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ORIGINAL RESEARCH

USE OF CLINICAL TEST CLUSTERS VERSUS ADVANCED IMAGING STUDIES IN THE MANAGEMENT OF PATIENTS WITH A SUSPECTED SLAP TEAR

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ABSTRACT

Background and Purpose: The Magnetic Resonance Arthrogram (MRA) has served as the gold standard for identifying patients with possible Superior Labrum Anterior-Posterior (SLAP) lesions and are often required by orthopaedic surgeons prior to clinical evaluation. However, as the literature shows MRA sensitivity as 0.65-0.98, and specificity between 0.80-1.00, there is still room for misinterpretation of the imaging study, and potential mismanagement of a patient who may or may not exhibit a true SLAP lesion. It is proposed that by grouping a series of clinical special tests it may be possible to develop greater sensitivity in identifying a SLAP lesion, resulting in the ability to better manage this patient population, thus avoiding unnecessary and costly imaging studies and decreased referrals to surgical specialists. The purpose of this study is to examine specific combinations of SLAP lesion special tests and identify which clusters of tests have the highest sensitivity and specificities. This may allow therapists to improve the management of their patients by reliably diagnosing a SLAP lesion and referring only those who may need surgery to a physician.

Study Design: Literature review, diagnostic sensitivity/specificity outcomes

Methods: A retrospective search of the current peer-reviewed literature was performed in an effort to identify the clinical special tests with the greatest sensitivity and specificity in identifying SLAP lesions. Based upon that search, the study was limited to five special tests: Biceps Load I, Biceps Load II, Speed's, Passive Compression, and O'Brien's tests. A multiple regression analysis was performed that looked at grouping of the tests to determine the diagnostic sensitivity/specificity when grouped.

Results: Obtaining positive results on three of the five special tests resulted in a sensitivity of 0.992-0.999 and a specificity of 0.992-0.999. The combination of the Biceps Load I/II and O'Brien's showed the highest sensitivity and specificity.

Conclusion: The results indicate that a combination of at least three positive SLAP lesion tests may be clinically useful in diagnosing a shoulder SLAP lesion with greater diagnostic accuracy than those reported for MRI/MRA, thus improving patient management by referring only those who may require surgical intervention to a physician.

Level of Evidence: 2c, "Outcomes" Research

Keywords: Magnetic resonance imaging, Magnetic resonance arthrogram, medical imaging accuracy, movement system, SLAP tear

