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ORIGINAL ARTICLE

Abduction extension cervical nerve root stress test: anatomical basis and clinical relevance

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Abstract

Purpose While the Lasègue straight leg raising test is an established test for lumbar nerve root compression, an established equivalent for cervical nerve root compression is missing. The aim of this bi-modal study was to find the most effective way to stretch the cervical nerve roots anatomically in cadavers and to assess its value in the clinical setting.

Methods Three positional maneuvers of the upper limb were tested on three cadavers to determine the displacement by stretch of the nerve roots C5, C6 and C7. The maneuver which was most efficient in nerve root displacement was applied in 24 patients with confirmed symptomatic cervical nerve root compression (cases) and 65 controls to assess the clinical value of the test.

Results The most efficient way to displace the cervical nerve roots by stretch was to apply dorsal pressure on the humeral head with the shoulder in 80° of abduction and 30° of extension, with slight elbow flexion while the head is facing the contralateral side. This maneuver produced 4–5 mm of nerve root displacement in cadavers. This test aggravated radicular symptoms in 79 % of the patients with cervical nerve root compression and was negative in 98 % of the controls.

Conclusion The described abduction extension test with posterior push on the humeral head creates a fulcrum over which the brachial plexus can be displaced to create stress on cervical nerve roots. This simple test is easy to perform clinically and aggravates radicular symptoms in most of the patients with cervical nerve root compression while it is negative in nearly all of the controls.

Keywords Cervical radiculopathy · Clinical test · Root stretch

Introduction

While the straight leg test, also known as the Lasègue test is used commonly when lumbar nerve root compression is suspected [1], its equivalent for cervical radiculopathy is not yet established. The straight leg test is known to have a valuable sensitivity with however a low specificity in the diagnosis of lumbar nerve compression [1, 2]. This is less clear regarding the tests for cervical nerve root compression [3]. The displacements of the L4, L5 and S1 nerve roots during the Lasègue test with and without exacerbation by foot dorsiflexion have been quantified previously [4, 5]. Similar in concept, the effect of different arm positions on traction on the cords of the brachial plexus are documented [6]. However, there is little information about the effect of different positions of the upper extremity on the cervical nerve roots.

While some report the upper limb tension test (ULTT, formerly named the brachial plexus tension test) to be useful to rule out cervical radiculopathy [3, 7], others report relief of radicular symptoms with shoulder abduction [8], a movement that is part of the ULTT. Further, spare anatomic information suggests that lower cervical nerves have a specialized anatomical arrangement which may protect them from forces generated in the upper limb and cervical spine by the ULTT [9, 10].

The concept of cervical nerve traction by specific positions of the upper limb seems insufficiently understood

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and needs further illumination. We aimed with this bi-modal study, firstly, to systematically find out the position of the upper extremity and the head that most effectively stretches the cervical nerve roots on anatomical basis, and secondly, to investigate the clinical value of this testing position in patients with cervical radicular compression.

Materials and methods

Experiments on cadavers

The dural sac and C5, C6 and C7 nerve roots were exposed from posterior in two male and one female Tiehl-embalmed cadavers. The nerve roots and the dural sac were exposed medially to laterally through laminectomy and facetectomy. The head of the cadaver was turned toward the contralateral side and fixed to avoid motion before each nerve root was tested from caudal to cranial in the following standardized manner: A size two fiberwire suture (Arthrex Medical, Naples, Florida, US) was used to grasp the nerve root (including the ventral and dorsal roots) and subsequently the nerve root was cut at the proximal end off the spinal cord (Fig. 1). A scale was fixed to the occiput and connected to the suture to measure the displacement of the nerve root in mm. Predefined movements of the ipsilateral upper extremity were carried out, namely [1] abduction of the shoulder (100°) with the elbow flexed to 130° (ulnar nerve stretch), [2] abduction of the shoulder (110°) with the elbow fully extended with a pronated forearm (radial nerve stretch) and [3] abduction extension of the shoulder as specified in Fig. 2.

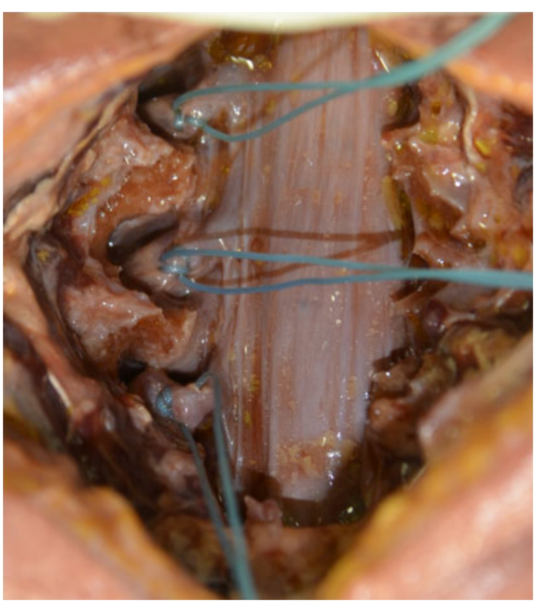

Fig. 1 Nerve roots C5, C6 and C7 are grasped with a suture before they are cut off the dural sac

Flexion and extension of the wrist was additionally carried out in each of the three positions to document a possible effect on root traction. The measurements were repeated thrice and the mean of the values was used for further analysis.

