Paper 04

Title:
Five-year Follow-up of Arthroscopic Superior Capsule Reconstruction for Irreparable Rotator Cuff Tears

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Objectives: For irreparable rotator cuff tears, we developed a new surgical treatment—arthroscopic superior capsule reconstruction (SCR)—to restore superior shoulder stability, muscle balance, and shoulder function. The objective of this study was to assess (1) changes in functional outcome; (2) changes in graft thickness; (3) rates of graft tear; and (4) rates of glenohumeral osteoarthritis during a 5-year follow-up period.

Methods: From 2007 to 2013, arthroscopic SCR using autograft of fascia lata was performed on 37 shoulders with irreparable rotator cuff tears. Seven patients were lost to follow-up. Consequently, 30 shoulders (mean age, 68.0 years) were enrolled in the study. Shoulder range of motion (ROM), American Shoulder and Elbow Surgeons (ASES) and Japanese Orthopaedic Association (JOA) scores, acromiohumeral distance (AHD), Hamada grade, and Goutallier grade were compared among before surgery, 1 year after SCR, and 5 years after SCR. Graft thickness, which was measured in MRI, was compared among 3 months, 1 year, and 5 years after SCR. One-way analysis of variance followed by Fisher's LSD post-hoc test was performed for statistical analysis. In addition, rates of return to sport or work were investigated in those patients who had been employed (12 patients: 5 carpenters, 5 farmers, and 2 construction workers) or played sports (8 patients: 2 table tennis, 1 golf, 1 martial arts, 1 yoga, 1 badminton, 1 mountain-climbing, and 1 ground golf) before injury.

Results: Both ASES and JOA scores after arthroscopic SCR improved significantly at both 1 year (P < 0.001) and 5 years after SCR (P < 0.001). ASES score at 5 years after SCR was significantly better than that at 1 year after SCR (P = 0.02). Postoperative ASES scores at both 1 year and 5 years after SCR were better in healed patients (27 patients) than in unhealed patients suffering from graft tear (3 patients). Active elevation was significantly improved at both 1 year and 5 years after SCR (P < 0.001). At five years after SCR, 11 patients were still working and one patient, who had returned to part-time work at 1 year, had retired. All 8 patients were still playing sport before their injuries at 5 years after SCR. AHD was increased significantly at both 1 and 5 years after SCR (P < 0.001). There was no significant difference in AHD between 1 and 5 years after SCR (P = 0.16). In the 27 patients in whom the graft remained intact, graft thickness did not differ significantly among 3 months, 1 year, and 5 years after SCR (P = 0.67). Hamada grade was significantly improved at both 1 and 5 years after SCR (preoperative: 2.3 ± 0.8; 1 year: 1.3 ± 0.7; 5 years: 1.3 ± 0.7, P < 0.001). All patients who had graft healing had no progression of glenohumeral osteoarthritis during the 5-year follow-up period. Two of the 3 patients with graft tear were suffering severe glenohumeral osteoarthritis (with narrowing of the glenohumeral joint space) at 5 years after SCR. The Goutallier grade did not change significantly after SCR in any patients.

Conclusion: In a 5-year follow-up study, arthroscopic SCR restored shoulder function and resulted in high rates of return to recreational sport and work. Shoulder function and ROM were likely to get better with time. Graft tear exacerbated the clinical outcome after SCR and caused glenohumeral osteoarthritis in 2 of 3 patients by 5 years after SCR. Graft thickness and postoperative AHD did not change significantly between 1 and 5 years of follow-up, suggesting that we can expect excellent functional outcomes with long-term follow-up.

