

NECK MOBILITY ASSESSMENT IN ANKYLOSING SPONDYLITIS: A CLINICAL STUDY OF NINE MEASUREMENTS INCLUDING NEW TAPE METHODS FOR CERVICAL ROTATION AND LATERAL FLEXION

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SUMMARY

The objective was to carry out a clinical assessment of different cervical mobility measurements in ankylosing spondylitis (AS), including two new tape methods for measuring cervical rotation and lateral bending. A range of cervical movements was measured in 52 consecutive male AS patients and the results correlated with detailed radiological changes in the whole spine and sacroiliac joints. Occiput- and tragus-to-wall distance (OWD/TWD), cervical rotation (CR) and lateral flexion (CLF) using a Myrin inclinometer (My) and a tape method (t), cervical flexion-extension (CFI-CExt/My) motion and chin-chest distance (CCD) measurements were taken and repeated (test-retest). The results showed a highly significant correlation of all measurements with cervical radiological changes, except for CCD, and also those of OWD/TWD with lumbar changes. CLF and CExt also correlated significantly with lumbar changes, other measurements did not, and only TWD and CExt correlated with thoracic changes. All measurements showed good reliability, intra-class correlation coefficients (ICC) ranging from 0.89 to 0.98. Occiput- or tragus-to-wall distance, cervical extension and lateral flexion proved to be valid and reliable measurements in AS, but cervical rotation also appeared to be a clinically relevant method. Cervical lateral flexion is a recommendable measurement for clinical trials in AS. The two new tape methods for measuring cervical rotation and lateral bending were as valid and reliable as the inclinometer method (Myrin), but also quick and easy. Chin-to-chest distance was not among the most valid tests in AS.

KEY WORDS: Cervical measurements, Ankylosing spondylitis, Roentgenogram.

ANKYLOSING spondylitis (AS) involves mainly the spinal and thoracic joints and ligaments, restricting mobility but also affecting extra-spinal structures. Age also reduces spinal and thoracic mobility [1, 2], the effect on different ranges of motion varying somewhat however [3]. A wide range of spinal mobility measurements has been adopted in the assessment of disease progression and treatment outcome in AS, but cervical ranges of motion have rarely been assessed in clinical trials [4-9].

Chest expansion and lumbar spinal forward and lateral flexion play an important role in AS diagnostics [10], but measurements of the cervical spine are not included in the diagnostics or routine follow-up of the condition, despite the fact that limitations in cervical mobility progress together with other spinal changes [9, 11-13]. Pile *et al.* [8] showed the clinically most useful measurements to be cervical rotation (using a protractor) and cervical lateral flexion (using a goniometer) in mild or moderate AS, as well as tragus-to-wall distance in severe disease, together with measurements of (whole) thoracolumbar flexion, lateral bending, modified Schober test and fingertip-to-floor distance.

The aim of the present study was to assess clinically different cervical ranges of motion, including two new measurements of cervical lateral flexion and rotation, using a tape method compared with measurements using the Myrin inclinometer technique. The results correlated with radiological changes in the whole spine

and sacroiliac joints used for assessment of their validity. In addition, test-retest reliability was evaluated.

SUBJECTS AND METHODS

The study population comprised 52 consecutive male patients with idiopathic AS [17], who participated in a 3 week in-patient course (treatment programmes, see [11]). Their mean age was 44.7 (s.d. 10.5) yr. Disease duration ranged from 4 to 49 yr (mean 19.5 yr) from the first typical symptoms and from 0 to 36 yr (mean 10.5 yr) from the diagnosis. The activity of the disease varies markedly, as assessed by erythrocyte sedimentation rate (ESR), from 2 to 70 (mean 21.5). During the study, 20 patients received only non-steroidal anti-inflammatory drugs (NSAIDs) and five had disease-modifying anti-rheumatic drugs (DMARDs) other than sulphasalazine. No neurological symptoms were observed in any of the patients. The demographic data are given in Table I.

