ASSESSMENT OF NEW METHOD OF POSTERIOR SPINAL FUSION IN THE TREATMENT OF PATIENTS WITH POSTTRAUMATIC KYPHOTIC DEFORMITY OF THE THORACIC AND LUMBAR SPINE

D.A. Ptashnikov[1, 2], Sh.Sh. Magomedov[1], S.P. Rominskiy[1], P.G. Mytyga[1]
[1]National Medical Research Center of Traumatology and Orthopedics n.a. R.R. Vreden, St.Petersburg, Russia
[2]North-Western State Medical University n.a. I.I. Mechnikov, St. Petersburg, Russia

Objective. To carry out a comparative analysis of two methods of the posterior bone block formation (with autograft bone chips or with a whole vertebral arch) and to assess the rate of bone block formation, the degree of surgery invasiveness and the patient-reported cosmetic satisfaction with the results.

Material and Methods. The study involved 31 patients with kyphotic deformity of the thoracic spine, of which 15 patients underwent spinal fusion using autograft bone chips (control group), and 16 were operated on using a new technique with a whole vertebral arch. The results of treatment were assessed using a modified MacNab scale. During the follow-up period from 1.5 to 2 years, pain syndrome was assessed according to VAS, quality of life according the Oswestry Disability Index, and cosmetic satisfaction was assessed using the SRS-22 scale.

Results. In the course of the work, it was revealed that in patients who were operated on using new method, the time of bone block formation according to CT data was shorter, the overall satisfaction with surgery result was higher (mainly due to the absence of a cosmetic defect), and the indicators of the operation duration and blood loss did not differ compared to those in the control group.

Conclusion. Based on the results obtained, spinal fusion using a whole vertebral arch can be recommended in clinical practice for surgical interventions in patients with kyphotic deformities of the spine.

Key Words: posterior fusion, deformity correction, bone autograft, kyphotic deformity.

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The surgical treatment of posttraumatic kyphotic deformity of the spine still remains an urgent challenge. A massive blood loss is associated with corrective surgeries, which are traumatic [1, 2].

In recent years, various techniques of osteotomy have become customary, allowing eliminating any kind of deformity. They are usually performed through the posterior approach. Nevertheless, some surgical methods, such as pedicle subtraction osteotomy (PSO), do not involve the formation of an anterior bone block. Therefore, the surgeon has to create conditions for the formation of an optimal posterior bone block, which will help to maintain the achieved intraoperative correction.

A posterior fusion is carried out using auto- or allograft bone. In 1911, Albee [3] was the first who performed this surgery in a patient with spinal tuberculosis (Pott's disease). In 1975, the variant of posterolateral fusion (PLF) was modified by Wiltse [4]. This technique is currently being applied. The author suggested creating conditions for interarticular and intertransverse fusion using a bone autograft from the iliac crest [5]. This technique implies additional trauma associated with the sampling of plastic material.

A peculiarity of corrective surgeries performed through the posterior approach in the thoracolumbar and lumbar spine is an extended decompressive laminectomy with the formation of a large interarch space. However, as a rule, it is not always possible to adequately perform posterior fusion without the risk of autograft bone migration towards the spinal canal. Moreover, the lack of a full-fledged contact of the autobone in the interarch space may result in the resorption of plastic material in the postoperative period.

Meanwhile, some patients are not satisfied with the surgery, due to the sunken skin in the surgical site. The reason for this is the lack of a spinous process in the posterior block area.

In view of these challenges, a posterior fusion technique was developed [6], which allows to avoid the neoarthrosis formation and improve the cosmetic results of treatment (an integrity in the interspinous space).

The objective is to carry out a comparative analysis of two methods of the posterior bone block formation (with autograft bone chips and with a whole vertebral arch) and to assess the rate of bone block formation, the degree of surgery invasiveness and the patient-reported cosmetic satisfaction with the results.

Material and Methods

The study involved 31 patients with posttraumatic kyphotic deformity of the thoracic and lumbar spine (Fig. 1). The surgeries have been performed at the Russian Scientific Research Institute of

Traumatology and Orthopedics named after R.R. Vreden from 2010 to 2018. The patients were divided into two groups by simple randomization, depending on the posterior fusion technique. All the patients underwent PSO in various modifications (types 3, 4 according to Schwab [7]) through the posterior approach without using interbody implants.

In Group A, the conditions for the posterior bone block formation during spinal fusion were created by autograft bone chips being placed between the structural rods (control group). In Group B, the damaged vertebral arch was removed through the posterior median approach using a monolithic block (Fig. 2).

