Symptom localization tests in the cervical spine: a descriptive study using imaging verification

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The concept of isolation of a movement to a single specific spinal segment by blocking/stabilization is considered useful and important during both examination and treatment. This descriptive study endeavoured to determine whether a typical manual stabilizing procedure changes movement patterns in the cervical spine. Lateral radiographs were taken of five volunteers in active/assisted extension with and without manual fixation grasping with the thumb and fingers around the dorsal aspect of the neck at the level of the vertebral arch. Vertebral angular differences between the fixated and non-fixated movements were measured for intra-rater and inter-rater reliability using an intraclass correlation coefficient (ICC) and analyzed for differences using a student t-test. Intraclass correlation coefficient values for intra-rater reliability were fair to moderate whereas inter-rater reliability was excellent. Although not statistically significant, the results showed that in relation to the active extension, the vertebrae above the fixated vertebrae moved slightly less (mean = -0.08° ; SD = 2.55) as did the vertebrae two levels above fixation (mean = -0.11° ; SD = 2.13). Movements of the vertebrae below the fixation and two levels below the fixation were also reduced (mean = -1.09° ; SD = 2.07) and (mean = -0.65° ; SD = 1.85) respectively. The results suggest the possibility of a three-point bending of the spinal column during fixation and symptom localization during fixation may be a product of soft tissue tension and/or pressure from the fixating fingers. Further research is necessary, including a design that allows consistency among all participants which is appropriately powered.

Keywords: Cervical spine, Pain specific segmental movement, Symptom localization tests

Clinical examination methods designed to localize symptoms to a specific spinal segmental level are key components of well known and frequently used manual therapy philosophies.^{1,2} The philosophical theory behind these examination methods is that by blocking a particular segment, movement provokes tension within the joint and periarticular structures, which in turn triggers the patient's concordant sign.³ The concordant, familiar, or comparable sign originating in the cervical spine is typically pain, but may also include others symptoms such as, stiffness or other neurological variants.⁴⁻⁸

During active movement, a patient with a mechanical dysfunction may alter their typical movement pattern in order to guard a painful segment. One common blocking technique is performed by stabilizing the posterior aspect of the vertebral arch with thumb and index finger for extension or the block can be administered using the lateral aspect of the second

metacarpal-phalangeal joint in a sidebending or rotational movement. Clinical supposition suggests that this blocking procedure should minimize segmental mobility below the fixated segment, prevent movement at the fixated segment, and enhance movement in the segments above the fixated level. It is not currently known what mechanical influence these blocking techniques have on the mobility of the fixated segment or adjacent segments.

To our knowledge, one cadaver study has examined the influence of manual fixation on segmental mobilization of the upper cervical spine.⁹ The study found no significant reduction of flexion-extension at the level being examined with manual fixation compared to a technique that did not involve fixation, although local coupled movements were reduced. Outside these tangential findings, no studies have examined the mechanical impact of blocking techniques for fixation *in vivo* for the lower cervical spine. Consequently, the purpose of this study was to determine whether the manual fixation of one vertebra during assisted active cervical extension

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alters the mobility in the segments above and below the fixation in asymptomatic subjects. It was hypothesized that blocking a given segment would result in increased movement above the blocked segment and reduced movement below the segment. This is the traditional rationale for symptom localization tests by specific segmental movements.

Methods

Subjects

Five subjects consented to participate in this preliminary descriptive trial:¹⁰ four males who were 54, 51, 47 and 35 years old and one 51-year-old female. All reported good general health, no previous neck trauma, and all presented without neck pain. Informed consent was given by all participants in accordance with the approval by Youngstown State University's Institutional Review Board.

Procedure

Cervical lateral radiographs were taken on each subject in a minimum of two and a maximum of four conditions (Table 1). The first radiograph and condition, which served as a control, was taken with the subject positioned in standing while performing maximal, end range, active cervical extension. Following the first radiograph, the subject slightly flexed the cervical spine and a vertebra was manually fixated (stabilized) by placing the thumb and index finger on the vertebral arch, directly adjacent to the spinous process of a specified cervical level.² Fixation of the vertebral arch was performed from behind to prevent posterior rotation of the vertebra during extension. The manual therapist performed this technique from behind with little force while active extension was performed again. At the end of active cervical range of motion, a slight overpressure was applied to ensure maximal end range extension was achieved and another lateral radiograph was obtained (second condition) (Fig. 1).

This procedure was repeated at additional segmental levels for three of the five subjects (conditions 3 and 4). The level of fixation was arbitrarily chosen according to the investigator's perceived ability to best stabilize the vertebral arch in order to produce the most substantive difference between the test movements. The order of fixation therefore was changed arbitrarily.

Figure 1 The subject first slightly flexed the cervical spine, then the therapist fixated one vertebra from behind and the subject extended the spine with little force, at the end of which the therapist gave an overpressure to reach full extension above the fixation.

