Clinical case
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A 3D German-designed brace used to treat adolescent idiopathic scoliosis

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Abstract

Introduction Adolescent Idiopathic Scoliosis (AIS) is a condition that affects an otherwise healthy child 10 years of age or older and is the high risk of severe deformity and surgery. Different brace applications include the Milwaukee Brace, Boston Scoliosis Brace, TLSO and others, and the success rates of orthoses vary. With little experience in the use of the Chêneau-type corset, the brace provides an effective means for the active correction of scoliotic spinal deformity.

The objective was to demonstrate an outcome with a 3D functional corrective German-designed corset used to treat a patient with AIS in the period from the onset of the curve to the onset of skeletal maturity.

Material and methods The medical history of patient S. including anamnestic, clinical and radiological findings recorded 2018 and 2023 when she used a 3D German-designed (3D GD) corset. The corset design was defined as 3CL/B2 according to the Lehnert – Schroth scoliotic classification as modified by Rigo.

Results The left-sided thoracolumbar curve of a 9-year-old patient with a Risser sign of 0 and a Cobb angle of 25° at baseline decreased to 12° at the age of 16 years (Risser sign — 5) due to bracing.

Discussion The AIS was diagnosed in the patient at the age of 5 years and bracing was initiated at the age of 9. The curve correction using 3D GD brace was based on the principles offered by Chêneau. The patient used the corset for 20 hours per day. The initial brace correction was 90 %. The curve decreased from Cobb angle 25° to 12° over a six-year period of brace treatment with no need for surgery. Three cases with identical outcomes were reported with the use of the Boston and Chêneau braces in AIS.

Conclusion The clinical case showed effective use of the 3D GD corset as a new exponent of corsets developed on the principles offered by Chêneau to prevent surgical treatment by the time of skeletal maturity.

Keywords: corset, adolescent idiopathic scoliosis, nonsurgical treatment

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ВВЕДЕНИЕ

Idiopathic scoliosis is the most common form of morphological scoliosis that can develop in healthy children during any period of development [1]. Scoliosis at a Cobb angle of 10º or more in a patient aged 10 years or less is termed as “early attack of scoliosis” due to poor prognosis as compared to a curve in adolescents [2]. Observation and bracing are most common nonsurgical treatments for patients with juvenile idiopathic scoliosis (JIS). Corsets are used for children with curves at a Cobb angle of 25 to 60° to stop the progression of the deformity and prevent surgical correction [3–7]. The success of bracing for JIS varies from 12.5 % to 95 % due to different examination methods, brace designs, and duration of follow-up [7–11], indicating a lack of consensus and uniform recommendations for the treatment. Milwaukee Brace, Boston Scoliosis Brace, and thoraco-lumbo-sacral orthosis (TLSO) are most common corsets used for children with JIS [5].

The corsets based on the principles offered by J. Chêneau (Chêneau brace) and made manually or using a computer-aided modeling and manufacturing (CAD/CAM) have been recently used in Central Europe for treatment of patients with adolescent idiopathic scoliosis (AIS) [12, 13]. The basic idea of the braces includes the design of highly specific contact and expansion zones on the positive matrix of the patient's body, producing regional derotation of the vertebrae in the curve with cranial and caudal anti-rotational forces. The augmented Lehnert-Schroth classification [14] and its modification according to Rigo [15] are used for tailored brace designs. Chêneau-type brace used to address AIS can prevent the progression of curves to levels requiring surgical treatment [16, 17]. This type of corset is used in the treatment of patients with AIS in Russia [18] and in the Republic of Belarus [19].

The objective was to demonstrate an outcome with a 3D functional corrective German-designed corset used to treat a patient with AIS in the period from the onset of the curve to the onset of skeletal maturity.

MATERIAL AND METHODS

This is a case report of a 9-year-old patient S. with a verified diagnosis of JIS treated with bracing. Review of the medical history, clinical and radiological findings and instrumentation methods of examination of the patient were performed in accordance with the ethical standards of the 1975 Declaration of Helsinki revised in 2013. The study received a favourable opinion from the relevant institutional ethics committee. Written informed consent for the participation in the research project was obtained from the subject's parent/legally acceptable representative.

The available medical documentation used included the history, dynamics in clinical and radiological parameters of the patient’s body and the spine under pressure of therapy using a 3D German-designed (3D GD) corset between 2018 and 2023. The 3D GD corset used in this case was a functional corrective corset, a Russian derivative of the Chêneau corset. The design of the 3D GD corset was classified as 3CL/B2 according to grading of a curve offered by Lehnert – Schroth / Rigo. The corset was used for 20 hours per day.

