Review Journal of Clinical Orthopaedics 2018 July-Dec;3(2):12-15

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

Teruhisa Mihata[1,2,3]

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 Othopaedic 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], partialrepair[9-11], transposition of the subscapularis tendon[12,13], transplantation of the teres major muscle[14], supraspinatus muscle advancement[15], deltoid flap reconstruction[16], latissimus dorsi transfer[17-19], pectoralis major transfer[20],grafting to the torn tendon[21-25], and reverse shoulderarthroplasty[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 with severe osteoarthritis, non-operative treatment could still improve shoulder function and decrease pain. 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

[1]Department of Orthopedic Surgery, Osaka Medical College, Takatsuki, Osaka, Japan
[2]Orthopaedic Biomechanics Laboratory, Congress Medical Foundation, Pasadena, California, USA
[3]Katsuragi Hospital, Kishiwada, Osaka, Japan

Address of Correspondence
Dr. TeruhisaMihata,
Department of Orthopedic Surgery, Osaka Medical College, 2-7 Daigaku-machi, Takatsuki, Osaka 569-8686, Japan
Email: tmihata@yahoo.co.jp, tmihata@osaka-med.ac.jp

Figure 1: Members of Orthopaedic Biomechanics Laboratory in 2002.
Front (from the left): Michelle H McGarry, Synthia Hernandez, Professor Thay Q Lee,
Back (from the left): William McGarry, YeonSoo Lee, TeruhisaMihata, Kevin Armstrong,

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 grafts34) had been reported. One reason for these poor outcomes was abrasion of the graft under the acromion because of a lack of superior stability.

Figure 2: Professor Frank W Jobe and Teruhisa Mihata at the Kerlan-Jobe Orthopaedic Clinic in 2003.

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 capsulewas 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 covered30% 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 SCRwould 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

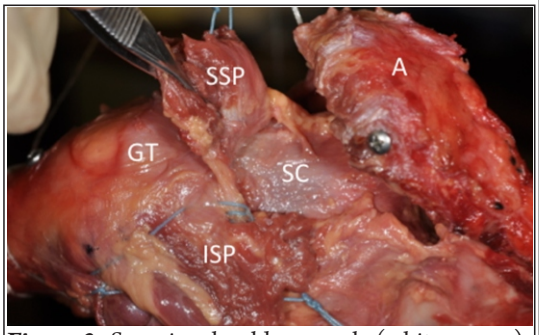

Figure 3: Superior shoulder capsule (white arrows). Acromion and rotator cuff tendons were resected.

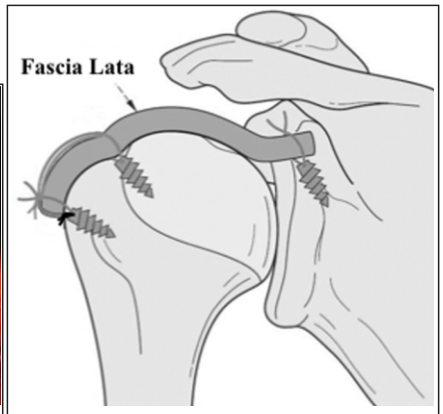

Figure 4: Superior shoulder capsule reconstruction.

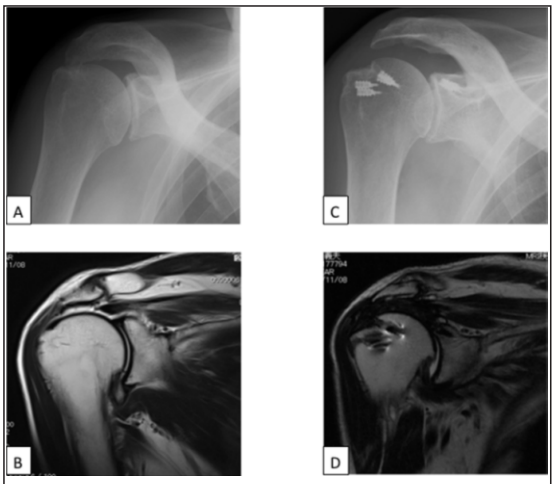

Figure 5: Plain X-ray and MRI findings before and after superior capsule reconstruction. (A, B) Before surgery. Humeral head was migrated superiorly (Hamada grade 2). The torn supraspinatus tendon was severely retracted, and the supraspinatus muscle is severely atrophied and infiltrated with fat. (C, D) Seven years after surgery. Acromio-humeral distance was increased compared with before surgery. The SCR graft was healed with sufficient thickness.

