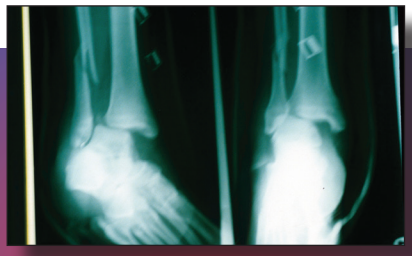

Fracture Blisters

Here's how to recognize and treat this complication.

BY GEORGE F. WALLACE, DPM, MBA

Objectives

After completion of this CME, the reader will:

1) Understand the etiology of fracture blisters.

2) Understand the difference between serous and hemorrhagic fracture blisters.

3) Gain information on the various treatment options for the blisters.

4) Understand ways to prevent fracture blisters.

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*Following this article, an answer sheet and full set of instructions are provided (pg. 146).—**Editor***

As a growing cadre of foot and ankle surgeons come in contact with more trauma cases of the foot and ankle, they may encounter a sequela—namely a fracture blister. In some instances, although rare, these blisters may even appear after more involved elective surgery, for example, even after correction of a hallux abducto valgus deformity. It is incumbent upon us that we recognize fracture blisters and treat them accordingly, being mindful that the underlying fracture has to be dealt with eventually.

Etiology, Incidence

Fracture blisters have also been called by the following names: trauma blisters, epidermal necrosis, epidermolysis, and avascular necrosis of the skin.[1] Conventionally, however, the more common name is fracture blister. That will be the term used throughout this discussion.

Fracture blisters have an incidence of 2.9% of all fractures. For ankle fractures, their incidence is 4.2%, and 10.9% of calcaneal fractures.[2] The higher the energy with components of either shear and/or torque during the traumatic event, the more one is predisposed to the formation of a fracture blister. The underlying fracture most likely will resemble a high-energy pattern.

Fracture blisters can be singular or multiple in number. They can be distal or proximal to the fracture itself. They do not necessarily form directly superficial to a fracture. Therefore, the entire foot and ankle has to be examined initially and for a few weeks after the event.

Why does the ankle have such a high incidence of fracture blisters? The factors attributed to this are: sparse or no sweat glands, no hair follicles, thin skin with no subcutaneous fat (thus having prominent osseous structures), no deep venous system, and the arborization of veins perimalleolarly. The epidermis and dermis lack the above-mentioned structures to stabilize these levels, not only to one another but to the underlying subcutaneous tissue.[3] For calcaneal fractures, in addition to similar anatomic findings of the ankle, the mechanism of injury en-

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Fracture *(from page 141)*

compassing a high-energy event increases the incidence (Figure 1, Figure 2).[4]

Fracture blisters form when the traumatic edema, which is part of the normal injury cascade, causes an interstitial pressure increase. Vascular congestion ensues. The epidermis and dermis lose their cohesion, and there is resultant separation. Fluid collects at the separated areas, yielding a fracture blister. Epidermal necrosis occurs and its extent will be predicated on the amount of energy generated to cause the injury.

On average, formation of fracture blisters occurs 2.5 days after injury. Appearance can be as early as six hours post-injury.[5] However, they can occur up to three weeks after injury.[4]

One has to remember that in the presence of an open fracture, fracture blisters can still form (Figure 3). Where present in conjunction with an open fracture, the Gustilo Anderson classification and treatment protocols are initiated along with concomitant fracture blister care.[6]

Compartment Syndrome

With a compartment syndrome, the appearance of a fracture blister over time does decrease compartment pressures.[7] However, one should not wait for fracture blisters to appear as a way to avoid surgical decompression of the compartments. Where one has a high index of suspicion that the trauma could predispose the foot to raised pressures, compartment pressures have to be monitored with or without fracture blisters in those cases. Once the pressures are elevated and the diagnosis of a compartment syndrome is made, then the appropriate fasciotomies are performed in an emergent manner.

The Podiatry Service at University Hospital conducted a brief retrospective analysis of foot and ankle trauma over a two-year period. The sole purpose was to quan-

