

PROGRESSION IN UNTREATED IDIOPATHIC SCOLIOSIS AFTER END OF GROWTH

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Seventy patients more than 16 years of age with untreated idiopathic scoliosis were followed-up for a mean period of 8.5 years. The majority of curves increased; 3° per year before 20 years of age and 1° per year after 20 years. Curves below 40° increased significantly less than bigger curves and curves from 60-80° increased the most. Single curves increased significantly more than double curves; thoracic curves increased significantly more than lumbar curves. It is concluded that surgery should be recommended to adolescent patients with thoracic or thoraco-lumbar single curves larger than 40°, and that patients not treated operatively should be followed-up through early adult life.

Key words: scoliosis; idiopathic; adult; untreated; progression

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There is sufficient documentation that thoracic and thoracolumbar scoliosis exceeding 60° can involve progressive pulmonary and cardiac failure and a higher mortality rate (Nachemson 1968, Nilsson & Lundgren 1968). Few investigations exist about curve behaviour in adult idiopathic scoliosis. Collis & Ponseti (1969) showed that scoliosis often progresses in adulthood. However, this fact has not yet been universally appreciated and the common opinion that progression stops at skeletal maturity has been difficult to dispel.

The purpose of the present study is to investigate curve behaviour in idiopathic scoliosis after the end of growth.

PATIENTS AND METHODS

The material consists of 70 patients, 64 females and 6 males, referred for medical advice to Sophies Minde Orthopaedic Hospital in 1936-77. Hospital records and X-rays were available for all patients. Non-idiopathic scoliosis was excluded. None of the patients received any treatment except occasional physiotherapy and in a

few cases a supportive lumbar corset, which does not prevent progression of the scoliosis.

The average ages at the first and last examination were 23 and 34 years, respectively (Table 1). The skeletal age was not calculated for all patients nor was the age for growth cessation available. It was also impossible to decide from the existing X-rays the age at skeletal maturity for all patients. Therefore, since most patients were females, we have suggested that the growth ended at 16 years of age, and that the skeleton was fully mature at 20 years.

For the purpose of this study, there were three follow-up periods (Table 2): period A, from age 16 or more to the last X-ray examination; period B, from 16 to 20 years of age; period C, from 20 years of age to the last review. In period A, all patients were available for investigation, but sufficient records were only available for 25 (23 females and two males) for the calculation of curve progression in periods B and C. The follow-up period varied from 6 to 36 years, average 8.5 years in A and 3.7 and 7.4 years in B and C respectively. The progression per year was calculated for different curve types and periods (Table 3).

Although the scoliosis angle can only be measured to approximately $\pm 2^\circ$, mean annual progression was expressed in tenths of a degree to facilitate predictive calculations. Differences in curve progression were tested by Welch's modified T-test. *P*-values below 0.05 were regarded as significant.

Table 1. Untreated idiopathic scoliosis, age and curve sizes

	Age mean (range)	Mean curve size (range)		
		Single <i>n</i> =55	Double <i>n</i> =15 Upper Lower	
First examination	23 years (16-63)	54° (10°-160°)	65° (20°-151°)	52° (23°-114°)
Last examination	34 years (18-69)	64° (21°-160°)	72° (25°-154°)	59° (25°-117°)

RESULTS

The majority of curves increased in patients 16-20 years old; 83% of the single curves and 65% of the double curves. Also after skeletal maturity about 60% of both single and double curves increased. During the whole follow-up period mean progression for single curves was 13° (Table 2), or 1.5° per year (Table 3). Single curves available for investigation in 16-20-year-olds increased 11°, 3° per year. Curves followed after the age of 20 years increased 8°, or about 1° per year. Double curves showed the same trend but progression was significantly less than for single curves ($P < 0.02$). Thoracic curves increased more than lumbar curves ($P < 0.05$). All curves increased significantly more before 20 years of age than after; taking both curves together, 3° and 1° per year, respectively ($P < 0.01$).

Curves below 40° showed much less progression than bigger curves in both single and double curve scoliosis, in all three periods ($P < 0.01$). Curves 60°-80° showed the largest increase during the whole period of follow-up.

No significant differences in curve progression were found between sexes; in double primary curves no difference was found between upper and lower curves.

