

Paper 103

Title:

Current Return to Sport Criteria after ACL Reconstruction Fail to Identify Increased Risk of Second ACL Injury in Young Athletes

Authors:

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Objectives: The incidence of 2nd anterior cruciate ligament (ACL) injury after ACL reconstruction (ACLR) and return to sport (RTS) ranges from 25%-33% in young, active populations; with the greatest risk in the first 12 months after RTS. Recent data indicate that failure to successfully meet traditional RTS criteria, inclusive of strength, functional hop testing and patient reported outcome scores, may identify athletes at increased risk of future injury after ACLR. However, these studies have focused on adult populations and it is unknown if similar RTS criteria apply to young, adolescent, pivoting/cutting athletes. The purpose of this study was to determine if meeting all current, standard RTS criteria would identify young athletes at risk for future ACL injury after primary ACLR and RTS. The tested hypothesis was the likelihood of 2nd ACL injury in the first 2 years after RTS would be lower in patients who met all RTS criteria prior to initiation of pivoting and cutting activity compared to patients who failed to meet all RTS criteria prior to RTS.

Methods: One hundred fifty-nine subjects (112 female, 47 male) with a mean age of 17.2±2.6 years old (range: 13-25 y.o.) underwent ACLR and were released to return to pivoting/cutting sport. These patients were enrolled in a prospective, observational cohort study, completed a RTS assessment and were then tracked for occurrence of 2nd ACL after ACLR for 24 months. The RTS assessment included 6 tests: isometric quadriceps strength, 4 functional hop tests and the International Knee Documentation Committee (IKDC) patient reported outcome survey. Limb symmetry index (LSI) was calculated for strength and hop test assessments [(involved/uninvolved) *100]. The IKDC was reported on a 0-100 scale with 100 representing a perfect score. Subjects were classified into groups that successfully passed all 6 RTS tests at a level of 90 and again at 95 compared to those that failed to meet all 6 criteria. Chi Square tests were used to determine if successfully passing all 6 RTS measures at various levels of symmetry resulted in a reduced risk of 2nd ACL injury in the first 24 months after RTS.

Results: Thirty-five (22.0%) patients suffered a 2nd ACL injury, with 26 occurring in the first 12 months after RTS. At the time of RTS, 42 patients (26%) achieved LSI values of 90 or greater on all testing as well as an IKDC value of 90 or greater. The remaining 117 subjects (74%) scored below 90 on at least 1 of the 6 assessments. At this level, there was no difference in 2nd ACL injury prevalence between patients who passed all RTS criteria (12/42; 28.6%) and those who failed at least 1 criteria (23/117; 19.7%) (p=0.23). When the passing criteria was elevated to 95 on all RTS testing, only 15 subjects (9%) successfully passed all 6 tests. There was no significant difference in 2nd ACL injury prevalence between patients who passed all RTS criteria (5/15; 33%) and those who failed at least 1 test (30/144; 20.8%) (p=0.32). Sub-group

analysis which evaluated the group by graft type, also indicated no significant differences between groups ($p>0.05$).

Conclusion: Current criteria to evaluate readiness to return young athletes to pivoting and cutting sports, using quadriceps strength symmetry, functional hop performance symmetry and patient reported outcomes, may not identify young, active patients at high risk for 2nd ACL injury. Future work must identify more appropriate criteria to assess readiness to RTS in the young, athletic population and incorporate these findings into practice.

Paper 104

Title:

Anterior Cruciate Ligament Reconstruction in Young Females: Patellar versus Hamstring Tendon Autografts

Authors:

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Objectives: Female athletes are two to eight times more likely to suffer a primary ACL tear than males. Although ACL reconstruction can successfully return many athletes to their pre-injury sports, re-injury to the ipsilateral or contralateral knee can occur in over 20% of young athletes. Both female sex and younger age have been shown to be risk factors for graft failure. The optimal graft choice for this high-risk population of young female athletes remains unknown and poorly studied. We compared the clinical outcomes in young female patients who underwent ACL reconstruction at our institution using bone-patellar tendon-bone (BTB) and quadrupled hamstring (HS) autografts. .

