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Proximal Junctional Kyphosis after Extensive Spinal Fixation (PJK, PJF). Clinical Case of Complication and Treatment

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Purpose Our goal is to demonstrate a typical clinical situation that promotes the development of PJF and PJK, as well as a variant of surgical treatment of these complications. **Material and methods** A case of a fracture of the overlying vertebra above the level of metal fixation of the vertebra and development of proximal junctional kyphosis (PJF and PJK) in a patient operated for degenerative scoliosis of the lumbar spine. Repeated extended stabilization of the spine without cranial level protection resulted in the re-development of this complication. Vertebroplasty of the bodies of two vertebrae cranial from the fixed vertebral motor segment was performed in order to prevent the development of PJF and PJK and a hybrid fixation with a polymeric band on the cranial vertebral motor segment (VMS) was performed. **Result** Observation for a year confirms a good result of treatment. **Conclusion** Using vertebroplasty of two vertebrae cranial from the fixed vertebral motor segment with 7-8 ml of bone cement per vertebra prevented the possible development of PJF and PJK in the presented clinical observation and achieved a good clinical outcome. Laminar band fixation of the cranial VMS ensured the transition of the rigid system into a semi-rigid system in its proximal part, which also contributed to prevention of PJF and PJK.

Keywords: proximal junctional kyphosis (PJK), proximal junctional failure (PJF), fracture of adjacent vertebrae, osteoporosis, transpedicular fixation

Transpedicular fixation (TPF) is currently the "gold standard" in the treatment of injuries and diseases of both thoracic and lumbar spine that need correction and stabilization of affected vertebral motor segments (VMS) [1, 2]. This method of fixing the spine has been recognized by many authors as the most reliable. At the same time, there is a rather high risk of developing a so called proximal instability accompanied by a vertebral fracture that happens cranial from the fixed VMS in extended TPF [3–6]. According to the results of some clinical studies, such complications arise in 15.3–19.9 % of cases [7, 8]. These data confirm the clinical relevance of the search and justification of prophylactic measures for vertebral fractures adjacent to the fixed VMS. Ignoring that can result in a fracture and proximal junctional kyphosis (PJF, PJK) which will require a revision surgery.

Our aim was to demonstrate a typical clinical situation that promotes the development of PJF and PJK, as well as a variant of surgical treatment of these complications.

MATERIALS AND METHODS

Our clinical observation is a case of a developed proximal junctional kyphosis (PJF and PJK) in a patient operated for degenerative scoliosis of the lumbar spine

Patient S., 56 years old, was hospitalized to our clinic on 24.11.2014 with the diagnosis of degenerative scoliosis in the lumbar spine, stenosis of the spinal canal at L2–S1 level,condition developed after microdiskectomy in L2–L3 (2001), L4–L5 (2009), aseptic postoperative discitis in L2–L3, frontal and sagittal disbalance of the spine. Associated conditions were IHD, angina of tension in grade I-II, hypertensive disease of stage III (Risk 4, CHF I-II, NYHA), diabetes mellitus type II of moderate severity, rheumatoid arthritis of stage I of activity (late stage), toxico-dismetabolic polyneuropathy in motor-sensory form, occlusive thrombosis of the popliteal vein of the right lower limb without flotation.

Upon admission, the patient complained of intense pain in the lumbar spine with irradiation to the lower extremities, more pronounced on the right and increasing with movements and walking (up to 9 VAS points in the lower back, 8 points in the right and 6 points in the left lower extremities). From the anamnesis of the disease it was established that the pain in the back was a trouble for more than 25 years. In 2000, the pain syndrome significantly increased and irradiated to the anterior surface of the right thigh. According to MRI taken in 2000, a right-sided paramedian intervertebral hernia

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at the level of L2–L3 was diagnosed. She had an operation of microdiscectomy of L2–L3 in 2001. After the operation, acute radicular pain was gone but lumbalgia persisted. In 2009, a sequestered hernia at the L4–L5 level was diagnosed on the left. In the same year, microdiscectomy of L4–L5 was performed. In 2014, lumbargia and radicular pain significantly increased. Conservative treatment was ineffective. She was hospitalized due to persistent pain and suspected L2–L3spondylodiscitis.