A standing posterior-anterior radiograph of the spine was produced using a Millenium teleradiography device prior to the use of a corset, with the corset on and subsequently during treatment (once a year). The Cobb angle was measured in degrees to quantify the magnitude of the curve. With the size and direction of the curve identified magnetic resonance imaging (MRI) of the spine was produced for the patient.

The effectiveness of bracing was assessed according to the SRS criteria [20]. An improvement suggested a decrease in the Cobb angle by more than 5°; stabilization suggested the Cobb angle

ranging between +5° to –5°, a poor outcome resulted in an increase in the Cobb angle by more than 5° or a Cobb angle measuring more than 45° at the time of skeletal maturity with an indication for surgical treatment.

The Risser sign was used to measure skeletal maturity with the degree of ossification of the iliac apophysis evaluated by x-ray on a scale 0–5 [21]. The patient started treatment at Risser = 0 which indicated skeletal immaturity, and completed treatment at Risser = 5, which indicated completed skeletal growth. The patient had to replace the corset during the treatment maintaining its design due to the growth of the spine and body.

Scoliosis was diagnosed in a patient S. born in 2006 at the age of 5 years according to her mother and according to available medical documentation. Her mother reported a radiological curve of about 30° an x-ray with unavailable radiographs.

The patient received treatment under our supervision since November 2016 (at the age of 9 years) at the pediatric surgery clinic of Yaroslavl State Medical University at the Rodnik Zdorovya medical center (Yaroslavl). A physical examination revealed asymmetry of the waist triangles and protrusion of the left scapula, and a radiograph of the spine showed a Cobb angle of 6° for a small right-sided thoracic (Th3–Th10) curve and a Cobb angle of 25° for a left-sided thoracolumbar curve (Th10–L4) (Fig. 1). Risser sign = 0. According to, spinal cord pathology was ruled out with MRI of the spine.

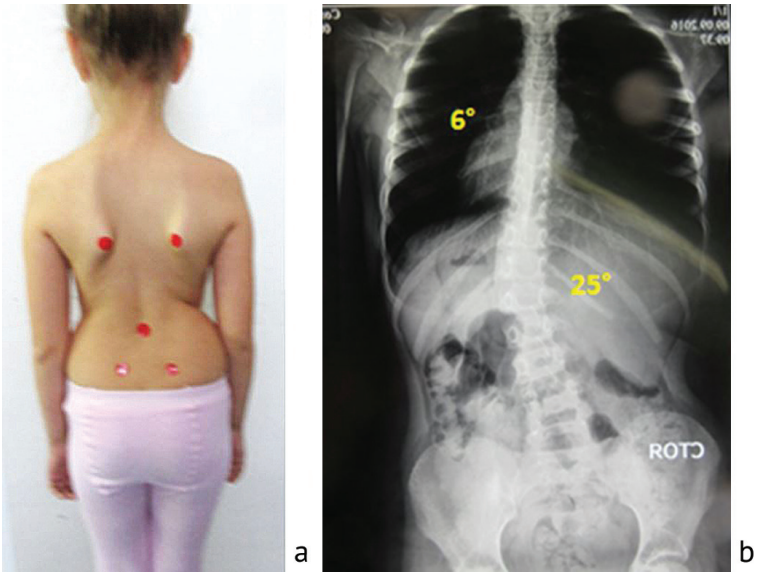

Fig. 1 Appearance (*a*) and AP view (*b*) of patient S. at the age of 9 years (December 2016) showing Risser sign = 0, right thoracic Th3–Th10 (6°) and left thoracolumbar Th10–L4 (25°) curves

RESULTS

The Gensingen brace (corset No. 1) was initially used for the treatment under the supervision of Dr. Weiss. Starting from 2018, the patient was treated with domestically produced alternative (corset No. 2 and No. 3) — the 3D GD functional corrective corset. The technique for a positive 3D NS corset was developed by Mogilyantseva (Fig. 2). A radiograph of the spine with the corset on was produced at a month. The in-brace correction is presented in Figure 3. The patient was requested to use

The patient was examined every 3–4 months during the treatment. The corset effect and the quality were clinically monitored, and belts were replaced and corrective pads placed, if needed. The extent of correction was assessed radiographically (Fig. 4).

