Relationship between spinal mobility and disease activity, function, quality of life and radiology. A cross-sectional Spanish registry of spondyloarthropathies (REGISPONSER)

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Abstract

Objective

To determine the relationship between anthropometric measurements and disease activity, functional capacity, quality of life and radiology in Spanish patients with ankylosing spondylitis (AS).

Patients and methods

A cross-sectional study was made of 842 patients with definite ankylosing spondylitis (REGISPONSER). Sociodemographic data, spinal mobility measurements, Bath AS disease activity index (BASDAI), nocturnal pain, Bath AS radiology index (BASRI), Bath AS functional index (BASFI), the Short-Format 12 (SF-12) and the AS specific quality of life (ASQoL) questionnaire were applied. Pearson correlation coefficient analysis and regression models were constructed.

Results

There was moderate correlation between fingertip-to-floor distance and lateral cervical rotation with the BASFI ($p<0.01$). Good correlation was evident between wall-occiput distance and lateral cervical rotation with the BASRI ($p<0.01$). Moderate correlation was found between chest expansion, the Schober modified test and fingertip-to-floor distance with the total BASRI ($p<0.01$). The anthropometric measurement with the lowest correlation value was lateral lumbar flexion. Significant association was found between the Schober modified test and BASFI, BASDAI and BASRI ($R^2 = 0.37$; $p<0.001$); chest expansion and BASFI, BASDAI and BASRI ($R^2 = 0.25$; $p<0.001$); wall-occiput distance and BASFI, BASRI and ASQoL ($R^2 = 0.44$; $p<0.001$); fingertip-to-floor distance and BASFI and BASRI ($R^2 = 0.30$; $p<0.001$); and lateral cervical rotation and BASFI and BASRI ($R^2 = 0.34$; $p<0.001$).

Conclusion

In our study, wall-occiput distance and lateral cervical rotation showed the strongest correlation to BASRI. Similarly, fingertip-to-floor distance and lateral cervical rotation exhibited the closest correlation to BASFI.

Key words

Spinal mobility, metrology, anthropometric measurements, ankylosing spondylitis, BASDAI, BASFI, BASRI, SF-12, AsQoL.

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Introduction

Ankylosing spondylitis (AS) is a chronic and inflammatory arthritis and enthesitis involving the spine and peripheral joints (1, 2). Commonly, the disease progresses to eventual fusion (*i.e.* ankylosis) of the affected joints, resulting in reduced spinal mobility (3).

Several measures have been included in the assessment of spinal disease in AS. In this sense, AS metrology includes several measurements: wall-occiput distance, the Schober modified test, lumbar lateral flexion, fingertip-to-floor distance, chest expansion, lateral cervical rotation and intermalleolar distance, which have been used to assess the degree of spinal mobility in relation to spinal inflammation and structural damage caused by the disease (4). Spinal mobility restrictions are the outcome measures most commonly used in AS (5).

In 1998, the Assessments in Ankylosing Spondylitis Working (ASAS) group recommended the use of a core-set of three instruments: occiput to wall distance; chest expansion and the Schober modified test for routine clinical use and outcome and prognostic studies in the assessment of disease-controlling antirheumatic therapies (6, 7). An additional index, the BASMI (Bath Ankylosing Spondylitis Metrology Index) includes tragus-wall distance, cervical rotation, intermalleolar distance, lateral flexion and the Schober modified test (8), while the EDASMI (Edmonton Ankylosing Spondylitis Metrology Index) includes four measures: cervical rotation, chest expansion, lateral lumbar flexion and hip internal rotation (9). The measurements recommended by ASAS, BASMI and EDASMI do not include fingertip-to-floor distance (FFD), but we have included this measure in our study because several publications have reported in favor of FFD. A study has been made in patients with ankylosing spondylitis where the fingertip-to-floor distance was the measurement most responsive to self-perceived change at 6 months (10). In other studies, FFD proved to be a good indication of change noted in the physical therapy treatment group (11-15). Finally, there is an article in which FFD was the measurement most sensitive to change after a two-month corticotropin treatment period[16].

The objective of the present study was to analyze the relationship between the anthropometrical measures and activity, functional capacity, quality of life and radiological effects in patients with AS.