Methods: Female patients aged 15-25 who underwent primary ACL reconstruction at our institution between January 2012 and May 2015 using either BTB or HS autograft were included in our review. Patients were further sub-divided into 2 age groups, 15-20 and 20-25. Patients with a prior history of ACL injury to either knee, or those with multiligament injury were excluded. Graft choice and fixation method were documented from a review of operative records. Medical records were reviewed to document the occurrence of chondral, meniscal or ligamentous injury to the ipsilateral or contralateral knee in the first two years following ACL reconstruction. Comparisons were made using the chi-square test with statistical significance set at $p < 0.05$.

Results: A total of 256 females were included in our review with 175 in the BTB group and 81 in the HS group. There was no difference between the groups with regards to average age or time to follow-up. The majority of patients in both groups, 80% of the BTB group and 77.8% of the HS group, were between the ages of 15-20. Interference screw fixation was used in all BTB cases and 63.0% of HS cases. In the remainder of HS cases, femoral suspension and tibial screw (27.2%), and femoral cross-pins and tibial screw (9.9%) were used. In our series, 22.2% of hamstring grafts were augmented with allograft due to inadequate size. Overall, graft re-tear occurred in 6.9% of BTB patients and 12.3% of HS patients [$p=0.16$]. Contralateral ACL tear occurred in 7.4% of BTB patients and 6.2% of HS patients [$p=0.72$]. Sub-group analysis showed that 75% of BTB and 100% of HS graft re-tears occurred in females aged 15-20. Within this group, there was a significantly lower rate of graft re-tears in the BTB group (6.4%) when compared to the HS group (15.9%) [$p=0.04$]. Allograft augmentation was used in four of the ten HS grafts that re-tore. The risk of failure with hamstring augmentation with allograft (4/18, 22.2%) was higher than that of hamstring autograft alone (6/63, 9.5%), but this difference was not significant [$p=0.18$].

Conclusion: The results of our study indicate that BTB autograft led to fewer graft re-tears compared to HS autograft following ACL reconstruction in female patients aged 15-20. However, this difference was not observed in females aged 20-25. Thus, further investigation regarding optimal graft choice is warranted in this age group.

Paper 118

Title:

Fatigue Increases ACL Injury Risk in Youth Athletes: Risk Assessment Study Using Drop-jump Test

Authors:

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Objectives: The impact of fatigue on injury risk to the anterior cruciate ligament (ACL) in adolescent athletes is unknown. Identifying athletes who demonstrate increased risk for injury may help determine who would benefit from early neuromuscular control intervention for injury prevention. The goal of this study was to determine if fatigue increases ACL injury risk in adolescent athletes using the drop-jump test to assess dynamic valgus.

Methods: Youth and adolescent competitive athletes were recruited for this video analysis study. Participants were recorded performing the standard drop-jump test assessing dynamic valgus on landing three times. They then completed a standardized fatigue protocol consisting of a timed period of high-intensity aerobic tasks. A set amount of fatigue was quantified and achieved using a maximum vertical jump, which was compared to pre-fatigue values. The drop-jump test was then repeated three additional times post-fatigue. All drop-jump recordings (six in total) were randomized by order and scored for dynamic knee valgus by three independent reviewers. A multivariable analysis was performed to assess the correlation between demographic variables and injury risk.

Results: Forty-seven female patients and thirty-eight male athletes were included in the study. The average age was 15.4 years (age 14-18). Athletes were found to have significantly higher ACL injury risk post-fatigue when compared to pre-fatigue ($p = .001$). Thirty-five athletes were found to change from low/medium injury risk pre-fatigue to medium/high risk post fatigue. No demographic variables were found to contribute to ACL injury risk.

Conclusion: In adolescent athletes, fatigue appears to increase risk of ACL injury through drop-jump testing. Age, BMI, and hip width were not found to contribute to ACL injury risk. Implementation of neuromuscular or conditioning programs for at-risk athletes may reduce injury risk.

