

# Arthroscopic Revision of Medial Rotator Cuff Failure Augmented With a Bioabsorbable Patch



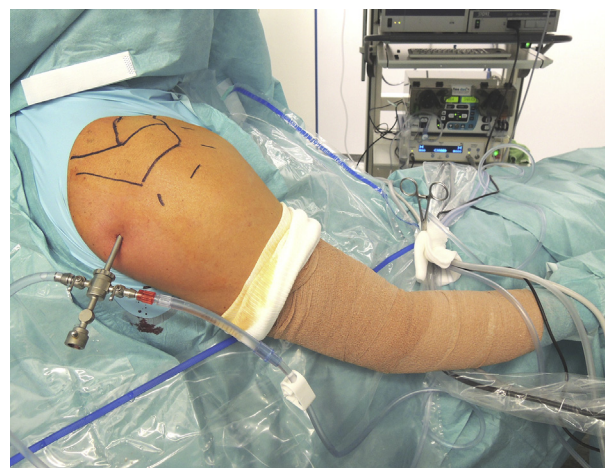
Eduard Buess, M.D., Michael Hackl, M.D., and Peter Buxbaumer, M.D.

**Abstract:** When revising failed double-row and suture-bridge rotator cuff repairs medial failures represent a potential feature. In the presence of a compromised healing environment, patch augmentation becomes a logical adjunct from a mechanical and biological point of view. A reproducible step-by-step revision technique is described that reinforces the weak central cuff area with an absorbable synthetic scaffold.

**F**ailure of rotator cuff (RC) repair basically depends on tear size, aging of the muscle tendon unit, and the fixation technique.<sup>1</sup> New failure modes appeared with double-row and suture-bridge (SB) fixation—typically the so-called medial cuff failure.<sup>2,3</sup> Double-row and SB repairs, as compared with single-row, are prone to overstress the tendon, which seems to be the main issue of medial failure.<sup>4</sup> In correlation with tear size, retears after RC repair are observed in 20% to 70% cases.<sup>5</sup> Two techniques show promise in improving healing rates, especially in the situation of a failed previous repair with a potentially compromised biological healing environment: the first option is to enhance the biologic healing response at the bone-tendon interface using bone marrow stimulation such as “multiple channeling” on the debrided footprint.<sup>6</sup> Secondly, patch augmentation is under consideration.<sup>7</sup> The options here include synthetic scaffolds, xenografts, and allografts.<sup>5</sup> To date, no consensus exists as to the choice of the best material, and till now, most authors have used open and mini-open techniques.<sup>8</sup> The purpose of this Technical Note is to describe a reproducible, standardized, and fully arthroscopic revision technique for medial cuff failures.

## Technique

We prefer the beach-chair position and use a custom-made soft tissue traction system with 2 kg that maintains the arm in loose anteversion of 30° to 40° allowing free rotation (Fig 1). The patient routinely receives general anesthesia combined with an interscalene block for better intraoperative monitoring of blood pressure and postoperative pain control. After skin marking of the osseous landmarks, we proceed to diagnostic arthroscopy and portal placement. Apart from the posterior standard portal, we routinely use 4 portals: an anterosuperior, anterolateral, lateral, and posterolateral portal. A soft Passport cannula (Arthrex, Naples, FL) measuring 40 mm in length and 8 mm in diameter is placed in the lateral portal for RC refixation, and a second one in the anterosuperior portal is added for



**Fig 1.** Patient in the beach-chair position, right shoulder: set-up and main working portals; trocar introduced into the glenohumeral joint from the posterior standard portal.

From the Klinik Engeried (E.B., P.B.), Bern, Switzerland; and Klinik für Orthopädie und Unfallchirurgie, Universitätsklinikum (M.H.), Köln, Germany.

