E-poster #56:
Microfracture versus Drilling of Articular Cartilage Defects:
A Systematic Review

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I (and my co-authors) have nothing to disclose.
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Introduction

Numerous surgical techniques exist for the treatment of isolated articular cartilage defects, including microfracture, debridement, drilling, osteochondral autograft transplantation, etc.

Microfracture (MFx) is often considered a first-line treatment option for these defects given the ease and low cost of the procedure, as well as the good short-term outcomes demonstrated with this technique.
Introduction

• However, recent evidence has suggested that the outcomes of knee MFx may worsen after 5 years postoperatively, particularly for larger lesions and chondral defects in athletes.

• Specific concerns regarding the durability of the MFx technique include the effects of microfractures in the subchondral bone, possibly making the bone brittle and leading to subchondral cyst formation and subchondral plate disruption.

Evidence-Based Status of Microfracture Technique: A Systematic Review of Level I and II Studies

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Introduction

• Based on this evidence, some sports medicine surgeons have recently abandoned the traditional MFx technique in exchange for drilling due to a belief that drilling is less detrimental to the subchondral bone and may result in deeper penetration and the stimulation of bone marrow cells with higher regenerative potential.

Abandoning Microfracture of the Knee: Has the Time Come?

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Purpose

• To perform a systematic review of basic science studies to determine the effect of microfracture versus drilling on articular cartilage repair
• The authors hypothesized that drilling would result in improved biological outcomes compared to microfracture
Methods

- Systematic review conducted according to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines
- Two independent reviewers (MJK, GMA) searched Pubmed, Embase, and the Cochrane Library up to May 5, 2019
- Electronic search strategy used was: *microfracture AND (drilling OR microdrilling)*
Methods

• Inclusion criteria were basic science studies that directly compared the effect of MFx vs drilling on the subchondral bone, bone marrow stimulation, and cartilage regeneration.

• Exclusion criteria included 1) studies without direct comparison between the two techniques; 2) studies which reported exclusively clinical outcomes; 3) studies which utilized biologic agents (e.g. platelet-rich plasma or bone marrow aspirate) without reporting the effects of MFx or drilling alone; and 4) studies which either did not clearly define the bone marrow stimulation technique or did not distinguish results between MFx and drilling.

• Human and animal studies were included.
Methods

• Outcomes assessed included cartilage histology (O’Driscoll scoring, International Cartilage Repair Society [ICRS] score, Sellers score), stereology, and micro-computed tomography (CT) for analysis of the subchondral bone.
• The ICRS histological score includes six categories each scored from 0-3; higher total scores indicate complete cartilage regeneration.
• The Sellers score is scored from 0-31; 0 correlates to normal articular cartilage and complete regeneration and 31 correlates to an empty defect with no repair tissue.
Results

- Seven studies met inclusion criteria and were included in this systematic review
- Four studies were performed in rabbits, one in sheep, and two in humans
- All of the included studies investigated cartilage repair in the knee joint
## Results

| Study               | Subjects | n  | Outcomes                                                                 |
|---------------------|----------|----|---------------------------------------------------------------------------|
| Chen et al, 2009    | Rabbits  | 4  | Micro-CT                                                                  |
| Chen et al, 2011    | Rabbits  | 24 | Scoring system for a qualitative assessment of subchondral bone repairs; 3D micro-CT |
| Chen et al, 2011    | Rabbits  | 16 | O’Driscoll histological scoring; quantitative histomorphometry             |
| Chen et al, 2013    | Rabbits  | 48 | Histology; stereology; histomorphometry; micro-CT                          |
| Kaul et al, 2012    | Humans   | 5  | ICRS score; Sellers score                                                  |
| Sakata et al, 2013  | Humans   | 4  | ICRS score                                                                |
| Zedde et al, 2016   | Sheep    | 4  | Micro-CT                                                                  |
Results

Effect on subchondral bone

- In four studies, deep drilling (6 mm) was superior to both shallow drilling (2 mm) and MFx in eliciting significantly more mineralized bone.
- Deep drilling cleanly removed bone, thereby allowing for free access channels to the marrow space, whereas MFx produced fractured and compacted bone around the microfracture, potentially impeding repair, and led to increased osteocyte necrosis.
- However, both MFx and drilling showed repair bone with atypical morphology compared to the native structure of subchondral bone, which was less organized and more isotropic, distinct from surrounding bone.
Results

Micro-CT images in a rabbit model at 1 day postoperatively showing effects on the subchondral bone following shallow drilling (MD2), MFx (MF2), and deep drilling (MD6).
Results

Bone marrow stimulation

• Deep drilling (6 mm) was superior to both shallow drilling (2 mm) and MFx in terms of increased subchondral hematoma with greater access to marrow stroma

• In one study, stromal cell density recruitment was similar in defects regardless of location (trochlea vs medial femoral condyle) or bone marrow stimulation technique
Cartilage regeneration

- In two studies, deep drilling (6 mm) was superior to both shallow drilling (2 mm) and MFx in terms of significantly improved cartilage repair.
- Overall, articular cartilage did not achieve the quality of normal hyaline cartilage, regardless of marrow stimulation technique.
- Kaul et al showed that marrow stimulation resulted in repair tissue with histological and biochemical properties of fibrocartilage.
- Macroscopic cartilage repair assessment showed ICRS grades II (nearly normal) and III (abnormal), with cartilage defects mostly filled with fibrocartilaginous tissue.
Safranin-O and collagen stains comparing deep (DRL6) and shallowing drilling (DRL2) in a rabbit model 3 months after repair. % defect fill was significantly greater in the deep drilling group.
Conclusions

• Based on the available basic science literature, deep drilling of cartilage defects in the knee joint results in improved biological features compared to MFx, including less damage to the subchondral bone and greater access to marrow stroma.
• Regardless of marrow stimulation technique, the overall quality of cartilage regeneration was poor and did not achieve the characteristics of native hyaline cartilage.
• Overall, there is a general lack of basic science literature comparing MFx vs drilling for focal chondral defects, and drawing clinical conclusions based upon the currently available studies should be avoided.
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