Microfracture: Is There a Role in 2018 and How?

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If it's good enough for the Pros…….

Houston Texans' Jadeveon Clowney has microfracture knee surgery

By KRISTIE RIEKEN – The Associated Press - Wednesday, December 10, 2014 8:54 a.m. CDT

Tim Hewett on Clowney 2014

- "Microfracture is sort of losing favor these days in large part. … It's more of a short-term remedy," said Hewett. "But if you look at the longer-term outcomes after microfracture, they're not very good. And this is especially apparent in the NBA. Some really high profile players in the NBA (such as Greg Oden) had microfracture and did not do well."

USA Today 2014

Cole's Website

- "The great part of this operation is, it's really safe," said Dr. Brian Cole, section head of the Cartilage Research and Restoration Center at Rush University Medical Center in Chicago and team physician for the Chicago Bulls and White Sox. "The bad part of this operation is it doesn't always work."

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

Steadman et al. J Knee Surg 2003

Football Outsiders

"A 2007 Football Outsiders study found that just 9 of 56 NFL players who underwent microfracture surgery remained in the league for at least five years after the operation."

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

Scillia, Andrews et al. Am J Sports Med 2015

How did We Get Here?

A Subset of "Marrow Simulation"

Evolution of Marrow Stimulation

The 100 Most-Cited Articles in Orthopaedic Knee Research

69 of 100

Pridie KH, Gordon G. A method of resurfacing osteoarthritic knee joints. Journal of Bone and Joint Surgery, British Volume. 1959 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.
- Fellowships with Bohler in Vienna, Watson-Jones in Liverpool and Girdlestone in Oxford.
- 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 **fibrocartilage formation is stimulated 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

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.

Johnson invented scope shaver: Abrasionoplasty

- Friedman MJ, Berasi CC, Fox JM, Del Pizzo W, Snyder SJ, Ferkel R. Preliminary results with abrasion arthroplasty in the osteoarthritic knee. Clin Orthop 1984.
- 73 patients with grade IV lesions, 60% showed improvement at minimum 1 year follow-up
- Johnson LL. Arthroscopic abrasion arthroplasty: historical and pathologic perspective: present status. Arthroscopy 1986; 2: 54-69. Majority Good results

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”

Adaptions of 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
- 71knees (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

- 350 subjects between 1992 and 2002.
- 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.

"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≥7 0 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 $\leq$4 cm ^{2} better than lesions $\geq$ 4 cm (P = .031)

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

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.

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 cm^2
- 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.

Clinical Outcomes after MicroFx: Midterm Follow-up: 2018

- Case-control study; Level of evidence, 3
- Retrospective PRO review 101 patients, mean age 36; mean defect 2.6 cm^2
- 45% MFC; 21% Troch; 8% patella
- All PROs demonstrated clinically and statistically significant improvements at 5.7 years.
- Male patients benefited more
- Largest benefit at isolated femoral defects
- Larger lesion size (>3.6 cm^2) and prior knee surgery predicted the need for additional knee surgery after microfracture.

Orthopaedic Journal of Sports Medicine | SAGE

Weber, et. al., Yanke, Cole 2018

Agonizing over Microfracture

Results after microfracture of full-thickness chondral defects in different compartments in the knee
Kreuz et al Osteoarhritis 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 cm^2
- 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

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"
- "Once considered experimental, it is now the most commonly performed cartilage repair procedure, with some 130,000 to 160,000 microfracture surgeries"

Sports Medicine Weekly 2014

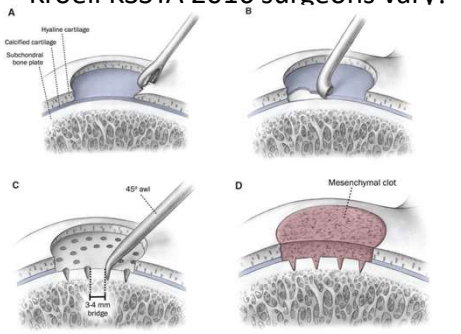
Current Modifications

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

Recommendations

LOE 5

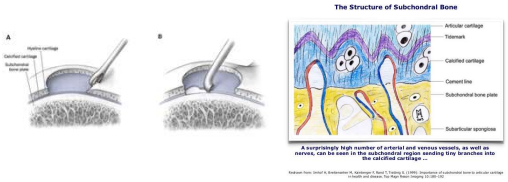
If you do it: do it right
Kroell KSSTA 2016 surgeons vary!



Mithoefer et al. AJSM 2009

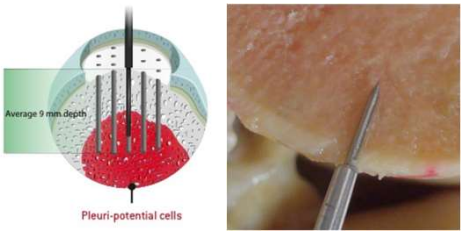
Or, Maybe stop with abrasion: Removal of Calcified Cartilage Exposed Vascularity

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



The non-calcified cartilage zone was interlocked tightly in the manner of "ravine-engomphosis" by the calcified cartilage zone
Wang 2008 Zhonqquo……. Chinese journal

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

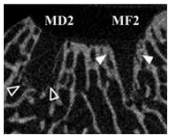


Courtesy Kevin Bonner, MD

Drilling and Microfracture Lead to Different Bone Structure and Necrosis during Bone-Marrow Stimulation for Cartilage Repair

Hongmei Chen,[1] Jun Sun,[2] Caroline D. Hoemann,[1] Viorica Lascau-Coman,[1] Wei Ouyang,[1] Marc D. McKee,[3] Matthew S. Shive,[2] Michael D. Buschmann[1]

- 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

Factors	Better Results With
Age	<40 years
Duration of symptoms	<12 months
Lesion size	<4 cm^2
Body mass index	<30 kg/m^2
Preoperative activity level	Tegner score >4
Previous surgery	Primary microfracture
Repair cartilage volume	Good defect fill (>66%)

Mithoefer et al. Am J Sports Med 2009

Thank you