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Bone marrow stimulation at the footprint of arthroscopic surface-holding repair advances cuff repair integrity

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Background: Bone marrow stimulation (BMS) at the footprint of arthroscopic rotator cuff repair has not been fully evaluated according to the preoperative tear size and surgical technique. In this study, we investigated the effect of BMS on cuff repair integrity after an arthroscopic surface-holding (ASH) repair.
Materials and methods: A total of 111 patients (mean age, 64.5 years) with chronic rotator cuff tears who underwent treatment by the ASH method with BMS by drilling of multiple holes at the footprint (67 shoulders) or without BMS (44 shoulders) were studied, and all patients were observed prospectively. Sugaya's classification was used to evaluate cuff integrity by postoperative magnetic resonance imaging, with types IV and V classified as rotator cuff retears.
Results: The mean scores for cuff integrity were 2.2 ± 0.2 and 1.7 ± 0.2 in the non-BMS and BMS groups, respectively. The mean scores were similar between the 2 groups for medium tears; however, scores for large-massive tears were significantly lower in the BMS group. The overall retear rate was 23.9% in the non-BMS group and 9.1% in the BMS group, and the distribution of repair types differed significantly. For large-massive tears, the retear rate was much higher in the non-BMS group (28.6%) than in the BMS group (4.5%), although the rates for medium tears were comparable between the 2 groups.
Conclusions: These findings demonstrate that applying BMS to the footprint during ASH repair results in improved cuff repair integrity, particularly in large-massive tears, and suggest the importance of biologic treatment for rotator cuff healing after arthroscopic rotator cuff repair.

IRB: Not applicable. This study and data collection were performed from 2009 to 2013, during which time an Investigational Review Board was not present at our institution. A detailed explanation of the study was provided to the patients before the investigation, and consent to participate was obtained.

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Level of evidence: Level III, Retrospective Cohort Design, Treatment Study.

Keywords: Bone marrow stimulation; mesenchymal stem cells; biologic healing; arthroscopic rotator cuff repair; surface-holding technique; cuff repair integrity

Rotator cuff disorders are the most common causes of disability in the shoulder.[6] Arthroscopic rotator cuff repair (ARCR) of full-thickness rotator cuff tears typically provides satisfactory results, including decreased shoulder pain and improved shoulder motion.[30] However, results are sometimes not entirely satisfactory because the repair does not result in complete tendon healing or recovery of full function, and a relatively high incidence of rerupture has been reported after standard rotator cuff repair.

To improve the biomechanical properties of rotator cuff repair, Yamaguchi et al[31,32] established a novel modified transosseous-equivalent procedure using medial anchors and lateral transosseous sutures, which they described as the surface-holding repair technique. Biomechanical testing has demonstrated that this technique provides relatively strong tendon-to-bone fixation compared with that achieved by double-row repair.[12] More important, finite element analysis has confirmed that the surface-holding repair model disperses the stress pattern in repaired tendons much better than is observed when the double-row repair model is used.[12] Recently, we reported that the clinical outcomes of the arthroscopic surface-holding (ASH) method resulted in a significant improvement in the functional recovery of the shoulder compared with preoperative scores, with an overall rotator cuff retear rate of 19.0%; however, a higher retear rate was still observed for large and massive rotator cuff tears (26.0%).[29] This finding is consistent with reports showing that the retear rate is high for large and massive tears after ARCR; imaging studies have shown retear rates for large and massive tears of 30% to 94% after arthroscopic single-row repair[4,13] and 40% to 64% after double-row repair.[15,28] In addition to excessive tension on the repair, smoking, patient noncompliance, and other factors, rotator cuff retear after ARCR is caused by poor blood supply to the rotator cuff itself, which prevents sufficient migration of the cells involved in healing of the torn rotator cuff.[3,10]

The aim of the bone marrow stimulation (BMS) technique is to stimulate migration of bone marrow–derived mesenchymal stem cells (MSCs). The scientific basis for this technique is to recruit MSCs from the surface of the bleeding bone. This approach has been widely applied to fill in cartilage defects using the secretion of fibrocartilage,[22,27] and applying BMS to perform rotator cuff repair has been proposed.[26] Maintaining the presence of MSCs in bone marrow allows the potential for differentiation into tendon tissues,[5] and the implantation of synovial MSCs into the bone tunnel accelerates early remodeling during tendon-bone healing.[19] However, the clinical application of BMS for rotator cuff repair has not yet been established. Herein, we hypothesized that applying BMS at the footprint during ASH repair may influence rotator cuff repair integrity after severe cuff ruptures.

Materials and methods

Patients

This is a retrospective cohort treatment study (level of evidence III) of 111 consecutive patients with full-thickness rotator cuff tears undergoing primary arthroscopic repair by the proposed method. The patients (43 women, 68 men) had a mean age of 64.5 years (range, 41-86 years) at the time of surgery. Surgery was performed by the senior author (N.S.), who had performed more than 200 ARCR procedures before the start of this study.

We began to use ASH repair in 2006. In this study, we compared patients treated by the ASH method without BMS (non-BMS group: 67 patients; average age, 64.3 years) between January 1, 2009, and December 31, 2010, and those who underwent the same surgery with the use of BMS (BMS group: 44 patients; average age, 64.7 years) after January 1, 2011. The goal of the study was to evaluate cuff integrity prospectively during a period when the surgical technique was established and stable and no technical problems were likely to influence the outcome. The patient groups were matched for age, gender, and size of the cuff tear as shown in Table I.

The tear size was measured intraoperatively with the system described by DeOrio and Cofield[7]: small (<1 cm), medium (1-3 cm), large (3-5 cm), and massive (>5 cm, or involving 2 tendons). We treated 32 shoulders with medium tears and 35 shoulders with large-massive tears in the non-BMS group as well as 22 shoulders with medium tears and 22 shoulders with large-massive tears in the BMS group. Patients with small tears were excluded from the study because single-row repair or the suture bridge method was used in these cases rather than the ASH method.

Patients were excluded if they had a history of dislocation or fracture of the shoulder, degenerative or inflammatory arthritis, infection, neuropathic changes, prior surgical procedures on the shoulder, or postoperative follow-up for <12 months.

Evaluation

Magnetic resonance imaging (MRI) was performed to evaluate rotator cuff tendon integrity before and at least 12 months after surgery. Oblique coronal, oblique sagittal, and axial T2-weighted spin-echo MRIs were obtained for all patients. For patients who complained of sudden shoulder pain, MRI was performed immediately to identify a potential rotator cuff retear.

Cuff repair integrity was classified into 5 types based on oblique coronal and oblique sagittal views, following Sugaya's