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

1. Bedi A, Dines J, Warren RF, Dines DM. Massive tears of the rotator cuff. J Bone Joint Surg Am 2010;92:1894-1908.
2. Oh JH, Kim SH, Kang JY, Oh CH, Gong HS. Effect of age on functional and structural outcome after rotator cuff repair. Am J Sports Med 2010;38:672-678.
3. Goutallier D, Postel JM, Bernageau J, Lavau L, Voisin MC. Fatty muscle degeneration in cuff ruptures. Pre- and postoperative evaluation by CT scan. Clin Orthop Relat Res 1994;78-83.
4. Melis B, Wall B, Walch G. Natural history of infraspinatus fatty infiltration in rotator cuff tears. J Shoulder Elbow Surg 2010;19:757-763.
5. Melis B, Nemoz C, Walch G. Muscle fatty infiltration in rotator cuff tears: descriptive analysis of 1688 cases. Orthop Traumatol Surg Res 2009;95:319-324.
6. Oh JH, Kim SH, Choi JA, Kim Y, Oh CH. Reliability of the grading system for fatty degeneration of rotator cuff muscles. Clin Orthop Relat Res 2010;468:1558-1564.
7. Burkhart SS. Arthroscopic debridement and decompression for selected rotator cuff tears. Clinical results, pathomechanics, and patient selection based on biomechanical parameters. Orthop Clin North Am 1993;24:111-123.
8. Rockwood CA, Jr., Williams GR, Jr., Burkhead WZ, Jr. Debridement of degenerative, irreparable lesions of the rotator cuff. J Bone Joint Surg Am 1995;77:857-866.
9. Burkhart SS. Fluoroscopic comparison of kinematic patterns in massive rotator cuff tears. A suspension bridge model. Clin Orthop Relat Res 1992;144-152.
10. Burkhart SS, Nottage WM, Ogilvie-Harris DJ, Kohn HS, Pachelli A. Partial repair of irreparable rotator cuff tears. Arthroscopy 1994;10:363-370.
11. Duralde XA, Bair B. Massive rotator cuff tears: the result of partial rotator cuff repair. J Shoulder Elbow Surg 2005;14:121-127.
12. Cofield RH. Subscapular muscle transposition for repair of chronic rotator cuff tears. Surg Gynecol Obstet 1982;154:667-672.
13. Karas SE, Giachello TL. Subscapularis transfer for reconstruction of massive tears of the rotator cuff. J Bone Joint Surg Am 1996;78:239-245.
14. Celli L, Rovesta C, Marongiu MC, Manzieri S. Transplantation of teres major muscle for infraspinatus muscle in irreparable rotator cuff tears. J Shoulder Elbow Surg 1998;7:485-490.
15. Debeyre J, Patie D, Elmelik E. Repair of Ruptures of the Rotator Cuff of the Shoulder. J Bone Joint Surg Br 1965;47:36-42.
16. Dierickx C, Vanhoof H. Massive rotator cuff tears treated by a deltoid muscular inlay flap. Acta Orthop Belg 1994;60:94-100.
17. Gerber C. Latissimus dorsi transfer for the treatment of irreparable tears of the rotator cuff. Clin Orthop Relat Res 1992;152-160.
18. Warner JJ, Parsons IMt. Latissimus dorsi tendon transfer: a comparative analysis of primary and salvage reconstruction of massive, irreparable rotator cuff tears. J Shoulder Elbow Surg 2001;10:514-521.
19. Gerber C, Maquieira G, Espinosa N. Latissimus dorsi transfer for the treatment of irreparable rotator cuff tears. J Bone Joint Surg Am 2006;88:113-120.
20. Jost B, Puskas GJ, Lustenberger A, Gerber C. Outcome of pectoralis major transfer for the treatment of irreparable subscapularis tears. J Bone Joint Surg Am 2003;85-A:1944-1951.
21. Nasca RJ. The use of freeze-dried allografts in the

management of global rotator cuff tears. Clin Orthop Relat Res 1988;218-226.

