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| **CRITICALLY APPRAISED TOPIC** |

**FOCUSED CLINICAL QUESTION**

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| When implemented in the prevention or treatment of acute and chronic musculoskeletal injury or pathology of the Glenohumural and/or scapulothoracic Joint (GHJ/STJ) in the avid rock climber (internal/external-impingement, RC pathology, capsular hypo/hypermobility, Hx of acute/recurrent subluxation/dislocation of the GHJ), would combining core stability/balance training with closed-kinetic-chain (CKC) positioning/movements at the upper extremity better promote sport-specific neuromuscular control at the trunk, hip and pelvis and correct sequencing of motor patterns at the UE to achieve optimal alignment, posture and stability at the STJ/GHJ compared to traditional open-kinetic-chain (OKC) strengthening of the rotator-cuff and periscapular musculature? |

**AUTHOR**

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| **Prepared by** | Chris Ball | **Date** | 11/22/2014 |
| **Email address** | christopher\_ball@med.unc.edu | | |

**CLINICAL SCENARIO**

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| Glenohumural joint dislocation (GHJD), chronic shoulder hyper/hypomobility, impingement syndrome and movement dysfunctions are common orthopaedic injuries/conditions of the upper extremity (UE) amongst indoor/outdoor rock-climbers of every age demographic and experience level. I believe that acute injuries suffered during active climbing such as GHJD have the potential to be functionally unique. My reasoning for this is two-fold which considers the orientation of the climbers body at the time of injury and the climbers GHJ/STJ will assume multiple, independent CKC positioning and motion within multiple planes of movement for the majority of the climbs duration.  With GHJD during the act of climbing, the UE’s CKC positioning results in the posterior-inferior dislocation of the thorax, scapula-glenoid from the humeral head followed by relocation in the anterior-superior direction. The large degree of skeletal muscle activation prior to GHJD as well as forces associated with reciprocal inhibition of the same musculature during relocation should also be considered. The CKC positioning of the climbers UE throughout the injury elicits reverse origin/insertion force coupling during concentric and eccentric muscle activation and transmitted to associated bony-segments of the GHJ, STJ and thoracic spine.  I have hypothesized that the implementation of CKC positions and motions in combination with core stability/balance training would better establish proximal stability along the UE kinematic chain and provide a stable base for the GHJ and distal segments of the upper extremity to function optimally. Further more this type of training will enhance somatosensory and neuromuscular functioning around the STJ/GHJ in a sport-specific fashion and thus, better able to recognize positions of instability at these joint and provide adequate functional stability to complete these movements successfully and repetitively without injury or re-injury. |
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**SUMMARY OF SEARCH**

[Best evidence appraised and key findings]

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| 31 studies met inclusion/exclusion criteria. Notable studies included 4 systematic reviews, 7 RCT’s, 2 non-randomized control trials and 4 clinical trials with single-group repeated measures design. 3 of these studies were ranked of the highest quality with supporting evidence were reviewed and discussed.   * Fair to moderate correlations have been indicated regarding instance of acute/chronic shoulder dysfunction and the presence of decreased core stability amongst collegiate overhead athletes when subjected to repeated measures design. * There is a significant risk of recurrent dislocation of the GHJ following first-time traumatic anterior GHJ dislocation as well as or with diagnosis of type II/III capsular or labral lesion within the first 48 months of initial injury when solely primary conservative treatment is utilized rather than initial primary repair. * Initial primary repair of such lesions is strongly indicated in those under the age of 25 years old and those who complete high intensity activities at the upper extremity of great frequency or duration as to avoid recurrent dislocations, residual shoulder instability and/or dysfunction. * It has been indicated that the use of both open and closed kinetic chain exercise interventions at the shoulder can significantly improve joint reposition sense and proprioceptive awareness from pre to post testing over a period of 6 weeks when used in a cohort of uninjured male military cadets who activity participate in multiple sports and average age of 16 years old. |
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**CLINICAL BOTTOM LINE**

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| Evidence suggests a relationship between chronic shoulder dysfunction, instability, pain, stiffness, or restricted ROM with deficits in core strength and impaired ability to generate proximal feed forward stability at the trunk and scapulothoracic joint within youth or collegiate athletes. Implementation of CKC exercises (standard push-up) has been shown to increase shoulder proprioception and reposition sense at the joint, indicating implementation of CKC interventions geared to challenge proprioception and feed-forward proximal stability can possibly enhance long-term outcomes when paired with traditional modes of GHJ rehabilitation.  For rock climbers who incur anterior/inferior dislocation of the GHJ with confirmed diagnosis of labral lesion, evidence based literature shows it is strongly indicated to undergo primary repair initially followed by extensive rehabilitation rather than solely conservative treatment.  Rock climbing in essence, is dependent on quasi-static equilibrium between four points of contact. With the removal of one or more of these points the climber must generate coordinated and adequate amounts of core tension and directional shifting of his/her center of mass (COM) as to provide stress shielding and facilitate normal amounts of static and dynamic stability requirements at the STJ and GHJ.  The high frequency, duration and intensity of climbing movements pose a significant and increased risk of GHJ/STJ overuse, muscle fatigue, GHJD, recurrent dislocation and poor long-term functional outcomes in climbers. Those who still elect to forgo surgery, it is recommended to adhere to rest-periods of adequate frequency and duration to better avoid overuse and fatigue of muscle-tendon units surrounding the GHJ and STJ as to provide optimal functional stability and hence, minimize further damage to intracapsular tissues as well as risk of future incidence of re-dislocation |

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| ***This critically appraised topic has been individually prepared as part of a course requirement and has been peer-reviewed by one other independent course instructor*** |

**SEARCH STRATEGY**

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| **Terms used to guide the search strategy** | | | |
| **P**atient/Client Group | **I**ntervention (or Assessment) | **C**omparison | **O**utcome(s) |
| Rock Climbing  Rock Climber  Competitive Rock Climbing  Recreational climbers  Youth climbers  Rock Climbing injury  Female Rock Climbers  Male Rock Climbers | Closed kinetic chain  Shoulder  Gleno-humeral joint  Rehab\*  Strengthening  Neuromuscular control  Proprioception  Rotator cuff  Periscapuar  Scapular  Scapulothoracic  Trunk  Core  Stablity  Perturbation training  Balance training  PNF  Rhythmic Stabilization  Prevention | None  Wanted to see effects of proposed interventions in concert with traditional OKC modes of shoulder rehabilitation | Proximal chain stability  Coordination  Joint reposition sense  Neuromuscular control  Pain  Dislocation  Re-dislocation  Gleno-humeral joint laxity  Posture  Return to sport  Gleno-humeral joint stablization |

**Final search strategy:**

*Show your final search strategy from one of the databases you searched. In the table below, show how many results you got from your search from each database you searched.*

Pubmed search:

(Rock Climber or Hanging-Athlete or Gymnastics) and (Dislocation or Rehab\* or Shoulder)

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| **Databases and Sites Searched** | **Number of results** | **Limits applied, revised number of results (if applicable)** |
| **General Databases**  Pubmed  EBSCOhost  Mendely  Google scholar  Cochrane Library | **Some duplicate**  N=13  N=3  N=6  N=7  N=2 | Articles types including RCT’s, meta-analyses, longitudinal cohort with follow-up, systematic reviews, since 2010 |

## INCLUSION and EXCLUSION CRITERIA

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| **Inclusion Criteria** |
| . Systematic Reviews, RCT, longitudinal cohort studies  . Greater than 10 subjects  . Utilized physical activity as means of intervention in shoulder rehabilitation  . Any study pertaining to climbing with shoulder rehabilitation  . Biomechanical Analysis / scholarly article on rock climbing  . Studies about incorporation of balance and postural stability with shoulder rehabilitation  . Measuring Glenohumural joint laxity  . Subject matter is prevention or treatment of GHJ laxity/dislocation  . All articles that have been published since 1990 |
| **Exclusion Criteria** |
| . Single Case-studies, dissertations  . Subject number less than 10 individuals  . Inclusion of subjects with history of acute or prior stroke, hemiparesis/hemiplegic, UMN lesion  . Abstracts  . Articles Published before 1990 |

**RESULTS OF SEARCH**

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| A total of | \_\_31\_ | *(insert number)* relevant studies were located and categorised as shown in the following table (based on Levels of Evidence, Centre for Evidence Based Medicine, 2011) and (insert name of) quality assessment rating scale |

**Summary of articles retrieved that met inclusion and exclusion criteria**

*Note that this table is arranged differently from the example CAT on Sakai. For each article that meets your inclusion and exclusion criteria, score for methodological quality on an appropriate scale, categorize the level of evidence, and note the study design (e.g., RCT, systematic review, case study). Add more rows as necessary.*

\*\* SEE ATTACHED EXCEL TABLE

**BEST EVIDENCE**

The following 3 studies were identified as the ‘best’ evidence and selected for critical appraisal. Reasons for selecting these studies were:

The following 3 studies were identified as the ‘best’ evidence and selected for critical appraisal. Reasons for selecting these studies were: These were studies that showed homogenous groups, randomization, single or double blinding, directly analysed the relationship between core stability and GHJ/UE function/condition, closed chain UE rehabilitation techniques as well as treatment and prevention of primary and recurrent GHJ dislocation and/or laxity with correct referral to orthopaedic as necessary.

