Are Weightbearing Restrictions Required After Microfracture for Isolated Chondral Lesions of the Knee? A Review of the Basic Science and Clinical Literature

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Context: A strict rehabilitation protocol is traditionally followed after microfracture, including weightbearing restrictions for 2 to 6 weeks. However, such restrictions pose significant disability, especially in a patient population that is younger and more active.

Evidence Acquisition: An extensive literature review was performed through PubMed and Google Scholar of all studies through December 2018 related to microfracture, including biomechanical, basic science, and clinical studies. For inclusion, clinical studies had to report weightbearing status and outcomes with a minimum 12-month follow-up.

Study Design: Clinical review.

Level of Evidence: Level 3.

Results: Review of biomechanical and biology studies suggest new forming repair tissue is protected from shear forces of knee joint loading by the cartilaginous margins of the defect. This margin acts as a shoulder to maintain axial height and allow for tissue remodeling up to at least 12 months after surgery, well beyond current weight bearing restriction trends. A retrospective case-control study showed that weightbearing status postoperatively had no effect on clinical outcomes in patients who underwent microfracture for small chondral (<2 mm^2) defects. In fact, 1 survey showed that many orthopaedic surgeons currently do not restrict weightbearing after microfracture.

Conclusion: This clinical literature review suggests that weightbearing restrictions may not be required after microfracture for isolated tibiofemoral chondral lesions of the knee.

Strength of Recommendation Taxonomy: C.

Keywords: knee; microfracture; weightbearing; review

Articular cartilage defects are common, affecting an estimated 900,000 people in the United States each year.[7] Such injuries present therapeutic challenges, as cartilage lacks intrinsic healing potential, and lead to joint degeneration and significant pain and disability.[18] A number of treatment modalities have been developed to aid in cartilage regeneration, including microfracture, autologous chondrocyte implantation, and osteochondral autograft and allograft transplantation.[2,16,29] Developed by Steadman in the 1990s, the microfracture procedure has become a surgical treatment option for patients with grade III or IV tibial and/or femoral cartilage defects because of its minimally invasive approach, low cost, and technical simplicity.[25,27] Traditionally, a strict rehabilitation protocol after microfracture has been considered essential for

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success of the procedure. This includes nonweightbearing or touchdown weightbearing status for 2 to 8 weeks for tibiofemoral lesions.[2,13] In the following biomechanic, basic science, and clinical literature review, we propose that patients who undergo microfracture may not require weightbearing restrictions.

MICROFRACTURE PROCEDURE

The microfracture procedure is generally used to treat focal chondral lesions. Focal defects usually result from trauma, such as a high load impact or repetitive shear and torsional forces on the superficial zone of the articular cartilage.[15] Microfracture has been shown repeatedly to have good results for small defects (<2 cm^2), especially in patients younger than 40 years of age.[8] It has been shown to significantly improve joint function and reduce pain.[1,20-23,27] It also quickly allows return to play in athletes.[11,23,26]

The microfracture procedure begins with arthroscopic evaluation of the chondral lesion. The defect is debrided of all unstable cartilage attached to the surface articular cartilage, as well as any underlying calcified cartilage down to the subchondral bone. The surrounding cartilage is also debrided so as to leave a stable rim of healthy cartilage. An arthroscopic awl is then used to create small holes, or microfractures, in the subchondral bone of the defect. Additional techniques, using K-wires or nanofracture subchondral drilling, have been described to stimulate cartilage regeneration.[29] The holes are placed 3 to 4 mm apart, so as to sustain the integrity of the subchondral plate. As a result, the bone bleeds and a hematoma is formed.[29] The theory behind the microfracture technique is that small fractures created by the awl allow undifferentiated mesenchymal stem cells and growth factors to seep into the defect and regenerate the fibrocartilage without compromising the biomechanical stability of the subchrondral bone plate.[9,14,30]

WEIGHTBEARING IN THE REHABILITATION PROTOCOL

The original rehabilitation protocols after microfracture advocated by Steadman varied with the location of the lesion and were focused on protecting the forming clot, which has been considered essential for the healing process.[29] For tibiofemoral lesions, the traditional postoperative course includes nonweightbearing status for the first 2 to 4 weeks, as articulation between the femoral condyles and tibial plateau is constant throughout knee range of motion. Additionally, the patient is not put in a brace.

