Background: Restoration of the original anatomical bone-to-tendon interface (BTI) after rotator cuff repair (RCR) remains a significant challenge, therefore a multitude of biocompatible biomaterials has been investigated to promote rotator cuff healing after repair. Purpose: To investigate the efficacy of 3D-printed scaffolds incorporated with spatiotemporal delivery of growth factors (GF) to accelerate BTI healing after RCR. Methods: Advanced 3D printing was used to fabricate the multilayered scaffolds, spatially embedded with different GFs to guide regional differentiation of endogenous stem/progenitor cells. A sustained, spatially controlled release of GFs was confirmed. The multi-lineage differentiation potential of mesenchymal stem cells (MSCs) in the scaffold was assayed. In vivo, a total of 50 rabbits, with induced chronic rotator cuff injuries, were divided into 4 groups: Normal (N, n = 2), saline control (C, n = 16), scaffold without GF (B, n = 16), and scaffold with GF (C, n = 16). At 6 weeks after the creation of rotator cuff tears, surgical repairs were performed when scaffolds were implanted between the bony footprint and supraspinatus tendon. RT-qPCR analysis was performed at 4 weeks after the repair, and biomechanical and micro-CT analyses were performed at 12 weeks after repair. Results: In vitro, the scaffolds successfully guided regional differentiation of MSCs, forming multilayered tissues with tendon, cartilage and bone-like regions. In vivo, group C showed higher collagen type Ia1, collagen type IIIa1, and aggrecan expressions than the other groups (P < 0.001, 0.005 and 0.006, respectively) at 4 weeks after repair. For the biomechanical evaluation, group C showed a significantly higher load-to-failure rate than the other groups (P = 0.003) at 12 weeks after repair. For the micro-CT analysis, group C showed higher bone mineral density and bone volume/total volume rate than the other groups (P = 0.001 and < 0.001, respectively) at 12 weeks after repair. Conclusion: This new bioactive spatially-embedded growth factor (SEGF) Scaffold effectively accelerated BTI healing in chronic rotator cuff tear model of rabbits.

Category: Shoulder - Rotator Cuff

Postoperative Graft Integrity Affects Clinical Outcomes After Superior Capsule Reconstruction Using Fascia Lata Autograft in Posterior-Superior Rotator Cuff Tears: A Multicenter Study

Abstract ID#: 23082
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Summary:
Postoperative graft thickness and size of graft tear affected clinical and radiographic outcomes after superior capsule reconstruction using a fascia lata autograft. Shoulders with intact grafts of sufficient thickness restored glenohumeral stability and showed better clinical outcomes compared to those with graft thinning or graft tears.

Data:
Background: Previous studies have postulated that graft thickness and graft healing may be important factors for optimizing clinical outcomes of superior capsule reconstruction (SCR) for patients with irreparable rotator cuff tears (RCTs). However, the relationship between postoperative graft integrity and clinical outcomes after SCR remains unclear. We aimed to assess the relationship between postoperative graft integrity, including graft thickness and size of graft tear, and clinical outcomes after SCR in patients with irreparable RCTs.

Methods: This retrospective multicenter study included 188 patients (86 women, 102 men; mean age, 69.2 years; range, 49–87 years) with irreparable RCTs who underwent arthroscopic SCR using fascia lata autografts. Postoperative graft integrity was evaluated using magnetic resonance imaging (MRI) at 1 year or later after surgery and was classified into four categories according to Hasegawa's classification: type I-II, intact graft of sufficient thickness; type III, thinned graft without discontinuity; type IV, presence of a minor discontinuity; and type V, presence of a major discontinuity. We compared (1) baseline characteristics, (2) visual analog scale (VAS) for pain, (3) American Shoulder and Elbow Surgeons (ASES) score, (4) active shoulder range of motion (ROM), and (5) acromiohumeral distance (AHD) among four groups based on postoperative graft integrity. Results: MRI scans revealed 152 shoulders (80.9%) with type I-II graft, 13 (6.9%) with type III graft, 13 (6.9%) with type IV graft, and 10 (5.3%) with type V graft. VAS and ASES scores significantly improved after SCR in all graft types (all P < 0.05). However, shoulders with type V grafts had significantly inferior postoperative VAS and ASES scores compared to those with type I-II grafts (all P < 0.05). Shoulders without graft tears (types I-II and III) showed significant improvements in shoulder ROM after SCR (all P < 0.05). In contrast, shoulders with large graft tears (types V) showed no significant improvement in shoulder ROM. Postoperative AHD was significantly increased only in shoulders with type I-II grafts (both P < 0.0001). Conclusion: Postoperative graft thickness and size of graft tear affected clinical and radiographic outcomes after SCR using a fascia lata autograft. Patients with large graft tears had significantly inferior postoperative clinical scores compared to those with intact grafts of sufficient thickness although arthroscopic SCR provided pain relief even in patients with graft tears. Shoulders with intact grafts of sufficient thickness restored gleno-humeral stability and showed better clinical outcomes compared to those with graft thinning or graft tears.

