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Heidi Prather, DO is a Professor in the Department of Physical Medicine and Rehabilitation (PM&R), Vice Chair in the Department of Orthopedic Surgery, Chief of Section in PM&R, Director of Orthopedic Spine Center, and PM&R Sports Medicine Fellowship Director at Washington University School of Medicine. Her clinical interests include the conservative management of all musculoskeletal conditions with a special interest in young adult hip, spine, female athletes, and women’s health. Her research interests include pregnancy and musculoskeletal problems.


Dr. Prather has also received many distinguished awards, such as: Distinguished Clinician Award at Washington University School of Medicine, Bernard L. Maas Visiting Lecturer at Sinai-Grace Hospital Department of PM&R, Wayne State, American Top Doctors 2001 to 2009, Best Doctors 2001–present, Excellence in Teaching Award in the Department of Orthopaedic Surgery–Washington University School of Medicine, Scott Nadler Teaching Award–Kessler Institute of Rehabilitation Research and Education Corporation 2006 among many others.

Dr. Mautner is assistant professor in the department of PM&R and the department of Orthopedics at Emory University in Atlanta, GA. He is the director of Primary Care Sports Medicine at Emory Sports Medicine Center. He is also the Program Director of Emory’s Primary Care Sports Medicine Fellowship.

Dr. Mautner came to Emory in 2004, after completing a Fellowship in Primary Care Sports Medicine at the American Sports Medicine Institute in Birmingham, Alabama. He is board certified in PM&R with a subspecialty certification in Sports Medicine. Dr. Mautner currently serves as head team physician for Agnes Scott College and Pace Academy and a team physician for Emory University and a consulting physician for Georgia Tech Athletics.

Dr. Mautner is an expert in diagnostic and interventional musculoskeletal ultrasound and teaches and directs courses across the country on how to perform office-based ultrasound. He regularly performs Platelet Rich Plasma (PRP) and Stem Cell injections for patients with chronic tendon and joint related problems and is recognized as an expert and thought leader in this area. In addition, he is the co-editor of the Atlas of Interventional Musculoskeletal Ultrasound.

Dr. Mautner’s other areas of clinical interest include sports concussions, where he is regarded as a local and regional expert in the field. He was recently co-chairman of the Georgia Concussion Coalition, a group of diverse stakeholders whose aim is to increase concussion awareness, education, and legislation in Georgia and was instrumental in passing the Georgia Return to Play Act for concussion.
Dr. Brandee Waite is an Associate Professor in the Department of PM&R at University of California Davis. She is the co-director of the PM&R Sports Medicine Fellowship and is a team physician for the UC Davis and American River College intercollegiate student athletes. She has been a team doctor in the NBA, WNBA, and USA Track & Field, private consultant in the NFL, company physician for the Sacramento Ballet, and medical director of multiple marathon and ultra-marathon events. Dr. Waite graduated with honors from Stanford University and received her medical degree from University of California San Francisco. She completed PM&R Residency at Stanford and Sports Medicine Fellowship at Johns Hopkins. She is board certified in PM&R and has CAQ in Sports Medicine. Dr. Waite’s main area of research is ultra-marathon athletes and has increasing interest in treatments for tendon and cartilage disorders.

Dr. Jason L. Zaremski is an Assistant Professor in the Divisions of PM&R and Sports Medicine in the Department of Orthopaedics & Rehabilitation at the University of Florida. He is currently the Co-Medical Director of the UF Adolescent and High School Outreach Sports Medicine Program. He serves as Team Supervising Physician to multiple high schools in the greater North Central Florida region. Dr. Zaremski received his medical degree from Tufts University School of Medicine. He completed his residency in Physical Medicine & Rehabilitation at Tufts Medical Center in Boston and then completed his Primary Care Sports Medicine Fellowship at the Geisinger Health System in Northeastern Pennsylvania. He is board certified in PM&R and has his Certificate of Added Qualification in Sports Medicine. Dr. Zaremski is currently active in AAPMR, AMSSM, and ACSM. His current research interests involve overuse throwing injuries.
Dr. Dinesh Kumbhare is an Associate Professor in the Department of Medicine at the University of Toronto and staff physician and affiliate scientist at the Toronto Rehabilitation Institute. He has an MSc in clinical epidemiology. He is part of the MSK program and has special interest in myofascial pain syndrome, chronic pain and electromyography. He is the medicine lead of the “Physiatry and Pain” week of the medical curriculum.

