

# Persistence of bone voids after calcaneal bone-graft harvest

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## Abstract

**Objectives:** The complications associated with iliac crest bone-graft harvest have resulted in the development of alternative harvest sites. Lower extremity alternative sites that have been reported for foot and ankle procedures include greater trochanter, proximal tibia, distal tibia, and calcaneus. These sites have been studied in terms of complications, postoperative pain, and quality of the harvested bone. The long-term effect of the harvest on the bone of the calcaneus has not been reported.

**Methods:** Case report on incidental CT imaging 4 years after bone graft harvest from the calcaneus.

**Results:** This case demonstrates the failure of the calcaneal trabecular bone to regenerate after harvesting cancellous bone graft for foot fusion procedure.

**Conclusions:** The calcaneal graft site should not be used for a repeat bone-graft harvest without advanced imaging to confirm reconstitution of the harvest bed.

## Keywords

Foot, cyst, calcaneal, graft, bone, void

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## Introduction

Among patients with foot and ankle deformities, bone grafts are commonly used to augment arthrodesis and to treat bone defects. Autografts are divided into cancellous, cortical, and vascularized grafts. Cancellous autograft is considered the gold standard for bone graft and has a high viable cell content.<sup>1</sup> Historically, the iliac crest bone graft (ICBG) has been the most frequently used site for bone-graft harvest. The proximal tibia, distal tibia, calcaneus, and greater trochanter are alternative sites that are used for grafting in the ipsilateral lower extremity.<sup>2</sup>

Some of the challenges of autogenous bone grafting include the potential for complications at the harvest site. Iliac crest graft harvest is associated with a range of complications, most commonly persistent pain. Such pain may arise from a hematoma, wound infection, neuropraxia, stress fracture, or incisional pain. It has been reported that anterior iliac graft patients experience pain lasting 3.75 weeks, with 2.8% experiencing persistent pain for over 3 months.<sup>3</sup> Other notable complications include decreased wound healing, residual bleeding, and nerve damage—especially the lateral femoral cutaneous and ilioinguinal nerves.<sup>4</sup> Proximal tibial harvests have documented complications such as non-displaced fractures of the tibial eminence and tibial metaphysis fractures.<sup>5–7</sup>

In foot and ankle surgery, the calcaneus is a convenient harvest site from which graft may be obtained. This site requires a minimal incision and can be reproduced with low morbidity and minimal cost.<sup>8–10</sup> Few published studies exist on the morbidity and complications associated with autograft harvest from the calcaneus. An evaluation of 114 bone-graft harvests, distal tibia (70), and calcaneus (44) showed no major complications associated with either harvest site; 10 patients (8.7%) had minor complications including initial incisional sensitivity or local numbness.<sup>11</sup> Another study evaluated calcaneal bone-graft outcomes in 210 patients treated by six surgeons. Of these, 86.2% reported no complications, 2.9% experienced only incisional nerve sensitivity, 1.9% indicated only incisional pain, 2% reported only shoe limitations, while 4.8% of responders had a combination of symptoms. Only 3 patients

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(1.4%) showed more significant complications including a fracture of the graft site and calcaneal stress fracture and 1 patient with permanent numbness along the sural nerve distribution.<sup>10</sup> A patient outcome study compared four harvest sites (proximal tibia, distal tibia, calcaneus, and ICBG), and their results indicate clinically significant postoperative pain in as much as 12% and 8.5% of subjects at 24 and 52 weeks, respectively. Patients with lower extremity bone-graft sites were indicated as having the highest risk for chronic pain.<sup>12</sup> None of the studies examined the effect of bone-graft harvest on the structure of the calcaneal bone. The case reported here demonstrates the long-term effect of the harvest on the structure of the trabecular bone.

### Case report

A 32-year-old female presented with a displaced Lisfranc ligamentous injury. Bone from the calcaneus was utilized in an arthrodesis of the second metatarsal base as well as the intercuneiform joint. She had an uncomplicated postoperative course. There were no reported complications from the graft harvest site.

After 4 years, she presented to the Orthopedic Surgery Clinic with left midfoot pain and swelling. The pain was exacerbated while standing or walking. The patient did not drink alcohol, use tobacco products, or have systemic illness that would have affected bone healing. There was no pain or swelling reported over the calcaneus or near the bone-graft harvest incisions.

Radiographs (Figure 1) were unremarkable except evidence of prior fusion and mild soft tissue swelling of the left midfoot, especially at the medial aspect. The graft harvest site was not apparent on the radiographs.

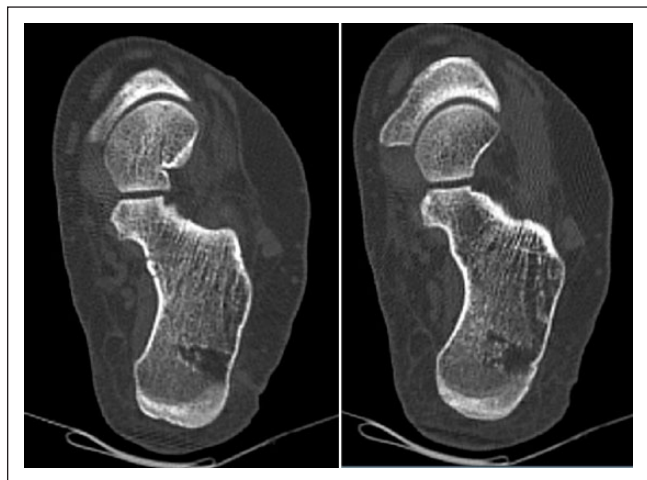
Computed tomography (CT) scan (Figure 2) indicated postoperative fusion of the first and second cuneiforms and base of the second metatarsal with good alignment. The midfoot appeared intact. The left calcaneus demonstrated two well-circumscribed cystic areas consistent with the tunnels created by the bone harvest trephines. The cortical wall of the lateral calcaneus was intact.