Category: Shoulder - Rotator Cuff

A Comparative Study of Patch Graft Procedure and Superior Capsular Reconstruction in the Treatment of Irreparable Large to Massive Rotator Cuff Tears

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Summary:
In treatment of massive rotator cuff tears with high-grade fatty degeneration of the infraspinatus, superior capsular reconstruction might not be superior to patch procedure for graft integrity.

Data:
Purpose: This study compared clinical and radiographic outcomes after superior capsular reconstruction (SCR) and fascia lata autograft patch procedure (PG) in treatment of large to massive rotator cuff tears (RCTs). Methods: This study included 42 shoulders in 42 patients who underwent the patch graft procedure (Group PG) and 42 patients who underwent SCR (Group SCR) for irreparable large or massive RCTs. Clinical assessments were assessed using Constant score ASES Scores. We used magnetic resonance imaging (MRI) evaluation especially focusing on the patch integrity or retears of the native cuff tendons (the infraspinatus and/or subscapularis tendons). The repair integrity was classified as intact or nonintact based on the appearance of the native cuff, the tendon-graft interface, and the graft at the anatomic footprint on the humeral head. Intact repairs showed no high signal intensity areas in the native cuff, the tendon-graft interface, or the graft-humeral interface. In addition, we assessed the presence of Sugaya 5 retear (a major discontinuity in each MRI image). Results: There were no significant differences in any variables between the 2 groups except for follow-up period, mediolateral tear size, anterior to posterior tear size, biceps tenodesis (0), preoperative supraspinatus Goutallier stage 3 or 4 (%), preoperative subscapularis Goutallier stage 3 or 4 (%). Postoperative MRI showed that 13 of 42 (31.0 %) shoulders had intact repairs in PG group and 27 of 42 (64.3 %) shoulders had intact repairs in SCR group (P = 0.004). In addition, Postoperative MRI showed that 19 of 42 (45.2 %) shoulders had shoulders with Sugaya 5 retear in PG group and 9 of 42 (21.4 %) shoulders had shoulders with Sugaya 5 retear in SCR group (P = 0.002). Compared with preoperative scores, the mean Constant, ASES scores were significantly improved at the final follow-up in both groups (P < .001 in the two groups. At the final follow-up, the mean Constant and ASES scores were higher in group SCR than in group PG without significance (71.8 vs 70.0; P = .474 for the Constant score, 84.4 vs 79.1; P = .118 for the ASES score). Stepwise multivariate logistic regression analysis identified the treatment group (PG vs SCR) and GFDI as the significant predictive factors for shoulders without intact repairs (odds ratio, 3.323; 95% CI, 1.271-8.691; P = .014 for the treatment group, odds ratio, 3.753; 95% CI, 1.374-10.253; P = .010 for GFDI, respectively). In addition, the analysis identified the presence of preoperative ISP Stage 3 or 4 and SSP stage 3 or 4 as the significant predictive factors for shoulders with Sugaya 5 retears (odds ratio, 6.791; 95% CI, 2.345-19.662; P < .001 for the ISP Stage 3 or 4, odds ratio, 5.681; 95% CI, 1.109-29.090; P = .037 for the SSP Stage 157
forming SCR or patch procedure, thought the two scores were signifi-
cerative ISP stage 3 or 4 may be risky for occurrence of large retear after per-
3 or 4, respectively). Conclusions Operative treatment of shoulders with preop-
erative ISP stage 3 or 4 may be risky for occurrence of large retear after per-
form SCR or patch procedure, thought the two scores were significantly
improved at the final follow-up in the two groups.

Category: Shoulder - Rotator Cuff

Analysis of Cellu lar Senescence in Hu man Arthroscopic Rotator Cuff Repairs

Abstract ID# 21603

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Summary:
Senescent cells accumulate in aging rotator tears and may contribute to and may impair the healing potential of the rotator cuff with advancing age.

Data:
Purpose: To quantify cellular senescence in supraspinatus tendon and sub-
cromial bursa of humans with rotator cuff tears. To investigate the in vitro ef-
cicacy of Dasatinib+Quercetin (D+Q) to eliminate senescent cells and alter markers of tenogenic differentiation. Methods: Tendon and bursa were harvested from patients undergoing arthroscopic rotator cuff tears. In part 1, cellular senescence was quantified utilizing immunohistochemistry and gene expression for senescent cell markers (p16 & p21) and the senescence-associated secretory phenotype (SASP) (IL-6, IL-8, MMP-3, MCP-1). Multiple markers were used due to a lack of specific markers for senescent cells. The amount of senescence was compared between patients <60 and ≥60 years old. In part 2, an in vitro culture model of rotator cuff tears was treated with D+Q or control. The ability of D+Q to kill senescent cells and alter markers of tenogenic differentiation was assessed by gene expression. Results: Part 1 demonstrated an age-dependent significant increase in the relative expression of p21, IL-6, and IL-8 in tendon, and p21, p16, IL-6, IL-8, and MMP-3 in bursa (p<.05). A significant increase was seen in immunohistochemical staining of bursa p21 (p=.028). Part 2 demonstrated that D+Q significantly decreased senescent markers in tendon (p21, IL-6, IL-8, and IL-8) and bursa (p21 and IL-8) (p<.05). ELISA analysis demonstrated decreased release of the SASP (IL-6, MMP-3, MCP-1; p=.002, p=.024, p=.001, respectively). Both tendon (p=.022) and bursa (p=.027) treated with D+Q significantly increased the expression of type I collagen. Conclusions: While there was an age-dependent increase in markers of cellular senescence, this relationship was not consistently seen across all markers and tissues. D+Q demonstrated moderate efficacy in decreasing senescence in these tissues and increasing type I collagen expression.