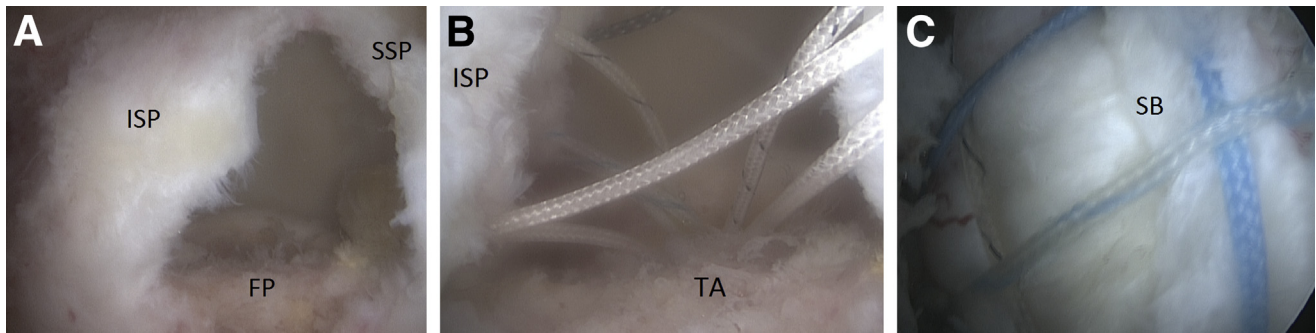
The author reports the following potential conflicts of interest or sources of funding: E.B. receives support from DePuy Mitek.

Received January 5, 2017; accepted March 6, 2017.

Address correspondence to Eduard Buess, M.D., Riedweg 5, Bern CH-3012, Switzerland. E-mail: [ebuess@shoulder-care.ch](mailto:ebuess@shoulder-care.ch)

© 2017 by the Arthroscopy Association of North America  
2212-6287/1722/\$36.00

<http://dx.doi.org/10.1016/j.eats.2017.03.009>

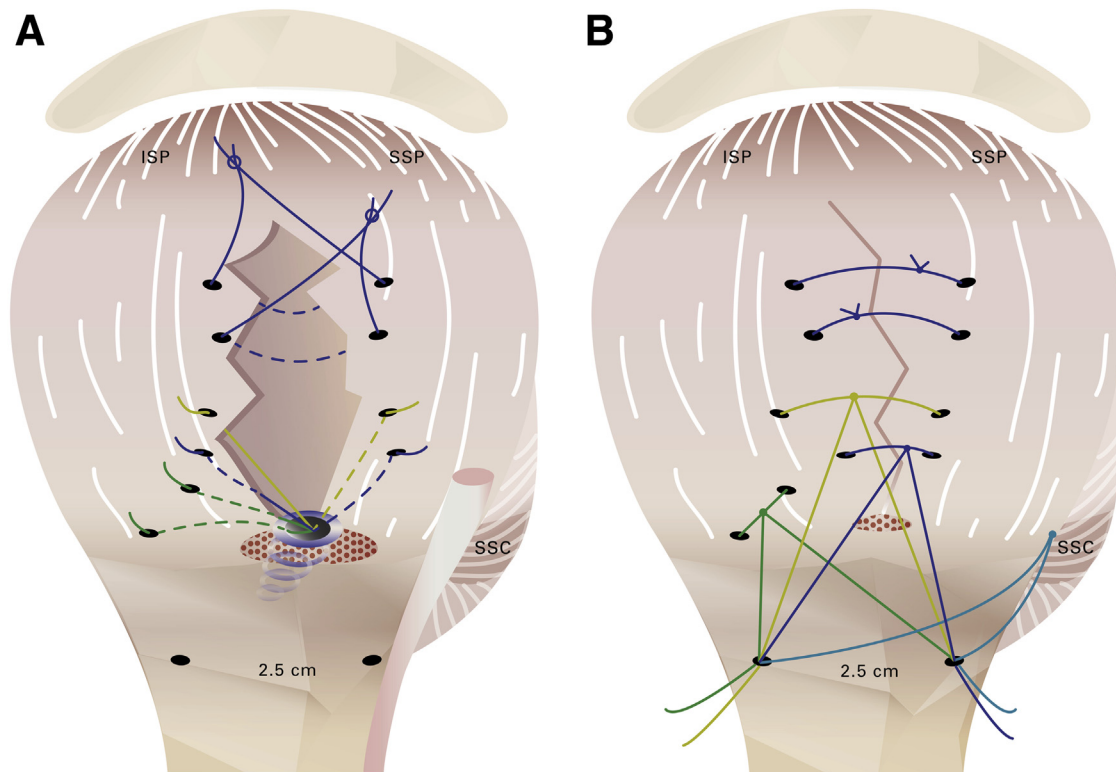


**Fig 2.** Right shoulder, lateral viewing portal. (A) Arthroscopic view of the debrided footprint. (B) Anchor with 3 sutures has been inserted at the articular margin. (C) Suture-bridge repair has closed the defect. (FP, footprint; ISP, infraspinatus; SB, suture-bridge; SSP, supraspinatus; TA, triple-loaded anchor.)

patch augmentation. Additional percutaneous portals are applied as needed for suture management.