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| * Radwan A. et al. Original Research: Is there a Relation Between Shoulder Dysfunction and Core Instability? The International Journal of Sports Physical Therapy, February 2014; Volume 9(1) * Jakobsen W. Bent et al. Primary repair versus conservative treatment of first-time traumatic anterior dislocation of the shoulder: a randomized study with 10-year follow-up. The Journal of Arthroscopic and Related Surgery, 2007; Volume 23(2) * Rogol M. Ian et al. Open and closed kinetic chain exercises improve shoulder joint reposition sense equally in healthy subjects. Journal of Athletic Training, 1998; Volume 33(4):315-318 |

**SUMMARY OF BEST EVIDENCE**

**Title:**  Is There A Relation Between Shoulder Dysfunction and Core Instability? (Feb 2014)

**Authors:** Radwan A, Francis J, Green A, Kahl E, Maciurzynski D, Quartulli A, Schultheiss J, Strang R, Weiss B

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| **Aim/Objective of the Study/Systematic Review:** |
| Primary Purpose: To analyse the difference between healthy athletes and those with shoulder dysfunction in regard to core stability and balance measures.  Secondary Purpose: To explore the relationship between measures of core stability and measures of shoulder dysfunction |
| **Study Design**  [e.g., systematic review, cohort, randomised controlled trial, qualitative study, grounded theory. Includes information about study characteristics such as blinding and allocation concealment. When were outcomes measured, if relevant]  Note: For systematic review, use headings ‘search strategy’, ‘selection criteria’, ‘methods’ etc. For qualitative studies, identify data collection/analyses methods. |
| This was a quasi-randomized case-control Study of experimental repeated measures design. The study evaluated the relationship between a potential risk factor and a disease or disorder; two groups of subjects- one of which has the disease/disorder (the case) and one which does not (the control) are compared to determine which group has a greater proportion of individuals with the risk factor.  Both shoulder-dysfunction (SDF) and non-shoulder dysfunction (NSDF) groups completed the Kerlan-Jobe Orthopaedic Clinical Scale (KJOC) and QuickDASH + Sport-specific mode (QD) at the onset of testing followed by completion of each of the four core stability measures including, single-leg stance balance test (SLBT), Double-leg lowering in supine position (DLL), sorensons test (ST) and modified-side plank test (MSPT). Subjects were randomized to what station they would start along the circuit of tests. Results were measured once during the testing period, analysis of within/between group differences and correlations with performance on core stability measures the were completed after the testing period was completed. |
| **Setting**  [e.g., locations such as hospital, community; rural; metropolitan; country] |
| Location: Utica College, NY; division III collegiate athletics institution, rural/suburb. |
| **Participants**  [N, diagnosis, eligibility criteria, how recruited, type of sample (e.g., purposive, random), key demographics such as mean age, gender, duration of illness/disease, and if groups in an RCT were comparable at baseline on key demographic variables; number of dropouts if relevant, number available for follow-up]  Note: This is not a list of the inclusion and exclusion criteria. This is a description of the actual sample that participated in the study. You can find this descriptive information in the text and tables in the article. |
| Total subject number: (N=61) recruited sample of convenience  Subject demographics: Male (N=28), female (N=33); Mean age weight and height was (19.3 yo +/- 1.1 years), (78.7 kg +/- 16.7 kg) and (172.2 cm +/- 8.9 cm), respectively. All subjects were recruited and Division III overhead athletes in which various overhead sports were represented including football (N=6), swimming (N=7), water-polo (N=3), lacrosse (N=31), baseball (N=1), softball (N=6), track/field throwers (N=6) and basketball (N=6). It was important for me to note that all athletes in this study are throwers who engage in mostly open-chain activities at the upper extremity  Diagnosis: All subjects were actively participating in there respective sport. Division III over-head athletes recruited were with or without shoulder dysfunction. Shoulder dysfunction was defined as previous history of non-contact shoulder injury, non-acute in nature at the time of the study and score of less than 80 on the KJOC  Group allocation: By excluding overhead athletes who were non-active in there respective sport due to shoulder pain or dysfunction, the authors may have depleted their prospective subject population with shoulder dysfunction and may account for the large disparity between the number of subjects allocated to each group, non-shoulder dysfunction (NSDF) (N=48), shoulder dysfunction (SDF) (N=14). This deficit in participants with shoulder dysfunction could potentially underestimate the magnitude of which balance and postural stability affect instance of shoulder dysfunction due to lack of subject pool included in the study. Those who were excluded based on the results could very well have had much more significant deficits in core stability and balance in comparison to those allocated to the SDF group. |
| **Intervention Investigated**  [Provide details of methods, who provided treatment, when and where, how many hours of treatment provided] |
| *Control* |
| N/A |
| *Experimental* |
| Repeated measures design; both groups SDF & NSDF competed each measure of core stability in a sequential, circuit-like fashion. Subjects were randomly assigned to starting point regarding initial core-stability measure completed*.* Not stated who or how many testers carried out the core-stability measures.  SLBT:Measure ability to maintain single leg balance with eyes closed   * + 1 practice trial   + 3 timed trials on each leg- patient position for each trial included:     - Eyes closed     - Arms crossed at the chest     - Contralateral leg slightly flexed     - Contralateral foot at the height of the opposite ankle   + Timer began with lift-off of testing foot   + Timer stopped when patient:     - Opened eyes     - Uncrossed arms     - Shifted weight     - Contact floor or stance leg with elevated foot     - Stance leg migrating out of testing position     - If the subject was able to hold the position for 45 seconds   + The best score on each LE was recorded   DLL: Tested stability of the abdominal muscles   * + Start position: Subject supine with knees extended, 90 deg hip flexion     - BP cuff under curve of lumbar spine     - Cuff inflated to 40 mmHg   + Keeping knees extended subjects attempt to lower into hip extension while maintaining the 40 mmHg of pressure in the BP cuff ( Digital goniometer)     - If pressure fell below 40 mmHg the subject instructed to pause then attempt to correct the pressure, bringing the pressure dial back to baseline position       * If unable then test was discontinued       * Test also discontinued with second instance of dropping below baseline pressure   ST:Tested the stability of the back musculature   * + Start position: Subject lying prone on exam table with legs secured.     - Upper body off the end of the exam table and supported by a chair   + A right angled/straight edge instrument was positioned     - Level to the highest point of the sacrum and BL scapulae     - Subject attempted to maintain contact with back (tactile feedback)   + With initiation of test, subject crossed arms over chest with neutral head/neck alignment     - Instructed to perform isometric contraction and hold till failure   + Testing was discontinued if contact with straight-edge/instrument was lost or upon the patient holding the testing position for 2 minutes   MSPT:Tested the stability of the lateral trunk walls   * + Starting position:subject side-lying with one shoulder on ground and arms crossed over the chest     - Head was rested on a wedge with feet support as well via peanut exercise ball   + 1 practice trial followed by test trial measured in duration (seconds)   + Subject instructed to lift hips off the ground as high as possible     - Dangling pulley system at the iliac crest for tactile feedback regarding maximum hip elevation   + Time started upon reaching maximum hip elevation and stopped upon subjects hip loosing contact with the pulley system |
| **Outcome Measures** (Primary and Secondary)  [Give details of each measure, maximum possible score and range for each measure, administered by whom, where] |
| Kerlan-Jobe Orthopaedic Clinical Scale (KJOC): This is a subjective functional questionnaire filled out by the patient/subject and has be validated and shown to be more specific in overhead athletes than the American shoulder and elbow surgeons scale. This measure has been shown to correlate well with the DASH and QuickDASH functional questionnaires. It is composed of 19 items, 9- yes or no questions related to prior history of injuries at the affected upper extremity as well as current participation and level of competition. There are also 10 items using VAS format regarding shoulder dysfunction and impact on function, pain, weakness/fatigue, stability, effects on QOL/sporting experience, compensations, playing ability etc. with the highest performance score of 100.(2)  QuickDASH sports module:  This is also a subjective functional questionnaire filled out by the patient/subject. The QuickDASH is a shortened version of the DASH Outcome Measure with 11 items rather than 30 to measure physical function and symptoms in with any or multiple musculoskeletal disorders of the upper limb. This short-form also contains two four-item optional modules which are intended for athletes, performing artists and other groups of workers who’s jobs require high levels of physical performance at the upper extremity and may only experience signs/symptoms at higher performance levels which go beyond the scope of the 11-item quick-dash. This shortened version of the tool provides clinicians with an option that enables faster measurement of disability and symptoms.(1)  *Scoring:* At least 10 of 11 items (each rated 1 to 5) must be completed for a score to be calculated. The values for each item are summed and averaged producing a score of 1 thru 5. This value is then transformed to a score out of 100 by subtracting 1 point and multiplying by 25. A higher score represents greater disability. This same procedure is used to score the optional four-item modules. All items must be answered with the optional modules.(1)  *Parametric analysis:*   * *Reliability:* Internal consistency- Chronbach’s alpha= 0.94, Test-Retest- ICC=0.94(1) * *Validity:* Convergent Construct- VAS of overall problem r=0.70, VAS of overall pain r=0.73, VAS of ability to function r= 0.80, VAS of ability to work r= 0.76(1) * *Responsiveness:* Change in treatment group- SRM= 0.79; Change in those rating problem as better- SRM= 1.03(1)   References:   1. Institute for Work & Health. The QuickDASH Outcome Measure, a faster way to measure upper-extremity disability and symptoms, Information for Users. Institute for Work and Health, 2006, Assessed October 21, 2014, [www.dash.iwh.on.ca](http://www.dash.iwh.on.ca) 2. Neuman BJ et al. Results of Arthroscopic Repair of Type II Superior Labral Anterior Posterior Lesions in Overhead Athletes: Assessment of Return to Preinjury Playing Level and Satisfaction. American J Sports Med, September 2011; volume 39(9): 1883-1888 |
