

Arm Squeeze Test: a new clinical test to distinguish neck from shoulder pain

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Abstract

Purpose Objective of this study is to evaluate the diagnostic values of the Arm Squeeze Test. The test consists in squeezing the middle third of the upper arm.

Methods 1,567 patients were included in this study. Diagnosis of cervical nerve root compression or shoulder disease was clinically formulated and confirmed with imaging before performing test. 350 healthy volunteers were recruited as controls. The test was positive when score on a VAS Scale was 3 points or higher on squeezing the middle third of the upper arm compared to acromioclavicular (AC) joint and anterolateral-subacromial area.

Results Patients were subdivided as follows: 903 with rotator cuff tear, 155 with shoulder adhesive capsulitis, 101 with AC joint arthropathy, 55 with calcifying tendonitis, and 48 affected by glenohumeral arthritis. The study sample included 305 patients with cervical nerve root compression from C5 to T1 with shoulder radicular pain. The test was positive in 295/305 (96.7 %) of patients with cervical nerve root compression, compared to 35/903 (3.87 %), 3/155 (1.93 %), 0/101 (0 %), 1/55 (1.81 %) and 4/48 (8.33 %) of those with rotator cuff tear, adhesive capsulitis, AC arthropathy, calcifying tendonitis and glenohumeral arthritis, respectively. A positive result was obtained in 14/350 asymptomatic subjects (4 %). If patients with cervical nerve root compression were compared to controls and patients with shoulder diseases, the test had sensitivity of 0.96 and specificity from 0.91 to 1.

Conclusions The Arm Squeeze Test may be useful to distinguish cervical nerve root compression from shoulder disease in case of doubtful diagnosis. A positive result to this test may lead to cervical etiology of the shoulder pain.

Keywords Neck pain · Shoulder pain · Cervical spine · Clinical test · Differential diagnosis

Introduction

Causes of pain localized on shoulder region are often difficult to be attributed because it might originate from a sufferance of different nature, of a cervical spine root or from shoulder disorders [1–3]. In addition, it is challenging to get to a correct diagnosis because the two conditions are often concomitant during the middle and advanced age [4, 5] and because they share common innervation patterns along with overlapping musculature. To our knowledge, there is no note in the literature about a specific clinical test that could help the surgeon in the differential diagnosis between cervical spine and shoulder pathologies. Often, the clinical diagnosis is overcome with the aid of imaging or electromyography [6] which generally causes a delay in the diagnosis and high cost for the patient or the health service. Hypothesis of this study is that squeezing the middle third of the upper arm (brachial biceps and triceps area), on the side complained by the patient with shoulder pain, with a strength necessary to have a moderate compression of skin, subcutis and muscle can elicit an intense reaction of local pain only in patients with cervical nerve root compression from C5 to T1, not when the pain arises from the shoulder. The anatomic rationale of the test is that in the middle third of the arm, the musculocutaneous nerve (cervical root from C5 to C7), the radial nerve (from C5 to T1), the ulnar nerve

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(from C7 to T1) and the median nerve (from C5 to T1) are relatively superficial and then it is easy to obtain a painful provocation response by squeezing the arm with a moderate compression of cutis, subcutis and muscles. We hypothesize that when there is a pathologic compression of a cervical nerve root from C5 to T1, one or more nerve of the arm is/are suffering and painful. A moderate compression of the brachial biceps and triceps area could be therefore more painful than other areas of the shoulder and upper arm frequently indicated as painful by patients. Objective of this study is to evaluate the diagnostic values of the “Arm Squeeze Test” in patients with cervical root compression compared to those with shoulder pathologies and in healthy controls.

Materials and methods

1,567 patients (mean age 57 year old, range 40–62, SD = 15) complaining shoulder pain were included in this study, of whom 930 (60.5 %) were women and 607 men. The source of these patients is our Shoulder Clinical Office and Orthopedic Spine Ambulatory. As control, the studied test was performed in 350 subjects without shoulder pain and meanly aged 55 years (range 51–63, 150 males and 200 females). The source of this control group is healthy volunteers. To all patients and control group, written consent for informing about the aim of this study and for the publication was obtained. This study was in compliance with the Helsinki Declaration. Ethical board of our University gave the approval for this research.