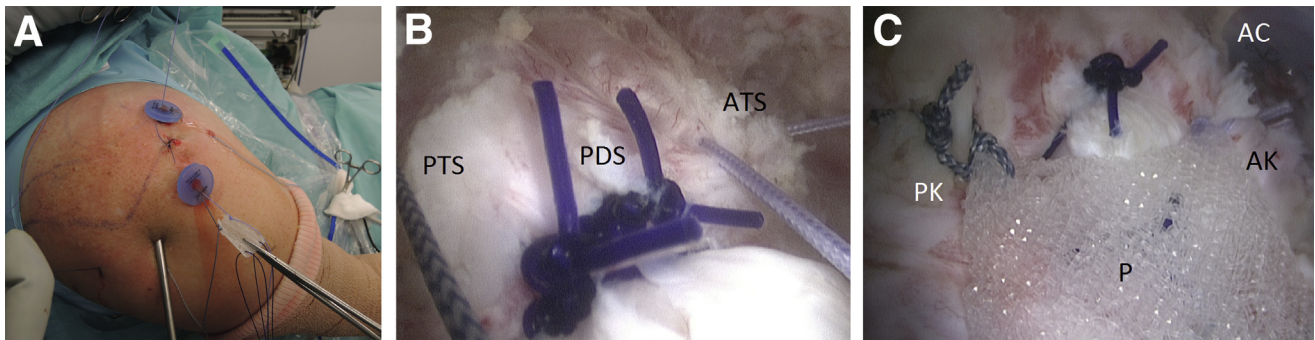
The glenohumeral phase most importantly includes—even for small partial tears—repair of the subscapularis (performed in approximately 1/3 of cases). The suture limbs closest to the comma sign are left uncut for later integration into the SB. After removal of loose suture material ([Video 1](#)), we carefully inspect the articular side of the supra- and infraspinatus and confirm (partial) healing at the footprint and a medial defect as

the criteria of a medial RC failure. Then, we proceed to footprint preparation with an aggressive shaver blade paying attention not to disturb healed areas of cuff insertion. As a result, we frequently encounter a facet of bleeding bone with a diameter of approximately 1 cm. Next, bone marrow stimulation should be performed with the preferred device. Before leaving the joint space, we visualize the posterior cuff from the anterosuperior portal paying attention to delamination of the infraspinatus with retraction of its deep layer.



**Fig 3.** (A) Right shoulder, lateral view. Diagram of suture passage after footprint preparation and anchor insertion. Side-to-side (blue) PDS sutures at the apex of the tear passed with a straight Spectrum needle. Anchor sutures are passed with Clever hooks; the posterior mattress suture (dark green) includes a deep layer of ISP. Light green and blue anchor sutures work as “margin-convergence to bone.” (B) Right shoulder, lateral view. Diagram after knot tying and lateral fixation with 2 PushLock anchors. Two suture limbs are left long for lateral fixation of the patch. Optional inclusion of suture strands from SSC refixation is sketched (not shown in [Video 1](#)). Figure courtesy of Sarah Bahler ([www.sarahbahler.ch](http://www.sarahbahler.ch)). (ISP, infraspinatus; SSC, subscapularis; SSP, supraspinatus.)