Paper 127

Title:

Why Do Patients Decide to Have Surgery for Their Symptomatic Rotator Cuff Tear? A Prospective Study

Authors:

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Objectives: While rotator cuff pathology may be amenable to conservative therapy, patients with full thickness tears not improving with non-operative treatment are indicated for repair. The decision to undergo surgery is often multifactorial with pain, loss of function, and concern for progression all factoring in the decision-making process. The purpose of this investigation was to evaluate patients main determining factors in deciding to have surgery for their rotator cuff tear, correlate these factors with strength of surgeon recommendation and clinical outcomes.

Methods: One hundred and fifty patients undergoing arthroscopic rotator cuff repair (ARCR) were enrolled prospectively. Patients received a questionnaire preoperatively to determine why they decided to proceed with surgical repair. This 13-question survey was developed based on evidence-based review of rotator cuff repair literature and the Delphi technique. Patients were asked to rate each factor with regard to importance in their decision to proceed with repair. Surgeons were given a similar Likert Scale and were queried on how strongly they would recommend surgery for their patients based upon various factors such as MRI findings, age, etc. Pre- and post-operative shoulder function was assessed with the American Shoulder and Elbow Society (ASES) Score. Descriptive statistics were used to evaluate the reasons to proceed with surgery and correlated with outcomes based on ASES scores.

Results: The most influential patient reported factors for proceeding with surgical repair were: limited functionality of the shoulder (81%), surgeon recommendation (80%), and daily chronic pain (77%). Patients improved from 42.6 to 77.0 on the ASES from baseline to 6-months ($p < 0.001$). Patients who listed that they were unable to play a favorite sport or hobby as their top reason for surgery demonstrated a significant increase in their ASES score relative to other factors at the 3 month time point ($p = 0.0014$); otherwise, there was no significant difference in outcomes for any other time point based on category importance. Subgroup analysis of males and females and older v. younger patients demonstrated significant findings. Females were more likely to proceed with repair due to inability to sleep and daily, chronic pain ($p < .005$) relative to males. Younger patients were more likely to proceed with repair for the inability to play a sport/hobby and increased demands of work relative to older patients ($p < .005$). There was no correlation between any decision factor and final outcome of ASES scores. Younger patients and male patients both demonstrated higher baseline ASES scores ($p < .05$); however, there was no difference in outcome measures at final follow-up.

Conclusion: Prior studies have shown that rotator cuff repair is best at alleviating pain for full thickness rotator cuff tears and may not be as impactful for improving function. Despite this evidence, the majority of patients undergoing rotator cuff repair in our study did so to improve function of their shoulder. While pain, inability to sleep, and inability to participate in ones favorite hobby/sport were important to our patient population, a strong surgeon recommendation had no correlation with our patients decision to proceed with repair. Surgeons should be mindful of these differences between gender and age when counseling patients pre-operatively. Outcomes of ARCR do not appear to be determined by pre-operative decision making on the part of the patient.

Paper 135

Title:

Efficacy of Osteochondral Allograft Transplantation in the Knee in Adults Forty Years and Older

Authors:

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Objectives: Fresh osteochondral allograft transplantation (FOCA) have been used successfully to treat large chondral and osteochondral defects of the knee. The purpose of the present study was to determine the efficacy of this treatment in patients older than 40, in comparison to a cohort 39 and younger.

Methods: We utilized a prospective database of 107 consecutive patients, with baseline PRO data receiving osteochondral allograft transplantation to the knee from a single surgeon practice over 8 years (March 2007-July 2015). Patient and donor characteristics were routinely collected, as were patient annual PRO measures, principally International Knee Documentation Committee (IKDC) and the Knee Injury and Osteoarthritis Outcome Score (KOOS). Table 1 summarizes cohort demographics; 68 patients completed surveys at a minimum of 24-month follow-up and were categorized into two cohorts based on age at surgery. Group A (study group) consisted of 33 patient's forty years of age and greater, 8 women and 25 men, with a mean age of 52.8 years (40-68) and average final up of 3.5 years. Group B (control group) consisted of 35 patient's less than forty years, 12 women and 23 men, with a mean age of 27.8 years (15-39) and average final follow up of 2.6 years.