Prospective clinical trial

Based on the findings of the cadaver study (see "Results") all patients with the diagnosis of cervical radiculopahty with a radiographic correlate of nerve compression in MRI (case group, $n = 24$, age 51 ± 13) underwent the abduction extension cervical nerve root stress test (AECNRST) consecutively (Fig. 2). Patients with myelopathic symptoms or those with known shoulder pathologies were excluded. Muscle weakness, if present, was documented. The patients were asked whether they have pain and/or paresthesia in a specific dermatome before and during the AECNRST. The AECNRST was also applied to other patients seen for reasons other than cervical radiculopathic symptoms (control group, $n = 65$, age 56 ± 16 years). The test was defined as positive if new pain or paresthesia, or exacerbation of preexisting pain or paresthesia along a dermatome was reported by the patient. *True positives* were defined as those, in whom the test was positive along a dermatome that matched the radiographic finding of nerve compression on the according level.

Results

Anatomical results of nerve root stretch with different upper extremity positions

The displacements of the nerve roots C5–C7 ranged around 2–6 mm (Table 1). The AECNRST produced at least equivalent amount of root stretch in all tested nerve roots if compared to the other two maneuvers (Table 1). The addition of wrist palmar or dorsiflexion did not change the values. With AECNRST, the root stretch amount increased from C5 to C7 continuously. This was not the case with the other two tested positions, in which the effect of the position was lowest on the C6 nerve root (Table 1).

Clinical value of the AECNRST

In the case group, the most common affected nerve root was C6 ($n = 13$) followed by C7 ($n = 6$) and one case of C4, C5 and C8 each. Two of the patients had a simultaneous C6 and C7 nerve root compression. 17 of the 24 patients (71 %) reported paresthesia in a specific dermatome, 22 of the 24

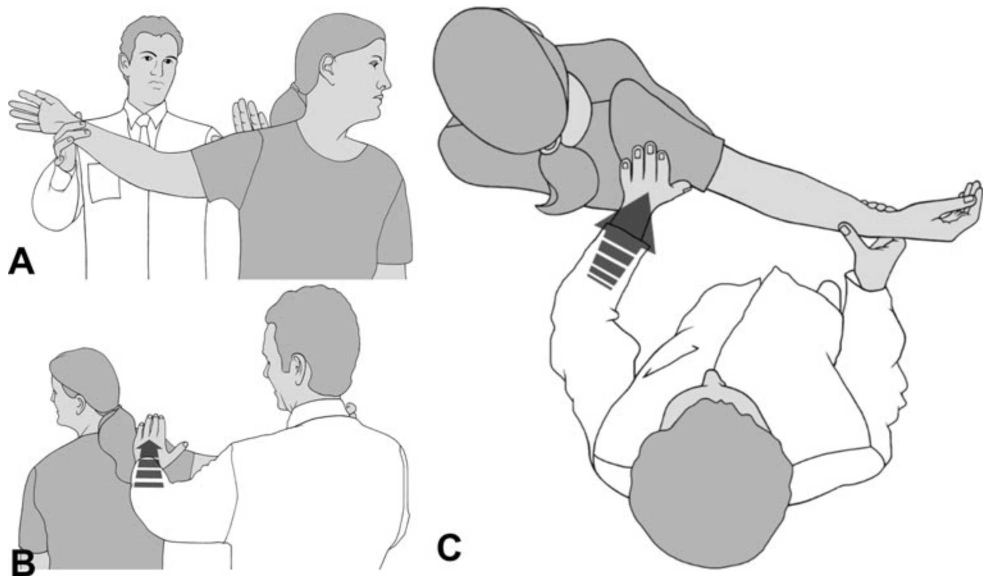

Fig. 2 The abduction extension cervical nerve root stress test (AECNRST) is performed with the patient standing and the head turned to the contralateral side. The shoulder is abducted not exceeding 90° and the elbow is slightly flexed (**a**). The examiner applies moderate dorsal pressure (**b, c**) on the humeral head while simultaneously retroverting the arm to 30°. The position is hold for a few seconds and the patient is asked about new or exacerbating pain or paresthesia along a dermatome

Table 1 Displacement distances (mm) of the cervical nerve roots by different positions of the upper extremity

Nerve root	Cadaver 1 female	Cadaver 2 male	Cadaver 3 male	Mean
Abduction (100°), elbow flexion (130°)				
C5	5	3	4	4.0
C6	4	3	3	3.3
C7	6	4	4	4.7
Abduction (110°), elbow extension (0°)				
C5	5	3	4	4.0
C6	4	3	2	3.0
C7	4	4	5	4.3
AECNRST* (Fig. 2)				
Abduction (80°)				
Extension (30°) with dorsal pressure on the humeral head				
Slight elbow flexion (30°)				
C5	5	3	4	4.0
C6	6	4	4	4.7
C7	6	4	5	5.0

*AECNRST** abduction extension cervical nerve root stress test

patients (92 %) reported brachial pain in a specific dermatome. Motor weakness corresponding to a affected nerve root was present in six patients.