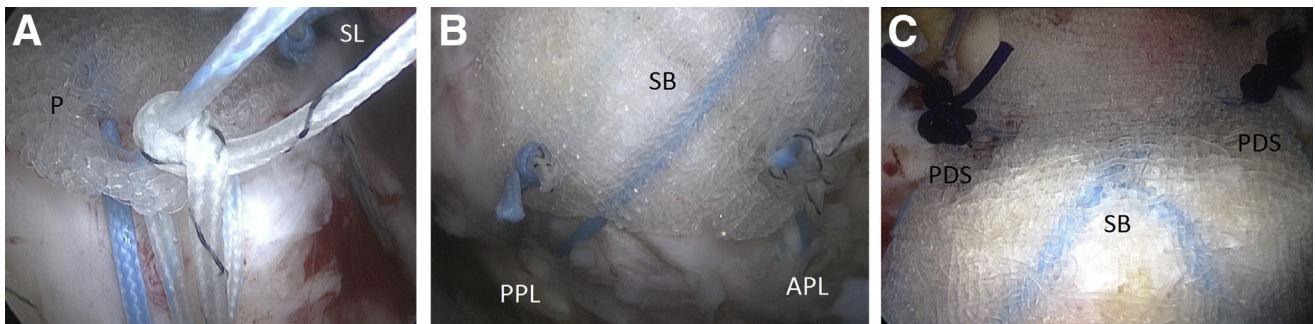


**Fig 4.** Right shoulder. (A) Picture showing pulling-in of the patch through the lateral Passport cannula; watch PDS shuttle sutures in the lateral corners. (B) Arthroscopic view from the posterolateral portal; patch is pulled into place with long Orthocord traction sutures passing at the musculotendinous junction. (C) Arthroscopic view from the lateral portal; sutures have been tied through the anterior cannula to complete medial fixation. (AC, anterior cannula; AK, anterior knot; ATS, anterior traction stitch; P, patch; PDS, margin-convergence stitches; PK, posterior knot; PTS, posterior traction stitch.)

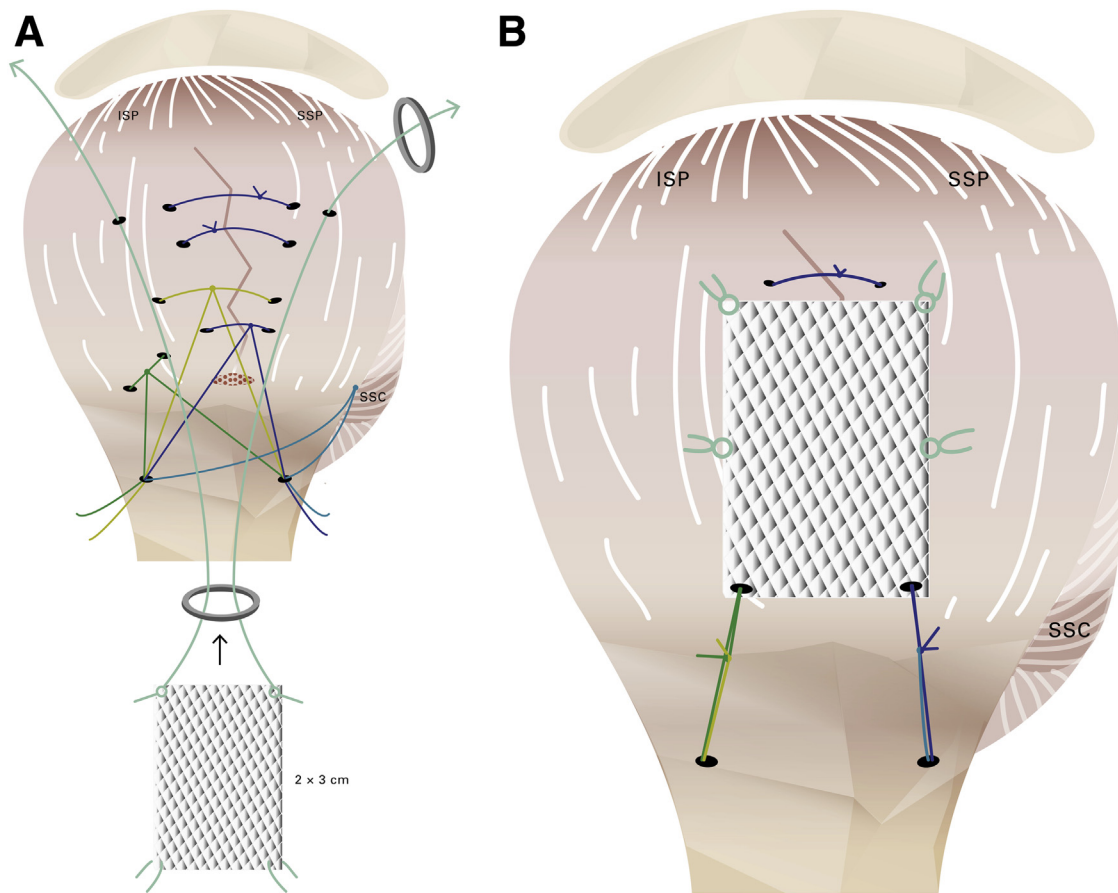
The arthroscope is now switched into the subacromial space (Video 1), where we proceed to bursectomy and sparse debridement of the cuff margins (Fig 2A) in the centrally torn or weak zone. Loose suture material of the lateral row is removed and an additional acromioplasty performed as needed. With the arthroscope in the lateral portal, extensive bursectomy is performed starting in the lateral gutter and then moving posteriorly. The posterior cuff is carefully checked for tissue quality and for delamination again. With the long-curved straight Spectrum device (Linvatec, Utica, NY), 2 side-to-side margin-convergence stitches (typically PDS No. 1, Ethicon, Somerville, NJ) are placed at the apex of the defect and left untied. Now a triple-loaded anchor (PEEK [polyether ether ketone] or bio-composite), for example, Healicoil (Smith & Nephew, Memphis, TN), is inserted into the subchondral bone at the articular margin of the footprint (Fig 2B). Bone quality is uniformly good here and we are not worried about anchor pullout. Curved suture retrievers (e.g., Clever Hook, DePuy Mitek, Raynham, MA) are well suited for rapid suture passing anteriorly and posteriorly. Typically one posterior mattress stitch shifts the retracted deep posteromedial layer of the infraspinatus superiorly;