Continued on page 143

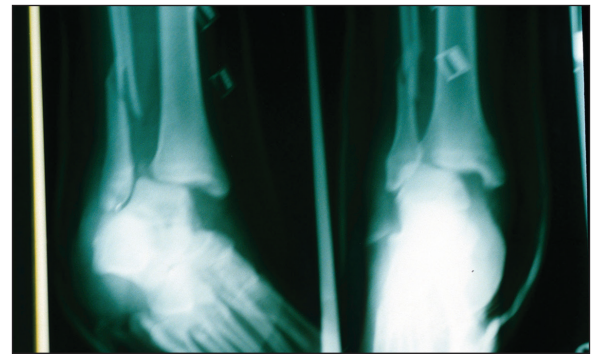

Figure 1: Ankle fracture

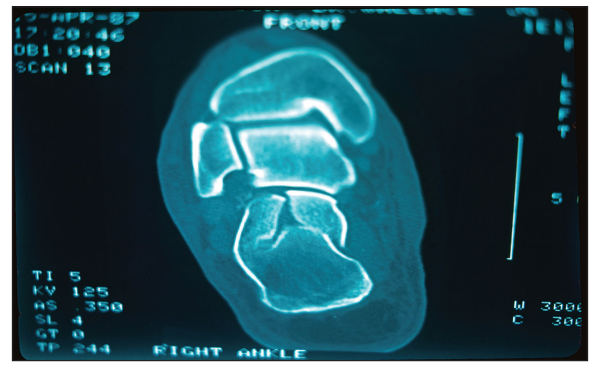

Figure 2: Calcaneal fracture

Figure 4: Serous fracture blister

Figure 7: Fracture blisters secondary to a talar neck fracture. This was consulted for a "vesicular skin condition".

Figure 3: Open fracture 1st metatarsal

Figure 5: Hemorrhagic fracture blister

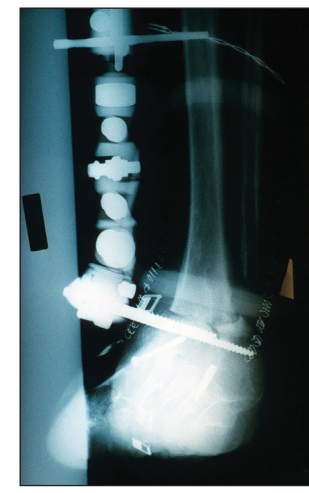

Figure 6: External fixator in place until definitive surgery

Fracture (from page 142)

tify the number of fracture blisters per anatomical location. The results follow. Total traumatic cases over that period:

31 ankle fractures
5 calcaneal fractures
5 talar fractures
11 Lisfranc fracture/dislocations

Appearance of fracture blisters with the following pathology:

2 bimalleolar fractures
2 trimalleolar fractures
0 calcaneal fractures
1 Lisfranc fracture/dislocation
1 post Kalish osteotomy
1 post Lapidus fusion[3]

Note the Kalish and Lapidus procedures with the fracture blisters above. Both cases were serous and over the second metatarsophalangeal joints. The fracture blisters were treated per protocol, which follows, and the patients had an uneventful recovery. In both cases, these lesions appeared at the first dressing change, which was day eight.

Anatomy and Types of Fracture Blisters

Fracture blisters share the following characteristics: all are sub-epidermal, and any fluid contained within this blister is sterile and has the characteristics of serum. From a histological perspective, fracture blisters resemble a second degree burn.[3]

Giordano, et al., in 1994, wrote the seminal article regarding fracture blisters.8 Through their observations, they were able to devise a classification based on appearance and characteristics. Thus, there are two types of fracture blisters: serous and hemorrhagic. (Figure 4, Figure 5)

The serous or clear fracture blister has a tense roof. The fluid within the blister is clear. This represents a partial separation of the epidermis from the dermis.[8]

The second type of fracture blister is the hemorrhagic. The roof is flaccid. The fluid is crimson. The blood tinge may be from a papillary vascular injury. A complete separation has occurred between the epidermis and dermis. Therefore, these blisters represent a higher energy event and are more devastating than their serous counterpart. Hemorrhagic fracture blisters take longer to heal than the serous ones. Although rare, both types may be present simultaneously.

Prevention of Fracture Blisters

Although we can never totally prevent fracture blisters, nonetheless there are maneuvers which can be followed to mitigate their formation.

The gold standard of rest, ice, compression, and elevation (RICE) are still pertinent to any trauma. When applying compressive dressings or devices, bony prominences need to be well-padded. Rapid swelling may necessitate bi-valving the dressing/cast prophylactically. If not, the extremity is examined frequently to monitor pain, neurovascular status, and movement.

Nelson advocates early reduction and stabilization of the fracture to reduce the incidence of a fracture blister.[5] Secondly, open reduction internal fixation if performed within the first 24 hours of injury has demonstrated a decrease in fracture blister formation. The ability to perform this surgery at that time is contingent upon the soft tissue envelope and whether the patient is medically optimized and ultimately cleared for surgery. The AO Foundation advocates postponing any surgery which can't be completed within the initial six to eight hours until seven to ten days have elapsed.[9] Hopefully, by that time, the soft tissue envelope will be ready for surgical intervention.

