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T. Iwahara
M. Imai
Y. Atsuta

Quantification of cosmesis for patients affected by adolescent idiopathic scoliosis

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T. Iwahara (✉) · M. Imai · Y. Atsuta
Department of Orthopedic Surgery,
Asahikawa Medical College,
4–5 Nishikagura,
Asahikawa 078, Japan
Tel. +81-166-65 2111 ext 2514;
Fax +81-166-65 8949

Abstract The aim of this study was to quantify cosmesis for patients affected by adolescent idiopathic scoliosis. Eight nonmedical judges were asked to examine photographs of 40 patients with adolescent idiopathic scoliosis, and to score the cosmesis of their backs without any information. Various parameters were measured from radiographs, Moiré topographies, and physical measurements of patients, and these were compared with the cosmetic scores of the judges. The judges' scoring proved to be reliable. The cosmetic scores showed a significant correlation with the Cobb angle, hump severity, asymmetry of the waist line, circumference of the chest, and obesity. Multivariate analysis produced equations to calculate the cosmetic score for the back. This equation is thought to have a useful clinical application.

Key words Scoliosis · Cosmesis

Introduction

Apart from serious scoliosis, which is accompanied by functional problems such as backache and pulmonary dysfunction, cosmesis due to spinal deformity is the most serious problem clinically. Scoliosis affects mostly adolescent females, and there have been several reports of psychological distress in adolescent females due to cosmetic defects resulting from scoliosis [3–5]. However, it is difficult medically to evaluate cosmesis, since evaluation is affected by a subjective judgment, just as in the evaluation of a painting. Also, although scoliosis is a three-dimensional deformity, the degree of the spinal deformity is generally determined only by the Cobb angle from the posteroanterior radiograph, and the cosmetic defect due to scoliosis may not be always proportionate to the Cobb angle. We therefore analyzed to what extent the subjective evaluation by nonmedical judges is related to the index of spinal deformity determined from radiographic measurements such as the Cobb angle, the index of deformity for external body appearance such as the hump seen on Moiré topography [1, 11], and the factors affecting the body appearance obtained from physical measurements such as obesity. We tried to quantify the cosmetic defects using these parameters.

Materials and methods

The subjects were 40 untreated patients with adolescent idiopathic scoliosis who visited the orthopedics department of Asahikawa Medical College for medical examination between April 1994 and March 1995. All the patients were female, and the average age was 14.9 (range 9–16) years. The average Cobb angle was 30.7° (range 10°–72°). Nine patients showed King type I curve, with an average Cobb angle of the thoracic and lumbar curve of 36. 9 and 26.1 degrees, respectively. Ten patients showed King type II curve, with an average Cobb angle of the thoracic and lumbar curve of 29.3° and 22.4°. Eight patients showed King type III curve, with an average Cobb angle of 27.4°. Two patients showed King type IV curve, with an average Cobb angle of 40.0°. Four patients showed King type V curve, with an average Cobb angle of the upper and lower thoracic curve of 37.0° and 39.5°, respectively. Seven patients showed a lumbar and thoracolumbar curve, with an average Cobb angle of 25.7°.

Photographs of the patients with posterior, lateral and forward bending views were taken (Figs. 1, 2). Eight nonmedical judges, who were healthy volunteers and didn't have a patient with scoliosis in their families, were asked to examine photographs of the pa-