Clinical Relevance: Cellular senescence contributes to diseases of aging and may impair the healing potential of the rotator cuff with advancing age.

Category: Shoulder - Rotator Cuff

A Biomechanical Evaluation of the Efficacy Of Suture Tape Augmentation for Subscapularis Tear Repair

Abstract ID# 21348

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Summary:
Augmentation of subscapularis peel with two inverted mattress suture tapes significantly increases the strength of the repair.

Data:
Background: Repair of the subscapularis tendon following anatomic total shoulder arthroplasty (aTSA) is important to restore the function of the shoulder. Failure of a subscapularis repair construct can result in difficulty with internal rotation and an increased likelihood of dislocation. While suture tape has been demonstrated to be an efficacious augment for tendonous repairs elsewhere in the body, it has not been investigated as a technique for augmenting sub-
scapularis peel repairs. The purpose of this study is to determine the biome-
chanical efficacy of suture tape augmentation for the repair of a subscapularis peel. Methods: Twelve human cadaveric shoulders underwent a subscapularis peel. Specimens were randomly split into two groups: one which underwent repair using three Mason-Allen sutures (control) and one which underwent the control repair with augmentation using two suture tapes placed in an inverted mattress fashion and secured to the proximal humerus using a suture anchor (augment). Shoulders underwent biomechanical testing to compare repair displacement with cyclic loading, load at ultimate failure, and construct stiffness. Results: There were no significant differences in displacement across cyclic loading between the two repair groups at the superior (p=.87), middle (p=.47), or inferior (p=.77) portions of the subscapularis tendon. Load to failure was significantly greater in the augment group (585.1N ± 81.8) than in the control group (558.5N ± 97.4; p=.001). Stiffness was also greater in the augment group (71.8N/mm ± 13.7) when compared with the control group (48.7N/mm ± 5.7; p=.003). Conclusions: Subscapularis peel repair with augmentation via two inverted mattress suture tapes secured with an anchor in the proximal humerus conferred significantly greater load at ultimate failure and construct stiffness when compared to a traditional repair using three Mason-Allen sutures.

Category: Shoulder - Rotator Cuff

Bridging Reconstruction For Large-To-Massive Rotator Cuff Tears Has A Low Rate Of Cuff Arthropathy Progression At A Minimum Five-Year Follow-Up

Abstract ID# 22515

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Summary:
At a minimum 5-year with a mean follow-up of 7.3 years, bridging reconstruction showed 98% survivorship rate with a low rate of conversion to rTSA and a low progression of cuff.

Data:
Background: Rotator cuff tears cause pain, muscle weakness, and difficulty with overhead activity. While smaller tears are easier to repair, large-to-massive cuff tears (>3 cm in size) are considered irreparable. For patients with large-to-
massive cuff tears, surgical options include maximal repair, superior capsular reconstruction, bridging reconstruction, tendon transfers and reverse total shoulder arthroplasty (rTSA). Bridging reconstruction was developed to improve outcomes and to avoid the morbidity associated with other technique. Bridging reconstruction, also known as graft interposition, has been shown to have superior outcomes as compared to maximal repair with better patient-reported outcomes at two-years post-operatively as recently demonstrated in a randomized controlled trial. These positive results are maintained at five years, however the midterm changes in progression of rotator cuff arthropathy and conversion to rTSA have not been assessed. Purpose: To assess the progression of rotator cuff arthropathy in bridging reconstruction patients at a five-year follow-up. Methods: Forty-four patients who underwent bridging reconstruction between 2012 and 2017 for large-to-massive rotator cuff tears were included. All patients had a minimum five-year follow-up. Data collected included de-

mographics, pre- and post-operative Western Ontario Rotator Cuff (WORC) Index, conversion to rTSA, and X-ray readings (including acromiohumeral di-

stance (as measured on anterior-posterior pre/post-operative radiographs) and Hamada grades for rotator cuff arthropathy). Furthermore, a sub-group analysis was performed on post-operative MRIs for graft status. Results: The mean age at