Dr. Jacob Sellon is an Assistant Professor in the Department of Physical Medicine and Rehabilitation at Mayo Clinic in Rochester, MN. He completed a PM&R Residency and Sports Medicine Fellowship at Mayo Clinic and is board certified in both. He has also attained the Registered in Musculoskeletal Sonography (RMSK) credential from the American Registry for Diagnostic Medical Sonography.

Dr. Sellon currently practices in the Mayo Clinic Sports Medicine Center and is the Program Director for the Mayo Clinic Sports Medicine Fellowship. He is the Course Director for the annual Mayo Clinic Symposium on Sports Medicine. Dr. Sellon also serves as the Medical Director for both Rochester Community Technical College Athletics and the annual Med City Marathon. He has peer-reviewed publications on a variety of sports medicine related topics and serves as a reviewer for several journals. His practice and research interests include regenerative medicine and musculoskeletal ultrasound.
Is Risk of Injury Higher in Young Athletes Who Train Intensively In One Sport?

Scott Simpson\textsuperscript{a,b,c}, Heidi Prather\textsuperscript{a,b}

Introduction: The number of children and adolescents playing organized sports is rising, and more young athletes are training intensively year-round for one sport. While several organizations, including the American Academy of Pediatrics and the American Medical Society for Sports Medicine, have discouraged early sports specialization, these recommendations have been based on limited data. Jayanthi et al. completed a case-control study to assess whether sport specialization, training volume, and growth rates are associated with injuries in young athletes.

Methods: Injured athletes between ages 7 and 18 were recruited from hospital-affiliated sports medicine clinics with uninjured control athletes recruited during sports physicals. Data collected through surveys, physical examination, and the medical record included age, growth rate parameters, sports enjoyment, degree of sports specialization, and number of hours per week spent in organized sports and free play. Injury details were also recorded for injured athletes. Sports specialization, defined as “year-round intensive training in a single sport at the exclusion of other sports,” was graded as low, moderate, or high. Injuries were separated into acute and overuse; overuse injuries were defined as “serious” if treatment was expected to require at least one month rest from sports.

Results: The study included 1190 athletes (822 injured, 368 uninjured). While growth rates were similar between groups, injured athletes were significantly older than uninjured athletes (mean 14.1 years versus 12.9 years). Sports-specialized training conferred an increased risk of injury, even after accounting for baseline group differences in age and time spent in sports activity. This was true for both injuries in general and serious overuse injuries in particular. Athletes with a serious overuse injury were more likely to be highly specialized than those with a non-serious overuse injury. In general, a dose-dependent effect was observed, with increasing sports specialization associated with a higher injury risk.

Risk factors for a serious overuse injury included training volume. The study was well-designed with a large number of subjects. Males and females were equally represented.

Weaknesses: The inherent limitations of the study design do not allow conclusions to be made regarding injury causation. There was also possible selection bias. The injured group included only athletes evaluated in sports medicine clinics, possibly selecting for more specialized athletes, since less specialized athletes may be more likely to seek care from their primary care provider. Acute injuries may be underrepresented in the study since those patients may be more likely to present to an emergency department or urgent care clinic.

Conclusion: The authors’ conclusion that there is a higher risk of injury with increasing sports specialization among young athletes is supported by their data and statistical analysis. Despite minor limitations, this is a well-designed and well-executed study.

Strengths: This is the first study to demonstrate early sports specialization as an independent risk factor for injury in young athletes, independent of age and training volume. The study was well-designed with a large number of subjects. Males and females were equally represented.

