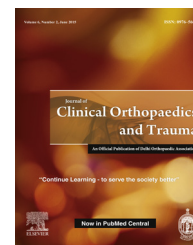




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Review Article

Management of infection following reconstruction in bone tumors



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ABSTRACT

Limb salvage surgery in bone tumors has evolved in recent years and includes all of the surgical procedures designed to accomplish removal of a malignant tumor and reconstruction of the limb with an acceptable oncologic, functional, and cosmetic result. This dramatic change came about as the result of three important developments, i.e. effective chemotherapy, improved precision imaging techniques and advances in reconstructive surgery. Reconstruction with a modular custom-made oncological endoprosthesis (megaprosthesis) has become a common procedure nowadays. These large foreign bodies make infection a common and feared complication. However, the occurrence of complications may be multifactorial, including a poor nutritional and compromised immune status due to chemotherapy and/or radiotherapy, a lengthy operation, extensive dissection and resection of soft tissues, inadequate soft-tissue coverage, a longer exposure of the wound resulting in infection, etc. Management of postoperative infection in these cases remains a challenge. This article analyses the current literature available for these cases and summarizes the cause and different available methods of treatment.

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1. Introduction

Over the last 30 years, limb salvage surgery has evolved and the technique has been proven safe and effective in most cases.¹ Limb salvage surgery includes all of the surgical procedures designed to accomplish removal of a malignant tumor and reconstruction of the limb with an acceptable oncologic, functional, and cosmetic result. Today, up to 85% of sarcomas in the extremities are treated with limb salvage surgery. This dramatic change came about as the result of three important developments, i.e. effective chemotherapy, improved precision imaging techniques, and advances in reconstructive surgery.² Options for skeletal reconstruction include modular endoprostheses, osteoarticular or bulk allografts, allograft-prosthetic composites, vascularized bone grafts, arthrodesis, expandable prostheses, rotationplasty, and limb-lengthening techniques. Reconstruction with a modular custom-made oncological endoprosthesis (Megaprosthesis) has become a common procedure nowadays.³⁻⁷ This procedure provides a durable and functional limb immediately after the operation, achieving immediate rigid fixation, and allowing early initiation of a postoperative rehabilitation program. Therefore, increasing numbers of patients are undergoing megaprosthesis reconstruction after resection of a malignant bone tumor and some other nonmalignant conditions. Complications common to all types of limb salvage surgeries are neurovascular injuries, local tumor recurrence, deep wound infections, and soft-tissue healing problems.⁸⁻¹¹ The occurrence of complications may be multifactorial,¹² including a poor nutritional and compromised immune status due to chemotherapy and/or radiotherapy, a lengthy operation, extensive dissection and resection of soft tissues, inadequate soft-tissue coverage, a longer exposure of the wound resulting in infection, etc. Early general complications include wound necrosis, infection, joint contracture, joint stiffness, joint instability, neuropraxia, vascular injury, etc. Infection is one of the most common complications of limb salvage operations, and the management of postoperative infection remains a challenge.

2. Significance of chemotherapy

In the early 1970s, new anti-neoplastic drugs such as adriamycin and methotrexate were introduced, and remarkable improvements in the prognosis for some sarcomas were seen.^{13,14} Neo-Adjuvant or "assisted" chemotherapy is now used for most bone sarcomas prior to surgery.¹⁵⁻¹⁹ Chemotherapy causes tumor necrosis, which allows for safer removal. In addition, chemotherapy causes the tumor to develop a rind or margin and in some cases shrink, helping the surgeon to completely resect the tumor and minimize the removal of normal tissue. However neo-adjuvant chemotherapy can compromise the immune status of the patient, which may result in complications such as postsurgical infection.^{20,70} Response to chemotherapy and patient fitness are important criteria in determining patient eligibility for surgery.²¹ Certain clinical parameters can be adopted to prevent complications for patient undergoing reconstructive surgeries after neo-adjuvant chemotherapy. Some clinical markers of recovery are:

- Absolute neutrophil count (ANC) $> = 1200 \text{ mm}^{-3}$
- Platelet count $> = 100,000 \text{ mm}^{-3}$
- Hemoglobin $> = 9.0 \text{ mg/dL}$
- Total bilirubin must be $= <$ the upper limit of normal (ULN)

2.1. Significance of radiotherapy

Besides chemotherapy, some bone tumors such as Ewing's sarcoma can be treated with radiation therapy prior to surgery to downsize the tumor grade.²²⁻²⁹ But radiation therapy also carries risk of skin necrosis, decrease in immune status, secondary malignancy, etc. Complication rates for preoperative radiotherapy reported by various authors range from 10% to 41%.^{26,30-33} In patients with megaprosthesis replacement, the reported risk of infection with preoperative radiation therapy is 20.7% and 35.3% in those receiving postoperative radiation therapy.³⁴ Cutaneous radiation injury can be caused by radiations as low as 2 Gy or 200rads and risk increases with increasing doses.³³ Therefore it is important to follow proper guidelines for maximum radiation dose for specific tumors.³⁵

The reported risk of infection is significantly higher with radiotherapy alone, and interestingly, combination of chemotherapy with radiotherapy is associated with decreased rate of infection (Table 1).³⁶

Emerging radiation delivery methods may reduce the toxicity to local normal tissue without, increasing the risk of disease recurrence. Newer techniques have been introduced for reducing the radiotherapy field in order to maximize radiation treatment and to decrease incidental morbidity. In recent years, precise field sculpting with intensity-modulated radiotherapy (IMRT) has become popular. IMRT is an advanced form of external beam irradiation and a type of three-dimensional conformal radiotherapy (3D-CRT). Intensity-modulated radiotherapy involves the use of computerized optimization techniques to deliver nonuniform radiation-beam intensities to a field that is planned with use of three-dimensional computerized tomographic scanning techniques.⁹² This precise delivery of radiotherapy avoids incidental treatment of surrounding tissues and therefore reduces radiation-associated complications.⁹³

2.2. Custom-made megaprosthesis

Megaprosthesis is a large metallic device designed to replace the excised length of bone and the adjacent joint (Fig. 1). Modular designs are available for the most common uses in the femur, tibia, and humerus that allow the surgeon to assemble the prosthesis intraoperatively to accommodate the needs of a particular patient. Custom prostheses are available for special applications. The prosthetic joint has a modified

Table 1 – Infection and adjuvant therapy.

Adjuvant	Infection rate	Relative risk
Chemotherapy alone	0.20	1.51
Radiation alone	0.50	3.85
Chemotherapy & radiation	0.09	0.66
No adjuvant therapy	0.13	1.00

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