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NEWEST GENERATION CHONDROCYTE IMPLANTATION

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Injuries of the articular cartilage surfaces of the knee are frequently observed in football players with an increasing number of chondral injuries particularly in players at the competitive collegiate, professional and world-class level. The high demands on the joint surfaces in football athletes and high risk for joint degeneration make treatment make effective restoration of articular cartilage injuries critically important to facilitate continued athletic participation even at the highest level. First generation Autologous Chondrocyte Implantation (ACI) presents a groundbreaking technology that was first reported in 1994. With this technique, chondrocytes are harvested from a nonweightbearing area of the joint and then multiplied in vitro before reimplantation is performed. ACI has achieved successful hyaline-like articular cartilage restoration with durability of functional improved of up to 20 years. In the athletes, good to excellent results were demonstrated in 72-96% with improvement of activity scores in 82-100%. Thirty-three to ninety-six percent return to high impact-athletics, 60-80% at the same skill level. Return to sport was best in competitive athletes (83%) and adolescent athletes (96%) and 87% of returning athletes maintained their ability to perform 52 months after surgery. Athletes with single lesions, age< 25 years, and short preoperative intervals had the best rate of return to sport. Participation in sports improved the long-term functional results after ACI. Limitations of this first generation technique include its invasiveness, prolonged postoperative rehabilitation, and graft delamination from periosteal hypertrophy. Sport-specific rehabilitation has successfully reduced time to return to sport while substitution of the periosteum with a collagen membrane has reduced the risk for hypertrophy and delamination. Second-generation autologous cartilage transplantation techniques use biodegradable scaffolds to temporarily support the chondrocytes. This so called Matrix-Associated Chondrocyte Implantation (MACI) uses a biomatrix seeded with chondrocytes and reduces surgical invasiveness, chondrocyte leakage, and graft hypertrophy. MACI demonstrated improved knee function scores and Knee Injury and Osteoarthritis Outcome Score (KOOS) sports and activity scores and hyaline-like tissue and Magnetic Resonance Imaging (MRI) after 60 months. Arthroscopic MACI has been described with a hyaluronic acid-based scaffold and showed improvement of knee function in 90% with durable improvement at 5 years. Better results were seen in patients younger than 30 years and athletes participating in higher level competitive sports. Neocartilage implantation presents the newest generation chondrocyte transplantation technology and uses advanced tissue engineering technology that generates an implant containing both chondrocytes and extracellular matrix. With this technique, chondrocytes are expanded in a two- dimensional culture, and then seeded in a collagen gel/sponge construct. Dynamic incubation of this three-dimensional construct under defined hydrostatic pressure in a specifically designed bioreactor stimulates the cells to produce cartilage matrix proteins resulting in formation of a firm sponge-like neocartilage containing both active chondrocytes and extracellular matrix (NeoCart). Implantation is performed using a novel bioadhesive which facilitates a minimally invasive surgical approach. Since it bypasses the initial phase of chondrocyte implantation and in vivo matrix production, this technique may allow for shortening of the prolonged rehabilitation after cartilage repair and possibly earlier return to sport. Phase I+II trials showed good cartilage fill in 75%, excellent peripheral integration, and pain relief in 86% up to two years after implantation. Advanced MRI with T2 mapping demonstrated hyaline cartilage in 57%. Larger prospective, randomized evaluation of this technique is currently being completed.
In conclusion, recently developed chondrocyte transplantation techniques can successfully improve joint function and facilitate durable return to high-impact sports such as football. Newest technologies allow for less invasive implantation and faster recovery making them a very attractive option for the competitive football population.