Practice Pearl: The study findings can be used to counsel young athletes and their parents regarding the increased injury risk associated with specializing in one sport. In particular, it provides useful guidelines to consider limiting the number of weekly hours in organized sports activities to less than the athlete’s age in years and to maintain a less than 2:1 ratio of time spent in organized sports activities versus unstructured play.

References:
Post-Concussion Return to Play Negatively Affects Motor Recovery

Robert L Bowers, MD, Ken Mautner, MD

Introduction: Post-concussion return-to-play guidelines and the effects of resumption of physical activity on recovery still remain unclear. Howell and colleagues completed a level-2, prospective, longitudinal cohort study with the purpose of examining how return-to-activity (RTA) affects recovery from concussion based on measures of symptom severity, cognition, and motor function. The hypothesis was that RTA within 2 months post-concussion would have a greater deleterious effect on dual-task walking than on symptom recovery, cognition, or single-task walking.

Methods: Nineteen adolescent athletes (16 men/3 women, age 15.4±1.4 yrs) who returned to activity within 2 months post-concussion were selected for inclusion in the study. Each subject was matched within 2 months post-concussion were selected for inclusion in the study. Each subject was matched in a convoluted fashion, which made them difficult to assess. The sample size is also relatively small with only 19 athletes included. In regard to changes with dual-task walking, a specific numerical difference that represents the threshold for clinical significance is yet to be established. Lastly, the results were presented in a convoluted fashion, which made them difficult to assess.

Results: Statistically significant results were seen primarily with dual-task walking. After RTA, post-concussion athletes increased total center-of-mass medial/lateral displacement by 11.8% (P = 0.009) and peak center-of-mass medial/lateral velocity by 23.9% (P = 0.048) with dual-task walking as compared to pre-RTA values. No changes existed pre versus post-RTA within the concussion group or between concussion and control groups with single-task walking or cognition. Clinical symptom improvement was significantly greater over the pre-RTA time period as compared to post-RTA (P = 0.009).

Strengths: Current return-to-play decision-making is based primarily on symptom resolution as well as cognitive and balance functions returning to pre-injury levels. However, motor ability may not be sufficiently recovered at the same time point. The authors realized the importance of this concept to the future of return-to-play guidelines and emphasized the need for further investigation. Therefore, they measured gait balance-control during dual-task walking to assess motor recovery after concussion. Gait stability during dual-task walking has previously been shown to be particularly sensitive to disruptions post-concussion in sports and military based studies. This was also well-controlled study with age, size, and sport-matched controls.

Weaknesses: The inherent variability among healthcare providers is the most easily identified weakness. This variability exists in both decision-making and qualification, as both physicians and athletic trainers were making the initial concussion diagnoses. Furthermore, lack of standardized return-to-play guidelines and variability in assessing concussion recovery likely influenced RTA times. The sample size is also relatively small with only 19 athletes included. In regard to changes with dual-task walking, a specific numerical difference that represents the threshold for clinical significance is yet to be established. Lastly, the results were presented in a convoluted fashion, which made them difficult to assess.

Conclusion: This study presents the thought-provoking idea that incorporation of a cognitive task while performing a motor task may be a more sensitive indicator of concussion resolution as compared to current standard clinical tests. However, weaknesses and design issues prevent the findings from being clinically applicable.

Practice Pearl: This study reinforces the notion that further investigations need to be completed to assist with the development of post-concussion return-to-play guidelines and post return-to-play assessment. Traditional methods may not be sensitive enough to determine post-concussion deficits that persist beyond symptom recovery and clinical resolution. Furthermore, premature RTA may exacerbate deficits related to incomplete recovery and could make the athlete vulnerable to further head or orthopedic injury. Therefore, this study is more important in regard to the questions it raises as opposed to the results it presents. At this time, it would be difficult to directly apply the findings of this investigation to clinical practice.

References:
Is There Benefit of a Distal Clavicle Resection for Acromioclavicular Joint Injury During Rotator Cuff Repair?

