

# MOIRE TECHNIQUE IN CONTROL OF

## EPIDEMIC SPINAL CURVATURE

Aleksandra Bujakiewicz, D.Sc., Ph.D.  
Associate Professor,  
Surveying Department, University of Zimbabwe,  
P.O. Box MP 167, Mt. Pleasant, HARARE,  
Zimbabwe.  
Commission No. V.

### ABSTRACT

In this paper the results of extensive experiments dealing with the use of the Moire technique in control of youths' spines are presented. Measurement of the spines of seven hundred school boys has shown extremely high frequency of the spinal curvature. The paper shows simplicity and rapidity of measurement and reliability of the final results.

### 1. INTRODUCTION

Since the structural abnormalities of the human spine are very common there is the need to use a fast and relatively cheap method for their documentation and detection. The two-dimensional image (like, for example, single X-ray) has distinct limitations when we consider that all structural abnormalities of the human body are inherently three-dimensional, or four-dimensional, if we add the dimension of time which is implicated in growth and other changes of living organisms. Scoliosis by definition constitutes a two-dimensional deformity, thereby distinguished from anteroposterior curvatures, such as kyphosis and lordosis. Then the diagnosis and treatment of the spine involve equal consideration of forces operating in all directions.

The Moire technique which permits the determination of external body topography in three-dimensions has proved to be very useful. Asymmetrical structure of the vertebrae causes its own deformity by its own growth. Accurate records of a patient with a progressing curvature can evaluate the effect of asymmetrical growth as well as the success of a certain type of treatment.

### 2. APPROACHES TO THE MOIRE TECHNIQUE

Generally, there are two ways of recording the Moire pattern depicted on an object. The first deals with the use of the ordinary photographic camera, the second with TV camera. Accordingly, there are two approaches to the problem of analysing the Moire topography: traditional graphic analysis of a photo of an object with the Moire contourgraph and a computer processing of the TV image. Though the second fully automated approach seems to be best fitted for widespread use, there are some countries where the traditional graphic analysis of the Moire topography can be more efficiently adapted for diagnostic purposes. In this case the system for the Moire technique includes the following:

- the holder for fixing the patient and the roster;
- two point light sources;
- an ordinary photographic normal angle camera.

The relative geometry of the roster, the lights and the camera should be such that the base of the lights 'b' must be parallel to the plane of the roster and perpendicular to the camera axes. These axes of the light sources should be situated symmetrically and directed at  $45^\circ$  to the axis of the camera. As was verified in practice, the width of the roster's lines and the space between them should be from 0,5mm to 2mm depending on the needs of the experiment (1). The space between two adjacent contour lines can be obtained analytically on the basis of known distance 'b', the distance between the lights and the roster and the width of the roster's lines (5). Knowing the scale of photo and the space between two adjacent contour lines the spatial shape of the object measured can be determined.

### 3. DESCRIPTION OF THE EXPERIMENT

The large clinical experiment has been made by a team from the Photogrammetry Department at the University of Science and Technology in Warsaw, Poland. To define deformation of the shape of the spine for diagnostic purposes seven hundred students from the Warsaw High School (2) were checked by the Moire technique. For obtaining 4mm distance between contour lines, suitable for checking of the spine's shape, the relative geometry of the roster, the lights and the camera has been under-taken as in Figure 1.

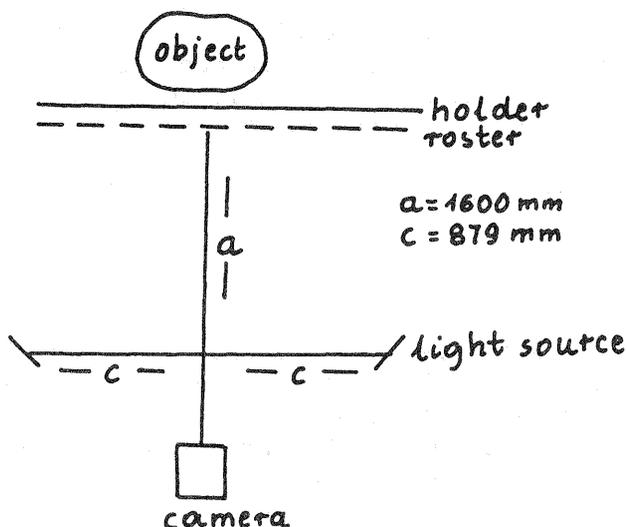


Figure 1. GEOMETRY OF THE MEASURING POSITION

The widths of the roster's lines and the space between them were 1mm. For proper identification of the measured points on the photograph eight chosen vertebrae were targeted on each patient's body by a physician. To prevent reflection the patient's back was powdered. Each patient was coded and fixed to the holder in a very precise manner. The photograph was taken after filling the lungs with air. During one hour photographs of fifteen patients were taken. All photographs were enlarged to scale one to two on the basis of known distances fixed on a frame of the holder.