DISCUSSION

Earlier, the general opinion was that idiopathic scoliosis did not progress after skeletal maturity (Zaoussis & James 1958). Collis & Ponseti (1969), however, found that many cases of scoliosis did not stop increasing after completion of iliac crest fusion. The results of the present study confirm the observation that scoliosis often

Table 2. Curve progression in untreated idiopathic scoliosis

Review period	Follow-up mean	Single curves		Double curves			
		Curves increased <i>n</i>	Progression mean (range)	Upper		Lower	
				Curves increased <i>n</i>	Progression mean (range)	Curves increased <i>n</i>	Progression mean (range)
A (<i>n</i> =70) (First to last examination)	8.5 years	(55)	13° (-10°-33°)	(15)	12° (-3°-17°)	(15)	10° (-3°-20°)
B (<i>n</i> =25) (Age 16 to 20)	3.7 years	(18)	11° (-3°-28°)	(7)	9° (-2°-20°)	(7)	8° (-2°-22°)
C (<i>n</i> =25) (Age 20 to last review)	7.4 years	(18)	8° (-3°-20°)	(7)	9° (-4°-22°)	(7)	8° (-4°-20°)

Table 3. Mean progression per year in different curve types and periods

	First to last examination		16-20 years of age		After 20 years of age	
	n	Mean progr. per year	n	Mean progr. per year	n	Mean progr. per year
All curves						
single and double	85	1.4°	32	2.9°	32	1.0°
below 40°	32	.8°	14	1.4°	14	.5°
40-60°	27	1.9°	11	3.2°	11	1.0°
60-80°	14	2.1°	4	1.6°	4	1.2°
above 80°	12	1.9°	3	1.2°	3	1.0°
thoracic	39	1.5°	15	3.1°	15	1.0°
thoraco-lumbar	27	1.4°	12	2.8°	12	8.°
lumbar	19	1.3°	5	2.3°	5	.7°
Female	77	1.4°				
Male	8	1.2°				
All single curves	55	1.5°	18	3.0°	18	1.1°
below 40°	24	.9°	10	1.7°	10	.5°
40-60°	16	2.0°				
60-80°	8	2.4°				
above 80°	7	2.3°	3	2.4°	3	1.0°
All double curves	30	1.2°	14	2.4°	14	.9°
below 40°	8	.6°	4	1.2°	4	.4°
40-60°	11	1.5°				
60-80°	6	2.0°	4	1.4°	4	1.3°
above 80°	5	1.7°				

progresses in adults. In this nontreated group idiopathic scoliosis increased in about 80 per cent of the cases in the age period 16-20 years and in about 60 per cent after 20 years of age. Annual progression was found to be three times greater before 20 years than after this age. The investigations of Collis & Ponseti (1969) and Heine & Reher (1975) showed a similar age dependent progression. Riseborough & Herndon (1975) and Keim (1976) held the opinion that idiopathic scoliosis in adults progresses about 1° per year. Keim also believed that a pregnancy leads to an increase of 6-8°. In the present study a possible progression during pregnancy is included in the average as we could not calculate it separately.

The degree of curve progression varied in the present material according to the size of the curve at start of follow-up. Curves below 40° increased significantly less than bigger curves, while curves from 60° to 80° increased the most over the whole

observation period. This is in agreement with Collis & Ponseti. In patients below 20 years of age curves from 40° to 60° showed the greatest increase; in this age group, however, few cases had scoliosis of 60° or more.

The investigation shows that, except for curves above 80°, the greater the curve, the greater the progression. This seems reasonable because of increasing imbalance, the influence of gravity, and mechanical advantage of the muscles on the concave side with increasing curve. The reason why curves above 80° increase less than curves from 60° to 80° may be that rigidity caused by osteoarthritis or even fusion in some segments on the concave side at the apex, often seen when operating these major curves, reduces or prevents progression.

In the present work, single curves increased significantly more than double curves and thoracic curves increased significantly more than

lumbar curves. This has also been found by James (1954) and Collis & Ponseti (1969).

The present investigation shows that idiopathic scoliosis above 40° increased significantly after cessation of growth, particularly rapidly before 20 years of age, but to a great extent also in adults. This observation should influence our attitude to treatment and lead to a change in the indication for surgery in thoracic and thoracolumbar single curves. The threshold for surgery should be lowered to about 40° in adolescents. Further, in cases not operatively treated it may be difficult to predict which curve will increase and which will not in adulthood. Therefore, patients with idiopathic scoliosis should be followed-up during the first years of adult life.

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