Acta orthop. scand. *53*, 769–774, 1982

A COMPARATIVE STUDY OF THE EFFICIENCY OF DIFFERENT TYPES OF SCHOOL SCREENING FOR SCOLIOSIS

STIG WILLNER

Department of Orthopaedic Surgery, Malmö General Hospital (University of Lund), Malmö, Sweden

The efficiency of scoliosis screening was studied among school children in the city of Malmö during the seventies. All children were investigated annually during this decade. The efficiency of the screening varied, however, from one in which no specific information at all was given to the school health authorities to the other extreme where a specially trained school nurse carried out a combined moiré – clinical screening programme. A significant decrease in the mean value of the degree of scoliosis was recorded when diagnosis was made with more effective screening. The best result was achieved when using the combined moiré – clinical screening programme. Furthermore, with this method, the scoliosis was diagnosed at an earlier age and consequently, the number of cases operated on decreased. Thus the cost of effective school screening will be covered merely by avoiding operation in a few cases.

Key words: moiré topography; school screening; scoliosis

Accepted 23.ii.82

During the last few decades the methods of treating structural scoliosis have improved considerably. This applies to conservative as well as surgical techniques. Now, progression of the curves can be effectively prevented. However, more severe secondary problems such as cardiopulmonary complications and rotational cosmetic defects cannot yet be alleviated to any greater extent. Therefore it is important to detect progressive scoliosis as early as possible (Torell et al. 1981). Moreover, with early bracing, surgical treatment may be avoided in many cases. Consequently, interest in school screening of scoliosis has grown during recent years and many papers have been published on the subject. Almost all screening programmes are based on clinical examination. The disadvantage is, however, that the status of the back cannot be documented without radiography. Extensive experience is also demanded of the screening staff so that early cases in a state of progression are not missed.

In the city of Malmö, a combined moiré – visual screening programme has been tested since 1977 (Willner & Willner 1982) and administered by *one* specially trained school nurse. A comparative study of the efficiency of this method and of a conventional clinical screening programme, based on the degree of scoliosis at diagnosis, will be presented. In addition the results of an earlier non-specific screening of the same population will be studied.

All the different scoliosis screening methods discussed here have one factor in common, viz. annual observations of all children from the same population during the seventies.

Financial support was obtained from the Swedish Medical Research Council, project no. B81-17x-04780-06.

0001-6470/82/050769-06 $02.50/0

MATERIAL AND METHODS

The posture of all school children in the city of Malmö aged between 7 and 15 years was examined annually by the school nurses, and every second to third year by the school doctors. The total population involved was 14,949 girls and 15,082 boys. All cases of scoliosis requiring further investigation were referred to the Spinal Unit at the Department of Orthopaedic Surgery, Malmö General Hospital.

The school screening programme for scoliosis can be divided into the following groups:

A. 1971–1974. No specific training or any relevant information had been given to the school health staff. Knowledge of the diagnosis of scoliosis varied considerably. The forward bending test, for example, was seldom used.

B. 1975–1976. A proper description of how to screen children scoliosis was presented to the school doctors and nurses. The child was to be examined in the erect and forward bending positions. In addition, lateral deviation of the spinous processes, asymmetries of the shoulders, scapulae and the outlines of the trunk were to be inspected. Special importance was attached to the forward bending position. All cases of structural scoliosis were admitted to the Spinal Unit in Malmö.

C. 1977–1980. Screening for scoliosis was intensified in two-thirds of the school children. A specially trained school nurse assisted and personally gave instruction on how to screen.

D. 1977–1980. In the remaining one-third of the school population, a combined visual – moiré screening method was initiated. Here a visual observation of the back was made both while standing erect and in the forward bending positions. All cases with any visible asymmetry were moiré photographed.

Cases with moiré positive findings were followed up annually. Minor moiré asymmetries (a deviation of one contour line) were observed at school and more evident ones (a deviation of two contour lines or more) were admitted to the Department of Orthopaedic Surgery for radiography. After the age of 11, only moiré positive cases were followed up. Children who were moiré negative at the age of 11 were not screened again. In a parallel study made by the school health service, no progressive curves had been seen in subjects who were moiré negative at this age (Willner & Willner 1981).

