

# THORACIC KYPHOSIS AND HAMSTRINGS: AN AESTHETIC-FUNCTIONAL CORRELATION

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## SUMMARY

**Objective:** The authors discuss the existent correlation between augmented thoracic kyphosis in patients with juvenile Kyphosis or Scheuermann's disease and hamstrings contraction. This correlation is marginally addressed by existing studies. **Methods:** Between June and December 2003, 38 patients belonging to the Spine Group at the Department of Orthopaedics from Santa Casa de São Paulo, Brazil, were analyzed. Among them, 26 (68.4%) were males and 12 (81.6%) were females. The youngest age was 10 and the oldest one was 20 years, with an average of 15.36. Twenty (52.6%) patients presented with Scheuermann's disease

and 18 (47.4%) with juvenile Kyphosis. **Results:** From all 38 patients under study, 32 (84.2%) presented hamstring contracture, which was statistically significant ( $p < 0.001$ ). 85% of patients presenting only Scheuermann's disease and 83.3% of patients with only juvenile Kyphosis had contracture. **Conclusion:** There was no statistically significant difference between contraction percentage in Scheuermann's disease patients versus juvenile Kyphosis patients ( $p = 0.61$ ).

**Keywords:** Kyphosis; Muscles; Scheuermann's disease.

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## INTRODUCTION

Among the deformities that may develop during childhood and adolescence, kyphosis remains often neglected<sup>(1)</sup>. It is frequently diagnosed as bad stance, and may also be a manifestation of a serious structural change of the vertebral spine<sup>(1)</sup>. Schanz<sup>(2)</sup>, in 1911, was the first to question the term "bad stance", and believed that it resulted from heavy work and excessive demands to the spine. With the advent of X-ray imaging, Holger Scheuermann<sup>(3)</sup>, in 1920, outlined the deformity changes by X-ray<sup>(1)</sup>. The Scheuermann's kyphosis, or juvenile kyphosis is characteristically fixed, developing around puberty period, caused by a wedge-shaped deformity in one or more vertebrae<sup>(4)</sup>. In its original description, Scheuermann reported having found three abnormal vertebrae in almost all cases; however, in 1936, he found that this number could range from one to five<sup>(4)</sup>. In 1964, Sorensen<sup>(4)</sup> further outlined the pathological process and suggested that the disease should be defined as a kyphosis including three central adjacent vertebrae, with 5-degree wedging or more<sup>(4)</sup>. Winter doesn't believe the wedging to be necessary for diagnosis, theorizing that other signs, particularly a relatively fixed deformity, would be sufficient for providing a diagnosis<sup>(5)</sup>.

Scheuermann's disease must be distinguished from postural curved dorsum, the latter being a moderately augmented kyphosis, with strong lumbar lordosis, clinically flexible, usually without muscle contractions, where X-ray images do not show vertebral wedging or irregularities on terminal plate. Scheuermann's disease may be not apparent until

the age of 10 - 12, being often misdiagnosed as postural curve dorsum<sup>(1)</sup>.

The cause for the disease remains unclear; Scheuermann, in 1920<sup>(3)</sup>, believed it was an aseptic bone necrosis; other investigators suggested damage to vertebral apophyseal ring by inflammation or infection. Schmorl<sup>(6)</sup>, in 1930, performed autopsies in six patients and suspected of a potential change to vertebral disc<sup>(4)</sup>. Some mechanical factors were mentioned as causative of kyphosis development. Scheuermann noticed that the disease most frequently affected young farm workers involved in heavy-load jobs. Hensinger<sup>(7)</sup> and Herndon<sup>(8)</sup> in 1981, also emphasized this mechanical theory<sup>(1)</sup>; however, experimental studies in rats did not confirm it<sup>(1)</sup>. Bradford et al.<sup>(9)</sup>, in 1976, suggested osteoporosis as the primary cause of Scheuermann's disease<sup>(4)</sup> and Lambrinudi<sup>(10)</sup>, in 1934, noticed tense hamstrings in many patients, finding it significant for the development of the deformity. Michelle<sup>(11)</sup>, in 1961, believed that iliopsoas muscle contractions were important in producing that pathological process<sup>(1)</sup>. Bradford et al.<sup>(1)</sup>, although considering those findings interesting, report that they cannot be found in all patients with Scheuermann's disease.

Changes noticed on pelvic muscles and, consequently, on pelvic balance, will induce the postural component of the entire vertebral spine, determining the variations of its physiological curves<sup>(12)</sup>.

