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Original Article

# Comparative study of arthroscopic treatment of osteochondral lesions of the talus

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## Abstract

**Objectives:** Evaluate and compare, through the American Orthopedic Foot and Ankle Society (AOFAS) score, the clinical and functional results of arthroscopy treatment of osteochondral lesions of the talus with bone marrow stimulation with or without association with the autologous matrix-induced chondrogenesis.

**Methods:** A retrospective comparative clinical study with 56 patients diagnosed with osteochondral lesions of the talus, eight of whom did not agree to participate in the study, 35 were submitted to surgical treatment with subchondral bone microperforation, and 13 to microperforation associated with collagen matrix membrane. The Mann-Whitney test was applied to compare continuous measurements between the two groups. The significance level adopted for the statistical tests was 5%.

**Results:** After intragroup analysis, the microperforation treatment group associated with collagen matrix membrane, all patients improved the AOFAS score (55.0 to 90.0). In the treatment with bone marrow stimulation, patients increased the AOFAS from 57.0 to 90.0. In the treatment with collagen matrix membrane, patients increased the AOFAS score from 51.0 to 90.0. There was no significant difference between the groups studied.

**Conclusion:** Both treatments, through ankle arthroscopy, can be great treatment options for osteochondral lesions of the talus, according to their specific indications, with significant functional and clinical improvement, identified by the increase in the AOFAS score.

**Level of Evidence III; Retrospectivef comparative study; Therapeutic studies - investigating the results of treatment.**

**Keywords:** Arthroscopy; Talus; lesion; Injuries.

## Introduction

Osteochondral lesions of the talus (OLT) are defined as erosions of the chondral layer and subchondral bone of the talus. They become important due to the cause of residual pain and functional deterioration after ankle sprains or other traumatic injuries, with an increased need for arthrodesis and arthroplasty of this joint. Hyaline cartilage has low metabolic activity, being avascular and hypocellular, which hinders the remodeling process and maintains residual defects after an injury[1]. The etiology of the injuries may be of traumatic or non-traumatic origin. Compared to cartilage injuries, OTL is more often caused by trauma, and the longer the time elapses between trauma and injury, the more severe the associated chondral injury becomes[2]. Among non-traumatic causes, vascular etiology is one of the most common causes[3]. In the study by DiGiovanni et al.[4], OLT was identified in 23.0% of patients diagnosed with chronic ankle instability. In general, medial lesions are shown in 62.9% of cases, lateral lesions appear in 33.4% of cases, and those of the central third are shown in 3.7%[5].

Study performed at the Department of Orthopedics and Traumatology, Pontificia Universidade Catolica de Campinas (PUC-CAMPINAS), Campinas, SP, Brazil.

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Magnetic resonance imaging (MRI) is the best imaging method for diagnosing and postoperative evaluation of OTL[6]. It was used in this study to assist in evaluating the lesion size. Computed tomography can also identify the lesion's depth, which can modify the proposed treatment.

Among the treatment options described, we can mention bone marrow stimulation[7,8], autologous grafts[8,9], heterologous grafts[10,11], and chondrocyte-inducing matrices[12-14]. The latter, also called autologous matrix-induced chondrogenesis (AMIC), is a very viable option to treat OTL involving stimulation of the bone marrow of the subchondral bone and application of a type I and III collagen bilaminal membrane, which works by protecting and stabilizing the chondrogenic cells that are stimulated after bone marrow perforation. When the subchondral bone defect is too large, a bone graft can fill the gap before the installation of the inducing matrix[14].

Regarding bone marrow stimulation, they can be used as a technique aimed at inducing healing by removing unstable cartilage segments and perforating the subchondral bone, producing bleeding, clot formation, and fibrocartilage; thus, trying to avoid early arthrosis[15].

With the data in the literature and previous studies, there is no consensus on a more advantageous treatment[16,17].

The objective of this study is to evaluate and compare, through the American Orthopedic Foot and Ankle Society (AOFAS) score[18], the clinical and functional results of arthroscopy treatment of OTL with bone marrow stimulation with or without association with the autologous matrix-induced chondrogenesis.

