

# Blown Back to Proportion: Balloon Kyphoplasty for Reduction of Cuboid Compression Fracture with Impeding Tendon Interposition

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## Purpose and Literature Review

One minimally invasive procedure that has become more prevalent of late is kyphoplasty, or the use of an percutaneously placed inflatable bone tamp (IBT) for intraosseous vertebral fracture reduction under fluoroscopic guidance. Since being developed for use in 1998, applications now include tibial plateau, talar dome, and distal radius, among others. Through introduction of an arthroscopic cannula, the IBT is used to reduce the periarticular fractures, which are then stabilized using an injectable synthetic bone cement (ISBC), a technique which has been shown to have equivalent outcomes as traditional fracture reduction and internal fixation. The placement of ISBC into fresh orthopaedic fracture sites has been proven beneficial and provides decreased subjective pain levels and earlier mobilization (1,2). Other authors have demonstrated that ISBC's are superior to traditional bone graft or no bone graft with respect to preventing fracture subsidence (3). Heim et al first described the successful treatment of a cuboid compression fracture utilizing this technique (4), but did not address the peroneal tendons.

This novel surgical approach was utilized to manage a comminuted cuboid compression fracture with peroneus longus (PL) entrapment due to concerns regarding wound healing and the patient's need for expedited recovery. PL tenoscopy was utilized to view the interposed tendon in conjunction with percutaneous IBT for intraosseous fracture reduction under fluoroscopic guidance, followed by fracture segment stabilization using ISBC. Adequate reduction of the cuboid fracture was confirmed along with near anatomic course of the PL tendon via intra-operative tenography.

## Case Study

A 34 year-old male roofer presented after initially being treated at a community Emergency Department for a painful lateral foot stemming from an all-terrain vehicle (ATV) roll-over accident while traveling at moderate speed. The patient's left foot was pinned beneath the overturning ATV, resulting in a dorsiflexion-inversion injury. Initial radiographs from that day were negative for acute fracture or osseous abnormality. The patient was treated conservatively and discharged.

Patient then presented to our clinic, where upon examination, patient was without skin or neurovascular compromise. The patient reported hearing a "pop" at the time of injury, followed by immediate swelling to the right midfoot and hindfoot which had persisted. There was tenderness upon palpation of cuboid, calcaneal-cuboid joint, and along the course of peroneal tendons. Repeat radiographs revealed a subtle radiolucency within the body of the cuboid with associated widening of the calcaneal-cuboid joint, suggestive of a fracture-subluxation (Figure 1). MRI was obtained, confirming a comminuted fracture with entrapment of the PL tendon (Figure 2).

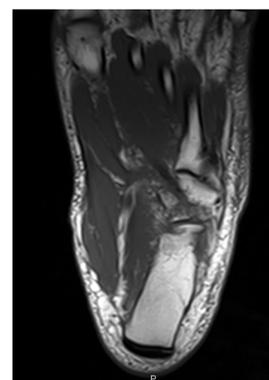
As the sole provider for his family, the patient was adamant about an expedited return to work. Concerns arose from his current pack per day smoker status (7.5 pack-year history) and inability to quit. A minimally invasive surgical approach was subsequently selected to minimize risk of wound complications and his time down.

## Preoperative Imaging

Figure 1:



Figure 2:



