Current Methods for the Evaluation of Shoulder Balance in Idiopathic Adolescent Scoliosis: A Literature Review

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Abstract

Shoulder's asymmetry is one of the most notable clinical manifestations in individuals with Adolescent Idiopathic Scoliosis (AIS). Several papers have reported a correlation between shoulders unbalance and patients' dissatisfaction. Despite the availability of several clinical and radiographic methods for the evaluation of the shoulders leveling in the current literature, there are still many controversies about how to do it properly. Moreover, the correlation between cosmetic deformity and x-rays images is also questionable and surgeons may be giving excessive attention to radiographic images in detriment to the clinical deformity. The present study aims to highlight the most recent methods for the clinical and radiographic measurements of the shoulder balance, as well as the advantages and limitations of each of them.

INTRODUCTION

The asymmetry of the shoulders is one of the most notable clinical manifestations in individuals with AIS [1], and the misalignment of the shoulders after surgical treatment worsens results in quality of life scores and generates patient dissatisfaction [2-4]. Thus, it is part of the routine of the orthopedic physical examination an adequate evaluation of thorax asymmetries and measurement of shoulders leveling, by clinical and radiographic methods, which must be repeated at different stages of the treatment [1].

There is no consensus in the medical literature about the best method of evaluating of shoulder misalignment. Several clinical and radiographic measurements are described. There are also radiographic measurements of the thorax and the ribs that can complement the analysis. More recently, software's have been employed for this purpose. The present study aims to highlight the most recent methods available in the current literature for the clinical and radiographic measurements of shoulder unbalance, as well as the advantages and limitations of each of them.

CLINICAL MEASUREMENTS

Clinical evaluation should be considered the most important reference, because it is the one that is visible to the patient. It can be performed ventrally or dorsally (Figure 1), but the correlation between these two evaluations is questionable [6].

Biacromial angle

Should be drawn in a clinically photography in posterior view. It is the angle formed between the line that touches both Acromion and the horizontal plane (Figure 2). The value obtained must be expressed in degrees. In medical literature, there is not a threshold value for the definition of "shoulder decompensation" [6].

External angle of the shoulder

Analogous to the biacromial angle, it is the angular measurement obtained between a straight line that touches the highest points of both Acromion and the horizontal plane (Figure 3a) [5].

Anterior axillary angle

Is the angle formed from a line that touches both axillary...
fold and the horizontal plane, with the patient being observed ventrally (Figure 3b) [5].

**Posterior axillary angle**

Is the angle formed from the line that touches both axillary fold and the horizontal plane, with the patient being observed dorsally (Figure 3c) [5].

**The trapezial prominence:** Should be drawn in a clinically photography in anterior view. Represents the angle between the horizontal line and the line connecting the intersections of sternocleidomastoid muscle and trapezius muscle profiles, with a positive value assigned when the left side was higher than the right. The trapezial area was defined as the area enclosed by the following borders: the line connecting the top margin of acromial processes, the perpendicular line to it through the intersection of sternocleidomastoid muscle and trapezius muscle, and the superior margin of the trapezial muscle.

**Radiographic measurements**

**Clavicle angle:** Measured in posteroanterior spine x-rays, it is the intersection of a line drawn between the highest points of the clavicles and the horizontal plane (Figure 4). Positive values are usually used to describe a left shoulder elevation and negative values for the opposite. However, there is no standardization for these measurements and the reverse can be also observed in the literature [7].

**Chest cage angle difference:** This tool can be used to identify the presence of superior chest cage asymmetries [8]. It is measured as follows: 1. A “central chest cage thoracic line” (CCCL) is drawn from the center of T1 to the center of T12; 2. A line is drawn perpendicular to the first line; 3. After that, two lines that touch the clavicles bilaterally are identified; 4. The angle formed by the intersection of the CCCL and the vertical line is the “chest cage clavicle angle” (CCCA). 5. The difference of the CCCA is calculated by means of the subtraction of the right and left angles (Figure 5). Such results determine the following classification: < 0 degrees, minimal deformity; 0 to 10 degrees, mild deformity; >10 severe, severe deformities.