## Methods

The study was approved by the Institutional Review Board. A retrospective comparative clinical study with 56 patients diagnosed with OTL, eight of whom were excluded from the study due to not agreeing with the terms described in the Informed Consent Form. The patients were submitted to surgical treatment by four experienced surgeons with bone marrow stimulation through subchondral bone microfractures (35 patients) and bone marrow stimulation associated with AMIC – collagen membrane I and III (13 patients). The surgical treatment indicated was based on the symptomatology of the patient with ankle pain, such as signs of joint instability and sprains, in addition to examination of radiographic images based on Berndt and Harty's classification[19] and MRI demonstrating OTL. The classification was performed on radiographic images due to the low quality of MRI in some patients and the absence of concise intraoperative reports describing the lesions. The follow-up period within the study was approximately 36 months after the arthroscopic intervention when the AOFAS questionnaire was applied. All patients were submitted to anterior ankle arthroscopy, and interventions were performed simultaneously with bone marrow stimulation and membrane placement. The postoperative period was performed with restrained weight-bearing in the first 6-8 weeks, and then weight-bearing was released gradually according to pain. All patients underwent physiotherapy starting in the second week after surgery.

Two groups submitted to arthroscopic treatment of OTL were analyzed: the group in which bone marrow stimulation was performed and the group in which collagen membrane was performed. The size measurement used to compare the lesions was centimeters (cm), with the identified sizes ranging from 0.5 x 0.5 cm to 1.5 x 1.5 cm. It was impossible to identify the lesions' depth and the subchondral bone's viability due to missing data in the intraoperative records. The first group (Membrane group) was submitted to spinal cord stimulation combined with AMIC, and the second (Microperforation group) was submitted to exclusive spinal cord stimulation with microperforation of the chondral lesion. They were evaluated in the pre-and postoperative using the AOFAS questionnaire to evaluate the pain, functional limitation due to lesion, and the patient's quality of life.

### Inclusion criteria

Patients over 18 years of age, of both sexes, with ankle pain caused by sprain, ankle fracture, and unspecified chronic pain associated with osteochondral injury were included in the study. All selected lesions can be classified according to Berndt and Harty's classification—all patients who followed the protocol and maintained postoperative follow-up.

### Exclusion criteria

Patients who did not agree to participate in the study and did not sign the Informed Consent Form, patients in whom lesion causes or sizes could not be identified, patients with a history of surgery for previous osteochondral lesion, and patients who lost follow-up postoperatively were excluded from the study.

### Statistical analysis

The patients included in the study were submitted for anamnesis, physical examination, and AOFAS questionnaire. After surgical treatment, between six months and two years, the AOFAS questionnaire was reapplied.

To describe the characteristics of the sample, frequency tables of categorical variables were performed with values of absolute frequency (n) and percentage (%), and, for quantitative variables, descriptive measures (mean, standard deviation, minimum, median, and maximum) were obtained. When necessary, the Chi-square test or Fisher's exact test was used to compare proportions. The Mann-Whitney test was applied to compare continuous measurements between the groups[20].

The ANOVA for repeated measures with transformation by rank was applied to evaluate the AOFAS score related to the groups, times, and other variables. The significance level adopted for the statistical tests was 5%[20,21].

# Results

## Overall analysis

Forty-eight patients submitted to ankle arthroscopy were included in the study, the mean age was 55.5 years, with a prevalence of males (56.3%) compared to females (43.8%). The main cause was chronic pain (50%), followed by sprain (45.8%), and only two cases were post-ankle fracture (4.2%). The lesion sizes visualized in the imaging exams had a median of 1.0 cm. The questionnaire applied before each surgery had a median score of 55.0 and the postoperative questionnaire of 90.0, as shown in Table 1.

## Intragroup analysis

In this analysis, as shown in Table 2, no statistical difference was detected between the pre-and post-moments for all comparisons of age (p = 0.2961), size (p = 0.6163), sex (p = 0.3902) and cause (p = 0.5427) in both groups.

## Intergroup analysis

As can be seen in Table 3, a descriptive analysis and AOFAS comparison between the groups was performed, and no significant differences (p = 0.2990) were found in the pre- and post-arthroscopy measurements. In both groups, there was an increase in the independent score of the variables, as identified in Figure 1, with an increase from 51.0 to 90.0 in the membrane group and 57.0 to 90.0 in the microperforation group.

## Results of interest

An evaluation of the effect of age and lesion size identified on MRI compared with pre-and post-arthroscopy scores in both groups was performed. The size measurement used to compare the analyzed lesions was centimeters. Table 4 shows a significant increase in the score after surgery, regardless of lesion size (p = 0.7218) or age (p = 0.2715).

