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Original article

Long-term quality of life after en-bloc vertebrectomy: 25 patients followed up for 9 years



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ABSTRACT

Objective: Assess quality-of-life results in patients who have undergone extensive curative surgery for spinal tumor and compare them to the general population in France.

Introduction: Life expectancy is not the only criterion to assess the outcomes after massive tumor resections. Residual quality of life is also crucial. An indication for major surgery for spinal tumor should take the patient's long-term functional status into account, but the literature is limited on this question.

Materials and methods: Twenty-five living patients from a group of 120 operated were assessed, all of whom were operated on by the same surgeon between 1984 and 2007. The mean follow-up was 9 years (range, 3–25 years). The mean age at surgery was 49 years. The patients completed different functional and quality-of-life questionnaires: the Oswestry Disability Index version 2 (ODI), the PROLO, the Karnofsky Index of performance status (KI), the Eastern Cooperative Oncology Group performance status (ECOG), the Short Form-36 Health Survey (SF-36), and the EuroQol-5 Dimensions (EQ5D). In addition, each patient was clinically and radiographically evaluated. Subgroups were identified considering the number of levels resected and histology. Their results on the SF-36 were compared with the results from the general population in France.

Results: The mean PCS (physical component summary of the SF-36) was 52.4, the MCS (mental component summary, the psychological component of the SF-36) was 47.7, the ODI was 18.2, the PROLO was 7, the ECOG was 1, and the KI was 80%. The resections at three levels were associated with worse results in terms of quality of life, but overall, the results were similar to the French general population data for all categories of the SF-36.

Conclusion: Appropriate indications for massive spinal resection give good oncological and functional results. Although the expected life expectancy justifies this aggressive surgery, postoperative quality of life shows that it can also be successful on a functional level.

Level of evidence: Level IV; retrospective clinical study.

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1. Introduction

Quality-of-life (QoL) assessment has become an indispensable tool to measure patients' experience after surgery. These long-neglected data should be taken into account in the implementation of therapeutic strategies in cancer treatment [1]. A large number of QoL assessments after cancer treatment have been carried out [2–5]. However, the evaluation of QoL after partial or total vertebrectomy for tumors remains very limited. We found no articles in the literature that had examined this subject over the medium or long-term. Partial vertebrectomy (or hemi-vertebrectomy) and

total vertebrectomy are interventions with high morbidity whose risk–benefit ratio can be unfavorable. It is therefore essential to determine its value taking into account objective evaluations such as the different QoL evaluation scores. The objective of this study was to assess the long-term QoL of patients after en-bloc vertebrectomy for tumor and to compare it to the QoL of a normal reference population.

2. Patients and methods

Between 1984 and 2007, 120 patients underwent partial or total vertebrectomy in our department by the same operator. The 25 living patients (20.8%) at the minimum follow-up of 3 years were reviewed and questioned by two independent observers. In addition, in the overall series, three patients were lost to follow-up. The

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sample included 10 females and 15 males. The mean follow-up was 112 ± 70 months, i.e., 9.4 years (range, 36–312 months).

The inclusion criteria in the series were partial or total cervicothoracic, thoracic, or lumbar vertebrectomy for primary tumor disease (13 patients), or for primary lung tumor with vertebral invasion or Pancoast-Tobias syndrome (PCT) (nine patients), or for isolated metastasis (three patients). Resections in the mid- or upper-cervical regions were not retained because of the great difficulty of obtaining radical resection on the oncological level. The resection criteria were based on a preoperative histological diagnosis. Computed tomography (CT) and magnetic resonance imaging (MRI) evaluated vertebral invasion and the adjacent soft tissues. The absence of adenopathies was required for PCT and metastases, as well as the absence of other secondary locations for metastases. After initial assessment of operability, the surgical indication was validated in a multidisciplinary meeting. Vertebrae were resected following the principle of en-bloc vertebrectomy described by Mazel [6], a technique derived from Roy-Camille [7,8] and Stener's [9–11] technique. In cases of lung tumors with Pancoast-Tobias-type locoregional vertebra invasion, a first phase of anterior release systematically preceded the second phase of posterior tumor exeresis and stabilization. This was done either by thoracoscopy, a supraclavicular approach [12], or by thoracotomy. These procedures were always performed by the thoracic surgery team for the first phase of anterior release.

