ANTERIOR INSTRUMENTATION IN SURGERY FOR LUMBAR AND THORACOLUMBAR IDIOPATHIC SCOLIOSIS

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Objective. To analyze the long-term results of surgical correction of idiopathic scoliosis in the lumbar and thoracolumbar spine with anterior instrumentation.
Material and Methods. A total of 24 patients (mean age – 18.2 years, male/female ratio – 3/21) were operated on using anterior two-rod instrumentation system. The mean operating time was 170 minutes, and the mean blood loss – 374 ml. The average postoperative follow-up period was 50 months.
Results. The primary curve was reduced from 48.7° to 14.8° (69.6 %). Postoperative progression was 6.4°. Thoracic counter-curve underwent self-correction from 27.7° to 14.7°, postoperative progression was 3.0°. The thoracic kyphosis and lumbar lordosis remained within the normal ranges. Rotation of the apical vertebra before the operation was 27.8 %, immediately after the intervention – 17.5 %, at the end of the follow-up period – 17.1 %. Coronal imbalance before surgery was 24.7 mm, immediately after the intervention – 27.5 mm, at the end of the follow-up period – 7.1 mm. The patients' self-evaluation of treatment outcomes was carried out using the Russian version of the SRS-24 questionnaire. At the first follow-up visit, patients reported expectedly lower postoperative function score and gave middle scores for the remaining domains. Later, there was a positive dynamics in all assessed parameters, most pronounced in pain syndrome, function and overall activity after surgery.
Conclusion. Correction of idiopathic scoliosis of lumbar and thoracolumbar localization using anterior instrumentation is a highly effective method of treatment, which in most cases gives a stable positive result. However, the development of pronounced trunk imbalance in some patients requires the continuation of studies in order to optimize the technique for determining the optimal extent of the instrumented fusion.
Key Words: idiopathic scoliosis, scoliosis correction.

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The concept of anterior instrumentation for the correction of scoliotic deformities was first introduced by an Australian orthopaedic surgeon Dwyer [9]. This author proposed the system as a flexible cable that is clamped onto screws implanted in vertebral bodies; cable was tensioned using a special device to achieve vertebral body derotation and deformity correction. Corrective manipulations were performed after the excision of intervertebral discs and the operation was completed by interbody fusion. In 1974, a German surgeon Zielke [31] modified the Dwyer's method by substituting a cable with a semi-rigid threaded rod. Both instrumentations proved to be good, but many researchers noted an adverse effect manifested as kyphosis formation or progression over the instrumental fusion area [13, 18]. The next generation of anterior instrumentation differed by the appearance of rigid single and dual-rod systems providing high strength, greater stability, and elimination of kyphogenic effect. The Japanese Kaneda instrumentation was one of the first such systems [13]. Currently, anterior corrective instrumentation has become popular worldwide [4, 5, 7–9, 11, 15, 20, 25, 27], although many surgeons prefer posterior multisegmental pedicle screw instrumentation [7, 14, 16]. The main benefits of anterior systems include direct vertebral body derotation, short fusion, less intraoperative blood loss, more acceptable cosmetic effect in terms of postoperative scarring.

The long-term outcomes of studies published in XXI century demonstrate the high efficacy of anterior instrumentation in correction of scoliotic deformities in the lumbar and thoracolumbar spine. Publications in the Russian literature mostly describe the short-term surgical outcomes [1, 2, 4, 5]. In addition, none of the studies we encountered include 3D-reconstruction of the pre- and postoperative posterior trunk surface.

The aim of this paper is to analyze the long-term outcomes of surgical correction of idiopathic scoliosis in the lumbar and thoracolumbar spine using anterior instrumentation.

Material and Methods

A total of 31 patients were operated on using an anterior dual-rod instrumentation system at the Clinic of Children and Adolescent Spine Surgery, Novosibirsk Research Institute of Traumatology and Orthopaedics n.a. Ya.L. Tsivyan in 2005–2009. Seven of these patients did not meet the inclusion criteria (three had congenital scoliosis and the postoperative follow-up was less than two years in four patients). The mean age of 24 patients was 18.2 (12–38) years; the male/female ratio was 3/21. Adolescent idiopathic scoliosis – 20 cases, adult scoliosis – 4. The location of the primary scoliotic curve: lumbar scoliosis – in 8 and thoracolumbar scoliosis – in 16. Right-convex primary curve was present in ten patients and left-convex primary curve – in 14. Counter curve was revealed in 16 cases (thoracic spine – 15, upper thoracic spine – 1). The initial neurologic symptoms (the pyramidal insufficiency syndrome) were revealed in one patient, vegetovascular dystonia was diagnosed in one case, and the rest patients were neurologically intact. Comorbid pathology was revealed in 12 patients: isthmic spondylolisthesis with about 28 % slippage of the lower lumbar (L5 or L6) vertebra (n = 2), chronic gastroduodenitis (n = 3), chronic pyelonephritis (n = 2), severe myopia (n = 1), hyperplasia of the thyroid gland (n = 1), L1 vertebral hemangioma (n = 1), degenerative disc disease (n = 2), and hypergonadotropic hypogonadism (n = 1).

