CASE REPORTS

FRACTURE OF THE MEDIAL SESAMOID BONE OF THE GREAT TOE:
CONTROVERSIES IN THERAPY

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The following case elucidates the difficulty in correctly diagnosing and treating the medial sesamoid fracture. Early diagnosis and proper treatment is imperative to avoid the debilitating syndrome of the painful non-healing sesamoid bone.

CASE REPORT

A 32-year-old woman noted sudden pain in the ball of her right foot while jumping during a high impact aerobics class. AP and lateral radiographs of the foot were normal (Fig 1). The patient noted slight pain but was able to continue her normal activities.

One week later, she attended an out-of-town conference. With increased walking, the pain worsened and swelling was noted. Two weeks after the injury, she consulted her orthopedist, who diagnosed a ligamentous injury. Although minimal soft tissue swelling was noted without ecchymoses, no further diagnostic tests or radiographs were ordered. She was told the pain would be prolonged while the ligament healed.

The discomfort persisted, and she began to note aching of the right calf due to reflex eversion of the right foot in an attempt to avoid weight bearing in the medial metatarsal phalangeal area. However, with avoidance of exercise the patient was able to resume other daily activities with minimal discomfort.

Approximately 2 months after the initial injury, she again experienced severe pain while attending an out-of-town conference. She returned to her orthopedist, who repeated a radiograph which demonstrated a non-displaced fracture of the right medial sesamoid (Fig 2). A controlled ankle motion walker was prescribed to decrease weight bearing to the sesamoid area. Despite 6 weeks of therapy, the patient noted increased pain and tenderness. Repeat radiographs showed no healing.

She consulted a second orthopedist, who recommended a non-weight bearing short leg cast and crutches for 4 weeks. When the cast was removed, 18 weeks after the initial injury, tomography demonstrated a non-displaced comminuted fracture of the medial sesamoid with no healing (Fig 3). The short-leg cast was converted into a bivalve cast. The patient continued to have discomfort during ambulation. Naprosyn 500 mg po bid relieved the pain substantially, but still did not allow for ambulation without the cast.

Six months after the initial injury, orthotics were dispensed and worn in a jogging shoe with a rocker bottom sole. Antiinflammatory medications were tapered, and the patient was able to ambulate successfully with marked reduction in her pain.

Fig 1: AP radiograph of right forefoot without evidence of fracture.

Fig 2: AP radiograph demonstrating a fracture of the right medial sesamoid 2 months after injury.

Fig 3: Tomography demonstrating non-displaced comminuted fracture of the right medial sesamoid.
DISCUSSION

Function. Several functions of the sesamoid bones have been postulated. The sesamoids elevate and protect the metatarsal head and flexor longus tendon. By dispersing forces on the metatarsal head, the sesamoid provides a shock absorber function. During a normal gait cycle, the sesamoid changes its location. In flexion, the sesamoid lies near the head/neck metatarsal junction. It is drawn 1 cm distally and tilted dorsally during extension of the hallux. During the normal gait cycle, the sesamoid bears three times the weight of the body, with the medial sesamoid accounting for the majority of the force.

The sesamoids also are points of insertion for the flexor hallucis brevis, medial and lateral sesamoid ligaments, and intersesamoid ligaments. There are limited insertions by the adductor hallucis, abductor hallucis, and the fibrous sheath of the flexor hallucis brevis. As such, the sesamoids increase the power of metatarsal phalangeal flexion by acting as a pulley for the muscle-tendon units. By attenuating the strength of the flexor hallucis brevis, the push-off maneuver during walking is potentiated.

Shear stress on the sesamoids is decreased by adipose tissue between the convex surface of the bone and the mobile underlying skin.

Sesamoidectomy of one sesamoid bone can result in excessive force on the remaining sesamoid. Interruption of the medial conjoined tendon may lead to hallux valgus. If the conjoined tendons are interrupted during sesamoid extirpation, the flexor hallucis brevis is compromised, resulting in a cocked-up hallux.

