

MOIRÉ TOPOGRAPHY IN SCHOOL SCREENING FOR STRUCTURAL SCOLIOSIS

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Schoolgirls, aged 10–17 years, were screened for structural scoliosis at school using both conventional clinical screening with a forward bending test and moiré topography. Those suspected of having scoliosis were examined in an orthopaedic clinic for the presence of clinically significant scoliosis, defined as lateral deviation of 10° or more measured according to Cobb.

The screening revealed 41 cases of scoliosis, corresponding to a prevalence of 4.1 per cent. In 39 girls the scoliosis had not been recognized previously.

In this study moiré topography revealed twice as many cases of scoliosis as did conventional clinical screening. The diagnostic sensitivity of moiré topography proved to be high (0.997). The method is, however, loaded by many false positive results.

No correlation between the degree of lateral deviation, judged by X-ray examination, and the difference in contour lines, judged by moiré topography, was found.

Key words: moiré topography; school screening; scoliosis

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In Denmark, screening of pre-adolescent children for scoliosis is primarily carried out by school doctors and school nurses. The children are screened routinely at the ages of 11 and 15. The screening comprises inspection of the back as well as a forward bending test.

Several epidemiological studies, however, have indicated that this procedure is inadequate (Brooks et al. 1975, Nachemson 1976). This is unfortunate as early diagnosis and treatment of scoliosis is of decisive importance to prognosis.

As promising results have been obtained with the use of moiré topography for revealing structural scoliosis (Adair et al. 1978, Willner 1979), there has been increasing interest in this method in recent years.

The object of this study has been partly to determine the diagnostic reliability of moiré to-

pography as a screening method for scoliosis (compared with clinical screening) and partly to estimate the applicability of the method as a means of determining the lateral deviation of the scoliosis.

PATIENTS AND METHODS

The study was carried out at seven schools in the district of Herning. All girls in the fifth to ninth forms of these schools, a total of 1034 girls 10 to 17 years of age, were offered screening for scoliosis.

The screening comprised both a clinical examination, including a forward bending test, carried out by the school doctors, and an independent moiré topographical screening, carried out by one of the authors.

Moiré topography, which is an optical stereometric method of three-dimensional perception of the formation of a surface, has been previously described in detail

by Adair et al. (1978) and Willner (1979). A 75 × 50 cm raster from the firm of Camp Scandinavia was used.

The subject is placed behind the moiré screen facing forwards with his back to the back of the raster. Equal weight is placed on both legs. The scapulae and buttocks touch the raster and the arms hang at the side of the body. The screen picture (the moiré picture) is photographed with an ordinary camera.

The picture is scrutinized for asymmetry of the topographical contour lines as described by Willner (1979). The maximum asymmetry between the fringes of the convex and the concave half of the back is found above, below or lateral to the contact surface of the scapulae.

In this study the difference in level between two consecutive topographical contour lines is 0.5 cm. An asymmetry of more than one contour line is designated moiré positive.

All pictures were judged independently by two of the authors with no knowledge of the results of the clinical screening. The results were then compared and all pictures that had been judged moiré positive by at least one of the authors formed part of the follow-up examination.

Girls suspected of having structural scoliosis by the school doctor and girls with a moiré positive picture had a clinical follow-up examination by an orthopaedic surgeon who had no knowledge of the inclusion criteria of each individual girl.

For reasons of radiation hygiene not all girls from the screening, with suspected structural scoliosis, were X-rayed. An X-ray examination was only carried out where the clinical follow-up examination suggested a scoliosis of 10° or more, or where a disparity between the results of the different examinations was then found.

Confidence limits stated in the study are exact 95 per cent confidence limits for *P*. The Mann-Whitney test and the *t*-test with a level of significance of 0.05 were used for hypothesis testing.

RESULTS

A total of 989 girls participated in the screening. Two were excluded as they did not want to participate in the follow-up examination.

The follow-up examination comprised 195 girls of whom 135 had a moiré positive picture and 108 a positive clinical screening. Both parameters were found to be positive in 48 girls.