| **Main Findings**  [Provide summary of mean scores/mean differences/treatment effect, 95% confidence intervals and p-values etc., where provided – if you need to calculate these data yourself, put calculations here and add interpretation later, under ‘critical appraisal’ on next page] |
| Multivariate analysis of variance test (MANOVA) was used to compare the difference between healthy subjects and those with shoulder dysfunction and followed by analysis of the relationship between the scores of the KJOC and different core stability measures using Pearson Product Moment Correlation Coefficient.   * Alpha level/significance: Set at 0.05 to minimize type I error * Outline of results:   + MANOVA was significant (p=0.038) when comparing SDF to NSDF for right SLBT   + SDF group had significantly lower balance than the NSDF group with means of 10.14 +/- (5.76)(p=0.05) and 18.98 +/- (15.22)(p=0.05) respectively.   + The correlation between the Quick-DASH sports module and the KJOC was calculated for each core stability test.     - Moderate (+) correlation found between the DLL and the KJOC (r = 0.394, p>0.05)     - Weak (-) correlation was found between the right SLBT and the QuickDASH sports module (r = -0.271, p>0.05) |
| **Original Authors’ Conclusions**  [Paraphrase as required. If providing a direct quote, add page number] |
| The Results of this study demonstrated that collegiate overhead athletes with shoulder dysfunction had more impaired balance compared to healthy athletes. Additionally, poor performances of these athletes in some of the core stability measures were correlated to the extent of their shoulder dysfunction. Such results may support the use of balance and core stability training in the design of successful rehabilitation protocols for overhead athletes with shoulder dysfunction. (Direct Quote pg. 12-13) |
| **Critical Appraisal** |
| **Validity**  [Methodology, rigour, selection, sources of bias, quality score on methodology quality rating scale (indicate the quality assessment tool used and the maximum possible score on that scale, e.g., 7/10 on PEDro scale), appropriateness of analytical approach (e.g., adjustments for confounding variables, management of missing data).]  Comment on missing information in original paper. |
| **Level of evidence: Defined from the Oxford Centre for Evidence-Based Medicine**  The authors rate the level of evidence as level **3b** which is consistent with Individual Case-Control Studies. Personally I would rate the level of evidence as **level 4**. This is due to a small sample size of convenience, excessively stringent exclusion criteria, non-blinding, modification of standardized functional measures and lack of transparency with regard to magnitude, variability, and precision of the results found. The authors do not list who or how many testers carried out the core stability measures and thus, adds to the uncertainty of the strength of results obtained.  **Dependent Measures of core stability**  All Core stability measures have been proven reliable and valid measures with regard to predicting deficits in core strength/stability in patients with lower back pain and dysfunction. I was unable to obtain parametric data with regard to core stability/strength with regard to shoulder pain.  SLBT:  Inter-rater reliability with eyes open and eyes closed were ICC: 0.994 (95% CI 0.989-0.996) and ICC:0.998 (95% CI 0.996-0.999), respectively.  DLL: (1)  Intra-rater reliability ICC: 0.84, Inter-rater reliability ICC: 0.79,, Sen: 0.98, Spec: 0.84, +PV: 0.862, -PV: 0.909, ROC: 0.95  ST: (1)  Intra-rater reliability ICC: 0.88 (95% CI 0.73-0.95) Intra-rater reliability ICC: 0.78, Sens: .92, Spec: .84, +PV: 0.808  -PV: 0.90, ROC: 0.90  MSPT: Modified from original version due to avoidance of pain at the affected shoulder and increased tolerance for subjects with shoulder dysfunction. As such the clinician is unable to determine the true reliability, validity, specificity, sensitivity, +PV and –PV with any confidence.  **Selection Criteria**  Excluding overhead athletes who were non-active in there respective sport due to shoulder pain or dysfunction, the authors may have depleted their prospective subject population with shoulder dysfunction and may account for the large disparity between the number of subjects allocated to each group, non-shoulder dysfunction (NSDF) (N=48), shoulder dysfunction (SDF) (N=14). This deficit in participants with shoulder dysfunction could potentially underestimate the magnitude of which balance and postural stability affect instance of shoulder dysfunction due to lack of subject pool included in the study. Those who were excluded based on KJOC and QD scores could have had deficits in core stability and balance of larger magnitude in comparison to those allocated to the SDF group, possibly strengthening the correlation between the independent and dependent variables. All of the over-head athletes would be classified as throwers and thus participate in largely open-chain activities at the upper extremity compared to my patient of focus (rock climbers). The subjects were randomized to what core measure station they would start. This would prevent learned effects from other participants observing form and technique of completion  Authors noted Limitations: Small sample size of participants with shoulder dysfunction, randomized sample of convenience due to strict inclusion criteria, absence of dynamic multi-planar testing procedures and modification of many of the testing procedures to increase patient comfort.  References:  1. Arab A.M et al. Sensitivity, specificity and predictive value of the clinical trunk muscle endurance tests in LBP. Clinical Rehabilitation, 2007;volume 21:640-647 |
| **Interpretation of Results**  [Favourable or unfavourable, specific outcomes of interest, size of treatment effect, statistical and clinical significance, minimal clinically important difference. You may calculate effect size or confidence intervals yourself from the data provided in the article.] Describe in your own words what the results mean. |
| MANOVA analysis found significant differences (p=0.038) in the mean score on the SLBT between the SDF and NSDF groups, however these findings only show that there was a difference in one of the groups rather than which group showed the actual difference. Mean scores with the SLBT in the SDF and NSDF group were 10.14 +/- (5.76)(p<0.05) and 18.98 +/- (15.22), respectively. Confidence intervals were excluded, which decreases my confidence in the amount of variance and associated accuracy and precision of the results obtained.  Pearson Product Moment Correlation was completed to examine the relationship between each independent measure (KJOC, QD) separately with regard to each of the core stability measures. The mean values obtained on all core stability measures in both SDF and NSDF groups had extremely large standard deviations that indicate increased variance and decreased precision of the results obtained. The authors again neglected to include confidence intervals as well as coefficient of determination (r2), decreasing the my confidence in the actual amount of variance, accuracy of the relationship and does not examine the actual magnitude of effect with regard to dependent variables on each independent variable separately. The authors found “moderate” positive correlations between the DLL core stability measure and KJOC subjective questionnaire score, r=0.394 (p<0.05) and “weak“ negative correlation between the right leg SLBT core stability measure and QD scores, r=-0.271. However, The Guide to Evidence-Based Physical Therapist Practice defines a “moderate” and weak” correlations as r-value ranges between 0.51-0.75 and 0.0-0.25 respectively, making the authors results somewhat misleading regarding the strength of correlations between deficits in balance and core-stability with instance of SDF as categorized on the primary outcome measures (KJOC, QD). Based on the literature, the true positive and negative correlations are “fair” rather than moderate and weak.   * The actual calculation and proof of Power analysis’ however, implied that the authors wanted to achieve 80% power making the Beta Error level 20% * With regard to the mean values on the SLBT which were found have significant between group difference (p=0.38), the DDS research calculator was utilized to calculate the necessary sample size of each group to reach a power of 0.80 and significance level of 0.05. The results indicate that a sample size of N=21 is necessary in both groups meaning that there was over 20% chance that the mean scores of the SDF group occurred by chance rather than true correlation between deficits in balance and SDF. The authors would have to increase there alpha level to 0.15 to achieve a power of .80. However this means that there would be a 15% chance of type I error, leading one to conclude that supposed effect or relationship exists when in fact it does not. With the amount of variability in results as demonstrated by the large standard deviations, lack of inclusion of confidence intervals as well as only fair to moderate strength of correlations found during the Pearson Product Correlation, it seems as though the authors decided to leave the significance level at 0.05 and neglect to expound objectively on the negative effects of their small sample size within the SDF on the power of the results.   Clinical Implications:  Though the subject population was composed of over-head, open-chain oriented upper-extremity activities, the studies purpose was similar to my clinical question regarding the contribution of decreased core stability and/or postural control in the development of shoulder dysfunction. The evidence does support the incorporation of independent and/or simultaneous core stability/postural control interventions in the prevention, treatment and rehabilitation of rock climbers with shoulder dysfunction. More research is needed with regard to reliability and validity of core-stability and balance measures with predicting shoulder dysfunction. More RCTs, longitudinal cohort studies with follow-up as well as case-series focused on core stability and balance perturbation in the rehabilitation of shoulder dysfunction of both the general population as well as closed chain oriented sport/vocation. These types of studies would be more apt to show the true strength of correlation between core stability and shoulder dysfunction with less variability and more precision, increasing my confidence in the implementation of such interventions with regard to my own patient population. |