Diagnosis. A high level of suspicion is necessary to diagnose a fractured sesamoid. At greater risk are patients with high arches and long first metatarsals who engage in activities which result in chronic repeated stress to the forefoot. The injury has been associated with activities involving jumping, such as ballet, jogging, basketball, volleyball and high impact aerobics. Acceleration/deceleration sports such as tennis, racquetball, football, and soccer also have been associated. Strenuous barefoot exercise may predispose to fracture. Indirect injuries from sesamoid compression against the metatarsal head during marked dorsiflexion and abduction of the toe also may result in fracture.

The patient may be able to pinpoint the exact time and activity when the symptoms began. Conversely, there may be insidious onset of pain in the first metatarsal phalangeal joint which is aggravated by activity and relieved by rest. The pain may not be so severe as to limit the patient’s activities. Sometimes, the patient may complain primarily of aching in the lateral calf muscle because of reflex eversion of the foot away from the area of the sesamoid.

Frequently, tenderness on clinical examination will fall far short of the patient’s subjective symptoms. Clinical examination may demonstrate swelling and tenderness to palpation in the plantar region of the first metatarsal phalangeal joint. If deep forceful palpation in the sesamoid region is unsuccessful in eliciting tenderness, the patient should demonstrate the typical activity or motion which produces pain. Some patients will notice pain on dorsiflexion of the metatarsal phalangeal joint. This is best elicited if the patient attempts to plantar flex while the examiner holds the toes in a maximally dorsiflexed position with or without simultaneous deep palpation of the suspected site.

Finally, it is imperative for the clinician to remember that it is possible for a patient with a sesamoid fracture to have few or none of these signs. Consequently, the diagnosis cannot be based on physical findings alone. Appropriate diagnostic studies and follow-up examination must be obtained. Improper treatment of the sesamoid fracture may lead to prolonged and debilitating pain.

Diagnostic Studies. Initial radiographs should include AP, lateral, lateral oblique, oblique, and
axial views of the sesamoid bone. Fractures of
the sesamoid may not be seen on initial foot
films. Consequently, the patient should return
for repeat films if the diagnosis is entertained.
The differentiation between a bipartite vs a
fractured bone can be made on radiograph. The
bipartite bone usually shows a transverse divi-
sion compared to an oblique or longitudinal
division in the fracture (Fig 4). The fractured
bone usually demonstrates a jagged dividing
line and irregular outline compared to the
smooth regular outline in the bipartite sesam-
oid. Unilateral or bilateral changes are not good
evidence for or against the diagnosis of fracture.

A bone scan should be performed if it is
difficult to determine whether a sesamoid is
bipartite or fractured, or if there is a suspicion
of sesamoid fracture although the radiograph is
normal. The bone scan will show increased
isotope uptake secondary to osteoblastic new
bone formation, and will reveal a metabolic
disturbance at the acute fracture site before
changes are apparent on radiograph. However,
the bone scan lesion is non-specific. Poor image
quality limits the ability to determine the actual
structure of the lesion. Acute fracture, stress
fracture, and sesamoiditis all may give positive
bone scans. An acute fracture may produce a
metabolic disturbance and result in a positive
bone scan within 24 hours after injury. A
negative bone scan can rule out an acute frac-
ture. The test is contraindicated during preg-
nancy and breastfeeding.

Radiologic study is important in determining
subsequent bone healing in the fracture site. The
axial sesamoid view removes the shadows of the
metatarsal bones and may be helpful in diagnos-
ing avascular necrosis (Fig 5). In this rare
complication, a hyperdensity will appear in the
area of the necrotic bone. Increased markings
surrounding the bone indicate periostitis. CT
scan and MRI also may be helpful in diagnosing
this complication.

Strength of the healing tissue may be dem-
strated by measuring the distance between the
bone fragments on planter flexion compared to
forced dorsiflexion. If the union is weak, dor-
siflexion may cause further bone displacement
and increase the distance between the sesamoid
fragments. CT scan can be used to demonstrate
the location and displacement of bone frag-
ments.

