

Nanofracture:

Rotator Cuff Repair with Nanofracture Augmentation

Scott A. Sigman, MD
Chief of Orthopaedics,
Lowell General Hospital, Lowell, MA

Introduction

According to a recent AAOS statement, more than 600,000 rotator cuff related procedures are performed in the US each year (1). Studies have indicated that the prevalence of rotator cuff tears may exceed 50% in individuals above 65 years of age and the rate of tears significantly increases with age (2). Twenty to 50% of these tears may become symptomatic over time (3-5). Both arthroscopic and open repair procedures have shown inconsistent success rates. Retears appear most frequently in the first 3 months after surgery and have been observed in 13 - 94% at 1- and 2-year follow-up (6-9). Many retears revert back to their preoperative size (8). The reason for retears is multifactorial. Successful tendon healing has been reported to be as low as 30% (10). In order to improve the healing response, biological augmentation of the index procedure through mesenchymal stem cell stimulation was introduced by Snyder and Burns in 2009 (11). The concept is based on microfracture of the greater tuberosity with the intent of bringing bone marrow elements to the repair site. The authors compared clinical and imaging outcomes after arthroscopic rotator cuff repair with and without microfracture and noted an improved healing rate in large supraspinatus and infraspinatus tears (11). In a prospective randomized clinical trial with 28 months follow-up, Milano et al. compared full thickness rotator cuff repairs with and without microfracture of the footprint and reconfirmed a significantly greater healing rate in the microfracture group for large tears (10).



Subchondral Marrow Stimulation



Figure 1
Top: Nanofracture System including Handle, Needle, and Single-handed Retrieval Mechanism
Right: Marrow Stimulation Response



Nanofracture

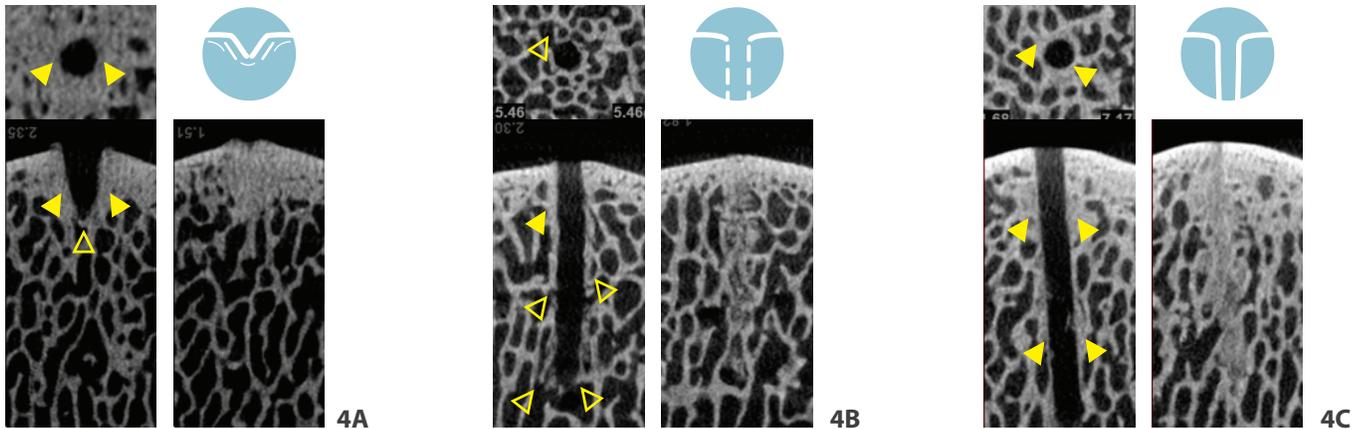
Recent insight into the limitations of microfracture and drilling has opened up new treatment pathways for mesenchymal stem cell stimulation (12,13). As an alternative to the shallow 2 mm wide, 3mm deep microfracture channels, Nanofracture (Arthrosurface, Franklin MA) was introduced in 2013 (13) (Figure 1). When compared to microfracture, this technique provides deeper, consistent, bone marrow access (9mm deep, 1mm wide) (Figure 2A,B). Drill-free bone perforations optimize trabecular bone venting and avoid channel closure from K-wire drilling caused by the bone slurry deposits that clog the trabecular tributaries (Figure 2C). Chen et al. demonstrated that deeper marrow access leads to an improved biological response and tissue quality (14,15). The sharp disposable needle tip (Nitinol) provides better control during placement of the perforations and avoids slippage and damage to surrounding tissues.



Figure 3:
A) Crescent Shaped Supraspinatus Tear Pattern
B) Tear Pattern and Footprint (arrow)
C) Nanofracture Stimulation of the Footprint (arrow)
D) Double Row Repair with Complete Coverage of the Humeral Head and Rotator Cuff Footprint

★ **Figure 2 A,B,C:** △ open trabecular channels;
▲ closed trabecular channels, microCT comparison:
Axial (top), Sagittal (bottom).

Clinical Monograph



Microfracture (2A): Trabecular wall thickness and density increased by apparent bone compression; limited trabecular channel access; channel borders with non-anatomic regularity; microfracture channel margins: Dense, compressed bone deposit (right).

Nanofracture (2B): Trabecular wall thickness and density appears normal; large number of open trabecular channels; anatomic irregularity of trabecular channel borders intact; nanofracture channel margins: Course and fragmented trabecular bone deposits (right).