the remaining 2 work as “margin-convergence-to-bone” stitches including both the anterior and posterior cuff. All sutures are now tied with sliding knots, the side-to-side sutures cut, and the anchor sutures left long for crossed SB configuration (Fig 2C) with 2 lateral push-in anchors (e.g., PushLock, Arthrex). These are placed approximately 1.5 cm laterally from the apex of the greater tuberosity for better bone quality. The anterior PushLock is inserted directly adjacent to the sulcus, and the second one 2 to 2.5 cm more posteriorly using internal rotation of the arm. Two suture tails per anchor are left uncut (Fig 3).

In the next step, patch augmentation of the repaired RC is performed (Video 1). The synthetic 2 × 3 cm scaffold (BioFiber, Tornier, Bloomington, MN) is prepared by the assistant on the side table, who places 2 PDS shuttle sutures in the lateral edges 3 to 5 mm from the margin. Simultaneously, the surgeon places 2 long nonabsorbable sutures (e.g., Orthocord, DePuy Mitek) at the musculotendinous junction 1.5 to 2 cm apart intended for pulling in and medial fixation of the patch. For this purpose, we like to use the 45° curved Spectrum device with a PDS shuttle. The location of these stitches is perpendicular to the acromioclavicular joint;



**Fig 5.** Right shoulder, lateral viewing portal. (A) Lateral fixation with leftover suture limbs from the posterior PushLock anchor. (B) Lateral fixation completed; some tension was applied. (C) Sideward fixation with PDS stitches. (APL, anterior PushLock; P, patch; PDS, sideward stitches; PPL, posterior PushLock; SB, suture-bridge visible under patch; SL, suture limbs.)



**Fig 6.** (A) Right shoulder, lateral view. Diagram of patch transportation into subacromial space. (B) Right shoulder, lateral view. Diagram of the final aspect of the patch secured over the weak cuff area; 6 fixation points to underlying tissue. Figure courtesy of Sarah Bahler ([www.sarahbaehler.ch](http://www.sarahbaehler.ch)). (ISP, infrapinatus; SSC, subscapularis; SSP, supraspinatus.)

the distance between them is measured with a calibrated probe and should add up to 1.5 to 2 cm. With a free needle the medial corners of the scaffold are pierced and secured with one half hitch extra-articularly (Fig 4A). We use these sutures to pull the

“flying carpet” into place (Fig 4B). The patch bends easily and can be molded as a “half pipe” permitting easy passage through the 8-mm Passport cannula. Now we tie the medial knots through the anterior cannula using nonsliding double square knots (Fig 4C).