**II**

**Title:**

Primary Repair Versus Conservative treatment of First-Time Traumatic Anterior Dislocation of the Shoulder: A Randomized study with 10-year follow-up (2007)

**Authors:** Jakobsen W. Bent, Johannsen Hans Viggo, Suder Peter, Sojbjerg Ole Jens

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| **Aim/Objective of the Study/Systematic Review:** |
| Purpose:   * To compare long-term outcome following first time traumatic anterior shoulder dislocation when treated with initial surgical repair (Bankart repair) followed by extensive rehabilitation versus primary conservative treatment/rehabilitation. * Following first time traumatic shoulder dislocation, evaluate the risk recurrent dislocation following primary Bankart repair versus primary conservative treatment in young male and female patients |
| **Study Design**  [e.g., systematic review, cohort, randomised controlled trial, qualitative study, grounded theory. Includes information about study characteristics such as blinding and allocation concealment. When were outcomes measured, if relevant]  Note: For systematic review, use headings ‘search strategy’, ‘selection criteria’, ‘methods’ etc. For qualitative studies, identify data collection/analyses methods. |
| * This was an multicentre, prospective, randomized controlled trial with long-term follow-up at 24 months and 10 years * Thirteen regional hospitals participated in the study. On a first-come first-serve 85 patients who presented to the emergency room and met inclusion criteria were asked and selected to participate in the study. * Each hospital designated one orthopaedic surgeon to complete all diagnostic arthroscopic procedure and subsequent Bankart repair techniques for prospective study participants. Prior to the study all 13 surgeons gathered to practice a methods of surgical repair, review the arthroscopic evaluation system and the Constant score measure to better achieve standardization and decrease variability when identifying the presence and gauging the severity of capsular and/or labral lesion as well as the actual repair technique. * All patients who agreed to random allocation (N=80) underwent evaluative arthroscopic procedures within 1 week post initial injury. Surgeons were unaware of the patient’s future group allocation during arthroscopic evaluation and thus blinded and unbiased regarding diagnoses and severity of lesion. * Patients were randomly allocated to groups, primary repair (PR) or conservative treatment (CT) through a sealed envelope process. Those who where allocated to PR were redressed and underwent primary Bankart repair. Patients allocated to CT had the arthroscopic probe removed and incision sutured.      * Patients in both CT and PR groups had their affected shoulder immobilized via fixed sling for 2 days followed by 1 week in a non-fixed fixed sling. With non-fixed sling removal at 1 week, all patients began subsequent rehabilitation programs with standardized protocol. * Follow-up assessments were completed at 24 months and 10 years postoperatively regarding both PR and CT groups and patient-reported instances of re-dislocation, subjective dysfunction/instability or surgical repair secondary to initial treatment received during the study period. At 24 month follow-up, evaluation of instability and apprehension at the affected joint was completed via clinical diagnostic testing (load-and-shift test; Apprehension test) and objective scoring based on the Constant shoulder evaluation system. Follow-up assessment 10 years postoperatively utilized the Oxford self-assessment shoulder score via phone interview. |
| **Setting**  [e.g., locations such as hospital, community; rural; metropolitan; country] |
| Recruitment (Emergency department) and arthroscopic evaluation was undergone at 13 hospitals based in Denmark. Authors do not divulge community or population demographics surrounding the participating hospitals nor do they specify information regarding the location of outpatient rehabilitation centres or 24-month follow-up assessment. |
| **Participants**  [N, diagnosis, eligibility criteria, how recruited, type of sample (e.g., purposive, random), key demographics such as mean age, gender, duration of illness/disease, and if groups in an RCT were comparable at baseline on key demographic variables; number of dropouts if relevant, number available for follow-up]  Note: This is not a list of the inclusion and exclusion criteria. This is a description of the actual sample that participated in the study. You can find this descriptive information in the text and tables in the article. |
| * All patients were recruited consecutively as they were encountered within the emergency department at the 13 area hospitals participating in the study. * The total patient population (N=80) who met all inclusion/exclusion criteria were between the age of 15 and 39 years, no prior history of shoulder dysfunction/instability, suffered first-time anterior traumatic shoulder dislocation according to radiographic imaging, without fracture of the greater tubercle, and eventual arthroscopic diagnosis of capsule/labral lesion.      * Furthermore upon arthroscopic evaluation lesions varied regarding severity including those with no-lesion (N=4), grade I indicating capsular tear w/o lesion (N=5), grade II indicating capsular tear w/partial labrum detachment (N=10), or grade III indicating complete detachment of anterior glenohumeral ligaments as well as labral disruption (N=61). Patients found to be without lesion were excluded from the study.      * Of the patient total included in the study 49% (N=37) incurred dislocation during sports participation, mostly due to external contact or falling with the arm extended while 10.5% (N=8) suffered dislocation during a motor vehicle accident. No abnormalities were identified upon radiograph * No significant group differences were found between PR (23yo; 15-39 years;30:7) and CT (20yo; 15-31 years; 32:7) regarding average age, age-range or male-to-female ratio, respectively (p>0.05). * The study was able to reach and obtain follow-up measures with >/= 98% of the total study population |
| **Intervention Investigated**  [Provide details of methods, who provided treatment, when and where, how many hours of treatment provided] |
| *Control: Primary Conservative treatment via rehabilitation (W/O Bankart repair)* |
| * Regarding patients randomized into CT group, only arthroscopy was performed. Postoperatively the patients affected shoulder was immobilized via fixed sling for 2 days followed by 1 week of wearing a non-fixed fixed sling with only passive range of motion permitted. The non-fixed sling was removed at 1 week. Patients began subsequent rehabilitation program immediately upon sling removal. Program was standardized and used for both groups.   **Rehabilitation Protocol:**   * nonfixed sling for 1 week * post both groups underwent identical rehabilitation programs consisting of   + passive ROM immediate post-op     - without rotation, lifting and pushing restrictions   + 3 wk post-op: Active internal rotation and abduction were permitted   + 8 wk post-op: Active external rotation exercise introduced   + 12 wk post-op: Light sport activity and swimming allowed   + 6 mo post-op: Return to overhead sports post 6 month |
| *Experimental: Primary Bankart repair + standardized rehabilitation protocol (mentioned in control)* |
| **Surgical Repair:** Patients randomized to surgery were redressed with the subscapularis tendon being exposed.1 The capsule and tendon were cut and the Bankart lesion repaired anatomically by the use of Mitek anchors.1 Following repair the capsule and subscapularis tendon were closed end to end.1 Postoperatively patients allocated to PR group, had affected shoulder immobilized via fixed sling for 2 days followed by 1 week of wearing a non-fixed fixed sling with only passive range of motion permitted.1 The non-fixed sling was removed at 1 week where Patients began subsequent rehabilitation program immediately upon sling removal1 (Protocol mentioned above).  Reference:   * Jakobsen B.W et al. Primary repair vs conservative treatment of first-time traumatic anterior dislocation of the shoulder: A randomized study with 10 year follow-up. Journal of Arthrocopic and Related Surgery;volume 23(2):118-123 |
| **Outcome Measures** (Primary and Secondary)  [Give details of each measure, maximum possible score and range for each measure, administered by whom, where] |
| **Constant shoulder evaluation system (Constant Score):**   * The Constant score is one of the first shoulder score systems developed.1 A clinician administered outcomes measure, the Constant score is widely used and accepted by the European Society for Surgery of the Shoulder and Elbow (ESSSE) as “the gold-standard” for the assessment of shoulder function regarding general shoulder disorders as well as in clinical research.1 The Constant score is used often to evaluate treatment progress and compare results of clinical trials for several specific shoulder disorders.1 The Constant score assesses subjective (score range:0-35) and objective (score range:0-65) shoulder function with respect to pain, activities of daily living (ADL), range of motion (ROM) and strength.1 Total scores (0-100) are the sums from the subjective and objective portions of the measure which is measured bilaterally. Grading of the Constant score is based on the difference between the affected and unaffected shoulder and rated as “Poor” (>30pts), “Fair” (21-30pts), “good” (11-20pts), and “excellent” (<11pts).3 Only the strength component of the Constant score has been methodologically standardized (Strength is measured at 90° lateral abduction by use of either an Isobex device or a defined spring balance technique: 1 point per 0.5 kg maximum 25 points)4 with variations in how pain, ADL, and ROM are implemented and/or interpreted between clinicians or institutions.2 Due to this lack of standardized protocol, interrater reliability of the Constant score is generally regarded as low to moderate (α=0.37- 0.60).1,2,4 However intrarater/test-retest reliability regarding Constant score total score as well as scores for each item/measure independently us shown to be high (α= 0.80-0.90).1,2,4   **The Oxford self-assessment shoulder Score (OSS):**   * The OSS is a self-assessment of pain and function of the shoulder. Easy to complete the OSS takes about 2 min to complete and consists of 12 items: 4 items about pain and 8 items focused on daily functioning.4 Each item is scored into 5 Likert categories: 1=no pain/easy to do, 2=mild pain/little difficulty, 3=moderate pain/difficulty, 4=severe pain/extreme difficulty, and 5=unbearable/impossible to do.4 Other revisions of the OSS use Likert categories 0-4 indicating worst-best, respectively.4 The (total) score is the sum of the (completed) 12 items (scoring 1–5): 12 = no disability and 60 = max disability. In the revision, it is 0 = max disability and 48 = no disability.4 Important to note is that missing items are scored as a “5” and thus can skew results. As such one must complete >/= 10 items on the OSS for it to reliably scored.4 The OSS is easy to read and comprehend and demonstrates low floor and ceiling effects.4 The OSS has been shown to be reliable with high internal reliability/consistency (α=0.94) and high test-retest reliability (r=0.98).4 Furthermore the OSS has moderate to good construct validity when compared to alternate measures of shoulder pain/functioning such as the Constant score (r(range)=0.65-0.87).4 However it is not thought to be most reliable when used to assess outcomes post non-stabilization treatment and/or surgical repair.2   **Objective testing: Load and Shift test & Apprehension/Relocation test**  Clinical diagnostic testing used in isolation are often poor predictors of pathology. This is especially true with shoulder special-tests and so it is suggested that using clusters of tests as well as clinical prediction rules (CPRs) when available to improve accuracy with diagnosing shoulder pathology. Additionally, regarding shoulder special testing, quality assessment of Diagnostic accuracy studies (QUADAS) attempt to discern internal/external validity through the measures sensitivity, specificity and positive/negative likelihood ratio (+/- LR) with a score of >/= 10 indicating tests of high diagnostic/assessment quality.   * **Load and shift test:** There are established psychometric properties reported regarding reliability, sensitivity, specificity, +LR, -LR or QUADAS quality rating * **Apprehension/relocation test:** Multiple studies have indicated psychometric properties of this test. There is no reported evidence regarding the tests reliability. However results are markedly variable, inconsistent with large ranges in the results obtained regarding QUADAS-score (9-12), sensitivity (0.04-0.85), specificity (0.27-1.00), +LR (0.05-3.38), and - LR (0.21-3.52). Clinical prediction rules regarding shoulder instability solely use apprehension and/or relocation. Results by Farber et al (2006) indicate with positive results for both apprehension and relocation can determine diagnosis/prognosis that is sensitive (0.81), specific (0.98), with increased likelihood with achieving true positive/negative result (+LR=37.0/-LR=0.19) of high quality (QUADAS score=11). However it is important to note that the CPRs pertaining to shoulder instability are graded as level IV and thus, have been derived but have not been validated within a general or specific patient population nor have the CPRs been implemented on small or large scale.   Refrences:   1. Ban Ilija et al. Standardised test protocol (Constant Score) for evaluation of functionality in patients with shoulder disorders. Dan Med Journal, 2013;volume 60(4) 2. Rocourt M.H et al. Evaluation of intratester and intertester reliability of the Constant-Murley shoulder assessment. Journ of Shoulder and Elbow Surgery, April, 2008;volume 17(2):364-369 3. Constant CR, Murley AH. A clinical method of functional assessment of the shoulder. Clin Orthop Relat Res. 1987 Jan;(214):160-4. (Assessed online 11/19/2014). [www.orthopaedic**score**.com/**score**pages/**constant**\_shoulder\_**score**.htm](http://www.orthopaedicscore.com/scorepages/constant_shoulder_score.htm) 4. Angst, Felix et al. Measures of adult shoulder function: DASH, QuickDASH, SPADI, ASES, Constant (Murley) Score, SST, OSS, SDQ and WOSI. Arthritis Care and Research, November 2011;volume 63(11):174-188 5. Essa, Michael, DPT, MA, ATC, LAT, CSCS. Evidence Based Evaluation of Shoulder Special Tests and Clinical Prediction Rules: An Audiovisual Guide to Shoulder Evaluation, April 2 (2013). [powerpoint presentation] assessed 11/19/2014. <https://sakai.unc.edu/access/content/group/2ec17f17-7909-48b1-ae92-5ff35361cd7b/Unit%20Two/Mike%20M%20-%202012%20class/Mike%20Essa%20Lecture/Shoulder%20Special%20TestsCPR.pdf> |
| **Main Findings**  [Provide summary of mean scores/mean differences/treatment effect, 95% confidence intervals and p-values etc., where provided – if you need to calculate these data yourself, put calculations here and add interpretation later, under ‘critical appraisal’ on next page] |
| **Alpha level/significance:** Pearson test was used with a threshold of 0.05 for P value with student t test via SPSS statistics package performed for comparison of the constant score  **24 mo follow-up:**   * + - (+) Apprehension tests were experienced in 39% and 7 % of those in CT and PR groups, respectively (p=0.014).     - (+) Load-and-shift test were experienced in 33% and 4% of those in CT and PR groups, respectively (p=.009).     - of the total subject population, 29% (N=22 of 76) sustained recurrent anterior dislocation       * All subjects with recurrent GHJ dislocation had Bankart type 2 or 3 lesion       * Of those who experienced recurrent dislocation, 95.5% (N=21) were allocated to the CT group, accounting for 53.8% of all group members (p=.0011).         + new traumatic event in 18 cases         + 80% with type 2 tears and 53% with type 3 tears experienced a recurrent dislocation by 2 years post-op       * N=1 (2.7%) of those in the PR group experienced recurrent dislocation (p=.0011).       * Recurrence was sustained within the first 11 months post-op in 64%       * No significant differences between groups were apparent regarding subjects without re-dislocation   **10 years post-op:** all subjects but one were contacted by telephone for an interview as well as completed the Oxford self-assessment shoulder score (N=75)   * 62% (N=24) and 9% (N=3) of patients in CT and PR groups respectively, incurred recurrent dislocation since the initial dislocation * Those in the PR group who incurred recurrent dislocation were all under 25 yo and resulted from significant trauma. * Furthermore 4 members of the PR group complained of pain and stiffness at 10 years postoperatively one patient in the PR group received a second repair which also resulted in poor outcome and continued instability * In total 20 patients between CT and PR groups received further surgery examination since the 24mo follow-up. * 80% (N=19) of those in the CT group underwent open or arthroscopic bankart repair with 64% of those receiving the surgical repair reporting good to excellent subjective outcomes on the Oxford shoulder assessment * 74% of patients who received conservative treatment had unsatisfactory results according to the oxford score compared to 72% of those with surgical repair reporting good or excellent results at the same point following surgery |