The conditions for the formation of the posterior bone block during spinal fusion were the following: an entire arch of the damaged vertebra was installed in the intervertebral space; the autografting of the interosseous ligaments was performed to further fix the implant and spread the load on the ligaments, as well as to improve the cosmetic effect. Additionally, the autograft bone chips made of local tissues was placed between the rods of the transpedicular system (Fig. 3).

The study consisted of patients with posttraumatic kyphotic deformity of the thoracic and lumbar spine (more than 11°, but less than 35°, which allows performing osteotomies of types 2 and 3 according to Schwab) and pain syndrome.

The patients with decompensated physical pathology and foci of persistent infection were excluded from the study.

The results of treatment were assessed using the following measures: a modified MacNab scale [5], VAS, quality of life according the Oswestry Disability Index, and cosmetic satisfaction by SRS-22 scale [8]. The patients were interviewed for a period of 1.5 to 2 years.

The bone block formation according to X-ray and CT data was assessed after 3, 6, 9, 12, and 24 months. The following signs were analyzed: diastasis loss at the "bone autograft" border, osseous structure homogeneity, and trabeculation [9]. We have used medical records to evaluate the time of the surgery and the blood loss.

The statistical data processing was carried out using Microsoft Excel. The groups were compared using the Mann-Whitney criterion.

Results and Discussion

Group A consisted of 15 people (9 women and 6 men). The average age was 47.5 ± 6.5 years. A local kyphotic deformity averaged 27.0° ± 5.5° (from 17 to 45°). Group B included 16 people (11 women and 5 men). The average age was 49.5 ± 6.5 years. A local kyphotic deformity averaged 29.0° ± 4.5° (from 16 to 47°).

There was no neurologic state deterioration in the early postoperative and in the follow-up period up to a year in the follow-up groups.

There were no intra- and postoperative complications during the follow-up.

The injury evaluation of surgeries is given in Table 1.

The surgery duration and blood loss were not significantly different ($p = 0.05$) in both groups.

The assessment of radiological signs of posterior bone block formation in patients is given in Table 2. It ought to be noted that, according to the X-ray examination, a bone block was formed in all patients 24 months after the surgery.

The findings of the VAS and ODI patient survey are given in Table 3.

The changes in VAS and ODI did not significantly differ in both groups. However, in Group B, the SRS-22 indicators were significantly higher, mainly due to the "self-perception" domain.

After the findings' comparison of patients, it can be concluded that, all other things being equal, the rate of posterior bone block formation and satisfaction with the surgery was higher in the group of patients operated on with the repair of the defect by the whole vertebral arch.

While using autograft bone chips, the soft tissue wasting is formed in the site of the obsolete spinous process (processes). This pathology is especially pronounced in slim patients. In the presence of a spinous process, it is more difficult to palpate surgical hardware elements, the patients do not feel uncomfortable in the lying position. In case of extended kyphosis, the soft tissue defect is more pronounced. It is associated with local tension and soft tissue wasting in the defect area.

The bone block formation is faster than when using autograft bone chips, not only according to the study data, but also in comparison with the literature data [10–13]. This is primarily due to the non-requirement for the displacement of the whole vertebral arch. An additionally laid autograft bone chips contributes to the formation of a more reliable block by the thickness of the bone displacement. The loosening risk of surgical hardware elements is significantly reduced due to the earlier onset of stability at the surgical site.

Technically, the performance of posterior fusion according to the original technique is simpler and does not require the surgeon to take actions increasing the risk of intraoperative complications.

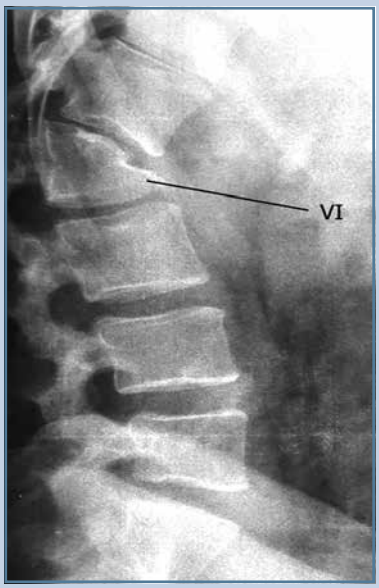

Fig. 1
An X-ray picture of the patient included in the study before the surgery: VI – deformed vertebra, the apex of kyphotic deformity

Conclusions

The analysis of the data obtained showed that the findings of surgical treatment performed according to the original technique are better in comparison with the ones derived from the patients who underwent posterior fusion in the traditional way. While the arch is implanted in the donor site, the formation of the bone block is faster. Thus, the probability of correction loss due to loosening of the surgical hardware elements is less. A cosmetic satisfaction of patients is associated with the absence of interspinous space depression. Meanwhile, blood loss, surgery duration, and severity of postoperative pain syndrome did not differ significantly in the comparison groups.