### Table 1. Key Points, Pearls, and Pitfalls

#### Key points

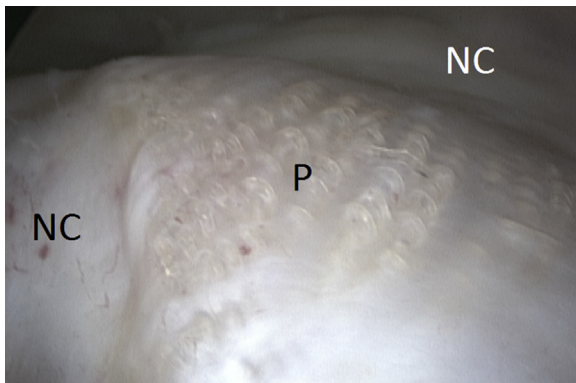
- Arthroscopic revision surgery is rewarding; however, it entails (according to the literature) more complications and a higher rate of nonhealing as compared with primary cases
- Interpret magnetic resonance imaging (MRI) with caution (high signal areas!), because the cuff might still be in its healing phase at 6-12 mo
- Augmentation with a synthetic patch in the proposed fashion is reproducible, easy to learn for the experienced shoulder arthroscopist, and shows promising results

#### Pearls

- Preserve healed areas of cuff tissue; retears are often smaller than at index operation
- Remove loose suture material and prominent anchors, but do not “excavate” them
- Watch out for tendon delamination, which can be seen in as much as 80%. Include the deep layer of infrapinatus into repair to make it stronger
- For the central areas we prefer strong absorbable PDS side-to-side stitches that degrade over 4-6 mo to avoid knot impingement and suture cut through
- Apply techniques of bone marrow stimulation
- Biocomposite anchors with an open-architecture design to allow bony ingrowth are increasingly preferred

#### Pitfalls

- Too early revision based on misled interpretation of MRI findings in case of “delayed biological healing”
- Failure to repair the transverse force couple of the subscapularis and infrapinatus and to use margin convergence
- Failure to address concomitant pathology such as biceps, acromioclavicular joint, and capsular stiffness



**Fig 7.** Right shoulder, posterolateral viewing portal. Arthroscopic image of reoperation at 6 months showing successful integration of scaffold in cuff tissue. (NC, native cuff; P, patch.)

After medial attachment, we proceed to lateral fixation (Video 1) of the patch using the leftover suture limbs from the lateral anchors that are shuttled through the lateral corners with the previously placed PDS shuttle sutures and tied as double square knots (Fig 5A) applying some tension in approximately 30° of abduction of the arm (Fig 5B). Fixation is completed with PDS No. 1 sutures on the long sides of the patch anteriorly and posteriorly. This is easily achieved with “direct shots” using the straight-curved Spectrum device (Fig 5C). The final aspect shows neat unfolding of the patch over the weak area in the center of the cuff (Fig 6; Table 1).

## Discussion

Medial failures represent a potential feature of revision RC repair.<sup>2</sup> Tissue quality is often suboptimal, so patch augmentation becomes a logically desirable adjunct.<sup>5,8</sup> The proposed scaffold (BioFiber, Tornier) has good mechanical stability, retains 50% to 70% of

**Table 2.** Revision Technique for Medial Cuff Failure: 12 Steps

1. Confirm magnetic resonance imaging findings at diagnostic arthroscopy
2. Remove loose suture material and proceed to an extensive bursectomy; debride cuff margins
3. Prepare a small area of footprint mainly at the undersurface of cuff insertion
4. Place one triple-loaded suture anchor centrally
5. Pass 2-3 side-to-side (margin-convergence) stitches at the apex of the retear
6. Suture passing of anchor sutures according to tear configuration, typically 4 strands posteriorly and 2 anteriorly
7. After tying the 3 mattress stitches proceed to crossed lateral fixation with 2 push-in anchors; leave 2 suture limbs per anchor uncut
8. Place 2 sutures at the musculotendinous junction 1.5-2 cm apart
9. Use these sutures to pull in a 2 × 3 cm patch (e.g., synthetic bioabsorbable scaffold) through the working cannula, and tie them to complete medial fixation
10. Fix the patch laterally with some tension using the leftover sutures of the lateral row
11. Fix the patch on the sides with additional sutures
12. The patch neatly covers and reinforces the weak cuff areas

