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# The Efficacy of Microfracture in the treatment of Athletes with Full Thickness Chondral Injuries

## **Abstract**

**INTRODUCTION:** Sports injuries can often result in full thickness chondral lesions. If left untreated, these injuries can lead to localized pain, inflammation, effusion and further cartilage injury. Such injuries in an athlete can be career ending. The current recommendation for treatment is microfracture. Many studies have evaluated this technique in the general population, but only minimal attention has been given specifically to athletes.

**METHODS:** The focus of this study was to review the current literature for the last ten years on all studies pertaining to treatment of athletes who suffered full thickness chondral injuries and were treated with microfracture. The majority of studies reviewed evaluated microfracture without comparison against other modalities. Only one study compared microfracture with autologous osteochondral transplantation (OAT).

**RESULTS:** Of the five studies that were evaluated in this review, all showed improvement in functional ability and a decrease in pain post microfracture surgery. The ability of the athlete to return to their sport at a pre-injury level showed variability among the studies.

**CONCLUSION:** Microfracture is an effective technique in the management of full thickness chondral injuries, however given the results of microfracture in comparison to OAT, it may not be the best option. Further studies, including more comparison trials will help to establish the best treatment modalities for both immediate and long term management.

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## **Degree Name**

Master of Science in Physician Assistant Studies

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## **Keywords**

articular cartilage, knee, microfracture, arthroscopic, athlete

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# **The Efficacy of Microfracture in the treatment of Athletes with Full Thickness Chondral Injuries**

Maureen F. McCaffrey



A Clinical Graduate Project Submitted to the Faculty of the

School of Physician Assistant Studies

Pacific University

Hillsboro, OR

For the Masters of Science Degree, August 15, 2009

Faculty Advisor: Dr. Mark Pedemonte

Clinical Graduate Project Coordinators: Rob Rosenow PharmD, OD & Annjanette Sommers MS, PAC

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## Biography

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Maureen McCaffrey is a native of Colorado, however having lived in the Pacific Northwest for the past 16 years she considers this area to be her home. She started her undergraduate degree at the University of Colorado, moved to Seattle during the summer of her sophomore year and became a professional waitress for the next five years. After realizing that this could only take her so far in life she decided to finish her education at the University of Washington. She graduated with a BS in Zoology and soon found herself waiting tables again while she searched for wild life biology jobs. In 2002 she was hired on by the University of Idaho to work on a mammal inventory for the National Park Service. Working seasonally for the next three years, spending her summers sitting by rivers all night studying bats, and her winters wherever she pleased (waiting tables and skiing), she soon found herself living in Bend, OR. She began volunteering at a community health clinic and it quickly became apparent to her that she missed the interaction with people during her summers. Of all of the people that she volunteered with at the clinic, the PA's were by far the most contented with their lives. She became a full time volunteer at the clinic and this experience solidified her decision to pursue admittance into a PA program. She was accepted to Pacific University in 2007, and is now graduating in 2009. She cannot imagine having gone through this experience alone, the love of Paul, her family and friends has given her the strength she needed to complete this journey.

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## Abstract

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**INTRODUCTION:** Sports injuries can often result in full thickness chondral lesions. If left untreated, these injuries can lead to localized pain, inflammation, effusion and further cartilage injury. Such injuries in an athlete can be career ending. The current recommendation for treatment is microfracture. Many studies have evaluated this technique in the general population, but only minimal attention has been given specifically to athletes. **METHODS:** The focus of this study was to review the current literature for the last ten years on all studies pertaining to treatment of athletes who suffered full thickness chondral injuries and were treated with microfracture. The majority of studies reviewed evaluated microfracture without comparison against other modalities. Only one study compared microfracture with autologous osteochondral transplantation (OAT). **RESULTS:** Of the five studies that were evaluated in this review, all showed improvement in functional ability and a decrease in pain post microfracture surgery. The ability of the athlete to return to their sport at a pre-injury level showed variability among the studies. **CONCLUSION:** Microfracture is an effective technique in the management of full thickness chondral injuries, however given the results of microfracture in comparison to OAT, it may not be the best option. Further studies, including more comparison trials will help to establish the best treatment modalities for both immediate and long term management. **KEYWORDS:** articular cartilage, knee, microfracture, arthroscopic and athlete.