Results: Both groups showed a significant improvement in outcome KOOS and IKDC scores at 12 months, 24 months and final follow up. 11 patients (31%) in the control cohort and 8 patients (24%) in study cohort underwent a second surgery on the index knee after the OCA transplantation. A statistically significant improvement in the study group from baseline to final follow-up ($p < .02$) was seen for all KOOS sub scores (Symptom: + 4.83, Pain: +13.05, ADL: +17.44, Sports: +14.48, QOL: +25.3) and IKDC (+22.46). A statistically significant improvement in the control group from baseline to final follow-up ($p < .02$) was seen for all 5 KOOS sub scores; (Symptom: +15.22, Pain: +8.68, ADL: +18.52, Sports: +30, QOL: +32.71) and IKDC (+32.9). In the study group, the maximum improvements (112% of baseline, 45% of baseline) were seen in the KOOS QOL and sports respectively. Similar changes in the control group included 138% improvement from baseline KOOS QOL and 83.3% for sports. Despite this, there was no significant difference between the two groups with respect to any average KOOS subscore or IKDC score, at any time during the observation period.

Conclusion: There was no significant difference between the group's outcomes data at final follow up. This implies the efficacy of OCA transplantation in adults forty years of age and older is similar to that of younger adults. Interestingly, we saw the greatest improvement in each of the two cohorts in the quality of life subscale of the KOOS. Significant sustained improvements in the symptom, ADL and pain subscales of the KOOS and IKDC were also observed in both groups. Overall, patients over 40 years

benefit in a similar manner to younger patients after FOCA and these benefits appear greatest for Quality of Life.

Patient Information and Clinical Assessment		
Clinical Information	Study Group	Control Group
No. of patients studied	33	35
Mean age at time of surgery (range)	52.8 (40-68)	27.8 (15-39)
Body Mass Index, kg/m ² (range)	28.1 (22.3-38.4)	26.5 (19.4-34.0)
No. of knees with previous surgery (%)	27 (81)	33 (94)
Mean No. of previous surgeries (range)	1.1 (1-3)	1.1 (1-3)
Location of graft, No.		
Lateralfemoral condyle	8	20
Medial femoral condyle	21	11
Other	4	4

Paper 163

Title:

Arthroscopic Shoulder Stabilization in the High-Risk Young Athlete: Return to Sport and Second Surgery Rates

Authors:

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Objectives: Shoulder instability in the young athlete has become an increasingly significant clinical problem in recent years. This high-risk population of athletes less than 25 years of age is a difficult cohort to manage because they have high failure rates with non-operative treatment and they reportedly have the lowest return to sport (RTS) rates and highest second surgery rates following arthroscopic shoulder stabilization compared to older patients. The purpose of this retrospective study is to evaluate the two-year clinical outcomes of a cohort of high-risk athletes less than or equal to 22 years of age following arthroscopic shoulder stabilization with a focus on RTS and incidence of second surgery.

Methods:

The primary outcomes evaluated were RTS and revision surgery following arthroscopic shoulder stabilization performed by the senior author at minimum follow-up of 24 months. Athletes were excluded if they had > 5 pre-operative episodes of instability, significant bone loss or had primary posterior instability. Demographic data was recorded including age, sex, BMI, last recorded range of motion, # episodes of recurrent instability, and revision surgery. A brief survey was completed regarding their shoulder instability history, sports prior to surgery, sports returned to following surgery, satisfaction with and level of RTS, time at which return to sports was achieved, recurrent instability, revision operations, and single assessment numeric evaluation (SANE) score.

Results: A total of 67 athletes met inclusion criteria, with a mean age of 17.4 years (range, 13-22 years). There were 19 females (28%) and 48 males (72%). The mean number of instability events was 2 (range 0-5), 57% in the dominant arm and 43% in the non-dominant arm. Evaluation of RTS, demonstrated that 59 (88%) were able to RTS with 56 (84%) of those returning to the same level or higher, while 8 (12%) patients did not RTS for reasons other than recurrent instability or apprehension. Among the 59 patients who RTS, the average time to return was 7.3 months (range: 5-12 months) and baseball and football were the most common sports. There was a gender specific difference with respect to RTS and revision surgery. The male RTS rate was 94% compared to the female rate of 74%. Four of 67 (6%) patients underwent revision stabilization 11 to 36 months for recurrent instability, however all were male athletes 4/48 (8%). There were no female athletes who required revision surgery. Patient reported mean SANE score was 88 (SD, ±15).