Gloria Rho\textsuperscript{ab}, Brandee Waite\textsuperscript{ab}

Introduction: Prior literature has been conflicting in regards to benefits of distal clavicle resection (DCR) in the setting of primary external impingement; few have reported outcomes of arthroscopic DCR for symptomatic acromioclavicular joint (ACJ) arthritis in those with rotator cuff (RC) tears. The purpose of this randomized controlled trial was to compare results of RC repair (RCR) versus RC repair combined with DCR in those with symptomatic ACJ arthritis (Level of evidence, 1). They hypothesized that the DCR in addition to RCR would beneficial in intermediate-term clinical outcomes.

Methods: Inclusion criteria were (1) full- or partial-thickness RC tear involving at least 50% as seen on MRI (2) tenderness at ACJ (3) ACJ arthritis on radiographs (4) positive diagnostic ACJ injection. Excluded were those with (1) incomplete RC tear repair (2) history of surgery, fracture of shoulder (3) open procedure (4) glenohumeral joint OA (5) inflammatory disease (6) worker’s compensation cases.

56 subjects (58 shoulders) were enrolled and blindly randomized into the two groups. All patients underwent arthroscopic RCR along with subacromial decompression. Of the 58 shoulders, 32 had isolated arthroscopic RCR and remaining 26 had simultaneous DCR.

The diagnostic lidocaine injection was done day before surgery. Evaluations occurred preoperatively then postoperatively at 6 months and at minimum of 24 months after surgery; ACJ was palpated for tenderness and graded (scale of 0 – 3). The Constant score, American Shoulder and Elbow Surgeons (ASES) score, ROM examination and VAS were also evaluated; scores were rated by a blinded physical therapist. MRI was completed at 6 months and at final follow-up. Patients also rated their surgery satisfaction at final visit.

All the surgeries were performed by a single provider. In cases with limited range of motion, gentle manipulation was performed under anesthesia. After making the anterolateral portal, a subacromial bursectomy, partial coracoacromial ligament resection, and minimal acromioplasty were performed. Then either an isolated RCR or a RCR with DCR was performed; the distal clavicle resection was done by exposing the inferior part of ACJ.

Postoperatively, the shoulder was immobilized in abduction brace for 4 weeks, with hand exercises and below-wrist daily activities allowed. This was followed by active-assisted passive range of motion then strengthening exercises.

Results: In comparing the DCR and isolated RCR groups, there were no baseline demographic differences including tear size distribution, Constant, ASES and VAS scores. At final follow-up evaluation, both groups had significantly improved all 3 clinical scores (P < .001). There was no difference in residual ACJ tenderness and in re-tear and reoperation rates between the 2 groups. At minimum 2-year follow-up, ACJ tenderness was found in more than 33% of the DCR group. Therefore, the authors concluded that there is no clinical difference between arthroscopic RCR versus combined DCR and RCR for treating rotator cuff tears in the setting of symptomatic ACJ arthritis.

Strengths: It was a randomized controlled study and the subjects were blinded to the surgical treatment. Inclusion criteria included MRI and radiographs as well as a diagnostic anesthetic injection. The postoperative follow-up included repeat MRIs and subjects were followed for a minimum of 2 years.

Weaknesses: Sample size was small. The measurement of ACJ tenderness was based on subjective grading. Finally, postoperative course did not delineate type, duration, and monitoring of rehabilitation.

Conclusion: The methods of inclusion criteria, as well as the diagnostic injection and surgery techniques appear to be appropriate. Statistical analysis on the clinical scores and the outcome factors were reasonable. The number of patients to achieve of power of 80% was also met.

Their results fulfilled the null hypothesis – there was no difference of clinical outcomes in the intermediate-term between the 2 surgeries.

