# **En bloc vertebrectomy**

- Application of 3D-Printed Artificial Vertebrae in the Reconstruction After Resection of Complex Malignant Spinal Tumors
- Management of Cervical Spine Metastasis from Renal Cell Carcinoma: A Rare Case Report with an Overview
- Systematic Analysis for the Reason of Revision-Surgery After Non-Total En Bloc Spondylectomy Open Surgery Among Spinal Metastatic Tumor Cases: A Retrospective Study
- En Bloc Total Vertebrectomy of the Thoracic and Lumbar Spine
- How I do it: en-bloc thoracic vertebrectomy
- En-bloc spondylectomy in the lumbar spine: indications, results and complications in a series of 47 patients affected by primary malignant bone tumors
- En bloc vertebrectomy: A radical technique for spinal metastases but rarely used
- Total en bloc vertebrectomy and immunochemotherapy for chondrosarcoma colliding with intraosseous lymphoma

En bloc vertebrectomy is a surgical procedure used to remove an entire vertebral body along with the adjacent intervertebral discs and associated soft tissues as a single block. This procedure is typically performed for the treatment of certain spinal conditions, particularly for the management of malignant tumors, severe infections, or traumatic injuries that involve the vertebral column.

Here are some key points about en bloc vertebrectomy:

Indications: En bloc vertebrectomy is most commonly performed when a patient has a malignant tumor, such as a chordoma or aggressive vertebral metastasis, which has invaded the vertebral body extensively, compromising the structural integrity of the spine. It may also be used in cases of severe spinal infection or trauma where the vertebral body is extensively damaged.

Surgical Technique: During the procedure, the surgeon carefully removes the affected vertebral body, the intervertebral discs above and below it, and any involved soft tissues, nerves, and blood vessels as a single unit. This is done to ensure complete removal of the disease or affected tissue.

Spinal Reconstruction: After removing the affected vertebral body, the surgeon needs to reconstruct the spine to maintain its stability and proper alignment. This may involve the use of spinal instrumentation such as rods, screws, and cages to bridge the gap created by the removed vertebra. Bone grafts or other biological materials may also be used to promote spinal fusion.

Neurological Monitoring: During the surgery, monitoring of the patient's neurological function is crucial, especially if the tumor or injury involves the spinal cord or nerve roots. The surgeon aims to minimize damage to these structures while performing the vertebrectomy.

Risks and Complications: En bloc vertebrectomy is a complex and high-risk procedure. Potential risks and complications include infection, bleeding, injury to nerves or blood vessels, spinal instability, failure of fusion, and neurological deficits. The overall success of the procedure depends on the patient's overall health, the extent of the disease, and the skill of the surgical team.

Recovery: The recovery period after en bloc vertebrectomy can be lengthy, and patients often require

physical therapy and rehabilitation to regain strength, mobility, and function. The exact recovery time varies from patient to patient and depends on the extent of surgery and individual factors.

En bloc vertebrectomy is a specialized procedure that is typically performed by experienced spinal surgeons in specialized centers. The decision to undergo this surgery is made on a case-by-case basis after careful evaluation of the patient's condition and a thorough discussion of the potential benefits and risks.

En bloc resection involves the surgical removal of the entirety of a tumor without violating its capsule, and requires resection of the lesion encased by a continuous margin of healthy tissue.

The rationale is to allow resection of the tumor in one piece together with a layer of healthy tissue (marginal or wide resection) and thus to reduce the local recurrence rate and to improve long-term survival of the patients 1/2/3.

Yeung et al. performed a comprehensive search of the PubMed database for articles relevant to primary spine neoplasms and en bloc spine surgery. Institutional review board approval was not needed.

Although Enneking - appropriate en bloc vertebrectomy. can be highly morbid, it often provides the greatest chance for local control and/or patient survival. However, there is growing data to support modern radiotherapy as a feasible and less morbid approach to certain primary neoplasms that historically were considered radioresistant.

