History and Future Direction of Superior Capsule Reconstruction for Irreparable Rotator Cuff Tears

Teruhisa Mihata¹²³

Abstract

Lesions of the superior shoulder capsule had been a neglected entity before I reported my technique for superior capsule reconstruction (SCR). I had noticed that patients with irreparable rotator cuff tears always had irreparable defects of the superior shoulder capsule as well as the rotator cuff tendons, because the superior shoulder capsule is attached to the undersurface of these tendons. Therefore, I hypothesized that reconstruction of the superior shoulder capsule might be useful to prevent superior migration of the humeral head and subacromial impingement in irreparable rotator cuff tears. To prove my hypothesis, our group performed a cadaveric biomechanical study in 2005. This biomechanical study showed that SCR completely restored superior stability of the glenohumeral joint, whereas patch grafting to the supraspinatus tendon (conventional patch graft surgery) only partially restored superior translation to the intact level. Consequently, in 2007, we started arthroscopic SCR for patients with irreparable rotator cuff tears. From our 10 years of experience with SCR, we conclude that arthroscopic SCR restores superior glenohumeral stability and improves shoulder function in irreparable rotator cuff tears.

Keywords: Irreparable, Reconstruction, Rotator Cuff, Shoulder, Superior capsule

1. History of SCR

Chronic large to massive rotator cuff tears are challenging to repair completely because of the development of tendon retraction with inelasticity[1,2], muscle atrophy[1,3-6], and fatty infiltration[1-6]. In 2004, when I completed a research fellowship at the Orthopaedic Biomechanics Laboratory in Long Beach, California, USA, under Professor Thay Q Lee (Figure 1) and a clinical fellowship at the Kerlan-Jobe Orthopaedic Clinic in Los Angeles, California, USA, under Professor Frank W Jobe (Figure 2), and restarted treating shoulder pathology in Japan, various surgical treatments were being performed, including debridement and subacromial decompression[7,8], partial repair[9-11], transposition of the subscapularis tendon[12,13], transplantation of the teres major muscle[14], supraspinatus muscle advancement[15], deltid flap reconstruction[16], latissimus dorsi transfer[17-19], pectoralis major transfer[20], grafting to the torn tendon[21-25], and reverse shoulder arthroplasty[26-28]. However, all of the alternatives to complete repair had proved unsatisfactory in terms of clinical outcome and postoperative complications[1]. Although reverse shoulder arthroplasty had proved effective in treating irreparable rotator cuff tears[26-28] in terms of shoulder elevation and pain, the Japanese government did not allow the use of this procedure until 2014. Other surgical options cannot achieve consistent improvement in shoulder function. Therefore, in 2004 and 2005, my main strategy for irreparable rotator cuff tears was non-operative treatment, including physical therapy, medication, and injection. Even in irreparable rotator cuff tears, shoulder symptoms did not improve after non-operative treatment. However, in some patients with irreparable rotator cuff tears, shoulder symptoms did not improve after non-operative treatment. These patients asked me to develop an effective shoulder surgery for their irreparable tears. Recently, anterior cruciate ligament reconstruction has become an accepted procedure all over the world[29,30]. Surgeons reconstruct the torn ligament, rather than repair it, because the poor quality of the torn ligament leads to a high failure rate after repair[31]. We can apply the same concept to rotator cuff tears. Even when rotator cuff repair has a high failure rate, or when the torn tendon cannot be repaired at all because it contains a large...
defect, the type of reconstructive shoulder surgery chosen needs to have consistently good clinical results. To develop a new type of reconstructive shoulder surgery, I focused on patch graft surgery. Since the 1970s, various grafts had been used for irreparable rotator cuff tears\[22,24,25,32-35\]. However, inconsistent clinical outcomes and high graft-tear rates (failure rates: 100% with allograft rotator cuff grafts\[33\], 100% with porcine dermal collagen grafts\[35\], and 91% with porcine small intestinal submucosa grafts\[34\]) had been reported. One reason for these poor outcomes was abrasion of the graft under the acromion because of a lack of superior stability.

The biggest question in developing a new strategy for reconstructive shoulder surgery was how to restore superior stability without rotator cuff repair in cases of irreparable tear. Superior shoulder capsule (Figure 3) lesions had been a neglected entity before I reported my SCR technique. From 2002 to 2003, I performed several shoulder biomechanical studies and dissected more than 100 human cadaveric shoulders. Therefore, although few textbooks had described the role of the superior shoulder capsule, I knew that the superior capsule was a shoulder stabilizer. After I developed my SCR technique, Nimura et al.\[36\] investigated the anatomy of the superior shoulder capsule. Their study showed that the insertion of the capsule covered 30% to 61% of the greater tuberosity, meaning that the capsule played an important role in the glenohumeral joint. Also, our biomechanical study showed that the superior shoulder capsule works as a superior stabilizer of the glenohumeral joint\[37\]. Furthermore, in 2004, I noticed that patients with irreparable rotator cuff tears always had irreparable defect of the superior shoulder capsule as well as the rotator cuff tendons, because the superior shoulder capsule is attached to the undersurface of these tendons. I therefore hypothesized that reconstruction of the superior shoulder capsule (Figure 4) might be useful for preventing superior migration of the humeral head and subacromial impingement in these irreparable rotator cuff tears. I also hypothesized that superior SCR would result in a high rate of healing of the graft, because the graft is attached to the bone. The reason for the high failure rate in rotator cuff reconstruction (i.e. conventional patch graft surgery) was attachment to the torn tendon, which was usually of poor quality and severely degenerated. To prove my hypothesis, we performed a cadaveric biomechanical study in 2005. This study showed that SCR completely restored superior stability of the glenohumeral joint, whereas patch grafting to the supraspinatus tendon (i.e., conventional patch graft surgery) only partially restored superior translation to the intact level\[38\]. We then started to perform arthroscopic SCR in patients with irreparable rotator cuff tears. The first arthroscopic SCR was performed in 2007 on a 60-year-old gardener. MRI revealed supraspinatus and infraspinatus tendon tears, with severe retraction and muscle atrophy. Non-operative treatment for 6 months had not been effective. In an effort to return to work, the patient elected to undergo the new arthroscopic SCR procedure using an autograft of fascia lata. Six months after arthroscopic SCR he returned to work with full active
shoulder range of motion.

2. Future direction of SCR
In recent years, irreparable rotator cuff tears of all types have been treated by SCR using autografts of fascia lata (SCR alone, arthroscopic rotator cuff repair with SCR, or total shoulder arthroplasty with SCR). Our clinical studies have shown that arthroscopic SCR using autografts of fascia lata restored superior glenohumeral stability (Figure 5) and improved shoulder function in patients with or without pseudoparalysis who had previously irreparable rotator cuff tears. However, various graft materials, which have different biomechanical characteristics, have been used around the world for SCR. Most of these materials have less strength and less stiffness than autografts of fascia lata. Our next aim is to develop a method of graft augmentation in SCR to reduce the graft tear rate, which is correlated with clinical outcome, and obtain consistently good functional improvement using any type of graft material.

References

21. Nasca RJ. The use of freeze-dried allografts in the


27. Farshad M, Gerber C. Reverse total shoulder arthroplasty—from the most to the least common complication. Int Orthop 2010;34:1075-1082.


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