The follow-up examination, carried out by an orthopaedic surgeon, resulted in an X-ray examination of 83 girls. Of these, 41 suffered from a scoliosis of 10° or more, equivalent to a prevalence of 4.1 per cent (confidence limits 2.7–5.5).

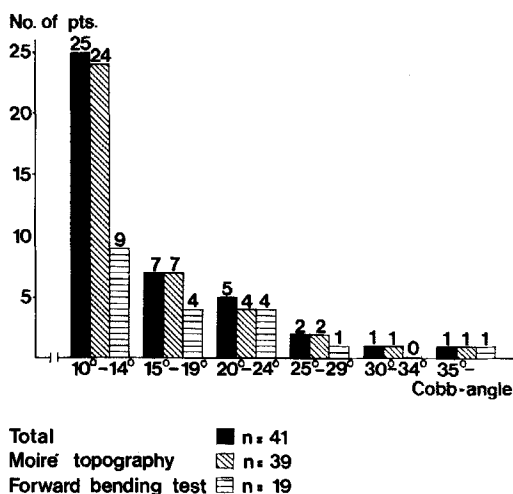


Figure 1. Histogram showing the total number of scolioses in the study and the scolioses diagnosed by moiré topography and forward bending test, respectively, distributed according to the Cobb angle.

In 39 girls the scoliosis had not been discovered previously.

The number of scolioses compared with their degree of severity is shown in Figure 1. Twenty-five girls had a scoliosis of between 10 and 15°, and 16 a scoliosis of 15° or more. The Figure shows the number of scolioses discovered by clinical screening as well as by moiré screening. From this it is evident that moiré topography detected 39 out of 41 confirmed scolioses while clinical screening, including the forward bending test, revealed only 19 out of 41 scolioses. In the case of scolioses of less than 15°, clinical screening discovered only 9 out of 25, whereas moiré screening discovered 24 out of 25 scolioses. With clinical screening six scolioses of 15° or more were overlooked; moiré topography overlooked only one curve of more than 15°.

Based on the results in Figure 1 the diagnostic probabilities of the two screening methods have been calculated (Table 1). The predictive value of a positive test ($P_{\text{pos.}}$) indicates the probability of the patient suffering from scoliosis when the test is positive and the predictive value of a negative test ($P_{\text{neg.}}$) gives the probability of the patient not suffering from scoliosis when the test is negative (Wulff 1976).

Table 1. Diagnostic probabilities of the two screening methods

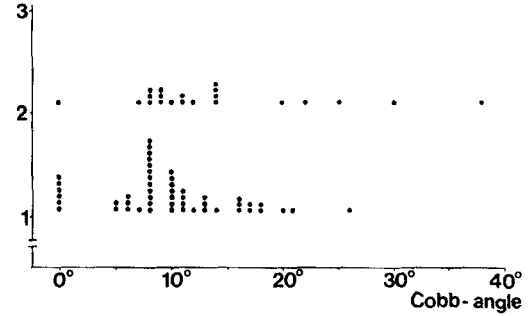
	Bending test	Moiré topography
Predictive value of a positive test ($P_{\text{pos.}}$)	0.18	0.29
Predictive value of a negative test ($P_{\text{neg.}}$)	0.97	0.997

A total of 71 girls who had moiré positive pictures were subjected to an X-ray examination. Figure 2 shows corresponding values of lateral deviation and moiré asymmetry. There is no linear connection between lateral deviation and moiré asymmetry, as scolioses with moiré asymmetry of more than two contour lines are not significantly different as regards the degree of scoliosis from scolioses with asymmetry of less than two fringes.

DISCUSSION

This double screening has proved that the routine forward bending test as part of the screening of scoliosis is inadequate. Using moiré topography

Moiré-deviation.
Fringes



n = 71

Figure 2. Moiré positive and X-rayed girls plotted against lateral deviation and moiré asymmetry.

we found significantly more clinically significant scolioses than using the clinical screening traditionally applied. Of the 41 confirmed scolioses only 19 were found by screening with the forward bending test, whereas moiré topography revealed 39 scolioses. Thus the forward bending test overlooked at least 22 scolioses, six of which were curves of 15° or more.