The study had no sponsors. The authors declare that they have no conflict of interest.

Fig. 2
The original technique of vertebral arch resection: **a** – a scheme of arch sawing; **b** – a resected arch, anterior projection; **c** – a resected arch, lateral projection

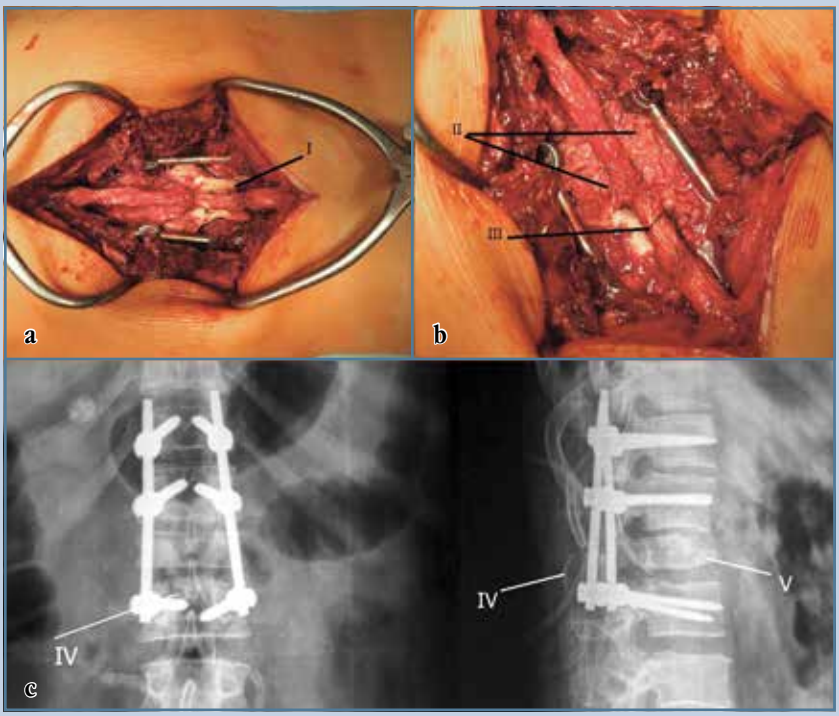

Fig. 3
Formation of the posterior bone block: **a** – the removed arch (I) is implanted in the defect area; **b** – posterior fusion using autograft bone chips (II); a supraspinous ligament suture (III); **c** – X-ray findings: IV – a reimplanted arch, V – vertebra after osteotomy

Table 1

An injury evaluation of the surgery

The injury criterion of the surgery	Group A	Group B
Blood loss, ml	430 ± 100	460 ± 90
Surgery duration, min	180 ± 35	200 ± 30

Table 2

Distribution of patients according to the duration of bone block formation, n

Duration of X-ray examination	Group A (n = 15)	Group B (n = 16)
9 months after surgery	4	10
12 months after surgery	13	15

Table 3

VAS and ODI indicators before and after treatment of study group patients

Average indicator	Group A (n = 15)	Group B (n = 16)
VAS before treatment, points	5.2 ± 1.2	5.6 ± 1.1
VAS 6 months after treatment, points	1.6 ± 0.6	1.2 ± 0.5
ODI before treatment, %	75.0	80.0
ODI 6 months after treatment, %	24.5	25.6
SRS-22	65.0 ± 13.0	82.0 ± 10.0
“Self-perception” domain (max. 25 points)	16.0 ± 3.0	23.0 ± 2.0

