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Case Report

Brace Treatment Can Improve Thoracic Kyphosis During Growth: A Case Report

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Abstract. While in scoliosis bracing today there is evidence that during growth curvatures can be corrected significantly, there is no evidence that the standard of kyphosis bracing we use today may lead to final corrections after weaning off the brace. *Case report:* A 12-year-old kyphosis patient presented at the office of the author with a curve of 58° in summer 2009. Brace treatment with a modern kyphosis brace was started immediately with an in-brace correction of more than 30 degrees. After one year of treatment the patient had outgrown his first brace, but was still immature. Therefore a new brace was constructed. The curvature was 37° without and 25° in the new brace. This brace was worn for another two years for 16 h/day and weaned off in summer 2012. 6 months later—the patient meanwhile was nearly mature (Risser 4/voice change 2.6 years) the final X-ray showed an angle of 38° (normal range of kyphosis angles) with full flexibility of the spine. *Conclusion:* Bracing with small size orthosis in kyphosis patients during growth can lead to an improvement of the curvature angle after the end of growth. The functional limitations there are in severe kyphosis angles can be improved and normalized in some cases.

Keywords: kyphosis, brace treatment, final correction

1. Introduction

Scheuermann's kyphosis is the most frequent structural kyphosis in adolescents. There are gaps in the knowledge of epidemiology, aetiology and treatment. There are strong genetic and mechanical factors in the aetiology. Treatment options depend on the Cobb's angle measured and the skeletal maturity. Training and brace treatment yield good results for milder curves, while surgical correction is regarded most effective for severe curves > 70° [1]. Indications for surgery are subject of debate as complications are not uncommon [2].

With the exception os some recent reviews [1–3], the body of scientific publications in this area remains small.

Wenger and Frick [4] in 1999 published an extensive review on this condition, but when looking into recent Pub Med listings, the condition of Scheuermann's kyphosis in the past 10 years seems to stimulate less scientific interest. There are some points of discrepency upon the definition of the pathological deviations of normal and sagittal spinal alignment [4]. Unlike scoliosis, where any significant lateral deviation in the coronal plane is abnormal, the sagittal alignment of the spine has a normal range of thoracic kyphosis. The Scoliosis Research Society has defined this range as being from 20° to 40° in the growing adolescent [5–7]. In a study of 316 healthy subjects with ages ranging from 2 to 27 years, the upper limit of normal kyphosis was noted to be 45°. It was also noted that the average thoracic kyphosis increases with age from 20° in childhood, to 25° in adolescents, to 40° in adults [8]. The lack of a consistent definition of Scheuermann's kyphosis in the literature makes it difficult to compare studies as the inclusion criteria may differ, thus making the distinction between the spectrum of upper normal thoracic kyphosis, severe adolescent roundback deformity, and Scheuermann's disease almost impossible [4].

Little is written on the subject of the lumbar or thoracolumbar patterns of Scheuermann's disease. The Schmorl's nodes and endplate irregularity may be so severe that the lower lumbar Scheuermann's disease can be confused with infection, tumor, or other conditions [4]. The etiology of lumbar Scheuermann's kyphosis is unknown, but strong associations with repetitive activities involving axial loading of the immature spine favour a mechanical cause [4]. Although the radiographic appearance may be similar, lumbar Scheuermann's kyphosis is regarded as a different entity than thoracic Scheuermann's kyphosis [4]. Unlike classic thoracic Scheuermann kyphosis, the treatment of lumbar Scheuermann's disease was not controversial in 1999 [4], as its course has been regarded as being non-progressive and its symptoms have been regarded to resolve with rest, activity modification and time [9, 10].

According to Wenger and Frick [4] the incidence of Scheuermann's disease has been estimated at 1 to 8% of the population [11, 12]. The typical presentation is in the late juvenile age period from 8 to 12 years, with the more severe fixed form commonly appearing between age 12 and 16 years. Patients with thoracic roundback, who have classic type I Scheuermann's disease, may have pain in the thoracic spine area, but more frequently present because of patient and parental concerns related to trunk deformity. The gender prevalence of Scheuermann's kyphosis is difficult to determine from the literature, and may be related to how Scheuermann's kyphosis is defined. In general, males and females are involved with equal frequency [5], although the reported ratios have varied widely [4].