| **Original Authors’ Conclusions**  [Paraphrase as required. If providing a direct quote, add page number] |
| * Arthroscopic evaluation after a first-time anterior shoulder dislocation revealed a Baker type 2 or 3 lesion in 93.5% of reported cases. This study found significantly more redislocators after conservative treatment compared to primary open Bankart repair. Due to the superior long-term outcomes regarding shoulder pain, stability, function and significant decrease with instance of recurrent dislocation associated with initial Bankart surgical repair followed by extensive rehabilitation compared to solely initial conservative treatment post initial injury, we recommend that the surgeon consider primary repair in active as well as younger patients to reduce the risk of recurrence and avoidance of prolonged shoulder dysfunction.1   Refrences:  1. Jakobsen W et al. Primary repair vs conservative treatment of first-time traumatic anterior dislocation of the shoulder: A randomized study with 10 year follow-up. Journal of Arthrocopic and Related Surgery;volume 23(2):pg 122 |
| **Critical Appraisal** |
| **Validity**  [Methodology, rigour, selection, sources of bias, quality score on methodology quality rating scale (indicate the quality assessment tool used and the maximum possible score on that scale, e.g., 7/10 on PEDro scale), appropriateness of analytical approach (e.g., adjustments for confounding variables, management of missing data).]  Comment on missing information in original paper. |
| Methodology:  The researchers went to great lengths to achieve a standardized protocol. Multicentre designs as well as long-term follow-up periods increase the difficulty of achieving a standardized protocol and ensuring the results obtained are valid and reliable. To counter this researchers decided to recruit subjects at the emergency room of participating hospitals who met inclusion criteria. Radiographic evidence on anterior dislocation was performed identically for each recruited subjects, using standard anteroposterior and lateral radiographs as well as the West Point view. Furthermore, the researchers used one surgeon exclusively from each participating hospital to preform the arthroscopic evaluation and surgical repair and required these same surgeons to gather together and standardize surgical technique, evaluation of the injury and implementing the Constant shoulder score at the 24mo follow-up. Researchers had potential subjects agree to random allocation where all underwent arthroscopic evaluation to diagnose lesion and severity. It is important to note that the subjects were randomized during the arthroscopic procedure but after the surgeon’s diagnosis, blinding him/her regarding CT or PR group allocation of the subject. Following randomization, surgeons were able to complete the procedure accordingly and thus, the researchers achieved excellent between group homogeneity regarding time elapsed from initial injury to surgical evaluation/procedure (1-week) and subsequent duration of the studies standardized protocol including periods of immobilization (2 days fixed sling + 1-week non-fixed sling) as well as initiation of standardized rehabilitation protocol and progressions for 6 months until the follow-up periods at 24 months and ten years.  The researchers present a large amount of evidence that strongly support primary repair over conservative treatment upon incurring capsular or labral lesions following first time traumatic anterior shoulder dislocation. The study also achieve excellent patient adherence with no patient attrition at the 24 month follow-up period and able to gather subjective outcomes information from all but one of the initial total patient population (98%). This along with good practice of standardization mentioned previously ensures that the results that were obtained were most likely valid across the entire course of the study. However, this evidence is almost exclusively expressed by percentages and statistical significance. The researchers only state the number of recurrent dislocations in each group and neglect to provide any written record of subjective or objective information regarding subject/group mean scores, standard deviations, confidence intervals, effect sizes on follow-up outcome measures. The authors also show that groups CT and PR were homogeneous regarding size, mean age and male to female ratios but neglect to show the relative distribution of number of patients recruited from each participating hospital (first come-first serve selection), patient age or type/severity of lesion across both groups. This lack of information proves to be very significant, leaving the reader unable to identify trends between positive/negative outcomes and the respective hospitals in which subjects are recruited as well as possible sources for these trends (ie:socio-economic status, adequate/inadequate recourses outside study, poor practice by therapist/surgeon etc.). More importantly, the studies results showed over 95% of recurrent dislocations incurring in those under 25 yo and with type II/III lesions and thus, the distribution of which could predispose a group for re-dislocation or poor overall outcome.(see interpretation section) The researchers also state that the majority of injuries occurred during sports participation (49%) with 10.5% due to MVA but neglect to divulge the mechanism of injury for the remaining 40% of patients (N=31) which also decrease the overall information to take into account with interpreting the results. The authors do not mention an attempt to blind as well as neglect to identify examiners and/or those scoring/conducting the Constant score nor OSS at the 24mo and 10-year follow-up, respectively. Due to the Constant score being discussed prior to the start of the study between respective surgeons the reader is left to assume they at least carried out the objective and subjective portions of the Constant score outcome measure at 24 months. The surgeons being unmasked for the Constant Score and potentially also the OSS present them with the opportunity to show results which favour their technique presenting a large potential source of bias and personal questioning of the research validity. I also believe the authors should have used a clinician administered outcome measure other than the Contestant score as well as objective measures (load and shift; apprehension at 24 months. The Constant score has been validated and shown as reliable regarding test-retest reliability however evidence shows that the outcome is most valid regarding shoulder dysfunction other than post-stabilization procedures. Furthermore, there is deficit or a total lack of current evidence of neither test quality nor psychometric properties regarding the load and shift or Apprehension tests. Also these stability tests are more abrupt and forceful which lend the patient to be more apprehensive and increased guarding and hence also may have skewed and affected the results. The inappropriateness of outcome measures is further amplified due to the vast majority of recurrent dislocations occurring within the first 24 months post initial injury (75%). This is illustrated by the confounding results at the 24 month follow up period where authors stated they found no significant between group differences or correlations regarding group mean score on the Constant score and incidence of re-dislocation which was shown to be significant between PR (N=1) and CT (N=21) groups. I and most readers would question this due the assumption that recurrent dislocation would correlate to a constant score that reflects worse overall functioning and presence residual signs and symptoms such as pain, stiffness or restricted ROM at the effected shoulder.  Level of Evidence: The authors state this study as Level I, high quality, prospective randomized controlled trial. Based on the PEDro quality rating scale I would rate this as a level 1B and of “good” quality rather than “excellent” quality. This is due to researchers neglecting to include and/or their lack of transparency regarding assessor/examiner blinding, measures of variability such as standard deviations, standard errors, confidence intervals, ranges of group means as well as point measures other than incidence of recurrent dislocation across both groups. This significantly reduces the reader’s ability to determine the true size of the treatment effect with less certainty of the precision of the results obtained when comparing the long-term efficacy with utilizing primary repair in addition to rehabilitation compared to solely conservative treatment. |
| **Interpretation of Results**  [Favourable or unfavourable, specific outcomes of interest, size of treatment effect, statistical and clinical significance, minimal clinically important difference. You may calculate effect size or confidence intervals yourself from the data provided in the article.] Describe in your own words what the results mean. |
| 24-month follow-up   * 75% of all recurrent dislocations occurred within 24 months of initial injury (N=22/29) with all but one instance occurring in the CT group (N=21), which amounts to 53.8% of those receiving primary conservative treatment suffering recurrent dislocation. The authors provide a bar graph schematic illustrating the age-group distribution and instance of non-recurrent/recurrent dislocation for the CT group only (figure 3). The reader can see that with in the CT grouping, out of 21 people who re-dislocated, 12 were </= 19 years old where 16 subjects were </= 24 years old; accounting for 57% and 76% of those show re-dislocated in the CT grouping. Furthermore, if you translate this information over to the CT group in its entirety, out of 39 total subjects, 17 were </= 19yo and 29 were </= 24yo, and thus indicates between 44%-75% of the CT grouping were more prone to re-dislocation to begin with. * The authors also show that 78% of those in the CT group had a positive apprehension and/or load and shift test compared to just 11% in the PR. This indicates that with or without recurrent dislocation, neglecting primary repair could dramatically increase the chance for residual instability or GHJ dysfunction. These findings seem to not translate over to functional impairment based on researcher stated absence of between group differences regarding performance on the Constant score outcome measure further illustrating the negative impact of the researchers using outcomes measures that were possibly inappropriate.   10-month follow-up   * 3 additional subjects re-dislocated in the CT group (Ntotal=24) where 2 additional subjects re-dislocated in the PR group (Ntotal=3) where all instances of re-dislocation at the 10-year follow-up were due to traumatic incidence and were under the age of 25 years. This amounts to 63% of those treated with primary conservative rehabilitation being almost 8-times more likely to re-dislocate the affected shoulder compared to 8% re-dislocation in subjects who received primary Bankart repair initially followed by rehabilitation. * 19 subjects out of the 24 who suffered recurrent dislocations went on to receive primary repair with 64% of these resulting in positive outcomes based on their OSS scores. This further points the efficacy of undergoing primary repair initially rather than conservative treatment. * Additionally, results further strong favour initial primary repair to achieve optimal long-term functional outcome. There were marked negative effects regarding long-term subjective functional outcomes associated with primary conservative treatment following first-time traumatic anterior shoulder dislocation. Only 12% of the CT group did not report recurrent dislocation, did not seek further treatment or surgical procedure nor experienced residual instability, pain or stiffness. Additionally, up to 75% of the CT grouping experiencing unsatisfactory results based on their subjective scoring on the OSS. In contrast, within the PR grouping, 53% of patients (19/36) had excellent long-term and 17% (6/36) of patients reported good results based on their subjective scoring on the OSS. Again however the actual magnitude of positive or negative effect size of the treatment can not be determined due to lack of inclusion regarding point measures of individual and or group mean scores and measures of precision and variability.   Clinical relevance  The GHJ incurs the most dislocations of any joint in the body due to the large amount of functional stability required overall from the muscle-tendon unit attachments relative to passive mechanical stability. Few prospective RCT’s comparing PR versus CT following anterior dislocation have been published, none of which incorporate a long-term follow-up period and strongly indicate the relevance of this study. The results obtained suggest flipping the current rationale regarding the treatment first time traumatic shoulder dislocations and diagnosis of Type II and III capsular or labral lesions; showing significant favourable long-term outcomes associated with referral to orthopaedic surgeon and undergoing primary surgical repair initially followed by extensive rehabilitation. Due to no significant differences seen between groups regarding the Constant Score at 24 months it seems that extensive rehabilitation by itself may provide improvements in strength as well as AROM and patient benefit by providing functional stability around the shoulder joint. However unrepaired capsular/labral lesions prolong deficits in passive mechanical stability which overtime promotes overuse, fatigue, further tissue degeneration and future chronic joint dysfunction (pain, stiffness, functional deficit) or total failure in functional stability and associated re-dislocation of the joint. This is especially true if the patient is active in sports/high-intensity physical activities, young (</= 25yo) with radiographic evidence of type I,II, III lesion. With this knowledge and the patient still elects to hold off on surgery, the clinician should be cognisant of the high risk of dislocation within the first 11 months to 2 years and make the patient and/or patients family aware of this critical period of increased risk as well. Furthermore, the clinician must be diligent regarding smart and gradual progressions based on the patient meeting functional progression criteria rather than at a predetermined period of time to better provide all around functional stability to the joint. This active, functional stability also must be patient- centred to required daily activities, vocation or sport/recreation to provide optimal long-term benefit as well as enable return to work and or sport. In the prospective study the researchers are grossly negligent and vague regarding their standardized rehabilitation protocol nor do they list functional progression criteria but rather progression based on periods of time. The protocol however seems to be made up of primarily of open-chain AROM and isotonic resistance exercises, pointing to the possible efficacy and increased benefit with incorporating a more holistic view of rehabbing the gleno-humeral joint; incorporating proximal feed forward stability at the trunk and scapulothoracic joint though challenging postural stability, incorporating balance perturbation as well as functional closed-chain therapeutic exercises along with the traditional open-chain forms of therapeutic exercise. By recruiting patients within hospital emergency departments the prospective patient population to those with dislocation due to major impact type of event such as falling from a large height or MVA and explains the large proportion (80%) of very severe type III capsular or labral lesions (complete detachment of the anterior glenohumeral ligaments and complete labral disruption). As such this patient population is not consistent with the normal presentation of shoulder dislocation, dysfunction, and instability associated with the competitive and/or recreational climber within the outpatient setting. This population is more apt to dislocate and relocate the shoulder as well as incur multiple subluxations due to muscle overuse, lack of rest/recovery and thus, functionally fatiguing structures providing dynamic stability to the shoulder joint. These less traumatic dislocations or recurrent subluxations can create laxity among passive mechanical stabilizers or smaller capsular or labral lesions such as Type I (capsular tear w/o labral lesion) or type II (capsular tear w/ partial labral lesion). Clinically at this point I would want to advise my patients with diagnosed lesions of the greater risk of recurrent dislocations in the future as well as poor long-term functional outcomes. I would indicate the increased risk of residual dysfunction at the shoulder and that early repair may be the smart and best long-term option for someone taking part in activity that requires great amount of stability at the shoulder. If the patient still is weary about having repair completed I would take the same precautions and clinical rational mentioned previously during rehabilitation and monitor for increases in sign/symptom presentation regarding pain, stiffness, restricted ROM and or functioning and refer out accordingly. |
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**III**

