Unicameral bone cysts are benign, fluid-filled lesions that typically occur in the metaphyseal-diaphyseal regions of long bones within the first 10 years of life. They represent approximately 3% of all bone tumors that are analyzed by biopsy, and their prevalence in males is twice that in females. Unicameral bone cysts are typically asymptomatic until a stress fracture occurs, which accounts for more than 80% of diagnosed cases. These cysts are relatively common in the humerus, femur, and tibia, but they rarely form in the calcaneus. Only two reports have appeared in the literature that involved adults. One report included a few adults (40 patients, mean age 13.2 years, ranging from 4–27 years), which described bone cysts in the humerus, femur, tibia, and fibula. The other report documented 36 cases (33 patients, mean age 37.9 years, ranging from 13–74 years), which stated that 14% of the cysts were localized to the calcaneus.

Case Report

A 36-year-old female runner (168 cm, 54 kg, 36–40 miles per week) presented right lateral midfoot and rear foot pain that was exacerbated by running. She had a history of recurring stress fractures of the midfoot over a period of 7 years. Prior to her most recent episode of pain, the patient had been diagnosed by bone scans as having had stress fractures to the navicular on three occasions. An orthopedist diagnosed the most recent injury as a cuboid stress fracture on the basis of plain radiographs, and she was immobilized in a walker-boot for 6 weeks. The patient reported only moderate aching for the first 4 weeks. During the 6-week period of immobilization, the patient swam four times a week. At the beginning of the 3rd week, she began biking without wearing the walker-boot. She was still using the walker-boot during the 5th and 6th weeks, but she complained of pain. Following the 6 weeks of immobilization, an attempt to run caused the patient to experience the same level of pain in the same location that she had experienced prior to immobilization. The patient then sought the assistance of an athletic trainer (AT). After performing a thorough evaluation that included postural assessment and gait analysis, the AT referred her to a podiatrist. Evaluation at 8 weeks after the diagnosis of a cuboid stress fracture, the patient exhibited an antalgic gait and pain was localized around the lateral calcaneus and cuboid. No obvious soft tissue deformity was apparent and talocrural joint range of motion was within normal limits. Palpation along the middle portion of the lateral aspect of the calcaneus revealed point tenderness, which rated by the patient as 10 on a 1-10 scale. On the basis of the previous radiographic evidence, the earlier diagnosis of a cuboid stress fracture was reaffirmed.
but symptoms in the calcaneus were apparent. MRI revealed a pathological signal intensity in the marrow of the mid-portion of the calcaneus that extended laterally to an area near the site of localized pain. The elevated signal intensity suggested the possibility of a calcaneal stress fracture.

A CT scan was subsequently ordered for comparison with the MRI results (Figures 1-2). The CT scan revealed a 1.8-cm smooth-margined area of radiodensity and several coarsened trabeculae extending through the site of marrow edema in the mid-portion of the calcaneus, which suggested the existence of an intraosseous cyst or hemangioma. Subsequent acquisition of plain radiographs confirmed the presence of some type of cyst or hemangioma.

The differential diagnosis included a unicameral bone cyst with a stress reaction or a pseudo-fracture in the mid-body of the calcaneus. Surgical intervention was recommended to evacuate the cyst, which the patient elected to have performed. An 8-cm lazy-S incision was created along the course of the peroneal tendons in the area proximal to the calcaneo-cuboid joint. Great care was exercised to avoid the sural nerve, which was visualized and retracted. After the cystic structure was identified, a window was created on the lateral aspect of the calcaneus to facilitate curettage and evacuation of the contents of the cyst. The cystic structure was measured to be approximately 3 cm in depth and 1.5 cm in diameter, which had several small branches protruding into other areas of the calcaneus. An osteocele allographic graft (2 cc) was packed into the cystic structure to fill the defect created by curettage, and the bone segment that had been removed to create the window was repositioned on the lateral aspect of the calcaneus.

The patient was immobilized and weight-bearing was avoided for 2 weeks following surgery. Treatment consisted of intermittent ice, compression, and elevation for 30 minutes every 2 hours for the first week. Daily cryotherapy treatments (47°F for 50 minutes) were continued throughout the postsurgical rehabilitation period (VascuTherm, ThermoTek, Inc Flower Mound, TX). For the first week following surgery, the patient received 30-minute cryotherapy treatments at approximately 2-hour intervals throughout the day (approximately five treatments per day). At 3 weeks postsurgery, the patient was placed in a walker-boot and was instructed to begin limited weight-bearing with crutches, and resistive four-way ankle exercises (plantar flexion, dorsiflexion, inversion, and eversion) were initiated. Ankle exercises were performed twice per day, which consisted of three sets of 10 repetitions.

Figure 1  CT of lateral calcaneal marrow intensity. The arrow indicates the area of increased bone marrow intensity.

