Microfracture: Is There a Role in 2016 and How?

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Financial Disclosures

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- BioMetal
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- Arthrex
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Book: "Cartilage Restoration: Practical Clinical Applications" (All Royalties donated to Arthritis Foundation)

If it’s good enough for the Pros.......
Good Results per Steadman:
MFX Technique in the Treatment of NFL Football Players

• 25 players
• Ave f/u 4.5 yrs (2-13)

76% Returned the following season
—For ave of 4.6 seasons


Not so Good per Andrews:
Return to Play After Chondroplasty of the Knee in NFL Athletes

• 52 pts
• 67% returned

• Players who underwent concomitant MFX were 4.4 times less likely to return to the NFL


How did We Get Here?
First: What is Microfracture?

A Subset of “Marrow Simulation”
Evolution of Marrow Stimulation

Underlying Concern

The 100 Most-Cited Articles in Orthopaedic Knee Research

# 69 of 100

Jan;41(3):618-9

Pridie, K H. A method of resurfacing osteoarthritic knee joints. JBJS Br 1959

- Kenneth Hampden Pridie (8 March 1906 – 4 May 1963)
- Discus and Shot Put competitor 1930, 34 and 38 British Empire Games.
- He studied at the University of Bristol.
- At 28 he became a fracture surgeon at Bristol Royal Infirmary.
- He developed several devices for fracture treatment and was an eminent surgeon.
- Pridie is known for a particular cartilage repair technique where repair by demarcating fracture is enhanced by drilling small holes into the subchondral bone plate after surgical debridement of cartilage defects, known as the Pridie Drilling. He died of a heart attack in 1963.
Insall Evaluated Pridie’s Patients
JBJS (Br) 1967

• OA knees treated from 1949: 62 knees in sixty patients were available for study.

• Pridie always maintained that after-treatment in knee surgery was as important as the operation itself.

Insall’s Findings of 62 Knees

1. 48 knees (77 per cent) were pleasing to the patient.
2. 40 knees (64 per cent) were rated as good at review.
3. The operation is most suitable for relatively active healthy people whose disability warrants a comparatively painful operation and lengthy rehabilitation.
4. The operation was most successful for relieving pain and improving stability.
5. Functional improvement was less.
6. Results were remarkably permanent. The knees showed little tendency towards further deterioration.
7. Most of the bad results were associated with removal of the patella.

Spongialization ≠ Pridie Drilling
Ficat et al COOR 1979

• Spongialization: a new treatment for diseased patellae.

• Spongialization is an extension of the concept of Pridie for resurfacing damaged joints. The diseased cartilage is excised and the subchondral plate completely removed exposing the cancellous bone or “spongiosa” from which a new fibrous tissue surface can grow. The technique is particularly applicable to a localized lesion of the patella. 85 patients who had patellar spongialization and were followed from 6–36 months (average 15 months) are reported, with 79% reporting good or excellent results.

• Early results are better than with either patellectomy or “shaving” of the diseased cartilage.
With advent of Arthroscopy: 
Johnson invented scope shaver: Abrasionoplasty

- 73 patients with grade IV lesions, 60% showed improvement at minimum 1 year follow-up

Problems with Abrasionoplasty lead to abandonment

- Difficult to teach the fine line between bleeding subchondral bone plate and loss of subchondral bone plate as “other surgeons” implemented incorrectly—breach SC plate: “if a superficial is good, a deeper is better”

Re-emergence of Abrasion Arthroplasty: Sansone Arthros 2015

- 1990 to 1996 75 consecutive patients with isolated MFC lesions treated with arthroscopic chondral abrasion.
- Retrospective analysis of Level IV, therapeutic case series
- KSS preoperatively, at 10 years postoperatively, and at final long-term follow-up at a mean of 20 years.
- At final follow-up, they were also assessed according to the WOMAC
  - Patients were divided according to the lesion size and by age
  
