

Review article

Microfracture for the treatment of cartilage defects in the knee joint – A golden standard?



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ARTICLE INFO

Article history:

Received 10 May 2016

Received in revised form 14 June 2016

Accepted 14 June 2016

Available online 28 June 2016

Keywords:

Cartilage

Microfracture

Golden standard

Registry

Knee

ABSTRACT

The evidence for the effectiveness of the microfracture procedure is largely derived from case series and few randomized trials. Clinical outcomes improve with microfracture for the most part, but in some studies these effects are not sustained. The quality of cartilage repair following microfracture is variable and inconsistent due to unknown reasons. Younger patients have better clinical outcomes and quality of cartilage repair than older patients. When lesion location was shown to affect microfracture outcome, patients with lesions of the femoral condyle have the best clinical improvements and quality of cartilage repair compared with patients who had lesions in other areas. Patients with smaller lesions have better clinical improvement than patients with larger lesions. The necessity of long postoperative CPM and restricted weight bearing is widely accepted but not completely supported by solid data. Maybe new developments like the scaffold augmented microfracture⁶ will show even more consistent clinical and biological results as well as faster rehabilitation for the treatment of small to medium sized cartilage defects in younger individuals.

All in all there is limited evidence that micro fracture should be accepted as gold standard for the treatment of cartilage lesions in the knee joint. There is no study available which compares empty controls or non-surgical treatment/physiotherapy with microfracture. According to the literature there is even evidence for self regeneration of cartilage lesions. The natural history of damaged cartilage seems to be written e.g. by inflammatory processes, genetic predisposition and other factors. Possibly that explains the large variety of the clinical outcome after micro fracture and possibly the standard tools for evaluation of new technologies (randomized controlled trials, case series, etc.) are not sufficient (anymore).

Future technologies will be evaluated by big data from international registries for earlier detection of safety issues, for detection of subtle but crucial co-factors for failure and osteoarthritis as well as for lower financial burdens affecting industry and healthcare systems likewise.

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1. Introduction

The microfracture technique often is considered the golden standard therapy for the treatment of cartilage defects. The first results and the technique were published in 1994.²³ The microfracture procedure was originally designed for patients with post traumatic lesions of the knee that have progressed to full thickness chondral defects. Unstable cartilage that overlies the

subchondral bone also is an indication for microfracture as well as degenerative changes in the knee joint with proper axial alignment. The technique has been developed by Steadman to enhance chondral resurfacing by providing an enriched environment for tissue regeneration and by taking advantage of the bodies own healing abilities.²⁷ For the surgical procedure 3 portals are recommended: for the inflow cannula; one each for the arthroscope and the working instruments. After assessing the full thickness articular cartilage lesion, the exposed bone is debrided of all remaining unstable cartilage. To debride the cartilage, the originating authors use a full-radius resector and/or a handheld curved curette. All loose or marginally attached cartilage from the surrounding rim of articular cartilage is also debrided to form a stable perpendicular edge of healthy vital cartilage around the

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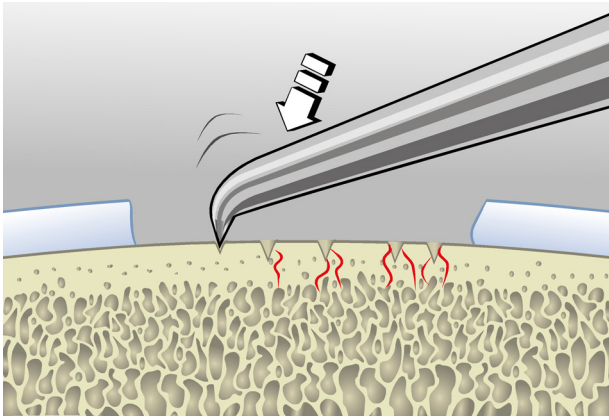


Fig. 1. Arthroscopic view of a medial femoral condyle after microfracture.

defect. This prepared lesion provides a pool that helps to hold the bone marrow clot as it forms. The calcified cartilage layer that remains as a cap to many lesions then is removed by using a curette. Thorough and complete removal of the calcified cartilage layer is extremely important according to Frisbie.⁷ To avoid excessive damage to the subchondral bone, an arthroscopic awl then is used to make multiple perforations, or microfractures, into the exposed subchondral bone plate.²⁷ The holes should be placed 3–4 mm apart without breaking the subchondral bone plate between them. Fat emerging from the marrow cavity indicates the appropriate depth (2–4 mm) (Fig. 1). There is no thermal damage to be expected to the bone as seen with drills. When the blood flow from the bone marrow seems to be adequate in all areas of the defect after reducing the irrigation fluid pressure the procedure is terminated. Intraarticular drains are not recommended.

