



En bloc spondylectomy in patients older than 60 years: indications, results and complications in a series of 37 patients

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Abstract

Purpose To review a series of patients > 60 years affected by primary spine bone tumors, who have undergone surgery, and to describe their clinical presentation, results and complications associated with surgical treatment.

Methods A review of all patients > 60 years affected by primary spine bone tumor surgically treated with en bloc spondylectomy from 1993 to 2015 was performed. Thirty-seven cases were identified, and clinical and radiological characteristics, therapy, complications and survival were evaluated.

Results Only 14/37 cases were not previously treated. Complications were quite frequent: 64% of patients experienced almost one early complication; 48% and 27% experienced 2 and ≥ 3 early complications, respectively; 37% of patients experienced almost one late complication; and 10% and 8% experienced 2 and ≥ 3 late complications, respectively. Massive blood loss and dural tear were the more frequent surgical complications; no deaths were reported during surgeries; one patient died during the first postoperative day due to hemorrhage and cardiac complications, one during the third postoperative day for the same cause despite of a savage surgery, and another one died at 7 days from index surgery due to myocardial infarction. The 5-year disease-related survival and global survival were 62.8% and 52.1%, respectively. Nineteen patients are still alive, 15 of whom without any evidence of disease.

Conclusions Primary malignant or locally aggressive bone tumors of the spine should be treated with wide surgery also in the older age, although the complications rate and the risk of patient survival can be considered high.

Graphical abstract

These slides can be retrieved under Electronic Supplementary Material.

Key points

- Purpose:** To review a series of patients >60 years affected by primary spine bone tumors, which have undergone surgery, and to describe their clinical presentation, results and complications associated with surgical treatment.
- Methods:** A review of all patients >60 years affected by primary spine bone tumor surgically treated with en-bloc spondylectomy from 1993 to 2015 was performed. Thirty-seven cases were identified, and clinical and radiological characteristics, therapy, complications and survival were evaluated.

Take Home Messages

Primary malignant or locally aggressive bone tumors of the spine should be treated with wide surgery also in the older age although the complications rate and the risk for patient survival can be considered high.

Survival Curves:

- A) Overall survival (OS) Kaplan-Meier curve: 52.1%
- B) disease-related (CRS) Kaplan-Meier curve: 62.8%

Textual Summary:

- Only 14/37 cases were not previously treated.
- Complications were quite frequent: 64% of patients experienced almost one early complication; 48% and 27% experienced 2 and ≥ 3 early complications, respectively; 37% of patients experienced almost one late complication; and 10% and 8% experienced 2 and ≥ 3 late complications, respectively.
- No deaths were reported during surgeries; one patient died during the first post-operative day for massive blood loss and cardiac complications, one during the third postoperative day for the same cause despite of a savage surgery and another one died at 7 days from index surgery for myocardial infarction.
- The 5-year disease-related survival and global survival were 62.8% and 52.1%, respectively. Nineteen patients are still alive, 15 of whom without any evidence of disease.

Keywords En bloc spondylectomy · Older age · Spine surgery · Wide surgery · Spine tumor

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Extended author information available on the last page of the article

Introduction

Wide surgery is considered to be the mainstay treatment for several primary bone tumors, including those of the spine, where this means to perform an en bloc spondylectomy (EBS) [1, 2]. EBS is usually considered a high-demanding surgery, technically difficult and with a high rate of precocious and tardive complications and a consistent risk of death, both intraoperatively and postoperatively [2]. This is also true in older patients, who often present multiple comorbidities. Nevertheless, EBS can be the only therapy for specific malignant histologies, but also for some benign but aggressive histotypes where local recurrences could be too dangerous and difficult to treat [3, 4]. However, to our knowledge, only scant evidence is available on the specific outcomes of EBS in elderly patients.

The objective of the current study is to review a series of 37 patients older than 60 years, affected by primary spine bone tumors, who have undergone EBS, and to describe clinical presentation, tumor characteristics, results and complications associated with surgical treatment.