Descriptive analyses were performed comparing the AOFAS score when related to sex (Table 5), where the mean score in females before arthroscopy was 56.0 and post 90.0, and in males, it was 55.0 to 90.0.

The causes were analyzed individually according to the complaints reported in the medical record for seeking care, indication and performance of ankle arthroscopy. Due to the traumatic origin in both cases, the sprains and fractures were grouped in the same subgroup to facilitate statistical comparisons. All patients underwent the same treatment protocol, being released for physiotherapy two weeks after surgery, with suspension of the weight-bearing until about 6-8 weeks, being released gradually according to the patient's pain tolerance. Table 6 shows that in all groups, there was an increase in the score after surgery, regardless of the cause, with chronic pain progressing from 56.0 to 88.5 and in the traumatic order from 54.5 to 90.0.

# Discussion

Based on the analyses performed in the study, an improvement in the AOFAS score in all groups after arthroscopy could be

**Table 1.** Descriptive overall analysis

| Variables | (n = 48) |
|---|---|
| Age (Mean ± SD) | 52.44 ± 10.74 (n = 48) |
| Age (Median (min-max) | 55.50 (29.00-70.00) |
| AOFAS Pre (Mean ± SD) | 54.13 ± 21.70 (n = 48) |
| AOFAS Pre (Median (min-max) | 55.00 (6.00-92.00) |
| AOFAS Post (Mean ± SD) | 85.33 ± 15.70 (n = 48) |
| AOFAS Post (Median (min-max) | 90.00 (45.00-100.00) |
| Bigger size (Mean ± SD) | 1.04 ± 0.34 (n = 48) |
| Bigger size (Median (min-max) | 1.00 (0.50-1.50) |
| **Variables** | **n (%)** |
| Group | |
| Membrane | 13 (27.1) |
| Microperfuration | 35 (72.9) |
| Sex | |
| Female | 21 (43.8) |
| Male | 27 (56.3) |
| Cause | |
| Chronic pain | 24 (50.0) |
| Sprain | 22 (45.8) |
| After medial malleolus fracture | 2 (4.2) |

AOFAS: American Orthopedic Foot and Ankle Society; SD: Standard deviation; Min-Max: Minimum-Maximum.

**Table 2.** Descriptive analysis and comparison between groups

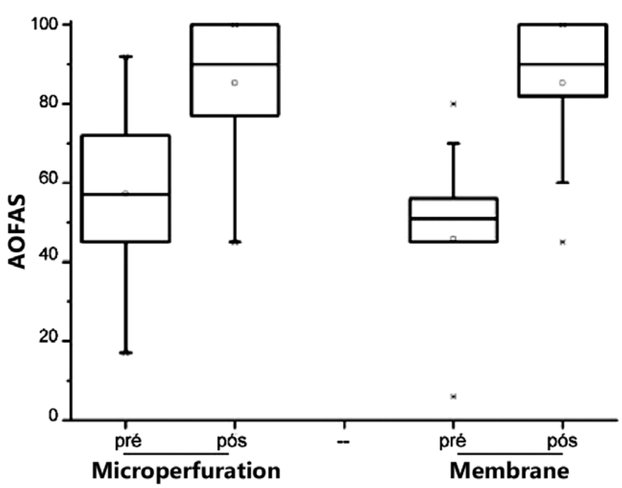
| Variables | Membrane group (n = 13) | Microperfuration group (n = 35) | Total (n = 48) | p-value |
|---|---|---|---|---|
| Age (Mean ± SD) | 50.31 ± 8.89 | 53.23 ± 11.37 | 52.44 ± 10.74 | 0.2961[1] |
| Age (Median, min-max) | 50.00 (35.00-62.00) | 56.00 (29.00-70.00) | 55.50 (29.00-70.00) | |
| Bigger size (Mean ± SD) | 10 ± 0.35 | 1.06 ± 0.34 | 1.04 ± 0.34 | 0.6163[1] |
| Bigger size (Median, min-max) | 1.00 (0.50-1.50) | 1.00 (0.50-1.50) | 1.00 (0.50-1.50) | |
| Sex | | | | |
| Female | 7 (53.8%) | 14 (40.0%) | 21 (43.8%) | 0.3902[2] |
| Male | 6 (46.2%) | 21 (60.0%) | 27 (56.3%) | |
| **Total** | 13 | 35 | 48 | |
| Cause | | | | |
| Chronic pain | 7 (53.8%) | 17 (48.6%) | 24 (50.0%) | 0.5427[3] |
| Sprain | 5 (38.5%) | 17 (48.6%) | 22 (45.8%) | |
| After medial malleolus fracture | 1 (7.7%) | 1 (2.9%) | 2 (4.2%) | |
| **Total** | 13 | 35 | 48 | |

[1]Based on Mann-Whitney test; [2]Based on Chi-square test; [3]Based on Fisher's exact test; SD: Standard deviation; Min-Max: Minimum-Maximum.