Radiography examination included standing survey radiography of the thoracic and lumbar spine in frontal and lateral views. Anteroposterior radiograms at lateral flexion to the convexity of the primary and secondary curves with the patient lying, MRI scans of spinal canal contents were recorded. Cobb angle magnitudes for scoliotic curve, thoracic kyphosis (T5–T12), lumbar lordosis (L1–S1), apical vertebral rotation using the Nash–Moe technique [20] as well as Cobb angles for scoliotic curve and lordosis over the instrumental fusion area during the entire follow-up were assessed.

Patients in the short-term and long-term postoperative periods filled the Russian [3] version of the SRS-24 questionnaire [29]. In addition, all patients were examined by computed optical topography (COMOT) before surgery, immediately after surgery, and in the long-term postoperative period [6].

The mean length of postoperative follow-up of 24 patients was 50 (24–107) months; the mean hospital stay – 13.7 (8–25) days.

Surgical technique. A patient was in lateral recumbent position with the concave curve side down. The pelvis was immobilized with two holders to apply pressure on the pubic symphysis and sacrum. The operating table is bent upward in order to push the spinal manipulation area closer to the surgeon. A common approach in deformities of the lumbar/thoracolumbar localization is through the IX or X rib bed. The rib is identified and resected subperiosteally within the wound. The parietal pleura is dissected. The compressed lung is pushed back to the root of the lung. The diaphragm is excised starting from 10–15 mm of its attachments at the ribs. Prior to diaphragm excision, the retroperitoneal space is exposed in site of costochondral joint separation and the peritoneal sac with the contents is carefully displaced exposing the lower surface of the diaphragm. The peritoneal sac is also carefully pulled from m. quadratus lumborum and m. iliopsoas. Only after the peritoneal sac has been visualized and mobilized, the diaphragm can be resected and m. obliquus abdominis internus and m. transversus abdominis can be dissected.

Segmental vessels are identified, separated and cut over the planned fusion area. The spine is available for manipulation from the T6 level and distally as long as necessary. Large vessels and the peritoneal sac are displaced and protected with the elevators. Intervertebral discs with endplates are removed up to the posterior wall of the annulus fibrosus. Two screws are inserted in each vertebral body in the frontal plane using special blocks with grooves for rod placement. The rods of a required length are precontoured following the normal sagittal alignment of the spine under manipulation. The first rod (posterior) is placed in the grooves and is fixated temporary using special clamps. The rod is rotated to achieve the maximum possible correction of spinal deformity. The second rod is implanted and the achieved correction is fixated with clamps. Chips of autologous bone derived from resected rib are placed in the intervertebral space. The wound is sutured in layers with gradual restoration of all anatomical structures.

The length of the instrumental area varied from two to five spinal motion segments (from three to six vertebrae) averaging four segments. The upper border of the instrumentation area was located at the T10–L1 level, the lower one – L2–L5. The mean operative time was 170 (115–340) min, the mean blood loss – 374 (200–700) ml. All operations were performed by the senior author.

Results

Primary curve. The average initial curve magnitude was 48.7° (33–70°) and it decreased to 19.3° (-2–47°) at flexion to the convex side, i.e., the preoperative mobility of the deformed spine – 29.4° (60.4 %). The postoperative magnitude of the primary curve reduced to 14.8° (6–27°); correction – 33.9° (69.6 %). At the last postoperative follow-up, the Cobb angle of the primary curve – 21.2°, the final correction – 27.5° (56.5 %). Postoperative progression of the primary curve – 6.4° (18.9 % of achieved correction).

Counter curve. The mean initial curve magnitude was 27.7° (18–36°), it decreased to 9.5° (1–22°) at flexion to the convex side, i.e., the preoperative mobility of the deformed spine was 18.2° (65.7 %). The postoperative magnitude of counter curve reduced to 14.7° (5–24°), correction – 13.0° (46.9 %). At the last postoperative follow-up, the Cobb angle of counter curve – 17.7° (9–30°), the final correction – 10.0° (36.1 %). Hence, postoperative progression of counter curve – 3.0° (23.1 % of the achieved correction).