The results of the spine's shape of each student were obtained in the form of three projections in plane: XY - frontal plane, YZ - sagittal plane and XZ - horizontal plane (Figure 2). For projections in plane XY (Figure 2a) and YZ (Figure 2b) the vertebra  $S_1$  has been assumed as the reference point with X and Y equal zero and Z equals 40mm.

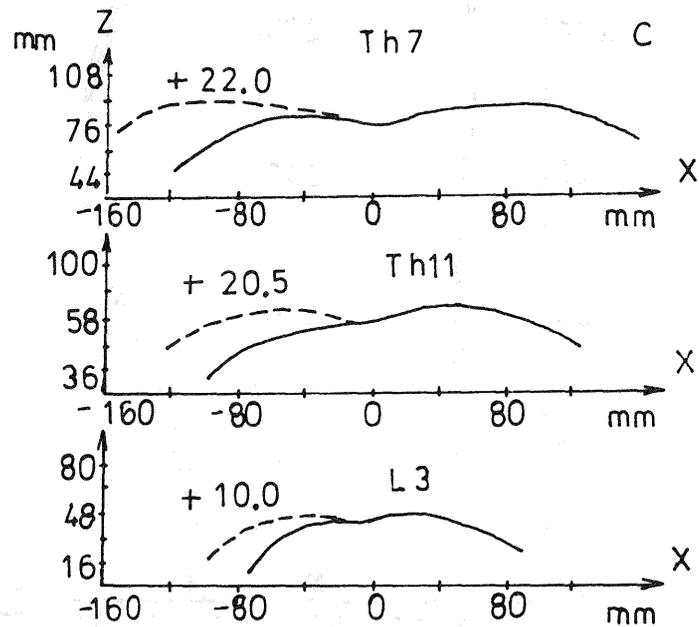
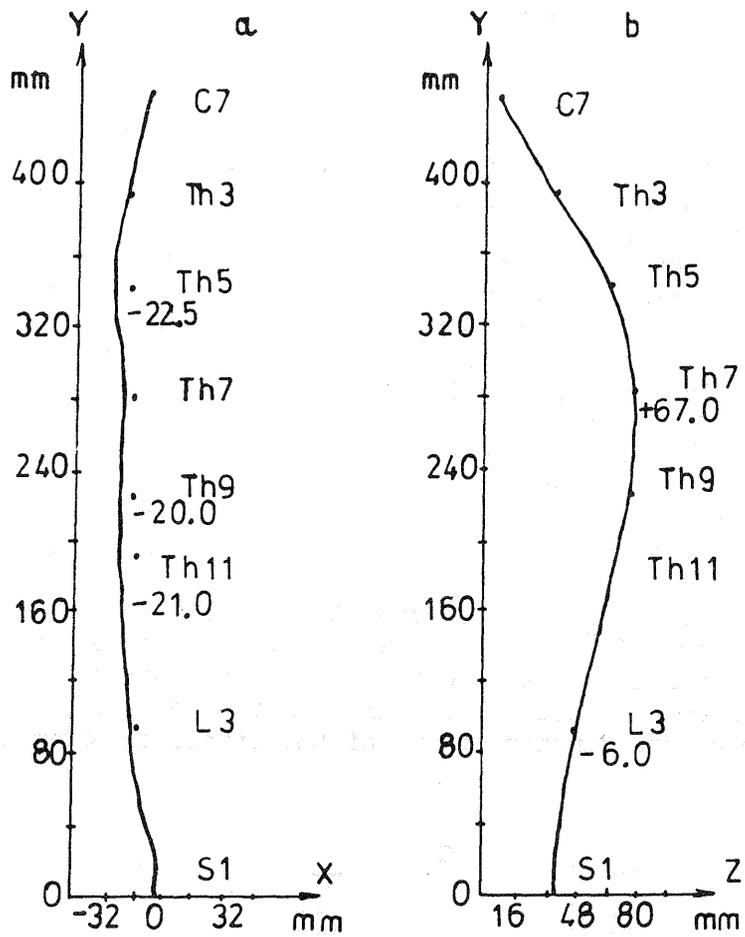


Figure 2 : DEFORMATIONS OF THE THORACIS-LUMBAR

(a) Frontal Plane (b) Sagittal Plane  
(c) Asymmetry of the shape of the back.

In plane XZ (Figure 2c) three crosssections through vertebrae Th<sub>7</sub>, Th<sub>11</sub> and L<sub>3</sub> have been determined, where for each of them the corresponding vertebra has been assumed as the reference point with X equal zero and Z the same as in projection YZ.

