Oncology orthopedic surgery

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Oncology orthopedic surgery has markedly evolved over the past three decades.
In the seventies, amputation of the limb was the gold standard for local control. Barely 20% of patients could survive more than 10 years.
The improvement in chemotherapy protocols has increased the survival of patients presenting with bone sarcomas. Nowadays, treatment should achieve cure in more than 70% of patients presenting with localized osteosarcoma. It becomes evident that these patients deserve better solution than ablative surgery.
Along with their growing surgical expertise, the introduction of neoadjuvant chemotherapy and the invention of MRI have allowed the surgeons to be more conservative without violating the principles of tumor surgery. Neoadjuvant chemotherapy induces preoperative shrinkage of the tumor and sterilization of the marginal zone. Magnetic Resonance Imaging provides the surgeon with an extremely precise tool to measure the extension of the tumor.
Soon, wide local resection replaced amputation of the limb. However, surgeons had to face another challenge to reconstruct the salvaged limb. Different techniques have been used such as bone autografts, allografts, distraction osteogenesis and prosthetic replacements.
Taking into consideration that most of the bone tumors are near the joints and their resections will usually require resection of the joint, prosthetic replacement became the most popular solution in limb salvage reconstruction.
In the eighties, the surgeon used to send the radiographs of the affected limb to the engineers of an orthopedic implant manufacturer with his planned resection level marked. The engineers would provide him with a custom-made prosthesis matching the dimension of the patient bone and replacing as well the resected part of the bone. This prosthesis needed between 6-8 weeks to be shipped back to the surgeon.
Later on, many manufacturers started to market a modular tumor prosthesis system, where the surgeon can assemble his own prosthesis directly in the operating room from the multiple on the shelf components.
Modular oncology prostheses are available nowadays through most major orthopedic manufacturers. They are relatively durable and are the treatment of choice for limb-salvage procedures in adult patients at most musculoskeletal oncology centers.
For children, the problem of reconstruction is more complicated. Almost one-third of patients diagnosed with osteosarcoma are skeletally immature. As surgical management of osteosarcoma usually involves resection of at least one major physis, limb-length inequality occurs as the uninvolved contralateral limb continues to grow normally.
The distal femur and the proximal tibia are the two most common locations for osteosarcoma and one or both of these physes must be sacrificed during tumor resection about the knee. The distal femoral physis contributes approximately 0.9 cm of longitudinal growth per year, while the proximal tibial physis contributes approximately 0.6 cm per year. Even if only one of these physes must be resected with the tumor, growth of the adjacent physis can be affected by placement of the prosthesis. Most boys grow until the age of 16, while most girls grow until the age of 14. Thus, an approximately 6-cm leg length discrepancy will be present at the time of skeletal maturity in a 12-year-old boy or a 10-year old girl who requires resection of an osteosarcoma about the knee.
Younger kids had no alternative options other than amputation till the invention of expandable prostheses.
There are three types of expandable prostheses:

1- Modified modular prosthesis: these are similar to the adult system, they allow limb lengthening through a surgical procedure in which a midsection of the prosthesis is exchanged for a relatively longer one. Several drawbacks exist when this type of prosthesis is used in very young patients. The prosthesis can only be lengthened through an open surgical procedure and only 2 cm can be safely gained during a single operation because of the risk of neurovascular compromise if more lengthening is attempted. Thus, very young patients would require multiple operations to maintain equal leg lengths as they grow. Each lengthening is associated with the risks inherent to any surgical procedure.

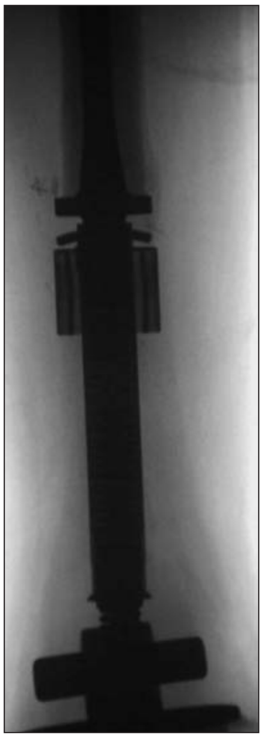
2- Minimally invasive expandable prostheses: Some of orthopedic

manufacturers have produced oncology prostheses that can be expanded through a minimally invasive procedure either arthroscopy or mini-incision. These prostheses lost some of their popularity because of repeated failures of their expansion mechanisms.

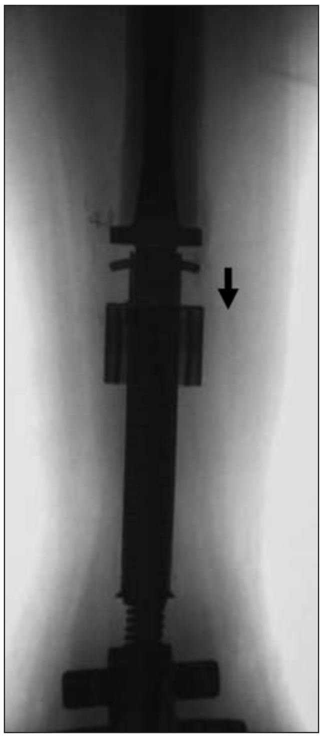
3- Noninvasive expandable prostheses: The repiphysis prosthesis was recently introduced in the market with the idea to minimize the risks associated with multiple surgical lengthening procedures. This prosthesis, originally named the Phenix prosthesis (Phenix Medical, Paris, France), was first used in the USA in 1998. Initially only available on a compassionate use basis, it was approved by the Food and Drug Administration under the name of Repiphysis (Wright Medical Technology) in 2002. The surgical technique for implantation of this device is similar to that of other endoprostheses. The postoperative course, rehabilitation, function and complications likewise are similar. The device is unique, however, in that it uses energy stored in a compressed spring for expansion of the prosthesis as the child grows. The expandable portion of the device consists of a titanium tube that 'telescopes' within an outer body made of poly-ether ether ketone. The device is manufactured with a spring in the middle that is held compressed by an annular protuberance at one end of the titanium tube that locks into a polyethylene tube. As the child grows and develops a limb-length discrepancy, an expansion session in the fluoroscopy suite is scheduled. With the child under light sedation, the locking mechanism on the prosthesis is identified with fluoroscopy. The electromagnetic coil is then placed over the patient's leg at the level of the locking mechanism and is activated for 20 s. This heats a ferrite element in the prosthesis, which heats and softens a small segment of polyethylene, which subsequently allows controlled expansion of the spring. The length of the prosthesis is re-evaluated under fluoroscopy and the procedure is repeated once or twice as necessary. Typically between 0.5 and 1.5 cm of length can be gained during each expansion session. This prosthesis is the most commonly used in young kids. Till to date, we have used around 16 Repiphysis prostheses at the Lebanese Children Cancer Center at AUB-MC (affiliated with St Jude-Memphis). The results are promising.

In conclusion, the improvement in radiologic imaging, chemotherapy protcols, surgical expertise and prosthetic designs allow the limb salvage to become the standard treatment for bone sarcomas.

Figures showing the expansion of the Repiphysis prosthesis:



Pre-expansion



Post-expansion of 1 cm

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