AN UNUSUAL CASE OF SCOLIOTIC CURVE OVERCORRECTION AS THE IMPACT OF GUIDED-GROWTH IMPLANT

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INTRODUCTION

Idiopathic scoliosis with onset in children before 10 years old and defined as early-onset scoliosis (EOS). EOS remains still to be a big burden for healthcare system in general and especially for pediatric spinal surgeons [1]. EOS surgery requires a list of principles to be applied: to stop scoliotic curve progression; to preserve spinal growth and to prevent thoracic insufficiency syndrome[2]. There are 2 groups of constructs in EOS surgery, all of them are growth-friendly. One of them requires several operations to prevent spontaneous spinal fusion and includes VEPTR and growing rods. Another one consist of constructs defined as guided-growth, which do not require additional lengthening procedures and usually preserve spinal growth but not always can be reliable causing sometimes serious complications including spontaneous spinal fusion or implant failure due to their mechanical properties [3]. We are presenting unusual case of changing thoracic scoliotic curve from right-sided to left-sided using operative correction of the curve using guided-growth implant type which leaded to growth modulation on both sides of scoliotic curve. This process took 4 years and then the implant was changed to transpedicular screw fixation according to guidelines for AIS surgery developed in our department [4].

CASE PRESENTATION

12-year-old girl entered the Department of pediatric orthopaedics Filatov Children's City Hospital in 2012 year. She developed scoliotic curve first at 7 years and diagnosis was made on regular yearly examination by pediatric orthopaedician in the children's out-patient hospital (fig. 1). There was a right-sided scoliotic curve with Cobb angle 11°. Scoliotic curve progressed to Cobb angle 21° during 3 years of once-a-half-of-the-year observation and then bracing was started. Unfortunately, young patient didn't attend regular examinations till the age of 12 years old, so scoliotic curve progressed to 60° at 12-year-old follow-up (39° in 2 years) despite bracing. The girl had the history of back pain and complained about unsightly appearance. Prominent rib hump, positive Adams test, asymmetry of shoulders, scapulae and waist triangles were found during examination. There was an S-shaped double scoliotic curve with main structural right-sided curve Th8–L2 and additional non-structural Th1–Th7 curve with the apex at Th4-level, Lenke 1A-N (fig. 1). Th5–Th12 sagittal Cobb angle was 16° with stability index value of 0,87 and Risser 1. We used CT-scan and MRI to exclude any congenital etiology of the scoliotic curve. C5–C7 herniated intervertebral discs and L2–S1 protruded discs were identified with MRI. Moderate vital capacity of the lungs decrement was identified by pulmonary function test.

Special mobilization of the spine program was used firstly to reduce stability index of the structural curve from 0,87 to 0,75, the program included physical therapy, massage, scoliosis specific exercises and distraction of the trunk using special device. Operative strategy for use of dorsal spinal implants developed in our department have been applied to choose an appropriate implant [4]. According to preserved growth potential (Risser 1) guided-growth type of implants have been chosen with up-going laminar hooks freely connecting to two bars and allowing slippage of hooks over that bars («LSZ-10» construct). This slippage provides growth-guiding preserving spinal growth [5]. Standard spinal approach was used with precisely preparation of vertebral laminae. Hooks were placed at Th1–Th2, Th4, Th7–Th9, Th11, L2–L3 levels in a free way and Th7–Th9 levels were fixed in firm way without any movement of hooks over bars of the implant. Derotational maneuver applied, then contraction on convex side and distraction on concave side carried out with special instruments. Hook-bar connections were checked for firmness and wound was closed in layers. Post-operative Cobb angle was 9° with correction rate of 85%, Th5–Th12 kyphosis angle of 21° (+5°). The girl developed 7 cm growth increment both measuring standing height (158 cm) and sitting height (80 cm).

There were 4 follow-ups after operation: first two made twice a year during first year after surgery, then 2-year post op follow-up and finally 4-year post-op follow-up. There was found on final follow-up at the age of 16 years old (4 years after operation, year 2017) that

the main scoliotic curve (Th8–Th12) turn into left-sided 13° curve with summary correction rate value of 122% and additional upper-thoracic curve (Th1–Th6) moderately progressed to Cobb angle 23° (fig. 2). In our opinion an inversion of the curve took place in that case due to a growth-modulation properties of the implant. Height measurement identified standing height increment of 4 cm (162 cm) and sitting height of 2 cm (82 cm). Standard AP spine series identified caudal end of bar decrement of 18 mm (4,5 mm per year) — fig. 3. Thus, not only preservation of spinal growth was found but it's modulation in accordance to Hueter-Volkmann law resulted in left side of curve isolated overgrowth due to different pressure on convex-side and concave-side parts of vertebral growth plates. Second operation for implant changing to transpedicular fixation carried out in 2017 (16 years old) to prevent complications development (bar migration and instability of the implant). Surgical approach similar to previous one was used, the implant was dismantled. Pedicles of Th4–Th6 on left side, Th4 and Th8 on right side; Th11–Th12 on both sides were fixed by polyaxial transpedicular screws using Pediguard device for preparing screw channels and C-arm guidance used for navigation. Screws were then connected to two 5.5 mm titanium rods. Spinal fusion was made using autologous spinal processes. The wound was closed in layers. Post-operative spinal series revealed left sided Th7–L1 curve with Cobb angle 20°, Th2–Th6 curve with Cobb angle 25° (fig. 4). Total correction rate from 2012 till 2017 after second operation identified as 133% with auto-correction due to a growth modulation — 48%, kyphosis Th5–Th12 Cobb angle 28o. SRS-24 used to assess patient's activity, well-being and treatment acceptance. The mean value drew up to 4,67 points and no complains about appearance was brought (fig. 4).