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To Paul: Thank you for the love and support you gave to me when I doubted myself and for the understanding you showed when I couldn't be the partner you deserved. You always seem to know just what I need to get through a tough time. You are the rock I lean on and the love I depend on. Thank you.

To Theresa and Jeff: Thank you for opening your house to me over and over again, always with open arms and a hot meal. Your love was a refuge and I cannot thank you enough.

To My Parents: Thank you for always helping me to believe I could be anything I wanted to be. Your unfailing love and support has given me the strength to be the person I am today.

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## List of Tables

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Table 1: Summary Matrix of included articles

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## List of Abbreviations

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ACD.....Articular cartilage defects

MF..... Microfracture

OAT..... Autologous osteochondral transplantation

HSS.....Hospital for Special Surgery<sup>©</sup>

ICRS.....International Cartilage Repair Society<sup>©</sup>

# **The Efficacy of Microfracture in the treatment of Athletes with Full Thickness Chondral Injuries**

## **INTRODUCTION**

Within the past decade, much attention has been paid to sports injuries. These injuries can often be career ending for the competitive athlete. The desire to return to a pre-injury performance level as soon as possible is of great importance and may dictate which treatment modality is chosen. Surgical interventions are continuously evolving, providing better immediate outcomes and shorter rehabilitation times. Additionally, these interventions may help to mitigate the long term complications, such as pain, dysfunction and early onset osteoarthritis, which often accompany injuries such as full thickness chondral lesions.<sup>1</sup>

Compared to other tissues, articular cartilage is avascular, aneural and alymphatic which is why it has difficulty healing itself after injury, particularly in the case of full thickness chondral lesions.<sup>2</sup> There are two distinct types of cartilage found in the knee joint, hyaline cartilage (covering bone surfaces) and fibrous cartilage (known as meniscus), which are distinguished by their structure, elasticity and strength. Although the two types differ structurally and functionally, they are essentially made up of the same two components, water and an intricate matrix composed of collagen, proteoglycans and noncollagenous proteins. The functional properties of each type of cartilage are dictated by the interaction of water and matrix, with every specific type having varying amounts of each. Water, being the main component, makes up approximately 65% to 80% with the remainder being made up of matrix. Embedded within the matrix, are small numbers of mesenchymal stem cells called chondrocytes, whose function is to maintain the health of the matrix.<sup>3</sup> When fibro cartilage is damaged it is often referred to as torn cartilage, or torn meniscus. This is a different injury then the damage to articular cartilage that will be the focus of this paper. The function of articular cartilage is to provide a low friction surface which will allow the knee to withstand the body's weight through the

range of motion needed to perform the activities of daily living as well as athletic endeavors. The highly complex structure of cartilage, with five distinct layers, each layer having its own biochemical makeup, combined with its avascular nature, make repair to the tissue difficult once it has been damaged or lost.<sup>4</sup> This failure of articular cartilage to restore itself has held interest for the medical community for centuries, with the first reference to articular cartilage's inability to heal itself mentioned by Hunter in 1743.

In the past two decades, many studies have been done to compare the clinical and histological outcomes of the current treatment options for articular cartilage defects, including microfracture (MF), osteochondral autografts (OAT), osteochondral allografts and chondrocyte implantation. The goal of treatment in cartilage repair, is to promote the formation of tissue that is as similar as possible to hyaline cartilage in structure and function, so that it may provide long term, pain free motion of the knee.<sup>5,6</sup> Only recently, has specific attention been given to athletes who suffer articular cartilage defects (ACD). It has been speculated that, given the high level of impact to an athletes knee joint, in comparison to the general public, that some specific treatment modalities may be more beneficial than others.