**Table 3.** Descriptive analysis and AOFAS comparison between times and groups

| Groups | Variables | n | Mean | SD | Minimum | Median | Maximum |
|---|---|---|---|---|---|---|---|
| Membrane | AOFAS Pre | 13 | 45.8 | ± 2.6 | 6.0 | 51.0 | 80.0 |
| | AOFAS Post | 13 | 85.3 | ± 17.2 | 45.0 | 90.0 | 100.0 |
| Microperfuration | AOFAS Pre | 35 | 57.2 | 20.9 | 17.0 | 57.0 | 92.0 |
| | AOFAS Post | 35 | 85.3 | 15.4 | 45.0 | 90.0 | 100.0 |
| Proteins (10%-35%) | 05 | 1.7 | 8.1 | ± 1.47 | 290 | 98.3 | 18.1 |
| **ANOVA results for repeated measures with rank transformation** | | | | | | | |
| **Effect** | | | | | | | **p-value** |
| Time | | | | | | | < 0.0001[1] |
| Group | | | | | | | 0.2990 |
| Time*group interaction | | | | | | | 0.2194 |

[1]Significant increase in score after surgery, regardless of group. p-value = 0.1016 (Mann-Whitney): no significant difference in pre-measurement between groups à homogeneous groups. AOFAS: American Orthopedic Foot and Ankle Society; SD: Standard deviation.




**Note:** There was no difference between groups (p = 0.2990); only the effect of time was significant (p < 0.0001). Significant increase after group-independent surgery (ANOVA for repeated measures).

**Figure 1.** AOFAS score box-plot pre- and post-surgery in each group.

**Table 4.** Evaluation of the effect of age and lesion size on the AOFAS score before and after surgery

| **ANOVA results for repeated measures with rank transformation** | |
|---|---|
| **Effect** | **valor-*p*** |
| Time | 0.0009[1] |
| Group | 0.2715 |
| Time*group interaction | 0.0924 |
| Time | 0.0152[2] |
| Bigger size | 0.7218 |
| Time*group interaction | 0.8749 |

[1]Significant increase in score after surgery, regardless of age; [2]Significant increase in score after surgery, regardless of lesion size. AOFAS: American Orthopedic Foot and Ankle Society.

**Table 5.** Descriptive analysis and AOFAS comparison between times and sex

| Variables | n | Mean | SD | Minimum | Median | Maximum |
|---|---|---|---|---|---|---|
| Female | | | | | | |
| AOFAS Pre | 21 | 49.8 | 22.9 | 6.0 | 56.0 | 92.0 |
| AOFAS Post | 21 | 86.9 | 14.9 | 45.0 | 90.0 | 100.0 |
| Male | | | | | | |
| AOFAS Pre | 27 | 57.5 | 20.5 | 17.0 | 55.0 | 90.0 |
| AOFAS Post | 27 | 84.1 | 16.5 | 45.0 | 90.0 | 100.0 |
| p-value = 0.3600[1] | | | | | | |
| **ANOVA results for repeated measures with rank transformation** | | | | | | |
| **Effect** | | | | | **p-value** | |
| Time | | | | | < 0.0001[2] | |
| Sex | | | | | 0.7267 | |
| Time*sex interaction | | | | | 0.0933 | |

[1] (Mann-Whitney) – no significant difference in the pre-measure between the sexes; [2] Significant increase in the score after surgery, regardless of sex. AOFAS: American Orthopedic Foot and Ankle Society; SD: Standard deviation.