At the time of hospitalization, the general condition was of moderate severity. She had an antalgic gait with support on the walker. Signs of radiculopathy at L2 from both sides, L3 on the right, L4 on the left, L5, S1 on the right were objectively revealed. X-ray examination showed the absence of lumbar lordosis, disorder of the frontal axis of the lumbar spine due to pronounced degenerative-dystrophic changes with the formation of right-side lumbar scoliosis. Signs of aseptic discitis at L2–L3 and L4–L5, combined discogenic and arthrogenic stenosis of the vertebral canal were revealed (**Fig. 1**).

The patient underwent surgery on 26.11.14: TPF throughout L2–S1-os ilium with a 12-screw system; decompressive facet-flavectomy at the level of L2–L5; laminectomy L2–L3; meningoradiculolysis at the levels of L2–L3, L4–L5; correction of scoliotic deformation; TLIF L2-S1 (4 VMS). The duration of the operation was 420 minutes with blood loss of 800 ml.

Intraoperatively, a critical stenosis was detected at all levels operated, as well as epidural fibrosis at the L4–L5 level on the left and L2–L3 on the right. At the level of L2–L3, a fairly coarse dorso-lateral scar was found with a large number of soft tissues on the dura mater (probably damage to the dura mater during the previous operation with the performed plasty). Meningoradiculolysis was performed at both levels (L2–L3 and L4–L5). The surgery achieved correction of the frontal and sagittal profiles of the spine and adequate decompression was performed. The position of the screws and inter-body implants was correct which was confirmed by CT (**Fig. 2**).

After the operation, there was a temporary aggravation of the neurological deficit: reduction of muscular strength in the proximal group of the right thigh in the zone of innervation of L2, L3 nerve roots to 1.5-2 points. In the early postoperative period, hormonal, vascular and anti-inflammatory therapy was administered in combination with physical and exercise therapy. The wound healed by primary intension. The motor function restored by the 16th day after the operation. She was discharged on the 21st day after the operation to be followed up by a neurologist, underwent rehabilitation in outpatient settings at her residence clinic, completely adapted to everyday conditions and independently ambulated without means of additional support to a distance of up to 2-4 km daily.

At nine months after the operation (August 14, 2015), after an awkward movement, pain sharply increased (up to 9 points of VAS scale) in the upper lumbar spine after which any movement in bed caused a sharp growth of pain.

Computed tomography was performed upon admission to the clinic which revealed instability of the screws in the body of L2 and the fracture of L1body. Transpedicular screws in the bodies L3, L4, L5, S1 and os ilium were stable. In the interbody spaces of L2–S1, the bone block was forming (**Fig. 3**).

