



En Bloc Resections in the Spine: The Experience of 220 Patients During 25 Years

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■ **BACKGROUND AND OBJECTIVE:** En bloc resections aim at surgically removing a tumor in a single, intact piece. Approach must be planned for the complete removal of the tumor without violation of its margins. The shared knowledge of the morbidity, mortality, risk assessment for local disease recurrence, complications, and death, related to spine tumors excised en bloc could improve the treating physician's apprehension of the diseases and decision making process before, during, and after surgical treatment. The purpose of this study was to review and report the experience gained during 25 years in one of the world's biggest spine oncologic centers.

■ **METHODS:** A retrospective study of prospective collected data of 1681 patients affected by spine tumors, of whom 220 had en bloc resections performed.

■ **RESULTS:** Most tumors were primary—165 cases (43 benign and 122 malignant); metastases occurred in 55 patients. A total of 60 patients died from the disease and 33 local recurrences were recorded. A total of 153 complications were observed in 100 of 216 patients (46.2%); 64 of these patients (30%) suffered 1 complication, whereas the rest had 2 or more. All complications were categorized according to temporal distribution and severity. These were further divided into 7 groups according to the type of complication. There were 105 major and 48 minor complications. Seven patients (4.6%) died as a result of complications. There were 33 local recurrences (15.28%) recorded. Contaminated cases, surgical margins of the resected tumor—intralesional, marginal, and malignant tumors—were statistically significant

independent risk factors for local recurrence of the tumor. Contamination, local recurrence, neoadjuvant radiotherapy, number of levels resected, and metastatic tumors compared with primary malignant tumor were shown to be independent risk factors for a patient's death.

■ **CONCLUSIONS:** Treatment of spinal aggressive benign and malignant bone tumors with en bloc resection is beneficial in terms of better local control and prognosis, although it is a highly demanding and risky procedure. Margins are the key point of this procedure, thus a careful preoperative oncologic and surgical staging is necessary to define the optimal surgical approach. The adverse event profile of these surgeries is high. Therefore, it should be performed by experienced and multidisciplinary teams in specialized high volume centers.

INTRODUCTION

Unlike appendicular skeletal primary bone tumors, primary bone tumors of the spine are very rare,¹ comprising only 10% or less of all bone tumors. In the United States, 7500 new cases are estimated per year.¹ The estimated overall world occurrence is between 2.5 to 8.5 cases per million inhabitants per year.¹ Spinal metastatic tumors, most common skeletal region for secondary tumors, are estimated to be 30–50 times more frequent compared with primary bone tumors of the spine.

Due to their low relative prevalence, primary spinal tumors can be misdiagnosed and consequently managed incorrectly.

Key words

- En bloc resection
- Morbidity
- Spine tumors
- Surgical planning

Abbreviations and Acronyms

- CC: Contaminated cases
- CH: Chordoma
- CHS: Chondrosarcoma
- NCC: Noncontaminated cases
- OGS: Osteogenic sarcoma
- OR: Odds ratio

PE: Pulmonary embolism

WBB: Weinstein, Boriani, Biagini

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En bloc resections² are the procedures aimed at surgically removing a tumor in a single, intact piece, fully encased by a continuous shell of healthy tissue, which is defined as the margin. In the spine, these procedures are surgically demanding,³⁻⁹ mostly due to the proximity of neural elements and anatomic limitations. The limitation in mobilizing the spinal cord, neural roots, or the dural sac mandates either combined multiple surgical approaches or an enlarged single posterior approach. Achieving tumor-free margins of the resected specimen requires, at times, the sacrifice of adjacent anatomic structures (e.g., pleura, dura, muscles, nerve roots, nerves, vessels).¹⁰⁻¹⁵ An intentional violation of oncologic principles^{2,5,16} is considered for reduced morbidity and better functional results, but this is weighed against the higher risk of recurrence.

Successful en bloc resection has shown to result in fewer local recurrences and improved prognosis in both primary^{7,16-19} and isolated spinal metastases such as renal cell carcinoma and thyroid cancer.²⁰⁻²² Previous studies that compared true en bloc to intralesional resections reported improved local control, where the recurrence was 92.3% versus 72.2% for giant cell tumors,^{22,23} 78% versus 22% for chordoma (CH),¹⁷ and 82% versus 0 in chondrosarcoma (CHS).¹⁸ In an earlier study¹⁶ reporting our previous experience of a series of 103 patients, marginal and intralesional resections were shown to be an independent risk factor for local recurrence, with hazard ratios of 9.45 and 38.62, respectively.