This study was conducted over a 2-year period so that patients operated on many years before could be included. During this period, of the 25 patients included in the study two had died by the end of the study. We decided to retain them in the study because death occurred for a cause that was not related to the tumor disease and they had been followed up for 26 and 12 years, and we were able to obtain the data necessary for this study before their death.

The general data – age, gender, type of tumor, characteristics of surgery – were collected from the patient file. The mean age of the patients at the time of vertebrectomy was 49.5 ± 13.4 years (range, 26–68 years). In the majority of cases, the lesions were intracompartmental according to the Tomita classification [13]. The mean Tomita prognosis score was 3. We divided the patients into three groups: primary tumors, PCTs, and metastases (Tables 1–3). Partial vertebrectomy was performed for 12 patients and total vertebrectomy for 13. One patient underwent total vertebrectomy at one level and partial vertebrectomy on the supra- and adjacent vertebrae. She was included in the total vertebrectomy group. Twenty-two vertebrectomies were performed at the thoracic level and three at the lumbar level. Of the 25 patients, 13 presented primary tumors, nine PCTs, and three isolated metastases. Finally, in terms of the number of resected vertebrae, ten patients had one vertebra resected, eight had two vertebrae resected, six had three, and one had five.

The functional and QoL evaluation made use of the following scores: the Oswestry Disability Index version 2 (ODI), the PROLO, the Karnofsky Index performance status (KI), the Eastern Cooperative Oncology Group performance status (ECOG) for function, and the Short Form-36 health Survey (SF-36) and EuroQol 5 Dimensions (EQ5D) for QoL. The scores were selected to have several recognized scales at our disposal, associating scores targeted to the spine (ODI) with scores covering general functional capacities (Karnofsky and ECOG), the socioeconomic repercussions of the disease (PROLO), and QoL (SF-36 and EQ5D) so as to obtain an overall view of the patient and compare the coherence of the study's results.

The ECOG [14] score and the Karnofsky Index [15–17] allow one to study the performance index of oncology patients. An ECOG less than 2 is associated with satisfactory QoL [18], whereas a KI of at least 80% is compatible with normal life without assistance.

The PROLO score is the sum of the economic and functional statuses, each scored from 1 to 5. A score between 7 and 8 is good, and between 9 and 10 is excellent [19].

The ODI comprises ten questions, each with six levels of responses ranging from 0 to 5. A review of the literature of the ODI scores showed that there was a mean between 10 and 19 [20] in the normal population. The ODI can be correlated with daily activities.

The EQ5D is a QoL score that assesses five parameters (mobility, autonomy in personal hygiene, autonomy in daily activities, pain, and anxiety-depression) on three levels. It is a reliable score [21], simple, and useful for the socioeconomic and QoL evaluation according to Choi et al. [22]. For each parameter studied, 1 corresponds to the optimal response, 2 to the intermediate response, and 3 to the worst situation.

The SF-36 was used in its second international version as translated into French. This reliable score has been validated [23,24]. The SF-36 comprises 36 items grouped into eight scales: PF (physical functioning), RP (role physical), BP (bodily pain), GH (general health), VT (vitality), SF (social functioning), RE (role emotional), and MH (mental health). The latter score is particularly useful because for these eight scales we have mean values for the normal population in France [25], which allowed us to compare them with the study results using a Student *t*-test. It is the repeated observation of the results of the factorial analysis of the eight SF-36 subscales that led its designers to construct two overall scores: the mental component summary (MCS) and the physical component summary (PCS).

3. Results

3.1. Clinical, radiological, and biological follow-up

Only one patient's reconstruction graft did not heal, requiring surgical revision 2 years postoperative, with bone healing obtained at 11 years of follow-up. Three patients presented persistent progression of their general disease, with no alteration of their QoL. Three patients presented brachial neuralgia related to the intraoperative section of nerve roots contributing to the lower trunk of the superficial brachial plexus. They were treated medically. This is certainly the main postoperative complication observed in this surgery at the cervicothoracic junction where the C8 and/or T1 nerve roots were sacrificed.

3.2. Functional scores

3.2.1. ODI and PROLO scores

The mean ODI was $18.2 \pm 15.6\%$ (range, 0–60). Sixteen patients out of 25 had an ODI score between 0 and 20 (Fig. 1). The highest ODI rates, 50 and 60, respectively, were found in two patients who had undergone resection at three levels.