Patients and methods

A review of patients affected by primary bone tumors of the spine, who underwent EBS by one of the authors from 1993 to 2015, was carried out. Patients aged > 60 years were considered for analysis.

In all cases, the diagnoses were based on the preoperative histology performed by an expert pathologist trained in muscular-skeletal tumors; CT-guided biopsy was performed in all cases where previous diagnosis was not available. A total body CT scan was carried out to exclude distant metastases and spine MRI to better identify the intracanal component. The Enneking classification was applied to describe the extension of the tumors [5]. Surgeries were performed by the same team in a research hospital. The Frankel system was used to assess the neurological status [6]. All patients provided their consent to the use of their data for research purposes.

Outcomes

Complications were defined as early or late if occurring before or after 30 days from surgery, respectively [7]. Blood loss was defined as massive when it exceeded 5 l in 24 h or 2 l in 2 h; hypotension was diagnosed when systemic pressure inferior to 85 mmHg was present for more than 15 min; neurological deterioration was present for a score higher than grade 1 at the ASIA (American Spinal Injury

Association) motor scale [8]; airway problems were identified as pneumonia and pulmonary embolism; a cardiac complication was considered an issue when a cardiac arrest (failure or an arrhythmia) occurred; cardiac infarction was identified at electrocardiogram and confirmed by an increase in myocardial enzymes.

Statistical analysis

Data were analyzed by descriptive statistics. The recurrence rates were valued in patients who had already undergone wrong intralesional surgery and in patients not yet treated. The results were compared by the χ^2 test, with a p value < 0.05 being statistically significant, to verify if a previous erroneous approach can influence local relapse. All analyses were performed using Microsoft Excel.

Survival was reported using the Kaplan–Meier curve.

Results

Epidemiology and clinical presentation

In total, 37 patients were enrolled. Epidemiological data are reported in Table 1. The lesions were located in the lumbar spine in 16 cases, in the thoracic spine in 15 cases and in the cervical spine in three cases; the cervicothoracic, thoracolumbar and lumbosacral junctions were involved in one case each (Table 1). The disease was extra-compartmental in 34 out of 37 cases (32 stage IIB and two IB of Enneking); then, in three cases intra-compartmental (one IA, one IIB and one S3).

Back pain was the most significant symptom present at diagnosis (36 cases out of 37), often associated with a vertebral fracture (15 out of 37 cases). The preoperative neurological status was “E”, “D”, “C” and “B” in 21, 12, 3 cases and 1 case, respectively, following the Frankel system (Table 1).

Diagnosis

Only 14 out of 37 cases presented to our department were not previously treated so the entire diagnostic process, stadiation, biopsy and histology were performed by our muscular-skeletal team; Nineteen out of 37 cases had already been treated in other, not specialized, centers so they underwent an intralesional surgery without a specific diagnosis, which was done just postoperatively. The specific histologies are reported in Table 1.

Treatment

Angiography was performed before surgery in every case, to study the cord blood supply and the origin of the

Table 1 Epidemiologic and surgical data

Parameter	Value	Patients > 70 years old
Patients (<i>n</i>)	37 (19 M and 18 F)	11 (4 M and 7 F)
Age, mean (median; min–max); years	67 (66; 60–81)	75 (75; 70–81)
Sites		
C	3	1
CT	1	5
T	15	5
TL	1	
L	16	
LS	1	
Enneking classification		
Extra-compartmental	32	9
IIB	2	1
IB	1	1
Intra-compartmental	1	
IA	1	
IIB		
S3		
Symptoms		
Pain	36 cases	10
Vertebral fractures	15	2
Myelopathy	12	2
Frankel neurological status	21	8
E	12	3
D	3	
C	1	
B		
Diagnosis		
Chordoma	22 cases	6
Chondrosarcoma	5 cases	2
Osteosarcoma	2 cases	1
Ewing's sarcoma	1 case	1
Rabdomiosarcoma	1 case	1
Myoepithelial high-grade sarcoma	1 case	
Malignant peripheral nerve sheath tumor	1 case	
Epithelioid hemangioendothelioma	1 case	
Other malignant tumors	2 cases	
Other benign bone tumors	1 case	
Surgical approach		
Posterior	17 cases;	5
Anterior–posterior	11 cases	2
Posterior–anterior	4 cases	3
Posterior–anterior–posterior	4 cases	1
Anterior–posterior–anterior	1 case	
Obtained surgical margin		
Marginal	20 cases	7
Intralesional	14 cases	3
Wide	3 cases	1
Intra-operative blood loss, mean (min–max)	4094 ml (200–14,000 ml)	3090 (800–7000 ml)