Thoracic kyphosis. The preoperative magnitude of thoracic kyphosis (T5–T12) was 30.3° (10–59°), it was 29.6° (3–58°) immediately after surgery, and 31.4° (14–59°) – at the last follow-up. The magnitude of thoracic kyphosis changed by 1.1° (3.6 %).

Lumbar lordosis. The preoperative deformity of the lumbar spine in the sagittal plane (L1–S1) was 60.0° (39–90°), it was 52.0° (34–88°) immediately after corrective intervention, and 53.5° (29–72°) – at the last follow-up. The magnitude of the lumbar lordosis changed by 6.5° (10.8 %).

Apical vertebral rotation. The preoperative rotation of apical vertebra was 27.8 % (12–50 %), it was 17.5 % (7–46 %) immediately after the operation, and 17.1 % (4–26 %) – at the last follow-up.

Scoliotic curve magnitude *over the instrumental fusion area* reduced postoperatively from 49° (33–70°) to 15° (0–48°) and it was 21° (3–36°) at the last follow-up.

Lordosis at the instrumental fusion area was 57.6° (44–85°) at baseline, 48.9° (34–69°) –immediately after surgery, and 52.4° (44–64°) – at the last follow-up.

Coronal imbalance. The preoperative distance of the T1 vertebral body centroid from the median sacral line was 24.7 (12–58) mm, it was 27.5 (12–67) mm immediately after surgery, and 7.1 (10–18) mm – at the last follow-up.

Anthropometric indicators. The average height of patients in the standing position before surgery – 163.0 (139–183) cm, immediately after surgery – 165.2 (153–183) cm, and at the last follow-up – 166.7 (155–183) cm. The mean weight – 50.5 (34–66) kg, 50.3 (33–66) kg, and 55.7 (44–69) kg, respectively.

Self-perceived treatment outcomes were assessed using the Russian version of the SRS-24 questionnaire to identify the indicators with the highest influence on the patient satisfaction with surgical outcomes. The questionnaire includes 24 items combined into seven groups (domains): back pain, general self-image, self-image after surgery, motor function after surgery, general function, professional activity, satisfaction with surgery. Each item is evaluated on a 5-point scale (where 1 is the lowest score and 5 is the highest score). The complex of postoperative follow-up to assess outcomes in dynamics consisted in questionnaire filling at each follow-up (Table 1).

According to the level of postoperative activity and the risk of complications, the first follow-up visit is scheduled after 6 months postoperatively, the second one is planned after 2 years (this period is associated with an increase in physical activity, but the risk of progression is still present), and the third follow-up visit is arranged in the long-term postoperative period (more than two years after surgery). At the first follow-up, patients reported expectedly lower postoperative function score and gave middle scores for the remaining domains. Later, there was a positive dynamics in all assessed parameters, most significant in pain syndrome, function, and overall activity after surgery.

COMOT. Data of 19 patients were analyzed (F/M = 16/3, the mean age was 17.3 (12–34) years, left-convex curve – 11°, right-convex curve – 8°. The preoperative Cobb angle was 46.6° (33–70°), it was 13.4° (7–23°) immediately after surgery, and 21.5° (7–42°) – in the long-term period. The patients were screened using the COMOT method [6] with a surface topography system to measure spinal deformity in the orthostatic position. This technique is a framework for 3D-reconstruction of the trunk from strips projection to assess balance as well as the postural disorders in frontal, sagittal, and horizontal planes.

Table 2 presents major topography indicators that describe postural status. Frontal plane indicators: FH, FP, and FT are the shoulder girdle tilt, pelvic obliquity, and trunk shift estimates. Horizontal plane indicators: GH – the shoulder girdle rotation angle, GP – the pelvis rotation, GT – twist angle of the shoulder girdle relative to the pelvis. Sagittal plane: SK, SN, ST, and SA1 – tilt of the thoracic kyphosis apex, C7 point tilt (the spinous process apex), trunk shift, and sacral slope. HIL and HIK – the curve height of lumbar lordosis and thoracic kyphosis. LNG – trunk length from the apex of the intergluteal cleft to the C7 point. RWL – trunk width to length ratio. The FT, GT and ST estimates assess trunk balance in three planes. PTI – the integral index for general postural status calculated for each plane: PTI_F (frontal), PTI_S (sagittal), and PTI_G (horizontal) integral indices; the overall integral PTI estimate for postural deviation from harmonic posture: 0–0.66 – normal posture; 0.66–1.0 – subnormal, 1.0–2.0 – postural disorder, more than 2.0 – spinal deformities.

