Limb Salvage Surgery:

An Advance in Surgical Technique

By Wendy McCulloch, R.N.

Abstract

"Surgery is the primary and oldest treatment for malignant musculoskeletal tumors. Until the 1970's amputation was the accepted surgical procedure for patients with malignant tumors of the extremities. Recent advances in adjuvant treatment modalities such as chemotherapy and radiotherapy, bioengineering designs of internal prosthetic devices, radiographic workups, and bone and tissue transfers provide some individuals with the option of limb-preservation" (Lewis, 1992, p. 477-478). One limb salvaging technique uses a metallic implant to replace resected tumors of the bone. It is this surgical orthopaedic advancement that is currently being used in the resection of primary malignant bone tumors of the lower extremeties at Mount Sinai Hospital, Toronto, Ontario.

The objectives of this paper are to review the management of musculoskeletal tumors in "skeletally mature patients", and to review a system currently being utilized at Mount Sinai Hospital which provides a surgical option for resection and reconstruction of malignant bone tumors. The role the perioperative nurse plays in providing care to patients having limb salvage surgery will also be described. All three objectives will provide insight into the challenges facing orthopaedic oncology patients who are living with cancer.

Introduction

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The objectives of this paper are as follows; first, to review the management of musculoskeletal tumors in "skeletally mature patients". Second, to review a system currently being utilized at Mount Sinai Hospital which provides a surgical option for resection and reconstruction of malignant bone tumors, and third to describe the role the perioperative nurse plays in providing care to patients having limb salvage surgery. All three objectives will provide insight into the challenges facing orthopaedic oncology patients who are living with cancer.

Management of Musculoskeletal Tumors

A musculoskeletal tumor can originate from connective tissue, fibrous tissue, fat, muscle, blood vessels, lymph vessels, synovial tissue, peripheral nerves or bone. Tumors can be classified as benign or malignant in soft tissue and bone. Both types of tumors can crowd and compress nearby organs, blood vessels and nerves causing pain and interference with normal function. Malignant tumors, accounting for one to two percent of all adult cancers, can also invade surrounding tissue and metastasize to other parts of the body. Soft tissue tumors will not be addressed in this paper. Diagnostic work-up may be similar but the management of soft tissue tumors is different.

Pre-operative work-up for the patient includes physical examination, x-rays, C.T. and M.R.I. scans of limb and chest, bone scans, angiography, diagnostic biopsies, and frozen section (pathology). Following a carefully planned open incisional biopsy, staging and grading of the patient's tumor provides an initial diagnosis. "Determination of the surgical procedure reflects the patient's age, histological diagnosis, associated tumor behavior, the anatomic location of the tumor, the results of staging work-up, functional goals and patient's viewpoints in the decision-making process" (Lewis, 1992, p. 478). Ultimately a decision is made for limb salvage or amputation.

Tumors of the bone can be classified as benign, metastatic, or primary malignant. Benign bone tumors can be aggressive, requiring curettage or excision and possible bone replacement. Bone from a donor (allograft) or the patient's own bone (autograft) along with some form of internal fixation are often used to provide adequate bone stabilization. Metastatic tumors of the bone are also treated surgically if required. These tumors may cause weakening of the bone which can result in pathological fracture. As a result, the patient becomes mechanically compromised. Tumors may also compress sensitive anatomical structures, i.e. the spinal cord, necessitating decompression or debulking of the tumor. Surgical goals would be palliative rather than curative.

High Grade and Low Grade Tumors

Primary malignant tumors are described as being low and high grade tumors. Low grade tumors, such as a Chondrosarcoma, are resected and reconstructed if feasible. Chemotherapy may be utilized preoperatively in order to reduce tumor size. High grade tumors such as Osteosarcoma are treated with pre- and postoperative chemotherapy according to appropriate protocol. Chemotherapy is an important part of the total treatment regime. It is usually necessary to wait one to two weeks following the patient's last session of chemotherapy before surgery is scheduled. This permits adequate time for the haematologic and immune systems to recover in order to minimize risks of postoperative immunosuppression and wound-healing complications. "The rationale for treatment is to treat micrometastasis, decrease the tumor size and viability, and assess the effectiveness of the chemotherapy agents on the individual tumor. Adjuvant treatment can increase the ability to salvage a limb" (Piasecki, 1991, p. 34-35).