The natural history of Scheuermann's disease remains controversial. The condition tends to be symptomatic during the teenage years but often in late teenage life less pain is reported [11]. In a long term follow-up study, Sorenson noted pain in the thoracic region in 50% of patients during adolescence, with the number of symptomatic patients decreasing to 25% after skeletal maturity [4]. The pain was described as mild and 'not incapacitating'. Later authors offered a contrasting view of the symptoms of untreated Scheuermann's disease, with Bradford stating that adults with Scheuermann's kyphosis have a higher incidence of disabling back pain than the normal population [13, 14].

Initial management of the patient presenting with Scheuermann's kyphosis includes documentation and assessment of the degree of deformity and/or pain, as well as an overall picture of the negative impact of the deformity on a patient's life [4]. Physical therapy (or physiotherapy) for postural improvement is often recommended, especially in central Europe, focusing on hamstring and pectoralis stretching and trunk extensor strengthening as well as improving function [15]. A good physical therapist can also assess whether there is any tendency towards increased hip flexion contracture and may work on associated lumbar lordosis [4]. There are no conclusive studies documenting improvement in kyphosis with exercises [4], although Bradford et al did note some improvement in patients with moderate degrees of deformity [16].

The initial report of Bradford et al. on Milwaukee brace treatment of kyphosis in 75 patients, who had completed treatment, documented a 40% decrease in mean thoracic kyphosis and a 35% decrease in mean lumbar lordosis after an average 34 months of brace wear [16]. In a later study [17] this sample has been followed-up. Gutowski and Renshaw [18] have reported on the use of the Boston lumbar and modified Milwaukee orthoses for Scheuermann's kyphosis and abnormal juvenile round-back (Idiopathic kyphosis) with an average 26-month follow-up. Out of 75 patients in their study group, 31% completely rejected the orthosis within 4 months. Compliant patients had an average improvement in kyphosis of 27% in the Boston group and 35% in the Milwaukee group, despite use of the Milwaukee brace for older patients who had greater curves [4].

The overall results of brace treatment for kyphosis patients seem reproducible [19] and promise a permanent correction of vertebral deformity, unlike bracing in patients with idiopathic scoliosis [20].

According to Lowe [21, 22] brace treatment is almost always successful in patients with kyphosis between 55 degrees and 80 degrees if the diagnosis is made before skeletal maturity. Kyphosis greater than 80 degrees in the thoracic spine or 65 degrees in the thoracolumbar spine is almost never treated successfully without surgery in symptomatic patients. Surgical treatment in adolescents and young adults should be considered if there is documented progression, refractory pain, loss of sagittal balance, or neurologic deficit.

Careful instructions for all individuals who will undergo brace therapy, psychological support for all patients who develop psychological reactions and physical training particularly for older girls should be recommended to increase bracing compliance [23].

Results of modern braces used for the treatment of kyphosis have also been documented in a recent textbook on spinal deformities [24]. In order to improve the patient's quality of life whilst wearing the brace and by that improving compliance as well, attempts have been made to reduce the material of the current braces as applied without losing the in-brace correction desired [25]. With this brace reasonable in-brace corrections have been achieved [3] (Figure 1), while long-term effects until the end of growth have not yet been shown. Therefore it seems important to present a case with a significant final correction after a bracing period of three years with this new brace design of small size. With

