Micro or Nano Does not affect the Functional Outcomes in the Midterm Follow-up

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ABSTRACT

Introduction: Bone marrow stimulation techniques are the most commonly preferred options in the treatment of articular cartilage damage due to many features. Although nanofracture method that was developed in order to improve this technique has proven efficacy in animal models and in vitro studies, functional outcomes of nanofracture have not been shown in actual patients. In this study, our purpose was to compare the clinical outcomes of nanofracture technique and traditional microfracture technique in the knee joint.

Material and Methods: Patients operated using the microfracture technique as group 1 (n=22) and patients operated using the Nanofx (Arthrosurface Inc., Franklin, Massachusetts) technique as group 2 (n=20) were prospectively evaluated. Demographic characteristics of the patients, defect size and localization were recorded. Patients with isolated cartilage damage who had ICRS Grade 3-4 cartilage lesion and no concomitant pathologies were included in the study. Each surgical procedure was performed by the same surgeon by following the same surgical protocol. Clinical outcomes in the patients were assessed using Modified Cincinnati and Tegner-Lysholm scoring systems at months 6, 12, 24, 36 and 48.

Results: Calculated mean follow-up periods were 50.8±3.1 and 51.2±3.2 in groups 1 and 2, respectively. There was no statistically significant difference between the groups in terms of the defect and demographic characteristics of the patients. In the follow-up of patients using functional scoring, there was no statistically significant difference in Lysholm (p=0.294) and Cincinnati (p=0.234) scores between the two groups.

Conclusion: There was no difference in the mid-term between the functional outcomes of microfracture and nanofracture techniques in the treatment of cartilage lesions.

Keywords: Cartilage; Bone Marrow Stimulation, Microfracture, Nanofracture, Functional Outcomes

INTRODUCTION

Articular cartilage damage is a common knee joint problem as is also shown by various knee arthroscopy studies.[1] Cartilage tissue that covers the articular surface does not have nerves, blood vessels or lymphatics. Therefore, spontaneous healing should not be expected.[2]

Although the selection of surgical treatment method in each patient is still debatable, microfracture, mosaicplasty, autologous chondrocyte implantation, and osteochondral allograft transplantation techniques are frequently preferred current treatments. Even though these techniques have their own drawbacks, there are evidences showing that these techniques are effective in restoring knee functions.[3-5]

Bone marrow stimulation techniques are the first choice of treatment that can be applied to small lesions. Bone marrow stimulation techniques are based on the principle of pluripotent mesenchymal cell migration from bone marrow to the damaged site with the penetration of subchondral bone plate. The most commonly used form of these techniques, i.e. the microfracture method, was first described in 1997.[3] Microfracture is an inexpensive and simple method that does not require additional preparation and it does not interrupt further treatment in case of failure, as it does not involve an implant.[6]

In a limited number of conducted studies, it was argued that better results could be achieved by using narrower instruments that can reach deeper into the subchondral bone layer in comparison to awl used in microfracture for the penetration of subchondral tissue, which is the main principle of bone marrow stimulation techniques.[7] A new system called Nanofx® (Arthrosurface Inc., Franklin, Massachusetts), which is predicted to provide better results for bone marrow stimulation in comparison to microfracture, was developed based on this principle. It is claimed that the guide wire(Pluristick®) of Nanofx with a thickness of 1mm inflicts less damage to the subchondral plate and penetrates three times deeper than the existing techniques with a depth of 9 mm. There are animal model studies investigating the superiority of cartilage repair tissue obtained in Nanofx method as compared to the microfracture method.[8] However,

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there is no data in the literature in terms of clinical outcomes. In this study, we aimed to compare the clinical outcomes of the microfracture method applied with a conventional awl and used in articular cartilage lesions of the knee with the clinical outcomes of the newly developed Nanofx application.

MATERIAL AND METHODS

Fourty-two patients, who were diagnosed with articular cartilage lesion of the knee and operated, were prospectively evaluated in this study. Patients who were operated using the microfracture method constituted Group 1 (n=22) and patients who were operated using the Nanofx (Arthrosurface Inc., Franklin, Massachusetts) method constituted Group 2 (n=20). In Group 1, mean age of the patients was 36.8±7.3 years and the female/male ratio was 17/5; whereas in Group 2, mean age of the patients was 37.8±4.1 years and the female/male ratio was 15/5. Mean body mass index (BMI)(kg/m2) of the patients in Group 1 and Group 2 was calculated as 28.9±3.5 and 26.9±3.3, respectively.