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INTRODUCTION

As physical therapy continues to grow as a direct access profession, therapists must be well equipped to accurately examine, assess, diagnose, treat, and manage their patients. Shoulder joint conditions involving degenerative changes and overuse trauma are commonly diagnosed through medical imaging studies such as Magnetic Resonance Imaging (MRI) and Magnetic Resonance Arthrogram (MRA).[1-5] As imaging is believed to be an accurate approach to diagnosing musculoskeletal pathologies, physicians often refer patients for conventional and advanced imaging studies early in the diagnostic process, although this is not always the best option for patients whom some forms of advanced imaging may be contraindicated (i.e. metal implants, pacemakers, claustrophobia, etc.). The Medicare Payment Advisory Commission reported in 2016 that MRI scans per 1000 fee-for-service beneficiaries increased by 229% between 2000 to 2014.[6] Additionally, several studies have suggested that between 20%-50% of high-tech imaging procedures fail to provide information that improves the patient's welfare, and may represent, at least in part, unnecessary medical imaging.[7-9] Hendee et al reported that many physicians ordering imaging studies often have little knowledge about techniques or possible alternate procedures, and may request studies prior to examining the patient thoroughly.[7] Imaging can be cost prohibitive and may take a long time to assess with potential for interpretation errors without the proper protocol.[2,10] Clinical tests that are not imaging based are routinely utilized worldwide to assist in the diagnosis of labral tears in the shoulder, yet little research has successfully identified which cluster of tests may provide greater accuracy than existing imaging technology.[11,12] Identifying the most effective combination of labral tests would provide physical therapists with a universal method to confidently and effectively make a clinical diagnosis and prognosis regarding the efficacy of non-operative management of the patient's condition. Precision imaging such as MRA has been accepted as the most effective and nearly fail-safe method, but past research shows not only are MRA's expensive and expose patients to contrasts which may trigger adverse responses but are not always as effective as perceived.[2] Looking further at the MRA diagnostics, it was noted that the sensitivity is often lackluster (Table 1). After following 90 patients who received an MRA for an unstable shoulder, Jonas et al discovered only 53 labral lesions were correctly identified by arthroscopy visual observation from a total of 83 confirmed lesions during initial MRA diagnostic.[2] These findings suggest a need for improvement and the likelihood of a more effective protocol in diagnosing labral lesions.[2] A systematic review examined the sensitivities from a number of past research studies to unveil the clinical accuracy of clinical tests on SLAP lesions of the labrum. Nine research studies of the fifteen reviewed uncovered clinical sensitivities and specificities in their results greater than 0.75.[12-24] The Speeds and Yergason's test were among a few of the special clinical tests used in combination throughout these studies that allowed a high clinical sensitivity to be reached.[12,13,15] That being said, Sandrey suggests that no single physical assessment tool has enough validity in itself to conclusively rule in or out a given pathology.[22] While no single test shows desired or perfect accuracy, imaging such as MRA's, commonly considered the gold standard, have shown low sensitivity in past studies and may not be the most ideal first choice of physicians in every medical scenario.[2-5] When looking at special tests individually and together, Oh et al found that no single physical examination was found to be simultaneously highly sensitive and specific when diagnosing Type II SLAP lesions.[12] Their research suggested that a combination of two tests that are clinically sensitive paired with one relatively specific test have a noticeable chance of diagnostic efficacy. A positive finding of one of the three

Table 1. *MRI and MRA Sensitivities and Specificities Used in Analysis.*

	Sensitivity	Specificity
MRI[1,3-5]	0.38 – 0.90	0.77 – 1.00
MRA[1,3]	0.65 – 0.98	0.80 – 1.00

MRI= Magnetic Resonance Image, MRA= Magnetic Resonance Arthrogram

tests (Speed, Yergason's, or biceps Load II test) demonstrated a sensitivity of about 0.75, and a sensitivity of 0.90 when all three tests are positive.[12] These findings suggest that clinical tests may be combined to diagnose a patient with a suspected SLAP lesion with a high degree of reliability, improving the management of this patient population and decreasing medical costs.

The purpose of this study was to examine specific combinations of SLAP lesion special tests in an effort to identify which clusters of tests have the highest combined sensitivity and specificity, thus allowing therapists to reliably diagnose a SLAP lesion without the reliance on advanced imaging. With so many special clinical tests designed to be used as examination tools for lesions of the labrum, the hypothesis was that clusters of clinical special tests may be more diagnostically accurate than an MRI/MRA in diagnosing SLAP lesions, thus allowing for improved medical management by decreasing unnecessary and costly referrals to specialists.

METHODS

An initial database review occurred from July 2016 to March 2017. Databases searched included the US National Library of Medicine, PubMed, ProQuest, EBSCOhost, and ScienceDirect. Keywords included "shoulder medical imaging accuracy", labral tear, shoulder labral tears, special tests, MRI SLAP tear, MRA SLAP tear, sensitivity, specificity, and SLAP tear. A second more focused database search was performed using the keywords Biceps Load Test I, Biceps Load Test II, Active Compression, Speed's Test, Supine Flexion/Resistance Test, Yergason's Test, Anterior Slide Test, and the Crank Test.

The current literature contained multiple studies that examined both individual tests as well as combinations of special tests in the evaluation of possible SLAP lesions. Researchers then carefully selected clinical tests from previous studies with a evidence provided regarding their sensitivity and specificity. Clinical tests taken from studies with too many variables or results focused on impertinent data were all omitted. After identifying the sensitivity and specificity data for each test, the five tests with the highest overall high-end values were selected. Biceps Load Test I, Biceps Load Test II, Speed's Test, O'Brien's Test, and the Passive Compression Test were chosen as the special tests for the current study as they yielded the highest sensitivities and specificities in the articles reviewed (Table 2) and these tests were used in this regression analysis.

