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CASE REPORT

Revision strategy and follow-up for implant failure in a case of combined anterior and posterior reconstruction after three-level en bloc vertebral body replacement and replacement of the aorta for chondrosarcoma of the thoracic spine

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Abstract

Objective In 2013, we reported a case of combined anterior and posterior reconstruction after three-level en bloc vertebral body replacement and replacement of the aorta for chondrosarcoma of the thoracic spine. Eight years after, we observed an implant failure and now report on revision strategy and 2-year follow-up (f/u) after revision.

Methods We report about the 2-year f/u of the same now 51-year-old gravedigger who needed to undergo revision surgery after implant failure. We did a combined anterior and posterior correction vertebral interbody fusion by (1) removal of broken screws in Th9 and L2, removal of broken titanium bars, correction of kyphosis, enhancement of the vertebral interbody fusion from Th8 to L4 using monoaxial titanium screws and cancellous bone transplantation and (2) removal of the broken plate and the loose cage, implantation of a novel expandable PEEK cage from Th11 to L1 and anterior stabilization from Th9/10 to L2/3, as well as autologous and allogeneic cancellous bone transplantation.

Results Two years after revision surgery, the patient presented fully reintegrated without any complains. No painkillers needed to be taken. Pain was reported with 2 out of 10 on the VAS.

Conclusion Both procedures offer a good primary stabilization with excellent pain reduction and good return to life. Limited information on long-term survivors is known. Therefore, the theoretical advantage of a biological solution needs to be checked in the long-term f/u for consistency.

Keywords Correction vertebral interbody fusion · Three-level en bloc vertebral body replacement · Chondrosarcoma · Spine

Introduction

Multilevel vertebral body replacement and vertebral interbody fusion were first described by Stener in 1971 and became a well-established technique which, however, remains a rare situation with very limited indications [9, 11, 13, 15, 19, 21]. The common principle is a posterior vertebral interbody fusion with tension band and anterior cage interposition for load transmission [11]. We recently reported the first case of a 51-year-old gravedigger who underwent three-level en bloc vertebral body replacement with combined replacement of the aorta after chondrosarcoma (G2, R0) in 2007 [9]. We performed constant at least yearly f/u during which the patient showed himself fully reintegrated to daily life. Between 2014 and 2015, a successive screw pullout and implant failure was observed, and we therefore saw the indication for revision surgery. We now want to report about the 2-year f/u with special emphasis on the different vertebral interbody fusion procedure.

Case

This case is a 9-year f/u after initial wide en bloc resection of Th11 to L1 with partial replacement of the aorta, cage interposition, cement augmentation and anterior–posterior stabilization and 2 years after revision surgery with

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two-stage anterior–posterior correction vertebral interbody fusion by (1) posterior removal of broken screws in Th9 and L2, removal of broken titanium bars, correction of kyphosis, enlargement of the vertebral interbody fusion from Th8 to L4 with monoaxial titan screws and cancellous bone transplantation and (2) anterior removal of the broken plate and the loosened cage, implantation of an expandable PEEK cage from Th11 to L1 and anterior stabilization from Th9/10 to L2/3 as well as autologous and allogeneic cancellous bone transplantation (Figs. 1, 2, 3, 4).

Initially after 1-year back pain, MRI showed a histologically confirmed chondrosarcoma (G2) surrounding the Th11 to L1 vertebral bodies which embraced more than 50% of the aorta. The tumor was classified as Tomita type 6, and en bloc resection was performed [7, 9, 21].

Postoperatively local radiation with 54 grays of Th9 to L2 was performed. Nearly half a year after operation, the patient could start rehabilitation and was fully reintegrated. Eight years after the operation, we observed a successive screw pullout and implant failure and we therefore saw the indication for revision surgery (Fig. 2). Operation time was (1) 301 min and (2) 598 min, and intraoperative blood transfusion was 0 ml and 1370 ml (5 EK), respectively. Total time in hospital was 22 days with 1 day on the ICU after the posterior stabilization and 2 days after the anterior stabilization. The patient could be discharged without neurovascular deficit and only limited pain on the visual analogous scale (VAS) 2/10.

Two years after revision surgery, the patient presented fully reintegrated without any complains (Fig. 5). No painkillers needed to be taken. Pain was reported with 2 out of 10 on the VAS. He reported free walking distance. The patient reported that he is able to work as a gravedigger and regularly carries coffins although we insistently urged him to avoid heavy weight carrying. Neurological evaluation showed no neurovascular deficit with full power for both lower extremities. F/u CT scan of the thoracolumbar spine showed no hint for implant failure (Fig. 3). The preoperative kyphosis was corrected as shown in Fig. 6.