Conclusion: Shoulder instability in the young high-risk athlete is a complex problem with a relatively high rate of recurrence and revision surgery in the literature. In our case series, we found a relatively low reoperation rate (6%) with a high rate of RTS (88%), at an average time of 7.3 months. There was a

gender specific difference with respect to RTS and revision surgery. The male RTS rate was 94% and revision surgery rate was 8% (4/48) while the female RTS rate was 74% and revision surgery rate was 0%. The athletes reported a return to near full function with an average SANE score of 88. We believe the improved outcomes in this cohort of high risk young athletes are related to the pre-operative selection criteria excluding those athletes with a greater number of pre-operative episodes of instability and those with significant bone loss and bipolar lesions as open stabilization and bone augmentation (Latarjet) are more predictable operations in athletes with these risk factors.

Paper 171

Title:

Operative and Non-Operative Management of Osteochondritis Dissecans in the Knee of Skeletally Immature Patients: Rates of Persistent Knee Pain, Osteoarthritis, and Arthroplasty at Mean 14-Years Follow-up

Authors:

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Objectives: The purpose of this study was to report long-term follow-up of skeletally immature OCD lesions treated operatively and non-operatively and determine risk factors for persistent knee pain at final follow-up.

Methods: A large, geographic database of over 500,000 patients was reviewed in this case series to identify and confirm patients with OCD of the knee. Presenting radiographs and MRI were reviewed. Clinical course including operative management, persistent knee pain, and conversion to TKA were obtained and analyzed through review of clinical and operative notes.

Results: 95 skeletally immature patients (70 males, 25 females) with OCD lesions diagnosed at a mean age of 13 years (range: 7-16) were followed for a mean of 14 years (range: 2-40). 53 patients (56%) were treated operatively and 42 patients (44%) were treated non-operatively. At final follow up, 13 patients with a mean age of 30 years noted persistent knee pain, 8 (15%) treated operatively versus 5 (12%) treated non-operatively. Risk factors for knee pain were female gender, patellar lesion location, and unstable lesions (Table 1). Four patients (8 %) treated operatively and two (5 %) treated non-operatively developed symptomatic osteoarthritis at a mean of 28.6 years following diagnosis. One patient treated operatively and two treated non-operatively converted to TKA at a mean of 37 years following diagnosis. Mean age at TKA was 52 years, significantly younger than that observed for primary TKA at our institution ($p = 0.004$).

Conclusion: Patients with skeletally immature OCD lesions have an estimated 14% rate of persistent knee pain, 6% risk of symptomatic osteoarthritis, and 3% risk of conversion to TKA at a mean of 14 years following time of diagnosis. Female patients, patellar lesions, and unstable lesions demonstrated increased risk of persistent knee pain at final follow-up. Patients with OCD of the knee convert to TKA at a significantly younger age than that of the general primary TKA population.