Intraarticular lidocaine block of the metatar-
sal phalangeal joint can differentiate between
an intraarticular or extraarticular problem. Sesam-
oid injury or flexor hallucis longus tendinitis
will not respond to an intraarticular block.7

Treatment. The optimal treatment of the frac-
tured medial sesamoid is controversial. Some
reports indicate that the true sesamoid fracture is
resistant to therapy. However, the literature
seems to reflect that the optimal treatment is
immobilization. Some advise avoidance of flex-
ion of the first metatarsal joint to decrease stress
on the fractured bone. Many also suggest avoid-
ance of weight bearing. It is imperative to
eliminate any activity that causes further stress
on the fractured sesamoid subjectively mani-
fested by increased pain.

With this goal in mind, initial treatment may
be a total non-weight bearing short leg cast with
crutches. To limit flexion, the short leg cast
can be modified to cover the area of the
sesamoid, or a local bunion cast may be added
to the short leg cast. Others observe that immo-
obilizing the hallux may increase stress on the
fracture fragments.

Some report that prolonged conservative ther-
apy with a short leg cast or molded supports is
ineffective. Finally, some suggest less aggressive
treatment with a padded shoe with a stiff sole or slight reduction in activity.

After healing is demonstrated, local therapy is
indicated to redistribute the patient's weight
away from the area of the sesamoid. Orthoses
must be fit by someone experienced with this
injury, as a few millimeters' shift of the foot will
make the difference between success and failure
of this device. A sesamoid pad can be placed
lateral to the patient's sesamoid area to effec-
tively increase the weight borne at the pad site.

Adjustments may be made in the patient's
shoe to decrease stress in the sesamoid area. It is
possible that a biking shoe with stiff soles and a
cleat on the forefoot may accomplish the same
goal. A rocker-bottom sole may decrease pain
by reducing dorsiflexion. These soles have a
wedge thickest beneath the first metatarsal pha-
langeal joint which gradually tapers to zero in
the region of the toe, thereby decreasing the push-off maneuver.

Some patients present months to years after the sesamoid fracture has occurred. Conversely, as in the case presented, initial diagnosis may be missed even if the patient has consulted a physician early in the course. Radiographs should be obtained. If there appears to be no bone healing, the choice of further therapy depends on the duration of the fracture. Permanent nonunion of the sesamoid bone is diagnosed when bone formation has not occurred 6 months after the fracture. At this point, casting and immobilization may have a minimal impact on healing. Prior to this, decreasing weight bearing and immobilizing the area of the sesamoid should be prescribed if it has not been previously attempted.

In some cases, a syndrome of persistent debilitating pain accompanies the non-healing sesamoid fracture. This entity occurs most often in young women from their 20s to 30s. If the patient’s fracture occurred within 6 months, conservative methods such as casting with non-weight bearing may potentiate bone healing. Advantages of prolonged casting must be balanced against the complications of muscle atrophy. Some authors feel that prolonged therapy with short leg casting is ineffective. If the fracture is diagnosed early and an initial 6 week trial of casting is unsuccessful in promoting bone healing or reducing pain, operative pinning of the bone may further potentiate immobilization and healing.

If casting is unsuccessful and pain persists, further prolongation of casting may not result in bone healing. At this point the goal of therapy changes from healing by bone formation to achieving a painless fibrous union.

Systemic anti-inflammatory medications may be prescribed. These may be helpful if pain is caused by synovitis. Antiinflammatory may decrease the inflammation and permit the patient to ambulate. Injection of extraarticular corticosteroids may relieve pain from local inflammation. However, steroid injection is controversial because it may reduce bone healing and is contraindicated if subsequent sesamoid bone graft surgery is entertained. Finally, local therapy with orthotics, sesamoid pads, and special shoes may reduce pain and thereby permit ambulation.