International Cartilage Repair Society (ICRS) Classification was used in classifying the cartilage lesions of the patients and all patients enrolled in the study had ICRS Grade 3-4 lesions. Arthroscopic measurement of defect size revealed a mean defect size of 3.5±0.7 cm^2 in Group 1 and 3.5±0.7 cm^2 in Group 2. Among the patients in Group 1, 19 patients had lesions in the medial femoral condyle (MFC), and 3 patients in the lateral femoral condyle (LFC). Distribution of defect localizations was as follows in Group 2: 16 medial femoral condyle and 4 lateral femoral condyles. Patients with 2-5 cm^2 cartilage damage in medial and femoral condyles after arthroscopic debridement were included in the study. Patients who had comorbidities in addition to cartilage damage such as meniscal lesions or anterior cruciate ligament injuries and patients who had received arthroscopic surgery in order to treat such conditions were excluded from the study. Moreover, patients who had cartilage lesions in the trochlea and tibia plateau, bone loss with osteochondral lesions and rheumatic disease along with cartilage damage and patients with malalignment and bipolar lesions were excluded from the study.

Surgical procedure

Both techniques were applied arthroscopically without using a tourniquet. The area with cartilage damage was debrided until reaching the surrounding intact cartilage margins using an arthroscopic curette and its size was measured with an arthroscopic ruler. Microfracture was performed with awls of different angles depending on defect localization by creating holes at 3-4 mm depth with 3-4 mm spacing from the periphery and towards the center, whereas Nanofx was performed by following a systematic spiral pattern and creating 9 mm-deep subchondral penetrations with 2 mm spacing.

Rehabilitation

Patients in both groups were followed-up in the same rehabilitation programme. Weight-bearing was not allowed on the surgery side for 6 weeks. Patients' range of joint motion was not limited as of the early post-operative period. Active movement and isometric quadriceps exercises were prescribed.

Patient evaluation

Clinical outcomes of the patients were assessed using Modified Cincinnati and Tegner-Lysholm scoring systems at months 6, 12, 24, 36 and 48.

STATISTICAL ANALYSIS

Statistical analysis was performed using the statistical package SPSS software (Version 24.0, SPSS Inc., Chicago, IL, USA). If continuous variables were normal, they were described as the mean±standard deviation (P>0.05 in Shapira-Wilk (n<30)), and if the continuous variables were not normal, they were described as the median. Comparisons between groups were applied using Student T-test for normally distributed data. The categorical variables between the groups were analyzed using the Chi square test. Pre-post measures data were analyzing Paired T test and Repeated Measure Analyses. Values of P< 0.05 were considered statistically significant.

RESULTS

Demographic distribution of the patients, defect size and

	Microfracture		Nanofracture		Total		
	n	%	n	%	n	%	P value
Sex							
Female	17	77.3	15	75.0	32	76.2	1.000
Male	5	22.7	5	25.0	10	23.8	
Defect Localization							
LFC	3	13.6	4	20.0	7	16.7	0.691
MFC	19	86.4	16	80.0	35	83.3	
	Mean±SD		Mean±SD		Mean±SD		P value
Age	36.8±7.3		37.8±4.1		37.3±5.9		0.578
BMI (kg/m^2)	28.9±3.5		26.9±3.3		28.0±3.5		0.064
Follow-up (month)	50.8±3.1		51.2±3.2		51.0±3.1		0.669
Defect Size (cm^2)	3.5±0.7		3.5±0.6		3.5±0.7		0.940

n: Number of Patients, LFC: Lateral Femoral Condyle, MFC: Medial Femoral Condyle; BMI: Body Mass Index, SD: Standard Deviation

Table-1: Distribution of demographic and clinical features

Follow up	Microfracture	Nanofracture	Total	
	Mean±SD	Mean±SD	Mean±SD	P value
Preop	58.9±7.3	56.9±5.8	57.9±6.6	0.343
6 months	87.8±2.3	86.2±1.8	87.0±2.2	0.017
12 months	90.1±2.9	88.2±2.1	89.2±2.7	0.026
24 months	86.6±2.8	86.1±2.7	86.3±2.8	0.572
36 months	83.3±2.7	83.7±3.2	83.5±2.9	0.647
48 months	76.6±4.1	77.6±3.9	77.1±3.9	0.416
SD: Standard deviation				

Table-2: Tegner Lysholm functional scores and analysis between groups during follow-up. The change in the patient follow-up scores on the 6th, 12th, 24th, 36th and 48th months according to preop. A statistically significant difference in Tegner Lysholm score was observed between the two groups only at the 6th and 12th months.