Steadman emphasizes the importance of an appropriate rehabilitation program after microfracture. The rehabilitation should be designed to promote the ideal physical environment in which the newly recruited mesenchymal stem cells from the marrow can differentiate into appropriate articular cartilage-like cell lines. Location of the defect, size and concurrently treated pathologies determine the postoperative plan. In general, continuous passive motion (CPM) is commenced in the recovery room with an increasing range of motion with usually one cycle per minute for 6–8 h per day.²⁷ Crutch-assisted touchdown weight bearing is prescribed for 6–8 weeks, depending on the size of the lesion. Elastic cord exercises and weight training are steps to full function and the return to more demanding sports not earlier than 4–6 months after microfracture.

Although the microfracture technique is performed by many orthopedic surgeons, clinical experience has shown that some patient populations may benefit more from microfracture than others. To identify factors which could possibly influence the outcome of microfracture this review study has been designed.

2. Literature search

In order to identify relevant publications a medline search was performed (PubMed April 29, 2016) which produced 432 hits using the keywords microfracture and knee. EMBASE and Google Scholar did not reveal any additional information. Additionally bibliographies from selected articles and pertinent journals from the last six months were searched for relevant citations.

Publications presenting previously unpublished original data regarding the clinical application of microfracture in human knee joints for the treatment of cartilage defects in adults were included in the study. From 42 studies fulfilling those requirements, 3 publications were excluded due to a combined treatment only

with microfracture AND high tibial osteotomy^{18,28} or to a duplication compared to a previous study.¹⁰ A report about an already included cohort at a different time point was excluded from the study as well.¹³ One study could not be evaluated since the original polish publication was not available.⁴ A report about a mixed patient cohort with knee and ankle treatment was not selected for review as well.²²

The remaining 36 publications (Table 1) were evaluated by 3 independent reviewers. The use of a specifically designed data extraction form enabled the standardized data collection regarding exact reference, objective of the study, study design, demographics of the participants, description of the intervention, possible control groups, outcome data and level of evidence according Journal of Bone and Joint Surgery criteria.¹¹ For selected studies a bias assessment was performed.

3. Results

The first studies were obviously published by Steadman and his co-workers beginning in 1994 by Rodrigo.²³ He examined 77 patients after microfracture treatment, all of them underwent second-look arthroscopy for various reasons. In a level III retrospective comparative series he compared one group with postoperative CPM treatment and a second group with no postoperative CPM with otherwise identical rehabilitation program. After a follow-up time of 64 weeks respectively 73 weeks macroscopic rating from 1 (excellent) to 5 (bad) showed an improvement of 2.67 grades for the CPM group in comparison to 1.67 grades for the non-CPM group. Rodrigo concluded that after microfracture treatment 8 weeks of postoperative CPM should be administered.

Blevins compared in 1998 the outcome of 48 professional athletes with 188 recreational athletes after microfracture.³ The clinical outcome scores showed significantly better results in both groups from baseline to follow-up 3.7 respectively 4.0 years after operation. 31 of 48 professional athletes responded to the outcome questionnaire of which 23 returned to the same athletic level. The tapes of 26 second-look arthroscopies in the professional group were available for blinded evaluation versus 54 in the recreational athlete group. The examiner had no information whether the lesion was being viewed at the time of initial treatment or at second look. The cartilaginous findings were graded on a scale from I to IV adapted from Outerbridge. The average improvement in grades was 1.6 respectively for the professional athletes and 1.4 respectively compared to baseline. 35% in the recreational athlete group showed no improvement in lesion grading with the exposed subchondral bone visible compared to 8% showing no improvement in the professional group.

In 2003 already Steadman presented data with an average follow-up of 11 years after microfracture for traumatic chondral defects of the knee.²⁵ 68 patients (71 knees) younger than 45 years were questioned regarding their functional outcome after microfracture with details shown in Fig. 2.

In another series, Steadman reported about 25 national league football players of whom 19 returned back to play ± 10 months after microfracture playing an average of 56 games.²⁶

In the microfracture arm of his study Bachmann included 7 patients with a mean age of 33 years (± 6) and found a clinical improvement using the Lysholm score from 45.5 to 74.2.¹ A complete defect fill in MRI was detected in 2/7 patients after 2 years.

A different set of patients was treated by Miller who presented outcome data 2.6 years (2–5) after microfracture of degenerative cartilage lesions.¹⁹ All 81 patients were 40 years and older (40–70) and had an average defect size of 2.29 cm² (0.25–20). The Tegner score increased from 53.8 (19–85) preoperatively to 83.1 (44–100) at follow-up. Patients' satisfaction was measured with 8.2 (1–10)

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