Steadman et al indicates that in the general population, MF is an effective and durable treatment to restore articular cartilage. The microfracture technique employs the use of an arthroscopic awl to create multiple perforations or "microfractures" in the subchondral bone. The bone is perforated to a depth of 3-4mm and the holes are spaced approximately 4-5mm apart. Fat, from the subchondral marrow can often be seen coming from the newly placed perforations. Dr. Steadman who is one of the pioneers of the microfracture technique recommends a "structured rehabilitation program with no weight bearing and continuous passive motion for 8 weeks" post-operatively.<sup>7</sup>

This paper's focus is to evaluate the use of microfracture as a method of treating athletes with full thickness chondral injuries. The ability of the athlete to return to pre-injury performance, increased functionality and decreased pain are of interest.

## **Materials and Methods**

A comprehensive literature search was compiled using Medline, Cinahl, and Google. The keywords: articular cartilage, knee, microfracture, arthroscopic and athlete were used. Literature from 1998 to the present was reviewed and weighted towards relevance at answering the hypothesis. These results were then compiled and analyzed (Table 1). The inclusion criteria were all relevant English language articles or data, published after 1998 that addressed athletes between the ages of 15-50 suffering from full thickness grade III to IV chondral lesions. Exclusion criteria were articles published before 1998, and articles not including adult athletes.

## **Results**

A total of 5 articles were published, between 1998 and 2009 meeting the criteria, on the use of microfracture to treat chondral lesions in adult athletes (Table 1). These articles addressed the treatment of chondral injuries with either the usage of microfracture alone or compared microfracture against other treatment modalities. Patient outcome was assessed using both subjective and objective data. The issues addressed, varied among the articles with results ranging from functional assessment to post-operative performance in athletic endeavors. The sample sizes range from twenty four to 188, with one study being randomized, one case control, two case series and one cohort.

Namdari et al assessed National Basketball Association athletes who received MF surgery between 1997 and 2006 for symptomatic chondral lesions. He evaluated twenty four NBA players who

were included in the study if they underwent MF surgery during that period of time. Patients were excluded if they had additional diagnoses or concurrent knee problems separate from the chondral lesion at the time of surgery.<sup>8</sup> The study compared the twenty four patients against forty eight controls who were matched by NBA standing, age, position, BMI and years of experience. Two controls were selected for every 1 case. The purpose of the study was to evaluate the effect that MF surgery would have on player performance and their ability to successfully return to the NBA. “33% (8 of 24) of National Basketball Association athletes who underwent microfracture surgery never returned to play in the NBA. 14 players returned to play for >1 season. Group comparisons revealed that points scored (P=.008) and minutes played (P=.045) were reduced postoperatively for MF patients. No performance variables were significantly different when averaged over forty minutes of play. When compared with controls, cases experienced a significant decline in points per game (P=.013). Multiple regression analysis revealed that cases were 8.15 times less likely to remain in the National Basketball Association than controls (P=.005) after the index year.”<sup>8</sup>

Mithoefer et al evaluated a case series that assessed thirty two athletes who regularly participated in high-impact, pivoting sports and sustained single articular cartilage lesions ranging from 24-200mm<sup>2</sup>. All patients received MF surgery and were evaluated post-operatively using functional outcome scores. The results were based on subjective rating, activity based outcome scores and the ability for postoperative participation in high-impact pivoting sports. 66% of the athletes reported good or excellent results. Activities of daily living, Marx activity rating scale, and Tegner activity scores increased significantly after microfracture. After initial improvement, score decreases were observed in 47% of athletes. 44% of athletes were able to regularly participate in high-impact, pivoting sports, 57% of these at the pre-operative level. Return to high-impact sports was significantly higher in athletes who were <40 years of age, had a lesion size of <200mm<sup>2</sup>, had pre-operative symptoms <12 months duration and who had received no prior surgical intervention.<sup>9</sup>