Clinical outcome before and after arthroscopic SCR

	Before surgery	3 months after SCR	1 year after SCR	5 years after SCR
ASES score (points)	29.0 ± 20.0	-	83.0 ± 16.0	92.3 ± 10.3
Active elevation (°)	85 ± 54	-	138 ± 38	151 ± 32
AHD (mm)	3.4 ± 2.2	-	9.1 ± 2.6	8.1 ± 3.2
Graft thickness (mm)	-	7.5 ± 2.0	7.9 ± 2.1	7.8 ± 1.8

Paper 05

Title:
The Associations of Early Sport Specialization and Training Volume with Injury Rates in NCAA Division I Athletes

Authors:
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Objectives: Sixty million United States youth ages 6-18 participate in organized athletics, with large increases in both sport participation and specialization in the past two decades. This study seeks to determine whether early specialization in a single sport and high training volume is associated with an increased risk of injury and surgery in NCAA Division I athletes. A secondary aim is to assess whether sport specialization and high training volume is associated with elite athletic status (i.e. being recruited and/or receiving athletic scholarships).

Methods: All NCAA Division I athletes at a single institution were sent a voluntary survey by email. Athletes were surveyed regarding demographics, scholarship status, reasons for sport specialization, age of specialization, training volume, and injury/surgical history. A total of 232 out of 652 athletes completed some portion of the survey. 30 surveys were excluded due to incomplete or incorrect survey completion, leaving 202 surveys available for analysis. Injuries were defined as those which precluded sport participation for > 1 week. Early sport specialization was defined as narrowing participation to one primary sport prior to age 14. High training volume was defined as greater than 28 hours per week during pre-high school years. Exclusion criteria included incomplete surveys and individuals less than age 18. Chi-square, Fisher's Exact, and Mann-Whitney U tests were performed to establish significant differences.

Results: Individuals who specialized in their varsity sport prior to age 14 were more likely to report a history of injury (86.9 vs. 74.0%, X = 4.7, p = .03), multiple injuries (64.6 vs. 49.4%, X = 4.2, p = .04), multiple college injuries (17.2 vs. 6.5%, X = 4.5, p = .03), total injuries (2 vs. 1, U = 3035, p = .02), and total time out for injury (15.2 vs. 7.0 weeks, U = 3150, p = .05). Early specializers were more likely to be recruited (92.9 vs. 83.1%, X = 4.1, p = .04) and receive a scholarship in their varsity sport (82.8 vs. 67.5%, X = 5.6, p =.02).

Full scholarship athletes were more likely to report multiple surgical injuries (11.7 vs. 3.5%, X = 5.0, p =.03). Those with a scholarships greater than 50% were more likely to report a surgical injury (34.1 vs. 18.3%, X = 6.5, p = .01).

Individuals who trained for greater than 28 hours per week in their varsity sport prior to high school were more likely to report multiple injuries (90.0 vs. 56.7%, X = 4.3, p = .04) multiple college injuries (40.0% vs. 14.0%, p = .05), a surgical injury (60.0 vs. 21.7%, p = .01), multiple surgical injuries (30.0 vs. 4.5%, p = .02), and greater total time out for injury (36.5 vs. 11.0 weeks, U = 424, p = .02). Individuals with a pre-high school training volume greater than 28 hours/week in their varsity sport were not more likely to be recruited (90.0 vs. 89.8%, p = 1.0) or receive a scholarship (80.0 vs. 74.5%, p = 1.0).
Those in non-contact varsity sports were more likely to report multiple college injuries than those in limited and full contact sports, respectively (20.4 vs. 6.4 vs. 8.8%, X = 7.0, p = .03). Those in individual sports were more likely to report a college injury (55.3 vs. 38.9%, X = 5.1, p = .02) and multiple college injuries (25.0 vs. 7.1%, X = 12.7, p &lt .001).

Conclusion: NCAA Division I athletes who specialized in their varsity sport prior to age 14 were more likely to be recruited and receive an athletic scholarship. However, these individuals, as well as those with high training volume prior to high school, had increased rates of injury and injuries requiring surgery.