Treatment of Fracture Blisters

Although Giordano[10] and others,[3, 11-14] have described the treatment of fracture blisters based on type, the treatments are varied. No clear consensus has been promulgated in the literature.[3]

After review of the various treatment plans, the following are University Hospital's protocols for each type:

1) Serous fracture blister: The blister is aspirated by incising the base with an 11 blade in two to four locations. The fluid is extruded. The roof then collapses, which serves as a biological dressing. A non-adherent gauze is applied, usually with an antibiotic ointment and dressing. After the roof desiccates in a few days, it is then debrided.

2) Hemorrhagic fracture blister: The roof in this type is thinner and flaccid versus the serous one. The entire roof is removed and the fluid gently wiped from the area. Silver sulfadiazine (SSD) with a non-adherent gauze is applied.

From a histological perspective, fracture blisters resemble a second degree burn.

Dressings are changed every few days until re-epithelialization of the base occurs, which may take upwards of a week or two. Hemorrhagic blisters will take longer than the serous ones to heal.

In some instances, both types may be present simultaneously. The above protocols are then followed for each. Should a fracture blister not be easily classified, it would be better to treat it as the one which represents a more severe injury, the hemorrhagic type.

Surgery and Fracture Blisters

The literature is replete with salient questions regarding surgery around and through fracture blisters. Pertinent questions which can be raised are:

1) Should surgery be done if any are present?

2) Should an incision be made through one?

3) How close can an incision be to a fracture blister?

Just like the discussion regarding treatment above, there is no clear consensus although statements are more forceful, if you will, as to what not to do. The rate of infection can be doubled and wound dehiscence can occur if the incision traverses the base prior to healing/re-epithelialization.[5] Those aforementioned consequences are more common with the hemorrhagic type.

Let's look at University Hospital's surgical fracture blister protocol in hopes of answering the above questions. It is a distillation of the various

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Fracture (from page 143)

opinions contained in the literature.[3,5] The following assumes the blisters are not healed.

1) Never incise through one, no matter the type. Serous fracture blisters will heal faster than the hemorrhagic kind. However, if it is for some reason unavoidable, incise through a serous one and never a hemorrhagic one.

2) An incision will be placed close to a serous blister. "Close" has no factual basis, but this protocol will be at least 2 cm from the outermost border of this lesion. Conversely, an incision will be placed "far away" from the hemorrhagic type. Conventionally, this distance is at least 5 cm from the border.

3) When fracture blisters are present but at a distance and surgery is performed, they are treated per protocol initially and covered with non-adherent gauze secured throughout the surgery's duration. When this is not done, any hand movement during the case could easily slough the base of the fracture blister, yielding a potential wound complication or even infection.

Anesthesia

A patient presents to the emergency room with a bimalleolar ankle fracture. It is close reduced and splinted. The patient is either admitted or sent home to await surgery. Prior to induction of anesthesia, the surgeon should first inspect the extremity, especially the site(s), for any incision. The presence of fracture blisters may lead to cancellation of the procedure, which one would want to do before induction of any anesthesia. Prior to this inspection edict, one of the patients admitted to the Podiatry Service at University Hospital with an ankle fracture was intubated, then the splint was removed. Multiple fracture blisters were at all the surgical sites. The surgery was postponed. No temporizing surgery was necessary then. In essence, anesthesia was for nothing. The fracture blisters were appropriately treated, per protocol. Once healed, surgery was performed.

Not only should there be no fracture blisters, but the area should be in "low tide".[7] By definition, there is minimal edema, the skin is easily pinched, skin lines are present, the ecchymosis has consolidated, and if fracture blisters were present, they have healed via re-epithelialization. High tide is just the opposite of low tide and is avoided as a time to do surgery.

Damage Control Surgery

What happens in cases where there are fracture blisters over incision sites and the foot or ankle is in high tide, and the fracture is unstable, there is tenting of the skin, or there is neurovascular compromise? This represents an emergent trip to the operating room, regardless of any fracture blisters.

Should the foot and ankle surgeon be faced with the above, then damage control surgery is performed.[7,9] This is a quick fix procedure utilizing external fixation (Figure 6). The fracture is thus stabilized, brought to anatomic position, any osseous tissue moved away from the skin, and neurovascular function restored. The external fixator is placed away from the zone of injury. It should also be placed in such a way that it does not impede future surgical incisions.

Damage control surgery is a quick fix procedure utilizing external fixation.

There is always the possibility that the damage control surgery is definitive with no further intervention necessary. Usually, however, this is not always so.