The AECNRST aggravated or produced dermatome-specific paresthesia in 17 of the 24 patients (71 %) and pain in 14 of the 24 patients (58 %). A *positive test*, defined by production of new or aggrevation of pain *and/or* paresthesia, was found in 19 of the 24 patients (79 %) with symptomatic cervical radicular compression.

In the control group, only one of the 65 patients reported new paresthesia in the thumb caused by the AECNRST.

Within the investigated cohort, which did include only patients with confirmed radiculopathy as the case group, the AECNRST showed a sensitivity of 79 % and a specificity of 98 % for cervical radicular compression. The odds to have a positive AECNRST with cervical radicular compression were 243 (95 %CI: 27–2,210). The accuracy of the test was 93 %, the positive predicative value 95 % and the negative predicative value 93 %. The likelihood ratio for a positive result was 51.5.

Discussion

The effect of specific positions of the upper limb on cervical nerve root traction seems insufficiently understood. This study aimed to find the most effective manipulation of the upper extremity and the head position to aggravate cervical radicular symptoms. In the cadaveric experiments the cervical nerve roots were stretched around 2–6 mm in all of three tested positions mentioned above. The highest values of nerve root displacements were observed with the AECNRST, a test position that involves arm abduction of 80° and shoulder retroversion. Abduction over 90° was avoided based on previous report on patients with cervical radiculopathy experiencing pain relief in such positions [8, 10].

The most important step of the AECNRST is retroversion of the shoulder in 80° abduction with slight push on the posterior aspect of the humeral head. This maneuver creates a fulcrum over which the brachial plexus is stretched. Herewith, a fulcrum is created that is as adjacent as possible to the cervical nerve roots. This is important in stretch testing of the nerve roots as this avoids the lessening of nerve traction by the elasticity of the tissue on a long stretch.

In our study design the AECNRST was useful to differentiate clearly between the cases and the controls. Therefore the AECNRST seems to be a clinically valuable test for cervical radicular compression. But the results of this study need caution to the limitations.

We used only three cadavers. However, since the differences of nerve root displacements were small and consistent between the cadavers, it seems unlikely that addition of sample size would add any valuable information. The cadavers were embalmed and dynamic investigations might therefore be confounded. However, former studies have shown that dynamic measures on embalmed nerves correlate sufficiently if compared to unembalmed nerves [11]. Further, the approach to the nerve roots, namely the removal of the posterior osseous elements might have changed the amount of nerve displacement. This potential phenomenon was not investigated in this study, as the primary aim of the first part of this bimodal study was to provide evidence that the nerve root moves with arm and shoulder motion. The investigated nerve roots C5–C7 displaced with the investigated maneuvers (Table 1) ranging from 2 to 6 mm, without an obvious pattern or relevant difference between the nerve roots. This seems plausible as the nerve root angles are not significantly different. The smallest angle was reported to be $50.9 \pm 6.4°$, corresponding to the C6 nerve root while the largest angle of the C7 nerve root was $53.3 \pm 4.2°$ [12]. Further, the nerve roots build the brachial plexus, a highly interconnected structure [13], and the movement of one peripheral nerve stretches the whole plexus.

The clinical value of the AECNRST has been investigated based on a case–control design. This gives some information about the value of the test mainly in regard to its specificity but does not specify the value of the test in patients with other cervical spine disorders. The presented sensitivity values, as well as other values used to quantify validity of a test, might be inaccurate since the case group consisted of patients who already presented with dermatome-specific radicular symptoms. The AECNRST was defined as positive if the symptoms were aggravated, which is a subjective sensation. A prospective cohort of patients who would undergo AECNRST first, in a blinded fashion, followed by MRI might have been more adequate to address test validity and is subject of current research. Further, the AECNRST was performed only once per patient, so that there is no information on inter- and intra-observer reliability. While the AECNRST is not validated trough this study, anatomic rationales are given and evidence on its clinical value is provided.

The AECNRST, namely abduction extension cervical nerve root stretch test, creates the anatomically most adjacent fulcrum over which the brachial plexus can be stretched to create cervical nerve root stress. It was positive in most (79 %) of the patients with cervical radicular compression and negative in nearly all of those (98 %) without any cervical radicular symptoms. This very simply performable test is recommendable for daily clinical use in diagnosing cervical radicular compression symptoms.

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