



Extending the Frontiers of Limb Salvage— Geographically and Surgically

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Late presentations, delays in diagnosis, and improper index surgeries are not uncommon presentations in patients with musculoskeletal tumors in the developing world. The reasons are multifactorial and include ignorance coupled with apathy, socioeconomic conditions, the need to travel vast geographic distances to access health care, reliance on alternate medical practices, and a shortage of trained orthopaedic oncologists. Though the developing world has considerable diversity in terms of resource and expertise availability, it is not unusual for even well-trained surgeons in established centers to continuously innovate and improvise when confronted with economic constraints while managing these difficult lesions. Balancing the goals of ensuring adequate resection of involved bone and soft tissue so as to minimize the chance of local recurrence while yet preserving adequate function of the limb after reconstruction using available resources is often a big challenge. In a resource-challenged setting, the ingenuity of the treating team is often tested when deciding on reconstruction modalities, resulting in the use of more inexpensive and locally applicable solutions for limb salvage as compared with conventional modalities. Increased experience and continuous refinement of these procedures devised owing to a lack of alternative options and sheer necessity can help them gain global acceptability even in developed countries that are facing increasing health care budgetary constraints.

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More than 80% of the population of the world and a myriad collection of orthopaedic pathology is located in developing countries.¹ Late presentations, delays in diagnosis, and improper index surgeries are not uncommon presentations in patients with musculoskeletal tumors in the developing world.^{2,3} Western literature makes a plea for improvement in diagnosing bone sarcomas, lamenting the fact that the size of bone sarcomas at presentation has not changed over time, with the mean size at diagnosis for bone tumors remaining approximately 10 cm over a 25-year period.⁴ In the developing world, a 10-cm tumor would rarely envisage surprise, and it is not unusual to see tumors almost twice that size regularly. The reasons are multifactorial.⁵ Ignorance coupled with apathy, socioeconomic conditions, lack of adequate trained personnel and infrastructure, the need to travel vast geographic distances to access health care, and reliance on alternate medical practices contribute to these late presentations.³

The absence of structured training programs and opportunities results in a paucity of trained musculoskeletal oncologists.⁶ Pakistan, a country of 180 million people, has only 3 trained orthopaedic oncology surgeons.² It is little wonder that a large number of patients are treated by inexperienced surgeons without observing oncologic principles. Almost 40% of soft tissue sarcomas referred to an oncology hospital in Karachi were treated by a prior “unplanned excision” resulting in poorer overall outcomes.²

There is considerable diversity in terms of resource and expertise availability when it comes to managing musculoskeletal lesions even across the developing world. The gamut ranges from centers that offer the latest technological advances with image-guided navigation and treatment with noninvasive expandable prosthesis to surgeons forced to resort to amputations owing to infrastructural hurdles. Modern orthopaedics is expensive, and even a surgeon trained to the highest theoretical and practical level would have to continuously innovate and improvise when confronted with economic constraints in the developing world.¹ The axiom “first save the life—then save the limb” is often a stark reality in everyday practice in developing countries. Overall survival being of

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paramount importance, often in a resource-challenged population, the priority is to make sure that funding is directed toward ensuring adequate adjuvant therapy during the multimodality management of malignant bone tumors. Even though limb salvage may be possible, the additional cost of reconstruction after resection can occasionally be a limiting factor in such situations. To avoid amputations in potentially “salvageable” situations, surgeons rely on their ingenuity, using inexpensive and locally applicable reconstruction modalities as compared with conventional prosthesis, bone bank allografts, or vascularized grafts requiring special surgical expertise.

Patients with larger tumors are at greater risk of having an amputation as primary treatment rather than limb-salvage surgery. Grimer⁷ demonstrated that the mean size of tumors undergoing limb salvage was 10.2 cm compared with 12.1 cm for those having an amputation. This occurs possibly because though the number of limb-salvage surgeries undertaken for malignant bone tumors of the extremity has increased, the principles that govern surgical resection of bone tumors have remained unchanged. The surgeon must ensure adequate resection of involved bone and soft tissue so as to minimize the chance of local recurrence. If after achieving this goal he is still able to preserve adequate function of the limb after reconstruction, then the patient is a suitable candidate for limb salvage. At no stage must adequate disease clearance be compromised in an attempt to achieve limb salvage. Balancing these 2 opposing goals can often be a Herculean challenge, especially in patients with large tumors, and it is not uncommon for patients with tumors in developing countries to have an amputation for local control (Fig. 1).⁸

This article seeks to illustrate some of the “different” options employed for limb salvage in bone tumors utilizing the local resources available.

Use of Indigenous Prosthesis for Limb Salvage

Megaprotheses form the mainstay in limb-salvage surgery for reconstruction after tumor resection and have demonstrated excellent functional results. Though international prostheses are routinely available, cost constraints preclude their use in most patients in the developing world. Hence, low-cost, locally manufactured prostheses have remained the workhorse for surgeons in these nations for prosthetic reconstructions after limb salvage.^{9,10} Though these prostheses (usually available at a cost between US \$1200 and \$1800) did have initial problems with early failure, the advent of better manufacturing techniques and increasing surgeon involvement in design development have helped create a durable prosthesis option at more affordable costs over the past decade.¹¹ These prostheses are now routinely being used even for total bone resections and complex pelvic resections.¹²⁻¹⁴ However, the limited availability of a “low-cost,” expandable prosthesis still poses constraints in reconstruction options for growing children.



Figure 1 A large proximal humeral tumor needing an amputation to achieve adequate local control. (Color version of figure is available online.)

Arthrodesis Around the Knee

Though arthrodesis of the knee may not be a favoured option after resection because of the functional limitations, it is still a popular alternative in developing countries. It is difficult to argue against the durability of this robust and inexpensive reconstruction, especially after resection of large benign lesions where the patient is expected to have a normal life expectancy. The physical demands placed on a reconstruction in patients whose livelihood depends on hard manual labor can be a deterrent to the use of prostheses. The potential costs of possible future revision surgeries often make patients opt for arthrodesis as the primary reconstruction modality. Traditionally, autografts and allografts have been used to bridge the defect so as to achieve an arthrodesis. Some authors have also successfully demonstrated the use of a 2-ring Ilizarov construct with bifocal bone transport over a thin-diameter, long intramedullary nail as a cost-effective means of achieving effective union with least complications.¹⁵

Another situation where an arthrodesis may be a possible option is in large tumors when a considerable amount of quadriceps muscle is sacrificed to obtain adequate oncologic clearance. A mobile joint may not be the best reconstruction modality in this scenario. Besides conventional means of

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