22. Neviaser JS, Neviaser RJ, Neviaser TJ. The repair of chronic massive ruptures of the rotator cuff of the shoulder by use of a freeze-dried rotator cuff. J Bone Joint Surg Am 1978;60:681-684.
23. Heikel HV. Rupture of the rotator cuff of the shoulder. Experiences of surgical treatment. Acta Orthop Scand 1968;39:477-492.
24. Ozaki J, Fujimoto S, Masuhara K, Tamai S, Yoshimoto S. Reconstruction of chronic massive rotator cuff tears with synthetic materials. Clin Orthop Relat Res 1986;173-183.
25. Post M. Rotator cuff repair with carbon filament. A preliminary report of five cases. Clin Orthop Relat Res 1985;154-158.
26. Klein SM, Dunning P, Mulieri P, Pupello D, Downes K, Frankle MA. Effects of acquired glenoid bone defects on surgical technique and clinical outcomes in reverse shoulder arthroplasty. J Bone Joint Surg Am 2010;92:1144-1154.
27. Farshad M, Gerber C. Reverse total shoulder arthroplasty-from the most to the least common complication. Int Orthop 2010;34:1075-1082.
28. Simovitch RW, Zumstein MA, Lohri E, Helmy N, Gerber C. Predictors of scapular notching in patients managed with the Delta III reverse total shoulder replacement. J Bone Joint Surg Am 2007;89:588-600.
29. Tan SHS, Huh LBP, Krishna L. Outcomes of Anterior Cruciate Ligament Reconstruction in Females Using Patellar-Tendon-Bone versus Hamstring Autografts: A Systematic Review and Meta-Analysis. J Knee Surg 2018.
30. Chin BZ, Wee IJY, Syn NL, Krishna L. Arthroscopic Anterior Cruciate Ligament Reconstruction: A Meta-Analysis Comparing Semitendinosus Alone and Semitendinosus with Gracilis Tendon Autografts. J Knee Surg 2018.
31. Osti M, El Attal R, Doskar W, Hock P, Smekal V. High complication rate following dynamic intraligamentary stabilization for primary repair of the anterior cruciate ligament. Knee Surg Sports Traumatol Arthrosc 2018.
32. Neviaser RJ. Tears of the rotator cuff. Orthop Clin North Am 1980;11:295-306.
33. Moore DR, Cain EL, Schwartz ML, Clancy WG, Jr. Allograft reconstruction for massive, irreparable rotator cuff tears. Am J Sports Med 2006;34:392-396.
34. Sclamberg SG, Tibone JE, Itamura JM, Kasraeian S. Six-month magnetic resonance imaging follow-up of large and massive rotator cuff repairs reinforced with porcine small intestinal submucosa. J Shoulder Elbow Surg 2004;13:538-541.
35. Soler JA, Gidwani S, Curtis MJ. Early complications from the use of porcine dermal collagen implants (Permacol) as bridging constructs in the repair of massive rotator cuff tears. A report of 4 cases. Acta Orthop Belg 2007;73:432-436.
36. Nimura A, Kato A, Yamaguchi K, et al. The superior capsule of the shoulder joint complements the insertion of the rotator cuff. J Shoulder Elbow Surg 2012;21:867-872.
37. Ishihara Y, Mihata T, Tamboli M, et al. Role of the superior shoulder capsule in passive stability of the glenohumeral joint. J Shoulder Elbow Surg 2014;23:642-648.
38. Mihata T, McGarry MH, Pirolo JM, Kinoshita M, Lee TQ. Superior capsule reconstruction to restore superior stability in irreparable rotator cuff tears: a biomechanical cadaveric study. Am J Sports Med 2012;40:2248-2255.

Conflict of Interest: NIL
Source of Support: NIL

How to Cite this Article

Mihata T. History and Future Direction of Superior Capsule Reconstruction for Irreparable Rotator Cuff Tears. Journal of Clinical Orthopaedics July-Dec 2018; 3(2):12-15