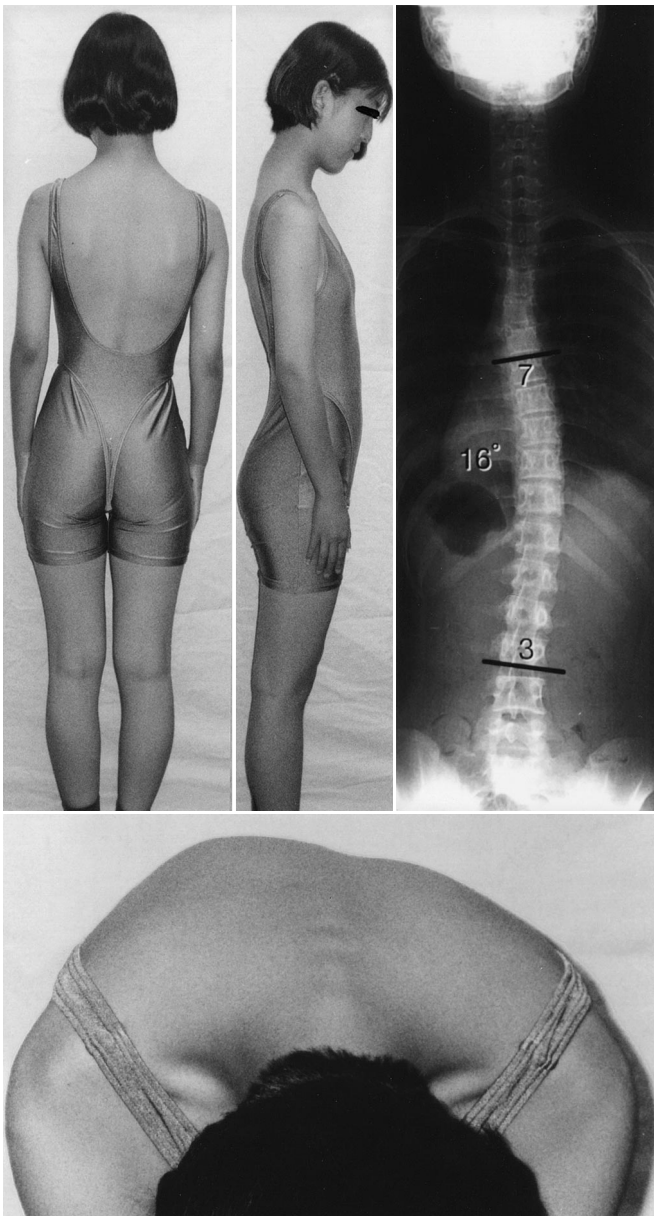

Fig. 1 Photographs and radiograph of a 15-year-old girl (case 1)

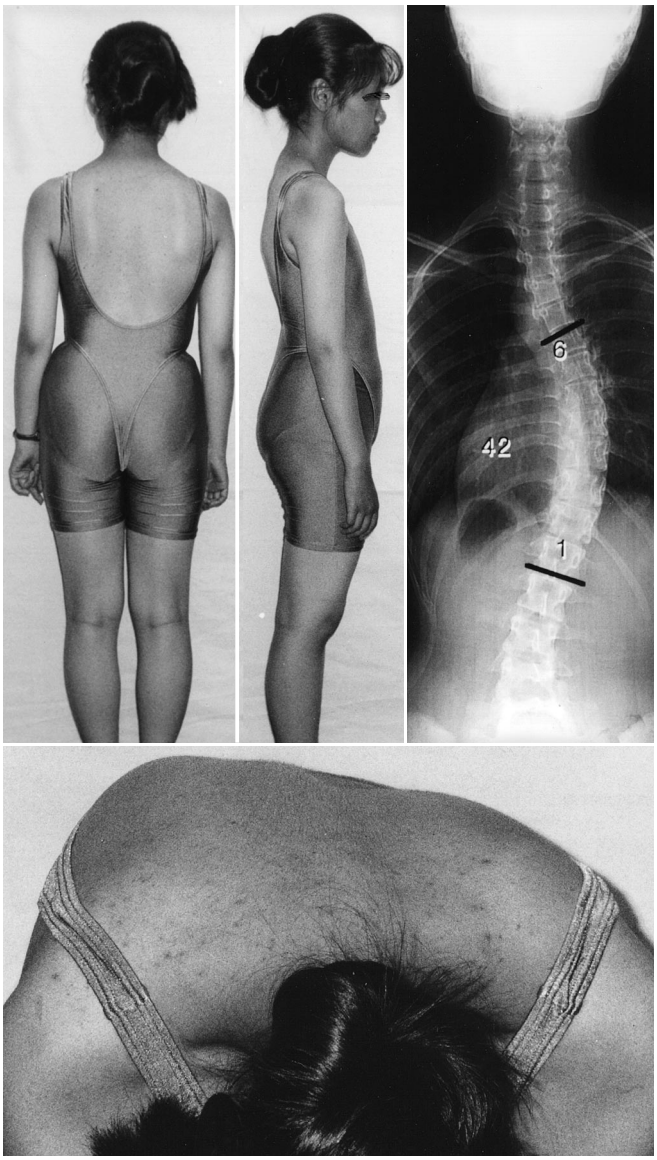

Fig. 2 Photographs and radiograph of a 15-year-old girl (case 2)

tients and give a cosmetic score out of a maximum of 100 points for the back of each patient. A score of 0 corresponded with the least cosmetically acceptable back, and a score of 100 corresponded with the most cosmetically acceptable back. No other scoring instruction or medical information was given to the judges. The same examination was repeated 6 months later.

Standing posteroanterior and lateral radiographs of the patients were taken, and the Cobb angle of the major curve, the angle of the thoracic sagittal curve using the Cobb technique, the rotation angle of the apical vertebrae using a Perdriolle torsion meter, and the rib vertebral angle difference (RVAD) were measured. The position of C7 over the sacrum and the angle of T1 tilt were also measured. The ratio between the position of C7 over the sacrum and the height were calculated using the measured values to correct for any differences in physique.

