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German Alejandro Jaramillo Quiceno, MD, Paula Andrea Sarmiento Riveros, MD, German Alberto Ochoa Perea, MD, Mauricio Gutierrez Vergara, MD, Luis Fernando Rodriguez Muñoz, MD, Ruben Dario Arias Perez, BS, MD, Nicolas Ochoa Piovesan, MD, Jaime Alonso Muñoz Salamanca, MD

PII: S2059-7754(22)00104-3
DOI: https://doi.org/10.1016/j.jisako.2022.11.004
Reference: JISAKO 69

To appear in: Journal of ISAKOS

Received Date: 25 May 2022
Revised Date: 26 October 2022
Accepted Date: 15 November 2022


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German Alejandro Jaramillo Quiceno, MDa*; Paula Andrea Sarmiento Riveros, MDb; German Alberto Ochoa Perea, MDc; Mauricio Gutierrez Vergara, MDD; Luis Fernando Rodriguez Muñoz, MDe; Ruben Dario Arias Perez, BS, MDf; Nicolas Ochoa Piovesan, MDg; Jaime Alonso Muñoz Salamanca, MDh.

a. Head of orthopedic and traumatology service of Fundación Clínica del Norte, address: Av. 38 #59-50, Bello-Antioquia, postal code: 051050, Colombia. E-mail: alejandrojllo@gmail.com, phone number: +57 3104341195

b. Orthopedic and traumatology service of Fundación Clínica del Norte, address: Av. 38 #59-50, Bello-Antioquia, postal code: 051050, Colombia. E-mail: dra.palanea@gmail.com

c. Orthopedic and traumatology service of Sportmeds medical center, address: St. 15a # 103-20, 3rd floor, Cali-Valle del Cauca. Postal code: 760003, Colombia. Orthopedic and traumatology service of Chiriquí Hospital, address: 3rd West Av. and Central St. David-Chiriqui. Postal Code: 0426-01141, Panamá. E-mail: german_alberto_chooa@hotmail.com

d. Orthopedic and traumatology service of Imbanaco medical center, address: Av. 38 BIS #. 5B2-04. Postal code: 760035, Colombia. Orthopedic and traumatology service of Sportmeds medical center, address: St. 15a # 103-
20, 3rd floor, Cali-Valle del Cauca. Postal code: 760003, Colombia. E-mail: mauroguti@hotmail.com

e. Orthopedic and traumatology service of CECIMIN, address: Av. 45 # 104-76, Bogotá DC-Cundinamarca. Postal code: 110221, Colombia. E-mail: luferro_99@yahoo.com

f. Biomedicas Uniremington research group, Corporación Universitaria Remington, Faculty of Health Sciences, address: coltabaco Building, St. 51 #51-27, Medellín, postal code: 050010, Colombia. E-mail: rubenarper@gmail.com

g. Fundación Universitaria Sanitas, address: St. 170 # 8-41, Bogotá DC-Cundinamarca. Postal code: 110141, Colombia. E-mail: nicolasopiovesan@gmail.com

h. Pontificia Universidad Javeriana, address: St. 18 # 118-250, Cali-Valle del Cauca. Postal code: 760031, Colombia. E-mail: jaimemusa16@hotmail.com
Satisfactory clinical outcomes with autologous matrix-induced chondrogenesis in the treatment of grade IV chondral injuries of the knee

Abstract

Objective

The research aims to evaluate short- and medium-term outcomes of patients treated using Autologous matrix-induced chondrogenesis (AMIC) with a hyaluronic acid scaffold (Hyalofast, Anika Therapeutics, MA-USA) in grade IV chondral lesions according to the Outerbridge classification in the knee.

Methods

This study is a multicenter, non-randomized, retrospective, conducted between 2017-2022. To determine the clinical outcome of the patients the follow-up was done with the subjective International Knee Documentation Committee (IKDC) score, pre-surgery, and with a follow-up at 12-, 24-, and 32 months.