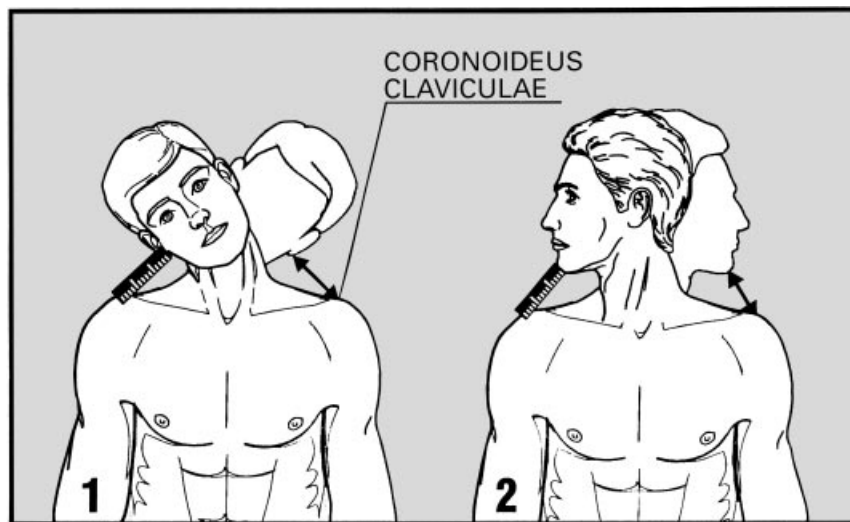
The method of Dale and Vinje [14], involving the same method for detailed assessment of the thoracic and cervical spine, was used for radiological grading, scoring from 0 (no changes) to 4 (the most severe

TABLE I
Demographic data on 52 male patients

	Mean	(s.d.)	Range
Age (yr)	44.8	(10.5)	27-69
Symptom duration (yr)	19.6	(9.3)	4-49
Diagnosis duration (yr)	10.5	(9.0)	0-38
ESR (mm/h)	21.5	(19.0)	2-70
Hb (g/l)	138.3	(12.1)	110.0-157.0

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FIGS 1 and 2.—(1) The decrease in distance between the ear lobe (tragus) and (tuberculum) coronoideus clavicularae was measured with a tape from zero position (head erect) to maximal bending on both sides (left and right) without rotation for assessment of cervical lateral flexion. (2) The decline in distance between the top of the chin (in horizontal position without flexion) and the coronoideus clavicularae was measured with a tape from zero position (chin straight ahead) to maximal rotation on both sides.

changes) (Table II). Radiological grading based especially on assessment of the following detailed changes shown to be typical for AS: syndesmophytes, ossifications of long anterior and interspinous posterior ligaments, changes in apophyseal joints, straightening anterior surfaces of vertebrae and sclerotic anterior border of vertebrae. While other detailed radiological changes also evaluated in the present study have shown no correlations with mobility restrictions due to AS [12].

The validity of the new tape measurement methods of cervical lateral flexion (Fig. 1) and rotation (Fig. 2) was tested by comparing with another method using a Myrin inclinometer and with other cervical range of motion measurements [15], as well as with radiological changes in the cervical, thoracic and lumbar spine, and sacroiliac joints.

Repeated tests were measured twice on successive days (during 72 h from entry) at the same time (11 a.m. \pm 2 h) by the physiotherapist for intra-tester as well as by a control physiotherapist for inter-observer reliability assessment without warming up.

TABLE II

Distribution of radiological gradings (0 = no changes, 1 = suspected or initial changes, ... 4 = most severe changes) in cervical (C), thoracic (TH) and lumbar (LS) spine and sacroiliac joints (SI) given as a percentage with the number of patients (total $N = 52$)

	Grading				
	0	1	2	3	4
	<i>N</i> (%)	<i>N</i> (%)	<i>N</i> (%)	<i>N</i> (%)	<i>N</i> (%)
SI	0	0	1 (2)	24 (46)	27 (52)
C	9 (17)	16 (31)	7 (14)	9 (17)	11 (21)
TH	3 (6)	7 (14)	11 (21)	22 (42)	9 (17)
LS	1 (2)	11 (21)	13 (25)	19 (37)	8 (15)

Measurement methods are given in the Appendix. Four different inclinometer (Myrin) measurements take ~ 2 min and the whole setting 4–5 min.

The data are given as means and s.d. Correlations between spinal ranges of motion and radiological changes are given as non-parametric Spearman's correlation coefficients for evaluation of the validity of each test (Table IV). Intra-class correlation coefficients of the measurements are given for the assessment of intra- and inter-observer reliability.

RESULTS

The demographic data are given in Table I.

The distribution of the radiological gradings of the whole spine are shown in Table II. Radiological spinal changes were observed in almost all patients.