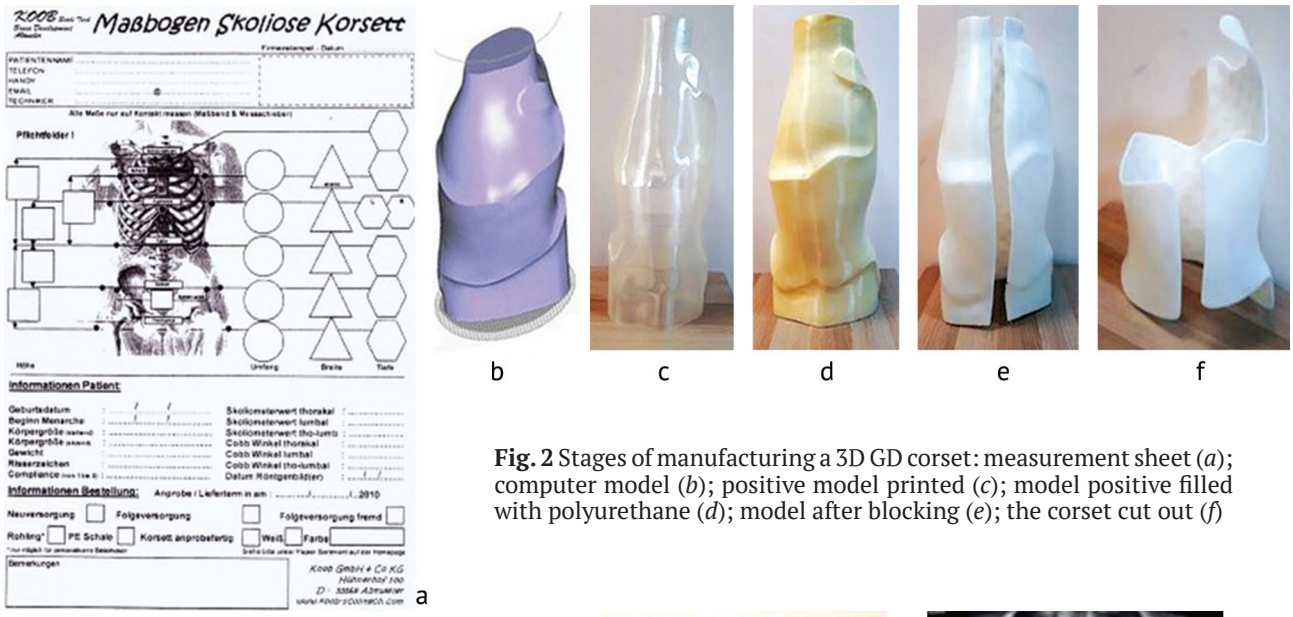

Fig. 2 Stages of manufacturing a 3D GD corset: measurement sheet (*a*); computer model (*b*); positive model printed (*c*); model positive filled with polyurethane (*d*); model after blocking (*e*); the corset cut out (*f*)

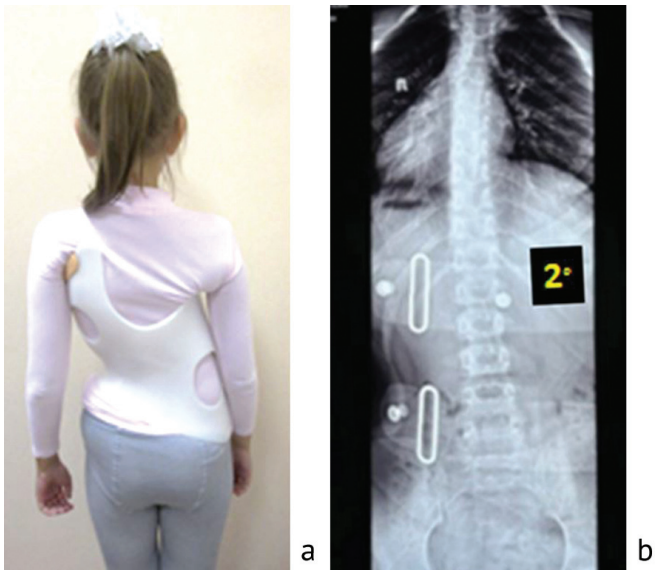

Fig. 3 Appearance (*a*) and radiograph of the spine (*b*) of patient S. wearing corset No. 2 (design 3CL/B2). The in brace correction of the thoracolumbar curve achieved by 90 %