1mm K-Wire (2C): Trabecular wall thickness and density close to normal; limited trabecular channel access; channel borders with non-anatomic regularity; k-wire channel margins: Pulverized and dense osseous deposits (right).

Intra- and Postoperative Considerations

Patient Positioning: Lateral decubitus

Diagnostic Arthroscopy

- Address secondary pain generators on glenoid, labrum, biceps, AC joint, and bursal tissues
- Analyze cuff tear pattern to avoid placing repair under tension (Figure 3A)
- Debride cuff to healthy tissue margins (Figure 3B)
- Visualize and prepare footprint with shaver to roughen the surface
- Avoid decortications to maintain a strong repair construct for anchor insertion

Nanofracture of the Greater Tuberosity

- The Nanofracture handle is introduced through the lateral subacromial portal and placed perpendicular to the surface.
- A gentle mallet tap advances the needle tip into the subchondral bone to a stop-controlled depth of 9 mm without creating thermal damage
- Pressure on the Thumble extractor releases the guidewire from the cortex
- The tunnels should be placed 3 mm apart in a circular pattern to provide adequate bone bridges between the tunnels and to protect the mechanical stability of the subchondral bone (Figure 3C)

Rotator Cuff Repair

- Double-row rotator cuff repair with coverage of the footprint (Figure 3D)

Rehabilitation

- Because of the rigidity of the construct, early range of motion exercises are initiated 10 days postoperatively
- Active assisted range of motion begins at day 10 with full forward flexion and abduction by six to eight weeks

Conclusion

Nanofracture introduces a new level of standardization and optimization in subchondral mesenchymal stem cell stimulation. The smaller diameter improves the stability of the cuff footprint when compared to larger microfracture channels and may yield higher repair rates through deeper, uncompressed trabecular channels. Future studies are necessary to quantify the treatment benefit.

References

1. Yamaguchi K. New guideline on rotator cuff problems. <http://www.aaos.org/news/aaosnow/jan11/cover1.asp>
2. Mall NA, Lee AS, Chahal J, et al. An evidence-based examination of the epidemiology and outcome of traumatic rotator cuff tears. *Arthroscopy* 29:366-376,2011
3. Moosmayer S, Tariq R, Stiris M, et al. The natural history of asymptomatic rotator cuff tears. *J Bone Joint Surg* 2013;95:1249-1255.
4. Mall NA, Kim HM, Keener JD, et al. Symptomatic progression of asymptomatic rotator cuff tears. *J Bone Joint Surg* 2010;92:2623-2633.
5. Yamaguchi K, Tetro M, Balm O, et al. Natural history of asymptomatic rotator cuff tears: a longitudinal analysis of asymptomatic tears detected sonographically. *J Shoulder Elbow Surg* 2001;10(3): 199-203.
6. Miller BS, Downie BK, Kohen RB et al. When do rotator cuff repairs fail? Serial ultrasound examination after arthroscopic repair of large and massive rotator cuff tears. *AJSM* 2011;39(10): 2064-2070.
7. Bishop J, Klepps S, Bird J, et al. Cuff integrity after arthroscopic versus open rotator cuff repair: A prospective study. *J Shoulder Elbow Surg* 2006;15:290-299.
8. Galatz LM, Ball CM, Teefey SA, et al. The outcome and repair integrity of completely arthroscopically repaired large and massive rotator cuff tears. *J Bone Joint Surg* 2004;86A: 219-224.
9. Kim S-J, Kim S-H, Lee S-K, et al. Arthroscopic repair of massive contracted rotator cuff tears: aggressive release with anterior and posterior interval slides do not improve cuff healing and integrity. *J Bone Joint Surg* 2013;95A:1482-1488.
10. Milano G, Saccoanno MF, Careri S, et al. Efficacy of marrow-stimulating technique in arthroscopic cuff repair: A prospective randomized study. *Arthroscopy* 2013;29:802-810.
11. Snyder SJ, Burns J. Rotator cuff healing and the bone marrow "Crimson Duvet" from clinical observations to science. *Tech Should Surg* 2009;10: 130-137.
12. Fortier LA, Cole BJ, Mcllwraith CW. Science and animal models of marrow stimulation for cartilage repair. *J Knee Surg* 2012;25:3-8.
13. Benthien J and Behrens P. Reviewing subchondral cartilage surgery: considerations for standardized, deep marrow stimulation. A Technical Note. *Int Orthop* 2013 Nov;37(11):2139-45.
14. Chen H, Sun J, Hoemann CD, et al. Drilling and microfracture lead to different bone structure and necrosis during bone-marrow stimulation for cartilage repair. *J Orthop Res*. 2009 Nov;27(11):1432-8.
15. Chen H, Hoemann CD, et al. Depth of subchondral perforation influences the outcome of bone marrow stimulation cartilage repair. *J Orthop Res*. 2011 Aug;29(8):1178-84.

Always refer to the package insert information, product labeling and/or user instructions before using any Arthrosurface product.

PATENTS PENDING, NanoFx™ is a trademark of Arthrosurface, Inc. U.S. © 2014

28 Forge Parkway, Franklin, MA 02038 • Tel: 1 508 520 3003 • Fax: 1 508 528 4604 • Visit our website: arthrosurface.com

PN 0020-0110 REV-A