Controversial Treatments of Shoulder Injuries

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Repair of shoulder injuries is rising and multiple treatment options exist. T. Bradley Edwards, MD, Texas Orthopedic Hospital, Houston, Texas, USA, discussed patch reinforcement in the repair of rotator cuffs. Multiple factors are involved in satisfactory healing of the rotator cuff including the quality of the tendon and muscle, repair biomechanics, and patient quality. The use of a patch in rotator cuff repair may be beneficial to aid in healing when reinforcement with the suture line, augmentation of the repair, or interposition/replacement of the tendon is needed.

Suture line reinforcement with an absorbable patch (such as poly-4-hydroxybutyrate) may be indicated in a case where a poor-quality tendon is present, as sutures can pull through such a tendon. Although suture line reinforcement logically should have favorable outcomes, clinical data is currently not available.

Augmentation of the repair with a patch may also be indicated in cases of poor tendon quality, particularly in the tendon opposed to the greater tuberosity. In this case, augmentation with a biologically engineered patch may improve the ability of the repaired tendon to handle a load. A Level I study demonstrated that the Restore patch caused an unacceptable level of postoperative inflammation [Iannotti JP et al. *J Bone Joint Surg Am* 2006], whereas several Level IV studies (without a control) demonstrated that human and porcine patches did not cause an inflammatory response [Malcarney HL et al. *Am J Sports Med* 2005]. Several Level IV studies found that the GraftJacket also did not cause an inflammatory response. In addition, a Level II, prospective, controlled trial demonstrated that tendon augmentation with the GraftJacket resulted in better American Shoulder and Elbow Surgeons (ASES) score, and constant and healing rates on magnetic resonance imaging (MRI), although these scores did not achieve minimally clinically important differences [Barber FA et al. *Arthroscopy* 2012]. Dr. Edwards noted that the limited data from these trials highlight that there is still question of whether tendon augmentation is worth the added time and effort, in terms of outcomes.

In the case of massive rotator cuff tear, a biologically engineered patch can be used to essentially replace the absent tissue. Dr. Edwards highlighted that he uses this technique rarely and only in patients who have good-quality muscle with minimal fatty infiltration and no pseudoparalysis.

Leesa M. Galatz, MD, Washington University School of Medicine, St. Louis, Missouri, USA, presented information about biologics that are available for rotator cuff repair. Platelet rich plasma (PRP) includes alpha granules that contain multiple growth factors, cytokines, and proteins involved in cell recruitment, proliferation, and angiogenesis, which are important to healing tissue.

PRP is available as activated or nonactivated. Clotting results in activation of PRP, in which the alpha granules degranulate and release 100% of their factors within 1 hour. In contrast, nonactivated PRP is activated by exposure to collagen and my result in delayed release. Platelet rich fibrin matrix (PRFM) is a fibrin matrix which contain platelets within a more solid clot-like substance. The platelets are activated as the fibrin matrix is absorbed, resulting in a slower, more sustained release. Because cell metabolism, proliferation, and extracellular matrix production occur between 10 and 14 days following a tendon repair, use of activated PRP may not be ideal for rotator cuff repairs, as the factors are depleted during the timeframe in which they are most needed (ie, 10 to 14 days).

Several studies have been conducted to evaluate the effect of PRP on rotator cuff repair and demonstrated no improvement in clinical or structural outcomes [Weber SC et al. *Am J Sports Med* 2013; Jo CH et al. *Am J Sports Med* 2011; Catricini R et al. *Am J Sports Med* 2010]. In addition, a Level II randomized trial of 79 patients demonstrated that the rate of healing was 67% in the arm that received PRFM compared with 81% in the control arm, which did not receive PRFM, suggesting that PRFM treatment may actually have a negative effect [Rodeo SA et al. *Am J Sports Med* 2012].

Another emerging biologic is mesenchymal stem cells, but there are few studies that evaluated the effect of mesenchymal stem cells in rotator cuff repair, and these studies have been mostly in animal models so far. In one study, stem cells alone had no effect on outcomes, but stem cells transfected to express MT1-MMP demonstrated improved insertion-site characteristics, and structural and material properties similar to that of healing tissue [Gulotta LV et al. *Am J Sports Med* 2010]. Similarly, the few human studies that have been performed have demonstrated that stem cells alone are not beneficial. Stem cells transfected with the transcription factor scleraxis provided some benefit in another animal study [Gulotta LV, Rodeo SA. *Clin Orthop Relat Res* 2011]. Only one published study documents the use of stem cells in a human. In this study, autologous bone marrow mononuclear cells (BMMC) were injected into the tendon borders during rotator cuff repair. Although there was no control group to compare the results with, the UCLA shoulder scale core increased from 12 to 31, and tendon integrity was maintained during the 12 months of follow-up. This study showed that use was

safe, but it is difficult to make conclusions about efficacy due to the lack of a comparator group [Ellera Gomes JL et al. *Knee Surg Sports Traumatol Arthrosc* 2012]. Dr. Galatz outlined the challenges that stem cells must overcome to be successful, such as needing to be present in large numbers, tissue adherence, angiogenesis, directing growth factors, inflammation, apoptosis, and differentiation.

