**COMPLEX EVALUATION OF SCOLIOSIS CORRECTION RESULTS USING SINGLE AND DOUBLE-SIDED TOOL SYSTEMS**

28 patients with scoliotic spine deformations were examined and operated. Correction at 12 patients was carried out with application of double-sided tool system, at 16 patients - with application of the single sided one. The best indicators of a functional outcome are noted at the installation of single sided design on the convex side of deformation.

**Keywords:** Scolioz, complex evaluation, scoliotic deformations correction, single and double systems.

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**Introduction**

Application of the concept of double-sided (bilateral) segmental fixation of the backbone offered by Luque (1982) and improved afterwards (Dove, 1982; Dubousset and Cotrel, 1989; Lenke et al., 1992) has allowed to increase twofold the indicators of correction of scoliotic deformations and to lower almost half the loss of the reached corrective effect in the long-term (Luque, E., 1982; Dove, 1982; Dubousset and Cotrel, 1989; Hall, 1998). At the same time, the complexity and the quantity of components of implanted tool systems have become increased. This situation further has complicated methods and resulted in growth of a hemorrhage and duration of operations against a total increase of complications (Richards et al., 2000; Helenius et al., 2003).

Research objective was the complex comparative estimation of results of scoliotic deformations correction by the one-side implanted design to be installed on the convex side of a scoliotic arch, against a way of correction by double-sided system of frame type.

**Material and methods**

Within the period from 2003 to 2009, the 28 patients with scoliotic deformations of a backbone were operated using two staged reconstructive and corrective bone surgery methods. The patients depending on a kind of applied tool systems have been divided into two groups.

The first group consisted of 12 patients. Correction of deformation in these patients was carried out with application of double-sided (frame) tool systems, influencing deformation on both sides from awned islets with rigid fixation of hooks to hinges and derotation possibility.

The second group consisted of 16 patients and differed from the first: deformation correction was carried out with application of single-sided tool system, influencing vertebra arch from the convex side, thus fastening hooks to carrying beam allowed the first to rotate freely on it. Application of derotation maneuver in given tool systems was not provided.

Average value of indicators of angle scoliosis by Cobb at patients from the first group were statistically authentically above than in the second. Such indicators as age, mobility of deformation, Risser sign value and average term of observation after operation had no statistically authentic differences in examined groups. It is necessary to notice that the patients observed for two years and more, made 87.5% (14 of 16) in the second group and 83.3% (10 of 12) in the first.
In both groups the scoliosis thoracic and thoracolumbar localizations prevailed in the ratio between the first and second groups 5 to 14 and 3 to 2 accordingly. In the first group there were four patients with localization of the basic arch in lumbar spine, the deformation of similar localization was not observed in patients of the second group.

Under the etiological factor in both groups patients with dysplastic (3 in the first, 6 in the second) and idiopathic scoliosis (1 and 8 accordingly) prevailed; 4 with congenital backbone anomalies and 1 with a system pathology (neurofibromatosis, Marfan, Élers and Danlo’s syndrome) - 4 and 1, accordingly.

The basic disease complications, accompanying pathology and anamnestic record at patients of the second group were revealed more often, but the first group dominated in severity and risk of complications development. In total, the first group manifested 10 cases of accompanying pathology and complications in 6 patients, including two cases of unsuccessful correction by CDI. In the second group, there were no patients repeatedly operated concerning scoliosis, and 16 cases of accompanying pathology and complications in 11 patients are revealed.

All patients at the first surgical stage had mobilizing discectomy, segmental reconstruction of front spine parts (when required) and initially unstable interbody vertebral fusion. In 14-22 days, the second stage was carried out - tool correction, resection of hump ribs, segmental resection of back departments, posterior spine fusion using bone autografts. At each stage 2-3 days antibacterial prophylaxis of a wound fever by cephalosporins was applied, 7-10 days – in special cases and at the presence of excesses, frequently in a combination with additional antibacterial preparations.