Gudas et al randomized 57 athletes who suffered from articular cartilage defects to undergo either an OAT or MF procedure. The study included athletes who were currently playing competitive sports at regional or national levels, and who had received no prior surgical interventions on their affected knees. Patients were evaluated using modified Hospital for Special Surgery (HSS) <sup>©</sup> and International Cartilage Repair Society <sup>©</sup> (ICRS) scores, radiographs, MRI and clinical assessment. Follow up was performed at 6, 12, 24 and 36 months by an independent observer. Arthroscopy with biopsy was performed at 12.4 months and was evaluated by a pathologist who was blinded to the study. Radiologic assessment was evaluated by a radiologist who was also blinded to the study. At 37.1 months of follow up both groups showed significant clinical improvement ( $P < .05$ ). The results of functional and objective assessment, HSS and ICRS scores showed that the OAT group had 96% excellent or good results compared to only 52% of MF patients. At the 12 ( $P = .03$ ), 24 ( $P = .006$ ) and 36 ( $P = .006$ ) month follow up the OAT group continued to show greater improvement in HSS and ICRS scores compared to patients receiving MF. The macroscopic evaluation was scored by the ICRS Cartilage Repair Assessment performed at 12.4 months showed excellent or good repairs in 84% after OAT and 57% after MF. Biopsy showed significant improvement with OAT over MF ( $P = .05$ ). MRI evaluation showed excellent or good repairs in 94% after OAT compared to 49% after MF. Both groups showed the most improvement in younger patients. 93% of OAT and 49% of MF patients returned to sports at a pre-injury level at 6.5 months, while the remaining patients showed a decline in sports activity. The study showed superiority of OAT over MF in the treatment of articular cartilage defect in the knees of athletes.<sup>10, 11</sup>

Gobbi et al evaluated fifty three athletes from 1991 to 1999 who underwent MF surgery for treatment of full thickness chondral injuries. The athletes were included in the study if they played competitively at the regional or national level, or if they were active in a sporting activity at least twice per week. Patients were excluded from the study if they suffered from partial thickness chondral lesions, osteochondritis dissecans, malalignment requiring osteotomy, total meniscectomy or

degenerative arthritis. There were 33 males and 20 females who met the criteria. Twenty six played sports at the professional level and twenty seven participated at the recreational level. The authors broke down the sporting events individually by type of activity and number of patients who participated in each sport. Patients were required to fill out pre-operative subjective questionnaires to assess activity level, functionality and symptoms. All patients underwent MF surgery using the Steadman technique and were on the same rehabilitation protocol. Post-operatively patients filled out subjective questionnaires measuring symptoms and functional ability. “Knee pain and swelling was improved in 70%, and tibiofemoral crepitus was improved in 60 %. Hop test was normal in 70% at final follow up. Subjective evaluation was 40/100 preoperatively and 70/100 at final follow up. Lysholm was 56.8 preoperatively and 87.2 final. IKDC revealed: 0A, 3B, 40C and 10D preoperatively while at final follow up 70% scored A or B. Tegner improved at two years from 3.2 to six; however at final follow up 80% showed a decline in sports activity level.”<sup>12</sup> Based on this observation Gobbi et al states that although MF offers improvement clinically and functionally, it may not be the best option for athletes.<sup>12</sup>

Blevins et al evaluated two tiers of athletes. Group A consisted of 38 high-level athletes who belonged to a professional or semi-professional team at the time of injury, inclusion criteria allowed for varsity collegiate or high school athletes, and full time ski instructors. Group B consisted of 188 athletes who were involved in recreational sporting activities on a regular basis. The study looked at patients who suffered full thickness chondral injuries between 1985 and 1990. Patients with prior injury to the affected knee and concurrent ACL injuries were permitted in the study and were accounted for during evaluations. Both groups had similar associated diagnoses, although patients in group B had more total prior meniscectomies. All patients underwent MF surgery and all procedures were performed by the same surgeon. Lesion size and location, treatment acuity and rehabilitation protocol, were all well documented. Both groups of patients completed a questionnaire pre-operatively and annual questionnaires post-operatively. The assessments graded symptoms, functionality and

activity levels for both groups. Demographically, the two groups were fairly similar but group B patients were older, 38 years versus 26 years ( $P < .001$ ) and the time between injury and treatment was longer in group B than in group A, with a median score of 94 versus 20.5 weeks. Evaluations were given from the time of surgery to final follow up and all parameters evaluated (pain, swelling, giving way, locking and limping) showed significant improvement. Follow up scores assessing functional and activity parameters showed significant improvement in group A over group B with the exception of stairs and sedentary work. The first postoperative year showed the greatest overall improvement in both groups. Scores tended to plateau over the following four to five years. 50% of the athletes who returned to competition were still competing at the time of the last follow up. The other 50% had retired from competition after competing for a mean of twenty three months post surgery.<sup>13</sup>