Patients and methods

In April 2004, the Spanish Spondyloarthropathies Study Group of the Spanish Society of Rheumatology (GRESSER) launched the National Spondyloarthropathies Registry (REGISPONSER) (17). The registry is available through an Internet database to all participating members (http://biobadaser.ser.es/cgi-bin/regisponser/index.html). Ten Spanish rheumatology departments were selected. All participating rheumatologists were required to include all patients that fulfilled the inclusion criteria up to a minimum of 100 patients per center.

Patients

The inclusion criteria were: 1) Confirmed cases of ankylosing spondylitis (AS) as defined by the modified New York criteria (18); 2) Blood tests available within 15 days of the visit, and a complete radiographic study (lateral cervical, lateral lumbar and pelvis radiography) within the previous year; and 3) Agreement to complete all self-administered questionnaires. Each patient was assigned a random code in the database to avoid the entry of personal data. The inclusion period was 12 months. All patients gave their informed consent to participate in the study, which was approved centrally by the Ethics Committee of Reina Sofia Hospital.

Data collection

This was an observational, cross-sectional study. In each center, all patients were evaluated by the same rheumatologist who had been previously trained in a standardization session. The sociodemographic information recorded comprised patient age, gender, employment-related variables and habits,

especially regular exercise. A considerable amount of collected data were referred to the diagnosis: time (year) of onset of AS; specific signs and symptoms (inflammatory back pain, peripheral arthritis, extraskeletal symptoms), what specific signs and symptoms the patient experienced at the time of diagnosis, the clinical form of the disease (axial, peripheral, enthesitic or mixed), and whether the patient had a family history of AS. To ascertain the degree of the disease, the number of inflamed peripheral joints, enthesitis according to MASES - Maastricht Ankylosing Spondylitis Enthesitis Score assessment criteria (19), and the extra-articular disease manifestations were recorded by physical examination of the patient.

For the evaluation of disease status, the following anthropometrical measures were used: occipital-to-wall distance, the modified Schober test, lateral flexion of the lumbar spine, thoracic expansion, lateral cervical rotation and fingertip-to-floor distance. We decided not to include intermalleolar distance due to the difficulty in measuring this parameter.

As measures of disease status, we also included: nocturnal pain on a 0 (no pain)-10 (maximum pain) Visual Analog Scale (VAS); physician and patient global assessment of disease activity, also on a 0 (very well)-10 (very bad) VAS; the Bath Ankylosing Spondylitis Disease Activity Index (BASDAI) from 0 (no activity) to 10 (maximum activity) (20), and functional capacity as scored by the Bath Ankylosing Spondylitis Functional Index (BASFI) from 0 (no disability) to 10 (maximum disability) (21).

Damage was accrued by the radiological assessment valued by the Bath Ankylosing Spondylitis Radiology Index (BASRI) (22), both for spine and on a total basis (BASRI spine + BASRI hips). The radiographs were interpreted by the same rheumatologist trained in a standardization session. The existence of erosions, osteophytes and protrusions in hips was also assessed.

Quality of life was additionally evaluated by the specific questionnaire of quality of life in spondyloarthritis (ASQoL) (23), where lower values indicate a better quality of life, and by the generic SF-12 (24) - in which higher values indicate a better quality of life.

Laboratory tests included erythrocyte sedimentation rate (ESR: normal 0-20 mm/h), C-reactive protein (CRP: normal 0-5 mg/l) and HLA B27 status.

Current treatments including non-steroidal anti-inflammatory drugs (NSAIDs), corticoids, disease-modifying antirheumatic drugs (DMARDs), and biological therapies were also recorded. The effectiveness of NSAIDs in relieving pain was defined as 50% reduction in pain within 48 hours after introducing the medication, or rapid worsening within 48 hours after discontinuing the treatment.

Statistical analysis

Descriptive statistics were given as means, standard deviations (SD) and ranges. Pearson correlation coefficient analysis was performed to examine the contribution of different anthropometric measurements. A value >0.6 was defined as indicative of a good correlation, with moderate correlation between 0.4-0.6, and poor correlation <0.4. Regression models were constructed. A two-tailed *p*-value of <0.05 was considered significant. All tests were performed using the SPSS version 13 statistical package.