The signs "+" and "-" in the first 10 indicators set the direction of scoliotic curve convexity: "-" for left-sided and "+" for right-sided curve. Because the side of the primary curve influences the parameters of trunk position in frontal and horizontal planes, statistics for FH, FP, FT, GH, GP, GT in patients with right-sided curve was estimated with "-" for right-sided curve.

As seen from Table 2, shoulder girdle tilt (FH), pelvis obliquity (FP) and trunk shift (FT) to the convexity of primary curve characterize frontal plane. Shoulder girdle rotation (GH) and trunk twist (GT) counterclockwise were observed in horizontal plane. After the surgery in the short-term and long-term periods, the FH, FP and FT estimates decreased indicating an improved trunk balance in frontal plane. In horizontal plane, trunk twist (GT) changes the sign, which may indicate a certain hyper-correction in this plane. The maximum rotation was 5.4°. This group of patients was characterized by slight trunk inclination forward (SK, SN, and ST) and flattening of the physiological curves to subnormal level (HIL = 17.4 mm at norm of 20 mm and HIK = 21.1 mm at the norm of 25 mm) in sagittal plane preoperatively. Lordosis and kyphosis flattened by 22 % of the initial magnitude postoperatively. In the long-term period, kyphosis almost restored and lordosis increased slightly, but remained by 12.5 % less than that of preoperative magnitude due to that sacral slope (SA1) reduced from 19.7° to 17.5° immediately after the operation and remained in the long-term period.

The outcomes of operative correction of scoliosis are estimated using the

Table 1

Quality of life estimates in patients using the SRS-24 questionnaire, scores

Domain	Up to 6 months postoperatively	Up to 24 months postoperatively	More than 24 months postoperatively
Pain	3.43 ± 0.57	4.27 ± 0.55	4.82 ± 0.36
General self-image	3.67 ± 0.24	4.43 ± 0.42	4.67 ± 0.67
Self-image after surgery	4.20 ± 0.65	4.29 ± 0.52	4.72 ± 0.50
Function after surgery	1.20 ± 0.45	1.71 ± 0.76	4.25 ± 0.96
General function	3.13 ± 0.56	3.24 ± 0.32	4.42 ± 0.42
Professional activity	3.47 ± 1.24	3.95 ± 0.71	4.92 ± 0.27
Satisfaction with surgery	3.80 ± 0.45	4.48 ± 0.33	4.92 ± 0.17

COMOT method with the overall integral index PTI and indices for each plane separately: PTI_F, PTI_G, and PTI_S. The mean correction by PTI was 25 % immediately after the surgery, it was 31 % in the long-term period; PTI_F estimates were found to be -43.9 and -46.9 %, respectively; PTI_G were -37.7 and -37.7 %; PTI_S were +40.7 and +16.9%, respectively. Thus, posture dramatically improved in frontal and horizontal planes while there was postural deterioration, most noticeable immediately after surgery, in sagittal plane (flattening of the physiological curvatures and trunk inclination forward); however, the condition markedly improved in the long-term period in this plane. The mean correction by PTI was -31 % in the long-term period.

Clinical cases of the conducted operations are shown in Figs. 1, 2.

Complications. A total of 14 (58.3 %) complications were revealed in 24 patients. Intraoperative complications included 5 – injury to the peritoneal sac over 2–5 cm(lock-stitch suture). No adverse effects were observed.

In the postoperative period, 3 patients noted symptoms of disorders of autonomic nervous system in the lower extremity on the side of the approach, which partially regressed over time. Lumbalgia was revealed in 1 patient, which was absent before the operation, 2 patients experienced symptoms of spinal root compression that regressed after conservative treatment. There were 3 cases of intervertebral disc wedging adjacent to the instrumental fusion area (cranial – in two cases and distal – in 1) accompanied by coronal trunk imbalance of varying severity requiring revision surgical intervention – posterior correction using segmental instrumentation. In two cases reoperation was performed within two weeks after correction with anterior instrumentation and in one case – in 2.5 years.