## Surgical Procedure

After receiving a pre-operative popliteal and saphenous nerve blocks, the patient was brought to the OR and placed on the operating table in supine position. Peroneal tenoscopy was commenced by accessing the tendon sheath via portal incision just distal to the lateral malleolus. A 2.7mm arthroscope was utilized, revealing mild fraying of the PL tendon without evidence of rupture. Iodine-containing contrast was then injected into the tendon sheath to track the course of the entrapped PL through the fracture fragments. Then, under fluoroscopy, a small incision was made at the dorsal-lateral aspect of the cuboid for trocar placement, overlying the the central fracture fragment. A 1.5cm long trephine was then drilled through the cannula using a 3.5mm drill-bit. Two additional trocars were placed on the medial and proximal margins of the cuboid to ensure no extravasation of the ISBC. A final trocar was placed centrally, over the dorsal aspect of the cuboid (Figure 3). The IBT was then inserted through the aforementioned trephine and inflated to 200 psi (Figure 4). Fracture reduction was confirmed under live fluoroscopy. This step was repeated slightly inferior to the first position. Following reduction, the balloon was deflated and five milliliters of ISBC was injected through the trocar into the newly created void to maintain reduction (Figure 5).

Final fluoroscopy (Figure 6) confirmed adequate reduction of the fracture and no extravasation of the ISBC into the calcaneal-cuboid or lateral tarsometatarsal joint. Lastly, PL tenography was repeated, confirming the tendon traversing plantar to the cuboid along its normal anatomic course (Figure 7). After copious irrigation, skin was closed with 3-0 nylon. The patient was placed into a CAM boot and was instructed to remain non-weight bearing to the left foot with crutches for 10-14 days.

## Intraoperative Imaging

Figure 3:



Figure 4:

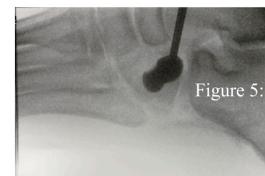


Figure 5:



Figure 6:

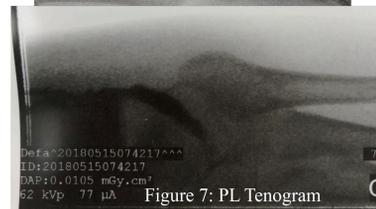


Figure 7: PL Tenogram

## Case Study (Part II)

The patient was then transitioned to weightbearing as tolerated in CAM walker with crutch assist at two weeks postoperatively once sutures were removed. At four weeks, patient was referred to physical therapy with focus on strengthening and increasing function of the affected PL. Radiographs revealed interval placement of ISBC within the cuboid with adequate anatomical reduction of fracture (Figures 8 & 9 below). At twelve weeks there was notable improvement seen in both the AOFAS midfoot and LEF scores in comparison to pre-operative. Patient continues to progress through his post-operative course uneventfully with continued regression of pain.

## Postoperative Imaging and Results



Figure 8:

Pre-Op AOFAS Score	Post-Op AOFAS Score
Midfoot: 53	Midfoot: 82
LEFS: 26/32.5%	LEF: 44/55%



Figure 9:

## Discussion

In this study, a technique used for high-energy crush injuries with a severe comminution, such as spinal compression fractures, can be translated to the small bones of the foot. The outcomes of spinal kyphoplasty have been proven effective with success rates as high as 95%, with significant pain relief following the procedure (5). In articular extremity fractures, use of an IBT followed by an ISBC was shown to be capable of obtaining and maintaining articular reductions in a good or adequate manner at 12-weeks post-operatively (3). Complications in kyphoplasty patients has also remained relatively low, with up to 10% of patients experiencing extrusion of bone cement (6).

## Discussion

The current case report describes percutaneous IBT, or balloon, reduction of a cuboid fracture with entrapped peroneal tendon, followed by internal fixation of the fracture segments via backfilling with a ISBC. In a meta-analysis, authors found the infection rates were significantly lower in fractures managed with ISBC than in controls who were managed with no bone graft substitute (1). Other authors have demonstrated that the use of ISBC are superior to traditional bone graft or no bone graft in regard to preventing fracture subsidence, and allow for less pain and earlier mobilization due to its fast setting nature and lack of need for union (1,2,7). The compressive strength of calcium sulfate bone cement has been reported as 55 megapascals, equivalent to the strength of intact cancellous bone (8), essentially eliminating the need and potential complications associated with the use of allograft (1,2).

