

Hyaluronic Scaffold and BMAC in Large Cartilage Lesions: The Biologic Arthroplasty 10-Year Experience

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BACKGROUND

Cartilage injury is a leading cause of functional disability and pain. A number of techniques of cartilage repair are available, with variable outcomes expected, depending on the method used and the characteristic of the cartilage lesion. Cartilage restoration treatments should ideally provide durable repair tissue for a wide range of lesion sizes and types. Advanced cell-based therapies, such as autologous chondrocyte implantation, have been associated with successful long-term results, however, procedures such as this are performed in multiple stages, and can be cost-prohibitive.

Increasing attention is being paid to the treatment of early degenerative lesions, with the goal of sparing the patient from total joint arthroplasty, or delaying the need for this type of surgical procedure. Many young and middle-aged patients who present with symptomatic cartilage lesions are not interested in surgical solutions involving joint prostheses, and are actively seeking out new therapeutic alternatives to treat early degenerative cartilage injury.

To restore areas of cartilage loss, there is growing interest in the use of mesenchymal stem cells (MSCs), as a one-stage procedure to treat cartilage injury. MSCs have an inherent potential to differentiate into mesenchymal tissues such as cartilage,^{1,2} and these cells are readily obtained from autologous sources, such as bone marrow.

In order to perform one-stage cartilage repair using a method that is cost-effective and capable of providing durable clinical outcomes, our center has examined the use of a hyaluronic acid-based scaffold in conjunction with bone marrow aspirate concentrate (HA-BMAC), and medium-term results have demonstrated encouraging treatment success, comparable to other methods of cell-based therapy.

CONTENT

Cartilage restoration procedures aim to provide long-term benefit by reducing the incidence of degenerative cartilage wear, or by slowing the progression of degenerative change. There has been a growing interest in alternative, cell-based methods of cartilage repair such as HA-BMAC. In addition to treating early and isolated cartilage lesions, our center has had promising results treating patients afflicted with knee arthropathy and early degenerative changes.

Regarding cell-based treatment options, there have been favorable preliminary results in one-stage repair using a scaffold-based bone marrow aspirate concentrate (BMAC).^{3,4,5} This technique relies on the presence of mesenchymal stem cells (MSCs), as well as growth factors, in order to stimulate differentiation into chondrocytes, potentially leading to restoration of hyaline-like cartilage.⁶ The technique of cartilage repair using HA-BMAC demonstrates that good medium-term clinical outcomes, superior to that of marrow stimulation, may be achieved in a one-stage procedure, at a cost significantly lower than would typically be associated with autologous chondrocyte use. In a cohort of patients affected by a mix of traumatic and early degenerative cartilage lesions, our most recent analysis of cartilage repair using HA-BMAC treatment compared to microfracture demonstrated a significant drop in the initial positive outcomes of microfracture at final follow-up, with only 28% of patients categorized as normal or nearly normal at 5 years.⁷ The clinical improvement in those treated with HA-BMAC over short-term follow-up were maintained at final follow-up of 5 years, at which time all patients in this treatment group were classified as normal or nearly-normal.

Clinical outcome analysis for those knees treated with cartilage lesion sizes up to and greater than 20cm² has demonstrated that even in patients who would be considered to have early degenerative changes, HA-BMAC treatment has provided pain relief and excellent functional recovery over medium-term follow-up. Furthermore, in our cohort analysis, knees with multicompartiment involvement that are treated with this cell-based repair procedure have had consistently good to excellent outcomes, similar to the outcomes expected with treatment of smaller, solitary lesions. When undertaking cartilage repair procedures in knees affected by early degenerative change, it is necessary to carefully assess lower extremity alignment, and to use corrective osteotomy when indicated in order to provide the optimal mechanical environment for the HA-BMAC graft to restore areas of cartilage damage with durable hyaline-like cartilage. Moreover, the benefits that were demonstrated in those patients over 45 years of age treated with HA-BMAC suggests that successful outcomes are not limited to a younger patient demographic.^{7,8}

Considering the routine use of marrow stimulation in cartilage repair, it is important to highlight the comparative superiority of HA-BMAC with respect to more durable clinical outcomes, and the similar results obtained compared to high cost autologous chondrocyte implantation procedures. Using the HA-BMAC procedure, our findings have demonstrated similar durability of cartilage repair at 5 years, and even in cases of multicompartiment cartilage damage that would be considered early degenerative change. Furthermore, the physical properties of this graft allow it to be applied to defects in a minimally invasive fashion, as in cases of arthroscopic cartilage repair.^{9,10} Although we are awaiting the long-term outcomes of this procedure, these results are encouraging, particularly given the reasonable cost of the procedure, and the one-stage nature of the technique.

In summary, repair of chondral injury using a hyaluronic acid-based scaffold with activated bone marrow aspirate concentrate provides good clinical outcomes, and durable cartilage repair at medium-term follow-up that is superior to marrow stimulation, and comparable to autologous chondrocyte implantation. Cartilage repair using HA-BMAC has thus far led to successful medium-term outcomes independent of age, lesion size, and the presence of multiple lesions. This procedure has also provided significant pain relief and functional recovery in patients affected by early degenerative change of the knee joint.

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