**Title: Open and Closed Kinetic Chain Exercises Improve Shoulder Joint Reposition Sense Equally in Healthy Subjects**

**Authors;Year: Rogol M. Ian, Med, ATC; Ernst Gregory, PhD, PT; Perrin David H., PhD, ATC (1998)**

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| **Aim/Objective of the Study/Systematic Review:** |
| Primary Purpose: To compare and/or contrast the effects of closed kinetic chain exercises versus open kinetic chain exercises in regard to improvement of joint position/reposition sense in the shoulder of adolescent athletes. |
| **Study Design**  [e.g., systematic review, cohort, randomised controlled trial, qualitative study, grounded theory. Includes information about study characteristics such as blinding and allocation concealment. When were outcomes measured, if relevant]  Note: For systematic review, use headings ‘search strategy’, ‘selection criteria’, ‘methods’ etc. For qualitative studies, identify data collection/analyses methods. |
| * This was a randomized controlled trial, which took place over a period of 6 weeks and included pre-testing where baseline measures were collected and post testing at 6 weeks upon completion of the intervention period. * The University of Virginia Committee for the Protection of Human Subjects approved the study. * Subjects in the study were volunteers and were randomized to one of three groups who would complete solely open kinetic chain exercise (group 1 N=13), solely closed kinetic chain exercises (group 2, N=13) or control (group 3, N=13) who completed no upper extremity exercise over the 6 week duration of the study. No subject performed alternative upper extremity exercise during the study period. * No subject was familiar with the testing neither protocol nor measurement device. During the pre-testing and post-testing period at 6 weeks, baseline assessment of passive and active joint reposition sense was completed for the dominant, non-injured shoulder on all subjects using the Cybex II isokinetic dynamometer. Reposition sense was tested in 3 positions; 30o internal rotation (IR), 30o external rotation (ER) and 10o from full external rotation. * During both pre-testing and post-testing at 6 weeks, the starting position during assessment was homogenous throughout the subject population. Subjects were positioned in supine on the Upper Body Exercise Table with the shoulder joint in neutral position regarding IR-ER. The shoulder joint axis of rotation was positioned so that it was inline with the rotational axis of the isokinetic dynamometer. Each subject’s elbow was flexed to 90o and shoulder elevated to 90o abduction. Subjects had their hands covered in elastic wrap to minimize tactile sensation of the Cybex lever-arm and possible confounding of results regarding perceived joint position. * During assessment of passive joint reposition sense, subjects were instructed to totally relax, where the examiner passively moved to each of 3 predetermined positions, held for 10 seconds and returned to neutral, starting position. Following return to staring position, the examiner again passively repositioned the shoulder towards the 3 pre-determined angles where the subject was instructed to call out “stop” when they felt the testing position had been replicated. For all passive movement assessments, the examiner repositioned the joint at the rate of 6 degrees/sec-1 as indicated by the Cybex dynamometer.      * This procedure was completed 3 times for each of the 3 testing positions independently, where an mean absolute value was obtained regarding the difference between the subjects perceived replication of the testing position and the true testing position. * Baseline assessment of active joint reposition sense was performed using the same methods and protocol as passive assessment but with the patient actively moving to the predetermined test position with examiner assistance followed by return to starting test position and subsequent active attempt by subject to replicate the 3 predetermined testing positions. The mean absolute values of the 3 errors were used for statistical analysis. * Researchers attempted to better relate the OKC (dumbbell bench-press) and CKC (push-up) interventions by using a criterion weight (CW) and progression of this weight with the OKC group. This was calculated by having subjects in-group 1 assume the up and down push-up positions with each hand placed on top of independent, identical bathroom scales. The average weight between the two scales were averaged for both the up and down positions and used as the CW for the OKC exercise protocol; where 75% (2 weeks), 85% (2 weeks), and 95% (2 weeks) of CW was implemented and progressed throughout the 6 week intervention. * The average absolute error scores of shoulder reposition sense both passively and actively were analysed with a mixed-model analysis of variance (ANOVA) with respect to the different modes of training (OKC vs CKC vs control) and the 3 testing angles (300 IR/ER and 100 end-range ER). Tukey post hoc analyses were conducted to determine statistical significance of the results obtained within and between groups. Alpha level was set at 0.05 for all statistical analyses. |
| **Setting**  [e.g., locations such as hospital, community; rural; metropolitan; country] |
| The study was conducted at the Curry School of Education, University of Virginia, Charlottesville, VA, USA |
| **Participants**  [N, diagnosis, eligibility criteria, how recruited, type of sample (e.g., purposive, random), key demographics such as mean age, gender, duration of illness/disease, and if groups in an RCT were comparable at baseline on key demographic variables; number of dropouts if relevant, number available for follow-up]  Note: This is not a list of the inclusion and exclusion criteria. This is a description of the actual sample that participated in the study. You can find this descriptive information in the text and tables in the article. |
| * The total subject population (N=39) was composed entirely of injury-free male military cadets who volunteered for the study. All subjects participated in multiple sports at the respective academy. * Of the total population who volunteered for the study, key subject characteristics were found regarding average age (16.31 years old +/- 1.54 years), average height (177.47cm +/- 4.2cm) and average weight (78.70kg +/- 17.42kg). no significant between group differences across all 3 groups were found after random allocation regarding key characteristics as well as baseline scores during pre-testing. |
| **Intervention Investigated**  [Provide details of methods, who provided treatment, when and where, how many hours of treatment provided] |
| *Control: GROUP 3* |
| * Subjects allocated to the control, group 3 (N=13) were instructed to complete no upper extremity exercise for the duration of the 6 week study. They completed neither OKC exercise nor CKC exercise. No other changes were made regarding daily-activities or military duties. |
| *Experimental: GROUP 1, GROUP 2* |
| * Intervention period lasted a total duration of 6 weeks. * Group 1 (N=13) were assigned to CKC exercise which consisted of subjects completing standard push-ups, 3 sets of 15 repetitions, 3 days per week for 6 weeks. * Group 2 (N=13) were assigned to OKC exercise, which consisted of subjects completing standard dumbbell bench-press. Subjects performed 3 sets of 15 repetitions, 3 days per week for 6 weeks. Resistance was determined using the predetermined CW (average=26.6kg +/- 6.5kg) and a progression based off of this CW was implemented across the 6 week intervention. This progression included:   -Weeks 1-2: 75% of CW (average=20.6kg +/- 5.03kg)  -Weeks 2-4: 85% of CW (average=23.3kg +/- 5.66kg)  -Weeks 4-6: 95% of CW (average=25.9kg +/- 5.98kg)   * Researchers do not mention who provided the treatment, and neither the duration of each treatment session nor if all sets and repetitions were completed at one time or throughout the day. |
| **Outcome Measures** (Primary and Secondary)  [Give details of each measure, maximum possible score and range for each measure, administered by whom, where] |
| Primary Outcome Measure:  The primary outcome utilized in the study was the subjects ability and precision with identifying joint reposition sense actively and passively via the Cybex isokinetic dynamometer. This was identified by the difference in mean error between pre and post-testing regarding perceived joint replication of the 3 testing positions. The maximal possible score would be perfect replication on all three trials either passively or actively and represented by a value of 0 for absolute mean error during pre and post testing. The researchers state that examiners completed the passive and active joint reposition sense protocol and assessment but do not explicitly mention their credentials. |
| **Main Findings**  [Provide summary of mean scores/mean differences/treatment effect, 95% confidence intervals and p-values etc., where provided – if you need to calculate these data yourself, put calculations here and add interpretation later, under ‘critical appraisal’ on next page] |
| * Mixed model ANOVA revealed a significant group-by-test interaction regarding improvement in joint reposition sense with F2,36=29.29 (P<0,001) * Tukey post hoc analysis revealed that both group 1 (OKC) and group 2 (CKC) showed significant decreases in absolute mean error score from pre test to post test regarding all 3 testing positions compared to the control, group 3. No significant differences between OKC and CKC groups regarding decreases in mean error score were seen. * 300 IR (mean difference): OKC (3.29 deg +/- 0.88 deg), CKC (3.09 deg +/- 1.36 deg), control (increased 0.42 deg +/- 1.75 deg) * 300 ER (mean difference): OKC (3.78 deg +/- 0.82 deg), CKC (3.07 deg +/- 2.83 deg), control (0.81 deg +/- 2.54 deg) * 100 End Range ER (Mean Difference): OKC (4.59 deg +/- 0.87 deg), CKC (4.11 deg +/- 1.8 deg), control (increased 0.55 degrees +/- 3.67) * Significant main effects regarding specific joint angle tested were found with F2,72=8.21 (P<0.001). Researchers found significantly less error regarding joint reposition sense at 300 IR and 100 from full ER compared to 300 ER; and no significant differences between 300 IR and 100 from full ER. * No main effect was found between active and passive ROM during the testing (F1,36=0.34, P=0.56). |
| **Original Authors’ Conclusions**  [Paraphrase as required. If providing a direct quote, add page number] |
| * For uninjured male military cadets with average age of 16 years old and participate in multiple sports, findings support both OKC and CKC resistance exercises regarding improvement of joint reposition sense with exercise groups better able to reproduce angles and with better awareness of the location of their upper extremity in space compared to control.1,pg.317  A strengthening program designed to improve neuromuscular control may also be of benefit to individual with shoulder proprioceptive deficits. Further study using subjects with unstable shoulder is needed to confirm out clinical impressions.1,pg318 * The authors note the mechanism for the improvement shown was most likely due to the increased stimulation of the joint and muscle mechanoreceptors as well as somatosensory units through the OKC and CKC resistance exercises. The authors also mention the large treatment effect with OKC/CKC compared to control was a surprise considering the use of only 1 exercise which was not proprioceptive-based and only 3 times per week. |