RESULTS:
  - Mean of final follow-up of 20 years (range, 16.94 to 23.94 years)
  - Positive functional outcome (KSS > 70 points or no reoperation) was recorded in 67.9%.
  - 20-year survivorship in this cohort was 71.4% (95% confidence interval, 0.5690 to 0.8590).
  - Survivorship was 89.5% for patients younger than 50 years and 55.7% for patients aged 50 years or older.
  - Functional results of <4 cm² better than lesions > 4 cm² (P = .031)
Early Arthroscopic Drilling Childers and Ellwood et al CORR 1979

- Partial Chondrectomy and Subchondral Bone Drilling for Chondromalacia
- 29 knees in 25 patients with chondromalacia patella
- Good or excellent results were achieved in most patients under the age of 30. The results in patients over the age of 30 were less satisfactory.

Early Arthroscopic Drilling Rae et al JBJS (Br) 1989

- Designed a new guide with a longer shaft of 80 mm, and a narrower bore of 2 mm
- Technique. Loose articular cartilage at the periphery of the defect is removed and the base of the crater is curetted with a small Volkmann's spoon to remove fibrous tissue and loose bone.
- 2 mm Kirschner wire creates several drill holes in the subchondral bone by simply re-positioning the guide.
- Immediate mobilization is encouraged post-operatively, and full weight-bearing is allowed if the defect is small. Results.
- In all 14 patients treated by this technique, symptoms have been improved significantly.

Microfracture: 1980s Steadman et al Arthroscopy 2003

- Case series of patients with 7 to 17 years' follow-up 1981 to 1991
- 71 knees (95%) were available for final follow-up (range, 7 to 17 years).
- Lysholm preoperative 59; final follow-up 89
- Tegner preoperative, 3; final follow-up, 6
- At final follow-up, the SF-36 and WOMAC scores showed good to excellent results.
- At 7 years after surgery, 80% of the patients rated themselves as "improved."
- Multivariate analysis revealed that age was a predictor of functional improvement.
Clinical Outcomes following the Microfracture Procedure for Chondral Defects of the Knee: A Longitudinal Data Analysis
Miller, Briggs, Downie, Steadman Cartilage 2010

- Mean age was 48 years (range, 12-76 years).
- Follow-up mean 4 years (range, 1-12 years).
- Lysholm score improved during the first 2 years following microfracture.
- After 2 years, the score remained steady with a slight decline but remained above preoperative level through the study period.
- There was no significant difference in improvement of outcome over time between degenerative and traumatic chondral lesions (P > 0.05).
- Age-dependent differences in the improvement in outcome over time.

Outcomes following microfracture of full-thickness articular cartilage lesions of the knee in adolescent patients
Steadman et al J Knee Surg 2015

- Patients < 19 years old with full-thickness knee articular cartilage defects treated with microfracture between January 1992 and June 2008 were identified.
- 37% patellar; femoral condyle defects (medial 26%, lateral 33%).
- Follow-up mean 5.8 years (range: 2.0-13.3 years).
- Majority patient satisfaction scores was 10 (range: 1-10).

Conclusion:
Adolescent patients who underwent microfracture for treatment of full-thickness knee chondral defects demonstrated increased activity levels and excellent function following surgery.

Do meta-analyses reveal time-dependent differences between the clinical outcomes achieved by microfracture and autologous chondrocyte implantation in the treatment of cartilage defects of the knee? Negrin and Vesei J Orthop; Sci 2013

- 6 study populations (9 papers) which satisfied our eligibility criteria. Overall, 399 patients aged between 16 and 60 years with 1-10 cm(2) chondral defects were available.
- Non-significant superiority of ACI over MF was revealed; surprisingly, this superiority decreased over the years.
- Both series of meta-analyses (combining either all ACI modifications or solely the second and third generations of ACI) suggest that the treatment effects resulting from ACI and MF converge over the years.
Cartilage Restoration of the Knee: A Systematic Review and Meta-Analysis of Level 1 Studies
Mundi et al AJSM 2015

- 12 eligible randomized trials with a cumulative sample size of 765 patients
- Lesion size of 3.9 ± 1.3 cm²
- 5 trials comparing ACI with MS
- 3 comparing ACI with OAT
- 3 evaluating different generations of ACI
- Pooled analysis comparing ACI with MS, there was no difference in outcomes at 24-month follow-up for function or pain
- CONCLUSION:
  - There is no significant difference between MS, ACI, and OAT in improving function and pain at intermediate-term follow-up. Further randomized trials with long-term outcomes are warranted.