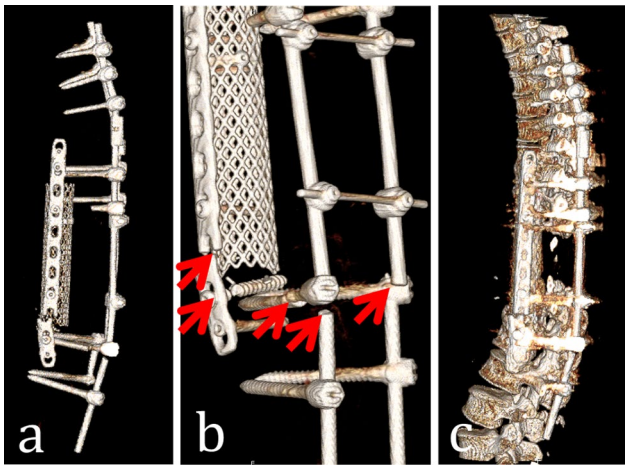


Fig. 2 F/u 04/2015 3D CT scan of the spine. A situation after anterior–posterior stabilization during the 2015 control. The patient has back pain. Red arrows: indicating the location of implant failure, **a** lateral few on the 3D spin. Only the implants are shown. Distal screws, bars and the plate are broken, **b** detailed few in the implant failure, the distal part is fully separated from the proximal part, and **c** implants are shown in relation to the spine

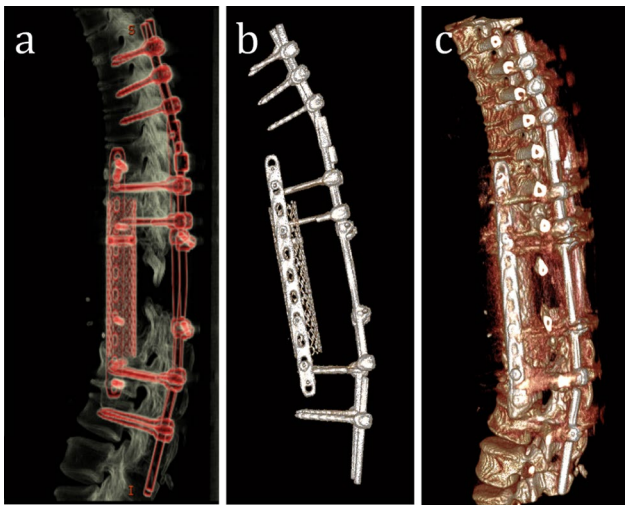


Fig. 1 F/u 02/2015 3D CT scan of the spine. A situation after anterior–posterior stabilization during the 2015 control. The patient has no complains. **a** Lateral few on the 3D spin with implants in slight red: **b** only the implants are reformatted, and **c** implants are well integrated. No hint for implant failure. No fracture

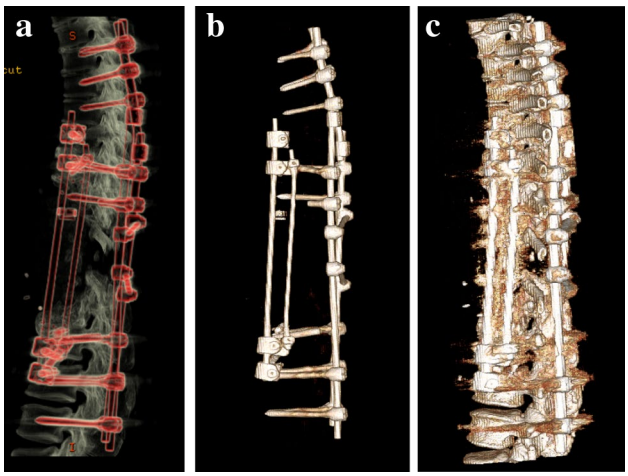


Fig. 3 F/u 05/2016 3D CT scan of the spine. A situation 1 year after anterior–posterior revision surgery in 2015. **a** Overview of the situs during the anterior: **b** only the implants are reformatted, and **c** implants are well integrated. No hint for implant failure. No fracture

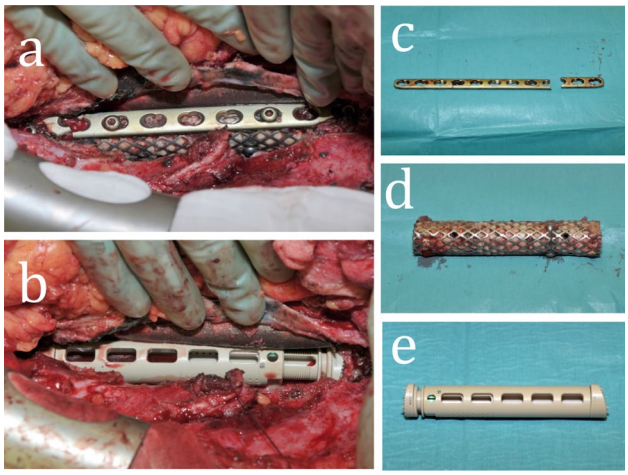


Fig. 4 Intraoperative documentation of revision surgery in 2015 with posterior correction vertebral interbody fusion, anterior replacement of the titanium cage and insertion of the PEEK cage. **a** Situs with broken anterior bar and loosened cage before removal, **b** detailed look at the PEEK cage in situ, **c** close-up on the broken plate, **d** removed cage, **e** PEEK cage