For patellofemoral lesions, the traditional postoperative course includes locking the knee in extension for 2 to 4 weeks and partial weightbearing status for the subsequent 2 weeks, with progression to weightbearing as tolerated soon after. A knee immobilizer set in 0° of extension is traditionally used for the first 2 to 4 weeks to minimize shear forces, as articulation between the patella and the trochlea begins between 10° and 20°.[12,13,25] It is important to note that in the current literature, there is significant variability in postoperative regimens, as some orthopaedic surgeons recommend neither weightbearing restrictions nor extension bracing.[25]

SUPPORT FOR WEIGHTBEARING AFTER MICROFRACTURE

Biomechanics

From a biomechanical standpoint, weightbearing should not affect clot formation in small defects in weightbearing areas such as the femoral condyles. Shear forces on the cartilage, however, can disrupt the clot.[29] However, when performing the microfracture procedure, the chondral injury is debrided down to the subchondral bone and a stable rim of healthy strong cartilage is left surrounding the defect. Therefore, the new forming clot appears in the recess of this defect and is protected from any shear forces from joint loading by the margins of the defect (which act as a shoulder to maintain axial height).[18,19] However, as the size of defect increases, the stable rim of cartilage provides less overall protection against shear forces. This theory can be extended to patellofemoral lesions. The stable rim of cartilage should protect the defect from shear forces during articulation of the patella and trochlea, and thus, an extension brace should not be required postoperatively.

Basic Science

Laboratory studies have shown that unloading of the joint has deleterious effects on cartilage, especially during healing, thus leading to proteoglycan loss and gradual weakening.[3,32] Weightbearing is essential to maintain cartilage integrity and facilitate healing by providing a cascade of signals. Chondrocytes that undergo mechanical forces produce more cartilage than those that do not, and chondrocytes that undergo shear forces produce more proteoglycans and collagen type II than those that undergo compression forces.[4,33] Therefore, any rehabilitation protocol should take into account early weightbearing, so that the healthy cartilage surrounding the defect remains intact and provides a supportive environment for the repair tissue to undergo the necessary pathway for cartilage formation.

Nonhuman studies have shown that immediately after surgery, the cartilage enters the proliferation phase for the first 4 weeks.[3,6] During this time, the defect fills with a fibrin clot; however, there is no fibrocartilage present. The lesion then enters the transition phase from about 4 to 12 weeks, during which the repair tissue strengthens.[8] At 6 weeks postoperatively, there is a thin layer of tissue that covers the base of the lesion, which is mostly fibroblastic and has few active chondrogenic cells.[10] Hyaline-like characteristics can be detected by 8 weeks, especially in the deeper layers of the repair tissue, although the defect has predominately fibrocartilagneous tissue.[5] By 12 weeks, the defect is completely filled. The subchondral bone is reconstituted, and there may be more fully differentiated hyaline cartilage present.[10] It is important to note that collagen type II, a component of hyaline cartilage, continues to be placed in the defect at least up to 12 months after surgery.[8]

Table 1. Clinical studies with immediate postoperative weightbearing status after microfracture of the knee

Authors	Year	WBAT, n	TDWB, n	NWB, n	Outcome Tool	Mean Score	Complication
Steadman et al	2003	—	71	—	Lysholm (knee)	88.9	None
Kreuz et al	2006	—	85	—	ICRS (knee)	1.5-3	None
Asik et al	2008	—	90	—	Lysholm (knee)	84.6	None
Mithoefer et al	2005			48	IKDC	40-60	None
Gudas et al	2005	—	—	29	ICRS (knee)	75	None
Kon et al	2009			40	IKDC (knee)	2.5-3	None
Knutsen et al	2007	—	40	—	Lysholm (knee)	70-80	23% (9/40)
Gobbi et al	2005		—	53	Lysholm (knee)	87.2	None
Masoud et al	2009		—	24	ICRS (knee)	2	None
Mithoefer et al	2006			32	Tegner (knee)	6.1-7	None
Levy et al	1996	23	—	—	ATSS	6.9.0	None

Dashes refer to unavailable data. ATSS, autologous transplant scoring system; ICRS, International Cartilage Repair Society; IKDC, International Knee Documentation Committee; NWB, nonweightbearing; TDWB, touchdown weightbearing; WBAT, weightbearing as tolerated.

