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One step treatment of talus osteochondral lesions with microfracture and cell free hyaluronic acid based scaffold combination

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ABSTRACT

Objective: The aim of this study was to assess the effectiveness of microfracture and cell free hyaluronic acid (HA) based scaffold combination in the treatment of talus osteochondral defects (OCD).
Methods: This study retrospectively evaluated the clinical results of the 20 patients (14 males and 6 females, mean age at the time of surgery: 32.9 years (range: 16–52 years)) who were treated with MFx and cell-free HA-based scaffold combination for talus OCD smaller than 1.5 cm^2 and deeper than 7 mm. Results were evaluated with AOFAS and VAS scores. Also, patients' satisfaction was questioned.
Results: Patients were evaluated after an average follow-up of 20.3 months. Intraoperative measurements showed that mean depth of the lesions were 10.4 ± 1.9 mm after debridement. The mean preoperative AOFAS score was 57.45 ± 9.37, which increased to 92.45 ± 8.4 postoperatively ($p < 0.05$). VAS score was improved from 7.05 ± 2.45 to 1.65 ± 2.20 postoperatively ($p < 0.05$).
Conclusion: MFx and cell-free HA-based scaffold combination appear to be a safe and efficient technique that provide good clinical outcomes for lesions deeper than 7 mm.
Level of evidence: Level IV, Therapeutic Study.
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Introduction

Talus osteochondral defects (OCD) are considered as a common cause of chronic ankle pain and disability. Without appropriate treatment, talus OCD have the potential to lead early cartilage degeneration and eventually osteoarthritis.[1] Treatment options vary ranging from conservative treatment to arthroscopic debridement and microfracture (MFx), mosaicplasty, allograft applications or autologous chondrocyte transplantations.[2,3] Optimal treatment is decided according to the size and location of the lesion and duration of the complaints.[4,5]

Among the surgical options, MFx is the most commonly used technique for lesions smaller than 1.5 cm^2 or 15 mm in size.[5,6] Lee et al in their two separate studies supported the good clinical outcomes of MFx in their smaller than 2 cm^2 patient population.[7,8] But even the lesions' size was appropriate, MFx's failure rate had found to be dramatically increased for deeper lesions than 7 mm. Up to 53% failure rates had been reported for these lesions.[4,9,10]

We believe that MFx technique's efficacy could be improved with the application of cell-free hyaluronic acid (HA)-based scaffold due to its structural support and increased osteointegrity. Our study aimed to report the results of void filling with a HA-based cell-free scaffold for the treatment of these small but deep lesions.

Methods

After the approval of our study by our institute's ethical committee, written informed consent was obtained from each patient. We retrospectively evaluated the clinical results of the patients who underwent surgical treatment for talus OCD. Between June 2014 and January 2017, 80 patients were operated with the clinical and radiological diagnosis of talus OCD (Fig. 1A,B). Among these patients, 23 were treated with MFx and cell-free HA-based scaffold combination because of their lesions were smaller than 15 mm but deeper than 7 mm after arthroscopic curettage of the lesions. Remaining 57 patients were treated by other techniques because of their lesions' size and depths.

