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Original Article

The value of standard chest radiography in the diagnosis of scoliosis

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Abstract

Aim: The aim of this study was to evaluate the benefits and limitations of chest radiographs in scoliosis screening and to compare these results with spine orthoroentgenogram.

Material and Methods: We performed a retrospective, repeated cross-sectional evaluation of 5160 digital standing posterior-anterior chest x-rays of patients, ages from 21 to 44 years old, obtained at our institution. The chest radiography was taken to the hospital for military check-ups. All posterior-anterior chest radiographs between January 2016 and December 2017 were gathered. We compared the spinal curvature types and Cobb angles detected in the chest radiographs (n=62) with the curvature types and Cobb angles detected on spine orthoroentgenogram radiographs.

Results: According to the type of major spinal curvature, overall matching of chest x-ray with the radiography of the spine orthoroentgenogram was 71% (44 of 62 cases). Measured mean Cobb angle on the chest x-rays and spine orthoroentgenogram was 9.8 (5.4) and 12.8 (6.5) respectively (p=0.009). Chest radiographs were 81% sensitivity and 50% specificity according to spine orthoroentgenogram, which was accepted as the gold standard in the diagnosis of scoliosis according to the spinal curvature.

Conclusions: The data obtained in our study can be considered as a valuable reference in the consultation of asymptomatic thoracic scoliosis detected on the routine chest radiograph and the necessity of examination of the axial skeletal with spine orthoroentgenogram.

Keywords: Chest X-Ray; Orthoroentgenogram; Scoliosis.

INTRODUCTION

Scoliosis refers to the 3D complex deformity of the body, which is described as the lateral deviation of the vertebral column in the frontal plane with the vertebral body rotation which results in asymmetric deformation of the vertebral column (1). Scoliosis is diagnosed by physical examination and radiological imaging. In the physical examination the Adam's forward bending test and scoliometer are suitable for screening purposes (2). Other scoliosis screening methods such as Symmetrigraf and Moire topography are also available (3). If a pathological finding is detected in these examination tests, an orthoroentgenogram graphy of the spine is taken to determine the extent of the disease and to plan its treatment, if necessary. In addition, radiological imaging for other causes such as chest x-ray was used for prevalence studies in large cohort studies (4-6). However, there is limited knowledge in the literature about whether this local imaging reflects the deformity of the spine and whether it is necessary to seek expert consultation because of these detected spinal deformities. Spine orthoroentgenogram is not suitable as a screening test. Because both patients are exposed to unnecessary radiation and it is not easily accessible imaging. However, scoliosis type and degree of curvature can be determined by orthoroentgenogram graphy with spine and treatment of patients is planned with the data obtained.

The aim of this study was to evaluate the benefits and limitations of chest radiographs in scoliosis screening and to compare these results with spine orthoroentgenogram.

MATERIAL and METHODS

We performed a retrospective, repeated cross-sectional evaluation of 5160 digital chest x-rays of patients, ages 21 to 44 years old, obtained at our institution. The chest radiography was taken to the hospital for military check-ups. All posterior-anterior chest radiographs between January 2016 and December 2017 were gathered.

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Patients who were not previously diagnosed with scoliosis were also included in the study. The patients who had congenital anomalies (spina bifida, hemivertebra, etc.), who had undergone surgery for spine, trauma history, spondylolysis and spondylolisthesis were removed from the study. The reason we keep these patients out of work is the possibility that the radiology doctors who know the history of the patients might have an effect when interpreting the chest radiograph.

Thirty-seven patients with a history of spine trauma, 7 patients with ankylosing spondylitis, and 13 patients with a history of lumbar sacralization were excluded from the study, regardless of whether a spine orthoroentgenogram radiograph was performed.

Military check-ups protocol in our hospital;
On the standardized chest radiograph, soft tissue and bony pathologies are screened and noted by the radiologist. Patients who have a lateral bending deformity of the spine in the chest x-ray are routinely drawn on the spine orthoroentgenogram. The patient is then consulted to the orthopedics clinic with spine orthoroentgenogram. Full neuromotor examination is performed routinely in the patients who are consulted in the Orthopedics and Traumatology clinic, and orthoroentgenogram graphs are analyzed.

We compared the spinal scoliosis type, side of major curvature and Cobb angles detected in the chest radiographs with in spine orthoroentgenogram (Figure 1).