Paper 06

Title:
Blood Flow Restriction Therapy Preserves Whole Limb Bone and Muscle Following ACL Reconstruction

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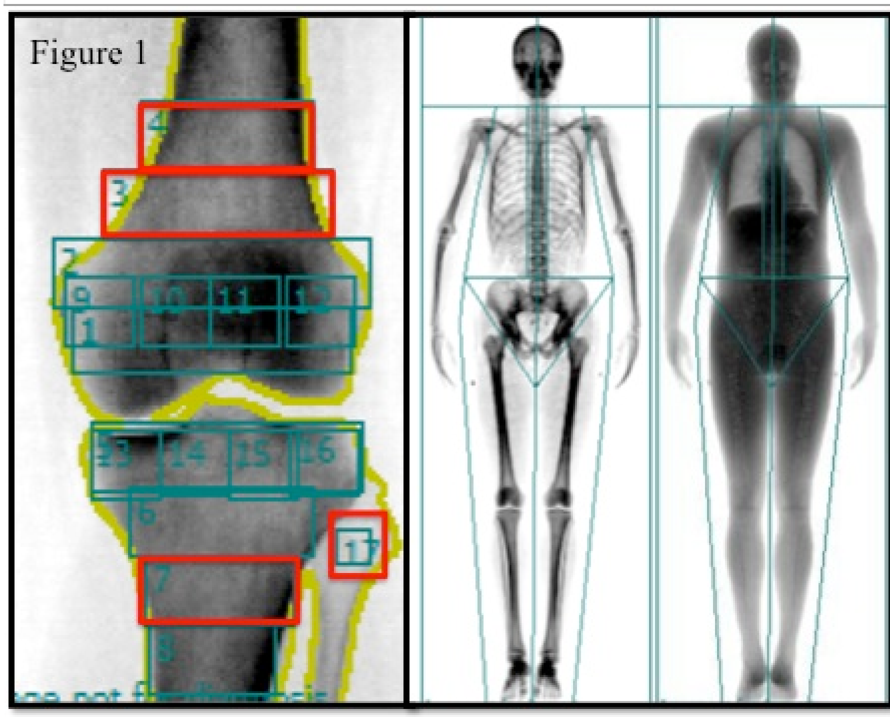
Objectives: Patients often experience atrophy and bone loss immediately following anterior cruciate ligament (ACL) reconstruction. Rehabilitation (rehab) combined with blood flow restriction (BFR) therapy have been shown to mitigate muscle atrophy and reduce timelines for earlier return to function. Little is known about how BFR may impact bone loss. The objectives this study were to determine if BFR provides additional benefits when added to standard rehab in young active patients following ACL reconstruction with regards to preserving bone, recovering muscle, and regaining physical function.

Methods: Fourteen active young adults (M=8, F=6; 23±7yr; 170±10cm, 75±14kg) undergoing ACL repair via patellar tendon autograft were recruited, provided informed consent, and were randomized into two groups (CONTROL, n=7 & BFR, n=7) who performed 12wks of rehab beginning at 10 days post-surgery (2/wk). Both groups performed the same rehab protocol. However, during select exercises [quadriceps contractions wks1-3, bilateral leg press wk3-12, eccentric leg press wk4-12, hamstring curl wk4-6, eccentric hamstring curl wk7-12.], the BFR group exercised with 80% arterial limb occlusion using an automated tourniquet around the proximal thigh outfitted with Doppler (Delfi®). Exercise resistance was set at 20% of predicted 1-repetition maximum assessed in the contralateral limb. Exercises were performed for 4 sets of 30-15-15-15 repetitions separated by 30s of rest. Functional assessments were performed at wk8 and wk12 post-surgery. Bone mineral density (BMD), bone mass, and lean muscle mass (LM) were measured using DEXA (Figure 1, GE®) at pre-surgery as well as wk6 and wk12 of rehab. Statistical Analysis: A 2(group) x 3(time) ANCOVA (co-varied on pre-surgery measures) was used to detect and compare changes in muscle and bone measures from pre-surgery at wk6 and wk12. A 2(group) x 2(time) ANOVA was used to detect and compare changes in functional outcomes tested at wk8 and wk12 between groups. Significant interactions were followed with a Tukey's post hoc test for pairwise comparisons. Type I error was set at $\alpha=0.05$.