Practice Pearl: From the findings of this study, we would generally avoid DCR for symptomatic ACJ arthritis without evidence of inferior osteophytes impinging on the rotator cuff. In primary external impingement, a rotator cuff repair and subacromial decompression may be sufficient to relieve symptomatic ACJ concomitantly. However, DCR can be considered for refractory ACJ pain without RC tear as this is a well-documented procedure for this indication.

References:
Prevalence of UCL Surgery Among Major League and Minor League Baseball Players

Thomas A. Starnes, MD, Jason L. Zaremski

Introduction: Elbow injury in baseball pitchers is a topic of ongoing research in sports medicine. Wilk et al performed a level 2 prospective longitudinal cohort study involving the pitchers of one professional baseball team. They hypothesized that reduced range of motion in the throwing shoulders of professional baseball pitchers measured during the preseason predisposes them to elbow injury during the season.

Methods: Over 8 consecutive seasons, examination of shoulder range of motion of 296 professional baseball pitchers (220 right-handed and 76 left-handed; age 24.7 + 4.1 years) was performed and documented. Goniometry was used to measure pre-exercise passive glenohumeral internal rotation, external rotation, and flexion. Total rotation was defined as internal rotation plus external rotation. Elbow injury was defined in the study as an injury to the throwing elbow which caused the player to be placed on the disabled list. Deficits in throwing shoulder ROM were defined as follows:

1. Internal rotation: more than 20° decrease in throwing shoulder compared to non-throwing shoulder
2. External rotation: less than 5° increase in throwing shoulder compared to nonthrowing shoulder
3. Total rotation: Nonthrowing shoulder ROM greater than 5° more than throwing shoulder ROM
4. Flexion: Nonthrowing shoulder flexion greater than 5° more than throwing shoulder

Results: In this study, 13% of the pitchers examined over the 8-year period sustained an injury to their throwing elbows (previous studies had shown an incidence of elbow injury around 26%). Statistically significant results include a 2.6 odds ratio (95% CI, 1.3-5.4, P = 0.007) for elbow injury in pitchers with a total rotation deficit in their throwing shoulders compared to non-throwing shoulders. Additionally, there was a 2.8 odds ratio (95% CI, 1.3-5.9, P = 0.008) for elbow injury in pitchers with a flexion deficit in their throwing shoulders compared to their non-throwing shoulders. Based on these findings, the authors concluded that baseball pitchers are more likely to suffer a throwing elbow injury if they have a deficit in total shoulder rotation or shoulder flexion rather than isolated deficits in internal or external rotation.

Strengths: This was a prospective cohort study in which range of motion data was gathered prior to injury occurrence. Additionally, the current study used a standard method of data collection year-to-year. The same two experienced examiners performed data gathering during each year of the study with a standardized system of measurement.

Weaknesses: Data was gathered on players who were in preseason instead of midseason form. Additionally, data was limited to measurement of passive range of motion, not active range of motion as would be seen in a competitive environment. There was no stratification of data regarding extent of injury. Internal rotation stretching is now a standard protocol for stretching in-season, but the use of such exercises in the cohort is unclear. Five degree differences in total arc or external rotation are defined as deficits, while twenty degrees differences in internal rotation are defined as deficits.

Conclusion: Examination methods were standardized year-to-year for all patients. Definitions for range of motion deficits were taken from previous peer-reviewed literature and applied to every patient in the study. The strict application of these definitions allowed the authors to make a compelling argument that there is a positive correlation between elbow injury and 1) deficits in throwing-shoulder total rotation or 2) deficits in throwing-shoulder flexion. There was not a positive correlation between elbow injury and strictly internal rotation deficits as has been previously believed.

Practice Pearl: The incidence of elbow injury, specifically ulnar collateral ligament rupture, at various levels of competitive baseball increased during the past 10-20 years. Deficits in total range of motion and flexion of the throwing shoulder were shown in this study to be risk factors for elbow injury in elite pitchers. It can be extrapolated that this would apply to pitchers at other levels of competitive baseball as well. Baseball pitchers should be encouraged to maintain the maximum range of motion of their throwing shoulder.