The mean PROLO was 7 ± 3 (range, 2–10). Fourteen patients out of 25 had good to excellent scores (Fig. 2). Nine patients were retired when the neoplasia diagnosis was made, and another patient retired after surgery; questioning these patients showed that they were all active. Four are on disability. Eight had resumed work in their initial position (office work for the most part) and three had their work station adapted.

3.2.2. 2- KI and ECOG scores

The mean KI was $80 \pm 10.7\%$ (range, 60–100). Twenty patients had at least 80% on the KI (Fig. 3). The lowest KI score was 60%, found in three patients who had undergone vertebrectomy at three levels.

The mean ECOG was 1 ± 0.5 (range, 0–2). There were no ECOG scores greater than 2. Twenty-two patients had an ECOG score lower than or equal to 1 (Fig. 4).

Table 1
Patients (no preoperative radiotherapy) operated for primary tumors.

Number	Age	Gender	Histology	HPS	Type of resection	Fixation level and type of bone graft	Radicular resection	Surgery duration (h)	Bleeding (cm ³)	Neoadjuvant chemotherapy	Duration of hospital stay (days)	Maximum follow-up (months)
1 ^a	28	M	Hemangiopericytoma	Yes	Partial T4, T5, T6, T7, T8	T3–T9. RRC+ anterior autograft (fibula)	No	12	4000	Yes	15	190
2	39	M	Epidural chordoma	Yes	Total T3, T4	C7–T7 Agora+ iliac tricortical autograft	T4 left+ T4, T5 right	7	700	No	30	150
3	68	F	Benign Schwannoma	No	Partial T11	T10, T12 Agora+ iliac crest cancellous autograft	T11 left	2.5	750	No	16	120
4	31	F	Ganglioneuroma	Non	Partial T2, T3	C7–T5. RRC+ Cancellous autograft	T1, T2 left	7.5	2600	No	12	102
5	45	M	Plasmocytoma	Yes	Total T5	T3–T7 Twinflex+ femoral head allograft	T5 right	4.5	400	No	10	187
6 ^a	32	M	Plasmocytoma	No	Total L5	L3–S3 Agora+ Harms Mesh+ Fibula+ iliac crest tricortical autograft	No	6	5900	No	15	63
7 ^a	60	F	Fibrous dysplasia	No	Total T4	T1–T7 Agora+ femoral head allograft	T4 right and left	3.3	650	No	7	59
8	45	M	Chordoma	Yes	Total L1	T11–L3 Agora+ femoral head allograft	L1, L2 left + T12, L1 right	3	1200	No	15	45
9 ^a	26	F	Giant-cell tumor	No	Total T3	C7–T6 Agora+ femoral head allograft	T3, T4 left	10	1400	No	21	43
10 ^a	65	F	Plasmocytoma	No	Total T8	T6–T10 Agora+ Harms+ iliac crest cancellous autograft	No	8	3300	No	7	38
11 ^a	67	F	Epithelioid hemangioma	Yes	Total T5+ Partial T6, T7	T3–T10 Agora+ Harms+ iliac crest cancellous autograft	T5, T6, T7 right and left	4.5	3000	No	30	36
12 ^a	46	M	Vertebral chondrosarcoma	No	Total T1, T2	C6–T4 RC+ femoral autograft	No	8	4000	No	30	264
13	45	M	Aneurysmal cyst	No	Total T4		T3–4 right and left	8	3000	No	25	312

RC: Roy-Camille; HPS: history of previous surgery.

^a Embolization.

Table 2
Patients operated for PCT (Pancoast-Tobias). Pre-, intra-, and postoperative evaluations.

