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Cartilage Injury: Overview and Treatment Algorithm

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The athlete's knee is exposed to various degrees of sporting activity, injury, and chronologic aging effects, which frequently result in a spectrum of meniscal, ligamentous, and articular cartilage disorders. Participation in routine and competitive sports may result in a higher incidence of acute and chronic injury, chronic overuse syndromes, and osteoarthritis. One of the goals of this chapter is to introduce a new concept, *chondropenia*, the earliest degenerative cartilage lesion, and highlight and highlight its pathogenesis leading to the end-stage articular cartilage lesion, *osteoarthritis*. The "chondropenia curve," a working concept, is also introduced. A treatment algorithm for knee articular cartilage injuries, based on the current understanding of the natural history of cartilage injuries and the current state-of-the-art treatments, is covered in detail. The emphasis of this algorithm is on preservation of long-term joint function.

THE LOSS OF FORM AND FUNCTION: CHONDROPENIA, THE EARLIEST ARTICULAR CARTILAGE LESION

Articular cartilage is a viscoelastic material that allows variable load bearing during daily functional and athletic activities. Functionally, stress reduction on the subchondral bone and minimization of friction are essential in fulfilling this role. The characteristics of articular cartilage are dependent on its specific structural composition and organization.[1] Normal articular hyaline cartilage is composed of an extracellular matrix, chondrocytes, and water. The range of water concentration varies from 65% to 85% depending on the load status and the presence or absence of degenerative changes. This structure is contiguous with and overlies the subchondral bone of the joint. The extracellular matrix is primarily made up of type II collagen fibers. Sulfated proteoglycans are linked to hyaluronate proteins that facilitate the creation of a hydrophilic latticework and are responsible for tensile strength and resiliency of articular cartilage. The functional organizational unit of articular cartilage is composed of four layers, including the tangential zone, intermediate zone, calcified cartilage, the tidemark, and the subchondral bone. The subchondral bone and the calcified cartilage are crucial supportive structures that become thickened and abnormal in the process of arthrosis. The complexities of composition, organization and morphology dictate the material and structural properties of articular cartilage.

It is the resilience of the functional load-bearing unit that is essential for functional success. The elite athlete is able to consistently perform at the highest levels of activity (dose) and perform (response) without any symptoms elicited from the knee joint. It is only loss of articular integrity, through injury, pathologic loading, and aging, that results in chondropenic and degenerative changes over time. These changes initially include loss of cartilage volume, then later articular cartilage defects with subsequent elevation of joint contact pressures develop. The clinical results of these changes amount to a conceptual drop on the dose–repose curve, or *"chondropenia curve"* (Figure 4.1). Clinically, as the articular cartilage integrity fails and with each step down the curve, the athlete finds he is unable to reach the same levels of performance (response) with an executed activity (dose).

The concept of the chondropenia curve defines a strategy aimed at maintaining the knee and its cartilage functional through the application of therapeutic interventions. Without intervention, the injured joint is destined to fail and succumb to dysfunction and further degeneration. In summary, the loss of cartilage integrity falls within a continuum, with chondropenia and osteoarthritis on the opposite poles of the spectrum. Therefore, the goal of the sports medicine physician is to optimize performance by maintaining articular cartilage integrity and preventing a downward slide on this chondropenia curve.

PATHOGENESIS OF CHONDROPENIA AND OSTEOARTHRITIS

A New Dilemma: Identifying Chondropenia

One of the principal challenges for the benchtop scientist and clinician comes from a lack of accurate measurement tools to objectively identify chondropenia and the pathologic progression of articular cartilage failure. For osteoporosis, the early osseous lesion, osteopenia, that predisposes patients to patho-