Pelvic flexion has, as a major and immediate consequence, sacral plateau's anterior bending, taking the 5th lumbar vertebra with it. Lordosis is enhanced to reestablish balance; automatically, thoracic kyphosis increases, aiming to keep

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gravity center stable, which is displaced by the augmented lumbar lordosis<sup>(12)</sup>. In Scheuermann's disease, an increased lumbar lordosis and hamstrings shortening (semitendinosus, semimembranosus, and femoral biceps) are usually reported. A typical patient with thoracic kyphosis has a relatively stiff thoracic deformity, which becomes more apparent with the torso flexed and partial fixing by hyper extending it. They also present augmented lumbar and cervical lordosis due to an offset mechanism<sup>(13)</sup>. There is no scientific evidence proving that the Scheuermann's disease is a consequence of a bad stance of a flexed pelvis, but this might be an acceptable hypothesis from a physiopathological view<sup>(14)</sup>. We found in literature a vast database addressing Scheuermann's disease and Postural Curved Dorsum and specially how to measure and determine values for quantifying hamstrings contractions, but just few of them correlate such muscles' contractions to thoracic kyphosis augmentation. This study intends to study the correlation between hamstrings contraction, represented by a measurement of the popliteal angle, and thoracic kyphosis behavior in patients with Scheuermann's disease or Postural Curved Dorsum.

## MATERIALS AND METHODS

A prospective study was conducted with the approval of the Committee on Ethics in Research, of the FCMSCSP. Between June and December 2003, at the Spine Group of DOT- Medical Sciences College, Santa Casa de São Paulo - FCMSCSP.

Thirty-eight patients (76 knees) with Postural Curved Dorsum (PCD) or Scheuermann's disease (SD), diagnosed according to the criteria by Sorenson<sup>(1)</sup>, namely: kyphosis involving at least three adjacent vertebrae with wedging 5 degrees on each vertebra<sup>(4)</sup>. Thirty-eight 10-20 year-old patients (average: 15.4) were assessed, being 12 (31.6%) females and 26 (68.4%) males. We found 20 (52.6%) patients with Scheuermann's disease and 18 (47.4%) with Postural Curved Dorsum. All evaluations were performed by the same investigator. Patients with thoracic kyphosis of other etiologies, as well as patients with knee conditions have been excluded. For the study of hamstrings contractions, the popliteal angle measurements<sup>(15)</sup>, in both limbs, were assessed. The patients were examined by using Reimers' method<sup>(15)</sup>, as follows: wearing hospital attire, lying at supine position, with hips flexed at 90 degrees. The contralateral limb was carefully kept extended, because the semiflexion of the opposite hip and knee would facilitate a complete extension of the knee studied, because of the interference it imposes on pelvic-femoral angle. From knee flexion at 90 degrees on, the leg was passively and carefully extended until any resistance was felt; the foot, during the maneuver, remained at a neutral position (Figures 1 and 2). A standard 360-degree plastic goniometer with double arm, 36-centimeter long and 4.5-centimeter wide and centralized at the level of the knee joint line was used. The upper arm was placed along tibial longitudinal axis and the lower arm parallel to femoral longitudinal axis, and the value for popliteal pit region was assessed. This method was chosen for the following reasons: it does not influence on pelvic-femoral angle, which could facilitate extending the knee in study, and because it is not influenced by abdominal volume, as happens with the Amiel-Tison's measurement method<sup>(16)</sup>; however, we agree with Vernieri<sup>(17)</sup>, who reports that, by definition, the Reimers' method<sup>(15)</sup> evaluates the value of the angle formed between leg's

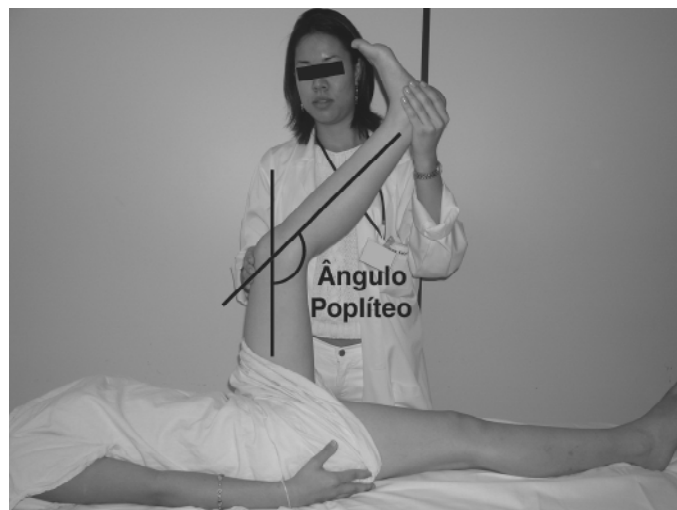


Figure 1- Popliteal angle measurement method.