In XY projection, deviations of the shape of the spine from a line C<sub>7</sub> S<sub>1</sub> at the most three vertebrae have been measured, if they were larger than 4mm. These deviations show the scoliotic deformity of the spine. Flattening or deepening of the chest kyphosis has been determined on the basis of the maximum deviation of the chest part of the spine from a line C<sub>7</sub> S<sub>1</sub> (in YZ projection). Flattening or deepening of the lumbar lordosis were obtained on the basis of the maximum deviation of the lumbar part of the spine from a line Th<sub>7</sub> S<sub>1</sub>. The curvature progress due to growth or weakening of the muscles and ligaments supporting the spine, gives rise to a rotation upon one another of the vertebrae located in the segment of the spine being deformed laterally. In the thoracic region this rotation of the vertebrae and attached ribs causes one side of the chest or rib cage to bulge anteriorly and the opposite side to protrude posteriorly. The asymmetry of the human back, shown in Figure 2c, relates to the above effect.

The shapes of the spines were reconstructed by the Moire technique with an average accuracy of  $\pm 2$ mm. This accuracy has been estimated on the basis of a few independent measurements of the same spines. For each measurement the patients were independently fixed in the holder. The graphic presentation of three measurements of one of the spines is shown in Figure 3.

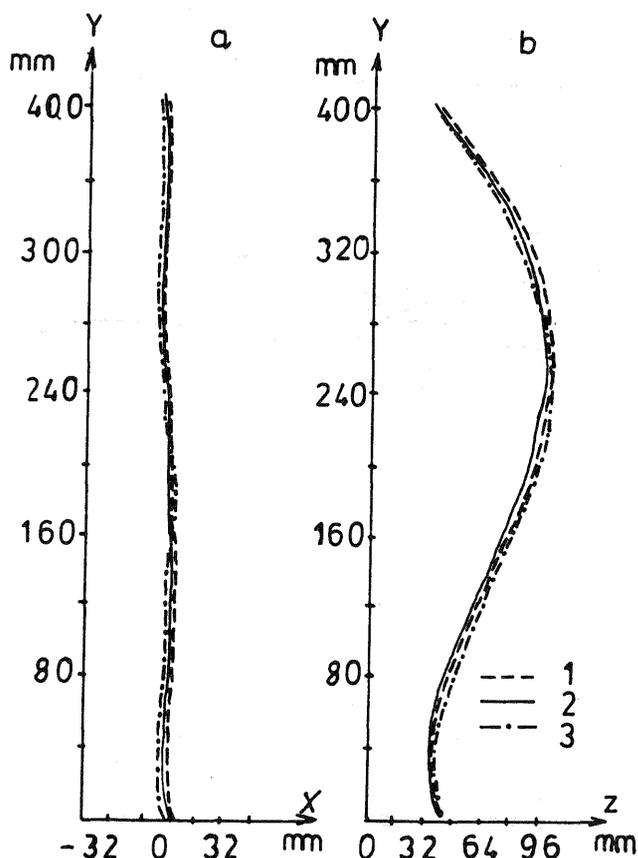


Figure 3 : RESULTS OF THREEFOLD MEASUREMENT

(a) Frontal plane: (b) Sagittal plane.

#### 4. ANALYSIS OF RESULTS FOR MEDICAL DIAGNOSIS

Medical analysis was based on the following criteria: in the case of scoliosis it has been assumed that the normal shape of the spine has deviations in plane XY smaller than 4mm. In the first degree scoliosis deviations are up to 10mm, in second degree - from 11mm to 20mm and in third degree - larger than 20mm. In the case of chest kyphosis the normal shape of the spine has deviations, in YZ projection, from 30mm to 40mm.

Flattening of chest kyphosis has for the first, second and third degree deviations from 29 to 20mm, from 19mm to 10mm and less than 9mm, respectively. Deepening of the chest kyphosis has deviations from 41 to 50mm, 51 to 60mm and larger than 60mm for the first, second and third degree respectively. In the case of lumbar lordosis the normal shape of the spine has deviations in YZ projection from 10mm to 15mm. Deepening and flattening of the lumbar lordosis have deviations larger than 15mm and smaller than 10mm, respectively. In Table 1, the frequency of occurrence of spinal deformations, in scoliosis, chest kyphosis and lumbar lordosis of students from fourteen to nineteen years old, are presented.

TABLE 1  
FREQUENCY OF OCCURRENCE OF DEFORMED SPINES IN %

SKOLIOSIS			CHEST KYPHOSIS						LUMBAR LORDOSIS		HEALTHY SPINES
			Flattening			Deepening					
I deg.	II deg.	III deg.	I deg.	II deg.	III deg.	I deg.	II deg.	III deg.	Flattening	Deepening	
64	16	2	13	12	0	27	17	9	38	25	2

The data of the Table show very dangerous epidemic deformations of the spines; 82% of students checked have scoliosis, 15% of students have deepening of the chest kyphosis and 53% have flattening of the chest kyphosis, 38% of students have deepening of lumbar lordosis and 25% have flattening of lumbar lordosis. Only 2% of students checked had properly shaped spines. This type of measurement allowed the formulation of prophylactic recommendations and correction exercises and will also become a basis for choosing appropriate work posts for the young generation in the future.

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