Table 2

The dynamics of major preoperative and postoperative topography indices

Indicator	Preoperative (PRE)	Postoperative (POST 1)	The long-term outcome (POST 2)	POST1—PRE	POST2— PRE
FH, degrees	1.55 ± 3.90	1.26 ± 2.90	-0.23 ± 2.10	-0.29	-1.78
FP, degrees	2.01 ± 2.30	0.48 ± 1.10	0.81 ± 1.60	-1.53	-1.20
FT, degrees	2.10 ± 2.00	2.16 ± 1.70	0.79 ± 1.70	0.06	-1.31
GH, degrees	-0.77 ± 3.40	0.54 ± 2.00	1.05 ± 2.70	1.31	1.82
GP, degrees	0.27 ± 2.50	0.15 ± 1.20	0.54 ± 2.40	-0.12	0.27
GT, degrees	-1.04 ± 3.40	0.58 ± 2.90	0.51 ± 2.90	1.62	1.55
SK, degrees	-0.72 ± 3.83	-2.56 ± 2.50	0.68 ± 2.80	-1.84	1.40
SN, degrees	-1.03 ± 2.61	-2.67 ± 3.50	-1.80 ± 3.00	-1.64	-0.77
ST, degrees	-0.87 ± 3.10	-2.62 ± 2.70	-1.24 ± 1.90	-1.75	-0.37
SA1, degrees	-19.73 ± 5.55	-17.50 ± 5.20	-17.40 ± 6.20	2.23	2.33
HIL, mm	17.40 ± 6.60	13.50 ± 6.40	15.20 ± 6.30	-3.90 (-22.40 %)	-2.20 (12.60 %)
HIK, mm	21.10 ± 8.90	16.30 ± 8.00	20.90 ± 9.00	-4.8 (-22.70 %)	-0.20 (-0.95 %)
PTI	2.01 ± 0.41	1.51 ± 0.39	1.38 ± 0.42	-0.50 (-25.00 %)	-0.63 (-31.30 %)
PTI_F	2.28 ± 0.70	1.28 ± 0.30	1.21 ± 0.55	-1.00 (-43.90%)	-1.07 (-46.90 %)
PTI_G	2.28 ± 0.50	1.42 ± 0.43	1.42 ± 0.56	-0.86 (-37.70 %)	-0.86 (-37.70 %)
PTI_S	1.18 ± 0.36	1.66 ± 0.77	1.38 ± 0.52	0.48 (40.70 %)	0.17 (16.90 %)
LNG, mm	498.80 ± 26.11	541.46 ± 30.70	520.30 ± 28.90	42.70 (8.60 %)	21.50 (4.30 %)
RWL, %	53.55 ± 3.20	48.89 ± 2.56	50.96 ± 3.19	-4.66 (-8.70 %)	-2.59 (-4.80 %)

Discussion

As far as we can judge, this article is one of the few papers in the Russian literature devoted to the outcomes of using anterior instrumentation in idiopathic scoliosis of the thoracic and thoracolumbar spine. Therefore, we believe it is reasonable to first provide a brief review of the foreign and Russian citations on this issue before discussing our own results. We selected papers of 2002–2016 with the postoperative follow-up lengths of at least two years [7, 8, 10–12, 14, 15, 17, 19, 22–26, 28, 30]. Sixteen articles presented data for 436 patients operated on using single or dual-rod anterior instrumentation, thus, an average described clinical group consists of only 27 (18–50) patients. The mean age ranged from 13 to 37 years, but it exceeded 20 years only in one group [25], i.e., the vast majority of patients were operated on in adolescence. The postoperative follow-up was 2 to 21 years, in most groups – from 2 to 5 years.

According to nine authors, primary curve (pre-, postoperative, and the last follow-up data are available) [8, 10, 11, 14, 15, 22, 24–26] reduced from 51.4° to 13.3°; correction was 38.1° (74.2 %), postoperative progression was 3.8° (10 % of achieved correction), and the curve magnitude was 17.1° at the last follow-up.

According to six authors [8, 11, 14, 24–26], the initial secondary (thoracic) curve magnitude was 32.3°, corrected to 20.1°, and it was 20.5° at the last follow-up. Correction – 12.2° (36.2 %), postoperative progression was minimal – 0.4° (3.2% of achieved correction).

Not all authors have studied the rotation component of scoliotic deformity [8, 12, 21, 26], which is slightly puzzling because direct vertebral body derotation is a feature of anterior instrumentation. A comparatively simple Nash–Moe technique has found most regular application. According to four authors, 50 % derotation was achieved remaining steady over the entire follow-up.

Thoracic kyphosis [8, 11, 14, 19, 24–26, 30] was initially 21.7°, the postoperative magnitude hardly changed – 22.4°, and it increased to 25.8° at the last follow-up.

Postoperative lumbar lordosis [8, 11, 14, 24–26, 30] reduced from 44.5° to 39.9° and increased to 43.4° at the last follow-up.