**Table 6.** Descriptive analysis and AOFAS comparison between times and causes (sprain+fracture)

| Variables | n | Mean | SD | Minimum | Median | Maximum |
|---|---|---|---|---|---|---|
| Chronic pain | | | | | | |
| AOFAS Pre | 24 | 56.0 | 20.7 | 9.0 | 56.0 | 92.0 |
| AOFAS Post | 24 | 84.9 | 15.3 | 45.0 | 88.5 | 100.0 |
| Sprain+fracture | | | | | | |
| AOFAS Pre | 24 | 51.9 | 22.9 | 6.0 | 54.5 | 90.0 |
| AOFAS Post | 24 | 85.8 | 16.4 | 45.0 | 90.0 | 100.0 |
| p-value = 0.4329[1] | | | | | | |
| **ANOVA results for repeated measures with rank transformation** | | | | | | |
| **Effect** | | | | | **p-value** | |
| Time | | | | | < 0.0001[2] | |
| Sex | | | | | 0.6735 | |
| Time*cause interaction | | | | | 0.2440 | |

[1] (Mann-Whitney) - No significant difference in pre-measure between causes; [2] Significant increase in score after surgery regardless of cause. AOFAS: American Orthopedic Foot and Ankle Society; SD: Standard deviation.

seen. Between the groups, when size, sex, age, and underlying causes were compared, no results were found that added value to the comparisons. Improvement in each participant's symptoms, pain, and functionality was identified highlighting the importance of performing arthroscopy with bone marrow stimulation associated or not with the collagen matrix in the treatment of OTL.

The OTL is within the scope of the most common injuries found in the ankle after acute fractures. These findings collaborate in the indication and performance of post-trauma arthroscopy to identify intra-articular injuries[22]. Ischemic necrosis is among the most notorious identifiable causes of atraumatic lesions triggered by hormonal factors, hereditary conditions, or some constitutional change[3].

A study by Raikin et al.[5] found that lesions on the medial dome of the talus are more common than other quadrants and are also larger in surface area and depth. Currently, the parameters used for the surgical treatment of OTL consist of clinical symptoms, joint instability, lesion size with or without unstable fragments, and morphology.

In the group of non-invasive diagnostic methods, MRI showed higher sensitivity (0.96), and computed tomography showed higher specificity (0.99)[6]. Such tests, compared to physical examinations and radiographs, are superior and essential for detecting lesions and their correct treatment.

The comparison between bone marrow stimulation techniques and the application of collagen matrix membrane for treating OTL revealed significant improvement in AOFAS scores for both groups, with no statistically significant differences. The results of this study are supported by the work of Migliorini et al.[1], who found no significant differences between arthroscopic and mini-arthrotomy approaches for the implantation of autologous chondrocytes in the knee, suggesting that the method of surgical application may be less influential than postoperative management and patient-specific conditions.

Becher et al.[23] reiterate that after performing arthroscopic bone marrow stimulation with or without collagen types I and III matrix implantation, good clinical results were observed, with no significant differences identified in the lesions visualized by MRI. Using the collagen membrane, an approach supported by Jantzen et al.[16], showed promise in improving cartilage regeneration and postoperative management.

Although our study did not identify statistically significant differences between bone marrow stimulation techniques and the combination with collagen membrane in a short- to medium-term follow-up, Volz et al.[24], suggest that the addition of a collagen matrix may provide sustained clinical benefits over 10 years when compared to simple bone marrow stimulation. These findings underscore the importance of future investigations with long-term follow-up to assess whether the improvements observed in our study are maintained or diverge over time.

Among the limitations are the small sample size, absence of randomization, absence of descriptive data of intraoperative lesion sites, and difficulty obtaining imaging tests to prove lesion improvement. However, all difficulties did not prevent a positive result in the study.

## Conclusion

This study confirmed the efficacy of both bone marrow stimulation techniques and collagen matrix membrane application in treating osteochondral lesions of the talus. The AOFAS score improved by a mean of 31.2 points, and both methods showed significant improvement. These results reinforce the existing literature, which suggests the feasibility of personalized approaches based on patient-specific conditions to optimize surgical outcomes.

**Authors' contributions:** Each author contributed individually and significantly to the development of this article: IOFG *(https://orcid.org/0009-0006-1323-3681), and RMRB *(https://orcid.org/0000-0002-0796-7148), and MMGDA *(https://orcid.org/0009-0006-4960-6398), and RGH *(https://orcid.org/0000-0003-3951-8408), and *HDB *(https://orcid.org/0000-0002-1901-3309) , and LPS *(https://orcid.org/0000-0003-4096-5563), and MSPC *(https://orcid.org/0000-0002-0758-2547) Conceived and planned the activity that led to the study, wrote the article, participated in the review process, data collection, bibliographic review, interpreted the results of the study. All authors read and approved the final manuscript.*ORCID (Open Researcher and Contributor ID) iD.

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