Table I. Demographic characteristics of the 842 patients.

	Mean ± SD
Males/females	639(76%) / 203(24%)
Age (years)	48.5 ± 12.6
Age at initial symptoms (years)	26 ± 9.7
Disease duration (years)	14.4 ± 10.3
Diagnosis delay (years)	8 ± 9
Employed fully/Unemployed/Housewives (n)	442 / 331 / 50
Occupational disability (n)	258
Family history of AS (n)	163

Results

After 12 months, 842 patients with ankylosing spondylitis responded to the invitation to participate, and were included in the study. There were 639 males (76%) and 203 females (24%), with a mean age of 48.5±12.6 years.

The demographic characteristics of the subjects are shown in Table I. Two hundred and twenty patients (26%) had peripheral joint involvement, 54 (6.4%) had psoriasis, and 35 (4.2 %) had inflammatory bowel disease. Six hundred and fifty-eight patients (78%) had positive HLA B27. At the time of the inclusion visit, 584 (70%) were with NSAIDs, 51 (6.1%) corticoids, 158 (18.8%) DMARDs [methotrexate (6.7%), sulfasalazine (11.6%) or leflunomide (0.5%)], and 139 (16,6%) were receiving biological therapies [infliximab (13.7%) or etanercept (2.9%)]. NSAIDs had a positive effect in 526 patients (62.5%). Three hundred and thirty-eight (40%) regularly practiced some type of physical exercise.

Disease-related scores are shown in Table II. The patients with a duration of disease of more than 10 years scored lower in the Schober modified test, with lesser mobility in lateral cervical rotation, and a greater occiput-to-wall distance and fingertip-to-floor distance ($p<0.001$). Females had significantly better mean scores in relation to the Schober modified test, occiput-to-wall distance and fingertip-to-floor distance than males ($p<0.001$). We found no differences in the anthropometrical measures between AS patients with or without peripheral joint involvement.

Table III shows the degree of agreement between the different anthropometrical measures. The best correlation was observed between occiput-to-wall distance and lateral cervical rotation. Lateral lumbar flexion showed very poor correlation. Thoracic expansion showed moderate correlation to the Schober modified test and lateral cervical rotation. The Schober modified test showed moderate correlation to

Table II. Results of disease-related variables*.

	Mean ± SD	Range
Nocturnal back pain (cm)	4 ± 3	0-10
Patient Global Assessment (cm)	4.6 ± 2.7	0-10
Physician Global Assessment (cm)	3.1 ± 2.1	0-10
BASDAI (cm)	4.1 ± 2.3	0-9.8
BASFI (cm)	3.6 ± 2.7	0-10
BASRI total	7.3 ± 4	2-16
Chest expansion (cm)	3.6 ± 2.1	0-21
Modified Schober test (cm)	2.8 ± 1.8	0-10
Occiput-to-wall distance (cm)	4.5 ± 6	0-35
Fingertip-to-floor distance (cm)	19.4 ± 14.5	0-100
Lumbar lateral flexion (cm)	22.5 ± 20	0-94
Lateral cervical rotation (>70º/20º-70º/<20º)	50.1%/ 31%/ 16.6%	
ESR (mm/h)	18.7 ± 17	1-111
CRP (mg/dl)	10 ± 16	0.01-192
AsQoL	7 ± 5	0-18
Physical component SF-12	37.6 ± 7.6	20-57
Mental component SF-12	50.6 ± 5.5	31-65

*BASDAI: Bath Ankylosing Spondylitis Disease Activity Index; BASFI: Bath Ankylosing Spondylitis Functional Index; BASRI: Bath Ankylosing Spondylitis Radiology Index; ESR: erythrocyte sedimentation rate; CRP: C-reactive protein; ASQoL: specific questionnaire of quality of life in spondyloarthritis; SF-12: 12-Item Short-Form Health Survey.

Table III. Pearson correlations between the different anthropometrical measures in AS patients.