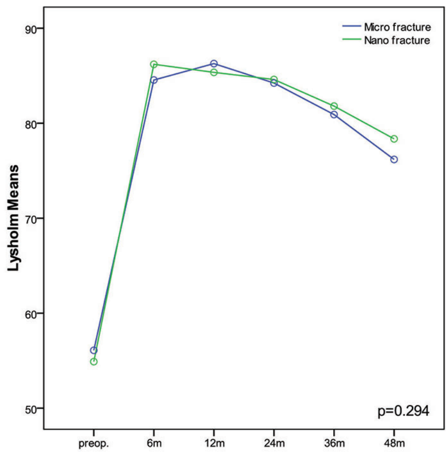

Figure-1: Tegner Lysholm scores during follow-up periods. The change in the Tegner Lysholm functional score averages of the two groups from the pre-operative time is indicated in the graph.

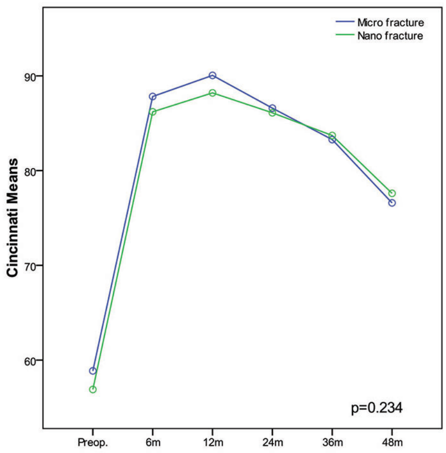

Figure-2: Cincinnati scores during follow-up periods. The change in the Cincinnati functional score averages of the two groups from the pre-operative period is indicated in the graph.

localization, follow-up periods and distribution of these by groups are provided in Table 1. A statistically significant difference was not observed between the groups from the demographic and clinical aspect (Table 1). Mean follow-up periods were 50.8±3.1 and 51.2±3.2 in Groups 1 and 2, respectively. Comparison of the postoperative functional scores revealed only one statistically significant difference between the two groups in Tegner Lysholm scores at months 6 and 12 in favor of nanofracture. The change in