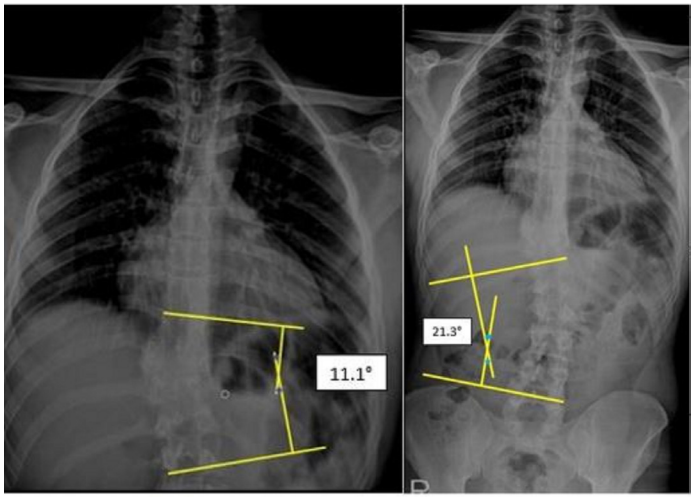

Figure 1. The measurement of Cobb angle on the chest x-ray and spine orthoroentgenogram graphy is shown. Although the main curvature was seen in the thoracic vertebra in the chest X-ray, it was found that the main curvature in the orthoroentgenogram was in the lumbar spine. Therefore, Cobb angle and scoliosis type have changed. Lines were drawn on the film connecting the upper spine at the top of the concave part of the curvature with the lower spine at the bottom of the curvature, and then a perpendicular line was drawn from each line, and the angle where the perpendicular lines intersected was the Cobb angle.

We also measured sensitivity and specificity of chest x-rays about the diagnosis of major curves (type of scoliosis) more than 10° assuming the orthoroentgenogram as gold standard. Cobb angles in chest x-rays and spine orthoroentgenogram were measured by a senior orthopedic surgeon and a radiologist (7). If the measured Cobb angles were different between the radiologist and orthopedic surgeon, the Cobb angles rechecked, and mean angle was selected.

Neurological examination of the patients, symmetry of the shoulders, symmetry of the scapular and costal bones (hump deformity), symmetry of the hips and symmetry of the hips were evaluated.

RESULTS

The mean age of the patients who were screened by chest radiography was 25± 6.7 (21-44) years, and all were men. Five patients (8%) had hump deformity and 5 patients had shoulder balance disorder according to biacromial angle. In all patients with shoulder imbalance, Cobb angles were more than 20 degrees. The neurological examination of all patients is normal. Physical examination revealed no hip asymmetry.

Radiological measurements of the patients on chest x-rays and spine orthoroentgenogram are presented in Table 1. Scoliosis with any degree of lateral curvature was detected in 62 (1.2%) of 5160 patients with chest X-ray. The number of patients with scoliosis greater than 10° angle in the chest radiography was 33 (53%) and the number of patients diagnosed with scoliosis greater than 10° in the spine orthoroentgenogram was 44 (71%) (p = 0.04). In the chest x-ray, 4 patients with Cobb angle more than 10° Cobb angle were observed to have a Cobb angle of less than 10° in the spine orthoroentgenogram. In the sensitivity and specificity test calculated by considering patients with Cobb angle greater than 10°, chest radiography was found to have 81% sensitivity and 50% specificity in the diagnosis of scoliosis.

In contrast to the chest x-ray, 2 patients had major cervical curvature, 9 patients had major lumbar curvature and 6 patients had thoraco-lumbar curvature (Table 1).

Table 1. Radiographic measurements and comparisons

	Chest x-ray (n=62)	Orthoroentgenogram (n=62)	p value
Cobb angle mean ± SD (95% CI)	9.8± 5.4 (8.5-11.2)	12.8± 6.5 (11.1-14.4)	0.009
Major Scoliosis type (n, %)			
Servical	-	2.3%	
Thorasic	44.70%	27.43.5%	*
Lomber	8.12.9%	17.27.7	-
Thoraco-Lomber	10.16.1%	16.25.8%	
Side of curvature (n, rigt /left)	28 / 34	10 /52	<0.001

We did not detect any double or triple major scoliosis
SD; Standart deviation, NS; Not studied, n; number,
CI; Confidence Interval of the Difference
*According to the type of major spinal curvature, overall matching of chest x-ray with the radiography of the spine orthoroentgenogram was 72.5% (45 of 62 cases)

According to the type of major spinal curvature, overall matching of chest x-ray with the radiography of the spine orthoroentgenogram was 72.5%.

A scatter plot shows the distribution and relation of Cobb angle measurements between chest radiography and spine orthoroentgenogram (Figure 2).

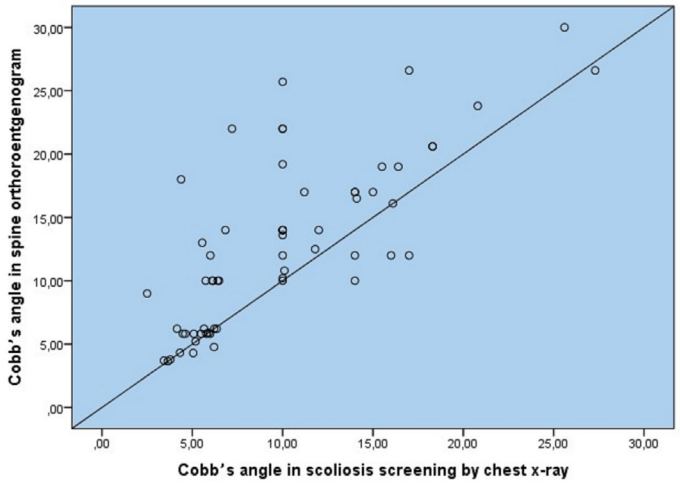

Figure 2. A scatter chart with raw data showing the distribution and association of the Cobb angle between the chest x-ray and the spine roentgenogram (r=0.76, correlation is significant at the 0.01 level)