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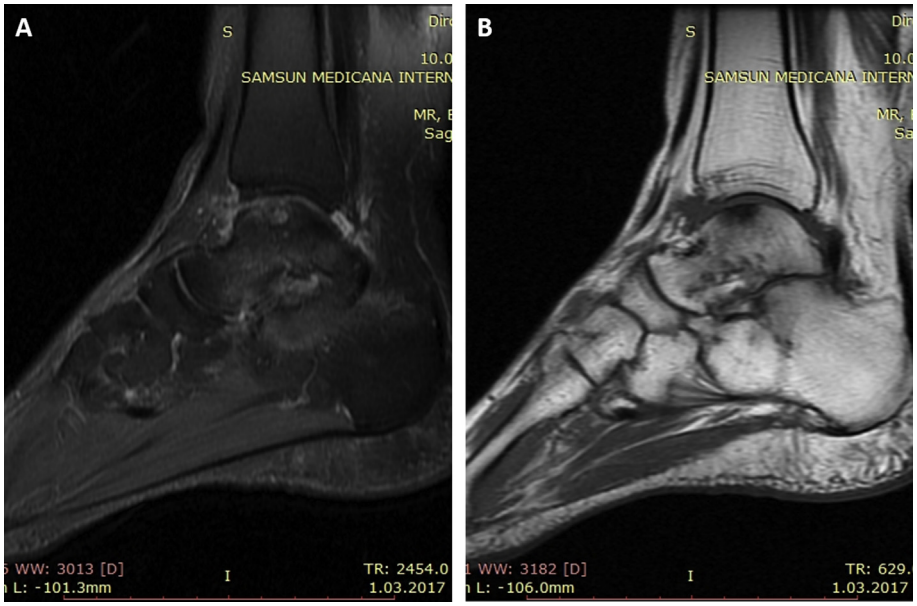

Fig. 1. Preoperative MRI demonstrating subchondral cyst formation with a potential for a lesion deeper than 7 mm after arthroscopic debridement. A. T2-weighted MRI. B. T1-weighted MRI.

Among these 23 patients, 3 were excluded because of duration of follow-up shorter than 6 months. Remaining 20 patients who had lesions smaller than 15 mm and deeper than 7 mm after intraoperative debridement were included to our study group consisting of 14 males and 6 females, their mean age at the time of surgery was 32.9 years (range 16–52). We accepted the intraoperative measurement of the lesions because even though MRI is highly specific for grading of the lesion, determination of width and depth can be erred. Intraoperative evaluation of the curettage is advised for precise debridement, thus surgical technique.[11–13] Due to wide acceptance of fragment fixation or conservative treatment before adolescence, we excluded the patients younger than 15 years of age. Also patients with osteoarthritis, impingement or kissing lesions of the ankle, and patients with rheumatoid arthritis were excluded from the study.

Surgical technique

During the surgery, arthroscopic antero-lateral and antero-medial portals were used. Localized lesion debrided down to health bone including the calcified layer which was assessed by visualization and the sound of cortical crackle[14] while debriding the sclerotic rim and microfracture was performed across the debrided area. With a probe or an arthroscopic curette for elliptical lesions, the lesion size and depth were measured whether the debrided area was within the previously mentioned limits or not (Fig. 2A). If the lesion size was larger than 1.5 cm^2, operative plan was converted to Autologous Matrix-Induced Chondrogenesis (AMIC) technique and through an arthrotomy, autograft harvested from iliac crest applied then covered with cell-free collagen membrane. After debridement, if the lesion was shallower than 7 mm, only MFx was performed (Fig. 2B). These patients were not included in the study group. If the lesion size was within the mentioned criteria, fluid flow was ceased and intra-articular fluid was evacuated. Then, cell-free HA-based scaffold (Hyalofast; Anika Therapeutics, Bedford, MA, USA) was applied to defect through arthroscopy portal with the help of a forceps and fixated with commercial fibrin glue (Tisseel, Baxter AG, Vienna, Austria) (Fig. 2C). Multiple passive ankle movements were performed under arthroscopic visualization to check the stability of the scaffold before closure of the portals.

After surgery, early range of motion exercises were started from the first postoperative day. Weight-bearing and daily life activities were allowed after a period of 3 weeks within a removable walking boot. After tolerance to full weight bearing patients were allowed to use sports shoes. Low-impact sports activities such as swimming or walking were permitted at the end of the 2 months postoperatively and contact sports or high-impact sport activities were not permitted till the end of 6 months.

We used the American Orthopaedic Foot and Ankle Society (AOFAS) Ankle-Hindfoot Scale score (90–100 points excellent; 75–89 points good; 50–74 points satisfactory; less than 50 points poor) and visual analog scale (VAS) (0: no pain, 10: insufferable pain) to evaluate postoperative outcomes. Also, we questioned the patients' satisfaction with the results and whether they would have the surgery again under same circumstances or not.