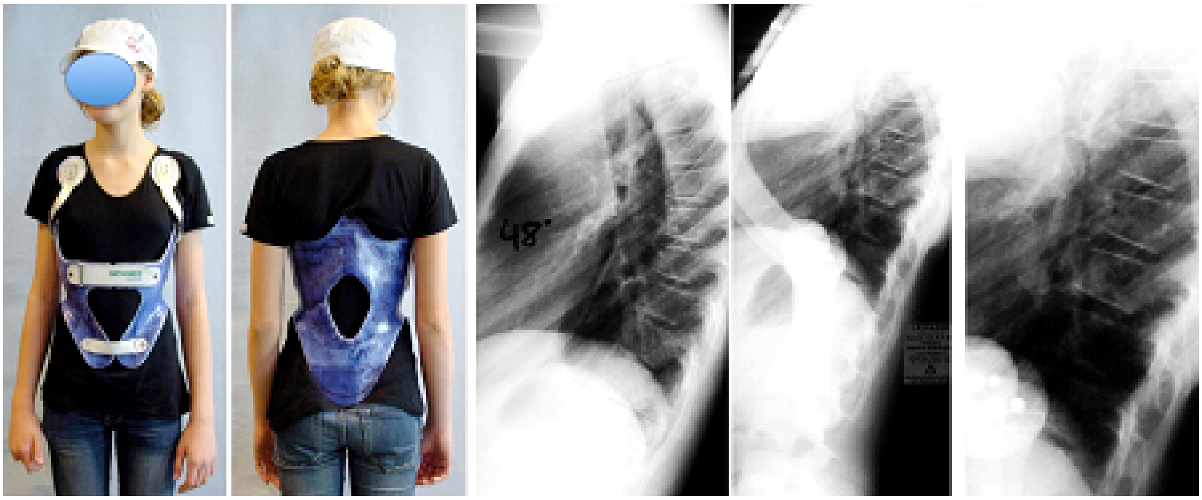

Figure 1: A good in-brace correction in a patient with rigid kyphosis in a kyphosis brace of recent design showing a release of the anterior growth plates. Patient with rigid kyphosis in a kyphosis brace of recent design. The in-brace correction is > 20° and on the right picture the opening of the intervertebral spaces is visible. Therefore we can expect an end result correction when the brace is worn, because the ventral growth plates have been released from pressure (taken from [3] BMC open access).

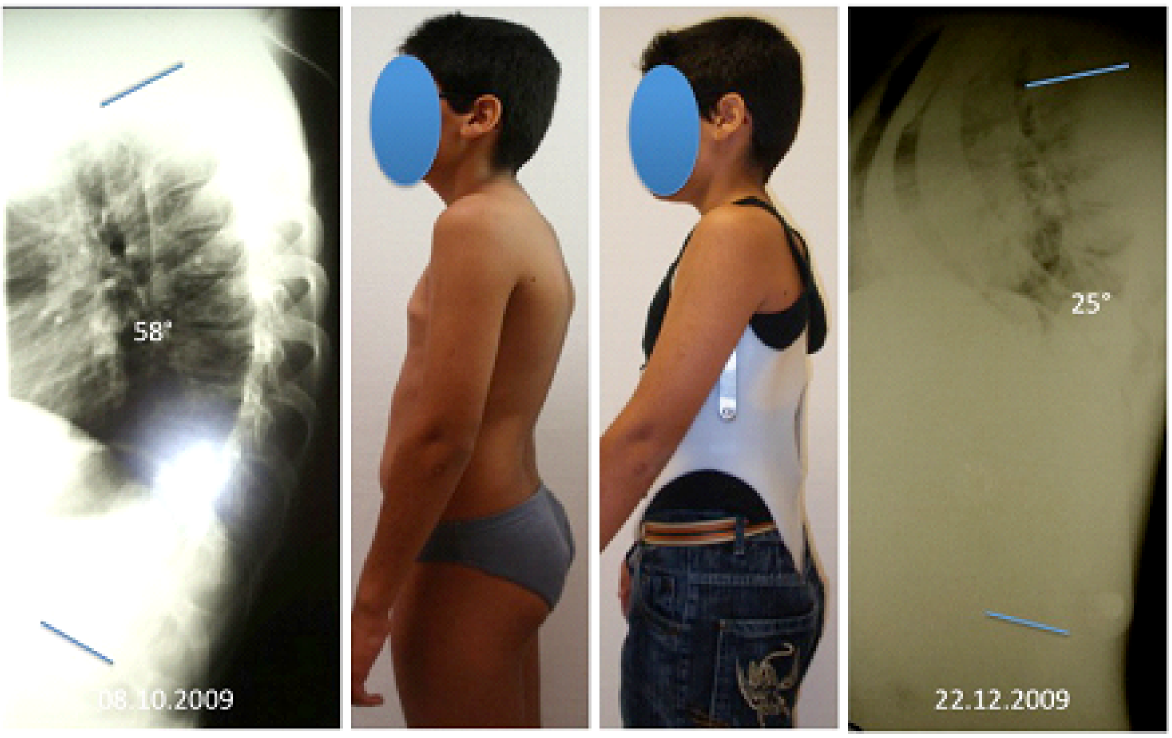

Figure 2: Immature patient with a Scheuermann's kyphosis of 58° Summer 2009. At that time the boy was 12 years old. As there was a clear indication for brace treatment a kyphosis brace was adjusted. In-brace correction in this brace was to 25°. The X-rays taken at that time were not digital and of poor quality. Therefore a reconstruction of the angle is visible within this picture.

