Long-term outcome of grade III and IV chondral injuries of the knee treated with Steadman microfracture technique

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Summary

Introduction. The aim of our study is to demonstrate the effectiveness of Steadman microfracture technique in the management of high-grade chondral defects at the level of the knee by clinical follow-ups at eleven years.

Materials and methods. This is a study conducted on fifteen patients suffering from Outerbridge grade III and IV chondral lesions of the knee, who underwent Steadman microfracture surgery between 2003 and 2004. Selective exclusion criteria to prevent that other treatments or comorbidities could invalidate the results were used. Patients were clinically evaluated with Lysholm and IKDC scale scores before surgery and at follow-ups at eleven years.

Results. There has been an improvement in the Lysholm scores (59.33 ± 18.2 at time zero vs 82.13 ± 14.16 at time t; p value: 0.0342) and in the IKDC scores (45.13 ± 17.07 at time zero vs 68.66 ± 21.47 at time t; p value: 0.04) that appears statistically significant.

Discussion. Currently microfracture surgery is not indicated in patients with high-grade chondral defects, but at the same time, it is a technique of easy execution, low cost and good results. The clinical improvement observed appears statistically significant, but we have also noticed a slight clinical worsening in two patients, possibly caused by: improper treatment, new trauma, incorrect rehabilitation and age at time of surgery.

Conclusions. The study has shown significant clinical improvements in patients, despite the fact that indications to the use of microfracture are still very limited and selective. It’s essential to underline the importance of the single patient assessment process, taking into account a variety of aspects including the site, the number and extent of the lesion, the degree of functionality, activity level, age and previous trauma. This shows the importance of a comprehensive assessment of the patient in order to choose the most suitable surgical option, which not necessarily has to strictly adhere to standard practice.

KEY WORDS: long-term outcome; grade III and IV chondral; knee; Steadman microfracture; technique Outerbridge classification.

Introduction

Over the last decade we have witnessed a remarkable evolution in managing chondral lesions. Experimental studies, at various levels, have compared the possible treatments for this type of pathology, taking into account new developments in the field of surgical, biological and engineering techniques. At the same time there has been an evolution in diagnostic, but especially, therapeutic algorithms according to the type of lesion. The attention from an exclusive consideration of the depth of the defect in choosing the right treatment has shifted to a more extensive evaluation that would also cover the extent, the site, the number of lesions and the functional demand.

In 2012, the US group Redler et al. (1) conducted a review study on numerous publications, dealing with specific options of treatment with the Steadman microfracture technique, developing a very accurate decisional algorithm (Figure 1).

However the algorithm shown above may not represent the gold standard decision, since a definitive and proven treatment for any type of chondral lesion has not yet been found; moreover, biological and engineering research are constantly evolving in the production of scaffolds or chondromimetic materials which are still to be validated.

Although it is clear that the chondrocytes have the ability to react to mechanical stress, their ability to synthesize new macro molecules to repair the damage to the matrix is quite low, and this is linked to the avascular nature of the tissue. In absence of an adequate blood supply it can’t provide an appropriate scaffold for the genesis of a repair tissue. Furthermore the absence of inflammatory factors and other cytokines does not allow the migration, proliferation and differentiation of mesenchymal latent cells (2). The articular cartilage defects are a common problem and dif-
ficult to resolve; after the onset of the injury, the cartilage undergoes a series of biochemical and biomechanical changes, which include loss of the typical structure and macromolecular organization, the reduction of proteoglycan, an increase in permeability and stiffness that causes vulnerability to future mechanical damage. The microfracture technique of Steadman provides for the execution of the micro perforations of the subchondral bone 3-4 mm away from each other, with formation of a stable clot that fills the defect, providing an optimal environment for the formation of repair tissue (3-11). In fact, the subchondral bone drilling allows to recruit growth factors, proteins and mesenchymal stem cells. These cells are present in bone marrow, skeletal and cardiac muscle, peripheral blood and adipose tissue (12). Totipotent mesenchymal stem cell differentiation will face in fibrochondrocytes (8), that can repair the defect with fibrocartilage tissue (13-16). This last has different biomechanical and morphostructural characteristics from the normal articular cartilage, containing collagen type I, II, III. The amount of type II collagen is significantly less than the hyaline cartilage but the content of collagen type III and proteoglycans is more than it. Recent studies have introduced precise and detailed indications for the treatment with Steadman microfracture, which are extremely strict in the selection of patients suitable for this kind of operation. Present evidence suggests the opportunity of this technique only in case of Outerbridge grade I and II lesions and smaller than 3 cm. Our study included clinical follow-ups at 11 years for patients suffering from grade III-IV chondral lesions treated with microfracture technique.