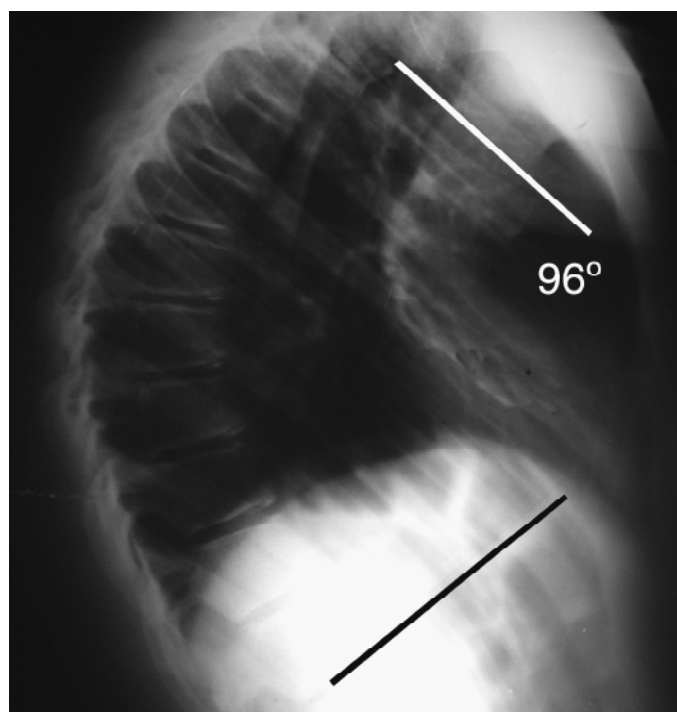


Figure 2-Kyphosis measurement by Cobb's method.

axis and the thigh axis extension at the anterior region of the knee, that is, it assessed the supplementary angle, which does not directly reflect knee flexors' length<sup>(17)</sup>. X-ray images of the thoracic spine were captured for all patients at an orthostatic (Figures 1 and 2) and lateral planes with a cushion placed at kyphosis apex; thereby, we assessed the X-ray flexibility. X-ray images of the lumbar lordosis were also captured at an orthostatic plane, which was measured by Cobb's method<sup>(18)</sup> from L1 to S1. The value regarded as normal was 50-60 degrees, according to Yochum and Rowe<sup>(19)</sup>. Kyphosis degree was assessed by Cobb's method<sup>(18)</sup> from T3 to T12<sup>(20)</sup> and regarded as normal when between 20 and 45 degrees<sup>(1)</sup>. For kyphosis X-ray flexibility, deformities were regarded as flexible when their values at the X-ray using a cushion were lower or equal to 45 degrees. Data were analyzed in a Pentium 4, 2.4 GB computer, and the statistical analysis employed was the Epi-Info 6.0 release.

## RESULTS

From the 38 studied patients, 18 (47.4%) showed increased lumbar lordosis, 15 (39.5%) normal lordosis values, and 5 (13.2%) hypolordosis. Assessing only patients with SD, we found 65% hyperlordosis, 5% hypolordosis, and 30% normal lordosis; for PCD, we found 27.8% hyperlordosis, 22% hypolordosis, and 50% normal lordosis. Among the patients with SD, we found X-ray thoracic kyphosis stiffness in 50%, and in 0% for PCD (Table 1). Of the 38 patients, 32 (84.2%) showed hamstrings contraction ( $p < 0.001$ ), which is statistically significant. When we assess each disease alone, we see 85% contraction in the 20 patients with SD and 83.3% in the 18 patients with PCD, which has not shown to be statistically significant by the analysis of Fisher's test  $p = 0.61$ . Of 6 patients who did not show contraction, 3 had Scheuermann's disease and 3 a Curved Dorsum. Kyphosis measurement at X-ray ranged from 47 to 95 degrees, with an average of 69.15 degrees. At popliteal angle measurement, we found values ranging from 90 to 165 degrees, with an average of 144.47. Lumbar lordosis measurement ranged from 25 to 95 degrees, with an average of 60.21 degrees. By the analysis of the dispersion graph (Graph 1), we found no significant correlation when assessing if the greater the thoracic kyphosis, the greater the increase of hamstrings contraction would be.