| **Critical Appraisal** |
| **Validity**  [Methodology, rigour, selection, sources of bias, quality score on methodology quality rating scale (indicate the quality assessment tool used and the maximum possible score on that scale, e.g., 7/10 on PEDro scale), appropriateness of analytical approach (e.g., adjustments for confounding variables, management of missing data).]  Comment on missing information in original paper. |
| * All participating subjects were unfamiliar with the testing protocol as well as the isokinetic dynamometer. Researchers do not mention subject attrition or incidence of dropout at the 6 week follow-up period and thus the reader is left to assume subjects data was recorded at pre and post testing periods. * The use of inclinometers such as the “Flexometer” utilized in the prospective RCT has been found to be a reliable instrument and can provide an affordable and accurate measure of range of motion and joint position sense (JPS) at the shoulder.1 In a similar 2003 study conducted by Dover et al, The inclinometer was found to be a reliable instrument as both intertester (.999) and intratester (.999) intraclass correlation coefficients were high.1 The JPS measurements were also found to be reliable, with intraclass correlation coefficients ranging from .978 to .984.1 * By using the Cybex II isokinetic dynamometer the clinicians were able to standardize the speed at which the examiner passively repositioned the joint (60/sec-1) as well as the rate of active patient movement to replicate the 3 testing positions (300 IR/ER, 100 from end-range ER) * Subjects were randomly allocated to the 3 groups, all were volunteers and injury-free and thus researchers avoided any source of intention-to-treat and possible confounding of the results obtained. Furthermore, the total subject population was homogeneous at baseline regarding mean age, height and weight. Researchers do not mention however if this homogeneity was maintained following group allocation. * Researchers attempted to make OKC (dumbbell press) and CKC (standard pushup) therapeutic interventions as similar as possible by producing a criterion weight achieved by averaging the weight exerted in the up and down positions of the standard pushup via dual independent bathroom scales. However, researchers do not mention any attempt to standardize the subjects hand positioning through relative distance between each scale or if this was adjusted in any way to take into account variability regarding subjects wingspan and thus decreases the reliability of the overall attempt to create homogeneity between the two interventions. * The researchers provide point measures regarding mean absolute difference in error regarding subject’s ability to replicate joint position as well as ability to detect joint position in space. The researchers also provide measures of variability via standard deviations of the mean absolute difference and thus reliable estimate of the true treatment effect with a good degree of certainty. * Both OKC and CKC groups completed 6 wks of the sole intervention with identical sets (3), repetitions (15), and frequency (3 times per week). However the researchers do not mention if or how they controlled for the subjects receiving therapeutic interventions as planned by the study design; whether this is throughout the day or in one single session. * The researchers implemented a progression of resistance via the criterion weight in the OKC group while the CKC group completed the same criterion regarding resistance with pushups. Finally researchers did not explicitly identify neither who were the testers at pre/post testing nor conducted the interventions over the 6-week period, decreasing the validity and reliability of the results.   Level of evidence: I would rate this study as level 1B (one higher RCT) as indicated by the PEDro scale.2 The prospective study scored 7/11, which designates this RCT as “good” based on the methodology, standardized treatment protocol and outcome measures, rigor, inclusion/exclusion criteria, random allocation of study subjects and thus, adequately controlled for sources of bias and type II error.2 This helps ensure the reader the results and associated treatment effect are reliable, valid and not due to chance.2  References:   1. Dover, Geoffrey et al. Reliability of joint position sense and force-reproduction measures during internal and external rotation of the shoulder. J Athl Training, Oct-Dec 2003;volume 38(4):304-310 2. The George Institute for Global Health. PEDro Scale, affiliated with The University of Sydney. Last updated November 3, 2014, assessed 11/19/2014. <http://www.pedro.org.au/english/downloads/pedro-scale/> |
| **Interpretation of Results**  [Favourable or unfavourable, specific outcomes of interest, size of treatment effect, statistical and clinical significance, minimal clinically important difference. You may calculate effect size or confidence intervals yourself from the data provided in the article.] Describe in your own words what the results mean. |
| Mixed-design analysis of variance model is used to test for differences between two or more independent groups whilst subjecting participants to [repeated measures](http://en.wikipedia.org/wiki/Repeated_measures). Thus, in a mixed-design [ANOVA](http://en.wikipedia.org/wiki/ANOVA) model, one factor, a [fixed effects factor](http://en.wikipedia.org/wiki/Fixed_effects_model), is a between-subjects variable (type of training: OKC vs. CKC vs. Control) and the other, a [random effects factor](http://en.wikipedia.org/wiki/Random_effects_model), is considered a within-subjects variable (3 testing angles; active vs. passive motion). Thus, overall, the model is a type of [mixed effect model](http://en.wikipedia.org/wiki/Mixed_model).   * The ANOVA revealed a significant group-by-test interaction with an F-ratio of F2,36=29.29 (p<0.001), showing that compared to control, both OKC and CKC groups showed significant improvement regarding the mean absolute error scores between pre and post testing with 2 and 36 degrees of freedom associated within the x and y coordinates respectively. An alpha level of 0.001 represents the statistical significance. When utilizing coordinate tables of critical values of the F-ratio and degrees of freedom x,y (2,36), I found that the critical value of F=5.25, indicating that the F-ratio obtained (29.29) is quite significant and not likely to have occurred by chance.1 * ANOVA revealed a main-effect regarding the specific testing joint angle with 100 from end range ER and 300 IR showing significantly less error compared to 300 ER (F2,72=8.21; p<0.001). The critical F-value via coordinate table was found to be 4.91 as indicated above, also indicating that the main-effect of joint angle with F=8.21 is indeed significant and not due to chance.1 * The use of Tukey post hoc analysis further decrease the error of measurement regarding F-ratios obtained as well as level of significance. * Regarding active versus passive motion, no main-effect was seen (F1,36=0.34; p=.56). This is not surprising due to the use of the isokinetic dynamometer and set speed and subject positioning during pre and post testing. * All point measures obtained during pre and post testing within OKC, CKC and control groups regarding mean absolute error scores are associated with measures of variability via standard deviation values. All values obtained at pre and post testing are well within +/- 2 standard deviations from the mean absolute error score obtained and thus ensure the reader of greater precision and accuracy of results with decreased amounts of variability and margin of error. * A power analysis was not conducted or mentioned within the study, however when plugging in the alpha level utilized for all statistical analysis (0.05), the subject sample size per group (N=13) and associated mean absolute error scores with standard deviations at each testing angle, you find that the sample size per group (N=13) as well as total sample size (N=39) provide the adequate power of 0.80 and hence increased likelihood that the effect positive effects of OKC and CKC with regard to improving joint reposition sense as well as perception of joint position in space at a particular time is true and reliable with decreased chance of an significant effect being found when in reality there was no effect or the effect was by chance (type II error).2   **Clinical Relevance:** Therapeutic exercise and interventions to improve proprioceptive capability and enhance neuromuscular control have been implicated as an important aspect of rehabilitation programs aimed to provide optimal stability at the shoulder joint.3 Further more it has been demonstrated that those with anterior shoulder instability and/or injury to capsular tissues, which provide mechanical stability to the joint preform more poorly regarding joint reposition sense and have decreased ability to detect when their joint is put in maladaptive positioning as well as provide the necessary functional stability to counter this positions of increased instability.4 This study indicates that even integrating a singular CKC or OKC exercise can have positive impact regarding increased proprioceptive functioning and joint position sense in contrast to a climber completing neither form of exercise in the treatment or prevention of shoulder instability or dysfunction. Furthermore, these gains were seen with CKC/OKC exercises that were not designed to challenge proprioception at the shoulder and thus, the positive effects that were seen possibly could be enhanced with implication of push-ups on an unstable surface such as foam-pad, bosu ball or preforming dumbbell bench-press on top of unstable surfaces such as Swiss-ball, assumption of decreased base of support or other means o challenging postural and proximal feed forward stability at the shoulder. Also, the results showed no difference in positive or negative treatment effect regarding use of CKC compared to OKC to improve joint position sense, indicating implementation of CKC activities along with traditional OKC therapeutic exercise interventions within a program geared toward prevention or treatment of shoulder instability or dysfunction would most likely not decrease positive outcomes of the prospective rehabilitation program. As this study utilized young, (16 years old) uninjured subjects who were exclusively male and thus, make it difficult to translate the findings across a general patient population. Further studies of this type should be completed across a more diverse patient population regarding patient sex, age and activity level as well as implementation of complete treatment protocol incorporating multiple interventions more geared to challenge proprioceptive capability of the patient.    References:   1. Western Michigan University. Table of critical values for the F distribution (for use with ANOVA). Assessed 11/20/2014 <http://homepages.wmich.edu/~hillenbr/619/AnovaTable.pdf> 2. Statistical Solutions, LLC. Power and Sample Size Calculator. Updated 2014, assessed 11/20/2014. <http://www.statisticalsolutions.net/pss_calc.php> 3. Lephart S.M et al. Proprioception of the shoulderjoint in healthy, unstable and surgically repaired shoulders. Journal of shoulder and elbow surg, 1994;volume 3:371-380 4. Dillman C.J et al. Biomechanical differences open and closed chain exercises with respect to the shoulder. Journal of sport and rehabilitation, 1994;volume 3:228-238 |

