Spring 4-1-2007

The Effectiveness of Shoulder Injury Assessment Techniques: Analyzing the Occurrences of False Positives

Alec Cianfichi
Lynchburg College

Follow this and additional works at: https://digitalshowcase.lynchburg.edu/utcp

Part of the Diagnosis Commons, Equipment and Supplies Commons, Investigative Techniques Commons, Other Analytical, Diagnostic and Therapeutic Techniques and Equipment Commons, and the Sports Sciences Commons

Recommended Citation
https://digitalshowcase.lynchburg.edu/utcp/46

This Thesis is brought to you for free and open access by Digital Showcase @ Lynchburg College. It has been accepted for inclusion in Undergraduate Theses and Capstone Projects by an authorized administrator of Digital Showcase @ Lynchburg College. For more information, please contact digitalshowcase@lynchburg.edu.
The Effectiveness of Shoulder Injury Assessment Techniques: Analyzing the Occurrences of False Positives

Alec Cianfichi

Senior Honors Project

Submitted in partial fulfillment of the graduation requirements of the Westover Honors Program

Westover Honors Program

April, 2007
Abstract

Shoulder injuries are very common in sports such as baseball, football, and tennis due to high impact and stress placed on the shoulder joint. Due to the greater chance of shoulder injuries in these types of sports, it is imperative for shoulder injury assessments to be accurate in order to ensure that the athlete does not participate with an injured shoulder or lose participation time due to an incorrect assessment.

In order to assess the validity of the Apprehension, Relocation, and Surprise test for shoulder instability, student athletes with no known shoulder injuries were evaluated. Tests were conducted under the supervision of a professional athletic trainer to ensure correct technique. The effectiveness of each specific shoulder injury assessment technique was determined by analyzing the occurrence of false positive results for each assessment test. False positives occur when an athlete tests positive for an injury during an assessment even though there is no injury present. A sensitivity score was given to each examination technique. The results showed an 87.5% specificity for apprehension and relocation tests and a 93.8% specificity for the surprise test. These results were above the 85% specificity which was found throughout previous literature leading to the conclusion that the results were not significant and that the assessment techniques did not have a strong occurrence of false positives.

Introduction

Shoulder instability is characterized by excessive looseness in the shoulder region causing the shoulder to slide around too much within the socket. In some cases, the shoulder can completely slip out of the socket causing a dislocation of the shoulder. The
apprehension, relocation, and surprise tests serve to evaluate and diagnose anterior shoulder instability. This is very important in determining the course of action to treat shoulder instabilities. However, a potential danger can occur if the assessment technique determines a false positive. A false positive occurs when the apprehension, relocation, or surprise test is positive for shoulder instability even though the shoulder is healthy. This can be dangerous leading to improper intervention caused by a wrong diagnosis from a false positive. Although many studies have examined the accuracy of these individual tests, none have inquired about the potential for false positives in the techniques. This needs to be examined in order ensure that shoulder instability techniques do not have a high occurrence of false positives. This could benefit doctors and patients alike. Patients would not have to worry about unnecessary damage from improper intervention and doctors would not have to worry about medical malpractice lawsuits cause from acting upon the findings from a false positive.

In 1990, a study was conducted that sought to define quantitively the requirements of adequate protective synergy of the internal and external rotator musculature as well as capsulolabral constraints. The study evaluated 15 asymptomatic volunteers, 28 patients with glenohumeral instability and 10 patients with impingement syndrome in order to quantify range of motion, laxity, and isokinetic strength for each group (Warner et al., 1990). The researchers determined that the patients with glenohumeral instability and impingement syndrome had significantly lower differences in the strength of the shoulder muscles as well as flexibility and laxity of the shoulder than individuals without these symptoms. This could be important for this study in the understanding of exactly how various injuries affect the shoulder joint. This knowledge
would increase the understanding of how the assessment techniques are able to predict shoulder instability.

A 1994 study evaluated the sensitivity, specificity, and accuracy of the shoulder relocation test. One hundred patients were tested with the relocation test before shoulder surgery (Speer, et al., 1994). The relocation test assessed the diminution of pain and apprehension after application of a posterior and then an anterior force on the proximal humerus. The results of the experiment showed that the relocation test was very specific for the diagnosis of rotator cuff injury. However, no study has been conducted that indicates the relocation test will not find false positives. Because of this, a study examining the occurrence of false positives would be good in further validating the technique.