Edward V. Craig, MD, MPH, Hospital for Special Surgery, New York, New York, USA, discussed treating fractures with reverse arthroplasty. One treatment of shoulder fractures is osteosynthesis, but fracture displacement, screw problems, and avascular necrosis can occur. Another treatment option is hemiarthroplasty (HA), but problems with tuberosity resorption or pull-off and late glenoid wear can occur. In addition, it is difficult to revise a failed HA. As a result of these issues, reverse arthroplasty was developed as another treatment option. Although complications such as hematoma, notching, and implant failure can occur, the rates of these nonmajor complications are decreasing.

A recent systematic review of nine studies included patients with a mean age of 77 years and a constant score of 55.9 found that with a mean follow-up of 43 months, patients scored a mean of 122 for front flexion and 18 for external rotation, and the scores were better if the greater tuberosity healed [Anakwenze OA et al. *J Shoulder Elbow Surg* 2014]. In addition, several clinical studies have compared HA with reverse arthroplasty (Table 1). In general, these studies found that outcomes improved or range of motion was achieved earlier with reverse arthroplasty compared with HA.

Table 1. Clinical Studies Comparing Hemiarthroplasty to Reverse Arthroplasty

Study	Results	Comments
Cuff DJ, Pupello DR. *J Bone Joint Surg Am* 2013	RSP better outcome, satisfaction, flexion	13% HA to RSP—GT not healed
Mata-Fink a et al. *J Shoulder Elbow Surg* 2013	RSP better outcome, flexion	Review 15 studies
Boyle MJ et al. *J Shoulder Elbow Surg* 2013	RSP results better at 5 years	Similar at 6 months
Namdari S et al. *J Bone Joint Surg Am* 2013	Outcome, motion similar	Review 14 studies
Chalmers PN et al. *J Shoulder Elbow Surg* 2014	Outcome scores similar, RSP better ROM, ROM earlier	RSP cost savings (less rehab)

GT=greater tuberosity; HA=hemiarthroplasty; ROM=range of motion; RSP=reverse arthroplasty.

Thomas Throckmorton, MD, Campbell Clinic, Germantown, Tennessee, USA, outlined the indications for HA and total shoulder replacement (TSR). The use of HA has been controversial over the past 10 years and evidence to date suggests that TSA is superior based on pain relief, function, range of motion, and rate of revision for osteoarthritis [Radnay CS et al. *J Shoulder Elbow Surg* 2007; Bishop JY, Flatow EL. *J Shoulder Elbow Surg* 2005; Bryant D et al. *J Bone Joint Surg Am* 2005; Collins DN et al. *J Bone Joint Surg Am* 2004]. Long-term studies indicate that the 20-year survival rate of the implant is greater, as well as better pain and function scores, for TSA versus hemiarthroplasty [Bryant D et al. *J Bone Joint Surg Am* 2005; Lo IK et al. *J Bone Joint Surg Am* 2005; Sperling JW et al. *J Shoulder Elbow Surg* 2004]. In addition, a long-term study with 11 years of follow-up demonstrated that only 20% of patients reported excellent outcomes; in contrast, 31% reported moderate to severe pain and 20% had to undergo revision to TSR [Rispoli DM et al. *J Bone Joint Surg Am* 2006].

Resurfacing hemiarthroplasty theoretically preserves proximal humerus bone stock. Intermediate follow-up of resurfacing demonstrated similar results as stemmed arthroplasty with good pain relief and range of motion improvement [Levy O, Copeland SA. *J Shoulder Elbow Surg* 2004]. However, little data are available for long-term follow-up. Dr. Throckmorton suggested that hemiarthroplasty is indicated in young or high-demand patients who have reasonable glenoid cartilage and/or a functioning cuff, meaning they can achieve forward elevation of 90° or better.

Ream and run modified HA has also demonstrated improvement in pain, range of motion, and function at up to 4 years of follow-up [Saltzman MD et al. *J Shoulder Elbow Surg* 2011; Lynch JR et al. *J Bone Joint Surg Am* 2007]. However, interposition modified HA has shown up to a 70% failure rate by 2 years and has therefore largely been abandoned [Straus EJ et al. *J Shoulder Elbow Surg* 2013]. Similarly, although lateral meniscus allograft initially showed favorable results, mid-term studies are now demonstrating that the failure rate is 45% at <5 years. Dr. Throckmorton suggested that modified HA may be indicated in young or high-demand patients with glenohumeral arthritis.

Indications for TSA include symptomatic glenohumeral arthritis with an intact rotator cuff, and TSA is considered the gold-standard treatment for osteoarthritis. Dr. Throckmorton stated that young to elderly and low-to-medium demand patients with an intact or reparable rotator cuff are candidates for TSA. Long-term studies dating from 1975 to 1981 with up to 17 years of follow-up demonstrated that 83% of patients had long-term pain relief and component retention was present in 87% at 15 years. Another long-term study demonstrated that the 20-year survival of the implant was 85% and the revision rate was only 7% [Deshmukh AV et al. *J Shoulder Elbow Surg* 2005].

Depending on the shoulder injury, multiple surgical treatment options that range from using a biologically engineered patch, to biologics, to prosthesis use are available. Although controversies exist as to which method is superior, clinical data are accumulating that can serve as a guide for surgeons who treat shoulder injuries.