**IMPLICATIONS FOR PRACTICE and FUTURE RESEARCH**

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| There exists a multitude of evidence, which indicate a moderate to strong correlation regarding core stability, balance capability and the presence of acute injury or chronic shoulder dysfunction amongst overhead athletes. However these studies are most often not clinical trials without pre and post testing but rather repeated measures of core stability among a single cohort. Specific to the activity of rock-climbing, most of the available evidence are based upon rate of traumatic injuries associated with the sport or curtailed to the wrist and hand specifically, the injury and pathology associated with the flexor pulley/tendon complex associated with assuming the “crimp-grip” position. There is widespread implementation of CKC exercise, core stability and means of challenging both at the trunk and GHJ/STJ via perturbation-like challenges. Closed-chain exercise protocols are felt to be preferable to other exercise programs in that they simulate normal physiologic and biomechanical functions, create little shear stress across injured or healing joints and reproduce proprioceptive stimuli. Due to these advantages, they are used during early rehabilitation and have been integral parts of accelerated rehabilitation programs.1 Specific to the shoulder methods of incorporating CKC and perturbation-based challenge include but not limited to rhythmic stabilization, the use of foam-mats, Swiss-balls, multi-sensory balance training or various modifications of the patients base of support such as single-leg stance, semi-tandem and tandem stances. There is no increased cost with utilizing these types of interventions with necessary equipment to implement these types of interventions being readily available within the normal outpatient rehabilitation setting.  Furthermore, there is strong evidence, which shows that those who are active participants in the activity of rock-climbing could be predisposed to shoulder pathology and dislocation. This is due to activity-induced muscle imbalance, with hypertrophy of muscle-tendon units which extend, adduct and internally rotate the shoulder-joint.2 Clinicians should become more familiar with the sport of rock-climbing and the style of functional movement this activity encompasses to facilitate an understanding of prospective mechanisms of injury and implement a more patient-centered plan of care. Based on quasi-static equilibrium, climbing is a dynamic and controlled upward or lateral movement of a bodies COM. This is achieved through continuous postural/proximal joint stability, automatic postural reactions, anticipatory postural adjustments, coordination of movements composed of open kinematic chain (OKC) as well as closed kinematic chain (CKC) motion, and continuous to intermittent maximal isometric contractions.3 The amount of internal force necessary to maintain stability and/or produce movement is continuously reorganized/reallocated to allow the climber to maintain equilibrium bilaterally along the trunk UE and LE with deviation of the climber’s body-weight. The act of climbing requires coordinated movements of the shoulder and depend on proper function and contribution of different agonist/antagonist muscle groups using specific modes of contractions.4  As the sport climbing places high demandson the shoulder, analyzing the strengthprofile of the shoulder musculature inthese athletes may help to understand theadaptation due to this sport, so that trainingmay be designed accordingly to maximizeperformance and prevent injuries.4  Future research is indicated including clinical trials that include baseline outcome measures as well as long-term follow-up. High quality clinical trials focused on proprioceptive challenge of the shoulder joint with CKC interventions or implementations of balance and/or core stability training in conjunction with traditional means of shoulder rehabilitation are warranted. Furthermore, such research designs are also indicated that are implemented across patient populations of rock-climbers. This rationale is due to the ever-growing popularity of indoor/outdoor rock-climbing as a competitive or recreational activity across all patient demographics and presents an increased probability of encountering these types of patients within the outpatient setting.  References:   1. Kibler W.B et al. Closed-Chain Rehabilitation for Upper and Lower Extremities. J Am Acad Orthop Surg, 2001;volume 9:412-421 2. Forster R et al. Climber’s Back- Form and Mobility of the Thoraco-lumbar Spine Leading to Postural Adaptations in Male High Ability Rock Climbers. Int J Sports Med, 2009;volume 30:53-59 3. Noe. F et al. Modifications of anticipatory postural adjustments in rock climbing task: The effect of supporting wall inclination. Journal of Electromyography and Kinesiology, 2006;volume 16:336-341 4. Wong Emmy K.L et al. Isokinetic Work Profile of Shoulder Flexors and Extensors in Sport Climbers and Non-Climbers. JOSPT, 2008;volume38 (9):572-577. |

*Notes on Implications Section*

* *This section synthesizes your comments from the appraisal of your articles, and may mention other related research that you have read or that supports your interpretation and discussion*
* *Comment on whether the intervention is used in practice in your region/country, cost of that treatment, need for education of local therapists/students about this intervention and/or outcome measures used in the CAT*
* *Students may wish/need to discuss implications with clinicians or peers for suggestions -- use the discussion board!*
* *This section should be ¾-1 page*
* *Be sure to address both implications for clinical practice and future research (separately)*

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[List all references cited in the CAT]

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| 1. Institute for Work & Health. The QuickDASH Outcome Measure, a faster way to measure upper-extremity disability and symptoms, Information for Users. Institute for Work and Health, 2006, Assessed October 21, 2014, [www.dash.iwh.on.ca](http://www.dash.iwh.on.ca) 2. Neuman BJ et al. Results of Arthroscopic Repair of Type II Superior Labral Anterior Posterior Lesions in Overhead Athletes: Assessment of Return to Preinjury Playing Level and Satisfaction. American J Sports Med, September 2011; volume 39(9): 1883-1888 3. Arab A.M et al. Sensitivity, specificity and predictive value of the clinical trunk muscle endurance tests in LBP. Clinical Rehabilitation, 2007;volume 21:640-647 4. Ban Ilija et al. Standardised test protocol (Constant Score) for evaluation of functionality in patients with shoulder disorders. Dan Med Journal, 2013;volume 60(4) 5. Rocourt M.H et al. Evaluation of intratester and intertester reliability of the Constant-Murley shoulder assessment. Journ of Shoulder and Elbow Surgery, April, 2008;volume 17(2):364-369 6. Constant CR, Murley AH. A clinical method of functional assessment of the shoulder. Clin Orthop Relat Res. 1987 Jan;(214):160-4. (Assessed online 11/19/2014). [www.orthopaedic**score**.com/**score**pages/**constant**\_shoulder\_**score**.htm](http://www.orthopaedicscore.com/scorepages/constant_shoulder_score.htm) 7. Angst, Felix et al. Measures of adult shoulder function: DASH, QuickDASH, SPADI, ASES, Constant (Murley) Score, SST, OSS, SDQ and WOSI. Arthritis Care and Research, November 2011;volume 63(11):174-188 8. Essa, Michael, DPT, MA, ATC, LAT, CSCS. Evidence Based Evaluation of Shoulder Special Tests and Clinical Prediction Rules: An Audiovisual Guide to Shoulder Evaluation, April 2 (2013). [powerpoint presentation] assessed 11/19/2014. <https://sakai.unc.edu/access/content/group/2ec17f17-7909-48b1-ae92-5ff35361cd7b/Unit%20Two/Mike%20M%20-%202012%20class/Mike%20Essa%20Lecture/Shoulder%20Special%20TestsCPR.pdf> 9. Dover, Geoffrey et al. Reliability of joint position sense and force-reproduction measures during internal and external rotation of the shoulder. J Athl Training, Oct-Dec 2003;volume 38(4):304-310 10. The George Institute for Global Health. PEDro Scale, affiliated with The University of Sydney. Last updated November 3, 2014, assessed 11/19/2014. <http://www.pedro.org.au/english/downloads/pedro-scale/> 11. Western Michigan University. Table of critical values for the F distribution (for use with ANOVA). Assessed 11/20/2014 <http://homepages.wmich.edu/~hillenbr/619/AnovaTable.pdf> 12. Statistical Solutions, LLC. Power and Sample Size Calculator. Updated 2014, assessed 11/20/2014. <http://www.statisticalsolutions.net/pss_calc.php> 13. Lephart S.M et al. Proprioception of the shoulderjoint in healthy, unstable and surgically repaired shoulders. Journal of shoulder and elbow surg, 1994;volume 3:371-380 14. Dillman C.J et al. Biomechanical differences open and closed chain exercises with respect to the shoulder. Journal of sport and rehabilitation, 1994;volume 3:228-238 15. Kibler W.B et al. Closed-Chain Rehabilitation for Upper and Lower Extremities. J Am Acad Orthop Surg, 2001;volume 9:412-421 16. Forster R et al. Climber’s Back- Form and Mobility of the Thoraco-lumbar Spine Leading to Postural Adaptations in Male High Ability Rock Climbers. Int J Sports Med, 2009;volume 30:53-59 17. Noe. F et al. Modifications of anticipatory postural adjustments in rock climbing task: The effect of supporting wall inclination. Journal of Electromyography and Kinesiology, 2006;volume 16:336-341 18. Wong Emmy K.L et al. Isokinetic Work Profile of Shoulder Flexors and Extensors in Sport Climbers and Non-Climbers. JOSPT, 2008;volume38 (9):572-577. |