**T1 tilt:** It is the angle formed by a straight line that touches the upper plateau of T1 and the horizontal plane [9].

**First Rib Index:** It is the difference between the diameter of the first vertebral arch on the right and left side divided by the diameter of the thorax at the same level. The value is expressed as a percentage [10].

**Coracoid height:** It is the distance, expressed in millimeters, between two horizontal lines, traced from the right and left coracoid processes in a posteroanterior x-ray. Due to the risk of distortions resulting from the magnification or minimization of the x-ray, calibration of the images must be carried out before measurements [10].

**SOFTWARE’S**

**SAPO**

Software for Postural Evaluation is free software that can be used to measure position, length, angles and the alignment of the body. It requires clinical images of the entire body in the anterior, posterior, right and left lateral views, marked with pre-established anatomical landmarks (Figure 7) [11].

**Surgimap**

Computer program developed for the measurement of several radiographic or clinical parameters in patient photographs and x-rays. It can be accessed, free of charge, through the website <http://www.surgimap.com>.

**DISCUSSION**

Shoulders’ leveling is a primary goal of the surgical treatment of AIS patients [12-16]. When absent, in addition to being related to worse indicators of quality of life [2], unevenness causes patient dissatisfaction. Thus, shoulder measurement has gained importance in recent years, and several methods have been described for this purpose.
Although most physicians evaluate patients looking at them from the back, the ventral deformity is the one seen by the individual when observed in the mirror [5]. Yang et al. [6], reported that patients with double thoracic deformities (Lenke 2 curves), only had ventral deformities correlated with radiographic changes. In addition, the correlation between ventral and dorsal clinical measurements of the shoulders was weak.

Several studies have attempted to correlate clinical and radiographic shoulder deformities [2,3,5,6,9,10,13]. Qiu et al. [12], evaluated 34 patients with Lenke 2 curves and observed that such correlation occurred only partially. The authors stated that the aesthetic balance was more important than the radiographic one, and that both did not always walk together.

Hong et al. [10], studied four radiographic methods for measuring shoulder height and found that the clavicular angle and difference height of the coracoids were the most reliable. The clavicular angle was also pointed out by other authors as having the best predictive factor for the postoperative balance of the shoulders [4]. According to Kuklo et al. [2], the leveling of the shoulders was also correlated with better quality of life scores. Residual elevation of two or more centimeters of the shoulder was a potential cause of dissatisfaction in patients submitted to spinal fusion [18].

Ono et al. [19], examined two clinical parameters of the shoulders: the clavicular tilt (biacromial angle) and the trapezius prominence in AIS patients with Lenke 1 and 2 type curves. According to them, there are two distinct deformities: the medial asymmetries of the trapezius muscle, which reflect the deformities created by inclined ribs and T1, and the lateral differences, which are related to changes on the clavicular angle.

Regarding T1 tilt, Menon et al. [16], studied 85 AIS cases (Lenke 1 and 2) and observed that the shoulder height may or may not correlate with the T1 slope. In addition, the deformity may depend on the magnitude of both the proximal and main thoracic curves. However, in a retrospective study, Lee et al. [19], reported that T1 tilt had no correlation with the shoulder asymmetry.

Currently, shoulder height has been subject of several publications for the indication of fusion level [20-25] and the density of pedicle screws constructions [26,27]. In addition, the development of more powerful surgical implants led to the creation of iatrogenic deformities, especially at the non-instrumented lumbar curves as well as at the shoulders [28-30]. Such arguments have stimulated the development of more accurate shoulder height measurement tools that should be easy to apply and have good reproducibility among observers.

**FINAL CONSIDERATIONS**

Currently, there are several clinical and radiographic methods for evaluating shoulder height, both in the ventral and in the dorsal view. There is no clear superiority between methods, although the clavicular angle presents the best clinical radiographic correlation. In Lenke type 2 curves, the measurement of the ventral deformity of the shoulders seems to be more reliable than the dorsal one.

**REFERENCES**


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