Utilization of Subchondroplasty for Recalcitrant Metatarsal Stress Fractures

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Care That's Always a Step Ahead.

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Introduction

First described in 1855 as march fractures (1), metatarsal stress fractures account for 38% of lower extremity stress fractures (2). These stress fractures often present as nonspecific midfoot swelling and pain with insidious onset. Treatment usually involves immobilization until radiographic evidence of bony callus and clinical symptoms improve, often over a period of 4-6 weeks (3). Advanced imaging such as magnetic resonance imaging is more sensitive and can detect T2 marrow edema or a hypointense T1 fracture line.

Subchondroplasty is described as injection of synthetic calcium phosphate (CaP) into a region of bone marrow edema, filling intertrabecular space, providing local mechanical support. This technique was originally utilized by orthopedic surgeons for arthritis associated bone edema in the knee (4). To our knowledge, subchondroplasty in the foot and ankle is limited; primarily indicated for treatment of osteochondral defects and avascular necrosis (5, 6). Given subchondroplasty's ability to fill intertrabecular space, we show with minimal periosteal disruption, once hardened, the CaP provides additional scaffolding and support for metatarsal stress fractures, in the same fashion as internal fixation, allowing an earlier return to activity.

Methods / Techniques

We present six patients with a total of 8 metatarsal stress fractures who underwent subchondroplasty. All six were female, with an average age of 52 and body mass index of 36.9. Initial treatment involved immobilization in a CAM boot along with Calcium and Vitamin D supplementation and serial radiographs every two weeks. Lack of clinical improvement and failure of radiographic signs of bony callus formation led to operative intervention. Additional MRI was performed to confirm diagnosis.

Surgical technique is relatively straightforward: a small stab incision was made under fluoroscopy to the affected site where a cannula was drilled into the metatarsal and calcium phosphate injected into the medullary canal with care to not overfill to backpressure. Patients were placed in a postoperative splint for one week, nonweightbearing cast for a week, and weight bearing as tolerated in a CAM boot. The patients were instructed to transition to regular shoegear based on clinical exam and radiographic findings.

Fig 1: Preoperative MRI

Fig 2: Preoperative Xray

Fig 3: 4 week postop Xray

Results

Six patients with eight metatarsal stress fractures were included in this case series. Patients were treated conservatively for an average of 86.5 days with no significant clinical improvement. All but 1 patient had MRI confirmation on average of 45.4 days after no improvement with conservative therapy. Seven of eight stress fractures were successfully treated with subchondroplasty (87.5%), with the one patient developing a radiographic nonunion and electing for no more intervention. Of the successful cases, resolution of pain in ambulatory boot occurred at 34.2 days, and patients were transitioned into regular shoes by day 37. All patients had a minimum 1 year follow up with no recurrences.

Patient	Age	Gender	L/R	Met	Smoking	EtOH	BMI	Imaging	Days Cons Tx	Symptoms Resolve	Reg Shoes
1	68	F	L	2	No	No	45.5	MRI	78	27	27
			L	3	No	No					
2	68	F	L	2	Former	Yes	39.1	MRI / CT	191	N/A	N/A
3	28	F	L	3	No	Yes	39.5	MRI	59	39	39
4	35	F	L	2	No	Yes	28.3	MRI	87	25	25
5	61	F	R	2	Former	No	37.6	MRI	43	40	54
			R	4							
6	53	F	R	3	Former	Yes	31.5	MRI	113	40	40
Avg	52						36.9		95.2	34.2	37

Analysis & Discussion

When conservative management of stress fractures fail, few additional modalities exist to choose from. We believe the application of subchondroplasty can offer an alternative to this group of patients. The CaP in subchondroplasty serves as a fast hardening porous inorganic scaffold, mimicking the strength and of normal cancellous bone, which over time is resorbed and remodeled, on average 6 months to two years (7). With careful closure of periosteum, the calcium phosphate does not extrude and serves as an internal splintage.

Subchondroplasty was originally indicated for bone marrow edema secondary to arthritis in tibial plateau injuries. Sharkey et al. retrospectively evaluated 66 patients with bone marrow lesions and advanced osteoarthritis, finding combined with arthroscopy, subchondroplasty improved VAS scores with quick return to activity on a two year follow up (8). Miller et al. reported subchondroplasty used to treat bone marrow edema of the talus with both patients returning to full activity (9).

Although our case series is small, results are promising. Stabilization of the trabecular scaffolding allows patients to transition to regular activity sooner. The average time to normal shoegear in patients treated successfully with subchondroplasty was 37 days after 86.5 days of unsuccessful conservative management. To this point, no patients have developed recurrent stress fractures, but follow up should ideally last two years, the time necessary to completely resorb the injectible CaP. Additional shortcomings of the study include insufficient patients and patient feedback reflected in validated scoring systems such as visual analog scale (VAS) or Short Form Health Survey (SF-36). We believe with additional more robust studies, subchondroplasty prove to be a viable treatment option for recalcitrant metatarsal stress fractures.

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