**Table 3.** Advantages and Limitations of the Procedure

### Advantages

- Added operation time after learning curve only 20-30 min
- Added costs of the patch less than equivalent of 2 anchors
- Patient is likely to experience less postoperative pain
- Patch adds mechanical stability during the critical period of the healing phase
- Integration of the patch and tissue ingrowth has been observed in cases of repeat arthroscopy
- Scaffold made from fully absorbable synthetic fibers degrading without known toxicity; no DNA residues present

### Limitations

- Synthetic scaffold that does not contain biomolecules enhancing tissue healing as likely present in extracellular matrices
- Does not act as an implant potentially recentering the shoulder by increasing the acromiohumeral distance
- Possible small risk of foreign body reaction and infection

strength at 3 months, and should be fully absorbed after 18 months.<sup>9</sup> The biosynthetic fibers from poly-4-hydroxy-butyrate are subject to slow degradation in the Krebs cycle breaking down into naturally occurring metabolites, eliminated without toxicity.<sup>5</sup> They are woven into a bilayer lattice structure that allows for cellular ingrowth. Passing of stitches with suture hooks is easy and costs are much lower as compared with commonly used matrices such as human dermis allografts.<sup>8</sup> The size of the patch of 3 × 2 cm is ideal for most situations; trimming is avoided, as this would mechanically weaken the scaffold. By applying tension on the lateral corners theoretically a load sharing effect to the underlying cuff tissue should be obtained.

The material has been successfully used in general surgery (abdominal wall hernias) and cosmetic breast surgery<sup>9</sup>; however, only few preliminary communications are available in the orthopaedic literature.<sup>10</sup> Figure 7 was obtained at arthroscopic evaluation of the patch 6 months postoperatively and revealed its unproblematic ingrowth.

This technique complies with all advantages of a fully arthroscopic technique including less postoperative pain, better cosmesis, and favorable patient acceptance. Following a systematic step-by-step suture management (Table 2), patch augmentation adds only approximately 30 minutes to the operating time. No additional bone anchors are needed for patch fixation making this procedure cost-efficient (Table 3).

## References

1. Mall NA, Tanaka MJ, Choi LS, Paletta GA Jr. Factors affecting rotator cuff healing. *J Bone Joint Surg Am* 2014;96:778-788.
2. Buess E. Failures following arthroscopic rotator cuff repair. Recurrent tears, incomplete healing or central cuff failure. *Arthroscopie* 2012;25:111-117 [in German].
3. Trantalis JN, Boorman RS, Pletsch K, Lo IK. Medial rotator cuff failure after arthroscopic double-row rotator cuff repair. *Arthroscopy* 2008;24:727-731.

4. Cho NS, Yi JW, Lee BG, Rhee YG. Retear patterns after arthroscopic rotator cuff repair: Single-row versus suture bridge technique. *Am J Sports Med* 2010;38:664-671.
5. Ricchetti ET, Aurora A, Iannotti JP, Derwin KA. Scaffold devices for rotator cuff repair. *J Shoulder Elbow Surg* 2012;21:251-265.
6. Jo CH, Shin JS, Park IW, Kim H, Lee SY. Multiple channeling improves the structural integrity of rotator cuff repair. *Am J Sports Med* 2013;41:2650-2657.
7. Yoon JP, Chung SW, Kim JY, et al. Outcomes of combined bone marrow stimulation and patch augmentation for massive rotator cuff tears. *Am J Sports Med* 2016;44:963-971.
8. Steinhaus ME, Makhni EC, Cole BJ, Romeo AA, Verma NN. Outcomes after patch use in rotator cuff repair. *Arthroscopy* 2016;32:1676-1690.
9. Williams SF, Martin DP, Moses AC. The history of Galaflex P4HB scaffold. *Aesthet Surg J* 2016;36:S33-S42.
10. Barbash S, Denny C, Collin P, Reish T, Hart JM, Brockmeier SF. Clinical outcomes and structural healing after arthroscopic rotator cuff repair reinforced with a novel absorbable biologic scaffold: A prospective, multicenter trial. *Orthop J Sports Med* 2015;3: 2325967115S00071.