Inclusion criteria were age between 40 and 66 years old, pain localized at the shoulder girdle and no received treatment before the time of Arm Squeeze Test execution. Exclusion criteria were represented by: patients younger 35 or older 66 years old; patients with shoulder instability, suprascapular nerve entrapment, os acromiale, insulin-dependent diabetes, rheumatoid or serum-negative arthritis; patients who already received any treatment for the shoulder pain, previous traumatic injuries to shoulder girdle or column spine. As gold standard to obtain the diagnostic values of the Arm Squeeze Test, diagnosis of cervical nerve root compression (at least one) from C5 to T1 was based on clinical examination of the cervical spine, of the shoulder and of the upper limb; electromyography (for C5 to T1 roots); X-rays (AP and lateral view); MRI of the cervical spine [7–9]. The clinical examination of cervical column provides assessment of range of motion, bicipital (C5), brachioradial (C6), tricipital (C7) tendon reflexes and assessment of strength. X-ray examination provides assessment of the degenerative changes of osteophytes, narrowing of intervertebral spaces and straightening of the cervical spine. In MRI, presence of

cervical disc protrusion or cervical disc herniation was noted. In patients affected by shoulder pathologies, the diagnosis was based on clinical and MRI evaluation in rotator cuff tears, Codman’s criteria, shoulder stiffness and MRI findings in adhesive capsulitis, and clinical and radiographic findings for calcifying tendonitis, glenohumeral arthritis and AC arthropathy [3, 7, 10]. The clinical examination of patients was performed by an independent physician not enrolled in this study.

On physical examination, it was recorded whether squeezing with the hand [simultaneous thumb and fingers compression, thumb from posterior (triceps muscle) and fingers from anterior (biceps muscle)] of the examiner, the middle third of the upper arm, elicited local pain (Fig. 1). To get an independent, blind comparison of test results with a reference gold standard, the two examiners were blinded to the diagnosis obtained by the independent physician. The test was executed by two of the authors (senior and junior) for 3 times per patient always with the same strength, and with the squeeze pressure, the same regardless of patient’s girth, size and BMI. To avoid bias depending on size of the examiner, we considered glove size of senior and junior author, which were 7 (small hands) and 8.5 (big hands), respectively. The strength necessary to perform the test was determined empirically before this study started, when we started to check the Arm Squeeze Test on patients. The test was ideated and performed 1 year before this study was developed. Thus, the applied fingers and thumb compression strength was scientifically measured with the MicroFET dynamometer (Hoggan Health Industries, West Jordan, UT, USA) by repeating the same maneuver of the test for one hundred times for each examiner (senior and junior). The two 7.2 ± 1.6 kg (range 5.9–8.1), which is necessary to perform a moderate compression of the skin, sub cutis and muscle. For comparison, digital pressure was also carried out on the acromioclavicular and anterolateral-subacromial area. Patients and controls were instructed to record the severity of pain on a VAS of 0 (no pain) to 10 points (most severe pain). The test was considered as positive when the score was 3 points or higher on pressure on the middle third of the upper arm compared with to the other two areas (difference between results in middle third of the upper arm area and in the AC joint and subacromial area).

Results were collected on to a database (Microsoft Office Excel) and were analyzed with Fischer’s Test. Following the outline of Sackett and Haynes [11], as phase I question, we have recorded the results and have matched if results differ in patients affected by cervical nerve root compression and patients affected by shoulder pathologies and controls. Then, as phase II question, the results in patients with cervical nerve root compression were compared to those with shoulder pathology and to the controls



Fig. 1 The Arm Squeeze Test

to assess sensitivity, specificity, positive predictive value, negative predictive value, likelihood ratios for an abnormal and normal test result (and their 95 % confidence intervals). Sensitivity was calculated as number of true positives/(number of true positives + number of false negatives); specificity was calculated as number of true negatives/(number of true negatives + number of false positives); positive predictive value was calculated as true positives/(true positives + false positives); negative predictive value was calculated as true negatives/(true negatives + false negatives); likelihood ratios for a normal test result was calculated as sensitivity/(1 – specificity); likelihood ratios for an abnormal test result was calculated as (1 – sensitivity)/specificity. The gold standard to obtain the diagnostic values of the Arm Squeeze Test was measured by evaluating clinical examination of the cervical spine, of the shoulder and of the upper limb; electromyography (for C5 to T1 roots); X-rays (AP and lateral view); MRI of the cervical spine [7–9]. Intra (repetition of test three times per author) and inter tester (between senior and junior) reliability of the Arm Squeeze Test was determined by use of a *k* correlation, which is used with categorical and nominal data. The scores for *k* range from 0 to 1, with a 1 representing perfect agreement [12].

Results

Subjects included in the study group were subdivided as it follows: 903 with posterosuperior rotator cuff tear (mean age 58 year old, range 40–65 years), 155 patients with primary (unrelated to trauma and/or surgery) shoulder adhesive capsulitis (mean age 54 year old, range 46–62 years), 101 with degenerative arthropathy of the acromioclavicular (AC) joint (mean age 57 year old, range

45–64), 55 with a calcifying tendonitis of the shoulder (mean age 50 year old, range 43–61 years) and 48 affected by glenohumeral arthritis grade I–II according to Samilson and Prieto classification [13] (mean age 56 year old, range 45–65). The study sample also included 305 patients (19.4 % of patients recruited in the study group) complaining pain starting from cervical spine and referred to the shoulder (mean age 48 year old, range 40–64). A large part of these patients (200, 65.7 %) were recruited in Orthopedic Spine Ambulatory before any treatment. The remaining 105 were wrongly referred to the Shoulder Clinical Office by the family doctor because suspecting shoulder pathologies.