Number	Age	Gender	Histology	Resection margin	Type of resection	Number of levels	Fixation levels and type of bone graft	Radicular resection	Surgery duration (h)	Bleeding (cm ³)	Preoperative radiotherapy	Chemotherapy	Maximum follow-up (months)
1	62	M	AdenoK	Healthy	Partial T1 T2 T3	3	C5-T5/RRC	No	9	1600	No	No	144
2	47	M	AdenoK	Healthy	Total T4T5T6 R	3	T1-T9/Agora+ fibular autograft	T4, T5, T6 right	11.5	2000	No	Neoadjuvant	156
3	39	F	AdenoK	Uncertain	Partial T1, T2, T3 R	3	C6-T5(RRC)+ iliac crest cancellous autograft	C8, T1, T2, T3 right	9.5	–72,000 ^a	No	Neoadjuvant	150
4	50	M	AdenoK	Healthy	Partial T2, T3 R	2	C6-T5 Agora+ iliac crest cancellous autograft	T2, T3 right	7	2000	No	Yes	110
5	46	M	AdenoK	Healthy	Total T2, T3	2	C6-T6 Agora+ Femoral head allograft	T1, T2, T3 right	11	2300	No	Yes	88
6	39	F	Epidermoid carcinoma	Healthy	Partial T1, T2 L	2	C6-T4 Agora+ iliac crest cancellous autograft	T1, T2 left	7	2000	Yes	Yes	81
7	55	M	Epidermoid carcinoma	Healthy	Partial T2, T3, T4 R	3	T1-T6 Agora+ iliac crest cancellous autograft	T3, T4, T5 right	5.5	2100	Yes	Neoadjuvant	61
8	55	M	Epidermoid carcinoma	Healthy	Partial T1, T2 L	2	C6-T4 Agora+ Cancellous tricortical autograft	C8, T1, T2 left	4	1300	Yes	Yes	60
9 ^a	47	M	Epidermoid carcinoma	Healthy	Partial T1, T2, T3	3	C6-T5 Agora	T1, T2, T3 right+ anastomosis C8-T1			No	Yes	100

RC: R Roy-Camille; AdenoK: Adenocarcinoma.

^a Embolization.

Table 3
Patients with single metastases.

Number	Age	Gender	Histology	HPS	Type of resection	Fixation levels and type of bone graft	Radicular resection	Surgery duration (h)	Bleeding (cm ³)	Pre-op Rx therapy	Pre-op chemotherapy	Duration of hospital stay (days)	Maximum follow-up (months)
1	72	F	Pulmonary adenoK	No	Partial T2, T3	C6–T5. Agora Cancellous + tricortical iliac Autograft	T2, T3, T4 right	6	400	No	No	14	120
2 ^a	68	F	Mammary adenoK	Yes	Partial T2 L	C6–T5 Agora+ Tricortical iliac crest autograft	T1, T2 left	3	1300	Yes	Yes	10	93
3 ^a	62	M	Neuroendocrine tumor	Yes	Total T12	T10–L3 Agora+ Harms+ iliac crest cancellous autograft	T11, T12 right+ T10, T11 left	4.5	700	No	No	15	37

HPS: history of previous surgery; AdenoK: adenocarcinoma.

^a Embolization.

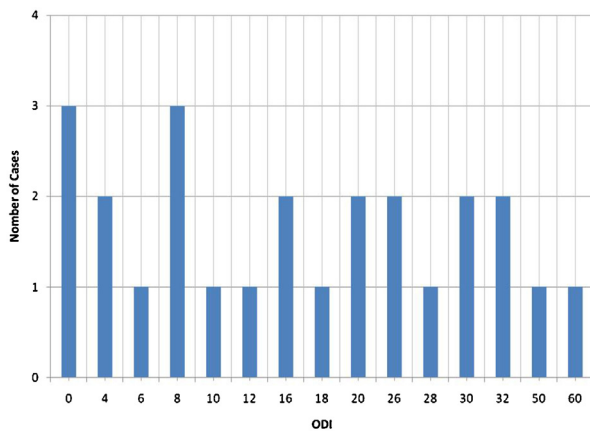


Fig. 1. ODI score a minimum 3 years after vertebrectomy.

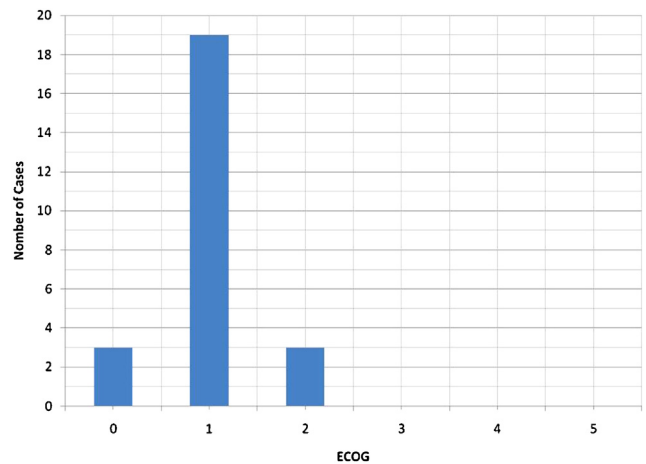


Fig. 4. ECOG score a minimum 3 years after vertebrectomy.