Data aggregation

In total, 15 radiographs were scanned and images were downloaded to Microsoft PowerPoint (Microsoft Corporation, Redmond, WA, USA) for data analysis. The 15 images were duplicated and cropped to eliminate all easily identified markers and 30 total randomized images were uploaded into Ergomaster4 software (NexGen Corporation, Montreal, Canada). A blinded investigator drew lines along the endplates of each vertebral level and used the posture analysis feature in the Ergomaster4 software to measure vertebral angles for each level of each radiograph from C2-3 to C6-7 (Fig. 2). A second investigator, also blinded to image order performed the same analysis of each radiograph.

Statistical analysis

Intra-rater reliability coefficients ($ICC_{(3,1)}$) were calculated for each of the secondary investigators. The means of each of the trials for those investigators were compared to determine an inter-rater reliability coefficient ($ICC_{(3,k)}$) for the four trials among two investigators.

The angle between the two vertebrae of a segment was measured at the end of active movement and at the end of the assisted movement with stabilization. Since the same segment was not fixated on each subject and more than one segment was fixated on three subjects, these data were reduced by comparing segments

Table 1 Participants and descriptions of the type of movement and level of fixation

Subject	Date of examination	Type of movement and method of fixation	Fixated segment
1	29 October 2006	Assisted extension with therapist fixation	C7
2	29 October 2006	Assisted extension with therapist fixation	C6
3	29 October 2006	Assisted extension with therapist fixation	C5
3	29 October 2006	Assisted extension with therapist fixation	C7
4	29 October 2006	Active extension with belt fixation	C7
4	29 October 2006	Assisted extension with therapist fixation	C5
4	29 October 2006	Active extension with self fixation	C3
5	30 January 2006	Assisted extension with therapist fixation	C6
5	30 January 2006	Assisted extension with therapist fixation	C5
5	30 January 2006	Assisted extension with therapist fixation	C5

Figure 2 A radiograph of a subject with C5 fixated and mean vertebral angles provided.

relative to the segment of fixation rather than by segmental level alone; therefore, the compared levels are delineated as above or below the fixated segment. These angles were analyzed using paired *t*-tests in SPSS 15.0. A *P* value of <0.05 was considered significant.

Results

The measurements of the angles between the cervical segments showed good values: intraclass correlation coefficients (ICCs) with standard error of measurement (SEM) demonstrated good intra-rater reliability with an $ICC_{(3,1)}$ of 0.72 (1.27°) for rater 1 and fair reliability with 0.54 (2.46°) for rater 2. Inter-rater reliability was found to be exceptional with an $ICC_{(3,k)}$ of 0.83 (1.14°)¹¹ (Table 2).

Examining the raw data of the 15 radiographs comprising 5 controls and 10 experimental conditions demonstrated a large range between minimum and maximum values. Angles in the following overview show the differences found between the two positions of a vertebra at the end of the active movement and at the end of the assisted movement with fixation of one vertebra:

- the vertebrae above the fixated level (for example C5-6 with fixation of C6) moved slightly less when compared to the active movement (mean of 10 measures: -0.08° , range from -4 to 2.75°);
- all vertebrae above the fixated one (for example C2-3 to C5-6 with fixation of C6) moved slightly less when compared to the active movement (mean of 34 measures: -0.25° , range from -4 to 3.0°);
- movements of the vertebrae below the fixated vertebra (for example C5-6 with fixation of C5) moved less when compared to the active movement (mean of 10 measures: -1.09° , range was from -3.5 to 3°);
- all vertebrae below the fixated one (for example C4-5 to C6-7 with fixation of C4) moved less when compared to the active movement (mean of 16 measures: -1.52° , range from -7.5 to 3.0°).

When analyzed with *t*-tests, the manual fixation did not significantly change the segmental movements compared to active extension without fixation for any

of the individual levels compared. These pairings examined included one, two, three, and four levels above the fixated level and one and two levels below the fixated level individually. The results of the statistical analyses can be found in Table 3.

Discussion

During the testing procedures, subjects reported feeling varying locations of tension in the cervical tissues by fixation of different vertebrae during extension. This perception of altered tension within the cervical spine likely contributes to the belief that external stabilization of specific segmental levels can result in measurable mobility differences of those segments. During extension in the lower cervical spine the inferior articular process of one vertebra (for example C4) glides caudally and dorsally on the superior articular process of the lower vertebra (for example C5).¹² It is believed that by fixating the caudal vertebra and moving the cranial one promotes this gliding thereby increasing extension. This would result in less extension caudal to the fixated segment, no apparent movement at the fixated segment, and increased movement cranial to fixation, particularly at the segment directly adjacent to the fixation. To date, *in vivo* validation of this concept is lacking and *in vitro* examination suggests that this concept is inconsistent and the total movement is minimal.⁹ The results of this study would suggest that less mobility may occur caudal to the fixated segment, but fails to support the assumption of an increase in mobility cranial to the fixated segment. In fact, the mean angle differences were smaller cranial during fixation suggesting refutation of this concept. Consequently, a traditionally driven theoretical rationale for symptom localization tests performed with specific segmental movement is questioned.