DISCUSSION

Idiopathic scoliosis with onset in children before the age of 10 years old defined as early-onset scoliosis [1]. Our patient developed scoliosis at the age of 7 years and had progression of the scoliotic curve during growth spurt from 10 till 12 years old. Despite fact that we decided to choose operative treatment at the age of 12, we carried that case to an early-onset scoliosis. The girl had Risser test 1 and still no menses so she was at risk for scoliotic curve progression. One of the challenging aspects of EOS surgery is to prevent crankshaft phenomenon formation which can lead to scoliotic curve relapse [6]. There are 3 main groups of growth-friendly implants nowadays: compression-based, distraction-based and guided-growth implants [7]. In its turn there are 3 types of guided-growth implants, which don't require several operations for implant elongation: Shilla, modern Luque-trolley [3] and implant with raising popularity — MAGEC [10]. The issue is that many modern guided-growth implants can cause serious complications. For example, Shilla implant can cause up to 73% adverse events [11], MAGEC — 44,5% complications including 33% unplanned revisions [12]. Relatively high complication rates and implant's elements' metallosis prompted NHS of the Great Britain to release warning article for orthopaedic surgeons to choose implant carefully [13]. We have chosen dorsal hook-type implant «LSZ-10» with free-type of hook-bar connection allowing spine to continue growing while fixing scoliotic curve dorsally. Hooks are sliding up and down relatively to bars preventing growth stopping and spontaneous dorsal fusion [5]. Complications rate after using this type of implant wasn't higher than 26% according to our previous study and almost all of them developed at the age of 13 years old and higher [4]. In the original study it was identified that the implant has positive influence not only on curve correction but also on wedge-shaped vertebrae making them turning into normal shape due to a growth modulation and sometimes curve overcorrection5, we collected the same data in our latest study [4]. This overcorrection phenomenon tightly related with Hueter-Volkmann growth modulation law [14] involved into the mechanism of curve progression. This case could be useful for pediatric orthopaedic surgeons and especially for that who practicing EOS surgery. In our opinion both mobilization program before surgery and initial high correction rate with contraction and distraction applied to corresponding sides of the curve could contribute to this unusual overcorrection phenomenon with self-correction of 48% after 1st implant placing. There are some cases of overcorrection which happened to 2 patients of 35 when stapling was used as a compression-based implant [15]. There is a consensus for use of transpedicular screw fixation devices for AIS surgery nowadays due to a relatively higher safety, lower complications rate and higher correction rate [16]. Especially relatively low complications rate was found to be at the age of 13–15 years old [4], so transpedicular screw fixation device was used in our department with spinal fusion for eventual curve correction retention.

CONCLUSIONS

It's recommended to use guided-growth dorsal spinal implants for effective correction of scoliotic curve in children with EOS and AIS with preserved growth potential, but there is a need for taking into account some possible predictive factors which may affect on curve overcorrection development. It's recommended to timely implant changing to transpedicular screw fixation device to prevent complications development rather then scoliotic curve relapse obtaining reliable bony block after spine stabilization and spinal fusion.

Fig.1. *Appearance and Cobb angle before operation*

Fig. 2. *AP X-Ray before second operation*

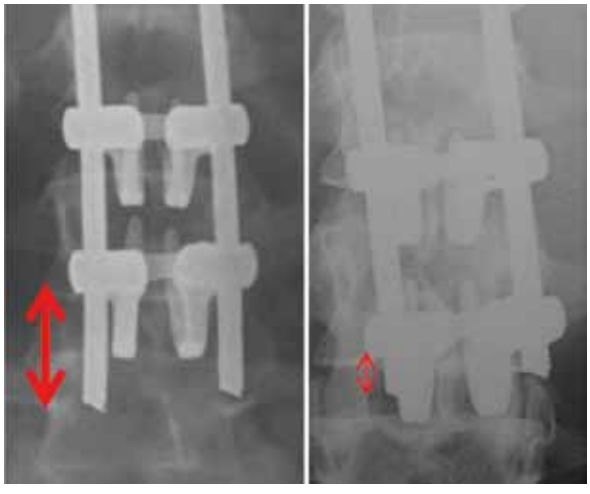

Fig. 3. *AP X-ray after operation (left) and before second operation (right) (4 years difference)*

Fig. 4. *Appearance and X-Ray 6 months after 2nd operation*

It's necessary to provide yearly post-operative follow-ups for timely assessment of curve pattern changes on spine X-Ray series to prevent possible overcorrection phenomenon. It's recommended to precisely dose contraction and distraction forces while correcting a curve intraoperatively.

PATIENT'S PERSPECTIVE

At the moment of the latest follow-up (6 months after second operation) the girl has normal life with full school activities and even sports (except collision sports) according to the guidelines of scoliosis treatment work group [17]. There isn't any curve progression and curve pattern changes after transpedicular fixation apllied with spinal fusion. This patient is going to be regularly assessed on follow-ups once-a-year for 3 years and every 2 years further because of possible deferred adverse events like late implant-related infection [18].

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