The essence of surgical management for patients with musculoskeletal tumors is represented as follows:

> "There is no treatment for tumors, only for patients. There is no place for applying a single method of treatment indiscriminately to all patients to accumulate a series. Each patient is entitled to receive customized, life-style oriented, one-of-a-kind management" (Enneking, Vol. 1, 1983, p. 218).

Surgical Technique for Resection of a Primary Bone Tumor

Competent recognition and management in terms of eradicating local disease at the primary tumor site is appropriately expressed as follows: "The early recognition of a primary malignant bone tumor and the proper management can mean the difference between a limb salvage and an amputation or the difference between life and death" (Lewis, 1992, p.1).

"The surgical treatment of high grade malignant musculoskeletal tumors during limb salvage surgery involves resection of the tumor, reconstruction of the surgical defect and provision of adequate soft tissue coverage" (Lewis, 1992, p. 479).

In the past, surgical reconstruction of bone tumors at the distal femur involved any combination of arthrodesis, use of donor cadaveric allograft bone, autograft bone and/or usually cemented prosthetic implants.

Another surgical option is a metallic implant system. At Mount Sinai Hospital patients having primary bone tumors of the lower extremity, with non metastatic disease, become candidates for this system.

The benefits of this particular system are: reconstruction without the use of allograft, a shorter period of rehabilitation following surgery and modified functional use of the salvaged limb.

At the knee, bulk allograft utilized to replace resected bone and tumor is found to have a higher risk

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of fracture and infection than utilization of a prosthesis alone (Wunder, 1993). The metallic implant system provides the surgeon with the option of tumor resection and reconstruction as well as the possibilities of replacing the proximal femur, distal femur, proximal tibia, total femur and total femur with proximal tibia (Howmedica, 1991).

Prior to surgery four to six units of blood are crossmatched. Pain management includes preparing for epidural catheterization insertion intra-operatively.

In the Operating Room, following induction, a Foley catheter and invasive monitoring lines are inserted. Preventative measures taken to reduce the risk of infection may include laminar air flow with body exhaust suits and prophylactic intravenous antibiotics. A complete selection of prosthetic components are chosen to replace the resected bone based on radiographic images.

After appropriate positioning, prepping and draping of the leg, a sterile tourniquet is applied. The skin incision is made. The lateral or medial approach must accommodate the previous biopsy scar to prevent creation of a tract which would further spread tumor cells.

The following steps highlight the surgical technique for resection of a distal femoral tumor using the metallic implant system.

1. Exploration and dissection of the bone tumor

Surgical exploration and dissection of the tumor begins with preservation of vessels, nerves and muscles, essential for postoperative limb function. This is the most tedious segment of the surgical procedure, but is essential for limb salvage.

2. Resection and removal of the distal femoral tumor

Margins have been estimated, prior to surgery, based on radiographic images. The femoral bone is cut proximal and a sample of bone marrow, proximal to the tumor, is sent to pathology to ensure a clear margin. If tumor invasion is suspected at the knee then the distal cut is made at the proximal tibial plateau and en bloc excision is made incorporating the knee joint. Removal of the knee joint in its completion prevents the joint from being opened and minimizes the risk of seeding tumor cells.

Resection of the tumor includes removing normal bone and tissue surrounding the tumor, in order to establish wide or radical resection margins. Once the femur and tibia are free the entire specimen is removed and sent to pathology. The pathologist cuts open the tumor and surgical margins are established.

Frozen sections are sent from the remaining bone marrow and soft tissue from the distal margin. If these margins are established as being clear of tumor cells the preparation of the femur and tibia begins for insertion of the prosthesis.