Table 1: Risk factors for persistent knee pain at the time of final follow-up

Variable	HR (95% Confidence Interval)	p-value
Treatment		
Non-Operative	Reference	
Operative	1.16 (0.35 – 3.83)	0.81
Age at diagnosis		
< 10	Reference	
≥ 10	10.3 (0.11 – 9.63)	0.98
Gender		
Female	Reference	
Male	0.24 (0.07 – 0.81)	0.02
Location		
MFC	Reference	
LFC	2.91 (0.57 – 14.97)	0.20
Patella	5.30 (1.37 – 20.48)	0.02
Trochlea	0.00 (0.00 – 0.00) ^a	<0.01^a
AP Radiograph Lesion Width		
< 20 mm	Reference	
≥ 20 mm	1.74 (0.23 – 12.97)	0.59
AP Radiograph Lesion Depth		
< 5 mm	Reference	
≥ 5 mm	0.68 (0.08 – 6.00)	0.73
Lateral Radiograph Lesion Width		
< 20 mm	Reference	
≥ 20 mm	1.75 (0.31 – 10.01)	0.53
Lateral Radiograph Lesion Depth		
< 5 mm	Reference	
≥ 5 mm	2.14 (0.38 – 11.95)	0.38
Lesion Contour		
Concave	Reference	
Convex	0.45 (0.08 – 2.54)	0.37
Disruption of subchondral bone		
No	Reference	
Yes	0.73 (0.15 – 3.54)	0.70
Intra-articular displaced fragment		
No	Reference	
Yes	0.85 (0.10 – 7.48)	0.88
Adjacent Focal Articular Cartilage Defects		
No	Reference	
Yes	0.85 (0.10 – 7.48)	0.88
Stability		
Stable	Reference	
Unstable	10.58 (1.26 – 88.63)	0.03

^aOf the n = 2 lesions present on the trochlea, none developed symptomatic knee pain[□]

Paper 173

Title:

Exceeding Pitch Count Recommendations in Youth Baseball Increases The Elbow Injuries

Authors:

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Objectives: With the incidence of Little League elbow increasing, pitch limit recommendations for preventing throwing injuries have been developed in the United States and Japan. In 1995, the Japanese Society of Clinical Sports Medicine announced limits of 50 pitches per day and 200 pitches per week to prevent throwing injuries in younger than 12 years old. However, the relationship between pitch limit recommendation and elbow injuries among pitchers has not been adequately studied. The aim of our study was to evaluate the association between pitch counts and elbow injuries in youth pitchers.

Methods: A total of 149 pitchers without prior elbow pain were observed prospectively for 1 season to study injury incidence in relation to specific risk factors. Average age was 10.1 years (range, 7-11 years). One year later, all pitchers were examined by questionnaire. Subjects were asked whether they had experienced any episodes of elbow pain during the season. The questionnaire was also used to gather data on pitch counts per day and per week, age, number of training days per week, and number of games per year. We investigated the following risk factors for elbow injury: pitch counts, age, position, number of training days per week, and number of games per year. Data were analyzed by multivariate logistic regression models and presented as odds ratio (OR) and profile likelihood 95% confidence interval (CI) values. The likelihood-ratio test was also performed. A two-tailed P value of less than .05 was considered significant. All analysis was done in the SAS software package (version 8.2).

Results: Of the 149 subjects, 66 (44.3%) reported episodes of pain in the throwing elbow during the season.

1. Analysis for pitch count per day

Univariate analysis showed that elbow pain was significantly associated with more than 50 pitches per day. Multivariate analysis showed that more than 50 pitches per day (OR, 2.44; 95% CI, 1.22-4.94), and more than 70 games per year (OR, 2.47; 95% CI, 1.24-5.02) were risk factors significantly associated with elbow pain. Age and number of training days per week were not significantly associated with elbow pain.

1. Analysis for pitch count per week

Univariate analysis showed that elbow pain was significantly associated with more than 200 pitches per week. Multivariate analysis showed that more than 200 pitches per week (OR, 2.04; 95% CI, 1.03-4.10), and more than 70 games per year (OR, 2.41; 95% CI, 1.22-4.87) were risk factors significantly associated

with elbow pain. Age was not significantly associated with elbow pain.

Conclusion: A total of 44.3% of youth baseball pitchers had elbow pain during the season. Multivariable logistic regression revealed that elbow pain was associated with more than 50 pitches per day, more than 200 pitches per week, and more than 70 games per year. Previous studies have revealed the risk factor with the strongest association to injury is pitcher. Our data suggest that compliance with pitch limit recommendations including limits of 50 pitches per day and 200 pitches per week may be protective against elbow injuries. Those who played more than 70 games per year had a notably increased risk of injury. With increasing demand on youth pitchers to play more, there is less time for repair of bony and soft tissues in the elbow. In conclusion, among youth pitchers, limits of 50 pitches per day, 200 pitches per week, and limits of 70 games per year may protect elbow injuries.