In 1996, researchers investigated the accuracy of magnetic resonance imaging (MRI) and physical examination in the diagnosis of glenohumeral instability and tears. Fifty-four patients were studied who were plagued with shoulder anterior instability or glenoid labral tears refractory to 6 months of conservative management and with no evidence of rotator cuff lesions (Liu et al., 1996). The ability to predict the presence of a glenoid labral tear by physical examination was compared with magnetic resonance imaging and then confirmed through arthroscopy surgery on the injured shoulder. The physical examination included the apprehension, relocation, load and shirt, inferior sulcus sign, and crank tests (Liu et al., 1996). Based on confirmation of injury from arthroscopic surgery, results showed that physical examination was more accurate in determining the presence of injury. The physical examination using the assessment techniques produced a sensitivity of 90% while the specificity was 85%. The MRI results for the sensitivity
were drastically lower, showing only 59% while the specificity was the same. Liu et al’s
study was the first used to evaluate the validity of the shoulder assessment techniques.
Comparing the known accuracy of MRI diagnosis to the shoulder assessment techniques
indicates that shoulder assessments are highly accurate in diagnostic power. Therefore,
the chance of obtaining a false positive result seems unlikely, provided that assessment
techniques are properly administered.

However, no experiment has specifically shown that the assessment techniques do
not produce false positives on non-injured or injured shoulders other than those
associated with shoulder instability. The majority of the research seems to assume that
false positives would not occur. While this may be true, it still needs to be verified. False
positives on non-injured shoulders could result in improper intervention and enhanced
likelihood of future injury caused by evasive techniques to correct perceived injuries
from the assessment. In seeking to verify the true accuracy of the assessment techniques,
I could use the results of this study to deduce that the potential for failure is low meaning
that the occurrence of false positives will be minimal.

A 1997 study was performed that sought to evaluate the effectiveness of the
anterior release for detection of shoulder instability through examination of 100 injured
shoulders prior to arthroscopic surgery. At the time of the study, the anterior release test
was a relatively new test for shoulder instability. The results of the examination found the
anterior release test to have 91.9% sensitivity, 88.9% specificity, 90.2% accuracy, 87.3%
positive predictive value, and 87.1% positive predictive value (Gross and Distefano,
1997). These results led to the conclusions that the anterior release test to be a reliable
and reproducible test for detection of shoulder instability. However, there is still a lack of research available on the total effectiveness of the anterior release test.

In 2000, Malhi and Khan conducted study to assess the accuracy of clinical examination of the shoulder by comparing results from clinical tests to the findings from arthroscopic surgery. In the study the researchers reviewed notes of 130 consecutive shoulder arthroscopies preformed over a 10 month period (Malhi and Khan, 2000). Preoperative diagnoses were compared with the arthroscopic findings. The preoperative clinical examinations were preformed by clinical fellows and non-upper limb consultant orthopedic surgeons. Through the use of non-upper limb orthopedic surgeons, the researchers took out a potential expertise factor. This step could support the contention that the assessment techniques used are specific and accurate enough that the potential of failure in the technique usage could negatively affect the results of the assessment. Contrarily, the investigation could reach faulty conclusions due to lack of experience or knowledge of the correct use of the assessment techniques on the part of test administrators. Could a false positive lead an inexperienced orthopedist to a wrong diagnosis? This would further add to the need of looking into whether the various shoulder instability techniques could produce false positives. Results from the study showed that the clinical examination diagnosed 76 impingement cases, 22 instability cases, 11 frozen shoulder cases, and four rotator cuff tears (Malhi and Khan, 2000). The other examinations found non-specific pain or no arthroscopic findings. The examinations that did not find anything through arthroscopic investigation could have been potential occurrences of false positives; the study did not touch on these findings. If the occurrences of false positives are too high, it could be very detrimental in the
Cianfichi 6

treatment of injuries. Many treatments are specific to certain conditions. If the conditions are not present or contraindications are present, then the treatments would be futile and potentially harmful. Through comparison of clinical examination and arthroscopic surgery results, the article emphasized the importance of accurate clinical examination in diagnosing shoulder injuries. The research also concluded that there was a need to teach the importance of shoulder injury assessment to evaluators at both the undergraduate and graduate levels (Malhi and Khan, 2000).