Once the fracture blisters heal and low tide appears, open reduction internal fixation can then be completed. Schedule this surgery for five to seven days after the damage control surgery. The soft tissue envelope is monitored during that time to make sure it will be ready for definitive surgery. If not, the surgery is postponed until low tide.

There is one important caveat to remember. After three weeks, it is difficult to do internal fixation. Procallus has begun to form and the bone on either side of the fracture is soft, which can impede fixation. With an external fixator in place and that three-week mark already met, the external fixator is then left on. The fracture is allowed to heal. Any mal-union is addressed after osseous healing, if clinically warranted.

Consultation

Recently, the Podiatry Service was consulted by the medicine team for "a vesicular skin condition" on the left foot and ankle. They did not know how long the vesicles had been there. Unfortunately, that was the only information conveyed by the requesting resident, other than that the patient had a concussion and a fractured jaw which was fixated by the oral and maxillofacial surgery service one day previously.

The patient was 39 years old. The medical history was non-contributory. He was in a fight, hence the jaw surgery. The left ankle was sore. The blisters didn't itch and were not present prior to admission (Figure 7).

Multiple bullae were around the left ankle. Pain was not elicited upon palpation of the ankle joint but at the talar head. Ankle range of motion was normal. Talonavicular joint movement resulted in "some pain".

Radiographs were ordered. The patient had a non-displaced left talar neck fracture, Hawkins I. To the surprise of the medicine team, the "skin condition" was actually multiple fracture blisters secondary to the talar neck fracture! A non-weight-bearing cast was applied and the patient healed uneventfully.

Conclusions

There are important concluding remarks regarding fracture blisters.

1) An index of suspicion that fracture blisters may appear is raised when dealing with high-energy trauma of the foot and ankle.

2) Early fracture care initially consisting of RICE and, when appropriate, early reduction and stabilization whether via surgical or nonsurgical means can lessen the incidence of these blisters

3) Careful placement of incisions is not only based on fracture blister type but also on being able to identify low versus high tide.

4) Inspect the injured lower ex-

Continued on page 145

Fracture *(from page 144)*

tremity prior to any anesthesia, preferably in the pre-operative holding area versus on the operating table.

5) Damage control surgery may be necessary.

6) Be able to ascertain the mechanism of injury and whether the fracture was the result of a high-energy event.

7) De-roof hemorrhagic blisters and evacuate serous blister fluid as treatments.

8) Be conversant with fracture and trauma classifications, general principles, and treatment algorithms. They are important as discussion points when conversing with the emergency room physician who consulted your team. **PM**

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CME EXAMINATION

SEE ANSWER SHEET ON PAGE 147.

1) Fracture blisters are also known as:
- **A) Epidermal necrosis**
- **B) AVN of skin**
- **C) Epidermolysis**
- **D) All of the above**

2) There are two types of fracture blisters:
- **A) Closed and open**
- **B) Serous and hemorrhagic**
- **C) Simple and complex**
- **D) Infected and non-infected**

3) In foot and ankle trauma, the highest incidence of fracture blisters occurs in what type of fracture:
- **A) Metatarsal**
- **B) Talar**
- **C) Calcaneal**
- **D) Ankle**

4) On average, formation of fracture blisters occurs how many days after injury:
- **A) 1**
- **B) 2.5**
- **C) 4**
- **D) 7**

5) Fracture blisters are akin to what type of burn:
- **A) First degree**
- **B) Second degree**
- **C) Third degree**
- **D) None of the above**

6) After trauma a patient presents with edema, fracture blisters, and ecchymosis. This represents:
- **A) "Low tide"**

Continued on page 146

B) "High tide"
C) An abnormal response
D) Cellulitis

7) Which type of fracture blister should never be the site of an incision:
A) Serous
B) Hemorrhagic
C) Infected
D) Non-infected

8) A patient presents with a trimalleolar ankle fracture. Fracture blisters are everywhere around the ankle. You decide to apply an external fixator and will wait until the fracture blisters heal; then you will do internal fixation. This is an example of:
A) Damage control surgery
B) Low tide
C) Compartment syndrome
D) Don't wait. Do the internal fixation immediately.

9) Fracture blisters can occur with which of the following:
A) Open fracture
B) Compartment Syndrome
C) Elective surgery (i.e., HAV surgery)
D) All of the above

10) What is the treatment for fracture blisters?
A) Biopsy all; then cover with gauze
B) There is no clear consensus
C) Prescribe an oral NSAID
D) Inject an antibiotic solution into them

SEE ANSWER SHEET ON PAGE 147.

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EXAM #1/17
Fracture Blisters
(Wallace)

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2.	A	B	C	D	7.	A	B	C	D
3.	A	B	C	D	8.	A	B	C	D
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