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TWO-STAGE OPERATIVE MANAGEMENT OF EARLY ONSET SCOLIOSIS

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INTRODUCTION

Early-onset scoliosis (EOS) remains challenging for spinal surgeons all over the world. The cornerstone of EOS treatment is a decision making. Deformity correction with dorsal instrumentation using transpedicular screw fixation (TSF) implant is a golden standard of adolescent idiopathic scoliosis treatment providing excellent results with relatively low complication rates[9]. Comparing with AIS, in EOS surgeon has to deal with growing spine, posing a child at risk of developing crankshaft phenomenon, correction loss and need for revision surgery in case of choosing TSF. However, the question about which spinal implant is the best for growing spine still remains controversial. Nowadays there are a plenty of growth friendly constructs but data referred to complications, reoperation rate and a risk of correction loss differs from study to study[6, 8, 10, 11].

The main issue is whether to perform an early operation using growth friendly implant or wait unless growth spurt finishing and perform TSF construct implantation. It's well-known that bracing alone can't be an effective way to prevent scoliosis progression to surgery[3]. Otherwise, traditional growing rods (TGR) being the most popular implant for EOS surgery, can lead to a different complications rate mainly associated with open implant distractions. Unlike TGR new implants such as MAGEC and Shilla don't require additional operation for distraction procedures, although there isn't any reliable evidence for one of these implants being superior to another[10].

Despite all mentioned issues there is an option for EOS management utilizing 2 stages of surgical treatment. First one is early deformity correction followed by implantation of growth-friendly non-distractable device with further reoperation changing growth-friendly implant to TSF construct ("implant conversion"). We present here a case for this tactical decision.

CASE PRESENTATION

10-year-old child have been referred to Filatov Children's City Hospital for operative treatment of EOS. He had his pectus excavatum been corrected earlier at the age of 4. The child has genetically proven Marfan syndrome. He received full list of conservative treatment regimens including bracing (TLSO), physical therapy and underwent treatment in our special scoliosis rehabilitation facility. Spinal deformity was presented as S-shaped scoliosis curve consisted of 2 curves. Curve magnitudes were 81o for thoracic and 80o for lumbar respectively. Side-bending X-rays revealed both thoracic and lumbar curves were structural. Curve type was defined as Lenke 3CN, King type 1 (fig. 1). Th4-Th12 kyphosis was 19o and Risser test 0. For the first operation growth-friendly hook-type non-distractableLSZ-3 implant was used which application is approved by the ministry of health of Russian Federation.The mechanism of distraction is presented with hooks at distal 2 levels of fixation freely attached to plate-like rods. This type of construct allows plate-type rods moving freely through distal hooks allowing the spine to grow caudally. Three-dimensional stability in this case is provided by rectangular plate-like shape of rods allowing them to move only axially at the distal level of fixation. We got excellent correction rate both for thoracic curve (84%) and for lumbar curve (82,5%) (fig. 2). Child's standing and sitting height increased to 147 cm and 73,5 cm with 6 cm increment. First 3 postoperative years underwent without any complications with stable curves but the X-Ray made on 4th postoperative year revealed increased curve magnitude for both curves. This trend remained unchanged till his child's next referral to our department (fig. 3).

Further history of curve magnitude shift presented in the Table 1.

The second operation was performed at the age of 16. After performing posterior longitudinal incision and achieving approach to pedicles we noticed unequally distributed bone formation on both side of vertebrae in lumbar region as well as completely bone cover in thoracic region (fig. 4). It was defined as a

Table 1. *Curve magnitude (Cobb angle) and correction rate (in brackets) for two curves (thoracic and lumbar) changing from pre-operative X-rays, during postoperative period, right after implant changing (conversion*) and 6-years post second surgery**.*

	Pre-op	Post-op	1 year	2 years	3 years	4 years	5 years	6 years	Conv*	6 mon**
Thoracic	80°	13° (84%)	14° (82,5%)	14° (84%)	14° (84%)	22° (72,5%)	22° (72,5%)	22° (72,5%)	19° (76%)	19° (76%)
Lumbar	81°	14° (82,5%)	12° (85%)	12° (85%)	12° (85%)	28° (65%)	29° (64%)	29° (64%)	23° (72%)	23° (72%)

Fig. 1

Fig. 2

Fig. 3

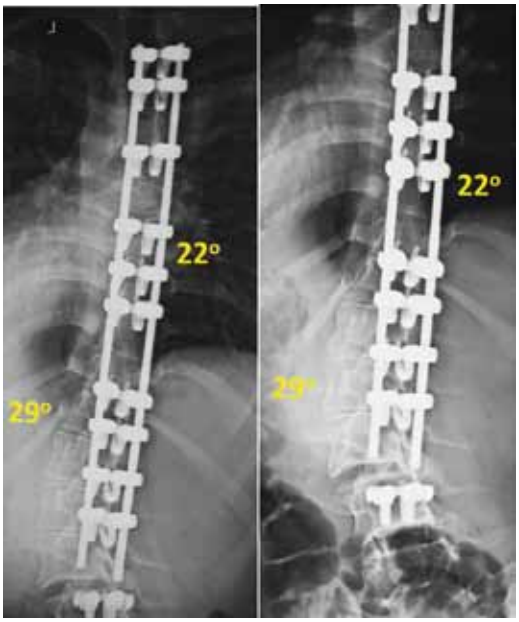

Fig. 4

partial spontaneous fusion. Standard TSF was applied using free-hand technique for screw placement and X-Ray for screw position confirmation. Immediate postoperative correction rate was 76% for thoracic and 71% for lumbar curve respectively which hasn't been changed till 6 months postop (fig. 5). SRS-24 used as patient-reported outcome measurement tool with overall median value of 4,23 representing overall excellent result especially addressing to appearance (fig. 6).

