Role Of Subchondral Bone In Cartilage Repair

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An osteochondral unit consists of calcified cartilage, cement line, subchondral bone plate and subarticular spongiosa; all four layer having a superficial covering of articular cartilage. For a cartilage surgeon, it is important to understand that osteochondral area works as a unit and not separate entities. Certain diseases of cartilage are actually diseases of subchondral bone rather than a disease of cartilage per se. OCD is one such disease where the pathological process starts in the subchondral bone, gradually causing separation of the affected bone from the surrounding healthy subchondral bone. An unstable and probably unviable subchondral bone causes overlying cartilage to stop functioning in its normal capacity. Gradually the whole osteochondral unit separates with overlying cartilage. A similar disease process might be affecting the cases with osteonecrosis.

There are various important roles that cartilage and subchondral bone play to support each other like load bearing, nutritional support and supply of cells and growth factors. Cartilage has a protective role for the underlying bone from the joint stresses and on the other side subchondral bone has a supportive role to play for the cartilage. This is a synergistic role where both work in a perfect homeostatic balance and neutralize abnormal stresses on each other. For example, an isolated chondral injury can alter the homeostatic balance of the joint leading to progression of surrounding cartilage damage. It also makes the area more vulnerable to the shear forces, ultimately leading to increase in the size of focal chondral defect and changes in the otherwise normal underlying subchondral bone plate in form of overgrowth or bone loss. Here, the protective role of the cartilage is lost, leading to damage to the underlying bone. On the other hand, a subchondral bone fracture also leads to changes in homeostatic balance of the joint and leads to unsupported cartilage over it. The supportive role of the subchondral bone is lost leading to the damage to the overlying cartilage. It has also been shown that blood vessels from subchondral region can extend in to the overlying calcified cartilage, and nutrients reach chondrocytes in the calcified zone. Their diffusion can occur in a similar way that can occur between synovial fluid and the superficial cartilage layers (Madry et al. 2010). Though collagen fibers cross between calcified and un-calcified cartilage, there is no crossing of collagen fibers between calcified cartilage and subchondral bone plate. In addition, there is a considerable change in the biomechanical properties of calcified and un-calcified articular cartilage in adults due to mineralization, making this area weak. This is the reason for a high incidence of
isolated chondral separation occurring due to shear forces in adults (Johnson-Nurse et al. 1985). The regenerative tissues in the repaired cartilage need support from healthy subchondral bone; otherwise the overlying cartilage repair will fail (Madry et al. 2010). In the regenerating cartilage, collagen fibers must also develop cross links so as to provide a scaffolding support till a week chondral or osteochondral construct gains maturity. An external brace support and limited weight bearing is needed till the time collagen fibers makes the scaffold strong.

A proper attention to the subchondral bone is thus important to maintain a healthy cartilaginous tissue and to regenerate a healthy cartilage in case of cartilage loss, as both tissues work as one unit.