We performed Moiré topography (FM40, Fuji Film, Japan) on the back in a standing position and measured the following: the height of the hump (*a*); the chest transverse diameter of the measured portion of hump (*a′*); the area surrounded by the tangential line from the axilla down to the pelvis and the waistline (*b* and *b′*); the difference between the right and left heights of the most concave part of the waistline (*c*); and the depth from the most concave part of the waistline to the above-mentioned tangent line (*d* and *d′*); as well as the difference between the right and left heights of the acromion (*e*) (Fig. 3). We then calculated the ratio between the height of the hump and the chest transverse diameter (*a*/*a′*, hump index), the right and left ratio between the waistline area (*b*/*b′*, waistline area index), the ratio between the difference of the waistline height and sitting height (*c*/sitting height, waistline height index), the right and left ratio between the waistline depth (*d*/*d′*, waistline depth index), and the ratio between the difference in the height of the acromion and the sitting height (*e*/sitting height, shoulder height index).

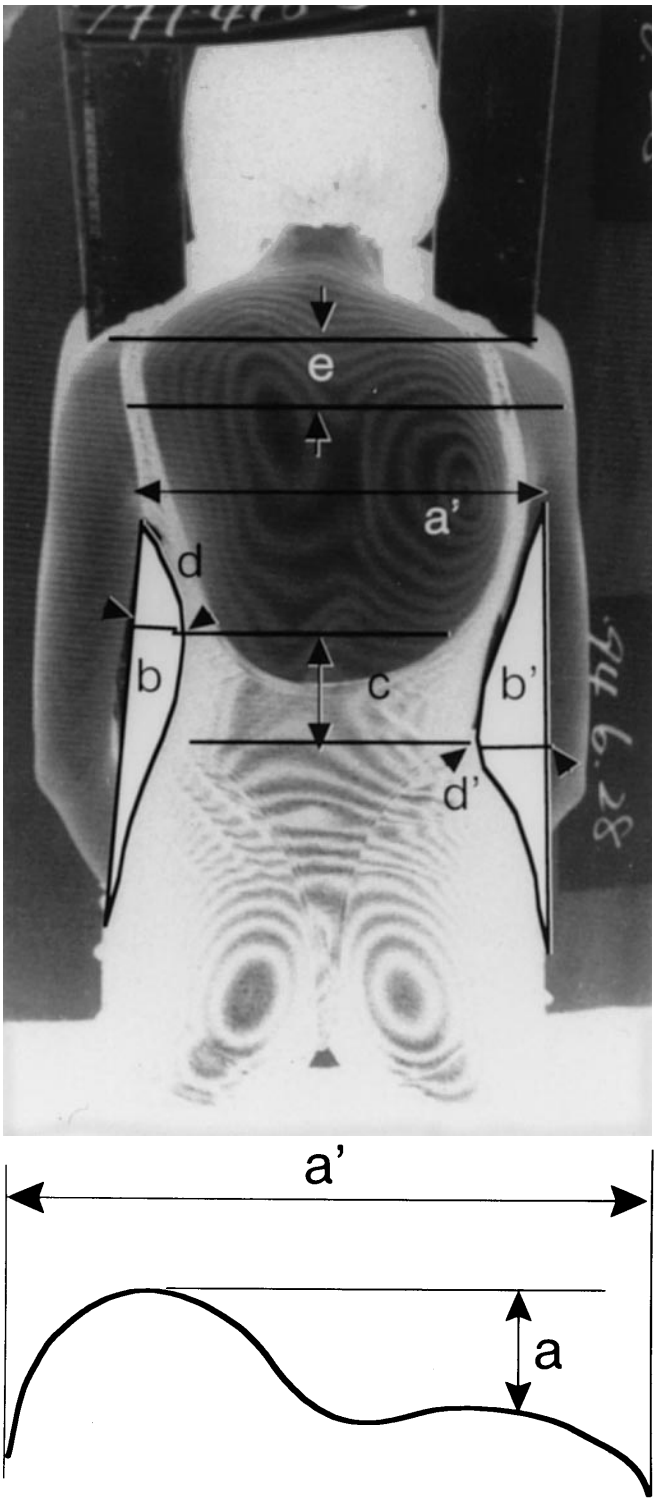

Fig. 3 Measurement method of Moiré topography. The following values are calculated: hump index = a/a', where a is the height of the hump and a' the transverse diameter of the chest; waistline area index = b/b', where b and b' are the area of the waistline; waistline height index = c/sitting height, where c is the right/left difference in the waistline height; waistline depth index = d/d', where d and d' are the right and left depth of the waistline; and shoulder height index = e/sitting height, where e is the right/left difference in the acromion height

We measured the subjects' height, arm span, sitting height, weight, shoulder breadth, chest circumference, circumference above and below the bust, waist circumference, and hip circumference. To correct for any differences in physique, the following ratios were calculated: the ratio of arm span to height, ratio of sitting height to standing height, Broca index (ratio of weight to height), ratio of shoulder breadth to height, ratio of chest circumference to height (chest circumference index), ratio of waist circumference to height, ratio of hip circumference to height, ratio of circumference above the bust to that below the bust, ratio of chest to waist circumference, ratio of chest to hip circumference, and ratio of waist to hip circumference.