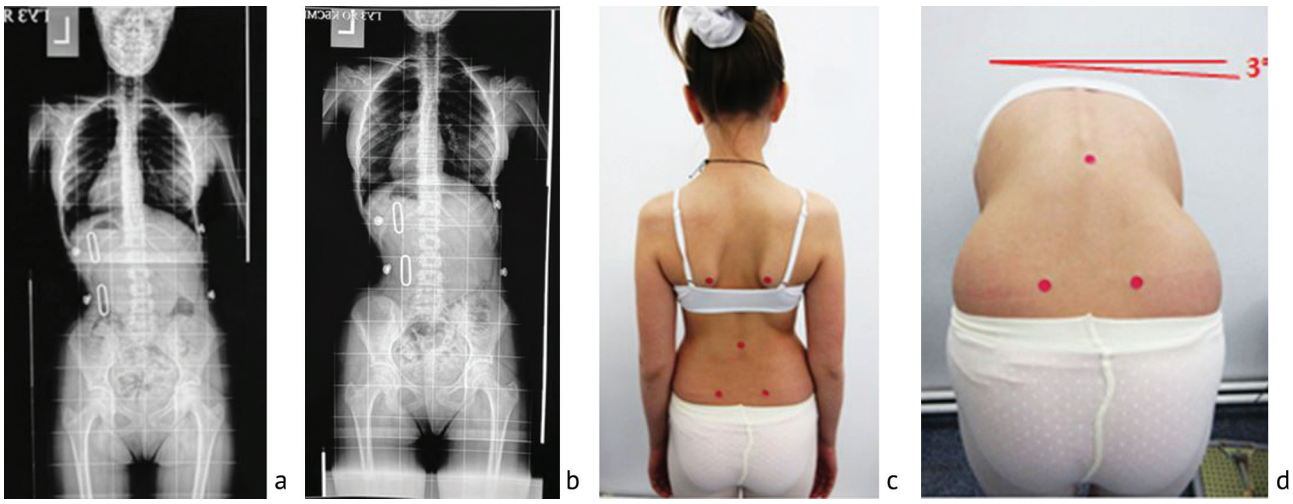

Fig. 4 Radiographs of the spine of patient S. wearing corset No. 2 in September 2018 (a) and March 2019 (b). The correction of both curves maintained. Appearance of patient S. from the back standing position (c) and anatomical landmarks used to measure the parameters of the back surface with the Adam test (d) in March 2019 (at 21/2 year follow-up)

The patient aged 13 years with Risser sign = 2 experienced a sharp “growth spurt” in August 2019 that required a scheduled replacement of the corset (corset No. 3). The curve outside the brace decreased to 3° (Fig. 5) by that time and she completed treatment with the residual Cobb of 12° at the age of 16 in January 2023 (Fig. 6).

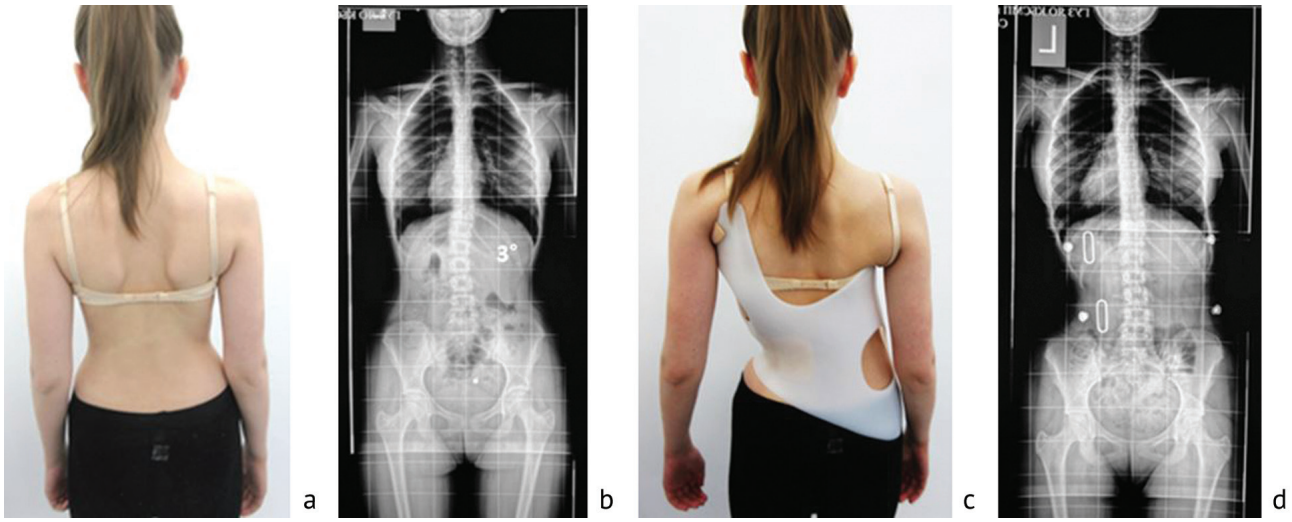

Fig. 5 Appearance (*a*) and radiographs of the spine of patient C. (*b*) without the corset (August 2019, Risser sign = 2). Correction of the thoracolumbar curve maintained (Th10–L4) at 3°. Appearance (*c*) and AP view (*d*) of the spine of patient S. wearing corset No. 3 (December 2020). Correction of both curves maintained

