Cartilage Repair

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Cartilage is a firm connective tissue that covers and protects the ends of long bones at the joint; provides structural support for the ribcage, the nose, and the bronchial tubes; and makes up the outer ear. It is not as hard as bone, but much stiffer and less flexible than muscle. Articular cartilage covers the surfaces of the joints, providing a smooth surface and facilitating movement.

Cartilage is composed of a dense extracellular matrix (ECM) that includes water, collagen, proteins and glycoproteins, and specialized cells called chondrocytes. Chondrocytes are metabolically active cells that assist in the development, maintenance, and repair of the ECM. As much as 80% of cartilage is water by weight, and one of the functions of the ECM is to retain water, which is required in order for cartilage to perform its mechanical functions and to deliver nutrients to the chondrocytes. Unlike other tissues, cartilage does not have blood vessels, nerves, or lymphatic tissue, which has led many medical professionals to conclude that damaged or diminished cartilage cannot be repaired.

Cartilage develops during childhood, and an important factor is activity levels, which help to determine the volume of cartilage in knees and other joints. One study showed that kids between the age of 9 and 18 who consistently participated in average-intensity sports gained approximately twice as much cartilage as those who exercised less.[1]

Damaged cartilage can cause inflammation, pain, and stiffness. However, damaged cartilage is not the only cause of joint pain, and people who have damaged cartilage do not always experience pain and stiffness. Abnormalities in knee cartilage are found in both people who do and do not have pain.[2]

There are several ways in which cartilage can be damaged, including trauma and osteoarthritis, or "wear and tear." Over time, the ECM becomes dehydrated, which results in stiffness and degradation of the cartilage. The most common structural change in knees associated with aging are defects in cartilage, thinning of cartilage, and increase in bone size without change in volume of cartilage. The incidence of knee cartilage defects increases with both age and body mass index.[3]

One of the biggest contributors to cartilage destruction is inactivity, since humans have to move in order to maintain healthy joints. Animal studies show that inactivity for only a few weeks can reduce the thickness of cartilage by as much as 50%.[4] Conversely, once animals are allowed to resume movement, the cartilage restores itself to normal after only a few weeks.[5]

Drugs are the first line of treatment and include pain medications like NSAIDS and steroid injections. But there is some evidence that NSAIDS, while reducing pain, actually cause more damage to the cartilage,[6] and steroid injections can interfere with recovery.[7] One of the most common treatments for damaged articular cartilage is knee and joint replacement, and every year hundreds of thousands of these procedures are performed in the U.S.

But these surgeries may not always be necessary because cartilage can regenerate. In addition to the animal studies cited above, a longitudinal study of 43 patients showed that 23% of grade 1 lesions returned to normal.[8]

A 2-year study including 325 subjects showed that 37% of patients experienced improvement in cartilage defects in at least one area of the knee. The authors wrote, "This suggests that knee cartilage defects are reversible and may represent an intermediate factor to study early in the natural history of knee OA."[9] Just as important, they wrote "there was no significant difference in chronic knee pain or past knee injury between those who had increases [in cartilage defects] and those who had decreases." This reinforces the point made earlier that damaged cartilage is not always the cause of pain, and the importance of identifying the cause before beginning any treatment plan.

A study conducted in Australia included 86 healthy subjects. At the beginning of the study, 19 locations were identified in which at least half of the cartilage tissue had worn away. At 2 years of follow-up, improvement was noted in more than half, slightly less than one third had gotten worse, and the remainder were the same. The most interesting finding was that those subjects with the worst cartilage destruction were the most likely to show improvement.[10]

Patients with osteoarthritis and damaged or diminished cartilage are often advised to avoid exercise in order to prevent further damage. But research shows that this is bad advice; exercise can actually help people with osteoarthritis and can stimulate cartilage regeneration.

A study in Sweden involved patients who had previously had knee surgery, many of whom continued to have pain, stiffness, and functional limitations. Twenty two patients were randomized to participate in exercise, and 23 were assigned to a control group. None of the subjects in the control group reported increased activity levels, while 68% of the exercise group increased their activity levels. The patients in the exercise group showed improvement in the compositional makeup of the cartilage in a dose-dependent manner – the more exercise they did, the more improvement noted.

This was the first human study that confirmed the findings of animal studies showing that improvement in cartilage and reduction in stiffness is related to the degree of joint loading. Humans in this study who exercised more showed increases in

glycosaminoglycans (GAG), an important component of cartilage, which can improve the elasticity of cartilage and protect it against biomechanical force.[11] Research has shown that patients who have joint disease often have decreases in GAG content in their cartilage, and that the severity of their pain is related to the GAG content of the cartilage.[12]

Connie Chu, MD, is a Stanford University orthopedics professor and researcher who also treats cartilage and ligament injuries. She and her colleagues have been researching ways to both predict and heal damage to cartilage in order to reduce the number of people who require joint replacement. In a recent study the group used a new imaging technique which was able to assess cartilage health in 42 subjects, 31 of whom had ACL tears. Following ACL reconstruction and rest, most of the injured cartilage repaired itself.[13]

The bottom line is that cartilage, like other tissues in the body, has amazing self-repairing capability. Individuals with damaged or diminished cartilage should be encouraged to engage in aggressive exercise in order to stimulate cartilage regeneration.

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