References

1. **Dulaev AK, Shapovalov VM, Gaydar BV.** Closed Thoracic and Lumbar Spine Injuries. St.Petersburg, 2000. In Russian.
2. **Schwab F, Blondel B, Chay E, Demakakos J, Lenke L, Tropiano P, Ames C, Smith JS, Shaffrey CI, Glassman S, Farcy J-P, Lafage V.** The comprehensive anatomical spinal osteotomy classification. Neurosurgery. 2014;74:112–120. DOI: 10.1227/NEU.0000000000000182o.
3. **Albee FH.** Transplantation of a portion of the tibia into the spine for Pott's disease: a preliminary report. JAMA. 1911;57:885–886. DOI: 10.1001/jama.1911.04260090107012.
4. **Wiltse LL.** Proceedings: lumbar spine: posterolateral fusion. J Bone Joint Surg Br. 1975;57:261.
5. **Rerikh VV, Borzykh KO.** Posttraumatic deformities of the thoracic and lumbar spine at patients in the late period of the vertebral and spinal trauma after earlier carried out surgeries. Journal of Applied and Fundamental Research. 2015;(12–4):657–660. In Russian.
6. **Vissarionov SV, Golubev KE.** Method of correction of congenital kyphosis of lumbar and thoracolumbar spine in children in case of disturbed segmentation of anterior parts of vertebrae. Patent RU 2435540 C1. App. 22/03/2010, publ 10/12/2011. Bul. 34. In Russian.
7. **Schwab F, Farcy JP, Bridwell K, Berven S, Glassman S, Harrast J, Horton W.** A clinical impact classification of scoliosis in the adult. Spine. 2006;31:2109–2114. DOI: 10.1097/01.brs.0000231725.38943.ab.
8. **Gubin AV, Prudnikova OG, Kamysheva VV, Kovalenko PI, Nesterova IN.** Clinical testing of the Russian version of the SRS-22 questionnaire for adult scoliosis patients. Hir. Pozvonoc. 2017;14(2):31–40. In Russian. DOI: 10.14531/ss2017.2.31-40.
9. **Bulkin AA, Bokov AE, Mlyavykh SG.** Factor affecting bone formation in patients with degenerative lumbar spine pathology. Russian Neurosurgical Journal n.a. Prof. Polenov. 2019;11(2):12–16. In Russian.
10. **Chen WJ, Tsai TT, Chen LH, Niu CC, Lai PL, Fu TS, McCarthy K.** The fusion rate of calcium sulfate with local autograft bone compared with autologous iliac bone graft for instrumented short-segment spinal fusion. Spine. 2005;30:2293–2297. DOI: 10.1097/01.brs.0000182087.35335.05.
11. **Blanco JF, Villaron EM, Pescador D, da Casa C, Gomez V, Redondo AM, Lopez-Villar O, Lopez-Parra M, Muntión S, Sanchez-Guijo F.** Autologous mesenchymal stromal cells embedded in tricalcium phosphate for posterolateral spinal fusion: results of a prospective phase I/II clinical trial with long-term follow-up. Stem Cell Res Ther. 2019;10:63. DOI: 10.1186/s13287-019-1166-4.
12. **Buser Z, Jakoi A, Katbamna B, Basho R, Wang JC.** Bone grafting and spinal fusion options. In: Holly L., Anderson P., eds. Essentials of Spinal Stabilization. Springer, Cham, 2017:453. DOI: 10.1007/978-3-319-59713-3_34.
13. **Wang H, Lv B.** Comparison of clinical and radiographic results between posterior pedicle-based dynamic stabilization and posterior lumbar intervertebral fusion for lumbar degenerative disease: a 2-year retrospective study. World Neurosurg. 2018;114:e403–e411. DOI: 10.1016/j.wneu.2018.02.192.

Address correspondence to:
Rominskiy Sergey Petrovich
National Medical Research Center
of Traumatology and Orthopedics n.a. R.R. Vreden,
8 Akademika Baikova str., St. Petersburg, 195427, Russia,
rominskiy@mail.ru

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Dmitrii Aleksandrovich Ptashnikov, DMSc, Prof., Head of the Department No.18, National Medical Research Center of Traumatology and Orthopedics n.a. R.R. Vreden, 8 Akademika Baikova str., St. Petersburg, 195427, Russia; North-Western State Medical University n.a. I.I. Mechnikov, 41 Kirochnaya str., St. Petersburg, 191015, Russia, ORCID: 0000-0001-5765-3158, drptashnikov@yandex.ru;
Shamil Shamsudinovich Magomedov, MD, PhD, Head of the Department No.12, Russian Research Institute of Traumatology and Orthopedics n.a. R.R. Vreden, 8 Akademika Baikova str., St. Petersburg 195427, Russia, ORCID: 0000-0001-5706-6228, dr.shamil@mail.ru;
Sergey Petrovich Rominskiy, orthopedic trauma surgeon, Department No. 12, National Medical Research Center of Traumatology and Orthopedics n.a. R.R. Vreden, 8 Akademika Baikova str., St. Petersburg, 195427, Russia, ORCID: 0000-0002-7771-3274, rominskiy@mail.ru;
Pavel Gennadyevich Mytyga, orthopedic trauma surgeon, Department No. 12, National Medical Research Center of Traumatology and Orthopedics n.a. R.R. Vreden, 8 Akademika Baikova str., St. Petersburg, 195427, Russia, ORCID: 0000-0002-4386-9780, paveji.official@gmail.com.