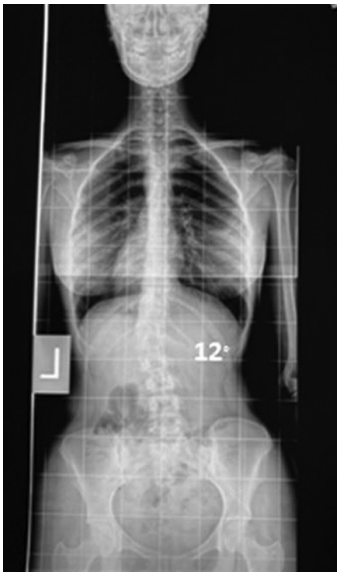

Fig. 6 AP view of the spine of patient S. aged 16 (Risser sign = 5) without a corset. The right-sided thoracic curve Th3–Th10 corrected, the left-sided thoracolumbar curve Th10–L4 measuring less than 12°

DISCUSSION

Patient S. started treatment with the brace at the age of 9 years with the Cobb angle of 25°. These parameters suggested juvenile scoliosis. With the JIS progressing at a rate of 4–7° per year [6], the information from the anamnesis that the onset occurred at the age of 5 years was reliable. We could not established whether that the patient's original curve was 30° because of the lost radiograph.

According to the SRS criteria, the Cobb of 25° in children and adolescents is an indication for bracing [5]. Timely treatment of the patient was essential.

Verification of JIS in a patient with a left-sided curve greater than 20° required MRI of the spine to rule out intraspinal pathology [22]. Hydromyelia was not detected in our patient.

The choice of the brace design was associated with lack of consensus on brace treatment for patients with JIS and the ability to select the most effective brace options. According to authors from Central Europe, the Chêneau brace and the Gensingen brace showed the greatest effectiveness in correcting scoliosis in patients with AIS [17].

The second author of this article received training from Dr. Weiss, who was a student of Chêneau and continued develop the design. Starting from 2018, the patient continued treatment with the 3D GD corset, a domestic analogue of the Gensingen corset. As a sign of gratitude to the developer of the classification of scoliotic arch models and corresponding corset designs, we termed our corset as a 3D German-designed corset." In design and effect on the patient's body and spine complied with the basic principles developed by Chêneau and his follower Weiss [23]. The CAD/CAM technology was used for manufacturing to allow individual use and accurate application of pressure to the appropriate areas of the body as compared to the plaster casts considering the contours of the patient's body. The production of the 3D GD corset was organized by the second author of this article at the Center for German Technologies for the Treatment of Scoliosis (St. Petersburg, Russia).

The 3D GD brace can provide for different designs and constructs to treat patients according to the scoliotic models resulting from radiography. A 3CL/B2 corset design was approved for patient S. according to the augmented classification of scoliosis graded by Lehnert – Schroth [12] and modified by Rigo [13] and the brace did not change during the treatment process.

The best effect was obtained with full-time wearing of the corset (23 hours a day) [13]. A similar mode was recommended for patient S.

The radiograph showed the in brace correction and the potential of the expected therapeutic effect [24]. The in brace correction was 90 % in our patient and was a good prognostic sign for the success of treatment.

There were three case reports describing patients with JIS treated using Boston [6] and Chêneau braces [18, 26]. The authors of these publications reported successful correction of scoliosis in patients by the time of skeletal maturity, eliminating the need for surgical correction. Our clinical case demonstrated the successful outcomes with the 3D GD functional corrective corset used to treat a patient with JIS.

CONCLUSION

The case report showed the high efficiency of the 3D GD corset as a representative of a new generation of braces based on the principles offered by Chêneau, in the treatment of a patient with JIS to allow timely initiation and full duration of treatment, to avoid the need for surgical treatment by the time of skeletal maturity.

Conflict of interest *None of the authors has any potential conflict of interest.*

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