The data were evaluated using SPSS 22.0 (SPSS, Inc., Chicago, Illinois, USA). The paired Student's *t*-test was used for assessing changes between preoperative and postoperative scores and $p < 0.05$ was accepted as statistically significant.

Results

Patients were evaluated after an average follow-up of 20.3 months. The minimum follow-up was 6.2 months, and the maximum was 36.5 months. The lesions were located medially in 19 cases (95%) and laterally in one case.

Intraoperative measurements showed that mean depth of the lesions were 10.4 ± 1.9 mm and mean area of the lesions were 0.969 ± 0.505 cm^2 after debridement.

AOFAS scores and VAS scores were used to evaluate the clinical outcome. The mean preoperative AOFAS score was 57.45 ± 9.37, which increased to 92.45 ± 8.4 postoperatively ($p < 0.05$). VAS score was improved from 7.05 ± 2.45 to 1.65 ± 2.20 postoperatively ($p < 0.05$).

There were no postoperative complications related with the surgery including nerve injury, infection, and delayed wound healing.

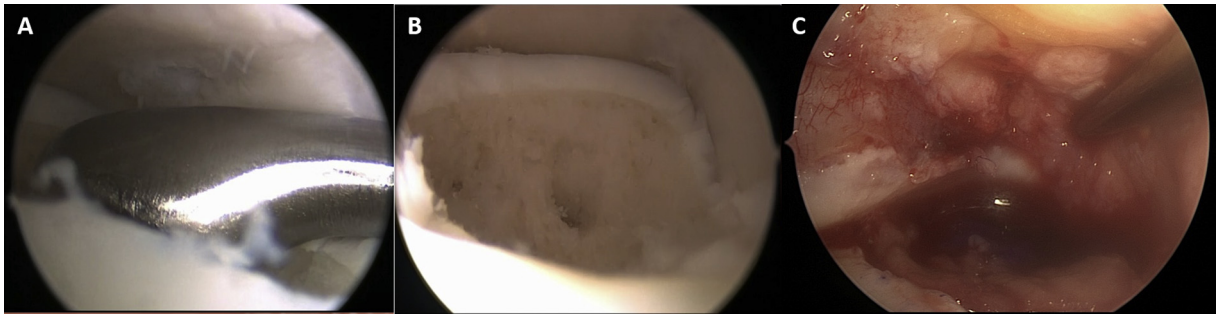

Fig. 2. A. Intraoperative measurement of the lesion size with the help of a curette. B. After debridement and microfracture. C. Appearance after cell-free HA-based scaffold application under dry scope.

As for patient satisfaction with surgery, 85% (17/20) of patients were very satisfied, 5% (1/20) were satisfied, and 10% (2/20) were not satisfied; with an overall patient satisfaction rate of 90%. Three patients (15%) who were not very satisfied with the surgery had postoperative AOFAS scores' 76, 77 and 76, respectively. Although the AOFAS score in this group improved by a mean of 26.3 points (from 50 ± 3.46 to 76.3 ± 0.57), two of these patients were not willing to be operated again under the same circumstances. Nonetheless, they were accepted as failure and also these two patients' lesions were the deepest ones in our study group which were measured as 14 and 15 mm.

Discussion

MFx technique has proven to have good clinical results in small lesions with its advantage of bone marrow stimulation but with the lesion depth increases its failure rates increased. This was explained by the lack of structural support of the surfaced stem cells.[3,6]

The most important finding of this study were the use of cell-free HA-based scaffold in combination with MFx can be used for deeper lesions with satisfactory results but due to our patients with deepest lesions were accepted as failure of treatment, there seems to exist a threshold value for the depth of the lesions, but prospective researches with power analysis and larger population is needed to further this claim.