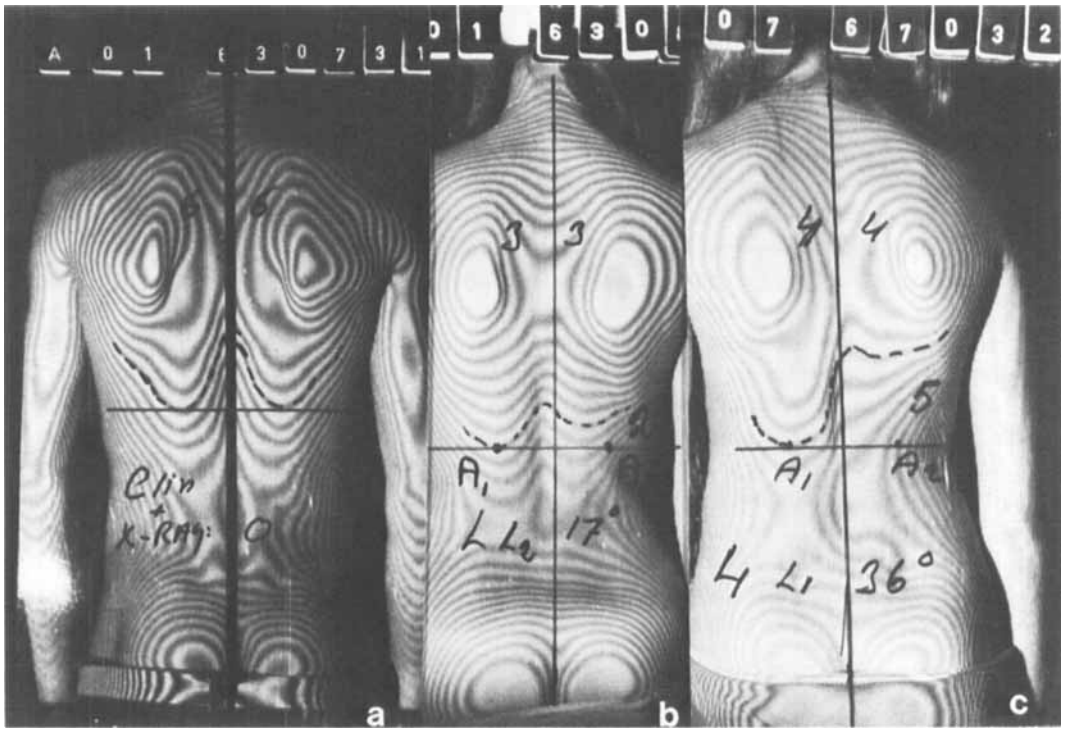
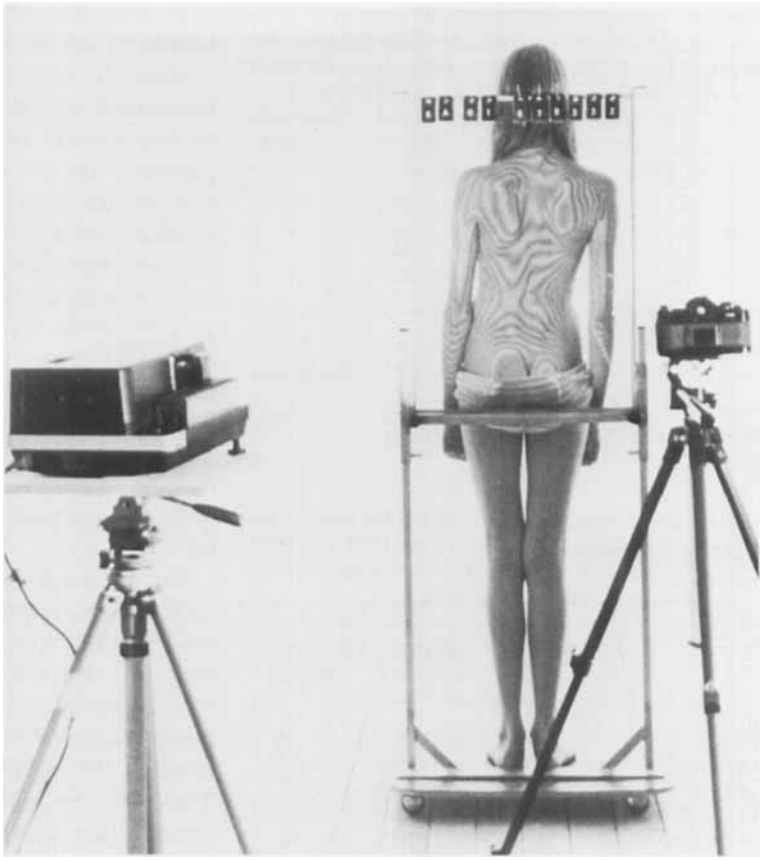


Figure 1. Moiré photography. a. Straight spine with a symmetric trunk. b. Left convex 17° lumbar curve with a deviation of two moiré fringes. c. Left convex 36° thoracolumbar curve with a deviation of five moiré fringes.

Figure 2. Moiré equipment.