Adamkiewicz artery; selective embolization of the mass was possible in eight cases. Five out of 37 patients underwent neoadjuvant chemotherapy; adjuvant chemotherapy was performed in only one case.

The approach was posterior in 17 cases, anterior–posterior in 11 cases, posterior–anterior in four cases, posterior–anterior–posterior in four and anterior–posterior–anterior in one case (Table 1). The mean operation time was approximately 9 h (549 min; range 150–840).

Reconstruction was performed with a 360° stabilization system consisting in a vertebral cage attached to posterior rods and transpedicular screws in 29 cases; in 26 out of 29 cases, the vertebral bodies were reconstructed with a carbon cage; in three out of 29 cases, the vertebral bodies were reconstructed with a titanium cage; in six cases, the vertebral bodies were reconstructed after a posterior stabilization, and the anterior column was reconstructed with an allograft shaft; no reconstruction was performed in the remaining two cases; autograft chips were added in 21 cases to increase the fusion rate.

Surgical results

The margin was marginal in 20 cases and was intralesional and wide in 14 and three cases, respectively (Table 1).

Considering the 14 patients with intralesional margin, only nine (64.3%) had undergone a previous surgery, versus 12 (60.0%) out 20 patients in the marginal margin group and two (66.7%) out three in the wide margin group. The margin was related more to the specific anatomy of the disease. Indeed, nine out of 14 intralesional margins were already defined during the preoperative planning; in the remaining cases, only one had a wide margin.

The mean intra-operative blood loss was 4.094 ml (range 200–14,000) (Table 1). The mean length of hospital stay was 23 days (range 1–85 days).

Complications

A total of 24 out of 37 patients (64%) experienced almost one early complication (Table 1); 13 patients did not experience any complications, and ten out of those 13 did not experience late complications either.

A total of 18 and ten out of 37 (48% and 27%) experienced two or ≥ 3 early complications, respectively. In total, 14 out of 37 patients (37%) experienced almost one late complication, and four and three out of 37 (10% and 8%) experienced almost two or ≥ 3 late complications, respectively.

The specific complications and related frequencies are reported in Table 2. No deaths were reported during surgeries; however, three deaths were reported during the first week, whereof one of the three deaths was reported during the first postoperative day for massive blood loss and cardiac complications, one death was reported during the third postoperative day for the same cause despite a savage surgery, and the third was reported at 7 days from index surgery for myocardial infarction. The perioperative mortality was therefore 8.1% (3 out of 34).

Follow-up and survival

The median follow-up was 42.2 months (min–max 1–5270 days). We reported six local recurrences, after 6, 32, 45, 103, 153 and 175 months, respectively; the recurrence rate valued for the 34 patients who survived more than 1 week was 17.6%.

The recurrence rate was 14.3% (2 out 14), 20% (4 out 20) and 0% in the group with intralesional, marginal and wide margin, respectively.

No statistical difference (χ^2 0.17, p = 0.67) was present between recurrence rate in the previously and not previously treated patients (four out of 22 and two out of 12 recurrences, respectively).