Results

Fifty patients (28 female) with a mean age of 45.9 ± 12.7 years were recruited. The mean size of the lesion was 3.5 cm² and the injuries located in the patella (30%) and trochlear groove (24%) were the most frequent. The total IKDC clinical score significantly increased from baseline to the 32-months of follow-up with a mean difference of 36.4 (95% CI, 29.1-43.7, p< 0.001). Besides, there was a statistically significant improvement in all categories of the IKDC (symptoms, sports activities,
function, and activity of daily living) compared between pre-surgery and 24 and 32-months of follow-up. The patients younger than 45 years presented better clinical outcomes than older ones with a difference between medians of 10.40 (95% CI, 1.10-11.50, p=0.0247) and a negative correlation was found between the 32-months IKDC score and the age. In addition, no statistically significant difference was found when comparing the last results of the IKDC between patients with and without associated surgical procedures, or between patients with single and several lesions, neither nor between men and women. The level of satisfaction with the procedure of all the patients, on a score of 1 to 10, was on average 8 ± 1.5.

Conclusion

The results of this study indicate that patients who underwent the AMIC procedure with hyaluronic acid scaffold for the treatment of grade IV chondral lesions in the knee presented satisfactory results throughout the follow-up.

Keywords: autologous matrix-induced chondrogenesis (AMIC); Chondral defects; knee; Cartilage; Tissue Scaffold.

Level of evidence: Level IV
What are the new findings

- Autologous matrix-induced chondrogenesis (AMIC) with a hyaluronic acid scaffold for the treatment of grade IV cartilage injuries in the knee presented statistically significant improvement in all categories of IKDC score when comparing the patient’s baseline status with 32-months of follow-up
- No statistically significant difference was found when comparing the clinical outcome between men and women, single or multiple lesions, and patients with and without associated surgical procedures in the studied patients

Introduction

Articular cartilage injuries can greatly affect the function and quality of life of patients, these injuries present a challenging clinical stage because they can often occur in young patients and the characteristics of the articular cartilage do not allow adequate healing [1,2]. These injuries are usually diagnosed by arthroscopy or magnetic resonance imaging [3–6]. Two retrospective reviews found an underestimated incidence of up to 60% in all patients undergoing knee arthroscopy [7,8]. Chondral injuries can affect all areas of the articular cartilage in the knee, but the medial femoral condyle and the patellar surface are the most affected areas [7,9,10]. Furthermore, the available treatment options are limited therefore surgical treatment is often required, which has an annual incidence reported in series of up to 90 surgeries per 10,000 patients [11–3].
Articular cartilage is a specialized tissue responsible for protecting the subchondral bone and allowing the articular contact surfaces to glide against each other without friction and absorb the impact on the joints [10]. However, since the cartilage that covers the articular surface is hypocellular and lacks blood vessels, lymphatic drainage, and nerves, it has a very limited intrinsic tissue repair capacity. For this reason, the focal lesions in the articular cartilage of the knee may have important consequences both in the short and long-term, due to the risk of generating early osteoarthritis [13,14].

Chondral injuries are produced by the degradation of articular cartilage, in response to various stimuli that can be of metabolic, genetic, vascular, and traumatic origin [15–18]. These injuries can occur from a single episode of stress on the joint, or repetitive episodes of small magnitude and are an important cause of chronic pain [19]. The injuries can be classified according to the thickness and diameter of the affected cartilage, one of the most commonly used is the Outerbridge classification [13,20]. This classification divides chondral injuries into four grades: grade I, cartilage softening; grade II, involvement in an area that does not exceed 1.27 cm² (half an inch) in diameter and has a depth of less than 50% of the thickness of the cartilage; grade III, the depth of the defect involves more than 50% of the thickness and the area of the lesion exceeds 1.27 cm² in diameter; and grade IV, a lesion that involves the entire thickness of the cartilage, exposing the subchondral bone [21].