Moiré topography overlooked two scolioses one of which was more than 15°. Of these two patients, one had a rather long thoracolumbar

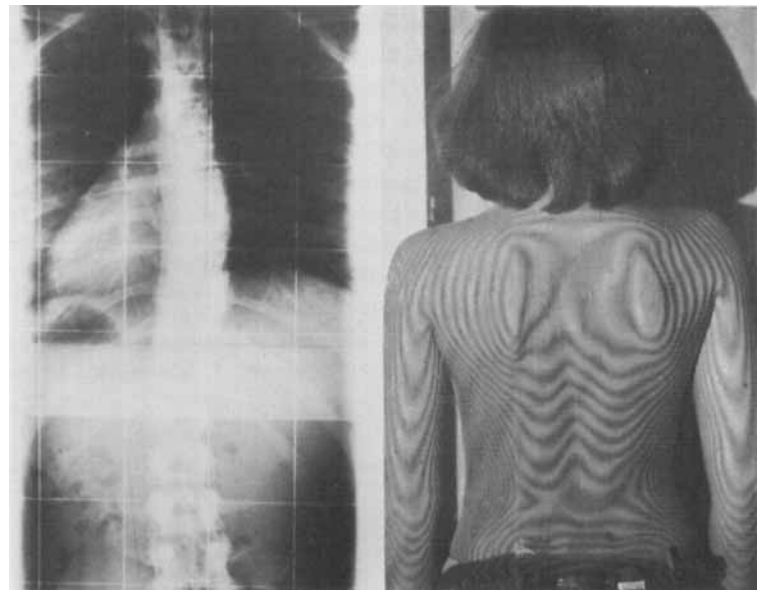


Figure 3. X-ray of a double curve in a 15-year-old girl and the symmetric moiré picture of the same girl.

scoliosis of 10° with no rotation of the spine. Therefore no rotational deformity was found, which explains the negative picture. The other patient (Figure 3) had a double curve which was right convex thoracic with a Cobb angle of 21° and a left convex lumbar with a Cobb angle of 14°. On a repeated moiré screening there was still no asymmetry.

As already stated by Adair et al. (1978), and confirmed by this study both moiré photography and the handling of the apparatus are quick and simple; the screening is also safe and cheap and involves no discomfort for the patient. These are essential criteria in the selection of a screening procedure. With some practice about 50 screenings per hour can be carried out. The photography may be done by the school nurse or by paramedical staff with later examination of the picture by qualified staff.

The fact that the real prevalence of scoliosis can only be determined if the whole population is X-rayed makes it difficult to evaluate the screening methods applied. For reasons of radiation hygiene this is precluded in advance. The prevalence of clinically significant scolioses found in this study corresponds, however, to results from more recent epidemiological studies (Brooks et al. 1975, Lancet 1981).

The weakness of moiré topography is the large number of false positive results, as only 29 per cent (39 out of 135 girls) with moiré asymmetry of more than one contour line suffer from clinically significant scoliosis ($P_{\text{pos.}}$). This, however, is significantly different from the result of the clinical screening where $P_{\text{pos.}}$ was 18 per cent. The reliability of the negative moiré picture is high, however, as almost 100 per cent of the patients with symmetric moiré pictures do not suffer from scoliosis. This value is also significantly different from the corresponding value for the clinical screening. When applying moiré topography for the screening of scoliosis it must therefore be

accepted, with the prevalence found and $P_{\text{pos.}}$, that about 12 per cent of the population screened must be subjected to a follow-up examination.

As is evident from Figure 2, this study has not been able to prove that there is a correlation between the degree of scoliosis and moiré asymmetry, as claimed by Willner (1979). This may be accounted for by the fact that the X-ray examination shows lateral deviation whereas moiré topography expresses the rotation of the scoliosis. A subject with an asymmetry of more than one moiré topographical contour line must therefore be checked by a doctor and often will require a supplementary X-ray examination.

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