Juvenile Onset Ankylosing Spondylitis (JAS) Has Less Severe Spinal Disease Course Than Adult Onset Ankylosing Spondylitis (AAS): Clinical Comparison Between JAS and AAS in Korea

HAN JOO BAEK, KI CHUL SHIN, YUN JONG LEE, SEONG WOOK KANG, EUN BONG LEE, CHANG DAL YOO, and YEONG WOOK SONG

ABSTRACT. ***Objective.*** To assess the frequency of juvenile onset ankylosing spondylitis (JAS) in Korean patients with AS and to differentiate the clinical characteristics of JAS from adult onset ankylosing spondylitis (AAS).

Methods. We studied 98 consecutive patients with AS who visited the rheumatology clinic of a tertiary referral center and compared clinical and radiographic features of JAS (n = 41) with those of AAS (n = 57).

Results. Median age at onset in JAS was 14 years (range 7–16) and in AAS 22 years (range 17–38) ($p < 0.01$). Patients with JAS at presentation showed fewer spinal symptoms and more frequent peripheral joint symptoms than those with AAS (41.5% vs 80.7% and 73.2% vs 36.8%, respectively; $p < 0.01$). Current cervical spine disease was more frequent in AAS (66.7% vs 43.9%; $p = 0.02$) and current knee disease in JAS (26.8% vs 8.8%; $p = 0.02$). Patients with JAS showed a shorter tragus–wall distance (mean ± SD 10.6 ± 1.7 vs 13.1 ± 6.9 cm; $p < 0.01$), more mobility on the modified Schober test (5.7 ± 2.0 vs 4.0 ± 2.6 cm; $p < 0.01$) and chest expansion (4.4 ± 1.7 vs 3.2 ± 1.8 cm; $p < 0.01$), and a better forced vital capacity (75.1 ± 14.1% vs 82.1 ± 16.1% of predicted value; $p = 0.03$) than those with AAS. Totally ankylosed sacroiliitis and spinal syndesmophyte on radiographs were less frequent in JAS patients than in AAS (19.5% vs 47.4% and 17.1% vs 54.4%, respectively; $p < 0.01$).

Conclusion. The frequency of JAS (41.3%) among Koreans was higher than that reported for Caucasians. General joint involvement pattern at disease onset in JAS was similar to previous reports. Our data suggest that clinically and radiographically JAS has a less severe spinal disease course than AAS. (J Rheumatol 2002;29:1780–5)

Key Indexing Terms:

JUVENILE ONSET ANKYLOSING SPONDYLITIS
ADULT ONSET ANKYLOSING SPONDYLITIS ANKYLOSING SPONDYLITIS

Ankylosing spondylitis (AS) is a chronic, systemic inflammatory disorder of the axial skeleton affecting the sacroiliac joints and the spine. Hip and shoulder joints, and less commonly, peripheral joints or extraarticular structures may also be involved. Symptoms usually begin in late adolescence or early adulthood[1].

Some patients with AS have juvenile onset disease (JAS), defined by onset at or before age 16 years. It has characteristic clinical features that distinguish it from adult onset disease (AAS) as follows. Patients with JAS have a higher frequency of extraspinal joint disease, those with AAS have increased frequencies of radiographic abnormalities of the spine[2]. Persistent hip, knee, and ankle arthritis and dactylitis of the hands occurred more frequently in juveniles[3]. Peripheral joint involvement as a mono- or oligoarthritis was significantly more frequent in juvenile onset patients, not only as a mode of onset but also during the course of the disease. Impairment of functional capacity was more severe in the juvenile onset group and hip joint involvement was closely related to a poorer prognosis[4]. Juvenile patients were found to require more hip replacements compared to adults on longterm followup[5].

From the Division of Rheumatology, Department of Internal Medicine, Clinical Research Institute, Seoul National University Hospital, Seoul, Korea.

Supported by a grant from Seoul National University.

H.J. Baek, MD, Assistant Professor, Division of Rheumatology, Department of Internal Medicine, Gachon Medical School; S.W. Kang, MD, Assistant Professor, Division of Rheumatology, Department of Internal Medicine, Chungnam National University College of Medicine; Y.J. Lee, MD, Assistant Professor, Division of Rheumatology, Department of Internal Medicine, Gyeongsang National University College of Medicine; K.C. Shin, MD, Clinical Fellow; C.D. Yoo, MD, Clinical Fellow; E.B. Lee, MD, Assistant Professor; Y.W. Song, MD, Professor, Division of Rheumatology, Department of Internal Medicine, Seoul National University College of Medicine.