this case report it is demonstrated that also with a brace design of smaller size improvements during growth are possible as has been shown in other braces of bigger size previously [16–18].

The desribed CAD/CAM (Computer Aided Design/Computer Aided Manufacturing) brace is made using a trunk scan of the patient and/or taking the measurements of the patient on certain, well defined measurement levels, such

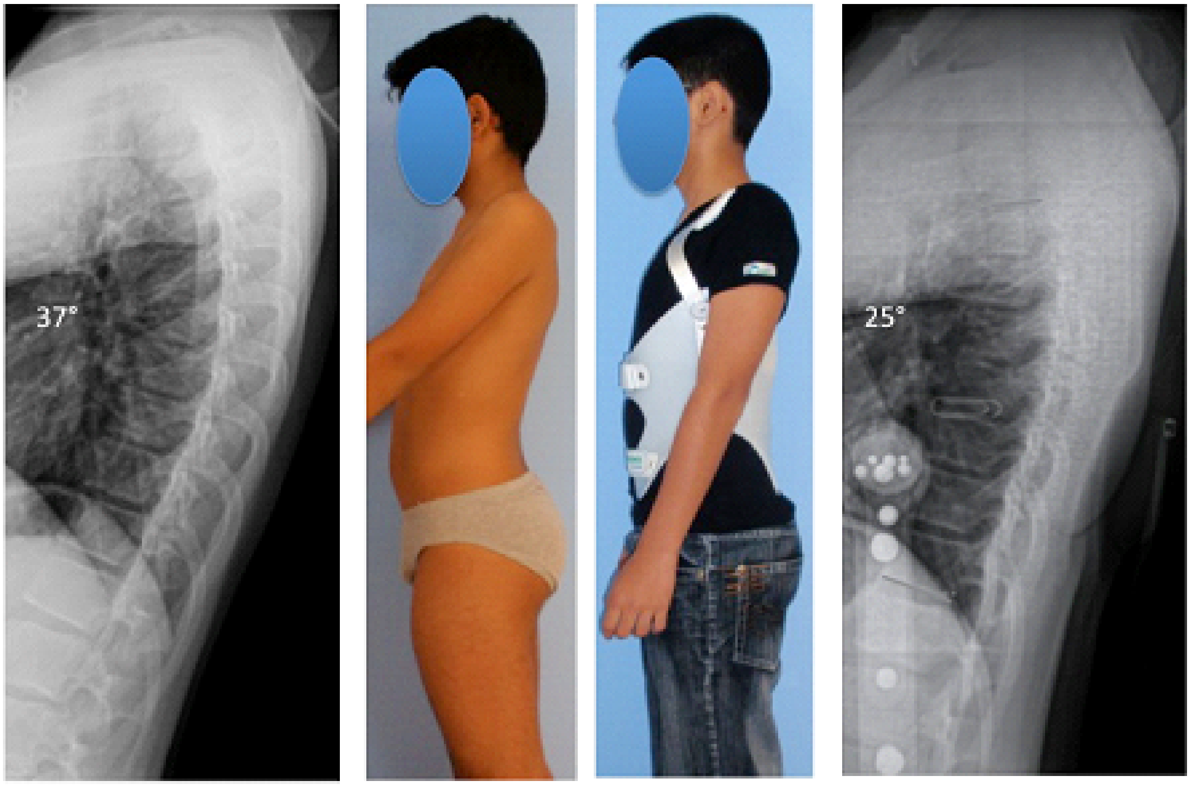

Figure 3: Second brace of the patient from Figure 1. After one year the patient had outgrown his first brace. Intermediate result was 37° without brace. Voice change meanwhile had occurred. A new brace was constructed. In-brace X-ray in this new brace again was to 25°.