3. Reconstruction using a metallic implant system

The prosthesis is a porous, uncemented, modular resection system made of vitallium. It is an updated version of the "Kotz Modular Femoral and Tibial Reconstruction System (KMFTRS)" and is the result of collaboration between Professor Kotz of Austria and Professors Campanacci & Capanna of Italy, all orthopaedic surgeons. Internationally the KMFTRS has been in use since 1982 and has benefitted more than 1500 patients (Howmedica International, 1991). At Mount Sinai this system has been used and evaluated since 1989. The updated system consists of three major components: bone and joint replacement parts and anchorage pieces. Accessory pieces and instrumentation are used to assemble the prosthesis together. All bone replacement prosthesis have a porous finish which provides a site for soft tissue attachment and autogenous bone grafting. Cost of the various components can total anywhere from $5,000 to 10,000 Cdn. per patient, considerably less than a custom made prosthesis. The prosthesis components are assembled to replace the length of the bone resected in order to preserve bone length and function. **(See Figure 1).**

Usually the tibia is templated and reamed first. A tibial replacement piece is inserted and secured using the tibial impactor. The resected femur is prepared by reaming and shaping the medullary canal to impact the chosen anchorage piece. A combination of extension pieces may be used to bridge the distance between the anchorage piece and the distal femoral piece, depending on the length needed.

These pieces are connected and are temporarily secured. The knee joint is then hinged together at its axis and a trial reduction performed. The limb is checked for stable alignment and length as in any joint replacement surgery. Leg length discrepancy can be corrected through resection and/or selection of different sized components. Once the appropriate length is achieved, the prosthesis is re-assembled and permanently secured with screws at the anchorage piece. The distal femoral piece is driven into the anchorage piece using the femoral impactor. The knee joint is then hinged and rechecked for alignment. The patella and patellar tendon may or may not require fixation depending on the tumor and degree of flexion achieved.

4. Adequate tissue coverage and wound closure

After successful implantation of the prosthesis, primary closure begins, to allow for adequate soft tissue and skin coverage of the prosthesis. Some patients may require a local transposition flap (i.e.gastrocnemius muscle flap) to replace muscle resected with the tumor. During wound closure it is important to avoid dead space thus reducing the risk of postoperative infection. Insertion of deep drainage (usually 1/8" hemovacs) is used at the subcutaneous layer and the skin is closed with staples. The patient's leg is immobilized in a soft, bulky Jones dressing and/or splint. Duration of the surgery ranges from two to six hours.

Post-operative rehabilitation begins five to 10 days after surgery, following an uncomplicated recovery. Functional mobility is aimed at achieving 90 degree flexion and full extension in the salvaged limb. However many patients face temporary if not permanent limitations in their mobility which may mean an adjustment in lifestyle.

Role of the Perioperative Nurse

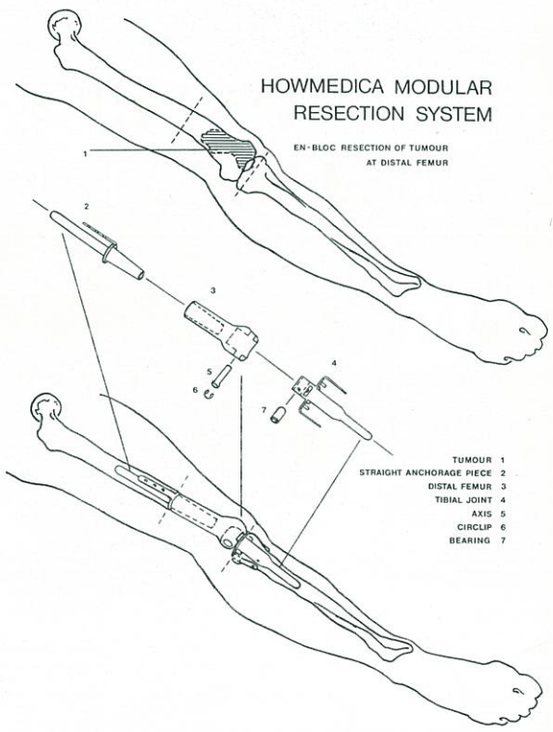
In tumor resection surgery our nursing practice follows standards according to the Operating Room Nurses Association of Canada and principles of orthopaedic tumor surgery based on Enneking (Enneking, 1983). Knowledge regarding instrument setups and tumor contamination principles for bone tumors are fundamental to limb salvage surgeries. Skeletal reconstruction may involve the use of donor allograft, autograft harvesting, arthrodesis with A.O. plate and screws, a total joint, free vascularized/pedicle flaps or any combination of these and other additional set-ups. Knowledge of these surgical procedures and equipment is essential for a technically successful outcome.