Address reprint requests to Dr. Y.W. Song, Division of Rheumatology, Department of Internal Medicine, Seoul National University College of Medicine, 28 Yungun-dong, Chongno-gu, Seoul 110-744, Korea. E-mail: ysong@snu.ac.kr

Submitted June 28, 2001; revision accepted February 28, 2002.

Personal non-commercial use only. The Journal of Rheumatology Copyright © 2002. All rights reserved.

Downloaded on April 24, 2024 from www.jrheum.org

Estimates of the prevalence and incidence of JAS are scarce. It was reported that JAS is relatively more common among Native Americans and Mexican Mestizos, and in many developing countries[6]. Retrospective studies have shown that 8.6% to 21% of Caucasians[2,7] and 28% to 54% of Mexican Mestizos with AS[8,9] experience disease onset before the age of 16. The frequency of JAS in Asians is not known.

We assessed the frequency of JAS in Korean patients and compared the clinical characteristics of JAS with AAS in a single tertiary referral center.

MATERIALS AND METHODS

We studied 98 consecutive patients with AS who visited or were referred to the rheumatology clinic at Seoul National University Hospital (tertiary referral center) between March 1997 and August 1998. All patients fulfilled the modified New York criteria[10] and had no history of psoriasis, inflammatory bowel disease, or urinary tract infection. We obtained information about current joint or enthesis symptoms, age at disease onset, presenting joint or enthesis symptoms, joint involvement during the disease course, and history of extraskeletal manifestations via medical records and interview. Presenting joint symptoms were defined as pain, swelling, or limitation of motion of joints at disease onset. In regard to axial joints, they were defined as pain or stiffness of neck, upper back, lower back, or buttock relieved by exercise. Hips and shoulders are considered as peripheral joints. Enthesopathy was defined as history of focal pain at entheses. Functional class of all patients was assessed according to the American College of Rheumatology criteria[11].

We performed complete joint and enthesis examinations and physical measurements in all patients at study entry. Current joint involvement was defined to be present when a joint had swelling, tenderness, or limited motion on examination. Wall–tragus distance and chest expansion at the level of the 4th rib anteriorly were measured. Spinal mobility was assessed by Macrae's modification of Schober's test[12]. At the same examination, joint radiographs and laboratory evaluations including HLA-B27, rheumatoid factor (RF), antinuclear antibody (ANA), urinalysis, electrocardiography, and pulmonary function test were performed in all patients. All patients had radiographs of cervical, thoracic, and lumbar spine and pelvis. Radiographs of peripheral joints were taken where there were current joint symptoms and involvement on history. JAS was defined when the joint symptoms occurred at or before age 16 and AAS was defined as after age 16. We compared the clinical, laboratory, and radiographic features of JAS with those of AAS. Differences in the results were analyzed using Student t test, chi-square test, or Fisher's exact test.

RESULTS

There were 41 patients (41.3%, 39 male, 2 female) enrolled in the JAS group and 57 (58.7%, 50 male, 7 female) in the AAS group (Table 1). Median age at onset of JAS was 14 years (range 7–16) and of AAS 22 years (range 17–38) ($p < 0.01$ by Student t test). Duration of disease was 10.0 ± 5.3 (mean ± SD) years in the JAS group and 11.2 ± 8.4 years in AAS (not significant). Duration of spinal symptoms was 7.3 ± 5.6 years in JAS and 10.2 ± 8.4 years in AAS ($p = 0.04$, Student t test). No significant difference was found between the 2 groups in terms of sex ratio, frequency of uveitis, or functional class.

Presenting spinal symptoms were less common in patients with JAS than those with AAS (41.5% vs 80.7%; $p < 0.01$ by chi-square test; Table 2). On the other hand, presenting peripheral joint symptoms were more frequent in JAS than AAS (73.2% vs 36.8%; $p < 0.01$, chi-square test). Knee joints were more commonly involved at presentation in JAS than in AAS (43.9% vs 15.8%; $p < 0.01$, chi-square test).