When an articular cartilage injury occurs, the fibrocartilage resulting from the healing process has inferior biological and biomechanical properties, compared to native hyaline cartilage, and can undergo degenerative changes that ultimately lead to
osteoarthritis [22]. For this reason, regeneration of the articular surface is very important [23]. There are several surgical approaches for the treatment of grade III and IV chondral lesions of the Outerbridge classification. However, there is no consensus on which should be the treatment of choice [24]. One of the most used therapeutic options is microfractures, which are cost-effective and are used extensively to treat small chondral defects [2]. This technique seeks to stimulate the bone marrow by drilling holes in the bone, and consequently form a clot of mesenchymal cells and growth factors that later will develop fibrocartilage in the lesion [1]. The clinical results of microfractures are highly dependent on the age of the patient and the size of the cartilage defect [1,25]. Microfractures are recommended in young, active patients, and present better results in defects smaller than 2.5 cm² [26]. Although this procedure has shown good results in the short term, some studies have shown that clinical improvement begins to diminish approximately two years after the procedure [2,27].

In recent years another method such as autologous matrix-induced chondrogenesis (AMIC) has become popular, which consists of biodegradable scaffold implantation associated with microfractures. It is a method that is being used frequently, due to their reduction in costs, time, morbidity and the clinical results have been significant in improving the symptoms, functionality, and quality of life of patients in the medium and long-term follow-up [24,25,28]. Among the different commercial biocompatible scaffold options that are used to repair chondral injuries, Hyalofast (Anika Therapeutics, Bedford, MA, USA) stands out, because it’s a scaffold that has a three-dimensional structure of nanofibers, hyaluronic acid non-woven, and is
characterized for its bioactivity, biocompatibility, and biodegradability. This generates a matrix that serves as structural support for mesenchymal stem cells released by bone stimulation since it promotes the union, proliferation, and differentiation of these cells into chondrocytes. As Hyalofast degrades, it releases more hyaluronic acid into the lesion, resulting in a microenvironment that further promotes hyaline-like cartilage formation [14,29]. Currently, limited literature is available evaluating the short- and medium-term outcomes of focal chondral lesions of the knee treated with microfracture in conjunction with the implant of a hyaluronic acid scaffold given the great variety of biological scaffolds. The present study aims to evaluate the short- and medium-term clinical outcome of patients over 18 years of age who presented grade IV knee chondral lesions, according to the Outerbridge classification, and who underwent AMIC, specifically microfractures with the implant of a hyaluronic acid scaffold (Hyalofast, Anika Therapeutics, Bedford, MA, USA). The clinical outcomes were assessed with the subjective International Knee Documentation Committee (IKDC) score, pre-surgery, and with a follow-up at 12-, 24-, and 32 months. Our hypothesis states that implementing a hyaluronic acid scaffold will result in satisfactory clinical outcomes for patients and early return to daily activities.
Methods

This study is a multicenter, non-randomized, retrospective, conducted between 2017 and 2020 in four specialized health institutions in Colombia and one health institution in Panama. For the treatment of the lesions, the implant of a hyaluronic acid scaffold (Hyalofast, Anika Therapeutics, Bedford, MA, USA) in combination with microfractures was performed in all patients. Microfractures were performed using 1.1-mm Kirschner wires drilled in approximately 3 to 5-mm intervals and 5-mm in depth across the exposed surface of the lesion. A hyaluronic acid scaffold was applied to fill the defect in dry conditions and waited until it came into contact with blood and formed a stable clot.

The inclusion criteria were patients over 18 years of age, focal cartilage tissue defect of the knee diagnosed by preoperative magnetic resonance imaging (MRI), no response to conservative treatment, and grade IV Outerbridge lesion according to intraoperative arthroscopic evaluation. Exclusion criteria were patients with a history of rheumatological diseases, intra-articular fracture, diffuse osteoarthritis, or previous surgical procedures on the knee to be intervened. Non-probabilistic sampling was used, and all patients who met the selection criteria were presented. A total of 84 patients were initially considered for this study, 28 were excluded based on the inclusion and exclusion criteria and 6 were lost to follow-up. Finally, 50 patients met adequate follow-up and inclusion-exclusion criteria.
The medical records of all identified cases were reviewed, and data of demographic (gender, age) and clinical variables were extracted (laterality, history of illness or surgery, time elapsed between injury and surgery, associated procedures performed in the same surgical time, satisfaction level on a numerical score, the number, size and location of the lesions, complications, and re-interventions). To determine the clinical outcome of the patients the follow-up was done with the subjective International Knee Documentation Committee (IKDC) score, pre-surgery, and with a follow-up at 12-, 24-, and 32 months. The present study was approved by the ethics committee of one university and the participating health institutions and was conducted according to the principles expressed in the Declaration of Helsinki. All patients were able to understand the nature of their treatment and written informed consent was obtained for the publication of images for research purposes.