Measures	Chest expansion	Modified Schober Test	Occiput-to-wall	Lumbar lateral flexion	Fingertip-to-floor
Chest expansion					
Modified Schober test	0.42**				
Occiput-to-Wall	-0.32**	-0.53**			
Lumbar lateral flexion	-0.19**	-0.05	-0.076*		
Fingertip-to-floor	-0.32**	-0.49**	0.38**	-0.06	
Lateral cervical rotation	-0.43**	0.53**	0.6**	-0.05	0.4**

**Correlation is significant at the 0.01 level (2-tailed). *Correlation is significant at the 0.05 level (2-tailed).

occiput-to-wall distance and fingertip-to-floor distance and lateral cervical rotation. Fingertip-to-floor distance exhibited moderate correlation to lateral cervical rotation.

We calculated the degree of agreement between the anthropometrical measures and the activity, functional capacity, quality of life and radiological manifestations of the disease (Table IV). In this context, fingertip-to-floor distance and lateral cervical rotation showed moderate correlation to the BASFI score. Occiput-to-wall distance and lateral cervical rotation showed good correlation to BASRI-spine and BASRI-total. Thoracic expansion, the Schober modified test and fingertip-to-floor distance exhibited moderate correlation to BASRI-spine and BASRI-total. The anthropometric measurement with the lowest correlation value of all the variables was lateral lumbar flexion. Pearson correlation coefficient analysis showed the best predictors of radiological damage evaluated by the BASRI to be occiput-to-wall distance and lateral cervical rotation.

The correlations between the spinal mobility measurements and the different radiological projections are shown in Table V. Occiput-to-wall distance showed good correlation to the lumbar radiological findings. Lateral cervical rotation showed a marked correlation to the cervical radiological findings. There was no correlation between lumbar lateral flexion and the spinal plus sacroiliac radiological scores.

Five multiple regression models were constructed to identify variables associated with spinal mobility measurements. The dependent variables were: Schober modified test, chest expansion, occiput to wall distance, fingertip-to-floor distance and lateral cervical rotation. The independent variables were: age, gender, disease duration, VAS, BASDAI, BASFI, BASRI-t, ASQoL and SF-12. The first model explained 37% of the variance of the Schober modified test. Disease duration [coefficient-beta -0.01; 95%CI (-0.02 to 0); p=0.019], BASFI [coefficient-beta -0.17; 95%CI (-0.23 to -0.11); p<0.001], BASDAI [coefficient-beta 0.10; 95%CI (0.04 to 0.17); p=0.002] and BASRI-t [coefficient-beta -0.20; 95%CI (-0.23 to -0.16); p<0.001] were independently associated to the Schober modified test. The second model explained 25% of the variance of chest expansion. Disease duration [coefficient-beta 0.02; 95%CI (0.01 to 0.04); p=0.01], BASFI [coefficient-beta -0.09; 95%CI (-0.17 to -0.01); p=0.03], BASDAI [coefficient-beta 0.11; 95%CI (0.02 to -0.19); p=0.01] and BASRI-t [coefficient-beta -0.18; 95%CI (-0.23 to -0.13); p<0.001] were independently associated to chest expansion. The third model explained 44% of the variance of occiput-to-wall distance. BASFI [coefficient-beta 0.55; 95%CI (0.35 to 0.75); p<0.001], BASRI-t [coefficient-beta 0.83; 95%CI (0.73 to 0.93); p<0.001] and ASQoL [coefficient-beta -0.15; 95%CI (-0.25 to -0.06); p=0.002] were independently associated to occiput-to-wall distance. The fourth model explained 30% of the variance of fingertip-to-floor distance. BASFI [coefficient-beta -2.15; 95%CI (1.78 to 2.51); p<0.001] and BASRI-t [coefficient-beta 0.81; 95%CI (0.55 to 1.07); p<0.001] showed an independent association to fingertip-to-floor distance. Finally, the fifth model explained 34% of the variance of lateral cervical rotation. BASFI [coefficient-beta 1.25; 95%CI (1.16 to 1.35); p<0.001] and BASRI-t [coefficient-beta 1.37; 95%CI

Table IV. Pearson correlations between anthropometrical measures and activity, functional capacity, quality of life and radiological involvement of the disease.