The test was positive in 295/305 (96.7 %) of patients with cervical nerve root compression from C5 to T1 (mean VAS scale 7.9 points, range 5–10), compared to 35/903 (3.87 %) (mean VAS scale 4.6, range 2–6), 3/155 (1.93 %) (mean VAS scale 4.1, range 3–7), 0/101 (0 %), 1/55 (1.81 %) (VAS scale 4) and 4/48 (8.33 %) (mean VAS scale 4.3, range 3–7) of those with rotator cuff tear, adhesive capsulitis, AC arthritis, calcifying tendonitis and glenohumeral arthritis, respectively ($p < 0,001$). A positive result was obtained in 14/350 asymptomatic subjects (4 %) (mean VAS scale 3.8, range 2–4) (phase I question) [11]. There is no significant difference in results obtained by the senior and junior author ($p = 0.71$). There is no significant difference in results of the Squeeze Test between patients with different level of cervical nerve root compression (based on MRI and electromyography) ($p = 0.73$). The mean diagnostic values (and their 95 % confidence intervals) of the test of squeeze-evoked brachial pain in patients with cervical nerve root compression compared to rotator cuff tear, adhesive capsulitis, AC arthropathy, calcifying tendonitis and glenohumeral arthropathy are reported in Table 1, as well as the mean values respect to controls (phase II question) [11]. In particular, sensitivity was 0.96; specificity ranged from 0.91 to 1; positive prognostic value ranged from 0.89 to 1; negative prognostic value ranged from 0.81 to 0.99; likelihood ratios for an abnormal test result ranged from 10.6 to 48 and likelihood ratios for a normal test result ranged from 0.04 to 0.44. The inter-observer *k* value was $r = 0.81$ (95 % confidence interval 0.79–0.82); the intra-observer *k* value was $r = 0.87$ (95 % confidence interval 0.85–0.89).

Discussion

Cervical spine and shoulder pathologies frequently coexist, especially in the aging population. The differential diagnosis between shoulder pain originating from cervical spine or from shoulder structures has been widely discussed in the literature [4, 5, 14, 15].

Table 1 Diagnostic values of the Arm Squeeze Test in patients with cervical nerve root compression compared to asymptomatic controls and patients with shoulder diseases (95 % CI)

Arm Squeeze Test	Value					
	Controls	RCT	AD	ACa	CT	G-H Arthr
Sensitivity	0.96 (0.85 to 0.99)					
Specificity	0.96 (0.87 to 0.99)	0.96 (0.86 to 0.98)	0.98 (0.88 to 1)	1 (0.95 to 1)	0.98 (0.87 to 0.99)	0.91 (0.8 to 0.95)
Positive prognostic value	0.95 (0.87 to 0.97)	0.89 (0.83 to 0.92)	0.98 (0.88 to 1)	1 (0.96 to 1)	0.99 (0.89 to 1)	0.98 (0.87 to 0.99)
Negative prognostic value	0.99 (0.9 to 1)	0.98 (0.89 to 0.99)	0.93 (0.84 to 0.96)	0.9 (0.96 to 1)	0.84 (0.8 to 0.91)	0.81 (0.75 to 0.99)
Likelihood ratios for an abnormal test result	24 (6.5 to 99)	24 (6.07 to 99)	– (7.08 to –)	– (24 to –)	48 (7.38 to 96)	10.6 (4.8 to 19.2)
Likelihood ratios for a normal test result	0.04 (0.01 to 0.17)	0.04 (0.01 to 0.17)	0.04 (0.01 to 0.17)	– (0.04 to –)	0.04 (0.04 to 0.044)	0.44 (0.2 to 0.8)

RCT rotator cuff tear, AD adhesive capsulitis, ACa acromioclavicular arthropathy, CT calcifying tendonitis, G-H Arthr glenohumeral arthropathy

In the Bone and Joint Decade 2000–2010 Task Force on neck pain and its associated disorders [16], it emerges that the clinical routine physical examination is more effective in ruling out cervical radiculopathy than confirming its presence. There is some evidence that some features of inspection, range of motion, strength, palpation and provocation tests can be useful [16]. Manual provocation tests designed to elicit nerve root compression in the cervical spine have high positive predictive value. This task force concluded that the combination of history, physical examination, modern imaging techniques and needle EMG has to be considered the gold standard to diagnose the cause and site of cervical radiculopathy [16]. Considering this scientific evidence, we have worked to find an easy-to-use, reproducible and with good diagnostic values test that could rapidly focus the attention of the clinician to neck or shoulder pathologies. According to phase I and II questions [11], the Arm Squeeze Test results differ significantly in patients affected by cervical nerve root compression respect to those in normal individuals and in those affected by shoulder pathologies, and the positivity to the test indicates that the examined patients are more likely to have cervical nerve root compression.