Examination revealed knee joint disease more frequently in JAS than in AAS (26.8% vs 8.8%; $p = 0.02$, chi-square test; Table 3). The cervical spine was less often involved in JAS than in AAS (43.9% vs 66.7%; $p = 0.02$, chi-square test). Otherwise, the pattern of joint involvement on examination was similar between the 2 disease groups.

The patients with JAS showed a shorter tragus–wall distance than those with AAS (10.6 ± 1.7 vs 13.1 ± 6.9 cm; $p < 0.01$, Student t test; Table 3). Both the modified Schober test and chest expansion showed more mobility in JAS than in AAS (5.7 ± 2.0 vs 4.0 ± 2.6 cm; $p < 0.01$, and 4.4 ± 1.7 vs 3.2 ± 1.8 cm; $p < 0.01$ by Student t test, respectively).

Laboratory studies except for pulmonary function test were not significantly different between the JAS and AAS groups. The frequency of HLA-B27, ANA, and RF in JAS patients was not different from AAS (100.0% vs 98.2%, 17.1% vs 10.5%, and 0% vs 5.3%, respectively). Abnormal urinalysis (microscopic hematuria and/or proteinuria) and abnormal electrocardiographic findings (all conduction disturbances) were observed in both groups with similar frequencies (14.6% vs 19.3%, 4.9% vs 7.0%, respectively). But forced vital capacity (FVC) was decreased in AAS patients compared with JAS (75.1 ± 14.1% vs 82.1 ± 16.1% of predicted value; $p = 0.03$, Student t test).

All patients showed radiographic sacroiliitis (Table 4). Sacroiliitis grade 4 (total ankylosis)[10] was less frequent in JAS patients than in AAS patients (19.5% vs 47.4%; $p < 0.01$, chi-square test). Radiographic abnormalities of the spine were less prevalent in JAS than in AAS (63.4% vs 80.7%), but this was not statistically significant ($p = 0.056$, chi-square test). However, patients with JAS showed significantly less common syndesmophytes than those with AAS (17.1% vs 54.4%; $p < 0.01$, chi-square test). Frequency of radiographic abnormalities of peripheral joint and entheses in JAS was not different from those of AAS (data not shown).

Since there was the difference in spinal symptom duration between JAS and AAS, we separated the patients into 2 groups by the criterion of spinal symptom duration of 5 years and made a selective comparison for spinal disease severity between JAS and AAS in each group (Table 5). Spinal involvement on examination and FVC were not different between JAS and AAS in both groups (data not shown). In the patients with spinal symptom duration ≤ 5 years, however, JAS patients showed less common grade 4 sacroiliitis and spinal syndesmophytes than in AAS (0% vs 25.0%; $p = 0.03$ and 0% vs 37.5%, respectively; $p < 0.01$ by Fisher's exact test). In those with spinal symptom duration

Personal non-commercial use only. The Journal of Rheumatology Copyright © 2002. All rights reserved.

Downloaded on April 24, 2024 from www.jrheum.org

Table 1. Patient characteristics of juvenile onset AS (JAS) versus adult onset AS (AAS).

	JAS, n = 41	AAS, n = 57	Total, n = 98	p*
Sex ratio (M:F)	39:2 (19.5:1)	50:7 (7.1:1)	89:9 (9.9:1.0)	
Age at study entry, yrs†	22 (15–37)	33 (20–65)	28 (15–65)	< 0.01**
Age at disease onset, yrs†	14 (7–16)	22 (17–38)	18 (7–38)	< 0.01**
Disease duration, yrs‡	10.0 ± 5.3	11.2 ± 8.4	10.7 ± 7.3	
Duration of spinal symptoms, yrs‡	7.3 ± 5.6	10.2 ± 8.4	9. 0 ± 7.5	0.04**
History of uveitis, n (%)	7 (17.1)	16 (28.1)	23 (23.5)	
Functional class III or IV, n (%)	5 (12.2)	11 (19.3)	16 (16.3)	
HLA-B27, n (%)	41 (100.0)	56 (98.2)	97 (99.0)	

* Comparing JAS and AAS; p > 0.05 is not shown.
† Median (range); ‡ mean ± SD; ** Student t test.

Table 2. Presenting joint symptoms of juvenile onset AS (JAS) versus adult onset AS (AAS).