In literature we have also seen studies on patients with grade III-IV chondral lesions treated with microfracture, showing satisfactory results. Negrin et al. (17) has conducted a meta-analysis on a total of more than 25,000 knee arthroscopies with microfracture surgery, and evaluated using KOOS. The results of this meta-analysis showed an improvement in postoperative clinical status compared to the preoperative state.

Materials and methods

Subjects of the study

Our study was conducted on 15 patients suffering from Outerbridge grade III-IV chondral lesions treated with Steadman microfracture technique. Inclusion criteria, as can be seen from the above, are represented by grade III-IV chondral lesions of the knee treated with microfracture surgical technique, between 2003 and 2004. The exclusion criteria from the study were: LCA and LCP reconstruction, meniscectomy, clear arthritis, excessive axial deviation, BMI greater than 35 and young people growing up. On the basis of the exclusion criteria, a careful and precise selection was made, which resulted in a total of 30 patients who fully complied with the criteria. Two evaluation charts of “clinical score” type were submitted to patients in order to assess the preoperative conditions (at time zero) and current ones (at time t). The Lysholm and IKDC scales were used.

The clinical evaluation was only performed on 15 patients, since 15 of the 30 were unavailable at follow up. There were 12 male and 3 female patients, with a current average age of 44.4 years (50.6 for females and 42.8 for males). Once the clinical evaluation was completed, we obtained for both scales, scores related to present and preoperative conditions.
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These data were appropriately compared among them in order to evaluate the presence of a statistically significant difference between preoperative and current values.

**Evaluation Tools**

The Lysholm scoring scale is a clinical questionnaire commonly used to evaluate the outcome following arthroscopic surgery on the knee (18); this score allows examination of the clinical symptoms and the degree of joint functionality, and is a valuable tool for evaluating the effectiveness of arthroscopic surgery.

The IKDC is an evaluation form made up of specific questions, which can be used separately; for our study we used the subjective knee evaluation form, which takes into account the clinical symptoms, the degree of functional limitation and the influence the patient's athletic activity.

**Statistical analysis**

Statistical analysis was performed with GraphPad Prism 5; the characteristics of the study population are summarized as mean ± standard deviation (SD) or standard error (SE) or prevalence rate when appropriate. The seriated modifications of the parameters (from preoperative state to follow-ups at 11 years) were tested by t-test for paired data. P values <0.05 were considered significant.

**Results**

The clinical evaluation of patients, as already mentioned above was performed by submitting two different score cards at time zero, or preoperative, and at time t (follow-up at 11 years).

Below is a comparison between the average of the total results of the Lysholm score at time zero (preoperative) and the average of the total scores at time t (follow-up at 11 years), expressed as mean ± SD (Table 1).

As shown by the results in the Table there was an overall improvement in the Lysholm scores (59.33±18.2 at time zero vs 82.13±14.16 at time t; p value: 0.0342) that appears statistically significant, as the value of p is less than 0.05. Comparing the average of the preoperative and current scores detected by IKDC, the difference obtained appears statistically significant (45.13 17.07 at time zero vs 68.66±21.47 at time t; p value: 0.04) (Table 2).