Table III gives the results of nine cervical measurements. The reliability of all measurements was good,

TABLE III

Mean, s.d. and ranges of cervical measurements, with added results of bilateral measurements, in 52 male patients with ankylosing spondylitis

	Mean	(s.d.)	Range
1. Occiput-wall distance (OWD)	68.3 mm	(55.7)	0–190 mm
2. Tragus-wall distance (TWD)	164.6 mm	(51.5)	95–280 mm
3. Cervical lateral flexion/tape (CLFt)	61.0 mm	(24.0)	0–202 mm
4. Cervical lateral flexion/Myrin (CLFMy)	40.0°	(15.5)	0–113°
5. Cervical rotation/Myrin (CRMMy)	93.9°	(19.8)	15–166°
6. Cervical rotation/tape (CRt)	146.9 mm	(37.6)	18–372 mm
7. Chin-chest distance (CCD)	49.8 mm	(27.0)	0–120 mm
8. Cervical flexion/Myrin (CFIMy)	39.3°	(16.9)	2–75°
9. Cervical extension/Myrin (CEExtMy)	31.3°	(17.6)	0–70°

TABLE IV
Correlations between cervical mobility measurements and radiological changes in cervical (C), thoracic (Th) or lumbar spine (Ls) and sacroiliac joints (SI) given as the Spearman coefficient (r)

	Ls r	Th r	C r	SI r
1. Occiput-wall distance (OWD)	0.37*	0.22	0.38*	0.20
2. Tragus-wall distance (TWD)	0.55**	0.33†	0.42*	0.30
3. Cervical lateral flexion/tape (CLFt)	0.33†	0.27	0.58**	0.43**
4. Cervical lateral flexion/Myrin (CLFMy)	0.28†	0.18	0.57**	0.36*
5. Cervical rotation/Myrin (CRMy)	0.21	0.19	0.47**	0.26
6. Cervical rotation/tape (CRt)	0.15	0.15	0.42**	0.25
7. Chin-chest distance (CCD)	0.23	0.25	0.27	0.16
8. Cervical flexion/Myrin (CFMy)	0.07	0.17	0.39*	0.17
9. Cervical extension/Myrin (CExtMy)	0.32†	0.39*	0.55**	0.34†

† $P < 0.05$; * $P < 0.01$; ** $P < 0.001$.

intra-class correlation coefficients ranged from 0.89 to 0.98.

Table IV shows the radiological correlations of the mobility measurements as Spearman coefficients for evaluation of their validity. The results showed that occiput- and tragus-to-wall distance (OWD/TWD), cervical extension (CExt) and lateral flexion measurements (CLF) correlated significantly with cervical and lumbar radiological changes, less with thoracic changes, whereas cervical rotation and forward flexion correlated with cervical changes only. The chin-to-chest distance (CCD) did not correlate. Thus, the tape methods for measuring cervical lateral bending and rotation also proved to be valid.

DISCUSSION

'There is an almost infinite number of possible head postures' [16]. Nonetheless, three cardinal spinal motion levels are clinically important, i.e. flexion-extension around the transverse axis, lateral flexion around the sagittal axis, and axial rotation. Over half of the rotation movement appears between the occiput and two upper cervical vertebrae (C1 + C2). On the other hand, most of the motion in flexion-extension appears in the central region, and lateral bending occurs only to a small extent between the occiput and C1 [16].

Most cervical ranges of motion decline during disease duration, playing a marked role in functional impairment due to AS [17]. The clinical value of careful measurements in AS, however, may be reduced by insufficient knowledge of normative values or changes in different diseases, which make assessments liable to bias.

Radiological changes in the thoracolumbar spine showed only weak correlations with the cervical mobility measurements. Occiput- or tragus-to-wall distance

is more a measurement of permanent postural changes, also correlating with the lumbar changes. Moreover, the results showed strong cervical radiological correlations with occiput- or tragus-to-wall distance, cervical extension and lateral flexion, yet significantly also with cervical rotation and flexion measurements, whereas chin-to-chest distance measurement did not correlate. In addition, all these measurements, by the tape methods as well, proved reliable.