Figure 2  CT axial section of calcaneus. The arrow points to the cyst.
for each exercise. Following the exercise sessions, cryo-compression treatments were administered for 30 minutes. At 5 weeks postsurgery, the patient discontinued the use of crutches and full weight-bearing was permitted while wearing the walker-boot immobilizer. From 5 to 8 weeks postsurgery, the patient continued to use of the walker-boot, and she was transitioned to self-directed exercise and treatment at home. At 9 weeks postsurgery, use of the walker-boot was discontinued and performance of normal activities was permitted as tolerated. During the same week, 30-minute sessions of gait retraining on a treadmill were initiated, which were performed three times per week under the direction of the AT.

When the patient was released for full activity, she began walking to gradually restore her preinjury running capability (7:20 per mile). During the final gait retraining session at 12 weeks postsurgery, the AT performed a two-dimensional analysis in the sagittal plane while the patient ran 5K at a moderate pace of 8:10 per mile. The patient continued to walk and run to prepare for 5K and 10K runs within 7 weeks of the release to full activity. At 15 weeks postsurgery, she completed a 5K race in 22:52, and at 16 weeks postsurgery, she completed a 10K race in 48:04. The timeline completion of the patient’s rehabilitation program is presented in Table 1. The patient devised her own postsurgery training program in consultation with the AT, which was based on her previous running regimen. Because the patient was an AT and a biomechanics professor, her knowledge facilitated a rapid progression. She generally used pain as a guide and decreased her training intensity for two days whenever pain was experienced.

### Discussion

Unicameral bone cysts are most commonly found in the proximal humerus or proximal femur of children, which have an unknown etiology. Typically, they have a unifocal presentation in skeletally immature individuals.7 Unicameral bone cysts are normally benign, with growth limited by genetics and spontaneously healing after skeletal maturity. Such cysts are rare in adults and are typically identified as a result of radiographs obtained for evaluation of some different condition. If the cyst is asymptomatic, it is best managed nonsurgically and its status monitored. No standard for treatment of a unicameral bone cyst has been universally adopted.1

The competitive runner whose case has been reported experienced stress reactions of the lateral foot

### Table 1. Calcaneal Bone Cyst Rehabilitation

<table>
<thead>
<tr>
<th>Weeks Post-Op</th>
<th>Modality</th>
<th>Frequency</th>
<th>Exercise</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Week 1 (days 1–3)</td>
<td>Ice Compression</td>
<td>30 minutes every other hour</td>
<td>Passive Range of Motion (plantar &amp; dorsiflexion; eversion and inversion)</td>
<td>2 times a day 3 sets of 10 repetitions</td>
</tr>
<tr>
<td>Week 1 (days 4–7)</td>
<td>Ice Compression</td>
<td>30 minutes as needed and following all exercise bouts</td>
<td>Active Range of Motion (plantar and dorsiflexion; eversion and inversion)</td>
<td>3 times a day 3 sets of 10 repetitions</td>
</tr>
<tr>
<td>Weeks 2–8</td>
<td>Ice Compression</td>
<td>30 minutes as needed and following all exercise bouts</td>
<td>Resistive Range of Motion with Thera-Band®</td>
<td>3 times a day 3 sets of 10 repetitions</td>
</tr>
<tr>
<td>Weeks 9–11</td>
<td>Ice Compression</td>
<td>30 minutes following exercise</td>
<td>Walk and run for 3 miles</td>
<td>Once daily</td>
</tr>
<tr>
<td>Week 12</td>
<td>Ice Compression</td>
<td>30 minutes following exercise</td>
<td>Walk and run for 4 miles</td>
<td>Once daily</td>
</tr>
<tr>
<td>Weeks 13–15</td>
<td>Ice Compression</td>
<td>30 minutes following exercise</td>
<td>Walk and run 6 miles</td>
<td>Once daily</td>
</tr>
</tbody>
</table>
over a period of more than 7 years, but the cause was not known until advanced diagnostic imaging identified the existence of a unicameral bone cyst. Unicameral bone cysts normally resolve without treatment and are nonsymptomatic, unless a pseudo fracture develops. The reported case is unique, because the patient was a 36-year-old, and the cyst was associated with a fracture. Once the diagnosis was made and the surgical intervention was performed, the patient returned to pain-free running at 12 weeks postsurgery and was able to compete without pain at 15 weeks postsurgery.

**Clinical Implications**

A unicameral bone cyst seldom presents a progressively worsening condition, and surgery is not needed if pain is absent. In the case that was reviewed, MRI and CT demonstrated the presence of the cyst that was the cause of pain during activity. The cyst had infiltrated the bone structure of the calcaneus, and surgical management was the only option for resolution of the problem. If the patient had continued to run without surgery, the cyst would have ultimately produced a calcaneal fracture and subsequent collapse of the internal bone structure. Athletic trainers and therapists should consider numerous possible conditions in the differential diagnosis when a runner who has a history of recurring injuries reports pain during activity. When pain does not completely resolve after a period of rest, the AT should refer the athlete for advanced diagnostic evaluation.

**References**


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