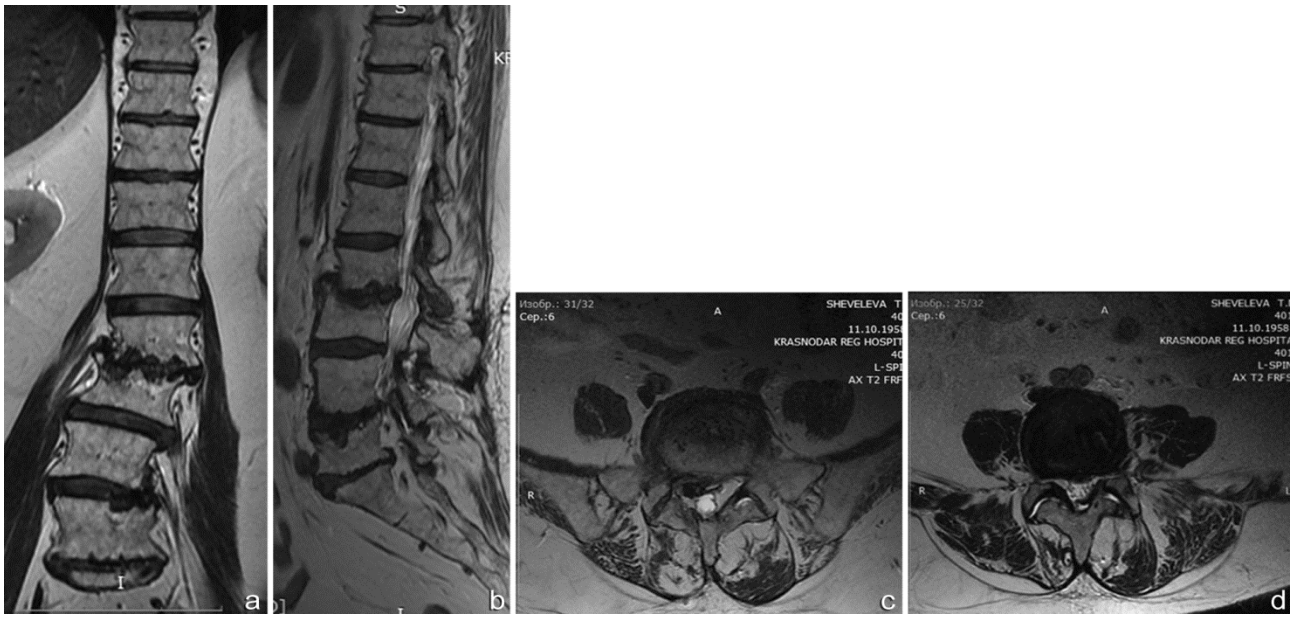

Fig. 1 MRI scans of the spine of patient S. at primary admission to the clinic on 24.11.2014: (**a**) coronary projection; (**b**) sagittal projection; (**c, d**) - axial slices

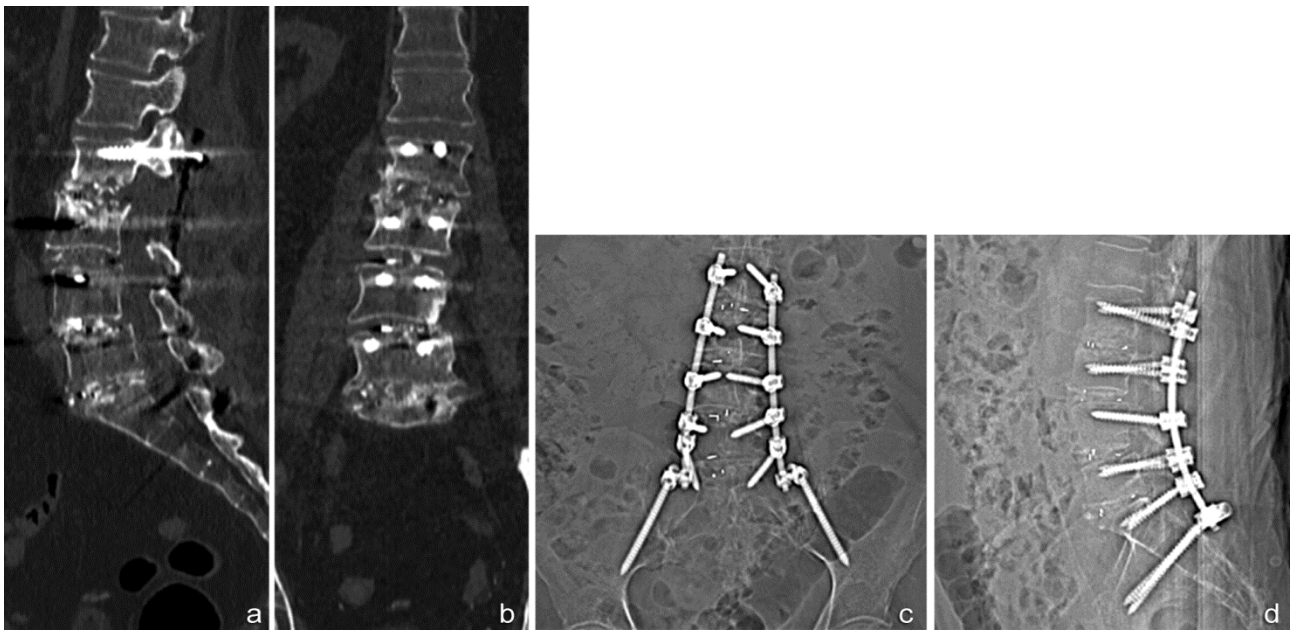

Fig. 2 CT scans of the spine (**a, b**) and spondylograms (**c, d**) of patient S. after the first surgery in the clinic

