



How far can we Minimize the Field Size in the Radiological Follow-up of Patients with Scoliosis?

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Abstract

Scoliosis patients are subjected to multiple X-ray investigations during growth. The need for X-rays during regular check-ups when clinical measurements are taken can be reduced (ATR, Surface Topography), however as indications and check-ups still rely on the measurement of the Cobb angle on a full standing X-ray, the exposure of children and adolescents with scoliosis cannot be avoided. Therefore, it would make sense to reduce the exposition of this patient group to radiation drastically.

One way to reduce radiation is the reduction of the exposure. The other way is the reduction of the diagnostic field. This study was undertaken to investigate the possibility to use one single 45 x 45 cm detector of a DR system for diagnosing and follow-up of adolescent girls with scoliosis.

Material and method: 32 consecutive standing X-rays of girls aged 10 to 14 made with a single 45 x 45 cm detector of a DR system were analyzed as to whether sufficient information has been provided for diagnosis and follow-up of the patients.

Results: Ground plate of Th1 was clearly visible in 31%, ground plate Th2 in 56% and ground plate Th3 in 88% of the rest. Major curvatures (thoracic and lumbar) were fully visible in 100% of those tested. Risser 3 or 4 would have been (or has been) detected in 100% of cases.

Conclusion: Adolescent girls with scoliosis can be checked-up and diagnosed with a drastic reduction of the diagnostic field using a 45 x 45 cm detector of a DR system for direct radiography. A drastic reduction of the exposure to radiation of children and adolescents with scoliosis is easily possible by reducing the diagnostic field (window) and by reducing the exposure time. For proper diagnosis and check-up it is rarely necessary to expand the field size to higher than Th3 level.

Keywords: Scoliosis; Adolescents; Radiography; Reduction of radiation dose

Introduction

Scoliosis is a three dimensional deformity of the spine and trunk, which may deteriorate quickly during periods of rapid growth [1-3]. Although scoliosis may be the expression or a symptom of certain diseases, eg. neuromuscular, congenital, due to certain syndromes or tumors, the majority of the patients with scoliosis (80 -90%) are called 'Idiopathic' because a certain underlying cause has still not been found. The treatment of the symptomatic scoliosis may primarily be determined by the underlying cause. The treatment of the so-called idiopathic scoliosis is determined by the deformity itself. As most of the scoliosis progresses during growth, some also in later life, the main aim of any intervention is to stop curvature progression [1,2].

While children grow until they have fully matured, there are certain times with more or less growth during childhood and adolescence and curvature progression is more or less probable during these different phases of growth [1,2].

With the first signs of breast development or pubic hair, the pubertal growth spurt begins (P1) and in its ascending phase before the onset of menarche 2/3 of progression may occur [1]. Shortly after the growth peak (P3) menarche in girls / voice change in boys appear to indicate the onset of the descending phase of growth up to its cessation (P5).

In patients with idiopathic scoliosis during adolescence, the risk for being progressive can be calculated using the formula by Lonstein and Carlson [4]. Based on this formula the treatment indications of scoliosis patients during growth are determined [5].

Scoliosis, simply defined as a lateral curvature of the spine, has been recognized clinically for centuries. The deformity is actually much

more complex and in order to describe more accurately and quantify scoliosis deformity, three planar and three dimensional terminology and measurements are required [2,6]. However, for practical purposes, the deformity is most conventionally measured on standing coronal plane radiographs using the Cobb technique [7,8] (Figure 1).

For the estimation of the actual risk for progression we also have to determine the maturity of the patients. Therefore, the Risser sign has been proposed and is today, still widely used. The Risser sign is determined by rating the maturity of the apophyse of the iliac crest [8] (Figure 2).

While premenstrual girls at average have Risser 0, the Risser sign arises after the onset of menarche / voice change (in boys). A 14 year old girl usually has Risser 3, sometimes 4, a 15 year old girl usually has 4, sometimes 5. While we are easily able to clinically see immaturity of the patients (Risser 0), for the weaning off a brace, the detection of the actual maturity is important. So for clinical use, a Risser 3 or 4 is important for distinguishing this fact.

