Genij Ortopedii. 2023;29(1):85-91.

Original article

https://doi.org/10.18019/1028-4427-2023-29-1-85-91

Surgical treatment of a patient with failed ventral fixation of an old Th12 fracture affected by severe osteoporosis (case report)

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Abstract

Osteoporotic vertebral compression fractures (OVCF) are common fragility fractures of the spine that can lead to the functional failure and neurological deficit in 15-35 % of cases. There is no clear understanding of preferred surgical techniques to be used for treatment of patients with complicated thoracic and lumbar OVCF. **The objective** was to analyze reasons of failed ventral intervention in a patient with old Th12 injury affected by osteoporosis and demonstrate a short- and long-term outcome of repeated surgery. **Material and methods** A 63-year-old patient underwent stabilization of the thoracolumbar spine using a combined polysegmental (screws/hooks) dorsal system with screws augmented with bone cement. **Results** Physical examination and radiography at 12 months showed no loss of correction or signs of structural instability. Bone-metal fusion was observed at the level of the mesh endofixator (Th11-L1). VAS scored 0-1 (standing = lying), the *Oswestry* Disability Index was 12 %. **Discussion** The poor outcome of ventral intervention was caused by inadequate instrumentation of the transitional thoracolumbar spine in osteoporotic patient leading to L1 destruction and gradual kyphotization of the stabilized spine. The satisfactory short- and long-term outcomes of the revision dorsal intervention indicated the effective surgical strategy in the case. **Conclusion** With the results of the case reported, the reliability of anterior fixation is to be considered in osteoporotic patients to determine the feasibility of extended ventral systems in elderly patients. Dorsal stabilization and spinal fusion without preliminary abdominal revision are practical with unstable anterior fixation being not accompanied by significant secondary spinal deformity.

Keywords: injury, thoracic and lumbar spine, osteoporosis, surgical management, ventral fixation, revision surgery

For citation: Shulga AE, Ostrovskii VV, Zaretskov VV, Bazhanov SP, Likhachev SV, Smolkin AA. Surgical treatment of a patient with failed ventral fixation of an old Th12 fracture affected by severe osteoporosis (case report). *Genij Ortopedii*. 2023;29(1):85-91. doi: 10.18019/1028-4427-2023-29-1-85-91

INTRODUCTION

The incidence of osteoporosis is increasing as the life expectancy of the population increases [1]. A musculoskeletal injury can lead to disability in individuals with low bone mineral density [2]. According to statistics, the spine is most susceptible to osteoporotic fractures (OVCF – osteoporotic vertebral compression fractures) [3]. Conservative treatment can be effective for osteoporotic vertebral injury, however, adverse effects including late kyphosis and chronic compression of the spinal canal are observed in 15-35 % of cases [4, 5]. The complications in the progression of the spinal dysfunction and/or neurological deficit lead to prolonged physical inactivity and negative consequences for the elderly [6]. Surgical treatment of patients due to low bone mineral density is associated with a high risk of poor outcomes [7, 8]. Most specialists emphasize the need for active surgical strategy in the complicated course of osteoporotic fractures of the thoracic and lumbar vertebrae [9, 10]. However, publications on the surgical treatment of this pathology do not give a clear idea of the preferred surgical techniques. The strategy of surgical treatment of patients with osteoporotic fractures of the thoracic and lumbar spine require clarification.

The purpose of the work was to analyze the reasons for poor outcome of anterior intervention in a patient with an old osteoporotic Th12 vertebral injury and to demonstrate short- and long-term results of repeated surgical treatment.