	No. of Patients (%)			
	JAS, n = 41	AAS, n = 57	Total, n = 98	p*
Spine	17 (41.5)	46 (80.7)	63 (64.3)	<0.01†
Neck	2 (4.9)	6 (10.5)	8 (8.2)	
Upper back	2 (4.9)	7 (12.3)	9 (9.2)	
Lower back	10 (24.4)	24 (42.1)	34 (34.7)	
Buttock	10 (24.4)	23 (40.4)	33 (33.7)	
Peripheral joint	30 (73.2)	21 (36.8)	51 (52.0)	< 0.01†
Shoulder	0 (0)	3 (5.3)	3 (3.1)	
Elbow	1 (2.4)	1 (1.8)	2 (2.0)	
Wrist	0 (0)	1 (1.8)	1 (1.0)	
Hand	0 (0)	0 (0)	0 (0)	
Hip	12 (29.3)	12 (21.1)	24 (24.5)	
Knee	18 (43.9)	9 (15.8)	27 (27.6)	< 0.01†
Ankle	3 (7.3)	3 (5.3)	6 (6.1)	
Foot	1 (2.4)	1 (1.8)	2 (2.0)	
Temporomandibular	0 (0)	0 (0)	0 (0)	
Enthesopathy	2 (4.9)	1 (1.8)	3 (3.1)	

*Comparing AAS and JAS; p > 0.05 is not shown. † Chi-square test.

> 5 years, JAS had a shorter tragus–wall distance (11.1 ± 2.0 vs 13.9 ± 7.9 cm; p = 0.04 by t test), more mobility on modified Schober test (5.4 ± 2.4 vs 3.3 ± 2.1 cm; p < 0.01 by t test), and chest expansion (4.0 ± 1.7 vs 2.9 ± 1.4 cm; p = 0.02 by t test) and less frequent spinal syndesmophytes (33.3% vs 61.0%; p = 0.04, chi-square test). In both groups, spinal symptom duration was not different between JAS and AAS patients.

DISCUSSION

In our series, 41.3% of the patients with AS experienced juvenile disease onset, which is comparable to the results for Mexican Mestizos (28% to 54%)[8,9] and higher than in Caucasians (8.6% to 21%)[2,7].

Chronic back pain is a typical symptom at presentation, and occurs in 75% of AS patients[1]. Peripheral joint involvement is a presenting feature in only 10 to 20% of the patients, and commonly affects knee joints unilaterally or bilaterally[13,14]. However, JAS seldom causes axial symptoms at onset and usually presents peripheral arthropathy, predominantly in the lower extremities, often accompanied by enthesopathy[15]. Definite axial disease does not develop until 5 to 10 years after onset or sometimes much later in most JAS patients[4,6,16]. In earlier studies, only 12.8% to 24% of patients with JAS had lumbosacral or sacroiliac symptoms; in contrast, 79% to 89.4% had peripheral arthropathy or enthesopathy at onset[16]. It was reported that enthesopathy and knee, ankle, and tarsal involvement during the first 6 months after onset was 82.9%, 77.1%, 48.6%, and 71.4%, respectively[6]. As in previous studies, in terms of presenting features, our patients with JAS had less common spinal disease (41.5%) and more frequent peripheral joint disease (73.2%) than those with AAS.

However, at presentation our patients with JAS showed elevated frequency of axial symptoms and decreased frequency of knee (43.9%), ankle (7.3%), and foot (2.4%) involvement and enthesopathy (4.9%) compared with previous reports on JAS. This finding can be explained as

Personal non-commercial use only. The Journal of Rheumatology Copyright © 2002. All rights reserved.

Downloaded on April 24, 2024 from www.jrheum.org

Table 3. Current joint involvement on examination and measurement of juvenile onset AS (JAS) versus adult onset AS (AAS).