as trochanteric level, waist level, xiphoid level and axillar level. The brace then is adjusted taking a new adjustment software (Final Surface® with the ScoliCAD® plug-in called, Brace Adjuster'). This software allows to adjust scoliosis braces as well as kyphosis braces from the brace library onto the patients' trunk virtually. After the brace has been adjusted the STL-file of the brace is generated which can be sent to a carving service via e-mail where PU (Polyurethan) foam blocks can be carved. After that a heated PE (Polyethylene) plate is wrapped around that PU model of the brace and vacuumed to its surface. After the PE material is cooled the brace can be cut off the model and finalized with closures and with smoothed trim lines.

2. Case report

A 12-year-old kyphosis patient presented at the office of the author with a thoracic curve of 58° in Summer 2009. The patient was without pain, normally sportly active but showed significant tightness of the pectoralis musculature and stiffness of the thoracic spine. Extension of the thoracic spine was not possible. Brace treatment with a modern CAD/CAM kyphosis brace was started immediately with an in-brace correction of more than 30 degrees (Figure 1). Brace wearing time was prescribed 16 h/day. After one year of treatment the patient had outgrown his first brace, but was still immature (but voice change had just appeared). Therefore a new brace was constructed. The curvature was 37° without and 25° in the new brace (Figure 1). This brace was worn for another two years for 16 h/day and weaned off in Summer 2012. 6 months later–the patient meanwhile was nearly mature (Risser 4/voice change 2.6 years) the final X-ray without brace showed an angle of 38° (normal range of kyphosis angles) with full flexibility of the spine, fully sportly active and without any pains (Figure 1).

3. Discussion

If we assume that outcome of brace treatment positively correlates with in-brace correction the treatment should start before the curvature angle exceeds 50–55° in patients that are continuing to grow. In scoliosis bracing an average in-brace correction of > 15° predicts an end result correction [24]. At average with this recent brace design we have achieved > 15° also in hyperkyphosis treatment. Therefore we estimate to achieve favourable outcomes using this brace type when compliance can be gained like has demonstrated for the Milwaukee brace earlier on [16–18].

This result has been reached with a brace wearing time of 16 h/day so as it seems a more than 20 h of brace wear, unlike

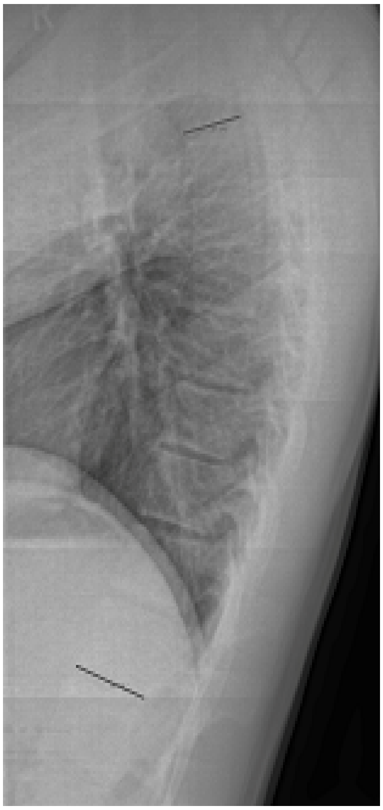

Figure 4: Last X-ray 6 months after weaning off the second brace of the patient from Figure 1. Curvature angle was 38° which is within the physiologic range of curvature angles (20–40°). No further treatment necessary.

in scoliosis treatment, is not necessary for the immature population with kyphosis.

Nevertheless, it should be demonstrated with a cohort followed up prospectively that also with this recent design of smaller size comparable results can be achieved in the long-term as has been shown for the Milwaukee brace [16–18]. No claims can be derived from this case report other than that improvements are possible to achieve with the new design. More studies are needed to support this brace design with more evidence.

4. Conclusion

Bracing with small size orthosis in kyphosis patients during growth can lead to an improvement of the curvature angle after the end of growth. The functional limitations there are in severe kyphosis angles can be improved and normalized in some cases.

5. Acknowledgment

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6. Competing interests

The author is advisor for Koob GmbH & Co KG, Abtweiler, Germany.

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