**Discussion**

The Steadman microfracture technique is one of many options for the treatment of chondral injuries of the knee. The objective of our study was to evaluate the effectiveness of microfractures in the treatment of high level chondral defects (Outerbridge grade III and IV) by follow-ups at 11 years. This treatment option does not comply with current indications, but being a long-term follow up, at the time of surgery, microfractures represented a technique easy to perform, at low cost and good results. Techniques such as microplastic were already performed 10 years ago, but no evidence, or long and detailed follow up were present in the literature to validate the results. It should be taken into account the progress and the new acquisitions which have occurred over the years in the surgical, biological and engineering fields, which have radically changed the management of chondral injuries.

Clinical evaluation was performed using Lysholm and IKDC scores; the choice of these two instruments is not random, but rather dictated by their characteristics and by the object of the evaluation; since they focus the attention on the patient's clinical symptoms and the degree of joint function, also in relation to daily and athletic activities. After submitting the Lysholm questionnaire for clinical evaluation to every patient, we compared the average of the scores at time zero (preoperative), with the average scores at time t (follow up at 11 years). The result obtained shows an improvement of the clinical condition of the patients; in fact, the difference between the two values appears statistically significant. In analyzing the data more in details and evaluating the differences between the values at time zero and at time t of each point of the Lysholm scale, it is clear that the difference is statistically significant only for three of the eight points: swelling, pain, instability in walking, running, and jumping.

Table 1 - Comparing the average of the total scores of the Lysholm at time zero (pre-operative) and the average of the total scores at time t (follow-up to 11 years), expressed as mean and SD.

| Time 0       | Time t       | P value  |
|--------------|--------------|----------|
| Average±DS   | Average±DS   |          |
| Lysholm      |              |          |
| 59.33±18.2   | 82.13±14.16  | 0.0342   |

Table 2 - Comparing the average of the scores obtained by patients to clinical evaluation by IKDC, at time zero (pre-operative) and at time t (follow-up to 11 years), expressed as mean and SD.

| Time 0       | Time t       | P value  |
|--------------|--------------|----------|
| Average±DS   | Average±DS   |          |
| IKDC         |              |          |
| 45.13±17.07  | 68.66±21.47  | 0.04     |

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not fully indicated in the specific case of those patients. Probably, the most correct choice in such cases would have been to proceed with a conservative treatment. Another hypothesis is that patients did not correctly follow all the steps of the rehabilitation program, which as explained above, plays a crucial role in the success of the surgery. Another possible explanation could have been the arising of new traumatic events, responsible for the worsening of the clinical symptoms of the patient. Moreover, as already assumed, the age of the patient at the time of surgery may affect the outcome, the duration and the degree of functional improvement. In support of this hypothesis, in our study we found better outcomes with scores near the maximum value (in both scales) in the two younger patients. Therefore it’s intuitive to think that the results of microfractures are also influenced by age of the patient (20, 21) which of course is correlated with the vitality and quality of the tissue.

Conclusions

Our study has shown a significant clinical improvement in patients with grade III-IV chondral lesions treated with microfracture and evaluated by follow-ups at 11 years. This is in agreement with the evidence present in the literature (19), although this type of treatment is included in the current standard directions. The ultimate goal is to emphasize the importance of the individual assessment of the patient, taking into account many aspects, not focusing the attention exclusively on the grade of the chondral injury.

There are many elements that should not be overlooked, among which the site, the number and the extent of the lesion, the degree of functionality, the level of activity, the age and previous trauma. Therefore, the surgeon cannot rigidly stick to therapeutic algorithms that must be considered an aid in selecting the most suitable treatment for the individual patient. This shows the importance of an overall assessment from which to choose the most suitable surgical choice, which does not have to rigidly adhere to the directions. Although our study has achieved good results, it has some limitations, especially related to the homogeneity of the sample and the modest numbers. But it does suggest the need for further randomized clinical studies (RCTs) and meta-analysis in order to identify the most reliable selection criteria and guidelines, which would take into account the patient as a whole.

Conflict of interest statement

All authors must disclose any financial and personal relationships with other people or organisations that could inappropriately influence (bias) their work. Examples of potential conflicts of interest include employment, consultancies, stock ownership, honoraria, paid expert testimony, patent applications/registrations, and grants or other funding.

Human and animal right

For this type of study is not required any statement relating to studies on humans and animals.

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