Discussion

We would like to discuss the following two aspects. First, the tumor expansion determines the type of resection and is strongly associated with the long-term outcome. In this case, en bloc resection was performed which was a hazardous procedure but was necessary to be curative according to the long-term survival [2, 4, 5, 11, 13–15].

However, limited experience on reconstruction techniques in long-term-survivors is known. Therefore, secondly, we would like to discuss the stabilization as in this case two different procedures have been used with failure of the initial surgery. Both in common is the anterior–posterior procedure and the combination of a posterior tension wiring like stabilization as well as the anterior space-filling load-holding column. In this case, the mechanical axis could be restored and the thoracolumbar angle (Th10-L2) as a parameter of the kyphosis was corrected from 22° before the first operation and 19° before the second operation, respectively, to 12° and 2° after the first and second operation, respectively. The pelvic incidence is a fundamental parameter for regulation of spinal sagittal curve. It equals the sum of pelvic tilt and sacral slope and is a constant individual parameter with a mean of 53 ± 10 in adult men [3]. The lordosis is largely related to the orientation of the pelvis expressed by the sacral slope with a mean of 41 ± 8 in adult men.

As the anterior fusion limits the overall result, with high nonunion rates up to 70% even after single-level anterior lumbar interbody fusion, we reconsidered the anterior fusion strategy after implant failure [1, 16, 20], whereas during the first operation, a cement augmented rigid cage was used, and during the second operation, an expandable PEEK cage with autologous and allogeneic cancellous bone transplantation was used. The major difference between both procedures was the time, following radiation and the resulting bone quality. After the first operation, an adjuvant radiation was planed. As radiation leads to loss of bone mass, a high risk of secondary loosening was anticipated and tried to be avoided. Therefore, we used a rigid cage with cement augmentation, which gives high primary stability. We added an anterior plate to give further stabilization [5, 10]. A biological situation would have been highly questionable, as during the radiation healing would have been prolonged or even impossible. The danger of an enlarged stress shielding at the bone implant interface by a too rigid fixation was accepted to reduce the risk of an early implant failure by screw cutout as a result of the osteoporotic bone. At the time of the revision surgery, we expected good, healthy, not osteoporotic bone which enabled us to use an expandable PEEK cage which is closer to the normal oscillation behavior of the spine and added cancellous bone for a biological reconstruction [5, 8]. An adequate solution between rigidity and stability needed

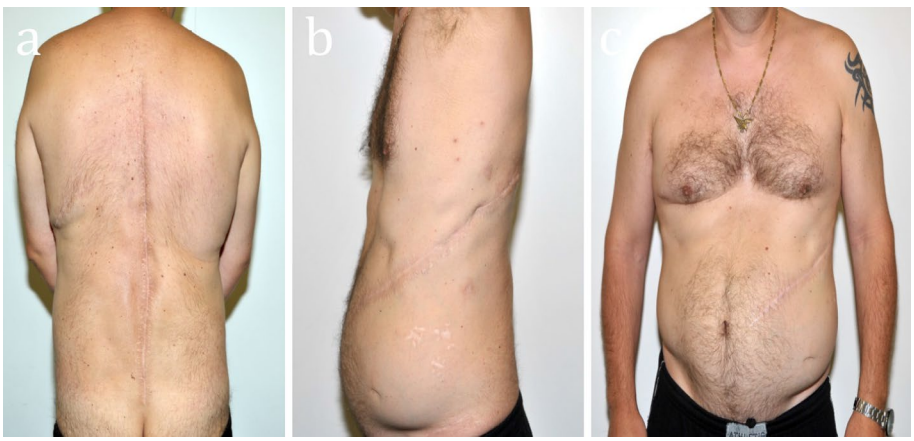
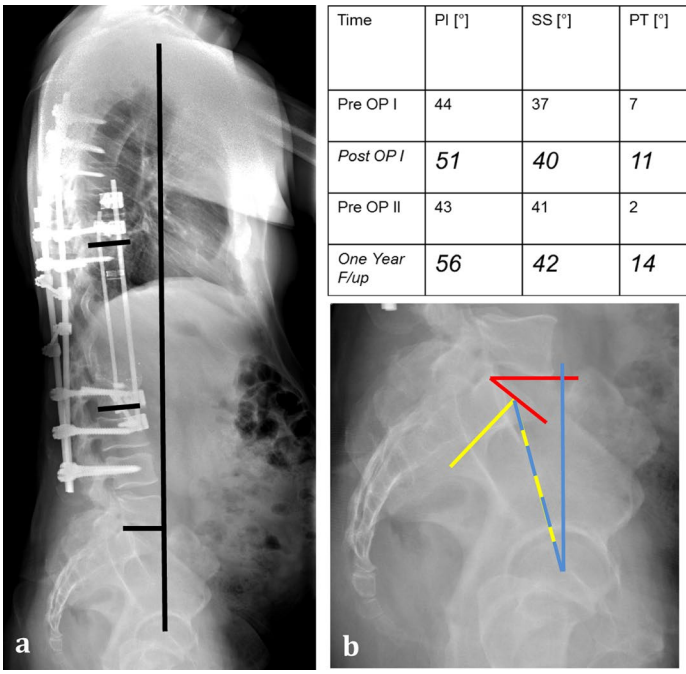