	No. of Patients (%)			
	JAS, n = 41	AAS, n = 57	Total, n = 98	p*
Spine	37 (90.2)	52 (91.2)	89 (90.8)	
Cervical spine	18 (43.9)	38 (66.7)	56 (57.1)	0.02‡
Thoracic spine	21 (51.2)	31 (54.4)	52 (53.1)	
Lumbar spine	25 (61.0)	43 (75.4)	68 (69.4)	
Sacroiliac joint	12 (29.3)	10 (17.5)	22 (22.4)	
Peripheral joint	26 (63.4)	33 (57.9)	59 (60.2)	
Shoulder	16 (39.0)	16 (28.1)	32 (32.7)	
Elbow	5 (12.2)	2 (3.5)	7 (7.1)	
Wrist	2 (4.9)	1 (1.8)	3 (3.1)	
Hand	3 (7.3)	5 (8.8)	8 (8.2)	
Hip	16 (39.0)	23 (40.4)	39 (39.8)	
Knee	11 (26.8)	5 (8.8)	16 (16.3)	0.02‡
Ankle	3 (7.3)	5 (8.8)	8 (8.2)	
Foot	5 (12.2)	3 (5.3)	8 (8.2)	
Temporomandibular	1 (2.4)	0 (0)	1 (1.0)	
Enthesopathy	23 (56.1)	31 (54.4)	54 (55.1)	
Tragus–wall distance, cm†	10.6 ± 1.7	13.1 ± 6.9	12.1 ± 5.5	0.01**
Modified Schober test, cm†	5.7 ± 2.0	4.0 ± 2.6	4.7 ± 2.5	< 0.01**
Chest expansion, cm†	4.4 ± 1.7	3.2 ± 1.8	3.7 ± 1.8	< 0.01**

* Comparing AAS and JAS; p > 0.05 not shown. † Mean ± SD; ‡ chi-square test; ** Student t test.

Table 4. Radiographic abnormalities of juvenile onset AS (JAS) versus adult onset AS (AAS).

	No. of Patients (%)			
	JAS, n = 41	AAS, n = 57	Total, n = 98	p*
Sacroiliitis	41 (100)	57 (100)	98 (100)	
Grade 1	0 (0)	0 (0)	0 (0)	
Grade 2	5 (12.2)	2 (3.5)	7 (7.1)	
Grade 3	28 (68.3)	27 (47.4)	55 (56.1)	
Grade 4	8 (19.5)	27 (47.4)	35 (35.7)	< 0.01†
Spine	26 (63.4)	46 (80.7)	72 (73.5)	
Squaring	11 (26.8)	25 (43.9)	36 (36.7)	
Syndesmophyte	7 (17.1)	31 (54.4)	38 (38.8)	< 0.01†
Facet joint disease	6 (14.6)	9 (15.8)	15 (15.3)	
Atlantoaxial subluxation	10 (24.4)	6 (10.5)	16 (16.3)	
Compression fracture	3 (7.3)	2 (3.5)	5 (5.1)	

* Comparing AAS and JAS; p > 0.05 not shown. † Chi-square test.

Table 5. Selected comparison of spinal symptom duration between juvenile onset AS (JAS) and adult onset AS (AAS).

	5 Years or Less			More Than 5 Years		
	JAS, n = 20	AAS, n = 16	p*	JAS, n = 21	AAS, n = 41	p*
Symptom duration†, yrs	3.0 ± 1.8	3.4 ± 1.5		11.5 ± 4.7	12.9 ± 8.5	
Tragus–wall distance†, cm	10.2 ± 1.1	11.2 ± 1.9		11.1 ± 2.0	13.9 ± 7.9	0.04**
Modified Schober test†, cm	6.0 ± 1.5	5.8 ± 2.9		5.4 ± 2.4	3.3 ± 2.1	< 0.01**
Chest expansion†, cm	4.7 ± 1.7	3.9 ± 2.3		4.0 ± 1.7	2.9 ± 1.4	0.02**
Radiographical sacroiliitis, n (%)						
Grade 1	0 (0.0)	0 (0.0)		0 (0.0)	0 (0.0)	
Grade 2	3 (5.0)	1 (6.3)		2 (9.5)	1 (2.4)	
Grade 3	17 (85.0)	11 (68.8)		11 (52.4)	16 (39.0)	
Grade 4	0 (0.0)	4 (25.0)	0.03‡	8 (38.1)	23 (56.1)	
Spinal syndesmophytes, n (%)	0 (0.0)	6 (37.5)	< 0.01‡	7 (33.3)	25 (61.0)	0.04***

* p value > 0.05 is not shown. † Mean ± SD; ‡ Fisher's exact test; ** Student t test; *** chi-square test.

Personal non-commercial use only. The Journal of Rheumatology Copyright © 2002. All rights reserved.