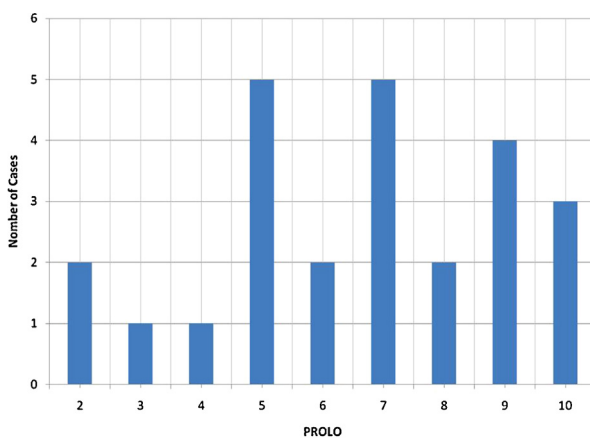


Fig. 2. Prolo score a minimum 3 years after vertebrectomy.

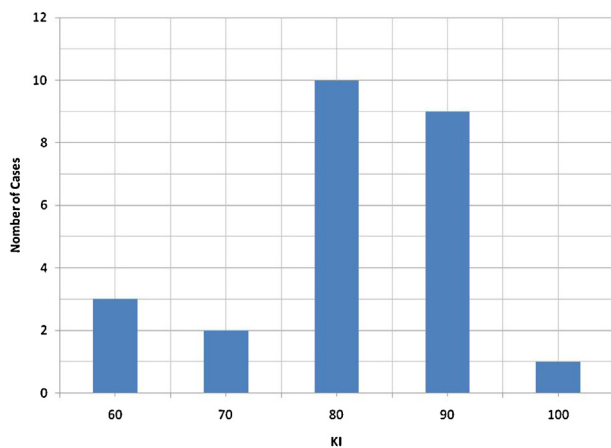


Fig. 3. Karnofsky Index a minimum 3 years after vertebrectomy.

Table 4

Value of SF-36 scales in present study compared to overall score of general population in France.

SF-36 variable	Overall score of general population in France	Score in present series	P-value
PF	84.45	78.2	NS
RP	81.21	83.00	NS
BP	73.39	76.40	NS
GH	69.13	75.60	NS
VT	59.96	67.60	NS
SF	81.55	74.40	NS
RE	82.13	74.40	NS
MH	68.47	70.80	NS

NS: non-significant; PF: physical functioning; RP: role physical; BP: bodily pain; GH: general health; VT: vitality; SF: social functioning; RE, role emotional; MH: mental health.

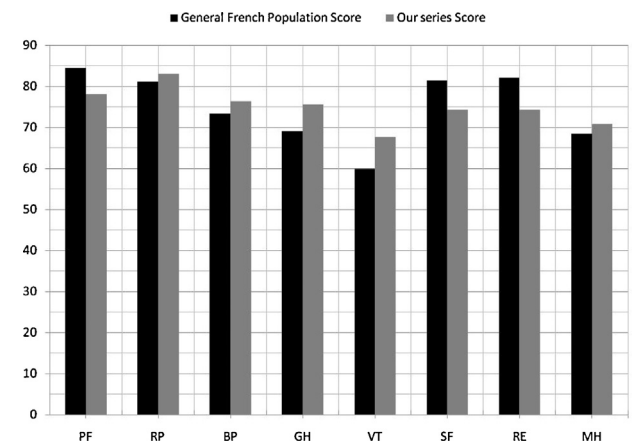


Fig. 5. SF-36 score for the general population in France and for the study's patients.