MATERIAL AND METHODS

A 63-year-old patient Sh. was admitted on May 18, 2021 to the neurosurgical department of NIITON SSMU. She fell on her back from the height of her own height in December 2020. A compression fracture of the Th12 vertebra was diagnosed at the polyclinic at the place of residence, and the patient was transferred to outpatient treatment with recommendations, however, the intensity of pain in the thoracolumbar spine progressively increased, and, the patient developed weakness in the lower extremities after two months. The follow-up examination showed a collapsed body of the Th12 vertebra by 2/3 and a

kyphotic deformity of about 28°. The patient with negative clinical and radiological dynamics was hospitalized at NIITON SSMU on March 16, 2021. On admission, a chronic Th12 injury of the OVCF vertebra (DGOU Type 4) [11] was diagnosed with spinal cord compression, SCLD (spinal canal lumen deficit) 57 % and neurological deficit (type D, ASIA/ISNCSCI) (Fig. 1a). The patient underwent surgical treatment including right thoracophrenotomy, resection of the Th12 vertebral body and anterior decompression of the spinal cord, deformity correction and fixation of the Th10-L1 spine with an anterior system and screws augmented with bone cement, anterior support fusion with a mesh endofixator (Fig. 1b).

Fig. 1 Radiographs of the spine of patient Sh. before (a) and after (b) anterior correction

The patient had postoperative pain relief with VAS decreased from 9 to 2 scores. Neurological symptoms completely regressed within 1 month, and the patient could initiate full weight-bearing. The patient developed a sudden pain in the thoracolumbar spine while walking at 2 months. The pain progressively increased and a radiography demonstrated lower dislocated construct. With failed fixation, the patient was admitted to NIITON SSMU for repeated surgical treatment.

The patient presented with constant pain in the thoracolumbar spine aggravated with a movement. VAS scored 5 at lying and 10 at standing; ODI was 85 %. There was a postoperative scar (~ 20 cm) on the right 10th rib from the scapular to the mid-clavicular line. Palpation and tapping at the level of the spinous process of the Th12 vertebra and paravertebrally were sharply painful. Physical examination showed no significant somatic pathology. No specific findings were seen neurologically. Conventional radiography and CT scan showed moderate segmental kyphosis (8°) with the apex at the level of the L1 vertebra (Fig. 2). The thoracolumbar spine was fixed with ventral system. The screws in the bodies of the instrumented vertebrae (Th10, Th11 and L1) were augmented with bone cement. The integrity of the construct was not impaired.

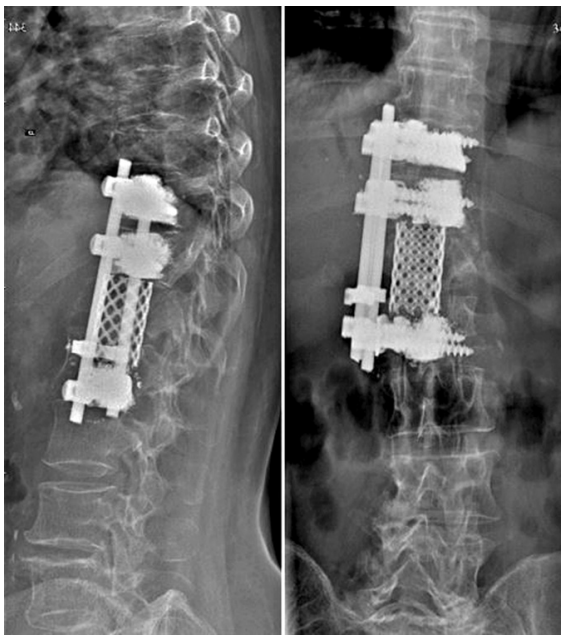

Fig. 2 Radiographs of the spine of patient Sh. at 2 months of the first operation

The lower body and the endplate of the L1 vertebra injured with screws and cement and migration into the intervertebral disc L1-L2 by 5-10 mm could be visualized (Fig. 2, Fig. 3a, b). The same block (screws/cement) broke the integrity of the anterior portions of the L1 vertebra, the fragmentation was noted with the system tended to tilt forward and form a sagittal deformity at this level (Fig. 2, Fig. 3a, c). The distal part of the mesh endofixator penetrated 1/3 into the upper part of the body of the L1 vertebra and rested against the metal-cement conglomerate (Fig. 3a, b). The spinal canal was passable throughout the entire length of the implanted system, no secondary compression of the spinal cord was detected.