Since the expected mechanical effect did not appear to be supported in this data set, alternate hypotheses may serve to explain the varying findings. Perhaps, during segmental fixation, a combination of movement and palpatory pressure from the fixating grip increases tissue's tension provoking the patient's concordant sign and the altered soft tissue tension rather than specific joint movement might be an explanation why the symptom localization tests clinically works. Another possibility may lie in the neurophysiological effect of compressing tissue at the given segment.

Postero-anterior (PA) pressure on one spinous process in prone lying also does not result in a specific movement, but in a general increase of lordosis

Table 2 Summary of reliability for spine segment angle measurement

Measure	ICC	SE	95% CI
Intra-rater 1	0.724	1.271	0.609–0.809
Intra-rater 2	0.547	2.462	0.367–0.687
Inter-rater	0.833	1.144	0.737–0.895

Figure 3 Example of three-point bending model with posterior fixation.

described as a three-point bending (Fig. 3).^{13,14} Lee *et al.*¹³ found even greater movement in the adjacent segments when pushing on the spinous process of C5 mostly in extension but also in some segments in flexion. McGregor *et al.*,¹⁵ however, found minimal movement when pushing ventrally on the second and sixth cervical spinous process, a consequence of soft tissue compression of 9.7 mm with a Maitland Grade I and 12.2 mm with a Maitland Grade IV. In the lumbar spine the posteroanterior mobilization also increases the lordosis moving most segments into extension and some into flexion.¹⁶

The mechanics of performing a fixation technique as described in this study may not be expected to behave the same as a PA glide since the cervical spine would not be stabilized in the same manner as lying prone during a PA mobilization. It should also be noted that any variability in the motion noted was not statistically significant in this study therefore interpretation should be that manual fixation of a segment had no significant effect on vertebral segmental mobility.

Figure 4 MRI with C5 fixated by the investigator's third digit.

Limitations

Although angular radiographic measurements are true representations of vertebral orientation observed,¹⁷ there are several possible sources of error in this trial. The first concerns execution of the tests including the inaccuracy of repetition in a three-dimensional movement in precisely two planes for radiographic presentation and inconsistent movement patterns of the volunteers. The examiner was standing behind the patient instead of laterally, which may have altered the examiner's ability to appropriately stabilize the segment. The fixation force was small, clinically enough to make subjects feel tension at different locations, but perhaps not enough to truly fixate the vertebra. Standardization of the fixation force was not used because the subject's perception of the fixation force is quite variable and the grip force is normally not increased when the subject feels substantial tension and pain provocation typically encountered in the clinical environment. This renunciation of standardization may be considered a lack of scientific rigor; nonetheless, it is closer to clinical reality.

Figures 4–6 show the large distance between the palpation finger and the vertebral arch even when pressing firmly into tissue resistance. This might be a substantive factor contributing to the insufficient

Table 3 Statistical analysis of vertebral angular change with segmental fixation

Level examined	Mean angle		Difference	SD	SEM	95% CI		t	df	sig.(2-tailed)
	Control	Fixed				Lower	Upper			
1 Above	7.950	7.875	0.075	2.555	0.808	-1.753	1.903	0.093	9	0.928
2 Above	8.190	8.080	0.111	2.125	0.708	-1.523	1.745	0.157	8	0.879
3 Above	7.625	7.250	0.375	1.343	0.475	-0.748	1.498	0.790	7	0.456
4 Above	8.450	7.850	0.600	0.652	0.292	-0.209	1.409	2.058	4	0.109
1 Below	8.844	7.750	1.094	2.066	0.730	-0.633	2.821	1.498	7	0.178
2 Below	7.400	6.750	0.650	1.851	0.828	-1.648	2.948	0.785	4	0.476

Figure 5 MRI of C3 fixation by investigator's thumb.

stabilization of the fixating fingers. In addition, previous research has identified that three-dimensional effects occur during a two-dimensional fixation procedure⁹ and our method of assessment cannot assess the potential effect in the third dimension. Another possible error relates to angle measurement. There may have been calculation error in angle measurement on the computer. We attempted to minimize this potential error by averaging the results of two examiners on two trials each but the potential for error persists.

Lastly, it should also be noted that our sample size was quite small limiting the power of the results. The exploratory nature of this study and the desire to minimize the investigator's exposure to X-rays warranted these small sample sizes. These factors limit generalizability of the results, but they may elicit more interest in research on the effects of fixation techniques on spinal movement.

Conclusions

Symptom localization tests performed with specific segmental movements in the cervical spine may function in clinical practice but the rationale is questioned. This pilot study did not identify significant changes in cervical segmental movements during extension with and without manual fixation of single vertebrae. The large variability in range of movements measured, however, outlines the inconsistency of movement patterns used by the subjects in the study. A three-point bending of the spine might occur in a similar manner to that described in PA mobilization, but further research with more standardized methodology and more participants is necessary. Further research is required to validate findings.

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Figure 6 MRI of C3 fixated using investigator's index finger.

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