Scoliotic deformity at the instrumental fusion area [7, 8, 28] was corrected from 43.7° to 11.9°, or by 72.8 %; the initial sagittal contour of this area [14, 15, 22, 28] was 3.7° and the sagittal contour was 6.7° at the last follow-up.

Almost all the authors who provided the information on instrumental fusion length [10, 17, 23, 24, 26, 30] report on inclusion of four spinal motion segments and two authors [7, 10] – five spinal motion segments into this area.

Intraoperative blood loss was 404.9 ml [7, 8, 10, 11, 17, 26, 28, 30], operating time – 237 min [8, 10, 17, 26, 28, 30].

The dynamics of coronal imbalance [7, 8, 10, 12, 14, 22, 23, 25, 26] was positive: the distance from the T1 vertebral body centroid to the median sacral line declined from 19.2 (4–49) to 6.5 (1–19) mm. Sagittal balance also normalized [10, 14, 25]: from 17.8 (8.5 to 30) to 10.2 (4.6–16) mm.

Health-related quality of life is assessed using questionnaires (SRS, ODI), but not all the authors use survey methods. According to some references [15, 25, 26, 28], all long-term postoperative indicators improve approximately by 50 %.

Neither purulent nor neurological complications were observed in the analyzed literature (436 patients). However, Bitan et al. [7], who operated on 24 patients, noted a temporary sympathectomy effect on the side of the approach in many of his patients postoperatively. Five authors mention mechanical failures [7, 8, 14, 22, 26]: screw displacement, rod fracture, and block pseudoarthrosis (13 cases). Two cases [26] required reoperation. Nambiar et al. [19] noticed two cases of repeated surgery associated with the progression of thoracic counter curve. A total of 15 cases of PJK development were reported by several authors [10, 11, 26]. In addition, four cases of junctional scoliosis proximal to the fusion area were described. The given literature data are supported by the only known meta-analysis devoted to this issue [18].

The first Russian publication on the topic under discussion belongs to A.K. Dulaev et al. [4] who described briefly two cases of using single-rod anterior instrumentation augmented with posterior correction and fixation.

Three articles were published by the specialists of the Priorov Central Research Institute of Traumatology and Orthopedics [1, 2, 5]. A total of 36 patients were operated on, most of them were adolescents. A 72 % correction of the primary curve was achieved; sagittal contour in dynamics was not shown. Apical vertebral derotation reached 13 %, the mean fusion length – 4 motion segments. No serious complications were encountered; however, one paper [2] reports hyperthermia in the area of innervation of the sympathetic nerve fibers that was revealed in several patients and gradually reversed. The long-term outcomes were not provided, but the authors communicated the absence of correction loss over the fusion area. Meanwhile, intervertebral disc wedging was present outside this area.

None of the publications contain 3-D assessment of the trunk posterior surface.

Comparison of our findings with the literature data demonstrates that our results are significantly similar by almost all parameters. At the same time, the main purpose of several cited papers was to compare the efficacy of anterior and posterior instrumentation using pedicle screws [10, 11, 17, 30]. The conclusions of these authors are ambiguous. Wang et al. [30] highlighted excellent outcomes achieved with both methods, but prefer anterior approach (less traumatic intervention, shorter fusion area, and cost-effective surgery). Ming Li et al. [17] report the shorter fusion area by one segment to be the only advantage of anterior instrumentation versus posterior instrumentation. A contrary attitude also appears to exist. Thus, Hee et al. [11] noted the advantage of posterior approach in shorter operative time and hospital stays. Geck et al. [10] emphasize the following benefits of posterior access: significantly better curve correction, less