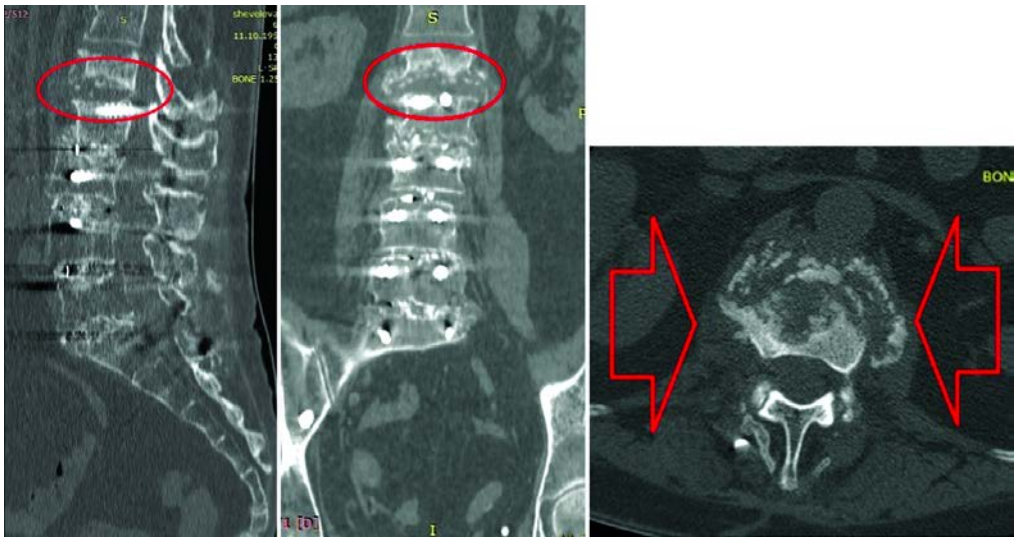

Fig. 3 CT scans of the spine of patient S. with signs of screw instability in L2 on the left. Fracture of the lower part of the vertebra L1

To eliminate the complication, a staged surgical treatment was performed. The first stage on 18.08.2015 included re-fixation of the spine, TPF throughout Th10-Os Ilium with a 17-screw system using revision screws at L2 level (d = 7 mm). The duration of the operation was 75 minutes with blood loss of 200 ml. The revision operation arrested pain. On the control CT, the frontal and sagittal profile of the spine was normal; the position of the screws was satisfactory (**Fig. 4**). Primary healing, sutures were removed on the 14th day and the patient was discharged to be followed up by a neurologist in outpatient settings.

She was hospitalized for the second surgical stage on 14.09.2015. Operation was performed on 15.09.2015 and included a left-side thoracotomy, diaphragmotomy, L1 corporectomy, Th12–L2 corporodesis with a container-type implant with autograft.

The duration of the operation was 100 minutes with the blood loss of 300 ml. According to the control CT, the position of the metal structure was satisfactory. At the TLIF level, L2–S1 bone block was formed (**Fig. 5**). Primary healing, and the patient was discharged on 02.10.2015 in a satisfactory condition.

Three months after the transplevral corporodesis, a sudden pain in the lower thoracic spine appeared on 02.12.2015 (9 points according to VAS). The patient was taken to the clinic. CT scan revealed the instability of the screws in Th10, a fracture of the Th9 body (**Fig. 6**). Screws below Th10 were without any signs of destabilization. At the level of TLIF, L2-S1 showed interbody fusion. The interbody implant in Th12–L2 without signs of destabilization in the stage of ongoing fusion.