In order to have data to compare these special tests, the final search was for the sensitivity and specificity of medical imaging. MRI and MRA are considered the gold standards for the diagnosis of labral tears; therefore, a comparison of the five special tests identified was made to these two medical image studies. To further narrow the results, only statistical values specific to MRI and MRA for labral tears were used. Data were collected using the same search engines as previously identified. A multiple regression analysis was performed to look in closer detail at the sensitivity and specificity of a variety of special tests for SLAP lesion tears. Each test's sensitivity and specificity were compared individually and then coupled together in combinations of two, three, four, and five tests (Tables 3-6).

RESULTS

All of the results were gathered from a combination of both research pertaining to SLAP lesions and case reports where these tests were performed on patients who presented with shoulder instability

Table 2. *Sensitivities and Specificities Used in Analysis.*

Test	Reported Sensitivity	Sensitivity Used in Analysis	Reported Specificity	Specificity Used in Analysis
Biceps Load I[11]	0.90	0.90	0.96	0.96
Biceps Load II[10]	0.90	0.90	0.97	0.97
Speed's Test[7-9,12]	0.18-0.90	0.54	0.14-0.87	0.51
Passive Compression Test[13]	0.82	0.82	0.86	0.86
O'Brien's[14,16,18,19]	0.83-1.00	0.92	0.95	0.95

Table 3. *Combinations of Two Tests for Sensitivity and Specificity.*

Tests	Sensitivity	Specificity
AB	0.99	1.00
AC	0.95	0.98
AD	0.98	0.99
AE	0.99	1.00
BC	0.95	0.99
BD	0.98	1.00
BE	0.99	1.00
CD	0.92	0.93
CE	0.96	0.98
DE	0.98	0.99

A= Biceps Load I, B= Biceps Load II, C= Speed's Test, D= Passive Compression Test, E= O'Brien's Test

Table 4. *Combinations of Three Tests for Sensitivity and Specificity.*

Tests	Sensitivity	Specificity
ABC	0.9954	0.999412
ABD	0.9982	0.999832
ABE	0.99915	0.99994
ACD	0.99172	0.997256
ACE	0.99609	0.99902
ADE	0.99847	0.99972
BCD	0.99172	0.997942
BCE	0.99609	0.999265
BDE	0.99847	0.99979
CDE	0.992962	0.99657

A= Biceps Load I, B= Biceps Load II, C= Speed's Test, D= Passive Compression Test, E= O'Brien's Test

Table 5. *Combinations of Four Tests for Sensitivity and Specificity.*

Tests	Sensitivity	Specificity
ABCD	0.999172	0.99991768
ABCE	0.999609	0.9999706
ABDE	0.999847	0.9999916
ACDE	0.9992962	0.9998628
BCDE	0.9992962	0.9998971

A= Biceps Load I, B= Biceps Load II, C= Speed's Test, D= Passive Compression Test, E= O'Brien's Test

Table 6. *Combination of All Five Tests for Sensitivity and Specificity.*

Tests	Sensitivity	Specificity
ABCDE	0.99992962	0.999995884

A= Biceps Load I, B= Biceps Load II, C= Speed's Test, D= Passive Compression Test, E= O'Brien's Test

and suspicion of SLAP lesions. The sensitivities (true positive rates) reached indicate the ability of the test(s) to rule out a SLAP tear. The specificities (true negative rates) reached indicate the ability of the test(s) to rule in a SLAP tear.

Single Test Results

The Biceps Load I proved to be one of the best tests to both rule in and rule out a SLAP tear with a sensitivity of 0.90 and a specificity of 0.96.[17] Biceps Load II also was proven to be a good indicator for

ruling in or out SLAP tears having a sensitivity of 0.90 and specificity of 0.97.[16] The Speed's test had varied results with sensitivities ranging from 0.18 to 0.90. The specificities for the Speed's Test also varied ranging from 0.14 to 0.87.[12,13,15,22-28] The Passive Compression test had a sensitivity of 0.82 and a specificity of 0.86.[14,19] O'Brien's Test yielded a sensitivity ranging from 0.83 to 1.00 and a specificity of 0.95.[20,21,23,24] For tests with a range of sensitivities and specificities the median value of the range was utilized for the analysis.