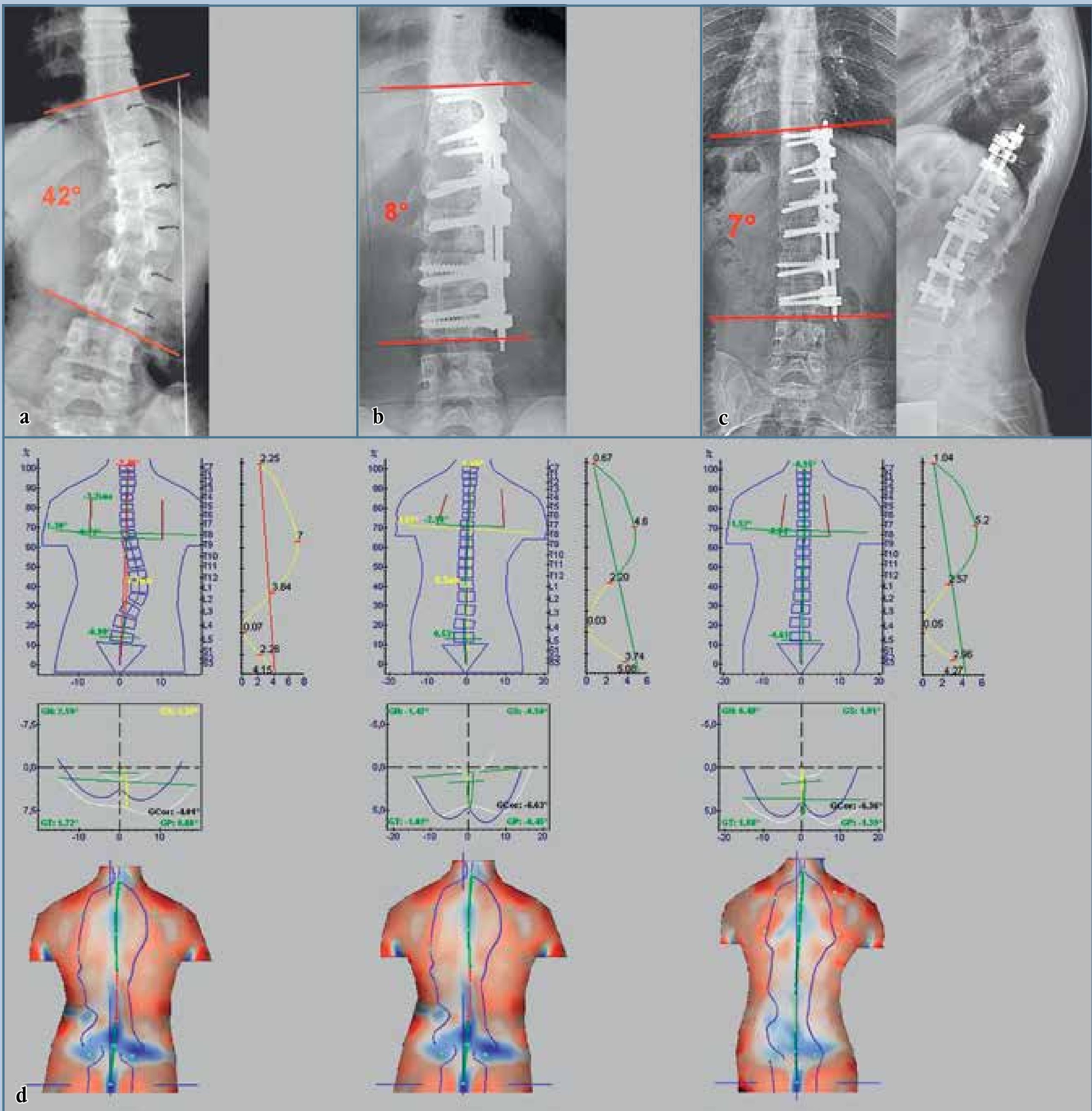

Fig. 1

A female patient P., 16 years old, operated on March 28, 2007; curve length – T10–L3, fusion length – T10–L3; short-term correction according to COMOT data was 70.2, -83.7, and -58.3 %, i.e., there was a significant improvement in all planes; indices for planes: 0.4 (PTI_F), 0.6 (PTI_G), and 0.8 (PTI_S), PTI – 0.6 (subnormal): initial deformity – 42° **(a)**; postoperatively (April 19, 2007) – 8° **(b)**; 4 years postoperatively (May 16, 2011) – 8° **(c)**; 3D-model of the posterior surface preoperatively, in the short-term, and long-term periods **(d)**

loss of correction, and shorter hospital stay. It is noted that Geck et al. resected articular processes at three or four levels during surgery through a posterior approach.

There is no single opinion on the choice of the length of instrumental fusion area. Many authors postulate own