3.2.3. Quality-of-life scores

3.2.3.1. SF-36. The PCS was 52.4 and the MCS 47.7. The SF-36 QoL scores of the patients in the present study are comparable to those of the normal population in France. We demonstrated no significant differences in the eight SF-36 scores between the study's patients and the values from the normal French population (Table 4 and Fig. 5).

However, analysis of the SF-36 brought out two points that should be highlighted.

The resections at three levels, all types of resection combined, were associated with the lowest QoL scores. For the PROLO scores, 4.7 and 8 were obtained, for the ODI 35.6, 11, and 15.4; the PCS, 47.4, 55.8, and 52; the MCS, 43.5, 48.7, and 48.8 with resections of three, two, and one level, respectively (Fig. 6).

Primary tumors are associated with better QoL scores than secondary tumors (Fig. 7 and Table 5).

3.2.3.2. EQ5D. The majority of the patients (22/25) were able to walk easily; the mean score for walking was 1.12 ± 0.33 . The same was true for personal hygiene, with a mean score of 1.16 ± 0.37 .

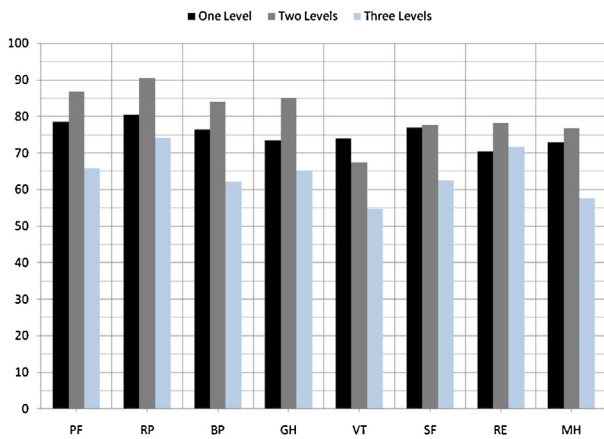


Fig. 6. SF-36 variables after vertebrectomy of one, two, and three vertebrae.

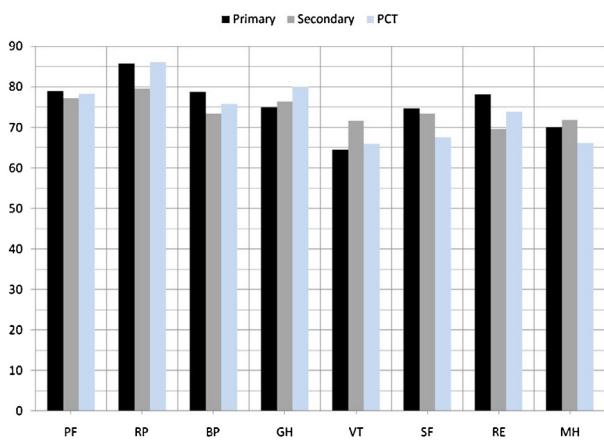


Fig. 7. SF-36 variables as related to tumor type.

Table 5
Functional and quality-of-life scores as related to type of tumor.

Type of tumor	PROLO	ODI	PCS	MCS
Primary	7	15	52.9	47.4
Secondary	6	22	51.8	48
PCT	6	24	53.8	45.2

Most patients described a few anxiety-depression problems, with a mean at 1.56 ± 0.50 for this parameter. However, 11 patients (44%) considered themselves lucky and happy to be alive. As for the occurrence of pain episodes, we obtained 1.6 ± 0.50 . It should be noted that eight patients (32%) had nearly forgotten their back other than rare episodes of pain. Finally, 14 patients (56%) had no problems accomplishing tasks of daily living; we found a mean 1.44 ± 0.50 for this parameter.

Moreover, none of these patients demonstrated total incapacity on any of the five parameters of the EQ5D. After surgery, ten patients experienced considerable improvement in their autonomy.

4. Discussion

4.1. Methodological analysis of the series: relevance

Given the low number of subjects, this series can be considered insufficiently significant from a methodological point of view, but the fact that the phenomenon studied is rare must be taken into account. Based on a sample of fewer than 30 individuals, to

make statistically valid comparisons we had to assume that the distribution of functional and QoL scores followed a normal distribution in our study. Actually, only 13 observations were necessary [26] to detect a one-standard deviation difference compared to the norm, whereas this study included 25, allowing a type I error (5%) and providing 90% statistical power, an acceptable consensus in biomedical research. Comparison with the general population in France is possible because 22 patients out of 25 in this study come from this population; the three others originated from nearby European countries (Italy, the Netherlands, Spain).