Mobility of deformation was calculated by relative size of Cobb’s angle change by means of spondilograms comparison executed in standing position and in extension at the moment of the patient hanging. At comparison of methods and tool systems the complex estimation way, including the most widespread standard techniques, was applied. The invasiveness of methods was defined according to the operational period; quantity of fixed metalware segments, prevalence of design taking into account single side and double side tool influence on vertebra, general hemorrhage, duration of operation. The corrective effect and reliability of methods were defined by means of comparison of following clinoradiologic indicators of Cobb’s angle changes after operation and at the end of observation.

The data obtained during the study were exposed to statistical processing by methods of variation statistics using PC Pentium IV with standard tabular editor Excel 2003. Difference of two compared values was considered authentic if the probability of their identity was less than 5 % (>0.05). Parametrical Student t-criterion was applied to statistical data processing and nonparametric U-criterion Wilcoxon-Mann-Witny and Wilcoxon T-criterion for independent and dependent samples accordingly.

**Study results**

Data of the operational period. The average quantity of implanted elements of tool systems and prevalence of tool influence of design on bilateral half of vertebra in the first group were more than in the second: 37.4 and 30.1, against 14.9 and 13.6 accordingly. It has led to increase of average absolute value of duration of all correction stage using bilateral tool systems in comparison with unilateral (Group 2) by 23.7 %, at the expense of increase of installation duration by 74.8%. Relative indicators of design installation duration per one implanted element in the first group were more by 41.9%, as compared with the second group that indicates the raised complexity of double-sided model installation against the single-sided.

Absolute and relative (per kg of mass of the patient’s body) volume considered intra-operational losses of blood in patients from the first group exceeded similar indicators of the second group by 54.7% and 43.9% accordingly. In this connection in patients of the first group, in comparison with the second, it was required to enlarge quantity of poured blood components at the closing stage, and volume of infusion of liquids and duration of intensive care in average absolute value by 46.2%, 20.6% and 47.1%, accordingly.
Results of X-ray examinations

Average indexes of scoliosis intra-operative corrections, value of scoliotic arch residual angle and size of correction loss after application of unilateral tool systems (group 2) - 71.5%, 18.3 and 8.6% (-4.8), than after bilateral (Group 1) - 62.4%, 36.6 and 9.4% (-8.7), accordingly. However, differences of correction values, both after operation and at the end of research, were not statistically authentic to p=0.055 and p=0.091, accordingly.

In patients of the first group, in six cases from nine pathological kyphosis is corrected to physiological indicators, and in three it was possible to reduce the central projective pathological kyphosis angle on average to 53.6. In the second group with two patients with hyperkyphosis, deformation was eliminated at one and reduced to 6 at another.

Though in the first group derotation methods of statistically authentic differences were applied, deformation in correction of rotatory component between groups was not revealed. Average value of correction of cranial and caudal arches of anti-curvatures in groups had also no statistically authentic differences.

Change of the radiological status of a design is noted in 9 patients of the first group, only two of them were turned to adverse consequences. In one case complication was noted, in other - loss of correction more than by 14 (shift of basic elements of tool systems - 4 cases, partial decomposition of tool systems - 4 cases, deformation of carrying elements of tool systems - 1 case) is noted. In the second group 4 cases of tool systems status change are noted (2 shifts of basic elements of tool systems, 2 deformations of basic and carrying elements of tool systems) out of which one became the reason of correction loss by more than 14, the others had no adverse consequences.

Complications

In the first group there were 22.2% (2) complications one of which one was connected with the late deep wound infection demonstrated in the form of fistulous process, in 6 months after operation (St. Aureus). Another one was related with tool systems instability with the subsequent pyesis of the generated bursa and formation of fistulas (Ps. Aerugenosa) in 13 months after operation. In the second group there was noted one (6.25%) infectious complication (St. Aureus) in 3 months after operation, at the patient who had a sepsis in the early childhood. All complications were taken off after elimination of tool systems for what it was required to execute two additional operations of two patients from the first group and one operation for patient from the second.