Fig. 5 Clinical F/u in 2016. The patient has no complains and only little pain VAS 2/10. **a–c** Inspection of the chest and abdomen with completely healed scars. Straight alignment of the spine



Time	PI [°]	SS [°]	PT [°]	C7Lot-S1 Distance [cm]	TLA [°]
Pre OP I	44	37	7	8.8	22
Post OP I	*51*	*40*	*11*	*3.6*	*12.6*
Pre OP II	43	41	2	3.3	19
One Year F/up	*56*	*42*	*14*	*5.0*	*2*

Fig. 6 One year postoperatively after revision surgery: **a** sagittal image with the C7 lot and the distance from the posterior edge of S1 to the lot with 5 cm indicating compensated imbalance. The thoracolumbar angle (TLA) with 2° is within the normal range. **b** Showing in red the sacral slope (SS), in yellow the pelvic incidence (PI) and in blue the pelvic tilt (PT), all values are within normal range. The table shows the measurements of the f/up with each time preoperative decompensation, with enlarged TLA, and reduced PI. After the initial surgery and, respectively, after the revision surgery, both the TLA and the PI were corrected

to be found as initial rigidity enlarges stress shielding at the bone implant interface [5]. As the PEEK cage has a higher primary, better adaptable stability, there was no need for the anterolateral plate [5, 6]. During the initial operation due to the anticipated loss of bone mass, it was important to get further stabilization by the anterior plate. Although over the time and additional regain of bone mass to a stable fixation certainly led to an implant failure due to the not physiological oscillation behavior [8, 10]. Therefore, we decided to use a more elastic anterior wire-stabilization system, which was additionally necessary as only a four-point anterior stabilization results in sufficient stability [5, 18]. An initially advantage in case of stress shielding by a strong fixation in the osteoporotic bone is accompanied by a higher risk of stress shielding and implant failure in the healthy bone [5]. Finally, the enlargement of the posterior fixation defines and increases the primary stabilization and is furthermore the tool for an adequate kyphosis correction [5].

However, according to Pumberger et al., osseous integration even in biological reconstructions was not observed in any of the patients after anterior fusion of multilevel vertebral body replacement. They could show that after biological reconstruction of the load-bearing anterior column in the PET-CT control, no spinal fusion could be seen. The general problem of multilevel en bloc vertebral body replacement and stabilization is, however, the anterior spinal fusion [17]. As the initial strategy was certainly non-biological without any chance of anterior fusion, our aim during revision surgery was the anterior fusion and mechanical stable reconstruction. Alternative reconstruction options like fibula or rib autografts from rather small case series show only limited and very heterogeneous results [12, 22].

The situation described by Pumberger et al. is different to our revision surgery. They discuss that in all their cases a postoperative radiation or chemotherapy reduced the osseous integration as we expected before initial surgery. We nevertheless did expect a normal healthy situation and adequate anterior fusion during revision surgery as no postoperative adjacent therapy was performed. In our case, the rather short follow-up with this excellent clinical function and stability after revision surgery might mask an ongoing micromovement without osseous integration, fusion and prolonged reimplant failure. Therefore, more satisfying data on the long-term survival of anterior–posterior spinal fusion need to be collected to hint at future stabilization strategies.

Conclusion

We conclude reconstruction strategies following column resections of tumors in the thoracic spine have to be balanced between optimal anti-tumor and biomechanical goals. Although an implant failure with a non-biological solution had to be expected after initial surgery on the long run, the long-term outcome and osseous integration after revision surgery with a biological reconstruction are unclear, too. Both procedures offered a good primary stabilization with excellent pain reduction and good return to life. We expect better long-term results with the now more biological solution.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

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