PL tenogram along with cuboid fracture management has not been previously described in literature. The utility of peroneal tenography has been demonstrated in identifying the prevalence of peroneal tendon impingement in patients with lateral pain following calcaneal fractures (9). Additionally, several authors have shown the usefulness of tenography in diagnosing various tendon and ligament abnormalities in the ankle with success in regards to dictating appropriate therapy (10).

Overall, this application of percutaneous balloon reduction with use of ISBC and use of tenography for management of a comminuted cuboid fracture is a viable and reproducible alternative to previously described techniques for these types of injuries. Expected risk and complication rates in our application of "cuboplasty" should be less than or equal to those previously described for spinal kyphoplasty due to lack of proximity to vital neurovascular structures. Using an ISBC as opposed to bone grafting, the time to healing is expected to decrease as compared to the traditional approach due to lack of need for biologic graft incorporation.

Overall, ISBC proves to be an acceptable method of fixation for fracture comminution or impacted articular surfaces in various crush injuries, and in conjunction with a percutaneous reduction, this technique will allow patients to return to activity in a timelier manner. PL tenography was vital to confirm the reduction of the tendon along its natural anatomic course through the peroneal groove, which was unable to be visualized via intraoperative fluoroscopy. Our technique allows for a percutaneous reduction of a severely comminuted cuboid fracture with restoration of the lateral column and explanation of the entrapped PL tendon while preserving the soft tissue envelope. To our knowledge, this is the only instance of this type of surgical technique described in the foot and ankle literature. We believe future studies are warranted to determine the efficacy and the long-term results of this procedure.

## References

1. Bujmala SS, Zlowodzki M, Ledwith A, et al. The use of calcium phosphate bone cement in fracture treatment: A meta-analysis of randomized trials. *J Bone Joint Surg Am* 2008;90(June (6)):186-96.
2. Keating JI, Haghighi G, Harper J. Minimal internal fixation and calcium-phosphate cement in the treatment of fractures of the tibial plateau. A pilot study. *J Bone Joint Surg Br* 2003;85(January (1)):68-73.
3. Henney, Jake E, Roberts E, Redfern, and Stephen Wanjiku. "Subjective and novel objective radiographic evaluation of inflatable bone tamp treatment of articular calcaneus, tibial plateau, tibial pilon and distal radius fractures." *Injury* 44:8 (2013): 1127-1134.
4. Heim, Kathryn A, et al. "Cuboid Reduction and Fixation Using a Kyphoplasty Balloon: A Case Report." *Foot & Ankle International*, vol. 29, no. 11, 2008, pp. 1154-1157, doi: 10.3113/foot.2008.1154.
5. Garfin, SR, Yuan, HA, Reiley, MA. New technologies in spine: kyphoplasty and vertebroplasty for the treatment of painful osteoporotic compression fractures. *Spine*. 26:1511-5, 2001.
6. Pfoeder, DR, Khanna, AJ, Lieberman, HE. Vertebroplasty and kyphoplasty for the management of osteoporotic vertebral compression fractures. *Orthop Clin North Am*. 38:409-18, 2007.
7. Cassidy C, Jupiter JB, Cohen M, et al. Nonion SRS cement compared with conventional fixation in distal radial fractures. A randomized study. *J Bone Joint Surg* 2003;85, 4(November (11)):2127-37.
8. Rohli J, Larson E, Linds E, Odgaard A, Jorgensen J. Tensile and compressive properties of cancellous bone. *J Biomech* 1991; 24:1143-1149.
9. Chen, Wei, et al. "Peroneal Tenography to Evaluate Lateral Hindfoot Pain after Calcaneal Fracture." *Foot & Ankle International*, vol. 32, no. 8, 2011, pp. 789-795.
10. Jaffe NW, Gilula LA, Wosman RD, Johnson JE. Diagnostic and Therapeutic Ankle Tenography: Outcomes and Complications. *Am J Roentgenology* 2001; 176: 365-371.