Measures	Chest expansion	Modified Schober	Occiput-to-wall	Lumbar lateral flexion	Fingertip-to-floor	Lateral cervical rotation
Nocturnal back pain	0.03	-0.01	-0.32	-1.22**	0.17**	0.003
PADA	0.01	-0.81*	0.61	-0.19**	0.17**	0.10**
PGA	-0.02	-0.10*	0.92**	-0.1**	0.24**	0.13**
BASDAI	0.02	-0.05	0.58	-0.19**	0.21**	0.12**
ESR	-0.10**	-0.09*	0.65	-0.04	0.04	0.10**
CRP	-0.01	-0.04	0.08	-0.05	0.04	0.07*
BASFI	-0.20**	-0.35**	0.35**	-0.09**	0.47**	0.42**
BASRI-spine	-0.44**	-0.58**	0.64**	-0.01	0.4**	0.64**
BASRI-total	-0.41**	-0.56**	0.63**	-0.01	0.4**	0.64**
AsQoL	-0.1**	-0.19**	0.13**	-0.05	0.3**	0.23**
Physical c. SF-12	-0.06	-0.16**	-0.14**	0.04	-0.28**	-0.21**
Mental c. SF-12	0.00	-0.08*	0.02	-0.04	0.11**	0.05

**Correlation is significant at the 0.01 level (2-tailed). *Correlation is significant at the 0.05 level (2-tailed); PADA: Physician Assessment of Disease Activity; PGA: Patient Global of Assessment; BASDAI: Bath Ankylosing Spondylitis Disease Activity Index; ESR: erythrocyte sedimentation rate; CRP: C-reactive protein; BASFI: Bath Ankylosing Spondylitis Functional Index; BASRI: Bath Ankylosing Spondylitis Radiology Index; ASQoL: specific questionnaire of quality of life in spondyloarthritis; SF-12: 12-Item Short-Form Health Survey.

Table V. Pearson correlations between the different anthropometrical measures and the different radiological projections.

Measures	Chest expansion	Modified Schober	Occiput-to-wall	Lumbar lateral flexion	Fingertip-to-floor	Lateral cervical rotation
Rx lateral cervical	-0.4**	-0.51**	0.57**	-0.005	0.32**	0.65**
Rx lateral lumbar	-0.40**	-0.55**	0.6**	-0.006	0.37**	0.53**
Rx sacroiliac	-0.32**	-0.41**	0.44**	-0.05	0.31**	0.43**
Rx hips	-0.17**	-0.30**	0.38**	0.02	0.23**	0.40**

**Correlation is significant at the 0.01 level (2-tailed). *Correlation is significant at the 0.05 level (2-tailed).

(1.29 to 1.47); $p<0.001$] showed an independent association to lateral cervical rotation.

Discussion

Evaluation of spinal mobility is widely accepted as an essential component of the assessment of patients with AS in both routine clinical practice and in the context of clinical trials. Spinal mobility assessment is advantageous, as loss of mobility can be an early feature. The ASAS group has recommended that spinal mobility measures be used as part of disease controlling antirheumatic therapy (6, 7). Thus, our purpose was to evaluate relationships between anthropometrical measures and activity, functional capacity, quality of life and radiological damage in patients with AS. Evaluation of the different spinal mobility measurements may be expected to provide a sound basis for relevant clinical assessment.

In our study there was a predominance of men (3:1 *vs*. women), as in previous studies (25, 26). We observed that the patients with a long disease duration had worse mobility measures than the rest of subjects. In the present study we also confirmed the previous observation by Viitanen *et al*. (27)**,** whereby the duration of disease is negatively correlated to the modified Schober test and cervical rotation, while wall-occiput distance and fingertip-to-floor distance is positively correlated. Indeed, the patients with advanced lumbar spine or sacroiliac joint changes had a much longer disease duration than the rest (27). Günsah *et al*. found chest expansion to be clearly reduced in patients with long-term AS (28). Tam *et al*. reported that prolonged disease duration is associated with functional impairment (29). Bostan *et al*. in turn concluded that BASMI and BASRI measurements are significantly higher in patients with long-standing disease (30).