### Discussion

The case reported here had an uncomplicated graft harvest from the calcaneus 4 years prior to obtaining a CT scan for pain in the midfoot. The patient's complaints were successfully treated without surgical intervention and did not appear to be associated with the bone-graft harvest site. Neither history nor clinical exam indicated any pathologic changes in the calcaneus. An incidental finding of tunnels created by the bone-graft harvest that had persisted in the trabecular bone of the calcaneus was noted on the CT scan. This persistence of the tunnels raises the question of whether there is reconstitution of the harvested cancellous bone bed. This potential structural change in the calcaneus has not been previously reported.



**Figure 1.** Prior fusion with mild soft tissue swelling of the left midfoot.



**Figure 2.**

The calcaneus is a short bone with a cortical shell and trabecular lines. There are five trabecular groups that have been described in the calcaneus. The thalamic and anterior apophyseal are compressive lines. The inferior plantar, anterior plantar, and posterior achillean are considered tensile.<sup>13</sup> The implications are that forces exerted on the calcaneus are dissipated by the trabecular bone on the interior of the

calcaneus. There is an area that is relatively free of trabecula referred to as Ward's triangle. This can be mistaken for a lucent lesion in the calcaneus.

When the trabeculae are disrupted by a cystic lesion, one would expect it to affect the structural strength of the bone. However, there have been studies that demonstrated that the strength of the calcaneus is not affected by the presence of a cyst.<sup>14</sup> More recent studies have shown that at a critical size, bone cysts can become symptomatic and risk fracture.<sup>15</sup> The implication is that the interior structure does affect the ability of the calcaneus to absorb stress, but it requires large disruption of the architecture to observe the effect.

The transmission of forces through the interior structure of the calcaneus should result in hypertrophy of bone structure by Wolf's law. The disruption of the architecture by the harvest of cancellous bone is likely to create areas of stress concentration. The harvest should also result in hemorrhage bringing progenitor cells to the site of injury. The presence of stress and elements in the hematoma could be assumed to lead to filling of the bone defects created by the harvest. The CT images obtained in this case dispute that line of reasoning. The voids created by the bone-graft harvest did not fill in over time.

The tunnel may behave more like a calcaneal cyst. These voids in the cancellous bone of the calcaneus can be quite large and persistent. These cysts are typically asymptomatic and are an incidental finding in 99.8% of cases.<sup>16</sup> However, symptomatic calcaneal cysts occur mostly in adults of middle age among whom ages range from 13 to 74 years. Over 60% of patients fall between the ages of 21 and 40 years.<sup>16</sup> Radiography of calcaneal cysts typically show them located in the anterior half of the calcaneus and within the trigonum calcis.<sup>17,18</sup> On X-ray, cysts are also indicated as pyramidal shaped, with sclerotic borders and purely lytic.<sup>19</sup> Typically on CT scan, these cysts are shown to be of similar density to water.<sup>16</sup> Since the calcaneus is not a common site for a solitary bone cyst, little is known about the natural history of these lesions. Nonetheless, symptomatic cysts of the heel are treated successfully with curettage and bone grafting.<sup>20</sup>

If one models the tunnels created by bone-graft harvest as calcaneal cysts, we would expect these voids to be asymptomatic. Previous studies do not report additional stress fractures or other indications of structurally compromised calcaneus after bone-graft harvest. There are no reports of the development of enlarging cystic structures. Like most calcaneal cysts, the presence of the tunnels is most likely to be detected incidental to other pathology.

The regeneration of cancellous bone has been documented at the proximal tibia, femur, and the iliac crest.<sup>21–23</sup> The effectiveness of a repeat harvest of cancellous bone at the iliac has been reported.<sup>23</sup> At these sites, it appears that the natural history of graft site is the gradual restoration of the cancellous bone architecture. This does not appear to be the result in the calcaneus.

There is clinical implication for the persistence of the harvest tunnels. The failure of the voids to resolve raises the question of the ability of the calcaneal site to be utilized a second time. Unlike calcaneal cysts, X-ray imaging did not readily demonstrate the presence of the tunnels. The presence of the voids in the cancellous bed would result in sub-optimal yields of bone at the site.

## Conclusion

Unlike other harvest sites, the calcaneus does not appear to regenerate its cancellous bed after percutaneous bone-graft harvest. It would be our recommendation that the calcaneal graft site should not be used for a repeat bone-graft harvest without advanced imaging to confirm reconstitution of the harvest bed.

## Declaration of conflicting interests

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## Ethical approval

Our institution does not require ethical approval for reporting individual cases or case series.

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## Informed consent

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