Given the rarity of the phenomenon studied, the significance of the observations made within the different subgroups can also be challenged. However, the fact that we showed that resection of three vertebrae is associated with lower QoL scores compared to resection of one or two vertebrae is not less significant.

4.2. Choice of functional and quality-of-life scores

We define QoL as being: “the value assigned to the duration of life as modified by the impairments, functional states, perceptions, and social opportunities that are influenced by disease, injury, treatment, or policy” [27]. In evaluating QoL, one should take into account patients’ culture and mental health.

QoL after vertebrectomy has rarely been assessed in the literature. We believed it relevant to use several scores that we found complementary, particularly since there was no score that, taken alone, could assess well-being that covers both the physical and psychological dimensions. A review of the literature showed how difficult it was to establish a consensual QoL evaluation form in the context of spinal metastasis [28].

We first wished to determine the general health of the patients after vertebrectomy, a major surgical procedure. We found the KI score useful, but we added the ECOG score to verify the agreement of the data. The results reported herein showed a mean 80% KI and a mean ECOG score of 1.

After spinal surgery, it is valuable to evaluate the repercussions of spinal pain on daily life. We therefore opted to use the ODI, which was found to be a mean 18% in this study. This value is also considered comparable to that in a normal population.

To evaluate patients’ socioeconomic situation, we retained the PROLO score, which takes into account the patient’s ability to return to an occupational activity. Returning to work is often related to the patient’s age, and we had to take into account that certain patients were already retired at diagnosis or on disability for medical reasons, and not due to the surgery itself. In fact, when questioning the patients, we noted that they presented little functional limitation. The mean PROLO score was 7, which is a good result.

A health QoL questionnaire should meet certain criteria to be considered reliable: it should take into account psychometric properties [29], be reliable [30], valid [30–32], reactive [33], practical to use, and sensitive. The SF-36 questionnaire is described as being the most widely studied generic QoL questionnaire [34]. The same is true for the EQ5D, which was designed as a self-administered questionnaire for the patient with the advantage of being simple and concise. These two QoL questionnaires meet the above-cited criteria that a QoL questionnaire should observe in assessing vertebral metastases [22].

We found no study similar to the present study in terms of methodology, which, in addition to the rarity of studies reporting on vertebral tumors in general, made comparisons difficult, particularly since today no health QoL questionnaire has been established with consensus in the context of spinal tumors. For example, Street designed the Spine Oncology Study Group Outcomes Questionnaire (SOSGOQ) [35], comprising 27 items. This is a practical tool for following up patients after spinal tumor surgery with the disadvantage of focusing on spinal symptoms, which limits QoL assessment.

Generic health QoL questionnaires in oncology also do not seem advantageous [22]: The Edmonton Symptom Assessment Scale (ESAS) [36] seems better adapted to terminal patients and therefore inadequate for our series. The European Organization for Research and Treatment of Cancer Quality of Life Questionnaire C30 (EORTC QLQ-C30) has few correlations with the EQ5D [37], perhaps related to the fact that its items seem better adapted to the general health of oncology patients than to that of patients with spinal metastases.

5. Conclusion

A vertebral tumor, whether it be primary or secondary, is a major vital and functional challenge for the patient. When the surgical indication for partial or total vertebrectomy, whatever the number of vertebrae to resect, is diagnosed, one must be aware that the simple objective of prolonging the patient's life cannot be the only purpose of this surgery. The QoL that accompanies this survival is an essential factor of the patient's well-being. The good results in the present series based on 25 patients demonstrate the relevance of this attitude on condition that the surgical indication is well diagnosed. The discussion of these cases in multidisciplinary meetings is fundamental, as is collaboration with surgical teams possessing complementary skills. Radical resection surgery, in addition to providing more or less totally the solution to the oncological problem, does not compromise QoL, quite the opposite, as demonstrated in this study in which the majority of long-term scores were close if not identical to the scores in the general population. It is therefore possible to conclude that en-bloc resection of tumor-invaded vertebrae gives good long-term results and QoL.

Disclosure of interest

The authors declare that they have no conflicts of interest concerning this article.

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