Subchondral Bone Remodelling After Nanofractures: An 1 Year In-Vivo Ovine Study

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Summary:
Nanofracture offers a smaller and deeper solution compared to a standard microfracture procedure. It penetrates down to a standardized 9mm depth to reach the marrow cells. We carried out a study to compare subchondral bone remodeling at 6 mm and 1 y after treatment of chondral defects with microFx or nanoFx with subchondral bone remodeling assessment with MicroCT and cartilage istological analyse

Abstract:
The microfracture still represents the most frequently used primary technique to repair chondral defects. However, the formation of a fibrocartilagenous tissue-type are important limitations. These shortcomings may be attributed to the limited perforation depth of the microfracture awl combined with apparent subchondral bone compaction surrounding the microfracture channel.
Nanofracture offers a smaller and deeper solution compared to a standard microfracture procedure. The instruments consist of a 1mm pick that disrupts less surface area than a standard microfracture technique and it was purposefully designed to reduce damage to the subchondral plate. It penetrates down to a standardized 9mm depth to reach the targeted marrow cells, three times deeper than comparable microfracture techniques.

Methods and Materials
In our Orthopaedic Clinic we carried out a study to compare subchondral bone remodeling at 6 months and 1 year after treatment of chondral defects with microfracture or nanofracture. Full-thickness chondral lesions were created in the load bearing area of the medial femoral condyle in 8 sheep. Each sheep was treated on one side with microfracture and on the other side with nanofracture. Subchondral bone remodeling was assessed on MicroCT using SKYSCAN (Bruker) and CTVOX software for image reconstruction. Trabecular bone density assessment was performed through color coded structure thickness analysis.

Results
MicroCT of the microfracture samples showed a limited perforation depth of the awl. The conical shaped channels had large diameters at the joint surface. Channel walls displayed high regularity with significant trabecular bone compaction and limited communication of the channel with the surrounding trabecular canals. MicroCT scans of the condyles treated with nanofracture showed instead a greater depth of the perforations, natural irregularities of the channel walls, absence of trabecular compaction and remarkable communication between pre-existing trabecular canals and the perforation. Color coded structure analysis showed less trabecular fragmentation surrounding the channels as well as intra-channel bone remodeling with a trabecular structure similar to the native subchondral bone. In the regenerated tissue analyzed at 1 year can be noted cell clones in multiple quantities. Immunofluorescence can identify collagen type 2, with a Hyalin-like tissue, but without tide-mark formation, and with no-bonding between repaired and healty tissue.

Conclusion
Nanofracture represents an innovative technique that allows for deeper perforation into the subchondral bone with less trabecular fragmentation and compaction when compared to microfracture. As a result, communication with a large number of the native trabecular canals allows better bone marrow access and therefore greater restoration of the normal architecture of the subchondral bone. The significance of new 1 year follow-up bone parameters has yet to be fully understood.