It is difficult to know when bone healing will probably not occur and to change the therapeutic goal to reduction of pain to allow ambulation. Most would attempt casting and immobilization if the patient presented within 6 months of fracture. Others would not consider casting if the patient presented more than 2 to 3 months after the injury because the possibility of bone healing with casting at this point has already decreased markedly. These choices should be discussed thoroughly with the patient so that the therapeutic alternatives and their implications are understood.

Finally, if the above regimens have been instituted and pain persists, surgical alternatives are indicated. Sesamoidectomy was first mentioned by Marx in 1904. Although some literature continues to reflect success with surgical excision, complications of neuralgia, hallux rigidus, hammer toe, and persistent pain postoperatively are reported. This may be due to the lack of experience of an individual surgeon, with this procedure because of the small number of cases performed. Because of the poor reputation of this procedure, alternative surgical treatments have been explored.

If the distal fragment of the sesamoid is small, a partial sesamoidectomy of only this fragment can be performed, avoiding the complications of complete removal of the bone. With the larger fragment in situ, the mechanical advantages of shock absorption and increasing the musculotendinous mechanical advantage are still preserved. However, if the pain persists postoperatively, removal of the remaining fragment may be necessary.

Bone grafting of the fractured sesamoid bone may be performed if there are large non-displaced fractures to reconstitute the bone and preserve the mechanical advantage. Although early results are promising, long term follow up is not yet available.

Finally, total excision of the bone may be the only practical surgical alternative if the sesamoid is fractured in multiple pieces. Serial radiographs should be obtained in the non-healing sesamoid. Surgical excision also may be required if there are signs of osteonecrosis with continued pain. These bones rarely heal, and debilitating pain may persist. Consequently a sesamoidectomy is indicated if the diagnosis of avascular necrosis is made.

**CONCLUSION**

Fracture of the medial sesamoid is a rare and difficult to diagnose entity. Optimal therapy of this fracture is still highly controversial. A multi-institutional study pooling the results of various forms of treatment is indicated to conclusively determine the optimal management of the fractured sesamoid.

**REFERENCES**

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CHARACTERIZATION AND INTRAOPERATIVE LOCALIZATION OF A SOFT TISSUE ARTERIOVENOUS MALFORMATION VIA ULTRASOUND

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The diagnosis of musculoskeletal soft tissue tumors and tumor-like masses is often difficult for both the clinician and radiologist, even with the availability of multiple new imaging modalities. Several studies have compared computed tomography (CT) and ultrasound in the diagnosis of soft tissue masses of the extremities.1-3 Although ultrasound does not provide the anatomic detail of CT, it nevertheless can play a significant role in the diagnostic workup of such masses. Magnetic resonance imaging (MRI) often proves valuable in the analysis of soft tissue masses of the extremities by taking advantage of differences in proton relaxation characteristics between normal muscle and pathologic tissue.4-10

We present a case of a soft tissue arteriovenous malformation of the thigh which was well characterized on ultrasound after other imagining modalities, including conventional roentgenograms and CT, were negative. MRI suggested the abnormality, although it could not characterize it. Ultrasound was then used intraoperatively to localize the lesion and help guide in its surgical excision.

CASE REPORT

A 14-year-old girl, with no significant past medical history, had a 1½ year history of sharp pain in the medial left thigh, which increased in frequency and severity prior to examination. The pain increased with motion; slight relief was noted when lying supine. Physical examination was negative except for elicitation of pain in the inner thigh on knee flexion and with local palpation, although no mass was palpable. Neurologic exam was normal. All pulses were intact and equal. Laboratory tests were all normal. Conventional roentgenograms and CT examination were interpreted as normal.

MRI (Technicare 0.6 T) examination (Fig 1) revealed a very subtle asymmetric area of increased signal in the area of the intermuscular septum in the left lower medial thigh between the sartorius and vastus medialis muscles on the T2 weighted images. Ultra-