In 2005, a review article of the current clinical methods for the examination of the unstable shoulder appeared. The author concluded that none of the current tests proved to be purely diagnostic for shoulder instability (Ozkan et al., 2005). The conclusion was based on the position that tests preformed to assess laxity and instability are different, in other words, that a positive laxity test does not always show instability. The importance of this determination is rooted in the awareness that in order to formulate an accurate diagnosis of shoulder instability, the examiner needs to incorporate all the assessment techniques used for shoulder instability. This determination validates the need to investigate the apprehension, relocation, and surprise test together within the thesis in order to get an accurate assessment of the techniques.

In 2004, a study that sought to examine the validity of tests that are used to diagnose shoulder instability was conducted. The study focused on the apprehension, relocation and surprise test to diagnose shoulder instability (Lo et al., 2004). There is a multitude of literature describing the uses and the tests for shoulder instability; however there is very little research exploring the validity of the specific techniques. Through the use of 64 patients with clear injury diagnoses of traumatic anterior instability, rotator cuff
tendinosis, posterior instability, glenor humeral osteoarthritis, or multidirectional instability, the researchers sought to validate the accuracy of their tests in determining shoulder injuries. The results of the study showed that the mean positive and negative predictive values were 93.6% and 71.9% respectively in those who had feelings of apprehension in all three tests that were preformed. Apprehension is potentially problematic in that the potential for apprehension to occur when there is no injury present may lead to a false positive diagnosis. The assessment techniques are based on the idea of apprehension within the shoulder region. This can be portrayed as pain or resistance to the movement. The problem occurs due to the fact that apprehension is subjective. Each individual can react differently to the test which could potentially bring about false positives. This furthers the need to test whether the techniques could produce the same feelings of apprehension in healthy individuals. The methods of this study were very encompassing, exploring the assessment on various different shoulder conditions. However, the study did not include a control group. Would the same results have occurred if individuals without injuries were tested? This thesis will hopefully answer this question which would lead to an even better understanding of the accuracy of the assessment techniques.

In early 2006, another study was carried out to determine the usefulness of various physical examination tests as tools for the diagnosis of traumatic anterior shoulder instability. The study incorporated the use of 364 patients between the years 2000 and 2004 (Farber et al., 2006). Forty-six patients that were diagnosed with anterior shoulder instability were placed in the study group, while 300 served as a control group. Through administration of the examination tests, including the apprehension and
relocation tests, the researchers concluded that the tests were specific, but not sensitive to anterior shoulder instability (Farber et al., 2006). The researchers also found that apprehension was a better criterion for a positive apprehension or relocation test than pain (Farber et al., 2006). These results of the study support the assertion that the apprehension and relocation tests are very reliable assessment techniques.

Based upon previous studies, I hypothesize that the occurrence of false positives will not be significant. This would lead to not being able to reject a hypothesis that states that there should be no significant difference between the occurrences of false positives and true positives. If the findings show otherwise, a conclusion can be reached that the administered tests returned a significant number of false positives, suggesting that the tests are unreliable indicators of shoulder injury.

Methods

The study tested to determine the validity of the Apprehension, Relocation, and Surprise tests for shoulder instability. The investigation specifically monitored the occurrences of false positives during the use of each individual shoulder instability assessment techniques. During this time, athletes from Lynchburg College came to the athletic training room to be tested by the athletic training students and me. Because of this, my study population consisted of athletes between the ages of 20-25 who participated in lacrosse, field hockey and basketball. Before beginning the experiment, short injury histories were taken to ensure that the athlete had no prior shoulder injury history. Questions included whether the subjected had recently been involved in any type of shoulder trauma retroactive to 6 months or whether pain has been present within the
shoulder in the past 6 months. Subjects who answered yes to anything from the injury history were not allowed to participate in the study. A prior shoulder injury could have skewed the data because the assessment techniques could produce positive results due to previous injury or current injury condition present within the shoulder. Once the injury history had been completed, the subjects were asked to sign an informed consent form. After this, I began the investigation.