DEXA performed for the patient during the first hospitalization showed measurements of BMD of the lumbar spine (T-score at the level of L1-L4 = -4.6 SD) and proximal femurs (T-score on the left = -2.6 SD, right = -3.1 SD) that indicated to severe osteoporosis. A collegial decision was made to stabilize the thoracolumbar spine with a multisegmental combined (screws/hooks) dorsal system and screws augmented with bone cement considering clinical and radiological signs of unstable anterior fixation and severe osteoporosis. The patient gave her consent to the planned scope of the surgical intervention and the processing of personal data.

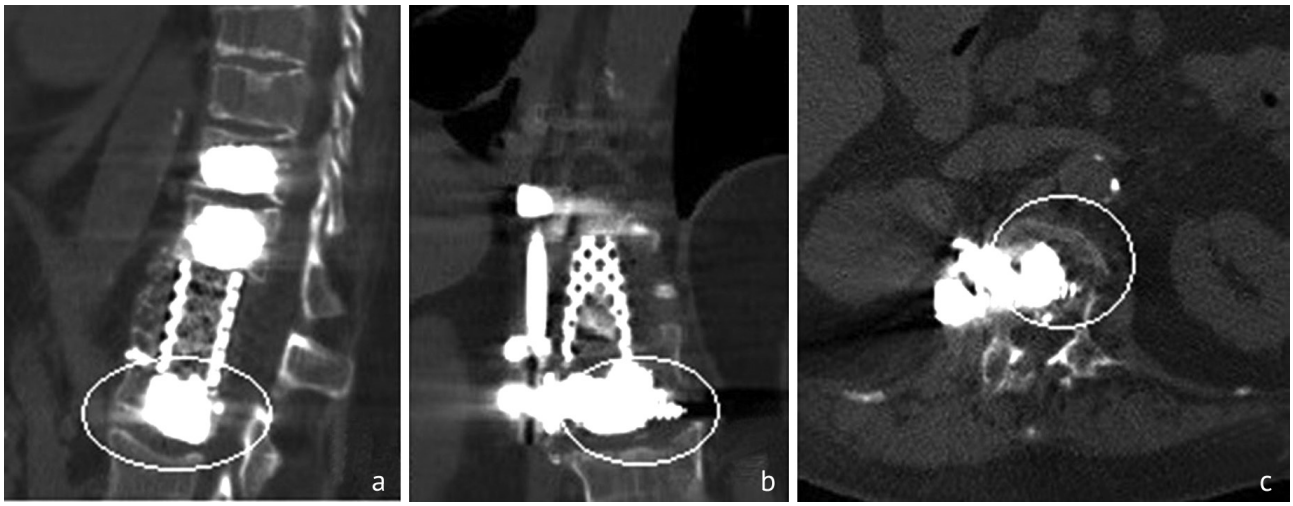

Fig. 3 CT scans of the spine of patient Sh. at 2 months of the first operation

The operation was performed on May 21, 21. With the patient in the prone position, an incision was made in the skin and subcutaneous tissue with an aponeurosis (~35 cm long) along the line of the spinous processes Th8-L4. The posterior bone structures of the spine were exposed. Primary cutting was performed on both sides at the Roy-Camille points (the base of the superior articular process) of the Th8, Th9, L2, L3, and L4 vertebrae with an awl (1.5 cm) and transpedicular canals formed to a depth of no more than ¼ of the bodies of the above vertebrae using a threaded tap. Jamshidi needles (10 pieces) were placed in the passages and pushed through the border of the anterior and middle third of the bodies. Bone cement was introduced through the needles (3 ml per needle) and 5 pairs of pedicle screws placed symmetrically on both sides. The laminar portion of the construct was implanted on and under the arches of the Th12, Th11 and Th10 vertebrae. Posterior fusion was performed with xenogenic osteoplastic material after radiographic control. The elements of the system were mounted on two rods according to physiological curvature and fixed with nuts. The operation was completed with radiographic control with the construct components finally drawn, active drainage of the wound arranged followed by layer-by-layer suturing. The patient was transferred to the intensive care unit after the operation. No negative dynamics in the neurological status was revealed. A standard treatment was prescribed to prevent infectious and thromboembolic complications. The patient was encourage to ambulate on the second postoperative day and could walk independently after 5 days. The radiography performed after 5 days showed adequate location of the metal construct (Fig. 4).