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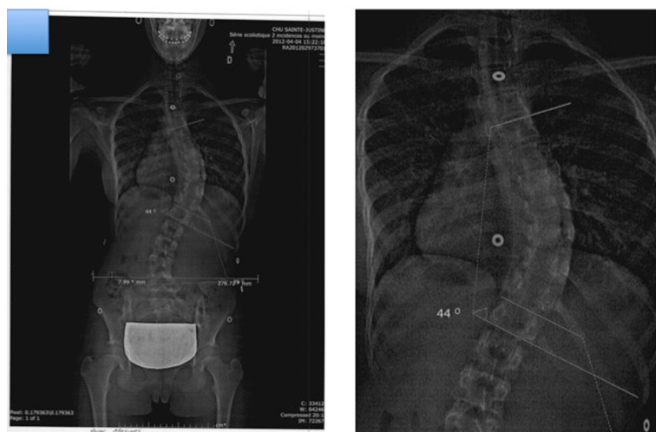


Figure 1: Full standing X-ray with Cobb-angle measurement. The most tilted and least rotated vertebra is measured as can be seen on the right. The head and full pelvis is visible without providing any information.

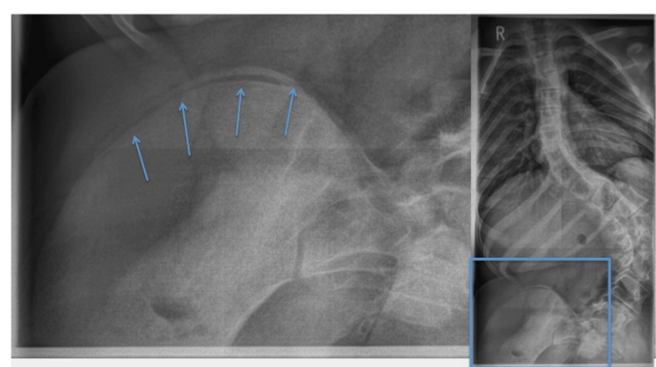


Figure 2: Standing X-ray from the sample of this study showing the Risser sign. The iliac crest is fully visible and the apophyse (arrows) is not yet closed. Th1 is also visible on the picture, so the full thoracic and full lumbar spine can be measured.

Adolescent Idiopathic Scoliosis (AIS) is the most frequent diagnosis of scoliosis [2].

The prevalence is very dependent on curve size cut-off point, decreasing from 4.5% for curves of 6 degrees or more to only 0.29% for curves of 21° or more [2]. It is also very dependent on sex, being equal for curves of 6–10° but 5.4 girls to 1 boy for curves of 21° or more [9]. The bigger the curve, the more girls are involved with a girls/boys ratio of 10/1 in curvatures exceeding 40° [2].

Scoliosis patients are subjected to multiple X-ray investigations during period of growth. Because the risk of getting cancer has increased in this population [10-13], ways to reduce the amount of radiation have to be found.

One can reduce the need for X-rays during the regular check-ups when clinical measurements are taken (ATR, Surface Topography), however, as indications and check-ups still rely on the measurement of the Cobb angle on a full standing X-ray [7,8] the exposure of children and adolescents with scoliosis cannot be avoided. Therefore, it seems sensible to reduce the exposition of this patient group to radiation drastically.

One way to reduce radiation is the reduction of the exposure time

we already have proposed earlier on [14]. The other way is the reduction of the diagnostic field (window).

This study was undertaken to investigate the possibility to use one single 45 x 45 cm detector of a DR system for diagnosing and check-up of adolescent girls with scoliosis.

Material and Method

Thirty two consecutively standing X-rays of girls aged 10 to 14 made with a single 45 × 45 cm detector of a DR system were analyzed as to whether sufficient information has been provided for diagnosis and check-ups of the patients under observation or treatment with a brace.

Results

Ground plate of Th1 was clearly visible in 31%, ground plate Th2 in 56% and ground plate Th3 in 88% of the population. Major curvatures (thoracic and lumbar) were fully visible in 100% of the population. Risser 3 or 4 was detected in 100% of the population.

Discussion

As it has been shown in the typical population of the most prevalent diagnosis of scoliosis (AIS) the radiation field size can be reduced drastically without losing a significant amount of information. We have been testing the radiographs of girls 10 to 14 years of age, the typical population in a conservative bracing practice when the patients are checked-up quarterly. During this period of time at many centers, full standing X-rays (ap) and lateral are performed (Figure 3), most of these being unnecessary.

Most of the X-rays performed quarterly, do not respect the possible measures to reduce radiation (Figures 1 and 4). The head and full pelvis is visible without providing any information. The lateral X-rays, obviously regularly performed (Figure 3) also do not provide any information, which could not be measured or even estimated clinically. However, the dose of radiation is even higher in lateral full standing X-rays compared to (ap) X-rays.