Choosing the optimal approach to primary spine tumors is complex. A comprehensive and up-to-date assessment of the evidence is required to guide patient care and to balance the often-competing goals of prolonging life and preserving quality of life <sup>4)</sup>

### History

The en bloc technique was first coined by Enneking et al., within the context of primary musculoskeletal sarcoma <sup>5)</sup>.

The first case of a total en bloc spondylectomy was published by Bertil Stener in 1971 in a case of chondrosarcoma of T6-T8 in a 49-year-old farmer <sup>6)</sup>.

Raymond Roy-Camille further standardized and popularized the technique <sup>7) (8) (9) 10)</sup>.

Larger series were published by Tomita et al. <sup>11)</sup> and Fidler in 1994 <sup>12)</sup>.

While Tomita's technique was an all posterior procedure, Fidler preferred a combined simultaneous posteroanterior approach. Fidler's series consisted of ten patients with mainly Giant cell tumors,

whereas Tomita et al. reported on 20 patients with solitary spine metastases. In a later publication Tomita et al. reported on five patients with primary malignant tumors of the spine <sup>13)</sup>.

Further authors adopted and modified these techniques and published their results with series of between seven and 29 patients <sup>14) 15) 16) 17) 18)</sup>.

# **Surgical Technique**

see En bloc spondylectomy Surgical Technique.

## Videos

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#### **Case series**

#### 2016

To describe the specific surgical details and report the lessons learned with a series of patients suffering from spinal tumours that underwent total en bloc spondylectomy (TES).

A retrospective case series review is presented, together with an analysis of the clinical and technical variables, as well as the outcomes.

A total of 10 patients underwent TES (2000-2016) for primary (osteosarcoma, chondrosarcoma, fibrosarcoma and chordoma) and secondary spinal tumours (lung, breast, thyroid, oesophagus, and meningioma metastases). According to the Tomita classification, 2 patients had intra-compartmental tumours, and the rest presented as extra-compartmental. All patients experienced an improvement in their pain level after surgery. Nine patients preserved ambulation post-operatively and one patient developed paraplegia. Six patients needed subsequent operations for wound debridement, tumour recurrence, or revision of the fixation. Other complications included pneumothorax, pleural effusion and venous thrombosis. Four patients remain alive (4 months to 15 years follow-up). The rest died due to primary tumour progression (6.5 months to 12 years). A detailed description of the surgical steps, tips, and pitfalls is provided. Modifications of the technique and adjuncts to resection are commented on. Observation of some considerations (selection of candidates, careful blunt vertebral dissection, strict blood loss control, careful handling of the spinal cord, and maintenance of the radical resection concept at all stages) is key for a successful operative performance.

TES is a paradigmatic operation, in which the concept of radical resection provides functional effectiveness and improves survival in selected patients suffering from spinal tumours. Our preliminary experience allows us to highlight some specific and relevant features, especially those favouring a simpler and safer operation <sup>19</sup>.

Aim of a study was to analyse the results of 21 patients with malignant lesions of the spine, all treated with en bloc excision in a combined posteroanterior (n = 19) or all posterior approach (n = 2). Twenty-one consecutive patients, operated between 1997 and 2005, were included into this retrospective study. Thirteen patients had primary malignant lesions, eight patients had solitary metastases, all located in the thoracolumbar spine. There were 16 single level, three two-level, one three-level and one four-level spondylectomy. The patients were followed clinically and radiographically (including CT studies) with an average follow-up of 4 years. Out of 11 patients with primary Ewing or osteosarcoma seven patients are alive without any evidence of disease. One patient died after 5 years from other causes and three are alive with evidence of disease. Latter had either a poor histologic response to the preoperative chemotherapy (n = 2) or an intralesional resection (n = 2)1). All three patients with solitary spinal metastases of Ewing or osteosarcoma died of the disease. Five patients with solitary metastases of mainly hypernephroma are alive. In total, six resections were intralesional, mainly due to large intraspinal tumor masses, with two patients having had previous surgery. In the remaining cases, wide (n = 10) or marginal (n = 5) resection was accomplished. There were one pseudarthrosis requiring extension of the fusion and two cases with local recurrences and repeated excisional surgery. At follow-up CT studies, all cages were fused. Health related quality of life analysis (SF-36) revealed only slightly decreased physical component and normal mental component scores compared to normals in those patients with no evidence of disease. En bloc spondylectomy enables wide or marginal resection of malignant lesions of the spine in most cases with acceptable morbidity. Intralesional resection, poor histologic response, and solitary spinal metastases of Ewing and osteosarcoma are associated with a poor prognosis <sup>20</sup>.