Fig. 4 CT reformation of the spine of patient S. after Th10-S1-Os Ilium revision fixation. 18.08.2015

Fig. 5 CT scans of the spine of patient S. after a corporectomy L1, corporodesis Th12–L2 with a container-type implant and autograft on 15.09.2015

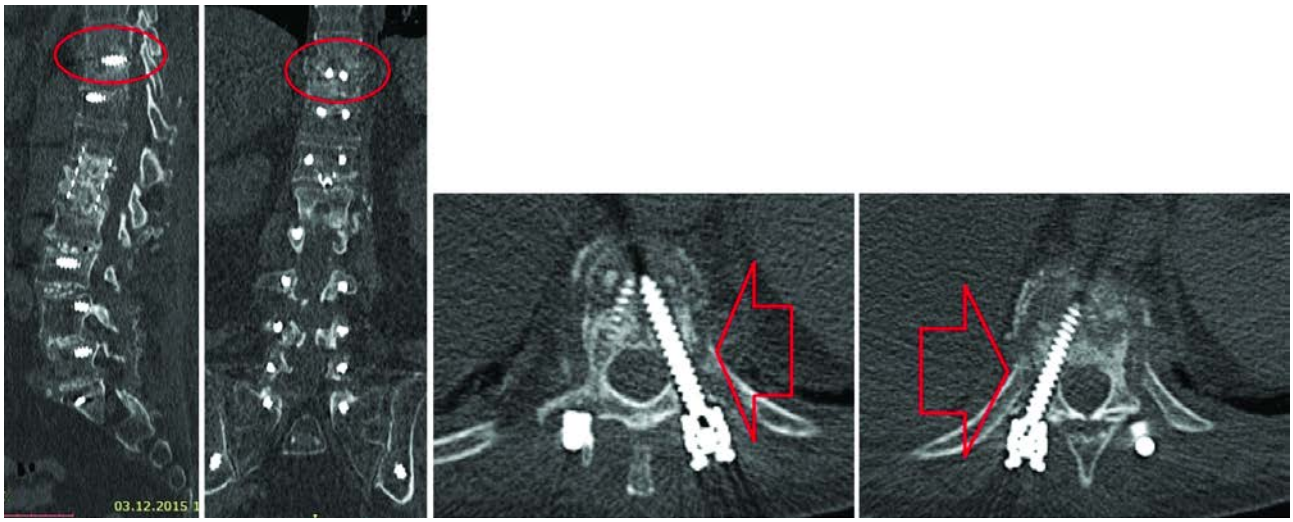

Fig. 6 CT scans of the spine of patient S. with signs of destabilization of the screw in Th10 and fracture of the body Th9

The recurrence of PJF and the emerging PJK was an indication for a revision operation involving an extension of cranial fixation. It was decided to use hybrid fixation with laminar cranial elements, as well as PJF prophylaxis by vertebroplasty of the adjacent vertebra cranial with respect to the stabilized VMS. Taking into account the planned protocol of stabilization of the spine, the Th6 vertebra was chosen for transpedicular screws implantation. Th4 and Th5 we left for preventive measures which included a planned puncture vertebroplasty of Th4 and Th5 vertebrae and laminar fixation with a "Universal Clamp" system for the Th5 arch (**Fig. 8**). In the case of a delayed onset of a fracture (PJF) over the metal structure and vertebrae with preventive vertebroplasty (Th3), we left the chance for extension of the metal structure to the level of the ocipitospondylodesis with fixation points in the upper thoracic region (Th1, Th2).

The operation was performed on December 7, 2015 and included revision TPF of the spine from Th6 to Os Ilium with additional laminar Th5 fixation by the "Universal Clamp" system; puncture cement vertebroplasty of Th4, Th5 bodies. In order to reduce the invasiveness, duration of the operation and blood loss, it was decided to have a partial access only to the cranial part of the spinal construct and incomplete replacement of the rods. To do this, connectors were used for bars d = 5.5 mm (end-to-end) (**Fig. 7** and **Fig. 8**). The duration of the operation was 60 minutes with blood loss of 400 ml.

For the publication of this material, informed consent was obtained from patient on the use of her non-personalized medical data.