The moiré method

Moiré topography is a non-invasive technique which gives a three-dimensional description of the shape of the trunk and records with great accuracy asymmetries between the two halves of the back. The shadow lines observed can be compared with the contour lines on a topographical map. The asymmetry of the shadow patterns is caused mainly by the rotational component, and less by the lateral deviation of the spine (Figure 1). The moiré instrumentation is presented in Figure 2. The moiré technique and evaluation of moiré asymmetry have previously been described in detail (Willner 1979a, b, Willner & Willner 1981).

Definition of structural scoliosis according to the moiré asymmetry findings

Asymmetries of less than one contour line are defined as non-scoliotic findings. An asymmetry (deviation) of one contour line is diagnosed as a small curve, which can be checked at school by taking a new moiré photograph; an X-ray is not required. None of these cases have been seen roentgenographically to have a scoliosis exceeding 15°; the curves are mostly between 5 and 10° (Willner 1979a, b). Cases with deviations of two contour lines or more are X-rayed since there seems to be a 50 per cent risk of finding a scoliosis of 20° or more (Figure 1).

Treatment of scoliosis is indicated in progressive curves of over 25° when at least 1 more year of growth remains. Between 1971 and 1980, 108 cases from the city of Malmö were treated, 99 being girls and 9 boys. Ninety-four were treated conservatively (Milwaukee or Boston braces) and 14 were operated on according to Harrington.

The distribution of this material in the different age groups, showing the different degrees of efficiency of the screening programme, is given in Table 1.

RESULTS

Between 1971 and 1980, a total of 108 cases of scoliosis from schools in Malmö were conservatively or surgically treated. This means that 99

Table 1. The distribution of the 108 cases of scoliosis detected with different screening methods in Malmö between 1971 and 1980. Treatment methods are also given

	Total No. of cases	No. of boys	Brace treated	Surgically treated
1971–74	36	2	28	8
1975–76	20	1	15	5
1977–80*	29	5	28	1
1977–80**	23	1	23	0
	108	9	94	14

* Clinical screening only
** Combined clinical – moiré screening

Table 2. Mean value, standard deviation and range of the degree of scoliosis at diagnosis between 1971 and 1980 divided according to the different screening programmes (A–D see p. 770)

	No. of cases	Degrees of Scoliosis Mean SD	Range
1971–74[A]	34	33.9± 8.7	15–50
1975–76[B]	19	32.6± 9.8	12–52
1977–80*[C]	23	29.2± 7.9	17–50
1977–80**[D]	21	24.3± 5.3	18–33
1971–80***	11	38.2±10.1	23–51

* Clinical screening only
** Combined clinical – moiré screening
*** Operated upon ad modum Harrington
t-test A/D $P < 0.001$
t-test C/D $0.01 > P > 0.001$

girls out of 14,949 (0.66 per cent) and 9 boys out of 15,082 (0.06 per cent) needed some form of treatment for scoliosis. With the increasing intensity of the screening programmes, the mean value of the degree of the scoliosis curve at the time of diagnosis was found to decrease (Table 2).

Common to all these groups was the fact that all school children between 7 and 15 years of age had been examined annually at school. Between 1971 and 1980 the mean value of the degree of the curves diagnosed by the clinical screening technique alone decreased from 34° to 29°. Many different school doctors and nurses were involved in the screening. More information was given on how to screen almost every year from 1975.

However, the best result was obtained by using a combined clinical – moiré technique performed by *one* specially trained school nurse. A comparison of the two different screening programmes, for the years 1977–1980, showed that the combined clinical – moiré programme was significantly more efficient ($P < 0.001$). With clinical screening, the range of the values of the degree of scoliosis did not change during the period 1971–1980; by contrast, with the combined clinical – moiré technique no cases had curves over 33° at diagnosis.

The mean value of the degree of scoliosis at diagnosis was also found to be significantly higher in those cases which were later operated on (Table 2).

The mean age of the girls at the diagnosis of scoliosis, requiring treatment, also decreased with more efficient screening programmes, especially with the combined clinical – moiré method (Table 3). The difference in this regard between the group diagnosed in 1971–1974 and that diagnosed in 1977–1980 was statistically significant. There was no statistical difference, however, between the different screening programmes carried out in the years 1977–1980.

Furthermore, with a more efficient screening programme, more cases were diagnosed during the prepuberal growth period (Table 4). This seems to be of importance as curves which start to

Table 3. Mean age at the diagnosis of scoliosis in the different periods between 1971 and 1980 with varying efficiency of the screening programmes

	No. of cases (girls only)	Mean age (years) ± SD (years)	Range
1971–74	34	13.9±2.4	6.1–17.2
1975–76	19	13.6±1.6	10.5–15.8
1977–80*	24	12.1±1.8	9.8–16
1977–80**	22	12.1±1.6	7.5–14.1
1971–80***	11	12.5±3.2	6 –16.5

* Clinical screening only
** Combined clinical – moiré screening
*** Operated upon ad modum Harrington

Table 4. Number of girls diagnosed in the prepuberal stage (A–D see p. 770)

	No. of cases (percentage)
1971–74[A]	32
1975–76[B]	58
1977–80*[C]	57
1977–80**[D]	80

* Clinical screening only
** Combined clinical – moiré screening

progress early can be expected to become more severe. The importance of early detection of scoliosis is also emphasized by the decrease in the number of cases operated on from the same population (Table 1). Between 1971 and 1976, 14 cases from Malmö were operated on but only one case diagnosed in the years 1977–1980 required operation (Table 1).