Various techniques for anterior column reconstruction have been described after en bloc resection of spinal tumors. Limited evidence exists regarding one being superior to another. The purpose of a study was to evaluate 3D-printed vertebral bodies for spinal reconstruction after en bloc resection in the thoracolumbar spine.

Prospective observational study on custom-made 3D-printed titanium reconstruction of vertebral bodies after en bloc resection for spinal tumor was conducted between November 2015 and June 2017. 3D-printed vertebral bodies were monitored for mechanical complications such as (1) migration, (2) subsidence into the adjacent vertebral bodies, and/or (3) breakage. Complications and related details were recorded.

Thirteen patients (7 females and 6 males) were enrolled, and reconstruction of the anterior column was performed using custom-made 3D-printed titanium prosthesis after en bloc resection for spinal tumor (8 primary bone tumors and 5 solitary metastases). Subsidence into the adjacent vertebral bodies occurred in all patients at both proximal and distal bone-implant interfaces; however, it was clinically irrelevant (asymptomatic, and no consequences on posterior instrumentation), in 11 out of 12 patients (92%). In 1 patient, severity of the subsidence led to revision of the construct. At an average 10-month follow-up (range 2-16), 1 implant was removed due to local recurrence of the disease and 1 was revisioned due to progressive distal junctional kyphosis.

Preliminary results from this series suggest that 3D printing can be effectively used to produce custom-made prosthesis for anterior column reconstruction <sup>21)</sup>.

The objective of the study was to describe and compare the surgical outcomes between the use of a new auto static spinal cord and thread wire guiding device and the traditional scalpel technique for en bloc vertebrectomies using only the posterior approach.

SUMMARY OF BACKGROUND DATA: As en bloc vertebrectomy has become more accepted as the ideal treatment for selected cases of spine tumors, its high morbidity has to be kept in mind. Uneven cutting surfaces and high risk of spinal cord lesions are among the problems. Although some modifications of the technique and development of new devices to minimize the risks have been reported, there are still some pitfalls associated with them.

METHODS: Twenty-five patients, divided into 2 groups, were retrospectively reviewed. Patients in group 1 (G1) were operated using the device, and the patients in group 2 (G2) underwent en bloc vertebrectomy by the traditional scalpel technique. The surgical time, amount of blood loss based on the total volume of blood transfusion during surgery, and the rate of complication were compared.

RESULTS: No differences regarding sex, age, and preoperative status occurred. The mean operative time was 294 and 388 minutes and the mean volume of transfused blood was 37 and 53 mL/kg for G1 and G2, respectively. These differences were not statistically significant.

CONCLUSIONS: Patient selection and surgical experience are the best outcome predictors. However, methods to reduce the risks of neural lesions, surgical time, and blood loss should always be applied, specially dealing with highly morbid and demanding procedures in the spine <sup>22)</sup>

Patients with primary bone tumors usually present with nonspecific axial pain over a period of time, with radicular or myelopathic symptoms absent in most cases.

Obtaining a histological diagnosis is essential, and CT-guided biopsy yields the best oncological results compared to those obtained with open biopsy.

Given the high rate of local recurrence if only intra-lesional excision or incisional biopsy is performed, the best treatment for these lesions is en bloc resection.

En bloc resection of primary spine tumors is the mainstay of treatment.

Paraspinal or chest wall primary tumors are rare, but their management principles are not different. Among the 52 cases reported by Boriani et al. only 7 were located in the thoracic spine.

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