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Original Research Article

Supine fulcrum bending test and in-cast correction of Scheuermann juvenile kyphosis

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ABSTRACT

Background: Patients with Scheuermann disease often require conservative management with a series of corrective casts, followed by anti-kyphotic brace. Flexibility of the kyphosis can be assessed during a supine fulcrum bending test. The aim of the study was to analyze the radiological flexibility of kyphosis and immediate in-cast correction in a series of patients conservatively treated.
Methods: Eighty-six adolescents were conservatively treated for Scheuermann disease of thoracic location. Charts of 55 patients, 39 boys and 16 girls, were accessible. The mean age was 14.6±1.6 years. On the lateral full-cassette standing radiograph, the angle of thoracic and lumbar lordosis were measured. The flexibility of kyphosis was assessed on a supine fulcrum bending lateral radiograph. The in-cast kyphosis angle was measured on a standing lateral radiograph.
Results: In 18 patients, a mild non-progressive scoliotic curvature was present; it did not exceed a Cobb angle measurement of 25°. The initial kyphosis angle was 59.2°±9.3°. The lordosis angle was 76.3°±9.3°. The kyphosis angle on supine fulcrum bending test was 30.4°±9.7°. The kyphosis angle in the reclining cast was 44.3°±12.5°. There was no correlation between age and the supine bending correction. There was a correlation between the correction obtained with the supine bending test and the immediate correction in the cast (r=0.64, p=0.0012).
Conclusions: The reduction of the kyphosis Cobb angle by supine fulcrum bending was 50% on average, while in the cast in standing position, only half of this correction was maintained.

Keywords: Scheuermann juvenile kyphosis, Scheuermann disease, Fulcrum bending test, Brace, Plaster cast brace

INTRODUCTION

Scheuermann disease (SD) is one of the most common causes of structural spine hyperkyphosis in adolescents.[1] Depending on localization of the kyphosis apex, two types of SD are distinguished: thoracic (SDT) and thoracolumbar (SDTL).[2] Although SD has been known for almost 100 years, its etiology remains unclear. The disease is considered as multifactorial with a genetic background.[2-5] The hypothetic pathoetiology is the weakness of the vertebral endplate due to a predisposing genetic background that influences the quality of matrix components (collagen types II and IX).[6,7] Abnormalities of cartilage with collagen fibrils and irregularity of mineralization and ossification of vertebral plates have been described.[8,9] It is supposed that the predisposition together with mechanical stress of the anterior part of vertebral bodies influences the severity of spinal impairment and vertebral wedging.[10,11] The prevalence of the disease is reported 0.4%–8% of population.[2,6,12]

The diagnosis of SD is established and based on clinical and radiological presentation of the disease.[13] Most authors use diagnostic criteria introduced by Sorensen; however, there are several other diagnostic classifications, differing in the number of affected vertebrae and additional findings, such as irregularities of the vertebral endplates, Schmorl nodes, narrowing of the disc spaces, and lengthening of the vertebral bodies in the sagittal plane.[13,14] The common factor of all radiological diagnostic criteria is the wedging of vertebrae.[13]

Untreated kyphosis in a growing child may lead to progressive deformity of the spine, back pain and even to neurological complications in the most severe cases.[15-17] The natural history of a patient with SD reveals that such patients have a 2.5-fold increased risk for constant back pain compared to controls, higher risk for difficulties in mounting stairs and in carrying a 5 kg load for at least 100 meters.[18,19]

Patients with SD often require non-surgical management mainly with physical therapy and brace treatment. There are few types of braces used in SD.[10,20,21]

According to Platero et al the combination of plaster of Paris casting and brace treatment provides the largest angular deformity correction and is significantly more efficient than other non-surgical means of treatment.[22]

The immature skeletal age and the flexibility of the curvature, together with good patient's compliance, are crucial factors of an auspicious treatment result. Flexibility of the kyphosis can be assessed during a supine fulcrum bending test. However, it is not clear how much of the initial correction, obtained during the fulcrum bending, can be maintained during the brace treatment. There is a loss of correction even in a plaster cast.

The aim of the study was to analyze the radiological flexibility of kyphosis and immediate in-cast correction in a series of patients treated conservatively.