Downloaded on April 24, 2024 from www.jrheum.org

follows. First, it is possible that our study could include a higher proportion of JAS patients with presenting axial symptoms. Although axial disease does not develop until 5 to 10 years after onset in most JAS patients, it is known that it can occur earlier and be more progressive in some populations[17,18]. Since our patients with current AS in a single tertiary center were classified and analyzed retrospectively according to age at onset, JAS patients with earlier and predominant axial symptoms may be more numerous in our cohort. Second, it is probable that there are recall biases of the onset symptoms, since our study relied to a large extent on the memory of patients. Unlike at onset, during the disease course, frequency of knee, ankle, and foot involvement and enthesopathy in our JAS patients was increased to 78.0%, 31.7%, 19.5%, and 75.6%, respectively (data not shown). These are comparable to previous reports.

Peripheral arthritis is usually episodic rather than chronic; spinal disease progresses at a variable rate and pattern in AS. In our series, current joint disease confirmed by examination at study entry showed no difference between JAS and AAS except for cervical spine and knee joint diseases. The cervical spine disease was more frequent in AAS and knee disease in JAS. Patients with JAS showed better results in the tragus–wall test, the modified Schober test, and chest expansion than those with AAS. Pulmonary function tests revealed less decreased FVC in JAS than in AAS. The reduced vital capacity is caused by restriction of chest wall movement due to fusion of the costovertebral joints[19]. These results suggested that JAS has a clinically milder spinal disease course than AAS.

The earliest and most common radiographic finding of AS is sacroiliitis[20], and all patients in our series had radiographic sacroiliitis. Totally ankylosed sacroiliitis was less frequent in those with JAS than in AAS. Patients with JAS also had less common spinal syndesmophytes than those with AAS. These findings suggest that JAS has a radiographically less severe spinal disease course than AAS.

Since the duration of spinal symptoms was shorter in JAS than in AAS in our cohort (Table 1), the less severe spinal disease course of JAS may be attributable to a lag of axial symptoms after disease onset and shorter spinal disease duration in JAS. However, JAS may also have a slower progression rate of spinal disease than AAS. In each patient group with a similar spinal symptom duration, JAS showed evidence of less severe spinal disease severity than AAS (Table 5).

Anterior uveitis is the most common extraskeletal feature in AS, occurring in 20–30% of patients at some time during the disease course[21], and 14–27% of JAS patients were reported to have uveitis[16]. We found a similar frequency of uveitis in 28.1% of AAS patients and 17.1% of JAS patients. HLA-B27 is known to be positive in > 90% of Caucasian patients, in 50% of Black patients[22,23], and in 83.3% of Korean patients with AS[24]. HLA-B27 positivity was very high in our patients — 100% in JAS and 98.2% in AAS.

Some limitations must be considered to interpret our data. Our study might have inevitable referral biases since the data were collected from a single tertiary hospital. And our series also included some prevalent cases referred from other hospitals or being followed in our clinic. Thus our data could be less representative than for patients identified at diagnosis, although this condition did not significantly influence the comparison between the JAS and AAS groups.

Our study describes clinical characteristics of JAS in Korean patients. The frequency of JAS was higher than that reported for Caucasians. Our patients with JAS at presentation showed elevated frequency of axial symptoms and decreased frequency of lower limb involvement and enthesopathy, compared with previous reports, but otherwise the general joint involvement pattern at disease onset was similar. Patients with JAS presented less common spinal symptoms and more frequent symptoms of peripheral joints, especially knee joints, than those with AAS. Current cervical spine disease was more frequent in AAS and current knee disease more frequent in JAS. Patients with JAS showed better results in spinal mobility tests and FVC, and had a decreased frequency of advanced radiographic sacroiliitis and spinal syndesmophytes than those with AAS. These results suggest that, clinically and radiographically, in JAS the spinal disease course is less severe than in AAS.