I first performed an apprehension test on the shoulder and was monitored by a certified athletic trainer to ensure correct technique was used. For the apprehension test, the subject was instructed to lie supine on a table. The subject’s shoulder was put into an abducted position at approximately 90º and the elbow was placed into a position of 90º of flexion (Tzannes & Murrell, 2002). While in this position, the subject’s shoulder was slowly externally rotated. A positive finding for this test was recorded if the subject looked apprehensive, expressed feelings of apprehension toward further moment in the externally rotated direction, or expressed pain. Once the test was complete, I recorded the results in a notebook. The research subjects were recorded in the notebook as numbers to keep the subjects anonymous. Immediately following the apprehension test, a relocation test was performed. With the subject still lying supine with the test shoulder in 90º of abduction and full external rotation from the apprehension test, an anterior force was applied to the subject’s humeral head with my hand while grasping the subject’s wrist. A positive finding for the relocation test is indicated if there is a reduction of pain and apprehension that was present during the apprehension test. An increase of shoulder external rotation is also indicative of anterior instability and a positive relocation test. Again, the results were recorded in a notebook. Finally, the surprise test was run. With
the subject lying supine with the test shoulder in 90° of abduction and full external rotation, a force was placed on the humeral head of the shoulder much like the relocation test. The hand was then removed from the humeral head. A positive test is indicated if there is a sudden return of symptoms that were elicited from the apprehension test. The results were recorded in the notebook as stating that the test was positive or negative to the surprise test. In total, there were 16 subjects with each doing the experiment twice for a total of 32 results. The total number of positives and negatives were counted and totaled for each assessment test. These numbers will then be used to a specificity score to determine whether the findings are significant and whether these results would be enough to reject or accept my hypothesis.

The data collected included the number of positives or negatives that occurred during each individual shoulder instability assessment technique. The determinations of a positive or negative test were dependent on the reaction of the subject to each assessment technique. A positive result occurred when an individual felt pain, was apprehensive toward the specific movement within the test, or produced signs that were indicative to a positive within the individual exams. A negative result occurred when an individual has no reaction to the assessment techniques. Constant communication was kept between the tester and subject to ensure that all symptoms were properly noted. These results were then given a specificity score. The specificity scores were then compared to a specificity score of 85%, which was consistently found in previous studies, to determine whether the results were significant. Specificity scores over 85% were considered not significant in determining whether to reject the hypothesis. A bar graph was also used to give a visual representation of the results acquired through experimentation.
Data and Results

<table>
<thead>
<tr>
<th></th>
<th>Apprehension Test</th>
<th>Relocation Test</th>
<th>Surprise Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive</td>
<td>4</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Negative</td>
<td>28</td>
<td>28</td>
<td>30</td>
</tr>
<tr>
<td>Specificity</td>
<td>87.50%</td>
<td>87.50%</td>
<td>93.80%</td>
</tr>
</tbody>
</table>

Figure 1 shows the number of positives and negatives found within each assessment technique. The chart also gives a specificity score to each of the tests. The specificity score is compared to previous findings of 85% to determine whether the tests are reliable indicators of shoulder instability.

Figure 2 gives a visual representation of the number of individuals who tested positive for shoulder instability with the apprehension test versus the individuals who tested negative. Thirty-two subjects were tested using the apprehension test. Of the 32 individuals tested, 28 tested negative showing no signs of apprehension or pain during the
test. Four individuals tested positive with some signs of apprehension from the movement, but did not feel any pain. The apprehension test was found to have a specificity score of 87.5%

Figure 3 gives a visual representation of the number of individuals who tested positive for shoulder instability with the relocation test versus the individuals who tested negative. Thirty two individuals were tested using the relocation test. Of the individuals tested, 28 did not notice any change of symptoms when an anterior force was placed upon the humeral head which is conducive of a negative finding. However, 4 individuals did notice a relief of symptoms from the apprehension test which indicates a positive finding for the relocation test. The relocation test was found to have a specificity score of 87.5%.
Figure 4 gives a visual representation of the number of individuals who tested positive for shoulder instability with the surprise test versus the individuals who tested negative. Thirty two individuals were tested using a surprise test. Of the 32 individuals tested, 30 did not notice a change when the anterior force from the relocation test was taken away which is indicative of a negative finding for the surprise test. However, 2 individuals noted a return of apprehensive feelings when the force was removed from the humeral head which indicates a positive finding. The surprise test was found to have a specificity score of 93.8%.
Figure 5 gives a visual representation of an overall comparison of the three shoulder assessment techniques. The surprise test was found to have the lowest occurrences of false positives.

Discussion and conclusions

For the apprehension and relocation test, 4 individuals were noted to have feelings of apprehension during the exam. This equated to approximately 12.5% of the subjects for each of these assessment techniques were found positive even though prior history stated otherwise. For the surprise test, 2 individuals were noted to have a return of prior apprehension from earlier assessment technique. This equated to approximately 6.25% of the subject were found to test positive for shoulder instability although the injury history stated otherwise. After giving the results of each assessment technique a specificity score, they were compared to previous specificity scores found within literature. The specificity score of 85% was used to determine whether the results were significant. All of the specificity scores were found to be above 85%. According to the comparisons of the
specificity scores, the null hypothesis that states that the apprehension, relocation and surprise tests that the occurrence of false positives would not be significant cannot be rejected. This supports previous studies that suggest that the assessment techniques are highly reliable indicators of shoulder injury.