With the technique proposed within this paper, we can reduce the surface (window) exposed to radiation significantly without losing important information (Figure 5). In the rare cases of a spinal malformation cranially to the vertebra, an additional X-ray of a specified region of interest (ROI) can be taken. This can also be done on patients taller than the typical population of adolescent girls.

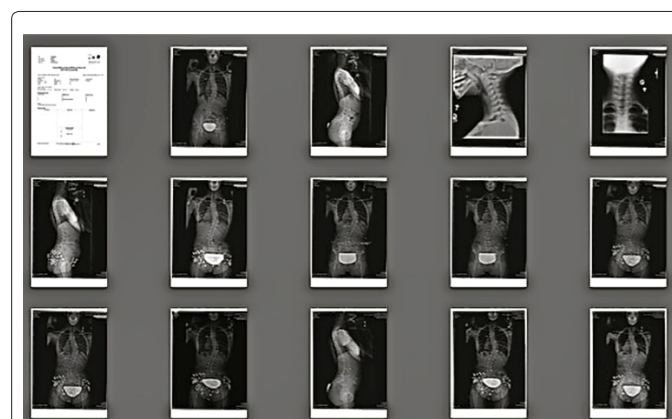


Figure 3: A series of (ap) and lateral X-rays made for a 12 year old girl under treatment.

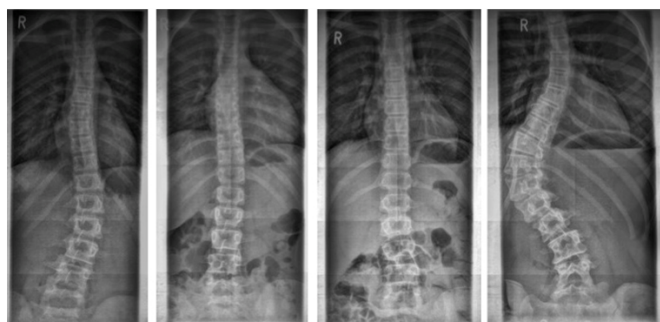


Figure 4: Examples of X-rays from our series: *left* ground plate Th1 is visible as is S1. *Middle left* full Th1 to S1 visible, *middle right* and *right* Th3 is visible and this is sufficient for measurement of the curves.

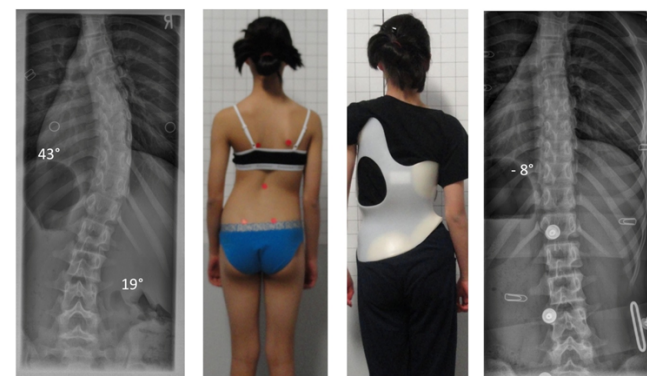


Figure 5: Left patient without brace clinically and radiographically with a curve measured 43°, *right* patient in the brace with a full correction of the curvature. The reduction of the diagnostic field did not reduce the necessary information on both X-rays.

Bracing in the treatment of patients with scoliosis is the only treatment with evidence on a higher level [15-17]. During the period of bracing X-rays in the brace are necessary to see the in-brace correction and the level of the pressure areas [18].

Therefore, a significant reduction of the exposition to radiation is necessary in adolescents under treatment. This can be achieved (1) by reducing the window of radiation and (2) by reducing the exposure time as discussed earlier on [14].

The technique of course, has room for improvement. In many of the X-rays from this series S3 level was on the picture caudally, while cranially we would have liked to see Th1 which was, unfortunately not on the picture. This paper can be viewed as a preliminary report. We will increase the number of X-rays in the same population and also analyze the data of the individual X-rays statistically.

Conclusions

Adolescent girls with scoliosis can be checked-up and diagnosed with a drastic reduction of the diagnostic field using a 45 × 45 cm detector of a DR system for direct radiography. A drastic reduction of the exposure to radiation of children and adolescents with scoliosis is easily possible by reducing the diagnostic field (window) and by a reduction of the exposure time. For proper diagnosis and check-up it is rarely necessary to expand the field size higher than the Th3 level.

Competing Interests

The authors declare to have no competing interest with respect to the content of this paper.

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