Table 2 Early and late complications in the analyzed cohort

Early complications	Late complications
Massive blood loss: 15 cases (40.5%; where 13 cases had important hypotension and one case undergone surgery)	Neurologic deterioration (> 1 grade ASIA Motor Scale): 3 cases
Dural tear: 6 cases (16.2%—one surgically resolved)	Wound dehiscence: 3 cases (8.1%; 1 with superficial infection, 1 with deep infection, 1 without infection)
Neurological deterioration (> 1 grade ASIA Motor Scale): 4 cases (10.8%)	Construct failure: 3 cases (2 without loss of correction, 1 with loss of correction)
Ventilation problems: 3 cases	Ductus thoracicus lesion: 2 cases
Pressure sore: 3 cases	Cardiac arrest/failure/arrhythmia: 2 cases
Aspecific Cardiac problems: 3 cases	Myocardial infarction: 2 cases
Cord Injury, PNX, thoracic ductus lesion, pulmonary embolism, vascular injury, myocardial infarction: 1 case	Pulmonary embolism, postoperative neuropathic pain, deep wound infection without dehiscence, paraplegia, pneumonia: 1 case

The overall survival (OS) at 5 years of follow-up was 51.1%; the survival related to the disease was 62.8%; the Kaplan–Meier curve related to the OS and to the specific survival is reported in Fig. 1a, b. At the time of this analysis, 19 patients are still alive out of whom, 15 are without any evidence of disease, three with evidence of local disease but no systemic disease and one with local and systemic disease;

On the other hand, 18 patients died, out of which six died of unrelated causes without evidence of local or systemic disease at the time of death, three patients died in the first week for surgical complications, and nine died from metastatic disease out of which five and four died with and without local recurrence, respectively.

Discussion

The spine is rarely involved in primary bone tumors, but it is the first site on the bone for metastasis.

If wide surgery has to be considered in secondary lesions just in case of solitary metastasis from a favorable histology onset after years from the primary tumor extirpation, it is the gold standard for primary malignant tumors eventually combined with chemotherapy and radiotherapy and for benign aggressive histologies to decrease the risk of local recurrence.

If osteosarcomas and Ewing's sarcomas are typical in patients of younger ages, other histologies, such as chondrosarcomas and chordomas, are more typical of older patients.

In those cases, wide surgery often is the only possibility to positively impact the survival. While proton therapy can be considered a valid alternative for sacral chondroma because of the high percentage of sequelae, surgery is the mainstay treatment for spine chondromas and all chondrosarcomas. Moreover, the absence of effective medical therapies underlines the importance of surgery. Noteworthy, EBS must

be considered as a high-demanding surgery because it is technically difficult and characterized by a high complication rate so it can only be approached in referred centers.

An exemplificative case of chordoma of L3 is reported in Fig. 2. Diagnosis was performed by CT-guided core biopsy; EBS was then performed by a posterior approach with a wide margin (marginal at the dura level) only (Fig. 3); reconstruction was carried out with a carbon cage filled with bone autograft and homograft linked to posterior carbon roads and screws.

A massive blood loss was reported (approximately 3200 ml), and several blood units were transfused during surgery and postoperative period (approximately 8000 ml). At 18 months of follow-up, the patient is apparently free of disease and in a satisfying general health condition, walking with a cane.

However, only scant information is available on the outcomes of elderly patients who undergo EBS. We therefore reviewed a cohort of patients aged > 60 years, who received a consistent management despite a long period of recruitment, to analyze their experienced complications and outcomes. However, it is important to point out that only few patients were aged ≥ 70 years, and therefore, a specific subanalysis on their outcomes was not possible.

First, it is interesting to notice that, in the present series, chordomas and chondrosarcomas represent 75% of the cases (22 and five cases, respectively).

Moreover, the presenting series confirm well-known data in the literature: the 51.3% (19 out of 37 cases) presented at our specialized center after they had already been treated in another non-referral hospital. Indeed, these diseases often undergo surgical decompression or open biopsy in non-specialized centers with contamination, then making successive surgery more difficult and invasive [9]; nevertheless, previous wrong surgery should not be influencing the recurrence rate [9].