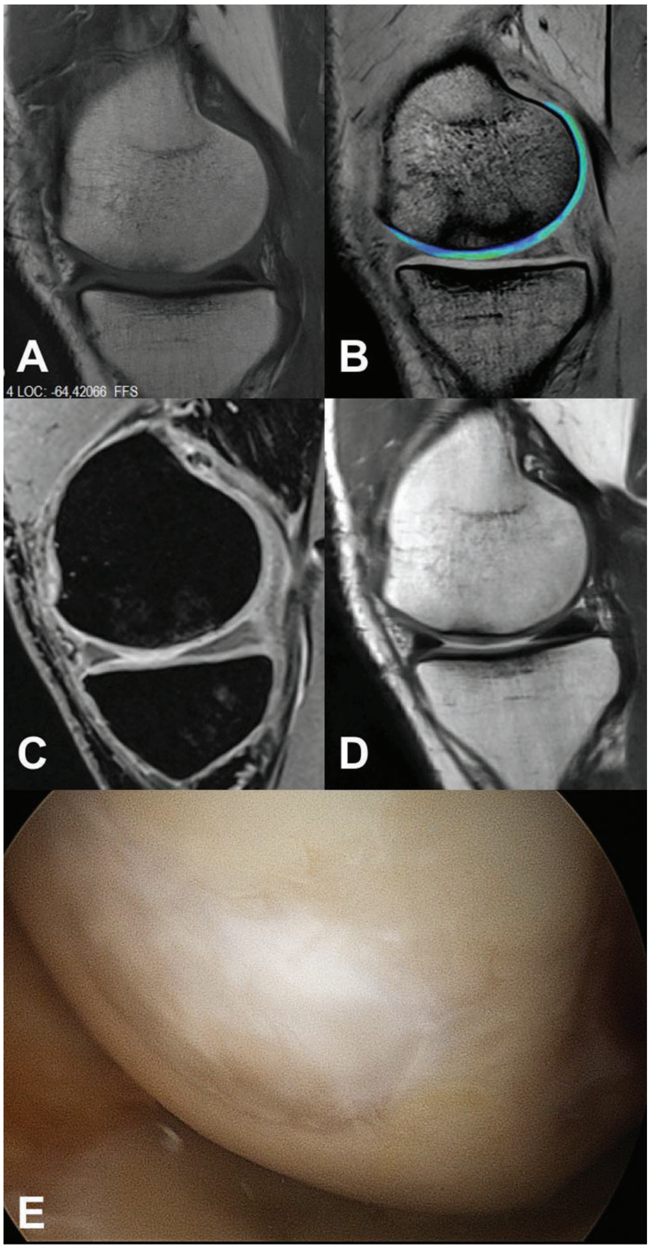

Figure-3: Magnetic resonance imaging (MRI) (12th months sagittal plane (A). 12th months T2 Mapping (B). 24th months fat-saturated T1-weighted (C). proton-density weighted (D) and second look arthroscopy (E) images of a nanofracture case.

Lysholm (P=0.294) and Cincinnati (P=0.234) measurements throughout the follow-up period was not statistically significant. The change in the functional scores according to follow-up periods is provided in detail in Table 2, 3 and Figure 1, 2. Magnetic resonance imaging (MRI) and second look arthroscopy (E) images of a sample nanofracture case given in figure 3.

DISCUSSION

This is the first study on this subject in terms of showing that the functional outcomes of microfracture and nanofracture methods were not different in the mid-term follow-up.

Bone marrow stimulation techniques are still commonly preferred options in the treatment of articular cartilage lesions due to the ease of surgery. low costs and proven success for many years. Bone marrow stimulation techniques can be applied using drills. awls of different sizes and angles and recently developed nanofracture with 1 mm diameter.

In repairing articular cartilage damage of the knee, the presence of concomitant pathologies such as meniscus tear and anterior cruciate ligament injury as well as operations performed to treat such conditions affect the rehabilitation protocol and the functional outcomes during follow-up.[9] A hundred and twenty six patients with articular cartilage lesions of the knee were screened before the study and the functional outcomes of 42 patients with isolated articular cartilage lesions of the knee were analyzed after excluding 84 patients who had concomitant pathologies.

In previous studies, it was argued that subchondral penetration performed by creating deeper holes with smaller diameter was more successful in animal experiments and in vitro studies. Zedde et al. have shown that nanofracture method provided a better cartilage architecture as well as higher type II collagen content in comparison to the traditional microfracture technique in a sheep model.[8] Two different studies have compared 1.0 and 1.8 mm subchondral penetration performed by an awl and drill in an animal model and obtained similar results.[10,11] Gianakos et al. evaluated the subchondral bone in a human cadaver ankle using Micro-Computed Tomography after microfracture and nanofracture applications, as in this study, and showed that drilling holes with a higher diameter caused more damage to the microarchitecture of the subchondral bone.[12] Hoemann et al. conducted an in vitro study on femoral condyle parts obtained from elderly patients during total knee arthroplasty and showed that the diameter and depth provided by the subchondral penetration technique employed in the study as well as the degree of sclerosis in the subchondral bone were determinants of compaction and fissures that will be seen on the bones.[13]

Although in vitro and in vivo (animal model) efficacy of this technique, which is frequently practiced in the treatment of articular cartilage damage, has been shown as mentioned above, its efficacy from the functional aspect has not been shown in humans until today. In this study, we compared the functional efficacy of the two techniques in two similar groups and found no difference in the mid-term outcomes.

The content of cartilage tissue obtained as a result of cartilage damage treatment is one of the most important determinants in terms of treatment efficacy and protection from osteoarthritis in the long-term. As shown in animal models, cartilage repair tissues obtained after microfracture and nanofracture applications are different. It is argued that the tissue obtained in nanofracture technique is richer in type II collagen, as desired.[8] Considering that the outcome would be the same in humans, it can be expected to see functional differences between the two techniques in the long term. The weakness of our study was that it only contained mid-term outcomes and it is necessary to show the outcomes from long-term follow-ups with further studies.

CONCLUSION

Bone marrow stimulation technique can provide successful outcomes in the treatment of articular cartilage lesions of the knee. Although there was no difference between the functional outcomes of the two commonly used bone marrow stimulation techniques, i.e. microfracture and nanofracture, in the mid-term, long-term results are required.

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