## **Discussion**

The purpose of this study was to evaluate the efficacy of MF technique for the treatment of full thickness chondral lesions in athletes. Specifically, this paper focused on the athlete's ability to return to their sport at a pre-injury level, overall functioning ability and a decrease in knee pain. Blinded control trials evaluating surgical interventions are difficult due to the invasive nature of most procedures and the complexity involved in executing such studies. In particular, Blevins et al makes the case that "the progressive nature of untreated full thickness chondral injuries results in localized pain, particularly synovitis, which may result in inflammation, effusion and further cartilage injury". This detail would make it irresponsible to attempt to have a blinded controlled study. All of the studies evaluated in this paper, with the exception of Gudas et al, focus specifically on MF as the single treatment modality for full thickness chondral injuries.

Each study chose to define "athlete" differently. This increased variability across the studies. Criteria ranged from strictly professional athletes to people who participated in sporting activity twice

a week. This extreme in variation makes it difficult to ascertain at what level of activity a treatment may be beneficial or potentially harmful.

With the exception of Namdari et al, all studies used the MF technique described by Steadman et al, so there was consistency in surgical methods; however it is unknown how skilled one surgeon was against another in each study.

The ability of the athletes to return to sport at the pre-injury level was evaluated in each study. Blevins et al reported 77% of athletes returned to sporting activity, and 71% of those athletes felt that they returned to a pre-injury level with equal or superior results. Namdari et al, who specifically focused on NBA players reported 58.3% of patients returned to play for >1 season after MF. This study failed to mention any inter-operative data such as which MF technique was used, or lesion size repaired. Gudas et al reported 52% of MF patients returned to sports at a pre-injury level, while others in the study showed a decline in sports participation without any explanation for the decrease in activity. Gobbi et al reported initial return to sport but then observed a decline in activity over time. This study had the longest follow up with an average of six years. The authors of the study speculated that the decline in sporting activity may have resulted from more than effects of MF, and may have had to do with the changing life style habits that occur over time. Mithoefer et al reported a return to play in only 44% of study participants. The authors reported that patients who had a shorter duration of injury prior to surgery tended to do better and were more likely to return to sporting activity, they also acknowledged that patients under forty years old were also more likely to return to sports. The factor of age reflecting outcome was mentioned in many of the studies with the greatest results in patients under 30. This detail alone warrants further study.

Functionality and pain were mainly assessed using subjective questionnaires and clinical observation through out the follow up process. Blevins et al had 70% of their study participants respond to all follow up questionnaires. All parameters showed significant improvement from time of surgery to final follow up. Namdari et al only assessed functionality by evaluating the players'

performance once they returned to the NBA by measuring time played, points scored and rebounds against closely matched controls that had no injuries. There were no patient derived assessment outcomes, and no mention of symptom evaluation either pre or post-surgery. Gudas et al reported improvement in functionality and decreased pain in both the MF and OAT groups that were assessed. However, the authors reported greater improvement in the OAT group, particularly as the time after surgery grew longer. They incorporated the ICRS questionnaire that has both a subjective and objective component. The objective component was utilized during evaluation of both MF and the OAT technique when evaluating macroscopic data utilizing post-surgical biopsies. This study incorporated the most objective data of any of the studies evaluated. Additionally, it was beneficial to compare MF against a separate treatment modality to assess which technique may be the most efficacious both on a subjective as well as a clinical level. The histological data collected may have implications in the long term outcome of chondral injuries. The authors found that the OAT technique was superior to MF in the quality of cartilage that was restored. It was speculated by the authors that this may have an effect over the long term since they saw a deterioration of functionality and pain relief over time in the MF group. Gobbi et al reported overall improvement in both functionality and pain. The study incorporated multiple subjective questionnaires to assess their patients' progress over the average 6 year follow up. This study did the most complete job of breaking down each athletic activity and number of participating patients in each sport. Mithoefer et al also reported overall improvement in functionality and pain relief in their patients. Two subjective questionnaires were utilized for evaluation over the two year follow up. This study also demonstrated greater improvement in patients with a shorter duration of time between injury and surgery and those less than thirty years of age.