There are two potential factors that could have caused the individuals to show a positive during the assessment techniques. The first factor could potentially be that shoulder instability was present within the subject. However, this could neither be proven nor disproved by the methods used in the study. A second factor could potentially be caused varying pain tolerance levels and perception of pain between the athletes. One athlete could view the technique as a threat causing the individual to seek protection from the movement even though no injury is present. This assumption could potentially lead to further investigation as to whether perception of pain and pain tolerance affect the outcomes of the assessment techniques. It can also be assumed that athletes and non-athletes could have different pain tolerance levels. Further research could examine whether occurrence of positives are higher in non-athletic populations compared to athletic populations due to believed varying levels of pain tolerance.

The apprehension, relocation and surprise test are used mainly to evaluate and test for shoulder instability. Shoulder instability basically refers to the ball and socket joint within the shoulder. The capsule that surrounds the shoulder joint is a very strong ligament that helps keeps the shoulder within the joint and functioning properly. Generally, it is difficult to tear the ligaments within the capsule or pull the shoulder out of the joint (Callahan et al., 2001). Injuries such as these usually occur only when a lot of force is applied to the shoulder or the arm. Some individuals have capsules that are loose
which can lead to subluxations, shoulder slipping partially of the joint, or a complete dislocation (Ciullo, 1996). If the shoulder frequently slips partially out of the joint and returns, the joint is considered unstable. The shoulder can move to the front part of the socket which is considered anterior instability (Gerber and Nyffeler, 2002). In less common circumstances, the shoulder can move out of the back of the socket which is known as posterior instability. When enough looseness is present within the ligaments of the shoulder, there is the potential that an individual could have instability in more than one direction; this is known as multidirectional instability (Gerber and Nyffeler, 2002). Shoulder instability can be a problem for many individuals as it creates apprehension from the fear of the shoulder slipping out of the joint if moved in certain positions.

When there is recurrent instability within the shoulder region, surgical intervention may be needed. Once the type of instability has been determined, arthroscopic surgery is preformed on the individual to further diagnose and repair ligaments that are causing the shoulder instability (Ciullo, 1996). However, if there is no true instability within the shoulder these procedures could potentially be harmful causing damage to uninjured tissue. This could result in loss of money for the patient caused by medical expenses of the procedure and/or downtime from work in order to recover from the procedure. The Apprehension, Relocation, and Surprise tests serve as preliminary tests to determine whether surgical procedures are needed. However, if the tests cannot accurately determine injury then they are worthless to evaluation of the shoulder. Faulty or unnecessary protocols could potentially be administered if the assessments find false positives on a healthy shoulder. This calls for the need to test the assessment techniques
not only on the ability to determine the type of injury but to determine whether there is no
injury present within the shoulder.

The results of this study found the occurrence of an occasional false positive. However, there was not a statistically significant amount present to reject a null
hypothesis. For this reason, this study offered support to much of the previous literature
available about the accuracy and effective of the apprehension, relocation and surprise
tests for shoulder instability. This study was not without faults though. It would have
been preferable to obtain a larger number of subjects in order to create a higher sample
size. A higher sample size would allow for a more accurate or representative result to the
specificity score that was calculated. Secondly, there is no way exact way of showing
whether the false positives that were shown are true false positives. The individuals could
potentially have an unknown injury that was picked up from using the assessment tests. If
this study were to be run again, the factors that would have been changed were the
amount of subjects and the ability to more accurately examine the results of each test.
This could be accomplished with more time and money to access X-ray or magnetic
resonance imaging equipment.

In conclusion, the results of this study showed that the apprehension, relocation
and surprise tests are specific for determining shoulder instability. Although there are
occurrences of false positives within the tests, the total amount false positives found were
not high enough to suggest that the administered tests were unreliable indicators of
shoulder instability. The results also showed that false positives occurred sporadically
throughout the administered tests. Generally, it is believed that a positive apprehension
test would lead to positive findings in subsequent tests. However, a positive apprehension
test was shown not to be a reliable indicator of positive finding in later tests. These results show that it is important to use all of the assessment techniques in order to determine whether shoulder instability is present.
Literature Cited