Fig. 1 **a** Overall survival (OS) Kaplan–Meier curve; **b** cause-specific survival (CSS) Kaplan–Meier curve

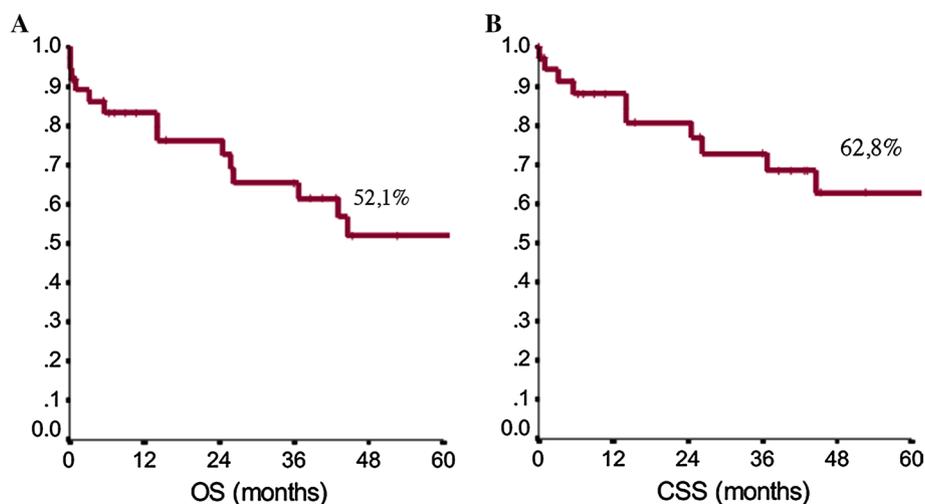
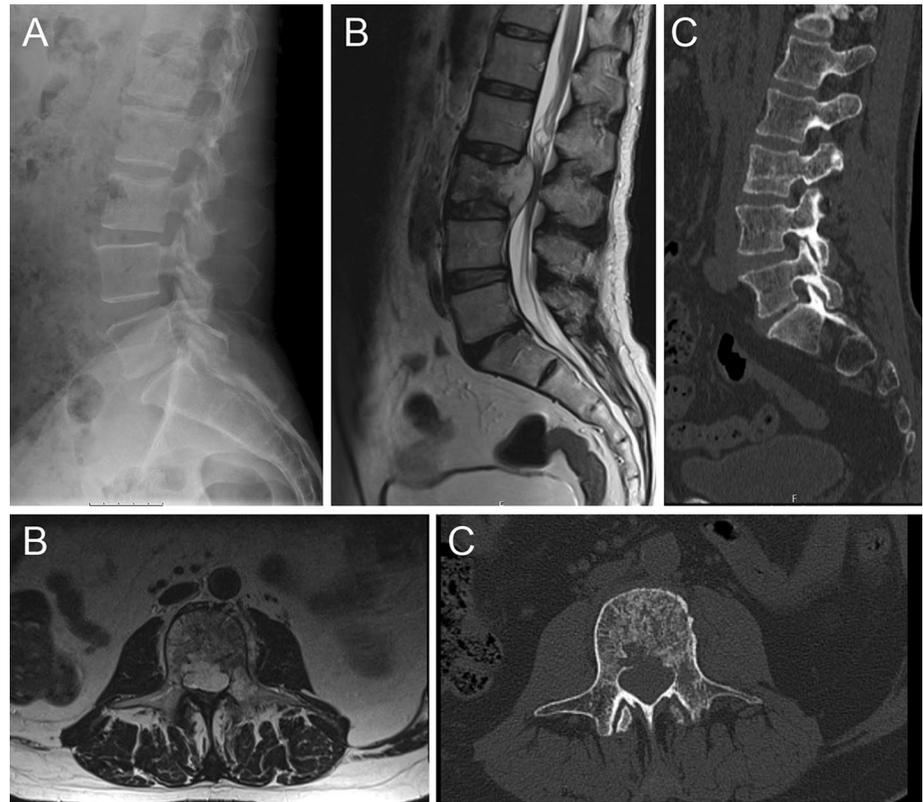