In the operating room we may see patients initially for an operative biopsy, again for porta-cath insertion, and then resection of their tumor with reconstruction. Complications, recurrence of disease and amputation are some of the set backs these patients face. The focus of intraoperative care is based on understanding what the patient may have previously experienced or expected surgically and what stage they are at in their disease process.

Care of a patient facing limb salvage or amputation is more than a technical skill. What the patient may be going through at the time of surgery is often overlooked. Fear and uncertainty regarding alteration in body image, self-esteem, recurrence of disease, death and dying are all important considerations.

Although the perioperative nurse's initial contact with these patients may be minimal it is at a time of peak anxiety. If possible, the perioperative nurse should visit the patient before the surgery to encourage both patient and family to discuss questions related to their surgery. Pre-operative patient education may include: showing patients an implant that will replace their resected tumor and bone , familiarizing the patient with O.R. routines and a face that will be at the O.R. doors the day of their surgery. Patients may need to feel involved in preparing for their surgery. Assessment of this need is promoted through nurse to nurse consultation by the nurse on the patient unit and the perioperative nurse. An optimal level of functioning may be achieved for the patient by including them in

Figure 1



preoperative planning and education, at the same time providing a time to enhance their sense of dignity and control.

Mount Sinai Hospital: Designated Referral Centre for Canada

Musculoskeletal tumors are rare and a small percentage of these cases present in the overall population. The University Musculoskeletal Oncology Unit, established at Mount Sinai Hospital, Toronto, is the designated referral centre for Canada. The Unit utilizes a multidisciplinary approach in the care of patients facing limb salvage surgery. The goal of this approach is to promote collaboration with colleagues in order to provide individualized, continuity of care for the patient. The perioperative nurse has a role in this approach.

Understanding the diagnostic and adjuvant therapies related to management of tumors and the initiative to become involved helps the perioperative nurse appreciate the options and rationale with respect to limb salvage surgery.

Conclusion

The outlined procedure may seem routine in terms of the surgical technique, however the surgery itself is unique to each individual. As patient survival improves the most challenging questions related to limb salvage surgery deal with efficacy and functional outcome. "Several long-term studies have confirmed that patients treated with limb salvage surgery have no higher risk of metastases than patients undergoing amputation" (Bell, 1992, p. 794). "Limb salvage surgery can potentially offer patients excellent function and cosmesis with no increased danger, but the method of reconstruction must be durable and not commit the patient to multiple surgical interventions" (Roberts, 1991, p. 767) .

Measured outcome is still unknown for patients having the metallic implant described in this paper. There is a need for analysis of "reconstructive survival" which will assess the appropriateness of this system as a surgical option. The durability of this surgical choice versus other options, including amputation, will undeniably include evaluation of the patient's quality of life.

Musculoskeletal tumor surgery, an orthopaedic subspecialty, is a challenging area of nursing care. The surgical goal can best be described in the following quotation:

> "The objective of modern tumor therapy is not solely the saving of life, but also an attempt to provide optimal rehabilitation for the patient whose life is saved. In the surgical treatment of osteosarcoma increased importance has therefore been attached to functional considerations" (Salzer, 1981, p. 131).

Sound knowledge with respect to surgical management, technique and technological advancement enables perioperative nurses to function as a multidisciplinary team members. But more importantly, it is a deeper understanding of patients who challenge their musculoskeletal disease that improves the nurse's ability to provide compassion and excellence in nursing care

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