Two Test Combination Results

With the combination of two tests the sensitivities and specificities that yielded highest were the Bicep Load I and Bicep Load II test when combined produced a sensitivity of 0.99 and a specificity of 1.0. Bicep Load I and Speed's test together yielded a 0.95 sensitivity a 0.98 specificity. When combined with the Passive Compression test the Biceps Load I test stats were 0.98 for sensitivity and 0.99 specificity. The O'Brien test and the Biceps Load I test had similar results to the Biceps I & II with a 0.99 sensitivity and 1.0 specificity. Together the Biceps Load II test and Passive Compression Test had a sensitivity of 0.98 and a specificity of 1.0. The O'Brien and Bicep Load II tests had the same results as Biceps Load II with a 0.99 sensitivity and a 1.0 specificity. The Passive Compression test and O'Brien test together have a 0.98 sensitivity and a 0.99 specificity.

Three Test Combination Results

With the combination of three different special tests the sensitivities and specificities yield excellent results as seen in Tables 4 and 5. The combination of the Biceps I, Biceps II and O'Brien's test have the highest sensitivity at 0.99915. The Biceps Load I, Passive Compression test, and O'Brien's test together have the highest specificity yielding 0.99847.

Four Test Combination Results

With four tests combined all sensitivities and specificities were 0.99 and higher with the highest test combination being the Biceps Load I, Biceps Load II, Passive Compression and O'Brien's test which yielded a sensitivity of 0.999847 and a specificity of 0.9999706. All test combinations can be seen in Tables 4 and 5.

Five Test Combination Results

With the combination of all five tests (Biceps Load I, Biceps Load II, Passive Compression, Speed's and O'Brien's) the sensitivity to rule in a SLAP lesion is near perfect at 0.9999873316 and the specificity to rule out a SLAP lesion is 0.999995884 (Tables 4 & 5).

DISCUSSION

The purpose of this study was to analyze the diagnostic accuracy of combinations of the Biceps Load I, Biceps Load II, Speed's Test, Passive Compression Test, and the O'Brien's Test using a multiple regression analysis to determine if greater diagnostic accuracy could be achieved using clusters of clinical tests than by advanced imaging studies. Combinations of at least three physical tests has better sensitivity and specificity for detecting a SLAP lesion than sensitivity and specificity reported for an MRI/MRA[2-5] (Figures 1 and 2). It was found that any combination of three of these tests, Biceps Load I, Biceps Load II, Speed's test, Passive Compression test and the O'Brien's test, would be sufficient to diagnose a SLAP lesion without an MRI or MRA for confirmation due to the excellent sensitivity and specificity of these cluster of tests.

MRI's are very expensive, time consuming, and are not suited for people who have metal implants or claustrophobia,[7,8] whereas clinical special tests are safe, quick, cost effective, and they may be performed easily in the clinic. If the patient demonstrates fewer than three positive clinical tests of the five discussed in this study, it is less likely that they exhibit a SLAP lesion, making it appropriate to manage them conservatively without outside referral to a specialist. If they remain symptomatic without significant improvement after 30 days of conservative management, it may then be appropriate to refer to a physician for additional workup and further management as appropriate.

The results of this study show that for ruling in a shoulder SLAP tear that a combination of having a positive test for at least Biceps load I, Biceps load II, and O'Brien's will be the best, yielding a sensitivity of 0.999. If the patient has a positive test for all five tests the sensitivity becomes 1.0. The results also show that a combination of at least three of the five tests being negative will rule out a shoulder SLAP