Many of the limitations observed were consistent across all of the studies. Most authors mentioned the lack of a randomized controlled model as being a weakness to their studies. Small numbers of study participants and poor follow up may have skewed the results. Confusing to the

author of this paper was the size of chondral lesions observed. Some of the studies reported lesion size in mm<sup>2</sup>, while others in cm<sup>2</sup>, for consistency sake, all lesions were converted to cm<sup>2</sup>. Mithoefer et al reported lesions ranging from 2.4 to 200cm<sup>2</sup>. Other studies such as Gobbi et al treated lesions that were 30 to 60cm<sup>2</sup>, and Blevins et al focused on lesions that were 22.3cm<sup>2</sup> +/- 18cm<sup>2</sup>. Gudas et al focused on lesions that were 1 to 4cm<sup>2</sup> in size. This is huge discrepancy and it is unclear to this author how a 200cm<sup>2</sup> lesion can fit on the articular surface of a knee. Additionally, many of the studies made mention that smaller lesions had a better outcome.<sup>9,10,12</sup>

## **CONCLUSION**

The difficulty in assessing the efficacy of MF in these studies is that only one study compared MF against any other treatment modality, and in that study, MF came up inferior.<sup>11</sup> Although MF showed improvement in the majority of the athletes studied, it was not measured against anything; therefore, while it has proven to be efficacious, it has not been proven to be the best option for the injured athlete. Further study involving comparison across multiple modalities would help to answer this question. “An argument can still be made for performing a low risk, simple, inexpensive arthroscopic procedure such as microfracture as an initial attempt at biological resurfacing, reserving more extensive procedures for failed cases.”<sup>15</sup> As athletics continue to remain such an integral part of our society, and younger athletes are undergoing more intensive training than has been seen in the past, it is imperative that the most efficacious treatments be available. In summary, based on this literature review, MF is an effective technique for the management of full thickness chondral injuries in athletes. However, further study to evaluate both subjective and objective data across multiple modalities would advance knowledge as to whether it is the best option for the injured athlete.

**TABLE 1**

Author	Published	Study type	Sample size and ages	Treatments evaluated	Lesion size/grade	Methods of evaluation	Follow up intervals	Results
Namdari et al	2009	Case control observational study	#24	MF versus matched controls	Not reported	Performance variables	none	33% of NBA players who underwent MF returned to play for >1 season. Pts were 8.15 times less likely to remain in NBA then matched controls
Mithoefer et al	2006	Case series	#32	MF	Single articular cartilage lesion ranging from 24-2000mm <sup>2</sup>	ADL scores, Brittenberg score, Marx activity scale, Tenger activity score	2 year	Increased functional scores in high-demand athletes at 2 yr follow up
Gudas, R, et al	2005	Prospective randomized clinical trial	#60 Age 15-40	MF and OAT	Grade III or IV , between 1-4 cm <sup>2</sup>	HSS, ICRS, MRI and clinical assessment	6, 12,24,36 months post surgery	Both groups showed improvement. Greater improvement in OAT over MF
Gobbi et al	2004	Case series	#53 Age 19-55	MF	300-600mm <sup>2</sup>	Tenger, IKDC and Lysholm score, MRI or CT pre/post follow up	6 year average	Significant improvement in clinical, functional assessments. Decline in sports activity over time
Blevins et al	1998	Cohort study	Group A: 48 Group B: 188	MF	Grade I-IV 223 +/- 180 mm <sup>2</sup>	Functional assessment questionnaire	3.7 +/- 1.4 years	Significant improvement from time of MF to final follow up

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