We conducted fully morphometric assessment of the spine using special parameters showed in fig. 7. The assessment of these parameters revealed general wedging index increase due to a disc-vertebral index on concave side decrease (fig. 8). This phenomenon occured during period of child's growth spurt starting at the age of 13 years and stabilizing at approximately 14 years. Patient's standing height increased to 178 cm (+31 cm), while sitting height increased to 83,5 cm (+10 cm). Both curves were involved in this process similarly.

DISCUSSION

Detailed morphometric analysis supported out theory about the cause of curve magnitude rising. According to previous studies male adolescents usually have their growth spurt during a period from the age of 13 till 15 years old [2]. We made a suggestion that this patient developed partial spontaneous fusionbefore growth spurt appeared. That could result in unequal growth distribution between 2 parts of vertebral end plates and served as trigger to activation of Heuter-Volkmann's law, which could lead to further curve progression. Another factor contributed to curve progression was so called crankshaft phenomenon which can develop in skeletally immature children after spinal fusion as a result of continued spinal growth with increased axial rotation of fixed spine[5].

Despite the evidence stating that TSF implants have higher correction rates and lower complication rates compared with hook-type constructs[4], our case is an example of an excellent correction rate of 82,5% and 84% for thoracic and lumbar curves respectively. As LSZ-3 implant is similar to Luque-trolley construct, it's well known that there are potential limitations for gaining spinal growth after surgery mainly caused by limited length of rods' free distal parts [7].

Despite loss of correction in some degree we achieved overall correction rate after conversion surgery 76% for thoracic and 71% for lumbar curve respectively with 2 surgeries, while traditional growing rods surgery requires usually up to 6 repetitive operations to perform lengthening which poses a child at risk of developing various complications [1]. We didn't observe any medical or implant-associated complications during 6 years before conversion surgery.

Fig. 5

Fig. 6

MAGEC implant was developed with the aim for achieving lower risk of reoperations and opportunity of distant lengthening at outpatient hospital, but there are still plenty of studies reporting relatively high rates of either implant-related and medical complications

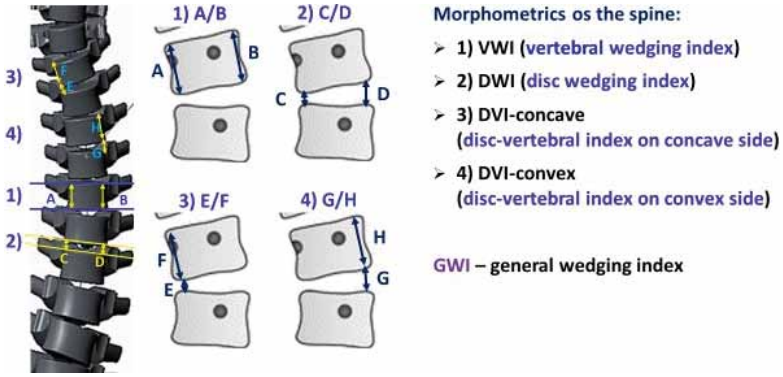

Fig. 7

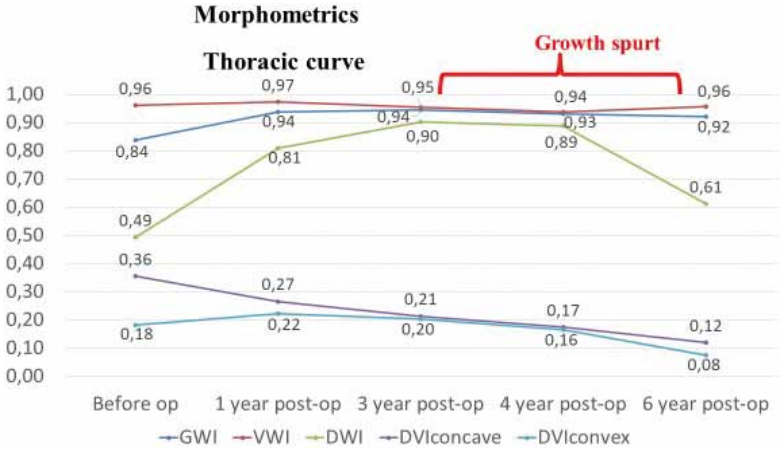

Fig. 8

[8].One of the key points of our clinical case is getting high increments of standing and sitting growth with values of 34 cm and 10 cm respectively.

CONCLUSIONS

Early EOS treatment allows to avoid many of complications and reoperations. Growth-friendly LSZ-3 implant can provide primary stabilization and maintain correction till growth spurt appear. Further TSF implant implementation can reliably stabilize the spine. However, it's still not defined which period of time is best fit for conversion surgery considering a risk that crankshaft phenomenon may occur. Further studies are necessary to define the best option for EOS correction.

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