Fig. 2 A 67-year-old patient affected by a chordoma of the L3 level; the X-ray (a) is not clear but the lesion is evident on the MRI (b) and CT scan (c)



In the present series, five cases underwent triple approach, 15 cases underwent double approach and 17 cases underwent a single approach with a mean operation time of 9 h.

Recently, Shah et al. [10] have reported their results in a series of 33 EBS for primary bone tumors, although not specifically aged > 60 years; the most common histology was chordoma; they reported a dural tear caused by the saw; perioperative complications in the 52% of cases with one death; 22% within 90 days after discharge; and 25% after 90 days from discharge. They obtained negative margin in the 94% of cases with local recurrence in only two cases; nevertheless, after assessing these data, it is important to consider the short follow-up reported (72 weeks).

Yokogawa et al. focused on the incidental durotomy during EBS; in a series of 105 patients, they reported dural tears in 18 (17.1%). They revealed older age was an important risk factor with an odds ratio of 6.09, radiotherapy and revision surgery (5.31 and 19.42, respectively) [11].

However, these findings were challenged in the recent study by Liu et al., who compared EBS for single metastasis in patients older and younger than 65 years; they suggested that older patients can experience survival and local recurrence rates similar to those of younger patients but a higher complication rate [2].

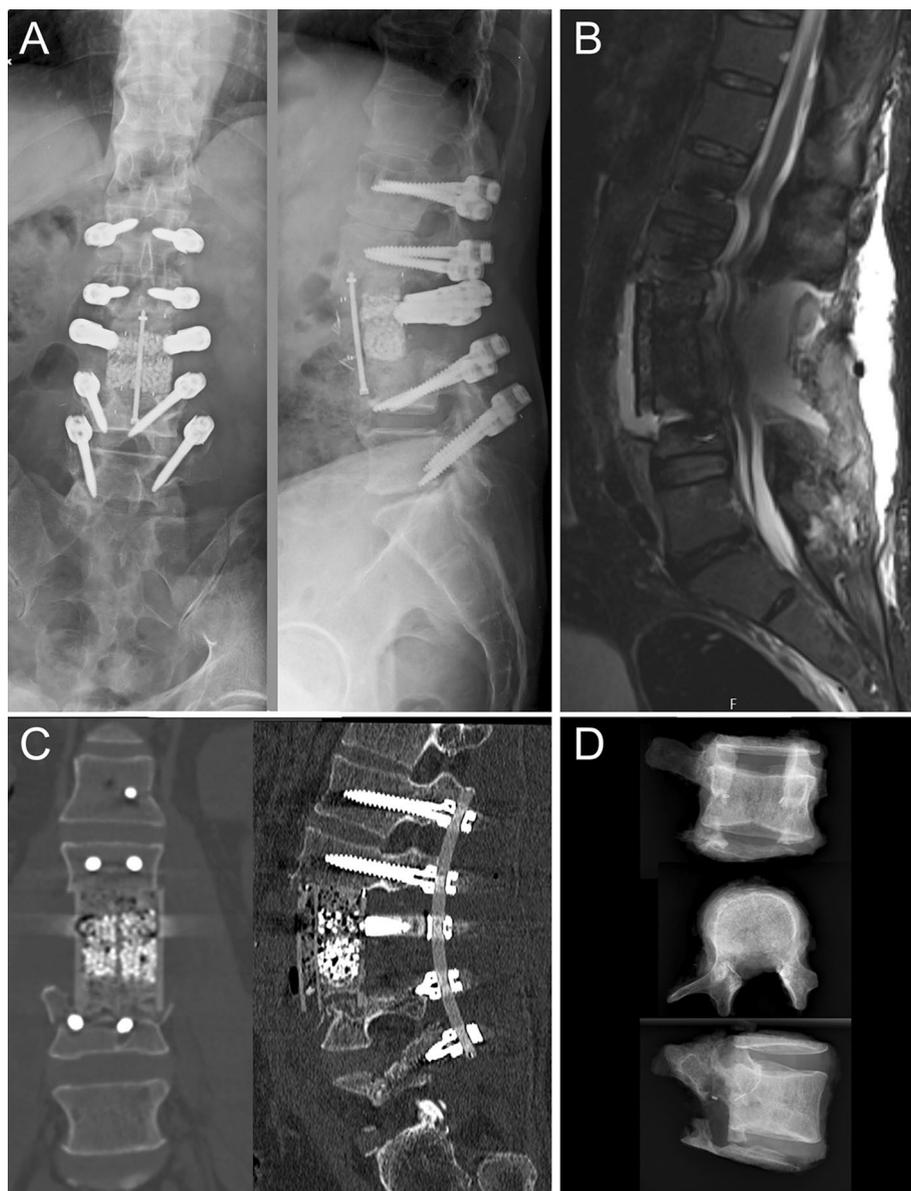
Amendola et al. [12] reported a complication rate of 41.7% in 103 EBS for primary spine bone tumors, finding a correlation with the non-intact group and the complexity of