The use of the Myrin inclinometer is based on a compass method, e.g. in cervical rotation measurement, which could be affected by electric fields in the environment, and seems not to be reliable in all circumstances [18]. In the tape measurement method for cervical lateral bending, a decrease was measured in the distance between the ear lobe (tragus) and the (tuberculum) coronoideus clavicularae (reference point on the shoulder). These new methods seem to fulfil the demands of a relevant clinical approach. Assessment of sensitivity to change of the useful methods is, however, desirable [19]. Only moderate, though statistically significant, radiological correlations show that other (soft) tissue changes, which could not be visualized by routine methods, also play a marked role in the development of restrictions in spinal movements.

In different goniometer studies [18, 20-24], the total range of motion in flexion-extension measurements has been observed to be from 123 to 148°, in lateral flexion from 88 to 154°, and in rotation measurements from 151 to 177°, except for one study yielding 78-83° only [21]. In radiographic measurement, mean cervical rotation has varied from 105 to 145° [24, 25] in the healthy, and was also 145° in a CT study [27].

In a study of 508 male and female employees, Alaranta *et al.* [30] observed in the age group 35-39 yr to 50-54 yr a decrease in cervical side-bending from 38 to 34°, and correspondingly total flexion-extension from 126 to 113° and rotation from 77 to 70°. Lind *et al.* [25] observed a linear relationship between motion and age, which seems, however, not to be similar in all measurements [3]. O'Driscoll and Tomenson [28] have also shown a cervical mobility decrease in the healthy as age progresses from 20 to 70 yr, e.g. in rotation from 151 to 111° and in flexion-extension from 124 to 84°. Youdas *et al.* [29] observed a decline in cervical lateral bending from 95° in the age group 20-29 yr to 60° in the age group 60-69 yr, and correspondingly in extension from 86 to 57° and (total) rotation from 146 to 110°.

O'Driscoll *et al.* [9] showed markedly decreased cervical movements in patients with AS. Their mean rotation was 54°, mean flexion-extension 51° and mean lateral flexion 26° (total). In the present study, mean total rotation was 14.7 cm, using a new tape method corresponding to 94° using a Myrin inclinometer, flexion-extension was 70° and total lateral flexion 40°, which was 6.1 cm measured by tape. The patients in question had disease of long duration and marked spinal changes. The results showed that a marked decline in all cervical movements due to AS could be observed, most prominent in lateral bending and

differing markedly from those in the healthy due to age. O'Driscoll *et al.* [9] came to the same conclusion.

We concluded that cervical extension (CExt) and lateral flexion (CLF) could be recommended for the AS index, but also that cervical rotation (CR) and occiput- or tragus-to-wall distance (OWD/TWD) should be included in 'the basic measurements' of AS, especially in long-term follow-up and clinical trials. It could, however, not be decided in the present study design how many cervical measurements should be chosen among the tests in the AS index.

Measurement of cervical lateral flexion seems to be one of the best indicators of cervical changes due to AS. We described here two new reliable and valid tape measurements for cervical rotation (CRt) and lateral flexion (CLFt), which would warrant further research.

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APPENDIX: MEASUREMENT METHODOLOGY

- Occiput-to-wall distance (OWD)*: The distance between the occiput and wall measured with a tape while the patient stands heels and back against a wall and tries to get the occiput against the wall with the chin horizontal.

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2. *Tragus-to-wall distance (TWD)*: As above, measured with a tape between the tragus (ear lobe) and wall.
 3. *Cervical rotation (CRMy)*: Total range of rotation of the cervical spine from maximal leftwards to maximal rightwards rotation, measured with a Myrin inclinometer.
 4. *Chin–coronoideus clavicular distance (rotation) with a tape (CRt)*: Decrease in distance between the chin and coronoideus process of the clavicle in maximal cervical rotation on both sides (left and right) without cervical flexion, measured with a tape.
 5. *Cervical lateral flexion (CLFMy)*: Maximal lateral bending of the head without rotation, measured with a Myrin inclinometer.
 6. *Tragus–coronoideus clavicular distance (cervical lateral flexion) (CLFt)*: Decrease in distance between the tragus and coronoideus process of the clavicle in maximal lateral bending of the head on both sides (left and right), measured with a tape.
 7. 8. *Cervical flexion–extension (CFIMy-CExtMy)*: Maximal cervical forward flexion and extension measured with a Myrin inclinometer in the sitting position.
 9. *Chin-to-chest distance (CCD)*: Distance between the chin and jugulum in maximal flexion of the cervical spine, measured with a tape.