Finally, there was no evident increase in the number of cases admitted to the Department of Orthopaedic Surgery from the school health administration, who doubtless suspected that more efficient screening programmes might increase the burden on the orthopaedic surgeons. As far as the combined clinical – moiré method was concerned, a decrease in the number of roentgenograms of the spine for smaller curves was seen.

DISCUSSION

With improved knowledge of school screening for scoliosis, diagnosis of the curves was made at an earlier stage. The mean value of the degree of scoliosis decreased significantly from 34° to 29° and also as a consequence the diagnosis was made at a younger age. The mean age at detection decreased from 13.9 to 12.1 years.

This comparison between the results of screening in different periods in the seventies clearly shows how important it is to educate the school health authorities regarding screening for scoliosis. The result of this study also emphasizes the importance of close cooperation between the members of the school health service and the orthopaedic surgeons responsible for scoliosis treatment in the area.

With earlier detection there has also been a tendency for a decrease in the number of scoliosis operations. This has been emphasized in papers published previously (Torell et al. 1981, Lonstein et al. 1981). This must be due to more effective bracing of curves in patients diagnosed at an early stage. The importance of the latter is seen in this study, as the degree of the curves at diagnosis was greater in cases operated on at a later stage (average 38°). Further support for this hypothesis is the evident decrease in the number of surgical procedures in this material with earlier detection of the scoliosis.

In an analysis of the cases operated on, five had a scoliosis of less than 30° at diagnosis. Of these, three, all with idiopathic scoliosis, refused to wear a brace and their deformities progressed. The other two cases, with neuropathic scoliosis, progressed in spite of proper bracing. If the bracing was started in cases of scoliosis of over 40°, the result of the conservative treatment seemed to be less successful. These patients were also generally older when their deformities were diagnosed.

Best results were achieved by combining moiré photography with the conventional visual screening programme. The mean value of the degree of the scoliosis at diagnosis was 24° compared with 29° in the other two-thirds of the pupils of the Malmö schools, where only well-informed clinical screening was carried out. Most of the cases diagnosed by the combined screening method were referred to the Spinal Unit before conservative treatment was indicated, i.e. curves in a state of progression between 25 and 30°. All cases of scoliosis were detected with the moiré – clinical technique before the curves reached 34°. With clinical screening, a few cases were diagnosed unnecessarily late (50°).

Another advantage of moiré photography was less radiography of minor spinal deformities and a decrease in the number of cases referred to the Department of Orthopaedic Surgery.

The possibility of three-dimensional documentation of the status of the back with the moiré technique also allows a better comparison between two observations. With clinical methods

alone, it is not possible to record small changes in spinal curvature; X-ray must be used in addition.

Effective school screening programmes also seem to be a good economic investment, as has been shown by Dahlberg et al. (1976) and Lonstein et al. (1981). Merely by avoiding surgical procedures in a few patients, by starting bracing early enough, the costs of an effective school screening programme are adequately covered.

REFERENCES

Dahlberg, L. & Nachemson, A. L. (1976) The economic aspects of scoliosis treatment. Proc. 5th symposium at the Cardiothoracic Institute, 21st and 22nd Sept 1976. In: *Scoliosis.* (Ed. Zorab, P. A.), pp. 73–101. Academic Press, London.

Lonstein, J. E., Björklund, S. A. & Nelson, R. P. (1981) School screening for scoliosis in Minnesota. *Proc. SICOT.* (Aug. 30–Sept. 4), p. 290.

Torell, G., Nordwall, A. & Nachemson, A. (1981) The changing pattern of scoliosis treatment due to effective screening. *J. Bone Joint Surg.* **63**-A, 337–341.

Willner, S. (1979a) Moiré topography for the diagnosis and documentation of scoliosis. *Acta Orthop. Scand.* **50**, 295–305.

Willner, S. (1979b) Moiré topography – a method for school screening of scoliosis. *Arch. Orthop. Traumat. Surg.* **95**, 181–185.

Willner, S. & Willner, E. (1982) The role of moiré photography in evaluating the small curves and the natural history of these curves. *Int. Orthop.* (SICOT) (In press).

Correspondence to: Stig Willner, M.D., Dept of Orthopaedic Surgery, Malmö General Hospital, S-214 01 Malmö, Sweden.