The reliability of the judges' scoring was assessed by analysis of variance and correlation test, and factor analysis followed by multiple regression analysis.

Results

Analysis of variance showed no significant differences between the scores of nonmedical judges. However, there was significant intercorrelation, with coefficients ranging from 0.32 to 0.80 ($P < 0.05$). There was also significant intracorrelation, with correlation coefficients ranging from 0.42 to 0.81($P < 0.05$, Table 1).

The judges' average score for each patient was defined as the cosmesis score. Several parameters were correlated with the cosmetic score for the back, especially the Cobb angle, hump index, apical vertebral rotation, waistline height index, Broca index, position of C7 over the sacrum, T1 tilt angle and chest circumference index ($P < 0.05$).

Multiple regression analysis produced the following equation to calculate the cosmesis scores for the back:

Cosmesis score = 85.2–13.5 × (waistline height index) –165.9 × (hump index) –0.3 × (Cobb angle)
($r = 0.83$, $R^2 = 0.69$)

If the waistline height index was excluded, the following simple equation could be derived:

Simple cosmesis score = 84.5–165.9 × (hump index) –0.4 × (Cobb angle)
($r = 0.78$, $R^2 = 0.62$)

Table 1 Reliability of the judges' score

Judge no.	Age (years)	Sex	Average score (SD)	Intracorrelation (correlation coefficient)
1	39	F	63.5 (11.2)	0.735
2	13	F	58.9 (12.8)	0.423
3	17	M	66.7 (12.1)	0.701
4	17	F	60.3 (16.2)	0.727
5	15	M	60.7 (12.6)	0.412
6	44	F	65.2 (13.5)	0.689
7	40	M	66.1 (13.5)	0.693
8	38	F	69.5 (14.1)	0.807

Summary of two cases

Case 1: a 15-year-old girl

The radiograph showed a Cobb angle of 16°. An asymmetrical waistline and hump were clearly observed. The cosmesis score by the judges was 58.1. The cosmesis scores and the simple cosmesis score calculated by the equations were 61.4 and 61.7, respectively (Fig. 1).

Case 2: a 15-year-old girl

The radiograph showed a Cobb angle of 42°. However, the hump and the asymmetric waistline were not conspicuous. The cosmesis score was 66.0. The calculated cosmesis score and the simple cosmesis score were 59.3 and 61.7, respectively. Although the Cobb angle in case 2 was almost three times that of case 1, the cosmesis scores were very similar (Fig. 2).

Discussion

Scoliosis is a three-dimensional deformity. Cosmetic defect resulting from spinal deformity is the critical factor for the patient. Although the Cobb angle is the most important index of spinal deformity, it only shows the deformity in the frontal plane, and not overall spinal deformity. Thoracic lordosis, asymmetrical waistline, shoulder tilt, type of scoliosis, body mass, as well as the Cobb angle and the hump, all affect external body appearance [6]. Although there are several reports that discuss the importance of cosmesis for patients who suffer from scoliosis [2–5, 9, 10], there are few reports that discuss to what extent the asymmetrical waistline and body mass influence cosmetic defects. Theologics et al. conducted an analytical study similar to the present study, using ISIS (Integrated Shape Imaging System, Oxford Metrics Ltd., Oxford, UK) and the Cobb angle [8]. However, their report did not include body mass and radiographic values other than the Cobb angle.

In the present study, we used Moiré topography instead of ISIS, and analyzed body mass using measures such as the Broca index. Moiré topography, which is a simple technique for measuring three-dimensional shapes such as humps, is generally used for school screening in Japan [7]. More information about body appearance can be obtained by Moiré topography than ISIS. The use of various parameters from radiographs, Moiré topography, and physical measurements allowed a more detailed analysis than that in the study by Theologics et al.

Lumbar curves have been considered to have a better cosmesis than other types of curve [6]. However, the type of curve did not affect cosmesis in the present study. The number of curves is probably insufficient to produce any statistically significant results.

Although there is a limit to the discussion of cosmesis based only on the points examined in this study, the results of this study have clarified that the waistline height index and chest circumference index, as well as the hump and Cobb angle, all effect cosmesis.

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