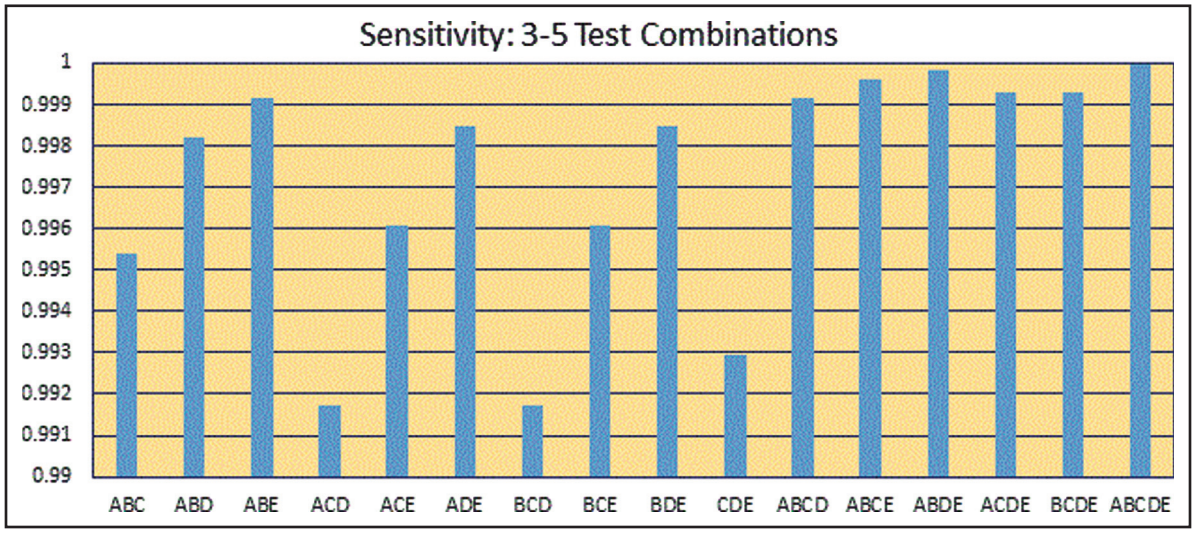

Figure 1. *Sensitivities for the Combinations of Three to Five Tests*
A = Biceps Load I, B = Biceps Load II, C = Speed's Test, D = Passive Compression Test, E = O'Brien's Test

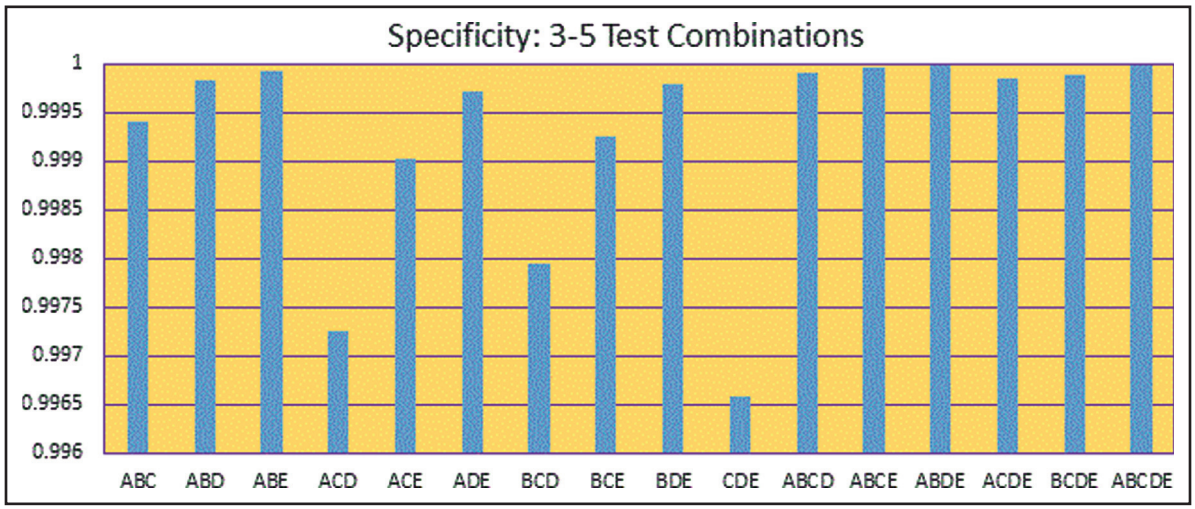

Figure 2. *Specificities for the Combinations of Three to Five Tests*
A = Biceps Load I, B = Biceps Load II, C = Speed's Test, D = Passive Compression Test, E = O'Brien's Test

