Core Decompression with Bone Marrow Aspirate Concentrate in an Equine Model of Subchondral Osteonecrosis: A Translational Platform for Regenerative Orthopedics

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INTRODUCTION: Core decompression (CD) with bone marrow aspirate concentrate (BMAC) is widely used to treat early-stage femoral head osteonecrosis in humans, where it alleviates intraosseous pressure (IOP), restores perfusion, and enhances angiogenesis and osteogenesis.[1-3] Early intervention before subchondral collapse (Ficat/ARCO I–II) is critical for success, with long-term preservation rates reaching 70-90% when BMAC is added.[4-5] Large-animal translational models that replicate subchondral ischemic bone injury under physiologic loading are limited.
The equine distal sesamoid (navicular) bone represents a uniquely relevant translational model. It is a dense, high-load subchondral structure with limited vascularity and a propensity for bone marrow-like edema and osteonecrotic lesions detectable by MRI.[6-7] Perfusion studies demonstrate venous stasis and increased IOP as key mechanisms underlying navicular pain,[8] analogous to human osteonecrosis pathophysiology. This small-cohort study evaluated the safety and long-term efficacy of CD augmented with autologous BMAC for MRI-confirmed distal sesamoid trabecular pathology refractory to standard therapies.

METHODS: Client-owned sport horses with chronic foot lameness localized by diagnostic analgesia, radiography- and MRI-confirmed trabecular pathology (Figure 1), and failed conservative management (orthopedic shoeing, bisphosphonates, corticosteroids, hyaluronic acid, 2.5% polyacrylamide hydrogel, or autologous protein solution) were retrospectively reviewed. All procedures were performed by the same surgeon (GM).
CD was performed under fluoroscopic guidance using a transthecal arthroscopic approach to the palmar recess of the distal interphalangeal joint.[9] A T-handle 8G open-tip needle and 3.2 mm drill were advanced into the lesion. Autologous BMAC (~2 mL) was injected intraosseously until fluid efflux was noted; residual BMAC was delivered into the joint. BMAC preparation followed an established equine protocol[10] consistent with human methods emphasizing low volume, high cell density, and minimal manipulation.[11-12]
Postoperatively, horses underwent two weeks of stall rest, ten weeks of hand- and under-saddle walking, and gradual trotting over six weeks. All received corrective shoeing. Clinical and MRI follow-up were conducted at ≥6 months, with radiographs up to 48 months. MRI evaluation (blinded) assessed STIR and T1-weighted changes indicative of edema resolution or trabecular remodeling.

RESULTS SECTION: Twenty-one horses underwent CD + BMAC between 2021 and 2024; nine (11 feet) had ≥18-month follow-up and are included in further outcome observations (Figure 2). All horses recovered uneventfully without intra- or post-operative complications. At six months, six (67%) were sound and returned to training, while three (33%) remained lame. Improved cases exhibited decreased STIR hyperintensity and increased T1 signal intensity consistent with revascularization and bone repair.[13] At 12-18 months, all six remained sound: one surpassed pre-operative performance, two returned to their prior level, and three performed below pre-injury capacity. Radiographs at 6-18 months showed partial to complete remodeling of cyst-like lesions in 3/6 horses, while others showed stable defect margins without progression. No new distal interphalangeal joint or navicular bursa pathology was detected.

DISCUSSION: Although based on a small cohort, these findings align closely with human data showing that combining core decompression with BMAC improves pain relief, radiographic outcomes, and joint preservation rates compared to CD alone in early osteonecrosis[4-5,14] The equine distal sesamoid bone offers a unique translational analogue for human subchondral bone disease: it is a high-load, avascular structure enclosed by dense cortical bone, with limited intraosseous circulation and high mechanical stress similar to the human femoral head, talus, and metatarsal head.[8] As in humans, impaired venous drainage and increased intraosseous pressure are thought to underlie bone marrow lesion-like pathology,[6-7] making this model highly relevant for studying intraosseous decompression and biologic repair.
The combined mechanical and biologic intervention produced sustained functional improvement and MRI evidence of reduced marrow edema and trabecular restoration.[13] These imaging changes reflect improved perfusion and bone remodeling consistent with human postoperative findings following CD + BMAC.[1, 11] The equine model further provides a natural weight-bearing environment where intraosseous pressure dynamics and mechanical adaptation occur under physiologic load, thereby capturing aspects of healing that small-animal models cannot.
Limitations include the retrospective design, small sample size, and lack of lesion staging. Future studies should adopt a standardized ARCO/Ficat-like classification to stratify severity, quantify BMAC cellular content,[15] and directly compare CD alone versus CD + BMAC. Collectively, these results support the distal sesamoid bone as a relevant large-animal platform for preclinical testing of regenerative and cell-based therapies for ischemic bone disease.

SIGNIFICANCE/CLINICAL RELEVANCE: Core decompression augmented by autologous BMAC was feasible, safe, and associated with durable clinical and imaging improvement in equine subchondral osteonecrosis. The equine distal sesamoid bone offers a powerful translational platform to evaluate regenerative and cell-based interventions for ischemic bone disease under physiologic load-bearing conditions.

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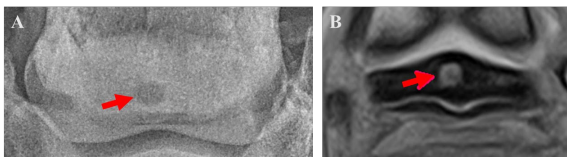

Figure 1. Preoperative imaging of DSB pathology.
(A) Lateromedial radiograph showing a focal radiolucent lesion in the distal third of the trabecular bone (arrow). (B) Corresponding transverse T1-weighted MRI showing a well-defined hypointense region with adjacent signal change, consistent with advanced trabecular pathology and increased intraosseous pressure.

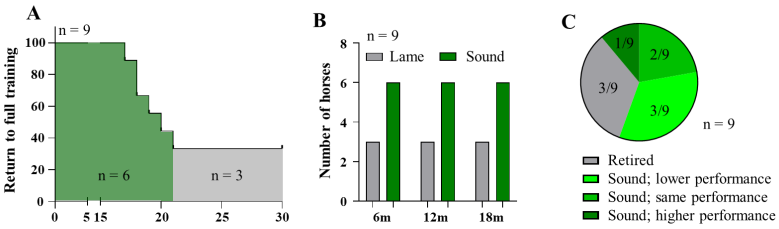

Figure 2. Postoperative clinical and performance outcomes following core decompression and BMAC therapy.
(A) Kaplan-Meier curve illustrating time to return to full training; six horses (67%) achieved training within 18–21 weeks, while did not resume full work. (B) Proportion of sound (green) and lame (gray) horses at 6, 12, and 18 months postoperatively. (C) Distribution of long-term performance outcomes: 1/9 horses achieved higher post-operative than pre-operative performance, 2/9 horses competed on the same level, 3/9 horses performed on a lower level post-operatively and 3/9 horses were retired.