Editorial Commentary

Editorial about: modified *en bloc* spondylectomy for tumors of the thoracic and lumbar spine

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Wide margin (microscopically negative) resection is necessary for local control and long-term survival of the patients with sarcomas, locally aggressive and recurrent benign tumors. However, wide margins resection is rarely feasible in the spine because of the spinal cord, nerve roots and major vessels (1). Therefore, the standard approach for primary tumors of the spine has been intralesional tumor excision (curettage); yet, local control of the tumor and survival of the patients has been dismal.

En bloc spondylectomy involves removal of the involved vertebra through laminectomy and vertebrectomy in one or two pieces, followed by circumferential reconstruction of the spinal segment with an anterior spacer and posterior instrumentation of the spine (1,2). Aiming for complete (wide margins) tumor resection, *en bloc* spondylectomy has been associated with lower local recurrence rates and better survival compared with intralesional excision (3). *En bloc* spondylectomy is indicated for patients with primary and metastatic malignant tumors (most commonly chordoma), and aggressive benign tumors (most commonly giant cell tumor of bone) that (I) do not invade adjacent organs, (II) show little or no adhesion to the vena cava or aorta, and (III) do not have multiple metastases (1-17). The number of resected spinal levels in spondylectomies depends on the vertical extend of the tumor (3-15); however, a relative contraindication for *en bloc* spondylectomy is contiguous involvement of more than three vertebrae (18). In general, *en bloc* spondylectomy is indicated for patients in whom spine surgery is performed for cure rather than for palliation (18); if wide margin (microscopically negative) resection cannot be achieved with *en bloc* spondylectomy, palliative treatments should be performed instead.

Initially, *en bloc* spondylectomy was described by Lièvre *et al.* (16) in the 1960s and Stener (17) in the 1970s; the technique was subsequently refined by Tomita *et al.* (18) and Fidler (19) in the 1990s. Currently, many studies have reported on the optimal approach for wide margin (microscopically negative) resection for spine tumors (1-15,20), and the optimal reconstruction technique after *en bloc* spondylectomy (1-15,20-24). The reported *en bloc* spondylectomies differ with respect to the number of stages of the procedure, the approaches used, the instruments with which osteotomies were performed, and the implants for spinal reconstruction (18-20). Posterior and combined approaches, and modifications have been reported (18-20). Osteotomies have been performed with Gigli saws, osteotomes, high-speed burrs, and threadwire saws (7,17,18,21-23).

En bloc spondylectomy has been reported as a one- or two-stage procedure, and through a posterior only, a posterolateral, or a combined anterior and posterior approach (1,2,20). Tomita *et al.* originally described the one-stage total *en bloc* spondylectomy through the posterior only approach for patients with primary malignant vertebral

tumors; no patient experience a local recurrence (25). Compared to previous reports (16,17,19), this technique involves *en bloc* excision of the tumor including the whole vertebra (body and lamina) as one compartment. It consists of two steps including *en bloc* resection of the posterior element and *en bloc* resection of the anterior part to salvage the spinal cord; occasionally, according to the original report, a small part of the vertebra (in most cases the pedicle) becomes unavoidably intralesional deliberately to protect the spinal cord (25,26). Subsequently, the same authors classified spinal tumors into seven types, and described improvement and modifications of the original total *en bloc* spondylectomy technique including a posterior only approach, a double posteroanterior and a double anteroposterior approach depending on the level of the spinal tumor and involvement of major vessels or segmental arteries (26,27). Specifically, they recommended a single posterior approach for tumors above the L4 that did not involve the major vessels, a double anteroposterior approach for tumors involving the major vessels or segmental arteries, and a double posteroanterior approach for tumors at the L5–L4 because of the difficulties anticipated by the iliac wings and lumbosacral plexus nerves. The one-stage procedure through the posterior approach only has been recommended to avoid extensive and multiple surgeries in cancer patients with poor respiratory function, medical co-morbidities, previous surgery or radiation therapy, and/or unresectable paraspinal tumor or scar tissue (8). The disadvantages of the posterior *en bloc* spondylectomy as described by Tomita *et al.* (18) are (I) the possibility of tumor cell contamination in the osteotomized pedicle if one or two pedicles are affected because the involved vertebra must be divided into two pieces to release the dural tube (two-piece spondylectomy); and (II) the risk of injury to the adjacent neural structures during excision of the pedicles, injury of the major vessels during blunt dissection of the anterior aspect of the vertebral body, disturbance of spinal cord circulation at the level of surgery, and excessive bleeding from vertebral veins and epidural venous plexus (18). In this respect, other surgeons described posterior *en bloc* spondylectomy techniques that enable extralesional tumor resection (one-piece spondylectomy) (19,20).