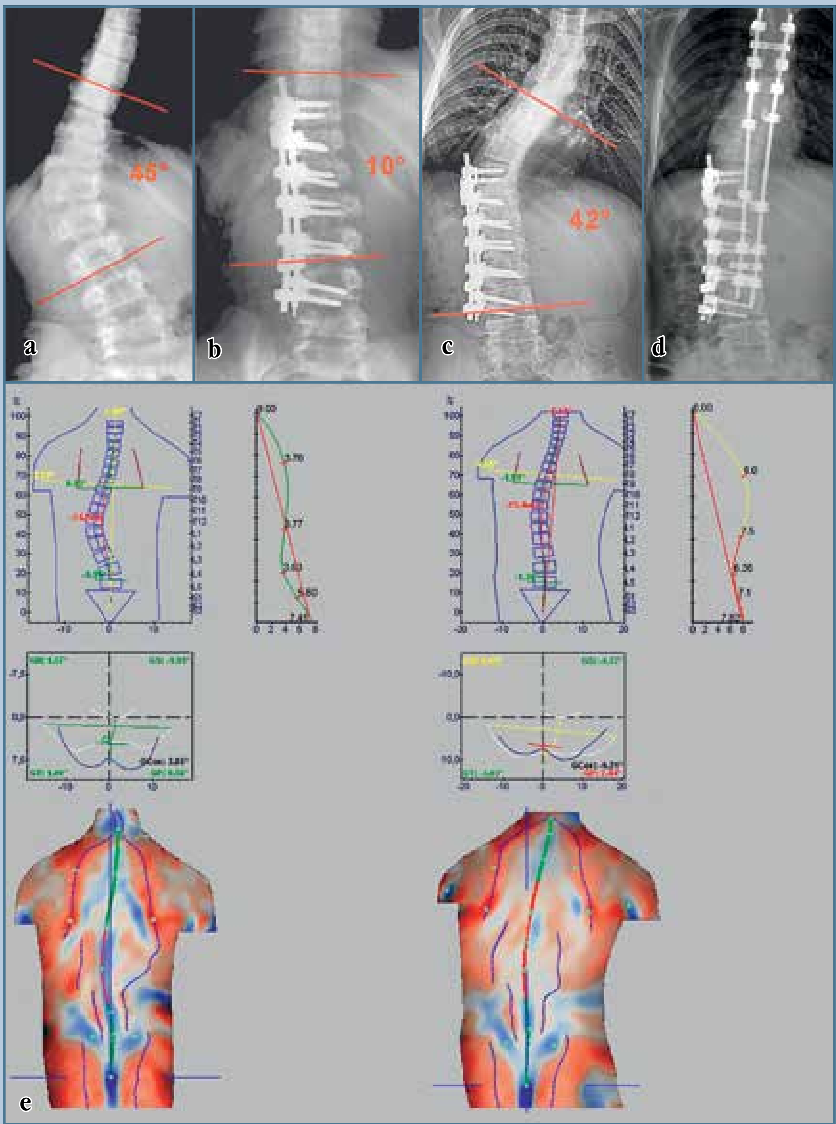

Fig. 2
Patient D., 14 years old, operation on May 17, 2007; curve length – T10–L3, fusion length – T11–L4; in the long-term postoperative period, junctional deformity was formed with prevailing scoliotic component, PTI result worsened by 23 % versus preoperative; loss of correction in the long-term period for planes: +18.7 (PTI_F), +7.6 (PTI_G) and +62.9 % (PTI_S), i.e., there was a significant improvement in frontal and sagittal planes and an insignificant loss of correction in horizontal plane: initial deformity – 50° **(a)**; postoperatively (May 28, 2007) – 10° **(b)**; in 2.5 years postoperatively (December 1, 2009) – 43° **(c)**; after the second operation (correction using posterior segmental instrumentation, December 8, 2009) – 24° **(d)**; 3D-model of the posterior trunk surface before surgery and in the long-term periods **(e)**

algorithms to select the end block vertebrae, most are guided by borders of deformity zone according to Cobb. Japanese authors in papers [25, 26] stress that choosing the end vertebrae according to Cobb is not essential. Moreover, it is advisable to reduce the instrumental fusion area stepping by one segment caudal and cranial to the end vertebrae of the curve.

These data disagree with the information we have received. Instrumental fusion area coincided with the borders of scoliotic curve or exceeded it by one segment in 14 of 24 patients. Postoperative trunk imbalance was not noted in any of the patients. In the other ten patients, the fusion area did not cover the scoliotic curve; a noticeable coronal imbalance was observed requiring repeated surgery in three cases. We plan to find out the following issues in a separate study: what is the cause of these failures and how the initial state of the intervertebral discs adjacent to the instrumental fusion area influences the development of such complications.

Using a high-precision COMOT technique in conjunction with clinical and radiological findings and assessment of health-related quality of life makes outcomes substantially more objective.

Conclusion

Correction of idiopathic scoliosis of the lumbar and thoracolumbar spine using anterior instrumentation is a high-performance method of treatment yielding steady positive outcomes in most patients. However, significant trunk imbalance in some cases requires further research to advance methods for determining the optimal length of the instrumental fusion area.

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