Discussion

The augmentation of components quantity of tool systems and rising their constructive complexity increase invasiveness of a method at the expense of augmentation of the area of influence, duration of operation and hemorrhage. For comparison, the average quantity of implanted components for CDI designs (Cotrel-Dubousset Instrumentation) is 39.6 at average duration of correction is 4.3 hours and average hemorrhage is 1072 ml. For similar TSRH (Texas Scottish Rite Hospital) system these indicators are following (Dubousset, 2000; Johnston and Ashman, 2000; Richards et al., 2000): 43.8 implanted elements on the complete set, duration of correction is 4.5 hours (2.8-10.3) and hemorrhage is 1122 ml (350 - 4000). In a series of our researches the average quantity of implanted elements in the second group was less, than in the first in 2.5 times (14.9 and 37.4, accordingly), that had enlarged duration of operative correction in 1.3 times and intra-operative hemorrhage in 2.2 times in the first group, in comparison with the second.

It is necessary to notice, that direct comparison of hemorrhage and time indicators from a series of our researches with similar indicators at correction by CDI and TSRH cannot be correct as in the latter case the resection of a costal humpback did not enter into a complex of operative treatment. Working out of more simple, low complete and
less invasive tool systems can become the basic direction of the further perfection of methods of tool scoliosis correction.

According to summary data of different authors the average value of correction of scoliosis arch, after application of bilateral tool systems CDI and TSRH, fluctuates near average value of 55% at average value of Cobb angle 52-61 before operation and 20 -34 (Guidera et al., 1993; Lenke et al., 1992; Richards et al., 2000; Helenius et al., 2003) after operation. That it is much better than similar indicators, after correction Harrington unilateral tool systems established by concave side of scoliosis 27°, 38° and 45°, accordingly (Helenius et al., 2003). In our studies, on the contrary, larger intra-operational corrective effect concerning scoliosis of thoracic and lumbar localizations, is noted at unilateral system from the second group. And not only in relation to bilateral (group 1), but also in relation to such most known foreign analogues of double-core tool systems as CDI and TSRH (Richards et al., 2000; Helenius et al., 2003).

In our researches, the best indicators of functional outcome (restoration of frontal balance, spine mobility and static power endurance of muscles of a back) are noticed at installation of unilateral design by the convex side of deformation (group 2), that might be explained by the least quantity of fixed vertebra. In comparative researches of the remote results of correction by Harrington and CDI (Helenius et al., 2003), on the contrary, it is underlined the best functional outcome of similar indicators after application of bilateral systems CDI. It is necessary to notice, that in Helenius et al. (2003) there were studied outcomes of application of the unilateral system installed on the concave side. Whereas in our case the unilateral design was installed on the convex side of the basic scoliotic arch (Helenius et al., 2003).

All complications in our research series have anyhow been connected with a late deep wound fever which was demonstrated in late terms after operation (3-13 months) in the form of fistulous process. And, if in the second group it was possible to predict and explain occurrence of 6.25 % of such complications by the lowered tolerance of the patient to infection (earlier old sepsis), the explanation of similar episodes after application of bilateral systems in the first group (22.2 % of complications) could have more difficult nature.

We agree with opinion (Herring et al., 1993; Richards et al., 2000) that the main necessary condition to reduce quantity of infectious complications may be return to rigid unilateral tool systems with smaller quantity of components which do not have devices of cross connection (DDT) and not forming cavities of dead space between elements of tool systems (Herring et al., 1993; Richards et al., 2000).

Economic data characterizing tool systems appears not less important for realization of surgical technology than such clinical indicators as efficiency, invasiveness and pathogenicity. Smaller quantity of labor inputs in manufacturing of the single-side tool systems applied in the second group of our studies, have caused their lower (more than in 5 times) production cost in comparison with bilateral systems (Group 1). But as more important should be consider the fact that in practice developed by the authors both bilateral and unilateral tool systems may be 5-10 times cheaper than foreign analogues.

References