Agonizing over Microfracture

Results after microfracture of full-thickness chondral defects in different compartments in the knee
Kreuz et al Osteoarthritis Cartilage 2006

- 1999 to 2002 85 patients (mean age 39.5 years)
- The best results femoral condyles.
- Patellar lesions did poorly
- Worse results for patients over 40
- Worse results for lesions over 2 cm²
- MRI 36 months after surgery revealed best defect filling in lesions on the femoral condyles with significant difference in the other areas (P<0.02).

CONCLUSIONS:
- Compared to Steadman’s patients our study population was less sportive and the mean age was higher. Furthermore our patients underwent serial objective observation instead of a subjective evaluation by questionnaires.
- Deterioration of the results starts 18 months after surgery
Evidence-based status of microfracture technique: a systematic review of level I and II studies
Goyal et al Arthroscopy 2013

- 15 studies that involved microfracture techniques
- CONCLUSIONS:
  - The use of microfracture for the treatment of small lesions in patients with low postoperative demands was observed to result in good clinical outcomes at short-term follow-up.
  - Beyond 5 years postoperatively, treatment failure after microfracture could be expected regardless of lesion size.
  - Younger patients showed better clinical outcomes.

Are surgeons following Jack Bert and abandoning Microfx?
"There is simply no justification in the literature to support the use of marrow stimulation procedures, especially MF, at this time.”
Arthroscopy March 2015

No, some form of Marrow Stimulation is still practice widely

- Microfracture and variations on theme still represent >90% of “cartilage restoration procedures”
Current Modifications

- Return to drilling
- NanoFx®
- Return to abrasionoplasty equivalent (aggressive removal of all calcified cartilage)
- Marrow stimulation augmentation (Biocartilage to BST-Cargel to Gelrin-C)

Recommendations

LOE 5

If you do it: do it right
Kroell KSSTA 2016 surgeons vary!

Mithoefer et al. AJSM 2009
Or, Maybe stop with abrasion:

Removal of Calcified Cartilage Exposed Vascularity

Lane JBJS (Br) 1977
Imhof MRI 1999; Bobic ICRS Zurmut

The non-calcified cartilage zone was interlocked tightly in the manner of "vinwe-angomphosis" by the calcified cartilage zone

Wang 2008 Zhonq quo

Chinese journal

Consider improving access to marrow and avoiding initiation of a "bone healing" response

Drilling may allow for more consistent open channels
No heat necrosis

Commercially available drilling options
- 4-6 mm depth
- 1.5 mm diameter

J Orthop Res 2009
Plan Options for Revision if failure occurs

Microfracture decreases success rate of ACI
- ACI poorer results after MicroFx
  - Minas, AJSM 2009
  - Pestka, AJSM 2012
- May not be related to intralesional osteophytes: Shive et al Osteo Cart 2014
- 80% very little overgrowth
- Not as severe as previously believed

Microfracture does not effect success rate of subsequent OCA
  Bugbee et al 2015
Optimize Patient Selection when considering Microfracture

<table>
<thead>
<tr>
<th>Factors</th>
<th>Better Results With</th>
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<tbody>
<tr>
<td>Age</td>
<td>&lt;40 years</td>
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<tr>
<td>Duration of symptoms</td>
<td>&lt;12 months</td>
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<tr>
<td>Lesion size</td>
<td>&lt;1 cm²</td>
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<tr>
<td>Body mass index</td>
<td>&lt;30 kg/m²</td>
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<tr>
<td>Preoperative activity level</td>
<td>Tegner score &gt;4</td>
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<tr>
<td>Previous surgery</td>
<td>Primary microfracture</td>
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<td>Repair cartilage volume</td>
<td>Good defect fill (&gt;60%)</td>
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Thank you