The influence of gender on the disease profile has been widely studied. In our study, women with AS had a lesser wall-occiput distance, and a better Schober test score and fingertip-to-floor distance - indicating less severe disability than in men. A recent report found wall-occiput distance to be significantly greater in females; this may be due in part to a higher frequency of peripheral arthritis and fewer spinal radiographic changes in women (31). Bostan *et al*. (30) reported that the BASMI scores are significantly lower in female patients, and Jiménez-Balderas *et al*. (32) indicated that women have less restriction of spinal extension - though without reaching statistical significance. Nevertheless, others studies have found no differences between men and women with AS in terms of spinal mobility (33, 34).

In the present work, the spinal mobility measurements did not show significant differences between patients with and without peripheral arthritis. This result is somewhat in contrast to the observations published by Baek *et al*. (35), who recorded improved modified Schober test scores in patients with peripheral arthritis, because they had a less severe spinal disease course. Nevertheless, Bostan *et al*. (30) found the metrological indexes to be worse in patients with peripheral involvement.

In previous studies, the strongest factors relating to functional disability were reported to be spinal mobility indexes (36). In our work, fingertip-to-floor distance and lateral cervical rotation were the measurements showing the best correlation to the BASFI. Bostan *et al*. (30) showed the modified Schober test to be the strongest variable predicting functional disability. Dalyan *et al*. (37) concluded that cervical rotation and the modified Schober test are

the most powerful predictors of functional loss in AS patients. Ariza *et al*. (38) suggested that the BASMI score is the main factor associated with physical function in AS. We found a lower correlation between spinal mobility measurements and BASDAI, ESR, CRP, AsQoL and SF-12. Haywood *et al*. (10) demonstrated that cervical rotation and fingertip-to-floor distance are moderately correlated to BASDAI and AsQoL. Bostan *et al*. (30) found a positive correlation between BASMI and the Nottingham Health Profile.

The diagnosis of AS is based on specific radiological findings and mobility restrictions (28). Correlation between radiographic damage and spinal mobility in AS has been demonstrated (27, 39, 41-44). In our study, the five measurements (fingertip-to-floor distance, lateral cervical rotation, wall-occiput distance, the modified Schober test and chest expansion) showed a clear correlation to the radiological changes measured by the BASRI. Kaya *et al*. showed that the BASRI correlates only to the modified Schober test and BASMI (43). Chandran *et al*. (40, 44) have investigated the relationship between the modified Stokes Ankylosing Spondylitis Spinal Score (mSasss) and various spinal measurements, and have found that mSasss is related to wall-occiput distance, the modified Schober test, and lateral spinal flexion. Kennedy *et al*. showed that BASMI is positively correlated to the total radiology score (39). Wanders *et al*. (42) have suggested that spinal mobility assessed with various instruments can be impaired by radiographic damage as well as by other unrelated processes (*e.g*. inflammation of soft tissues, structural damage in the thoracic spine or zygapophyseal joints), and the relationship between impaired spinal mobility and radiographic damage is only strong when radiographic damage is high. This supports the notion that spinal mobility measurements are measures of disease severity or deformity rather than of activity. In our work, lateral lumbar flexion showed the lowest correlation to BASRI, in contrast with other studies (42-44).

The results of our work demonstrated strong cervical radiological correlation to cervical rotation. Wall-occiput distance correlated significantly to lumbar radiological changes. These findings are comparable with the results in most other AS studies (27, 39, 41, 45).

The regression models suggested that the wall-occiput distance and cervical rotation are the main factors associated with BASRI, while the fingertip-to-floor distance and lateral cervical rotation were the strongest predictive variables with the BASFI.

A potential limitation of our study is its cross-sectional design.

In conclusion, we recommend the fingertip-to-floor distance, lateral cervical rotation, wall-occiput distance, Schober test and chest expansion for the assessment of the AS in everyday practice, because: 1) assessment takes only 10 minutes; 2) it is inexpensive; 3) it is objective measure while that the BASDAI and BASFI are more subjective; 4) it can be repeated as often as required and 5) it evaluates the severity and progression of the AS.

Key messages

- Lateral cervical rotation showed a good correlation to BASRI and BASFI.
- Fingertip-to-floor distance, cervical rotation, wall-occiput distance, Schober test and chest expansion are recommended measurements.

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