tear, yielding at least a 0.99 specificity or higher for any combination of three. Conversely, if the patient has a negative test for all five tests the specificity becomes 1.0 for ruling out a shoulder SLAP tear. While it was determined that three positively tests effectively ruled in a SLAP lesion, and three negative tests effectively ruled out a lesion, it may be necessary to perform more than three tests in a given exam to effectively achieve three positive or negative tests depending on the special test choices of the examining clinician. While the data shows excellent sensitivity and specificity with only two special tests, the concern that there may be variability in the performance of individual special tests throughout the profession led to the recommendation of at least three tests to account for this possible variability.

Several limitations were identified throughout the course of this study. The clinical special tests examined were specifically selected due to their highest overall results based upon current literature, leading to a selection bias on the part of the authors. Additionally, for tests with a range of values, the median value was utilized in the statistical calculations. As multiple authors reported varying levels of sensitivity and specificity, it is impossible to determine if

the "true" value is higher or lower than the value utilized for the regression analyses. Clinical trials will need to be conducted in order to validate the hypothesis further because of the limitations of this study utilizing values from previous research.

CONCLUSION

The results of the current study indicate that a combination of at least three or more positive clinical tests for a shoulder labral tear may be used to confidently diagnose (or rule out) a shoulder SLAP lesion. This study may allow clinicians to better identify when and MRI/MRA or specialist referral is needed for a suspected SLAP tear in the shoulder versus managing the patient conservatively, allowing for improved management of patients with shoulder pathology by physical therapists. These patients may be appropriate candidates for a referral to an orthopaedic surgeon for investigation of additional treatment options while continuing to co-manage in physical therapy. Patients with fewer than three positive clinical tests are less likely to have a SLAP lesion, and therefore may be considered appropriate to be managed conservatively. A grouping of special tests demonstrates increased accuracy in the identification of SLAP lesions as compared to a single test alone, allowing for improved patient management and a potential decrease in medical costs for patients.