For data analysis, GraphPad Prism V.8.0 (San Diego, CA, USA) software was used. Normality was evaluated using the D'Agostino & Pearson test. The variables that presented a normal distribution were expressed with mean and standard deviation (±), otherwise, they were expressed with median and interquartile range (IQR). The comparison between the two groups was made using the unpaired T-test or Mann-Whitney U test, for parametric and non-parametric data, respectively. Similarly, the comparison between three or more groups was made using one-way ANOVA or Friedman test, in the case of statistical association post hoc tests (or multiple benchmarks) were performed, using the Dunn or Turkey tests as appropriate. In
addition, correlations were made using the Pearson or Spearman tests, according to the variables. A value of p lower than 0.05 was considered statistically significant.

Results

In total, 50 patients were analyzed and 56% of them were women, the right knee was the most affected by chondral lesions (56%). 76% of the patients presented a single lesion. At the same time, the most common additional surgical procedure was anterior cruciate ligament reconstruction in 12% of cases (Table I). The level of satisfaction with the procedure of all the patients, on a score of 1 to 10, was on average 8 (± 1.5).

The clinical evolution in each parameter of the IKDC score, such as symptoms, sports activities, function, and activity of daily living, statistically significantly improved between the pre-surgery state and months 12, 24, and 32 of follow-up (Figure 1). Except in the parameter of function, and activity of daily living, when comparing the pre-surgery state and the 12 months of follow-up (Table II).

It was found that there is no correlation between the time elapsed between injury and surgery, and the last IKDC result at 32-months follow-up (p=0.471), or between the size of the lesion and the last result of the IKDC (p=0.673). However, a negative correlation was found between the last IKDC score at 32-months of follow-up and the age of the patients (Figure 2A). Similarly, a statistically significant difference was found when comparing the last results of the IKDC between patients older and younger than 45 years (Figure 2B). On the other hand, no statistically significant
difference was found when comparing the last results of the IKDC between patients with and without associated surgical procedures \( (p=0.535) \), or between patients with single and multiple lesions, neither nor between men and women \( (p=0.117) \).

The extent of cartilage regeneration and the quality of regeneration of some patients were also evidenced with MRI assessment (Figures 3,4). The MRI comparison between pre-and post-surgery showed filling of the defect with new cartilage-like tissue. Finally, no patient required additional surgeries, and no complications were reported during the follow-up period.

**Discussion**

The present study analyzed the clinical evolution of patients who presented grade IV knee chondral lesions, according to the Outerbridge classification, and who underwent AMIC, specifically microfractures with the implant of a hyaluronic acid scaffold (Hyalofast, Anika Therapeutics, Bedford, MA, USA). The main findings of this study were a continuous increase in the IKDC score at 12, 24, and 32 months of follow-up (Figure 1), a negative correlation between age and IKDC total score (Figure 2A), and better clinical outcomes in patients younger than 45 (Figure 2B). Similar results have been published in the literature with satisfactory clinical evolution in the short and medium-term using AMIC for the treatment of knee chondral defects [1,30,31].

Although other methods such as mosaicplasty or osteochondral transplantation have favorable results because transplant the full-thickness of the lesion, which allows its use in lesions of greater diameter with satisfactory results [23]. Nevertheless, the
larger the defect, the larger the area removed from the donor site, which limits the possibility of indicating this procedure for large defects, and the donor site will heal with fibrocartilage, which could cause associated morbidity [24], it has also been shown that the clinical success decreases among patients over 50 years of age [32,33]. Osteochondral allografts are also a treatment option for some chondral lesions and are used in larger defects. Although they don’t generate morbidity at the donor site, there is a risk of failure in the bone incorporation and non-viability of the chondrocytes [34]. Although the clinical results in several series are satisfactory in the medium and long-term follow-up, it presents the limitation of availability in some centers [35,36].