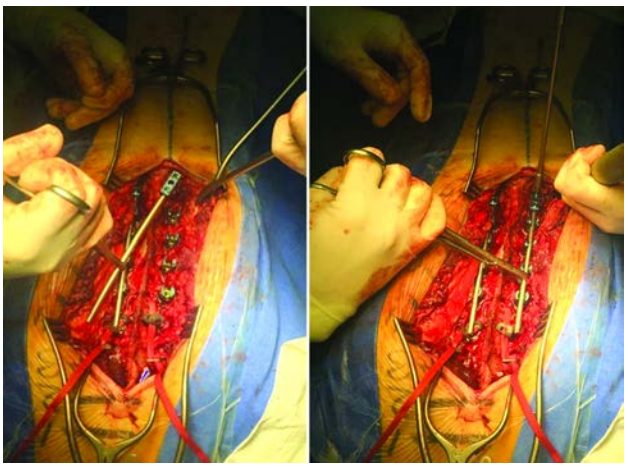

Fig. 7 Installation of the cranially extending part of the implant; connection to a previously implanted construct using connectors

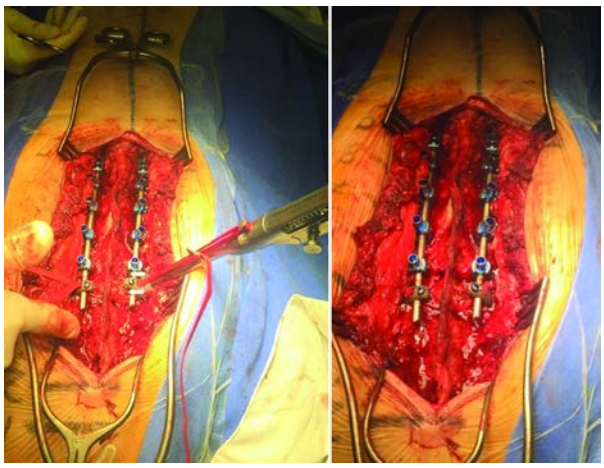

Fig. 8 Mounting of laminar bands on the top of the extended structure (Th5)

RESULTS

The follow-up examination of the patient was carried out in August 2016 and January 2017 (**Fig. 9**). Her general state of health is satisfactory. She ambulates independently without additional means of support. Back pain at rest is 2 VAS points while during walking 4 points. Pain in the legs at rest is 1 VAS point and by walking is 2 points. She is able to walk up to 4-6 km daily.

According to CT control, the spine is fixed with an extended hybrid metal structure from Th5 throughout to Os Ilium. In Th4 and Th5 bodies, vertebroplasty was performed. The level of Th5 is fixed with the laminar band "Universal Clamp". At the level of Th9-Th11, there are connectors. The position of interbody implants is satisfactory. There are no signs of metal structures instability (**Fig. 10**).