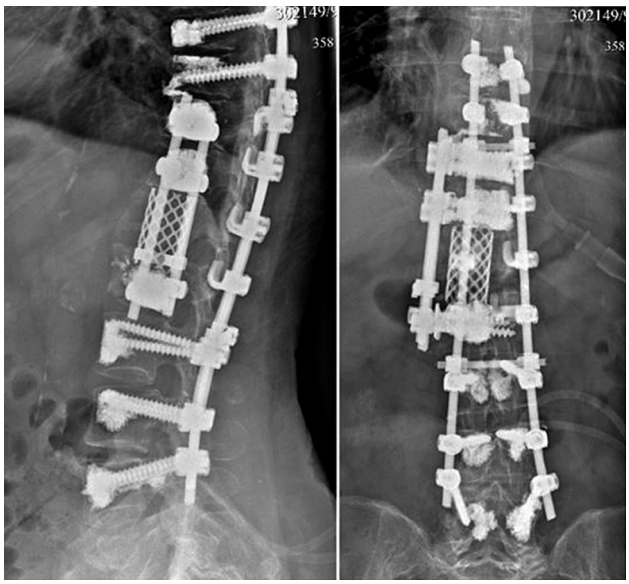

Fig. 4 Radiographs of the spine of patient Sh. after the second operation

The wound healed by primary intention, the sutures removed after 14 days after the operation, the patient was discharged in a satisfactory condition with recommendations for further treatment. Questionnaire before discharge showed the VAS score of 2 points (standing = lying down).

RESULTS

Physical examination and radiography performed at 12 months demonstrated no loss of correction and signs of structural instability (Fig. 5a). Bone-metal block was seen at the level of the mesh endofixator (Th11-L1) (Fig. 5b). No negative dynamics was noted in the neurological status. The patient's gait was confident, no additional support required with adequate posture. Control questionnaire showed VASa score of 0-1 points (standing = lying down) and ODI of 12 %.

Fig. 5 Radiograph (a) and CT scan (b) of the spine of patient Sh. At 12 months of the second operation

DISCUSSION

The treatment strategy for patients with OVCF of the thoracic and lumbar spine is often planned empirically due to the lack of generally accepted concepts of rehabilitation. Indications for cemented vertebral augmentation are one of the most controversial problems. Most specialists prefer conservative treatment of acute stable injuries (DGOU Type 1 and 2) referring to objective data on increased incidence of fractures of adjacent vertebrae after vertebro/kyphoplasty, which is recommended for stable pain [12, 13]. On the contrary, other authors suggested a more widespread use of vertebral augmentation in stable injury with a good analgesic effect and the possibility of early ambulation of patients [14, 15]. They reported the occurrence of fractures in adjacent vertebral segments due to progression of osteoporosis [16]. Both groups of specialists agreed that an unfavorable initial type of fracture (DGOU Type 3-5) or a complicated course of the pathology (progressive vertebral collapse and/or neurological symptoms) were indications for metal fixation [17]. An injury to the Th12 vertebra was detected in the patient in the early period of trauma and conservative treatment was prescribed without assessing the type of fracture with control radiography performed at 2.5 months after the onset of conduction neurological symptoms. Although the initial injury was difficult to be assessed without baseline radiographs, a rough collapse of the Th12 vertebral body (Fig. 1) with significant spinal cord compression (DPCC – 57 %) suggested a significant injury of DGOU Type 3. An adequate surgical intervention was needed in the early period (1 week) considering the type of fracture. In our opinion, short-segment transpedicular fixation of Th11-L1 with bone cement screw augmentation and balloon kyphoplasty of the Th12 vertebra could be optimal in this scenario.