Another method that stands out to regenerate articular cartilage is the implant of autologous chondrocytes, either using a three-dimensional scaffold of biocompatible components, which serve as structural support, or implanting them directly in the lesion and covering them with periosteum [19]. This method has shown satisfactory results in lesions up to 10 cm² and presents better long-term clinical results when compared with other methods such as microfractures [37,38]. However, since two surgical procedures are required, in the first one, a cartilage biopsy is performed, to cultivate the chondrocytes in the laboratory, and later implant them through another procedure. This method is associated with higher costs and presents the limitation of the availability of an experienced laboratory to perform the cell cultures, which has influenced the search for alternative methods for the repair of cartilage injuries [39]. Such as the use of a biodegradable scaffold alone or associated with mesenchymal stem cells derived from bone marrow [29,40]. Through this method, it is sought that
the cells derived from bone marrow differentiate into chondrogenic and osteogenic lineages, and generate better-quality scar tissue [27,29,40]. Furthermore, the procedure can be completed in a single stage and does not need cell culture, resulting in a significant reduction in costs and morbidity in the patient, and clinical short and medium-term results are satisfactory in large lesions [41,42]. Despite this, bone marrow aspirate concentrate is a method that is not available in all institutions. Therefore, although there are many methods with good results, the limited availability of these in some institutions has made methods such as the AMIC more widely used in middle-income countries. Though there is no consensus on which should be the treatment of choice [24], it should be selected according to the characteristics of each patient, such as age, the size, number, and location of the lesions, availability, cost, and the experience of the treating specialist.

There are several reports, including randomized controlled clinical trials that confirm that treating focal knee cartilage defects with AMIC generates satisfactory clinical results in the medium term compared to other procedures such as microfractures [1,43]. It should be taken into account that there are several types of scaffolds used for the treatment of articular cartilage injuries, which can generate diverse results, since they may differ in composition and three-dimensional structure [15]. Despite this, the findings found in this study agree with several reports, in which satisfactory clinical results have been demonstrated using a hyaluronic acid scaffold as a support component in different techniques for the treatment of chondral lesions [6,14,25].

In the present study, a relationship was found between the last IKDC score and age (Figure 2). This is evidenced by better clinical outcomes in younger patients.
Although the results in the literature are diverse [44], some reports show better clinical outcomes in young patients when AMIC [45], or another therapeutic option is used [46]. In our results, the patients younger than 45 years show better results even removing confounding variables such as additional surgery and more than one chondral lesion. However, many authors have reported satisfactory clinical evolution in older patients when using a hyaluronic acid scaffold [6,14,17]. Despite this, some studies do not find age as a prognostic factor [15,44,47], though it is a matter of debate at the moment [1,48].

Although the size of the lesion has been reported as a negative predictor of the clinical outcome [48], in the present report, the size of the defect was not related to the last IKDC result. This could be explained because the mean size of the injuries found was 3.5 cm$^2$, and the reports in multiple series show that a difference is only evidenced in the clinical result when the injuries are greater than 8 cm$^2$ [16]. With small and medium-sized lesions such as those reported in this study, the clinical results are usually satisfactory [40,44,45]. In addition, it would be expected to find worse outcomes in patients with injuries in multiple compartments of the knee compared to a single injury, but in the patients studied there was no difference, perhaps due to the limited number of patients.

There is a previous report in the literature where cartilage repair was more effective in men when analyzing the results by gender [49]. However, most reports do not find a clinical difference related to the gender of the patients [1,44,45,47], as found in the present study. Although little is known about sex-specific differences in the treatment of chondral lesions, women often have unfavorable conditions related to the cause
of the lesion, the site, and the level of activity that may influence the final clinical outcome [50]. Therefore, more studies are required to allow a better understanding of the treatment of chondral lesions in different subpopulations.