Statistical analysis

All results were analyzed using SPSS 20.0 (IBM Corporation, New York, USA). Demographic characteristics of the study patients and radiographic parameters were described as mean ± SD with range. The Chi-Square (χ^2) test was used for categorical variables and expressed as observation counts (and percentages). When at least one expected value was less than 5, the Fisher Exact test was used instead of the Chi-Square test. To evaluate the usefulness of chest x-rays for detection of scoliosis and accompanying deformities, the sensitivity and specificity of chest x-rays were calculated. The Cobb angle accuracy was defined more than five degrees as a meaningful difference between chest radiographs and spine orthoroentgenogram. Inter-observer repeatability was estimated for two of the observers with intraclass correlation coefficient. The level of statistical significance was set at $p < 0.05$.

DISCUSSION

In the literature, the frequency of scoliosis is reported between 0.3-12.5 according to the screening tests such as physical examination and chest x- rays (8-10). In these studies, gender, age and most importantly, screening method of the patients were not similar. In our cross-sectional study, the frequency of scoliosis which include any degree of lateral curvature was found to be approximately 1.2%. However, 0.8% of the patients with scoliosis were found to have more than 10 degrees of lateral curvature which is accepted as a pathologic curve. The reason for the low prevalence of scoliosis in our study may be that patients diagnosed with scoliosis do not start military service. Because patients who have additional diseases in primary health care institutions without being admitted to the army are consulted on the relevant specializations. Among these diseases, patients who were exempted from military service due to spine related diseases may have been. In addition, the variability of scoliosis frequency with age, racial differences, as well as changes in measurement and screening techniques may explain this. However, the main focus of our study is not scoliosis prevalence. Our primary aim was to show how much information the lung radiography could give us about the scoliosis deformity.

In our study, all patients with lateral spine curvatures on the chest x-ray had spinal curvature in the spine orthoroentgenogram. However, in the comparison of Cobb angle with pathological upper border (10°), we found that 4 patients with scoliosis were found to have physiological curvature and 10 patients with physiological curvature on the chest radiography had a Cobb angle of ≥10°. However, we found that the Cobb angles measured by chest radiography and spine orthoroentgenogram showed statistically significant correlation. Although the mean scoliosis angle between the two methods was statistically significant, we found that the mean difference was approximately 3°, which is not a clinically important one. In addition, in our patient group, we found that the sensitivity of the chest x-rays with a sensitivity of 100% in detecting the lateral curvature of the spine was 81% in detecting the curvatures with a pathological angular degree. The sensitivity was 50%. However, the fact that it cannot assess the entire spine and only can show the deformity of the coronal plane appears to be disadvantages of the chest radiography. This disadvantage was encountered in 16 patients with different types of scoliosis with orthoroentgenogram in our patient group. The sensitivity of chest X-ray to detect pathological angular values was 81% and the specificity was 50%. First step of measuring Cobb angle degree of scoliosis begins with choosing the most tilted vertebrae above and below the apex of the curve. The angle between intersecting lines drawn perpendicular to the top of the top vertebrae and the bottom of the bottom vertebrae is the Cobb angle. However, we couldn't assure which vertebra is the most tilted vertebrae above and below the apex of the curve on the chest x-rays. Furthermore, the spinal alignment on chest x-ray could be flexible depending on the patients' posture, given the fact that most curves we observed on chest radiograph lacked consistency (29%).

In our best knowledge, in the literature, there is only one study that shows similarity with ours according to the demographic data of patients and our study methodology (4). In this study, according to the type of major spinal curvature, they reported the frequency of overall matching of chest x-ray with the spine orthoroentgenogram as 58.2%. They observed a meaningful difference between chest x-ray and spine roentgenogram at 37.2% according to cobb angle. They found the sensitivity of the chest

X-ray to detect scoliosis as 93.94% and the specificity as 61.67%. In this study as well as in our study, chest radiography was not very successful in detecting the main curvature, but it had a high sensitivity in detecting lateral spine curvature.

Our current work has some limitations. First, all patients were male, because this study was carried out on the candidates of the armed security forces who applied to our hospital. The other restriction is age. Our study does not include all ages. However, we do not think that chest radiography will vary according to age and gender in recognizing scoliosis. This issue will be discussed in the future with more patients with a wider range of age groups and all genders.

CONCLUSION

In conclusion, chest x-ray is an important step for further investigations, although the accuracy of detecting scoliosis type is low. The data detected in our study could be considered as a valuable reference for the consultation of asymptomatic thoracic and lumbar scoliosis on the routine chest radiograph and the necessity of axial skeletal orthoroentgenogram examination.

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