METHODS

From 2001 to 2007, eighty-six adolescents were conservatively treated for Scheuermann`s disease using the Lyonaise method.[23] This method consists of preparative specific physical therapy, a series of three plaster casts, followed by anti-kyphotic plastic brace.

The diagnosis was based on the following criteria: 1) wedging of 5° of the vertebral bodies, 2) involvement of 3 or more vertebrae, 3) presence of the Schmorl`s nodes.[13,17] Patients with a history of spine surgery, diseases of the spine other than SD, kyphosis due to postural disorders, fractures or trauma, infections, tumors, congenital deformations, neuro-muscular or syndromic disease influencing spinal alignment were excluded from the study.

All patients underwent radiographic examination containing 4 radiographs: 1) standing long-cassette AP, 2) standing long-cassette lateral, 3) lateral, fulcrum bending in supine position and 4) standing long-cassette lateral in the cast.

The AP and lateral radiographs were obtained with each subject standing in natural position, with horizontal gaze (patient looks at a point marked on the wall, at the sight level of 2 m distance) with hips and knees fully extended. The radiographs covered the space of the pelvis with the hips as well as the whole spine up to the level of the cranium. The only difference between the AP and the lateral view was the position of the upper limbs. For the AP, the upper limbs were on both sides of the trunk whereas, in the lateral position, the forearms were crossed and the hands were resting at the chest.

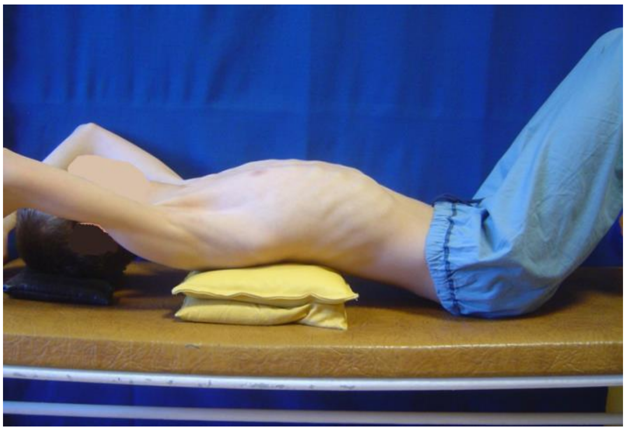

Figure 1: Fulcrum bending test.

Figure 2: Putting on the plaster cast on the Cotrel frame.

The fulcrum bending radiographs were performed in a supine position with horizontal x-ray beam. The fulcrum, made of sand bags of 15 cm height, was placed at the apex of kyphosis 30 minutes prior to the radiograph. The patient was lying in a supine position with the arms placed on the examination table above the head (Figure 1).

The standing long-cassette lateral radiograph in the plaster cast was taken on the next day after the plaster cast was applied. The position was the same as for regular lateral radiograph.

The plaster cast brace was put on according to Lyonese method. Elongation and anti-kyphotic forces were applied at the Cotrel frame and the plaster cast brace was put to maintain the maximal correction (Figure 2). The cast was put on without anesthesia. The application was preceded by specific physical therapy focused on anti-kyphotic and contractures stretching exercises.

The angle of scoliosis was measured at the AP radiograph according to Cobb method in case any scoliotic curve was present. The following radiological parameters were measured on lateral radiographs: 1) Thoracic kyphosis (TK) - the angle between the line subtended by the upper end plate of T4 and the lower end plate of T12; 2) Lumbar lordosis (LL) - the angle between the upper endplate of the L1 vertebra and the endplate of S1 measured with Cobb method; 3) the apex of the kyphosis - patients with the apex at T10 or proximally were included to the SDT group and those with the apex located at T11 or distally were included to SDTL group. The flexibility of kyphosis was assessed on the supine fulcrum bending lateral radiograph with the measurement of TK. In-cast correction was measured with TK angle at the standing lateral radiograph.

For each parameter, the mean values, standard deviation and range were calculated. The normal distribution of data was analyzed with the Kolomogorov-Smirnov test. The difference between the initial kyphosis angle, fulcrum bending test and in brace kyphosis was evaluated with repeated ANOVA with Bonferroni correction. Correlations between the parameters were evaluated with Pearson correlation test. The data were analyzed using GraphPad InStat software (Graph Pad Software, San Diego, CA, USA). P-level of 0.05 was considered significant.

