding that may be intuitive initially in that calcaneal fractures with laterally based fractures are more likely to injury the peroneal retinacular and tendinous structures immediately adjacent to the fracture. However, this is the first study that has demonstrated this statistically. We conclude that it is reasonable for surgeons to inspect the peroneal tendons on CT, and even specifically intraoperatively regardless of negative CT findings particularly in the presence of the A fracture line (11).

The weaknessnes of our study are those inherent in any retrospective study in that we are limited by documentation performed prior to the initiation of the study. We performed no review regarding outcomes nor was it our intent, so it is not possible to make any conclusions regarding the therapeutic effect of our intervention. In addition, the presence of retinacular redundancy does not conclusively make any claims that the fracture mechanism was the sole source of the redundancy as there are patients who develop peroneal tendon subluxation as their primary pathology, a concern less attributable to the avulsion types (12). The fact that the study investigators were not blinded to the studies outcome could have resulted in the investigators over-reporting their CT findings. Nonetheless, this did not influence the treatment as the study was retrospective in nature.

Table 1. Patient demographics (90 patients, 97 cases).

Patient number	Sex	Age (years)	Side	Sanders fracture type	Superior peroneal retinaculum intraoperatively	Computed tomographic report on superior peroneal retinaculum and/or peroneal	Computed tomographic findings by study investigators
1	M	30	L	II B	intact	no comment	normal
2	M	44	R L	II A III AB	avulsion intact	avulsion no comment	avulsion normal
3	M	52	R L	IV IV	intact intact	no comment no comment	normal normal
4	M	47	R	II C	intact	no comment	normal
5	M	33	R	II C	avulsion	no comment	avulsion
6	M	43	L	III AB	avulsion	no comment	redundant
7	F	72	L	II A	intact	no comment	normal
8	F	70	L	II B	intact	no comment	normal
9	F	35	R	IV tongue	redundant	no comment	redundant
10	M	70	L	II A	intact	no comment	normal
11	M	26	R	III BC tongue	intact	no comment	normal
12	M	63	L	II B	intact	no comment	normal
13	M	41	L	II C	intact	no comment	normal
14	M	42	R	II B	intact	no comment	normal
15	F	53	R	II A	intact	no comment	normal
16	M	61	L	II A	intact	no comment	normal
17	M	47	L	II B	intact	no comment	normal
18	M	38	L	II B	intact	no comment	normal
19	M	42	L	IV	intact	no comment	normal
20	M	51	L	II C	intact	no comment	normal
21	M	49	L	III AC	intact	no comment	normal
22	M	33	R	II B	intact	no comment	normal
23	M	38	R	II B	intact	no comment	normal
24	M	51	R	III BC	intact	no comment	normal
25	F	40	R	II B	intact	no comment	normal
26	M	38	L	IIC	intact	no comment	normal
27	M	48	R	IV	intact	entrapped peroneus brevis in lateral calcaneal	intact superior peroneal retinaculum
28	M	23	L	IIC	intact	no comment	normal
29	M	43	R	IV tongue	redundant	no comment	normal
30	M	30	L	II A	avulsion	avulsion	avulsion
31	F	34	R	II B	intact	no comment	normal
32	F	62	L	II C tongue	intact	no comment	normal
33	M	34	L	II C tongue	intact	no comment	normal
34	F	55	R	II A	intact	no comment	avulsion
35	M	19	R	II C	intact	no comment	normal
36	M	39	L	II B	intact	no comment	normal
37	F	59	L	II B	intact	normal	normal
38	M	22	L	IV	intact	subluxed peroneal tendons	redundant superior peroneal retinaculum with
39	F	37	R	III AB	intact	no comment	normal
40	F	31	L	IV	intact	no comment	normal
41	M	49	L	IV	avulsion	avulsion/dislocated	avulsion
42	M	40	L	II A	intact	normal	normal
43	M	42	R	II A tongue	intact	normal	normal
44	M	47	R	II B	intact	no comment	normal
45	M	46	R	II C tongue	intact	normal	normal
46	M	32	L	IV tongue	intact	normal	normal
47	M	36	R	III AB tongue	avulsion	avulsion	avulsion
48	M	46	R	IV	intact	no comment	normal
49	F	59	R	IV	redundant	subluxed	redundant
50	M	45	R L	II C tongue II C tongue	intact intact	no comment normal	normal normal
51	M	53	R	III AC	intact	normal	normal
52	M	60	R	III BC	intact	no comment	normal
53	M	52	L	III AB	intact	subluxed	redundant
54	M	37	R	III BC	intact	no comment	avulsion
	M	37	L	III BC	intact	no comment	normal
55	M	46	L	II B	intact	subluxed	redundant
56	M	48	R	II A	intact	no comment	normal
57	M	35	L R	IV IV	intact intact	no comment no comment	normal normal
58	F	26	R	III AB	redundant	subluxed	redundant
59	M	48	R	II A	intact	no comment	normal
60	M	38	R	II A	intact	no comment	normal
61	M	52	L	III AB	intact	no comment	redundant
62	M	36	R L	III BC II B	intact intact	no comment no comment	normal normal
63	F	48	R	II C tongue	intact	no comment	normal
64	F	35	R	III AB	intact	no comment	normal
65	M	46	R	II B	intact	no comment	normal
66	M	35	R	IV	intact	no comment	normal
67	F	35	R	III BC	redundant	no comment	redundant
68	F	63	L	III AB	intact	normal	normal
69	F	54	R	III AC	intact	no comment	normal
70	M	45	L R	III BC IV	intact intact	normal normal	normal normal
71	M	33	R	IV	intact	no comment	avulsion
72	M	47	R	II B	intact	no comment	normal
73	F	36	R	II C	intact	no comment	normal
74	M	24	L R	III AC tongue III AC tongue	intact intact	normal normal	normal normal
75	F	61	R	III AB	intact	no comment	avulsion
76	M	53	L	II B	intact	no comment	normal
77	F	51	R	II A	intact	no comment	avulsion
78	M	69	R	II A	intact	no comment	normal
79	F	55	R	II A	intact	no comment	normal
80	M	30	R	IV	intact	no comment	avulsion
81	M	21	R	II A	intact	normal	normal
82	M	27	L	III AC	redundant	no comment	redundant
83	F	45	L	II B	intact	no comment	normal
84	F	47	L	IV	intact	no comment	normal
85	M	18	R	IV	intact	no comment	normal
86	F	44	R	II B	intact	no comment	normal
87	F	27	R	II A	intact	subluxed	redundant
88	F	34	L	IV	redundant	no comment	normal
89	F	61	R	IV	intact	no comment	redundant
90	M	44	L	III AC	intact	no comment	normal

There is also the remote posibility that the nonstandardized force utlized to inspect the retinaculam with the Freer elevator could potentially injure an otherwise marginally intact retinaculum. The likelihood of this is low considering the superior peroneal retinaculum was intact in 86.6% of our cases. Nonetheless, perhaps a more blunt instrument could have reduced this uncertainly. There was no control group to elucidate as to whether there was a quantifiable clinical benefit of repair of the ligament in our cohort but as previously mentioned this was not our focus. Nonetheless, considering the incidence of vertebral injuries with calcaneal fractures primarily as a result of the mechanism of injury, our findings demonstrate an even higher comparable incidence and note the importance of clinically inspecting for this pathology. Missing this pathology could potentially further confound patient outcomes as previous reports have demonstrated (13).

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