Fig. 9 Photos of the patient after surgical treatment

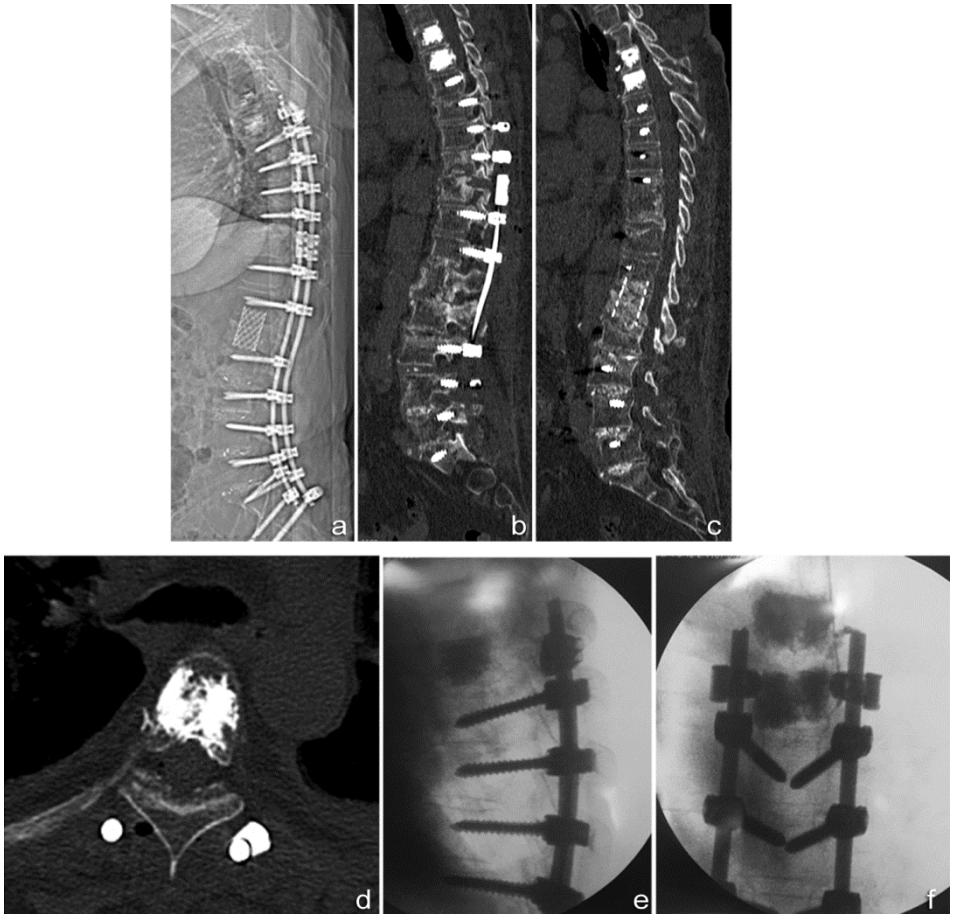

Fig. 10 Control radiographs and CT scans of the spine of patient S. after the completion of surgical treatment. The spine is fixed by an extended hybrid metal structure from Th5 throughout to Os Ilium (**a, b, c**). At the Th9–Th11 level, the connectors (**a, b**) vertebroplasty (**d, e, f**) in the bodies of Th4, Th5 are seen. Th5 level is fixed with the laminar band "Universal Clamp" (**e, f**)

DISCUSSION

One of the ways to prevent PJF and PJK by extended spinal metal fixation is the use of hybrid systems using hooks or polymer bands on cranial VMS. The hybrid system forms a semi-rigid region over rigidly stabilized VMS, which reduces the likelihood of the above complications [4]. In order to prevent the development of PJF and PJK, we proposed vertebroplasty of the body of the adjacent vertebra, cranial from the fixed VMS [9]. The effectiveness of this method of prevention was proven in experimental studies [10, 11].

The clinical case presented by us confirms that in TPF the mechanically weakest vertebra is the upper stabilized vertebra and the adjacent cranial vertebra. Despite the presence of osteoporosis, none of the screws in the middle and lower part of the implanted structure destabilize during the observation. Interbody fusion provided the formation of a ventral bone-and-metal block, which, in our view, guarantees the stability of the metal structure throughout the fused VMS. Nevertheless, the upper instrumented vertebra and adjacent cranial vertebra remained problematic. The reason for this, in our opinion, is non-physiological mechanical conditions that arise in the transition zone between the rigidly fixed VMS and the free mobile cranial region of the spine. The presence of osteoporosis creates the prerequisites for a more rapid instability of the proximal pair of screws and cranial vertebra fracture.

CONCLUSION

In the presented clinical observation, the use of vertebroplasty of two vertebrae, cranial from fixed VMS, with 7-8 ml of cement per vertebra prevented the possible development of PJF and PJK and achieved a good clinical outcome. Laminar band fixation of the cranial VMS ensured the transition of the rigid system into a semi-rigid one in its proximal part, which also contributed to the prevention of PJF and PJK.