As a general guideline, a localized pain, as when the patient can pinpoint a specific area of discomfort, tend to be due to pathology of local structures, whereas pain that is diffuse and difficult to describe or pinpoint tend to be radicular pain. Patients' medical history is the first element to support the physician in making the proper diagnosis; in fact, it is essential to focus on general features of the patient (age, working activities and eventually sport activities, traumatic or non-traumatic, correlation with shoulder activities). Wainner et al. [17] have established

the validity of some clinical examination procedures (UL tension test, cervical rotation, active ROM, Spurling's test) to detect cervical radiculopathy in patients with neck and shoulder radiating pain. Positive findings on those clinical examination procedures should increase the index of suspicion of cervical pathology.

The international literature proposes several diagnostic algorithms for physical examination either of the shoulder or of the cervical spine. The shoulder has long been considered one of the potential sources of pain in patients with elbow, wrist, and hand disorders, thus complicating the differential diagnosis process. There is no evidence in the literature to support such claims. Shoulder disorders can be divided into two groups based on patient's age, with older patients generally suffering from more degenerative conditions and younger patients suffering more from traumatic, inflammatory, or instability diseases [3, 8, 13]. It is recommended to examine active and passive joint motion and evaluation of strength, thus, it is necessary to perform specific clinical tests for rotator cuff tears and for all other pathologies not related to cervical spine disorders [3, 8, 13, 18]. As final step, X-ray or MRI of the shoulder are obtained to confirm the diagnosis and to quantify the severity of the lesion. Of course, there are some overlapping situations, such as patients with pain in the neck and shoulder region who have concomitant cervical spondylosis and a rotator cuff tear on MRI but do not have night pain, pain while lying on the affected side, or pain with overhead activities. One more challenging situation is when a chronic type III acromioclavicular joint dislocation causes pain in the neck region, as described by Gumina et al. [19]. In these cases, the cervical spine is probably the main source of their pain.

In general orthopedic offices, there is consistent percentage (105 of 1,567, 6.7 %) of patients with cervicobrachial pain and with radicular shoulder pain. Depending on age of patients, it is mandatory to exclude shoulder pathologies before considering the cervical spine column. In case of cervical pathology, the symptoms may worsen in certain positions (e.g., turning the neck to the affected side worsens symptoms because it causes more compression on the nerve root by decreasing the volume of the neural foramen) [5, 20]. On physical examination, the Spurling's maneuver may be positive because it decreases the volume of the neural foramen and transiently increases compression on the affected nerve root [5, 9, 21]. The Elvey "brachial plexus tension test" can be useful, too; in fact, this is able to discriminate referred and local sources of upper limb pain [22]. Sensory changes and muscle weakness may also be present depending on the severity of the nerve root compression. To the end, various clinical provocative tests for the neck have been proposed. These tests are specific for cervical spine disease after an examination of the neck motion which includes flexion-extension, lateral rotation and lateral binding [13, 21]. In this study, the Squeeze Test has been easily and quickly performed by two instructed examiner (senior and junior), with very good inter and intra tester reliability. In case of irritation of cervical nerve roots (one or more) from C5 to T1, this maneuver has elicited intense local pain, as in the 96.7 % of patients with cervical spine root compression, demonstrating high sensitivity (0.96). Low percentages of patients with shoulder disease have been positive to this test and it was almost consistently negative in asymptomatic subjects (4 %); thus, it is also very specific. Probably, in cases without cervical nerve root compression and test positivity, shoulder pain was so intense that the patient could not distinguish the pain source area.

This study has some limitations that need to be assessed. First, we have not matched phase III and IV questions [11] because it is a preliminary study. As a phase I and II diagnostic test, the Arm Squeeze Test has to be validated and requires evaluation in phase III and IV designs before it can be recommended for widespread clinical adoption [16]. Thus, the results are preliminary and need to be confirmed in a phase III study before being routinely used in a clinical setting. Second, the test itself and the patient assessment utilize subjective measures. Although we have standardized the force of squeezing by use of MicroFET dynamometer, it may not guarantee an absolute precision. Finally, we could have compared the test to other tests helpful in clinical practice [17].

Our study proposes an easy-to-use, repeatable and rapid test which can be executed on a patient after an appropriate and deep examination of the shoulder and of the cervical spine. In fact the "Arm Squeeze Test" could represent an

additional diagnostic tool that can be added to the surgeon armamentarium to confirm the etiology of the radicular shoulder pain.

Conflict of interest The authors declare that they have no conflict of interest.

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