References:
Autologous Tenocyte Injection in Treatment of Refractory Lateral Epicondylitis

Daniel R Lueders<br>a,b,c, Jacob L Sellon<br>a,b,c

Introduction: While most cases of lateral epicondylitis (LE) are self-limiting, management of refractory LE is controversial. Biologic treatments, such as platelet-rich plasma (PRP), have shown promise in improving symptoms, but have not consistently demonstrated superiority to injections of saline, corticosteroids, or autologous whole blood. Wang et al. initially reported a 1-year case series (Level 4 evidence) of refractory LE patients treated with autologous tenocyte injection (ATI). More recently the 3-5 year outcomes were reported.

Methods: Twenty subjects of mean age 49 yr (range 37-63 yr) were prospectively enrolled. All had a clinical diagnosis of LE confirmed with MRI. Symptoms averaged 29 months (mo; range 6-240 mo) duration and were resistant to nonoperative treatment, including physical therapy, bracing, corticosteroid injection (not within 3 mo).

Needle biopsy was used to harvest tenocytes from the patellar tendon. Tenocytes were then cultivated for expansion over 3 weeks using previously described techniques in compliance with the Australian Therapeutic Goods Administration. Flow cytometry and real-time polymerase chain reaction (PCR) of the ATI were used to ensure tenocyte characterization. Up to 2 mL of autologous tenocytes (2-5 x 10^6 cells/mL) were injected under sonographic guidance into the site of common extensor tendinopathy using an 18-gauge needle and 1-2 passes. Two days of rest followed by 4 weeks of light activity were advised before all restrictions were lifted. Forearm extensor muscle stretches were recommended 4 times daily. No supervised therapy or strengthening regimen was prescribed.

Outcome measures included visual analog scale (VAS) pain score, quick Disabilities of the Arm, Shoulder and Hand (QuickDASH), Upper Extremity Functional Scale (UEFS), and grip strength, evaluated at baseline, 1, 3, 6, and 12 mo after ATI, and at a final follow-up evaluation (FFE). MRI was used to assess and grade tendinopathy at baseline, 12 mo, and at FFE.

Results: Fifteen patients completed the study to FFE (mean 54 mo), while 3 dropped out prior to ATI, 1 underwent surgery after work-related reinjury, and 1 died of metastatic prostate cancer deemed unrelated to the treatment by a medical assessment panel. No patellar tendon donor site or elbow injection site complications were reported. Flow cytometry and PCR analyses confirmed the ATI had tendon-specific cell markers.

VAS for pain, QuickDASH, and grip strength improved significantly by 1 mo post-ATI, and those improvements persisted through FFE, with grip strength continuing to improve. Similarly, UEFS showed significant improvement within 3 mo that was durable at FFE. MRI tendinopathy score improved significantly at 12 mo and persisted at FFE, with all but 2 subjects scoring the same or better. At FFE, 93% were satisfied with ATI treatment.

Strengths: ATI is a novel therapy for refractory LE and theoretically has more biologic specificity to pathologic tendon than PRP or mesenchymal stem cells (MSC). This study was thorough in its methodology of tendon biopsy, tenocyte culturing, and tenocyte character confirmation. The outcome measures, using not only subjective measures of pain and function, but also objective measures of grip strength and MRI tendon appearance, helped mitigate the potential placebo effect in this uncontrolled study. The long follow-up duration strengthened evidence of treatment durability and safety.

Weaknesses: The primary limitation was the absence of a control or comparison group. This rendered the study susceptible to the powerful placebo effect. It also precluded comparisons of ATI with the natural history of LE or to other LE treatments. With no control arm, it is difficult to conclude that the MRI changes described after ATI differ from the natural history of LE at the same time points. Another weakness was the lack of pre-intervention treatment standardization. Specifically, there was no mention of eccentric strengthening, a first-line LE treatment with reasonable supporting evidence. Finally, the lack of blinding potentially introduced bias throughout the study.