Instrumented correction of a “fixed” deformity is required in the surgical treatment of patients with long-term consequences of OVCF, as in cases with ordinary

chronic injuries. Both isolated ventral and dorsal interventions and combined (staged) operations are used in modern surgery for this purpose [18]. Several surgical options were primarily considered for our patient, including one-stage dorsal correction which has been commonly used [19]. They explain their choice by routine dorsal anatomy and the possibility of avoiding traumatic abdominal approaches due to the introduction of various spinal osteotomy (SPO, PSO, VCR, VCD) [20, 21]. However, a safer ventral decompression was performed in the presence of severe anterior compression of the spinal cord in the patient, accompanied by decompensated conduction function [22]. In these circumstances, there was a question of choosing between staged surgical treatment (posterior/anterior; anterior/posterior/anterior) and isolated anterior intervention. The traumatic nature of operations should be minimized in elderly patients with the limited use of combined (multi-stage) interventions [23, 24]. Nevertheless, the techniques have their supporters, who consider this issue from the point of view of minimally invasive surgery [25, 26]. Other studies reported isolated anterior correction as a preferred option and, despite the complexity and traumatic nature of "anterior" surgery, the treatment can be effective in simple (without displacement) moderate kyphosis (up to 30°) and anterior compression of neural structures [27, 28].

Anterior decompression of the spinal canal structures and ventral correction of the kyphotic deformity with cement "augmentation" of the screws was considered an option with the patient's stable somatic condition, moderate kyphotic deformity and severe anterior spinal cord compression (Fig. 1). Screw augmentation in the bodies of instrumented vertebrae is supported by most specialists [29]. Screws augmented with bone cement are reported to significantly reduce the risk of instability in the dorsal and ventral methods [30, 31]. Despite the good clinical and radiological result of the operation radiographs and CT scans showed signs of unstable fixation at a short term (Figs. 2 and 3). Analysis of the possible causes of unsuccessful surgical treatment indicated inadequate instrumentation of the transitional thoracolumbar spine. Four screws were placed above the injury level, and only the L1 vertebra was included in the fixation zone below the fracture. The assembly provided prerequisites for a "lever" between the fixed spine and the mobile lumbar spine with the apex at the level of the L1 vertebra, and regular weight-bearing in osteoporotic patient led to a gradual kyphotization of the stabilized thoracolumbar spine. In these circumstances, the metal-cement conglomerate impaired the integrity of the anteroinferior part of the body and the endplate of the L1 vertebra, and migrated into the intervertebral disc L1-L2. An increased length of the construct due to L2 vertebra being included in the fixation zone allowed to avoid instability in the case. The reliability of anterior fixation in osteoporotic cases and advantages of extended ventral systems in elderly patients are to be considered.

Despite the paucity of publications reporting revision interventions in unstable anterior fixation, the available literature demonstrate the current trends in the surgery. Indications to abdominal revision (rethoracotomy, relumbotomy) are a most relevant issue. The authors prefer to avoid these operations due to the traumatic nature; therefore, isolated posterior stabilization of the spine is advocated in case of moderate clinical and radiological manifestations of failed anterior fixation [32].

Removal of anterior implants may be required if there is a risk of injury to internal organs, vessels and neural structures and during surgical treatment of secondary rigid deformities [33]. Dorsal fixation of the thoracolumbar spine with cement augmentation of the screws was used for the patient with unstable lower pole of the ventral metal construct in moderate kyphotic deformity, without gross dislocation of the implants. Satisfactory results at short and long terms of the dorsal intervention performed for the patient indicated the effectiveness of the surgical strategy employed.

CONCLUSION

Timely diagnosis and adequate treatment of OVCF in the acute period are key factors in the successful rehabilitation of patients. Indications for conservative or one of the options for surgical treatment can be identified according to morphological type of the primary lesion. The results of the clinical observation suggest that anterior fixation of the spine is associated with a high risk of unstable construct and might require an extended hardware in osteoporotic patients. Anterior instrumentation of a large number of vertebrae can reduce the risk of unstable fixation and increase invasiveness of the operation that can be inappropriate for elderly patients. Dorsal stabilization and spinal fusion without advance abdominal revision is practical for patients with failed anterior fixation that does not lead to significant secondary spinal deformity.

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The article was submitted 28.07.2022; approved after reviewing 05.08.2022; accepted for publication 19.12.2022.

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Conflict of interests and funding *The study was performed as part of the state research project "Development of a system for predicting and preventing adverse outcomes of surgical treatment of injuries of the thoracic and lumbar spine based on a comprehensive personalized analysis of the rate of vertebral repair", number of registration REDTW 122022700112-4.*