surgery. The mortality rate related to surgery complications was 1.9%, whereas tumor-related mortality was 15.5%.

Conversely, in our series the perioperative mortality rate was quite higher underlying the high operating risk in these massive surgeries. Most patients experience almost an early complication (64%); the risk to have late complications is lower but consistent (37%). Complications are very different and correlated with several aspects; nevertheless, only one case of death related to surgeries was reported, confirming the importance of approaching this patient where several competences are available.

In this series, the main early complication was massive blood loss (15 out of 37 patients), which caused patient deaths in two cases. During EBS, bleeding is considered the main problem. A careful preoperative embolization of the index levels is helpful to decrease intra-operative bleeding. Moreover, step-by-step hemostasis is then mandatory in long surgeries, otherwise the total amount of blood loss could be highly relevant. The use of the new ultrasound bone saw can also contribute to decrease the bleeding in the bone. Indeed, the use of these kinds of saws compared with traditional saws allows to make more accurate cuts and bone hemostasis. Other complications can be indirectly correlated to hemorrhage, such as cardiac failure, myocardial infection, wound dehiscence and deep infection. In addition, a correct anesthesia management aiming to maintain a controlled hypotension could be helpful.

Fig. 3 Postoperative imaging showing reconstruction after extirpation of a chordoma of L3; in **a** the X-ray, in **b** the MRI and in **c** the CT scan. Note the low artifacts level caused by the carbon rods; in **d** the X-ray of the specimen showing the wide resection of L3 and the L2 inferior vertebral plate and the L4 superior vertebral plate



Dural tear is also quite frequent; nevertheless, in just one case, a surgical repair was necessary; in the majority of cases, it resolved spontaneously with bed rest.

Late complications are more variable even if neurological deterioration, wound dehiscence/infection and construct failure can be considered more frequent. Unfortunately, EBS is associated with an important instability because it is hard to obtain arthrodesis; to decrease the risk of loss of correction could be useful to extend the length of the construct even four levels above and under the vertebrae removed, moreover, if they are more than one.

Despite the inherent limitations of our analysis, including the small number of patients enrolled and the lack of a control group, we believe that our data show EBS

in elderly patients must be approached in specialized centers where it is present not only a trained surgical team but also specialists able to resolve every possible complication.

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Compliance with ethical standards

Conflict of interest The authors have no conflicts of interest directly relevant to this study.

Informed consent Informed consent was obtained from all individual participants included in the study.

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