REFERENCES

1. Krut'ko A.V. *Khirurgicheskaia taktika i organizatsiia spetsializirovannoi pomoshchi bol'nym s degenerativno-distroficheskimi zabolevaniiami poiasnichnogo otdela pozvonochnika*. Avtoref. dis. dokt. med. nauk [Surgical tactic and organizing specialized medical care for patients with degenerative-dystrophic diseases of the lumbar spine. Extended abstract of Dr. med. sci. diss.]. Novosibirsk, 2012. (In Russian).
2. Shapovalov V.M., Dulaev A.K., Shulev Iu.A., Orlov V.P., Nadulich K.A., Teremshonok A.V. Ortopedicheskie aspekty khirurgicheskogo lecheniia bol'nykh degenerativno-distroficheskimi zabolevaniiami poiasnichno-kresttsovogo otdela pozvonochnika [Orthopedic aspects of surgical treatment of patients with degenerative-dystrophic diseases of the lumbosacral spine]. *Khirurgiia Pozvonochnika*, 2005, no. 3, pp. 61-70. (In Russian).
3. Hassanzadeh H., Gupta S., Jain A., El Dafrawy M.H., Skolasky R.I., Kebaish K.M. Type of anchor at the proximal fusion level has a significant effect on the incidence of proximal junctional kyphosis and outcome in adults after long posterior spinal fusion. *Spine Deform*., 2013, vol. 1, no. 4, pp. 299-305. doi: 10.1016/j.jspd.2013.05.008.
4. Helgeson M.D., Shah S.A., Newton P.O., Clements D.H. 3rd, Betz R.R., Marks M.C., Bastrom T.; Harms Study Group. Evaluation of proximal junctional kyphosis in adolescent idiopathic scoliosis following pedicle screw, hook, or hybrid instrumentation. *Spine*, 2010, vol. 35, no. 2, pp. 177-181. doi: 10.1097/BRS.0b013e3181c77f8c.
5. Kim Y.J., Bridwell K.H., Lenke L.G., Kim J., Cho S.K. Proximal junctional kyphosis in adolescent idiopathic scoliosis following segmental posterior spinal instrumentation and fusion: minimum 5-year follow-up. *Spine*, 2005, vol. 30, no. 18, pp. 2045-2050.
6. Kim Y.J., Lenke L.G., Bridwell K.H., Kim J., Cho S.K., Cheh G., Yoon J. Proximal junctional kyphosis in adolescent idiopathic scoliosis after 3 different types of posterior segmental spinal instrumentation and fusions: incidence and risk factor analysis of 410 cases. *Spine*, 2007, vol. 32, no. 24, pp. 2731-2738.
7. Fernández-Baíllo N., Sánchez Márquez J.M., Sánchez Pérez-Grueso F.J., García Fernández A. Proximal junctional vertebral fracture-subluxation after adult spine deformity surgery. Does vertebral augmentation avoid this complication? A case report. *Scoliosis*, 2012, vol. 7, no. 1, pp. 16. doi: 10.1186/1748-7161-7-16.
8. Trout A.T., Kallmes D.F., Kaufmann T.J. New fractures after vertebroplasty: adjacent fractures occur significantly sooner. *AJNR Am. J. Neuroradiol*., 2006, vol. 27, no 1, pp. 217-223.
9. Afaunov A.A., Takhmazian K.K., Lysykh E.G. Khirurgicheskoe lechenie povrezhdenii grudnogo i poiasnichnogo otdelov pozvonochnika na fone osteoporoza [Surgical treatment of the injuries of the thoracic and lumbar spine through osteoporosis]. *Problemy osteoporoza v travmatologii i ortopedii: materialy V konf. s mezhdunar. uchastiem* [Osteoporosis problems in traumatology and orthopaedics: Materials of V Conference with international participation]. M., 2012, pp. 56-57. (In Russian).
10. Basankin I.V., Takhmazian K.K., Afaunov A.A., Ptashnikov D.A., Ponkina O.N., Gavriushenko N.S., Malakhov S.B., Shapovalov V.K. Sposob profilaktiki perelomov smezhnykh pozvonkov pri transpedikuliarnoi fiksatsii na fone osteoporoza [A technique to prevent adjacent vertebrae fractures for transpedicular fixation through osteoporosis]. *Khirurgiia Pozvonochnika*, 2016, vol. 13, no. 3, pp. 8-14. (In Russian).
11. Kebaish K.M., Martin C.T., O'Brien J.R., LaMotta I.E., Voros G.D., Belkoff S.M. Use of vertebroplasty to prevent proximal junctional fractures in adult deformity surgery: a biomechanical cadaveric study. *Spine J*., 2013, vol. 13, no. 12, pp. 1897-1903. doi: 10.1016/j.spinee.2013.06.039.

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