RESULTS

Fifty-five patients had fulfilled the inclusion criteria and had all required radiographs available. Group description is listed in (Table 1).

Table 1: Characteristic of the study participants.

Variables	N
Patient	
Boys	39
Girls	16
Mean age (years)	14.6±1.6
Kyphosis localisation	
Thoracic	50 (90.1%)
Thoraco-lumbar	5 (9.9%)
Scoliosis	18 (32.7%)

In 18 patients (32.7%), a mild non-progressive scoliotic curvature was present. In none of the patients the scoliosis exceeded 25° Cobb degrees. The scoliosis was found in 50% of girls (n=8) and 25.6% of boys (n=10). The scoliosis pattern did not follow any currently used scoliosis classification.

Table 2: The radiological sagittal alignment profile of patients prior to treatment, during the fulcrum bending test and in brace correction.

	Mean	Standard deviation	Range
Initial kyphosis angle	59.2°	9.3°	40°-80°
Initial lordosis angle	76.3°	9.3°	53°-96°
Fulcrum bending test	30.4°	9.7°	13°-55°
In brace correction kyphosis angle	44.3°	12.5°	22°-74°

The sagittal alignment analysis revealed a decrease of the thoracic kyphosis in both the fulcrum bending test and the plaster cast (Table 2). The difference between the initial kyphosis angle, fulcrum bending test and in brace kyphosis was statistically significant, p=0.0001.

There was a correlation between the correction obtained with the supine fulcrum bending test and the immediate in cast correction (r=0.64, p=0.0012).

There was no correlation between age and the supine bending correction.

DISCUSSION

Most investigators agree that mechanical factors have a significant role in the pathogenesis of SD.[13] When the excessive mechanical stress is applied over vertebral endplates of the growing spine, the kyphosis is induced. The reported success of brace treatment lends support to a mechanical etiology.[13]

The non-surgical treatment of the SD with brace has been proven to be effective in compliant immature patients. The results of brace treatment are reproducible and the treatment allows to achieve permanent correction of vertebral deformity.[20]

According to Platero et al the best results of the SD conservative treatment are achieved with application of the plaster cast in maximal possible correction prior to the plastic brace use.[22] This method has been originated from Lyon in France and it is called Lyonese method. At the beginning, it was considered for scoliosis treatment, however with time, it was also applied for SD treatment.[23-25] According to de Maurroy et al, more than 60-year experience in this technique, the plaster casting method has never been abandoned because any better solution has not been found yet.[25]

The plaster cast is put on the Cotrel frame with the elongation forces applied through the head and the pelvis traction and the anti-kyphotic forces placed directly at the apex of the kyphosis. In our results, the in cast kyphosis angle maintained only half of the correction achieved during the fulcrum bending test. We assume that it is due to the difference in position of the radiographs (supine versus standing). We observed that the cast provided good support for the lower part of the curvature however, the upper part support revealed some limitation. Together with patient`s habits, muscles contractures and poor postural control a part of the correction may be lost when standing. Nevertheless, the correction in the plaster cast was very satisfactory and according to de Mauroy et al. the immediate reduction in plaster cast is an excellent predictive criterion of the final correction.[23,24]

We found that almost one third of the evaluated patients with SD revealed scoliotic curvature. All curves were mild below 25°. It is in line with a study by Ristolainen el al.[18] In our study the scoliosis was present in half of females and one fourth of males, whereas in Ristolainen et al a bigger prevalence of scoliosis was noted in males. The scoliosis pattern did not follow any currently used scoliosis classification. The curvatures were not harmonious and were more similar to the congenital scoliosis than to the idiopathic one.

The strong side of this study is that it has been the first study analyzing the measurement of possible correction in conservative treatment of SD and the method to predict the brace treatment effect.

The limitation of this study is that it is focused on a preparatory step to full scheme of treatment and long-term studies are needed.

CONCLUSION

In Scheuermann disease, the correction of the thoracic kyphosis Cobb angle by supine fulcrum bending was 50% on average, while in the cast in standing position, half of this correction was maintained.

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