Multiple clinical studies on microfracture have shown good to excellent results by requiring 2 to 8 weeks of nonweightbearing and then progressing to full weightbearing starting at 4 to 8 weeks. However, much of the basic science research shows that there is significant remodeling of the defect from 6 to 12 weeks and even onward.[9,10] If good outcomes can be achieved without weightbearing restrictions before the defect is fully healed, a period of weightbearing restrictions might not be necessary.

It may also not be necessary to protect the clot that forms after microfracture, as evidence surrounding its role in cartilage healing is unclear. It is possible that the new cartilage grows from the subchondral bone and displaces the clot, as opposed to forming from a reorganization of the clot itself. Collagen type II is located primarily in the deep and intermediate zones of the repair tissue at 8 weeks after microfracture.[9] This was confirmed by another study, which showed that collagen type II and proteoglycans (another component of hyaline cartilage) are located primarily in the deeper layers of the repair tissue 3 months after microfracture and, a similar procedure, drilling.[5]

These findings support the hypothesis that the new cartilage grows out from the subchondral bone, as a reorganization of the clot would likely cause new cartilage to be found uniformly throughout the repair tissue. If indeed this is the mechanism of repair, then protecting the clot by restricting weightbearing might not be necessary.

Furthermore, many of the animal studies that investigated the microscopic changes after microfracture did not restrict weightbearing or prevent articulation at the microfracture site, and these studies showed similar results. In fact, in one of the first histological studies of microfracture by Frisbie et al,[8] the horses, although rested in box stalls, were not restricted regarding weightbearing after microfracture. In rabbits, the knees were allowed unrestricted motion immediately after microfracture surgery of the trochlear groove, allowing articulation between the patella and the trochlea, and the defects still had significant repair tissue at 3 months.[5] In dogs, healing of articular cartilage was noticed after a similar marrow-stimulating procedure–chondral abrasion–despite being ambulant within 12 hours of recovery from anesthesia.[1] These animal studies demonstrate good cartilage healing after microfracture without weightbearing restrictions, which had similar cartilage remodeling to animal studies that did restrict weightbearing.[10]

Clinical Research

Currently, weightbearing restrictions after microfracture vary significantly between orthopaedic surgeons (Table 1). In a survey of practicing Canadian orthopaedic surgeons, more than 25% allow full weightbearing immediately postoperatively, suggesting that it is becoming more common as a postoperative regimen.[31] Additionally, clinical studies have demonstrated that good results can be achieved with no weightbearing restrictions after microfracture.[19,27,31] In soccer players, good to excellent results were shown at 1 year after a procedure very similar to microfracture, whereby the lesions were debrided to a stable border and the calcified cartilage was removed to bleeding

bone. Patients were allowed to immediately bear weight and were expected to start full weightbearing at less than 1 week. Athletes returned to play at an average of less than 11 weeks.[17]

Weightbearing status postoperatively had no effect on clinical outcomes in patients who underwent microfracture for small chondral defects.[19] In a retrospective cohort study, patients with focal cartilage deficits less than 2 cm^2 on either the medial or lateral femoral condyle underwent 2 different rehabilitation protocols after microfracture surgery. One group used continuous passive motion and was touchdown weightbearing for 6 weeks, and the second group did not undergo continuous passive motion and was weightbearing as tolerated immediately after surgery. There was no difference in postoperative scores between the weightbearing and touchdown weightbearing groups.[19]

DISCUSSION

Weightbearing status after microfracture continues to be controversial, with postoperative regimens varying from 8 weeks of touchdown weightbearing to weightbearing as tolerated immediately postoperatively. Based on current evidence, weightbearing restrictions and extension braces may not be necessary after microfracture of tibiofemoral lesions and patellofemoral lesions, respectively. However, these are areas that require further research to better understand the relationship between lesion size and different microfracture techniques on weightbearing status.

Additionally, there are limitations to this study. There was a dearth of level 1 randomized prospective clinical trials that compared outcomes after early full weightbearing with those of restricted rehabilitation protocols after microfracture, which limits the overall strength of the recommendation.

The preceding discourse relates primarily to microfracture for isolated defects in articular cartilage. Rehabilitation protocols must be adjusted as appropriate for specific injuries, as there is great variability in chondral defects in location and size. Furthermore, microfracture is often performed in conjunction with treatment of concomitant injuries, such as anterior cruciate ligament reconstruction. These additional injuries and treatments might require their own more rigorous rehabilitation protocol.

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