REFERENCES

1. Connolly KP, Schwartzberg RS, Reuss B, Crumbie D, Jr., Homan BM. Sensitivity and specificity of noncontrast magnetic resonance imaging reports in the diagnosis of type-II superior labral anterior-posterior lesions in the community setting. *J Bone Joint Surg Am.* 2013;95(4):308-313.
2. Jonas SC, Walton MJ, Sarangi PP. Is MRA an unnecessary expense in the management of a clinically unstable shoulder? A comparison of MRA and arthroscopic findings in 90 patients. *Acta Orthop.* 2012;83(3):267-270.
3. Magee T. 3-T MRI of the shoulder: is MR arthrography necessary? *Am J Roentgenol.* 2009;192(1):86-92.
4. Magee TH, Williams D. Sensitivity and specificity in detection of labral tears with 3.0-T MRI of the shoulder. *Am J Roentgenol.* 2006;187(6):1448-1452.
5. Sheridan K, Kreulen C, Kim S, Mak W, Lewis K, Marder R. Accuracy of magnetic resonance imaging to diagnose superior labrum anterior-posterior tears. *Knee Surg Sports Traumatol Arthrosc.* 2015;23(9):2645-2650.
6. Commission MPA. *A Data Book: Health Care Spending and the Medicare Program.* 2016.
7. Hendee WR, Becker GJ, Borgstede JP, et al. Addressing overutilization in medical imaging. *Radiology.* 2010;257(1):240-245.
8. Picano E. Sustainability of medical imaging. *Br Med J.* 2004;328(7439):578-580.
9. Smith TO, Hilton G, Toms AP, Donell ST, Hing CB. The diagnostic accuracy of acetabular labral tears using magnetic resonance imaging and magnetic resonance arthrography: a meta-analysis. *Eur Radiol.* 2011;21(4):863-874.
10. Pannu GS, Shah MP, Herman MJ. Cervical Spine Clearance in Pediatric Trauma Centers: The Need for Standardization and an Evidence-based Protocol. *J Pediatr Orthop.* 2017;37(3):e145-e149.
11. Michener LA, Abrams JS, Bliven KCH, et al. National Athletic Trainers' Association Position Statement: Evaluation, Management, and Outcomes of and Return-to- Play Criteria for Overhead Athletes With Superior Labral Anterior-Posterior Injuries. *J Athl Train.* 2018;53(3):209-229.
12. Oh JH, Kim JY, Kim WS, Gong HS, Lee JH. The evaluation of various physical examinations for the diagnosis of type II superior labrum anterior and posterior lesion. *Am J Sports Med.* 2008;36(2):353-359.
13. Bennett WF. Specificity of the Speed's test: arthroscopic technique for evaluating the biceps tendon at the level of the bicipital groove. *Arthroscopy.* 1998;14(8):789-796.
14. Guanche CA, Jones DC. Clinical testing for tears of the glenoid labrum. *Arthroscopy.* 2003;19(5):517-523.
15. Holtby R, Razmjou H. Accuracy of the Speed's and Yergason's tests in detecting biceps pathology and SLAP lesions: comparison with arthroscopic findings. *Arthroscopy.* 2004;20(3):231-236.
16. Kim SH, Ha KI, Ahn JH, Kim SH, Choi HJ. Biceps load test II: A clinical test for SLAP lesions of the shoulder. *Arthroscopy.* 2001;17(2):160-164.
17. Kim SH, Ha KI, Han KY. Biceps load test: a clinical test for superior labrum anterior and posterior lesions in shoulders with recurrent anterior dislocations. *Am J Sports Med.* 1999;27(3):300-303.
18. Kim TK, Queale WS, Cosgarea AJ, McFarland EG. Clinical features of the different types of SLAP lesions: an analysis of one hundred and thirty-nine cases. *J Bone Joint Surg Am.* 2003;85-A(1):66-71.
19. Kim YS, Kim JM, Ha KY, Choy S, Joo MW, Chung YG. The passive compression test: a new clinical test for superior labral tears of the shoulder. *Am J Sports Med.* 2007;35(9):1489-1494.

20. O'Brien SJ, Pagnani MJ, Fealy S, McGlynn SR, Wilson JB. The active compression test: a new and effective test for diagnosing labral tears and acromioclavicular joint abnormality. *Am J Sports Med.* 1998;26(5):610-613.
21. Owen JM, Boulter T, Walton M, Funk L, Mackenzie TA. Reinterpretation of O'Brien test in posterior labral tears of the shoulder. *Int J Shoulder Surg.* 2015;9(1):6-8.
22. Sandrey MA. Special physical examination tests for superior labrum anterior-posterior shoulder tears: an examination of clinical usefulness. *J Athl Train.* 2013;48(6):856-858.
23. Wilk KE, Macrina LC, Cain EL, Dugas JR, Andrews JR. The recognition and treatment of superior labral (SLAP) lesions in the overhead athlete. *Int J Sports Phys Ther.* 2013;8(5):579-600.
24. Wilk KE, Reinold MM, Dugas JR, Arrigo CA, Moser MW, Andrews JR. Current concepts in the recognition and treatment of superior labral (SLAP) lesions. *J Orthop Sports Phys Ther.* 2005;35(5):273-291.
25. Dodson CC, Altchek DW. SLAP lesions: an update on recognition and treatment. *J Orthop Sports Phys Ther.* 2009;39(2):71-80.
26. Gill HS, El Rassi G, Bahk MS, Castillo RC, McFarland EG. Physical examination for partial tears of the biceps tendon. *Am J Sports Med.* 2007;35(8): 1334-1340.
27. Parentis MA, Glousman RE, Mohr KS, Yocum LA. An evaluation of the provocative tests for superior labral anterior posterior lesions. *Am J Sports Med.* 2006;34(2):265-268.
28. Walsworth MK, Doukas WC, Murphy KP, Mielcarek BJ, Michener LA. Reliability and diagnostic accuracy of history and physical examination for diagnosing glenoid labral tears. *Am J Sports Med.* 2008;36(1): 162-168.