REFERENCES

1. Kahn MA. Ankylosing spondylitis. In: Klippel JH, Weyand CM, Wortmann RL, editors. Primer on the rheumatic diseases. 11th ed. Atlanta: Arthritis Foundation; 1997:189-93.
2. Riley MJ, Ansell BM, Bywaters EGL. Radiologic manifestations of ankylosing spondylitis according to age at onset. Ann Rheum Dis 1971;30:138-48.
3. Marks SH, Barnett M, Calin A. A case-control study of juvenile- and adult-onset ankylosing spondylitis. J Rheumatol 1982;9:739-41.
4. Garcia-Morteo O, Maldonado-Cocco JA, Suarez-Almazor ME, Garay E. Ankylosing spondylitis of juvenile onset: comparison with adult onset disease. Scand J Rheumatol 1983;12:246-8.
5. Calin A, Elswood J. The natural history of juvenile-onset ankylosing spondylitis: a 24-year retrospective case-control study. Br J Rheumatol 1988;27:91-3.
6. Burgos-Vargas R, Vazquez-Mellado J. The early clinical recognition of juvenile-onset ankylosing spondylitis and its differentiation from juvenile rheumatoid arthritis. Arthritis Rheum 1995;38:835-44.
7. Bennett PF, Wood PHN. Population studies of the rheumatic diseases. New York: Excerpta Medica Press; 1968:456.
8. Burgos-Vargas R, Naranjo A, Castillo J, Katona G. Ankylosing spondylitis in the Mexican Mestizo: patterns of disease according to age at onset. J Rheumatol 1989;16:186-91.
9. Jimenez-Balderas FJ. Cuadro clínico de la espondilitis anquilosante en el caucásico y en el mestizo mexicano. Rev Mex Reumatol 1989;4:17-21.
10. van der Linden S, Valkenburg HA, Cats A. Evaluation of diagnostic criteria for ankylosing spondylitis. A proposal for modification of the New York criteria. Arthritis Rheum 1984;27:361-8.
11. Hochberg MC, Chang RW, Dwosh I, Lindsey S, Pincus T, Wolfe F. The American College of Rheumatology 1991 revised criteria for the classification of global functional status in rheumatoid arthritis.

Personal non-commercial use only. The Journal of Rheumatology Copyright © 2002. All rights reserved.

Downloaded on April 24, 2024 from www.jrheum.org

Arthritis Rheum 1992;35:498-502.
12. Macrae IF, Wright V. Measurement of back movement. Ann Rheum Dis 1969;28:584-9.
13. Eastmond CJ. Seronegative spondyloarthropathies. In: Weatherall DJ, Ledingham JGG, Warrell DA, editors. Oxford textbook of medicine. 3rd ed. Oxford: Oxford University Press; 1996:2965–74.
14. Gran JT. An epidemiological survey of the signs and symptoms of ankylosing spondylitis. Clin Rheumatol 1985;4:161-9.
15. Cabral DA, Malleson PN, Petty RE. Spondyloarthropathies of childhood. Pediatr Clin North Am 1995;42:1051-70.
16. Burgos Vargas R, Petty RE. Juvenile ankylosing spondylitis. Rheum Dis Clin North Am 1992;18:123-42.
17. Burgos-Vargas R, Clark P. Axial involvement in the seronegative enthesopathy and arthropathy syndrome and its progression to ankylosing spondylitis. J Rheumatol 1989;16:192-7.
18. Burgos-Vargas R, Vazquez-Mellado J, Cassis N, et al. Genuine ankylosing spondylitis in children: a case-control study of patients with early definite disease according to adult onset criteria. J Rheumatol 1996;23:2140-7.
19. Boushea DK, Sundstrom WR. The pleuropulmonary manifestations of ankylosing spondylitis. Semin Arthritis Rheum 1989;18:277-81.
20. Resnick D, Niwayama G. Ankylosing spondylitis. In: Resnick D, editor. Diagnosis of bone and joint disorders. Philadelphia: W.B.Saunders; 1981:1040-102.
21. Rosenbaum JT. Acute anterior uveitis and spondyloarthropathies. Rheum Dis Clin North Am 1992;18:143-51.
22. Schlosstein L, Terasaki PJ, Bluestone R, Pearson CM. High association of an HLA antigen, w27, with ankylosing spondylitis. New Engl J Med 1973;288:704-6.
23. Brewerton DA, Caffrey M, Nicholls A, Walters D, James DC, Sturrock RD. Ankylosing spondylitis and HLA-B27. Lancet 1973;1:904-7.
24. Choi SJ, Park MH. HLA-B27 frequency in Korean patients with ankylosing spondylitis. Seoul J Med 1987;28:247-50.

Personal non-commercial use only. The Journal of Rheumatology Copyright © 2002. All rights reserved.

Downloaded on April 24, 2024 from www.jrheum.org