Conclusion: ATI appears to be a safe, minimally invasive treatment alternative for refractory LE. Significant improvements were observed in pain, arm function, grip strength, and MRI tendon appearance within 1 mo and are maintained after 3-5 yr.

Practice Pearl: While this study suggests ATI may be safe and effective for refractory LE, blinded randomized controlled trials are needed to confirm these findings. The cell cultured ATI preparation as described in this study is not currently approved by the United States Food and Drug Administration.

References:
Minimal Effective Corticosteroid Dose in Patients with Mild Adhesive Capsulitis

Michael Catapano\textsuperscript{a,b,d}, Harpreet Sangha\textsuperscript{c}, Dinesh Kumbhare\textsuperscript{a,c}

**Introduction:** An intra-articular corticosteroid injection is one of the most well-known and practiced interventions for adhesive capsulitis. Despite its popularity, there has yet to be definitive evidence indicating the appropriate dose to obtain maximal improvement in patient function and pain. To address this issue, Yoon et al used a randomized, triple-blind, placebo-controlled trial to test whether high-dose corticosteroid is more efficacious for relieving pain and improving function compared to low-dose corticosteroid or placebo.

**Methods:** Participant population was between the age of 20 and 70 who were in the freezing stage of adhesive capsulitis according to the Hannafin and Chiaia scale. Injections were done under ultrasound-guidance and came in opacified syringes to blind all parties to the contents, which were 5 mL of either 40 mg of triamcinolone acetonide, 20 mg triamcinolone acetonide, or 2% lidocaine. Outcomes included the Shoulder Pain and Disability Index (SPADI), Visual Analog Scale (VAS), and range of motion at baseline, 1-week, 3-weeks, 6-weeks and 12-weeks post-injection. All patients were given a home exercise program to complete at home over the 12-week study period, however compliance was not measured or compared between groups.

**Results:** The authors concluded that, although all groups improved over time, patients receiving corticosteroid improved clinically and significantly more than placebo in SPADI, VAS, flexion, abduction, and internal rotation (p<0.05). Despite corticosteroid being significantly more efficacious than placebo, there was not a statistically significant difference between low-dose and high-dose corticosteroid for any of the outcome measures. From these results, the authors concluded that patients should receive 20 mg triamcinolone acetonide at initial presentation as it is as efficacious and limits theoretical side effects of higher doses.

**Strengths:** This study was well done as it was triple-blinded which effectively removes placebo effect or evaluator bias. Additionally, clinically relevant doses of corticosteroid were used compared to previous studied which used sub-therapeutic doses of corticosteroid compared to high-dose corticosteroid.

**Weaknesses:** One of the primary weaknesses of this study is that the sample size calculation was done using expected differences between corticosteroid and placebo. This calculation resulted in a much smaller sample size due to the large expected difference between placebo and corticosteroid groups. The use of an appropriate, smaller expected difference between high-dose and low-dose corticosteroid would have yielded a much larger sample size requirement. This may have adequately powered the study to determine whether the consistent increased improvement in SPADI, flexion, abduction, internal rotation at 12-weeks in the high-dose compared to low-dose group is significant.

Additionally, the patient population studied represents those with milder disease than the average population, as VAS scores in this study were 4.9 - 5.5, and may have only needed low-dose corticosteroid to induce regression. Follow-up of after intervention was only 12-weeks, which may have only provided evaluations of immediate benefits in a disease where patients remain symptomatic for a much longer period.

**Conclusions:** The study design and statistical analysis was well thought-out and executed however the sample size was too small to properly determine a statistically or clinically significant difference between high-dose and low-dose groups. Despite a clear indication that either dose of corticosteroid is more efficacious compared to placebo, the study was underpowered to determine whether there is a difference between high-dose and low-dose groups.

**Practice Pearl:** Clinically, high dose corticosteroid may not be more efficacious than low dose, however the use of low dose corticosteroid should reduce many issues that can arise from excessive corticosteroid use (i.e. steroid flare, local joint/tissue destruction, high blood sugars, hypertension).

**References:**