Results: Results are shown in Table 1. Both groups experienced similar decreases from pre-surgery measures in total LM at wk6 ($p<0.05$) with total lean mass in only the CONTROL group remaining diminished at wk12 ($p<0.05$). Whole leg LM in the injured limb was decreased in the CONTROL group, but not the BFR group, at both wk6 and wk12 ($p<0.05$). Thigh LM was found to be decreased in both groups at wk6 but to a greater extent in the CONTROL compared to the BFR group and remained decreased in only the CONTROL group at wk12. Whole leg bone mass was decreased in the control group at wk6 and in both groups wk12 ($p<0.05$). The CONTROL group was observed to have a decrease in BMD at the distal femur and proximal tibia as wk12 as well as the proximal fibula at wk6 and wk12 ($p<0.05$). Both groups demonstrated similar improvements in single leg squat distance, Y-balance, leg curl, and leg press from wk8 to wk12 of rehab ($p<0.05$). (Completed Data, N=32 anticipated by time of conference).

Values = Means +/- SEM (Change from Pre-Surgery). Sig: #=diff from pre-surgery, $=diff between group

GROUP:	**BFR**		**CONTROL**	
Independent Variable	**wk6**	**wk12**	**wk6**	**wk12**
Total Lean Mass (kg)	-1.07 ± 0.60 (-1.94 ± 1.22%) #	-0.01 ± 0.87 (-0.06 ± 1.77%)	-1.31 ± 0.80 (-2.39 ± 1.32%) #	-1.14 ± 0.59 (-2.23 ± 0.98%) #
Leg Lean Mass (kg)	-0.19 ± 0.09 (-2.31 ± 1.19%)	-0.11 ± 0.17 (-1.53 ± 1.65%)	-0.72 ± 0.31 (-7.69 ± 3.03%) #	-0.48 ± 0.21 (-5.5 ± 2.29%) #
Thigh Lean Mass (kg)	-0.13 ± 0.03 (-4.45± 1.31%) #	-0.03 ± 0.05 (-1.26 ± 1.72%)	-0.26 ± 0.10 (-7.72 ± 2.57%) #	-0.16 ± 0.05 (-5.21 ± 1.62%) #$
Leg Bone Mass (g)	-8.05 ± 3.40 (-1.29 ± 0.56%)	-11.97 ± 4.39 (-1.92 ± 0.72%) #	-13.40 ± 3.29 (-2.43 ± 0.52%) #	-16.26 ± 3.03 (-3.01 ± 0.52%) #
Distal Femur BMD (g/cm^2)	-0.06 ± 0.03 (-4.55 ± 2.22%)	-0.09 ± 0.03 (-7.41 ± 2.54%)	-0.09 ± 0.03 (-7.83 ± 1.95%)	-0.12 ± 0.02 (-10.35 ± 1.78%) #
Proximal Tibia BMD (g/cm^2)	-0.05 ± 0.02 (-3.55 ± 1.14%)	-0.03 ± 0.05 (-1.68 ± 3.61%)	-0.06 ± 0.07 (-3.42 ± 4.90%)	-0.15 ± 0.02 (-10.35 ± 1.57%) #$
Proximal Fibula BMD (g/cm^2)	-0.02 ± 0.02 (-4.35 ± 4.05%)	+0.01 ± 0.02 (+1.66 ± 5.81%)	-0.07 ± 0.03 (-13.49 ± 5.47%) #$	-0.08 ± 0.02 (-15.9% ± 3.14%) #$



Conclusion: In addition to recovering muscle to a greater extent than standard rehab alone, the addition of BFR to ACL rehab exercises appears to have a protective effect on bone. This effect also appears to not be limited to the site of cuff compression. Future studies are needed to examine the biochemical and mechanical mechanisms by which BFR may simultaneously act on bone and muscle.