## DISCUSSION

The prevalence of Scheuermann's disease in general population is 0.4 - 8.3%. According to Bradford et al.<sup>(1)</sup> and Murray et al.<sup>(21)</sup>, the ratio for genders is 2 males to each female. In this study, from 20 patients with Scheuermann's disease, we found a ratio of 1.85 men to each woman, which is very close to literature reports. The incidence of these diseases (SD and PCD) is higher in young adolescents; thus, we studied a population aged 10-20 years, as defined by the World Health Organization for adolescents.

During literature review, a fact that strongly called our attention was the lack of standardization regarding the measurement of the popliteal angle by authors. Originally, the popliteal angle was described by Amiel-Tison<sup>(16)</sup>, in 1968, which measured the popliteal pit angle. Bleck<sup>(22)</sup>, in 1979, named the complementary angle as popliteal angle, formed between leg's axis and thigh axis extension. In our study, we used the Vernier's method<sup>(17)</sup>, for the reasons previously mentioned. We didn't find in literature optimal and absolute values for comparing to our sample; thus, comparison with other studies is difficult. We used values

recommended by national literature, because they would reflect similar samples, being those studied by Affonso Filho and Navarro<sup>(23)</sup>, who, in 2002, studied 500 10-20 year-old adolescents with no spinal or knee condition, and determined that a normal popliteal angle value ranges from 120 to 180 degrees, but they reported normal values divided by gender and age groups of 10-13 years (skeletally immature), 14-17 years (maturation phase), and 18-20 years (skeletally mature). The values to be compared in this study are shown on Table 2.

	MALE Popliteal angle	FEMALE Popliteal angle
10 - 13 Y.O.	153°	158°
14 - 17 Y.O.	151°	161°
18 - 20 Y.O.	156°	162°

Source: Rev Bras Ortop vol 37-466.

**Table 2- Normal values for popliteal angle by age group.**

Malheiros et al.<sup>(23-24)</sup> found no statistical difference regarding the assessed limb, weight, ethnicity or patient's gender. We positioned the foot at a neutral dorsiflexion, because, according to Affonso Filho and Navarro<sup>(23)</sup> there was no statistical difference regarding the foot, which could lead to gastrocnemius muscles influence, as well as regarding assessed limb.

Fisk and Baigent<sup>(20)</sup>, proposed studies that could establish a correlation of hamstrings contraction and Scheuermann's disease, questioning the cause-and-effect relationship. Later, in other study, Fisk et al.<sup>(25)</sup>, assessed 500 patients aged 17-18 years and found that the patients presenting hamstrings contraction had a X-ray evidence of SD in 56.3% of male patients and in 30.3% of female patients, but they also did not correlate hamstrings contraction percentage to augmented kyphosis. In their study, Murray et al.<sup>(21)</sup> found 29% of hamstrings contraction in the 67 SD patients assessed, in contrast to our study, where we evidenced 85% of contractions in SD patients. Among PCD patients, we also found significant hamstrings contraction values in 83.3% of the patients, which usually is not described in literature (4). Assessing the dispersion graph (Graph 1), we can notice that no hamstrings contraction increase happened when thoracic kyphosis was augmented. The result of the analysis of lumbar lordosis was also consistent with literature (4, 14), which reports that lumbar lordosis is greater in SD patients, being an offset mechanism; in the present study, we found 65% of hyperlordosis in SD, and 27.8% in PCD.

The average thoracic kyphosis in our study was 69.15 degrees, which is very close to the publications by Murray et al.<sup>(21)</sup> with an average of 71 degrees and by Loder<sup>(26)</sup> of 65 degrees (Table 1).

## CONCLUSION

By studying those 38 patients with Scheuermann's disease or Postural Curved Dorsum, we can state that among the patients carrying these diseases and presenting augmented thoracic kyphosis, most of them also present hamstrings contraction.

There is no direct correlation between augmented thoracic kyphosis and hamstrings contraction increase.

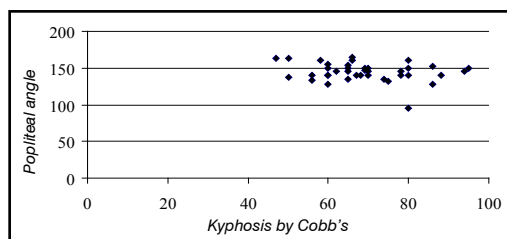
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	X-ray stiffness	Hamstrings contraction
SD	50%	85%
PCD	0%	83,3%

Source: Spinal Infirmary, DOT-FCMSCSP

**Table 1 - Relationship between disease and clinical and X-ray test.**



**Graph 1- Correlation between kyphosis and hamstrings contraction.**

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