Based on the current literature, MFx is defined as first line of treatment option for talus OCD especially for the lesions smaller than 1.5 cm^2 or 15 mm.[15,16] With MFx, vascularized subchondral bone is penetrated. This results with the formation of a blood clot that contains growth factors and progenitor cells that stimulate healing.[17] With time, blood clot shows metaplastic changes and promote formation of fibrous cartilage repair tissue. Although formed fibrous cartilage has less resistance to compression and shear forces than the normal articular cartilage tissue; it is shown that approximately 78–86% of patients achieve good to excellent results after MFx.[18–21]

MFx's major prognostic factors were accepted as lesion size, patient age, body mass index, cystic nature or depth of the lesion, duration of the symptoms and containment of the lesion. Among these factors, there is a consensus that lesion size has a prognostic value, thus lesions smaller than 1.5 cm^2 or 15 mm are accepted as suitable for MFx treatment. Smaller lesions are known to have good results with MFx alone but there are studies that report up to 53% poor outcome when the depth of the lesion is increased.[10,22,23] Yoshimura et al suggested that deep lesions were not adequately filled with blood clot and stabilization of the clot itself was also diminished.[23] Because of this, when surgical treatment is decided for these smaller but deeper lesions, surgeon may need to use scaffolds (with or without cells) to increase the stability of the blood clot, to provide structural support for cartilage repair and to stimulate the healing process of the damaged tissues[11] or has to use restorative techniques like mosaicplasty, autologous chondrocyte transplantation (ACI, MACI), AMIC or allografts that are suggested for larger lesions.[4,24] These restorative techniques are time consuming, relatively expensive and more complicated treatment modalities that also have increased morbidity associated with arthrotomy and/or osteotomy requirement for exposure when compared with MFx and they may be reserved for a revision procedure in case of a failure.

Our study aimed to report the results of treatment of deep lesions with MFx and void filling with a HA-based cell-free scaffold. HA had been shown to induce chondrogenesis[25] and HA-based scaffold permits arthroscopic placement without need for arthrotomy. There are several reports that combined HA-based scaffolds with bone marrow derived stem cells (BMDSC) and PRP with up to 85% good or excellent results.[26–28] But, using scaffolds without any cell source other than MFx itself offer advantages like no donor site, off the shelf availability, no cell culture, avoidance of the phenotype loss risk during cell manipulation, reducing costs, simplifying the procedure and application as a single stage procedure.[29–32] There are also studies that report no significant improvement with the use of cell-loaded scaffolds.[33]

Recently, in their systematic review Kon et al stated that the clinical use of cell-free scaffolds have promising preliminary results with increasing literature that supports their usage.[28] In this study, we found 85% clinical and 90% subjective success rate with cell-free scaffold application which was similar to the results of cell-combined procedures and also that was comparable with the approximately 78–86% reported success rate of previous studies focused on shallower talus OCD treated with MFx alone.

There are studies that report good results with MFx for cystic talus OCD[7,8,34,35] and suggest that MFx could be a primary treatment strategy for small, cystic lesions; but only Lee et al reported the mean lesion depth. In their study, depth of subchondral cysts were 8.0 mm (5.0–13.7) on preoperative MRI measurements and they reported 94% good or excellent results for the patients with or without an underlying cyst.[7] Even with this high success rate, they stated the need for a comparative study between MFx and a void-filling operation to determine the efficacy of MFx as a treatment for cystic osteochondral lesions.

The present study has some limitations. First, we retrospectively evaluated prospectively followed patients. Secondly, we did not have postoperative MRI evaluation, second look arthroscopy or biopsy. Thirdly, we didn't perform power analysis to be ascertain our findings to make solid claims with our small number of patient population. On the other hand, we operated on highly selective patient group within a specific range with the same technique, thus it is quite difficult to obtain a larger patient group.

Conclusion

Although treatment of talus OCD remains controversial, MFx indication can be extended for smaller but deeper lesions when it is used in combination with cell-free HA-based scaffold.

Conflicts of interest

The authors declare that they have no conflict of interest.

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