It is reported that major spine surgery can be associated with high morbidity.²⁴⁻³³ To that extent, spinal en bloc resection, due to multiple surgical approaches, tumor surgery, and lengthy surgical procedures,³⁴ can be expected to involve intraoperative, early postoperative, and long-term adverse events. At present, few reports focusing on complications and outcomes of en bloc resections in the spine have been published.^{16,35-37} Some focusing on specific area of resection such as the cervical spine,³⁸ sacrum,^{39,40} whereas others addressing complications related to surgical treatments of various pathologies such as CH^{38,39} and metastatic thyroid carcinoma.²⁰ In a recent study published by our group,³⁶ focusing on the morbidity of 220 en bloc resection conducted between 1990 and 2015, a 45.45% complication rate was observed. This high rate requires continuous attention and effort to understand and reduce the morbidity of this operation.

Because these operations are not performed frequently in the world, it is imperative that the experience gained in large centers specialized in treating these pathologies be reviewed and shared. This shared knowledge of the morbidity, mortality, risk assessment for local disease recurrence, complications, and death, related to spine tumors excised en bloc could improve the treating physician's understanding of the diseases and the decision-making process before, during, and after the surgical treatment. This report includes a summary of the previously reported morbidity,³⁶ as well as local recurrence and mortality, and a thorough review of the gained experience approaching the surgical management of these tumors.

The purpose of this study is to review and report the experience gained in one of the world's largest spine oncologic centers conducting these surgeries during 25 years.

METHODS

From January 1990 to July 2015, 1681 consecutive patients with spine tumors were diagnosed and treated in one referral center. A total of 220 en bloc resections were performed on 216 patients by Stefano Boriani and his team. For all patients, clinical radiographic and histologic studies were completed and classifications according to the Enneking,² Frankel⁴¹, and the Weinstein, Boriani, Biagini (WBB)⁴² staging systems were determined before the surgical intervention.

Data were prospectively collected to build a database for clinical and research use.

Patients who were diagnosed and treated at the Department of Oncologic and Degenerative Spine Surgery, Unit of Oncologic Spine Surgery, Rizzoli Institute, Bologna, Italy, were classified as noncontaminated cases (NCC). Conversely, patients who were referred for treatment after either open biopsies or an initial surgical attempt of resecting the tumor at another institution were categorized as contaminated cases (CC).

Patient outcome factors including local recurrence, mortality from the disease, morbidity (intraoperative, early and late postoperative complications), and change in neurological status were reviewed in the present study.

The morbidity is summarized in this report in concordance with our recent article describing the complications of en bloc resection.³⁶ Major complications were considered as "any complication that appeared to substantially alter an otherwise full and expected course of recovery," as described by McDonnell et al.²⁶ Other complications were regarded as minor.

Complications were studied and stratified based on temporal distribution (intraoperative, early postoperative [within the first 30 days after surgery], and late postoperative [>30 days after surgery]), type of resection, and the approach adopted (single posterior approach or combined anterior and posterior approaches in the same surgical session). All complications were categorized into 7 groups (vascular failure and bleeding, hardware failure, injury to adjacent structures during and after surgery, injury to the dural sac and neurological unplanned deficit, infections of soft tissue and wound problems, systemic morbidity [including cardiac, renal, respiratory, and immunologic systems], and hypercoagulable problems [including pulmonary embolism, PE, and deep vein thrombosis]).

Terminology for Resections

1. Intralesional excision: piecemeal removal of the tumor, further subcategorized into:
 - a. Intracapsular—incomplete tumor removal where gross or histologic remnants inside the tumor capsule could be expected.
 - b. Extracapsular—complete resection of the entire tumor's mass together with the peripheral tissue (3–5 mm of healthy peripheral tissue).
2. En bloc resection: removal of the entire tumor's mass, including a cuff of healthy tissue encasing the tumor. After histopathologic evaluation of the resected specimen, further subclassification as:

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