When the spinal tumor extends outside the anterior margins of the vertebral body and/or it involves the major vessels and segmental arteries, the rate of local recurrence with the posterior-only approach ranges up to 25%; in these cases, a combined anterior and posterior approach is recommended (2,3,18). Additionally, the one- or two-stage, combined anterior and posterior approach has been recommended for tumors involving three spinal columns, multilevel vertebral body or epidural tumors, vertebral body tumors with bilateral or circumferential epidural spinal cord compression, and/or major spinal deformity (2). Compared to the original *en bloc* spondylectomy technique, the advantages of the combined approach are that (I) it enables control of both the posterior neural structures and the anterior visceral structures and vessels during the resection, (II) it allows direct exposure and visualization of the tumor margins, and (III) it facilitates hemostasis (2,3). The disadvantages of the combined approach are (I) the need for patient repositioning and possibly a staged procedure, and (II) the increased operative time, more extensive surgery therefore increased patients' morbidity and risk for tumor contamination (18).

Compared to the original one-stage *en bloc* spondylectomy (25), staged procedures have been recommended (I) to reduce perioperative complications and morbidity/mortality for the patients, and (II) to facilitate tumor dissection from the anterior visceral structures and major vessels in surgically difficult cases (2,15).

The most important aspect of *en bloc* spondylectomy is its superior oncologic outcomes (1-15,18-20). The microscopically negative (wide margins) resection rate and the local recurrence rates obtained with *en bloc* spondylectomy in the published related studies range from 71% to 100% and 6.3% to 33%, respectively (1-3,7,20,21,24). However, the morbidity and mortality for the patients after *en bloc* spondylectomy is considerable with a complications rate ranging from 17.1% to 65.2% (4,7). Reported complications of *en bloc* spondylectomy include dural tears and cerebrospinal fluid leakage, pleural tear, ileus, pneumothorax, neurovascular injuries, paraplegia, venous thromboembolism, urinary tract infection, wound dehiscence and necrosis requiring plastic surgery and reconstruction, pseudarthrosis, infection, and late implant failures (1-22,24). Previous radiation therapy makes surgical treatment difficult, with respect to approach, tumor resection and risk for complications (7,15). If significant intraoperative hemorrhage is anticipated, preoperative embolization is recommended; in these cases, a permanent embolic agent should be used for permanent occlusion of the tumors' pathological vessels (6,10,28). Electrophysiological monitoring may be used to improve the safety of embolization and *en bloc* spondylectomy for intra-operative major nerve injury (6).

The long-term clinical outcomes of the patients after

en bloc spondylectomy are favorable with low rates of local recurrences and a rate of metastasis that is not directly related to the procedure itself (14,25). However, *en bloc* spondylectomy is the most aggressive mode of therapy for spinal tumors (25), and it is unclear if the lower local recurrence rates justify the morbidity and quality of life of the patients (11). A recent study using outcomes measures of quality of life reported that the patients experience more pain after *en bloc* spondylectomy compared to radiation therapy alone (11). Preoperative factors such as better performance status, tumor location in the cervical spine, lack of mechanical spinal pain, and less extensive surgery with less fusion levels were the most important independent predictors of quality of life (11). Postoperative factors such as poor performance status, chronic administration of narcotics, and local recurrences were more important predictors compared to preoperative factors for worse quality of life (11). Another study reported significant physical impairment in the early post-operative years that usually returned to normal approximately 3 years after surgery; overall, approximately 90% of the patients were satisfied or very satisfied with the end results of *en bloc* spondylectomy with good performance in their daily living activities (14).

In our practice, as orthopaedic oncology surgeons, we aim for complete, wide margins resections of any primary malignant tumor. In the spine, this is challenging and difficult. Resection of a spinal tumor with salvage of the spinal cord has become feasible with *en bloc* spondylectomy. After treating tumor patients for more than 3 decades, we concur that *en bloc* spondylectomy is a feasible and effective procedure for primary and metastatic spinal tumors; the oncologic outcomes are good, especially for patients undergoing *en bloc* spondylectomy as their first surgical treatment. Yet, it is an aggressive spinal surgery with an increased rate of complications, instrumentation failures and patients' morbidity and mortality. The surgeons should have a high level of technical ability, and should be familiar with the indications and surgical technique. The risks of perioperative complications and should be acknowledged; the most important include hemorrhage, vascular, nerve roots and spinal cord injury, intralesional osteotomy and tumor cells contamination of margins, and spinal instability. Preoperative embolization and careful planning are required for the optimal approach, decision for a single or staged procedure, and type of instrumentation and reconstruction to be planned. A staged procedure through a combined approach may probably reduce the rate of complications and improve the oncological outcome for the patients. In any case, the performing surgeons should be applauded for their practice.

In conclusion, *en bloc* spondylectomy techniques have improved the outcome of the patients with primary and metastatic tumors of the spine. Oncological outcome of the patients are favorable, however, with an increased risk for complications. Combined approach, staged procedures are probably recommended to reduce the risk for complication and allow for wide tumor resection. Further research is required with respect to reconstruction techniques.

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Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

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