Although there were some images presented (Figures 3,4) that show a regenerated tissue similar to those assumed to be indicative of healthy hyaline cartilage could not be performed postoperative follow-up using MRI or arthroscopy in all patients to assess tissue quality after the procedure. Besides, this study has other limitations, such as the lack of a control group, treated with microfractures only and the heterogeneity of the patients studied, although this reflects the reality of the patients suffering from chondral lesions because randomized controlled trials do not necessarily match with most patients [31]. Likewise, the follow-up time was 32 months, which could be a limitation when evaluating the long-term clinical outcome. However, the long-term studies using AMIC confirmed the stability of pain reduction and improved function for at least 5 years [27,31] and the findings reported in our study presented a progressive increase in IKDC score during the 32-months of follow-up, confirming the persistence of clinical improvement in the medium-term.

The strengths of the study were its international and multicenter nature, and patients with different age ranges were included, even older than 60 years old. Besides, the IKDC score was performed at different times in the clinical course, which allows an adequate analysis of the clinical evolution. Finally, the number of patients was adequate when compared with reports in the literature [6,13].
Conclusion

The repair of chondral lesions of the knee using AMIC with hyaluronic acid scaffold (Hyalofast, Anika Therapeutics, Bedford, MA, USA) provides satisfactory clinical results in the short- and medium-term follow-up. This procedure improved symptoms, sports activities, and functionality and presented a high level of satisfaction among evaluated patients.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Acknowledgments

The authors thank the patients who participated in this study and the collaboration of the personnel from the institutions where the patients were recruited.

Conflict of Interest

All authors reported no conflict of interest.

References


https://doi.org/10.1016/j.asmr.2020.05.006


https://doi.org/10.1016/j.knee.2007.02.001


https://doi.org/10.1016/S2255-4971(15)30339-6


Available from: https://doi.org/10.1016/j.arthro.2016.04.020

https://doi.org/10.1177/0363546517732531

Available from: https://doi.org/10.1016/j.arthro.2019.06.033

https://doi.org/10.1016/j.arthro.2019.09.004


Available from: https://doi.org/10.1177/2325967120981872


Table I. Patient characteristics
Table II. Results of the IKDC parameters of all patients
Pre: Pre-surgery; CI: confidence interval; ±: standard deviation.

Figure 1. Box-and-whisker plots show total IKDC clinical scores and its parameters, pre-surgery and at the different follow-ups
A. Total IKDC. B. Symptoms. C. Sports activities. D. Function, and activity of daily living. Comparisons were made using the one-way repeated measures ANOVA test with a 95% confidence level; and a post hoc test (multiple benchmarks) was performed, using Turkey's test. Significant differences are represented in the upper part of each figure. (*p<0.05, **p<0.01, ***p<0.001, ****p<0.0001).

Figure 2. Analysis of the IKDC according to age
A. Correlation between the last IKDC result at 32-months follow-up and the age of all patients. Analysis using Pearson correlation coefficient. The r and p values are indicated in the figure. B. Comparison of the result of the last IKDC evaluation between patients older than 45 years vs younger than 45 years (removing confounding variables such as additional surgery and more than one chondral lesion), with a difference between medians of 10.40 (95% CI, 1.10-11.50, p=0.0247). The comparison was made using the Mann-Whitney U test, with a confidence level of 95%. Significant differences are represented in the upper part of this figure (*p<0.05).

Figure 3. Magnetic resonance imaging of a chondral defect of the medial femoral condyle in a 25-year-old male patient.
A. Preoperative coronal image using a proton density turbo spin-echo (SPIR) sequence. B. Preoperative sagittal image with SPIR sequence. C. At 7 months follow-up coronal image. D. Postoperative sagittal image.

Figure 4. Magnetic resonance imaging of a chondral defect of the patella in a 40-year-old female patient.
A. Preoperative axial image. B. At 10 months follow-up axial image. C. Postoperative axial image with T2-mapping sequence.
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<td>Number of patients, n</td>
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<td>Age, mean ±</td>
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<td>Right</td>
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<td>IKDC Parameter</td>
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A. $r=0.3060$, $p=0.0325$

B.
Declaration of interests

☒ The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

☐ The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: