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REVIEW AND UPDATING

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Limb salvage procedures in osteosarcomas around the knee joint.

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Surgical techniques developed for restoring skeletal continuity after a local resection of a bone tumor (limb salvage procedures) revolutionized the management of the patient suffering from osteosarcomas around the knee.
In this article the authors review the current status of various reconstruction procedures; they include osteoarticular allograft arthrodesis, rotation plasty, expandable prosthesis and knee arthroplasty.
In summary they suggest that the knee arthrodesis is the preferred procedure for young and active patients, the rotation plasty should be recommended as the alternative to amputation for very young patients, and the customized prostheses are preferred for patients with limited longevity.

UNITERMS: Osteosarcoma, knee, reconstruction, limb salvage.

The interest in limb salvage has increased dramatcally in the last decade in the treatment of coventional osteosarcomas, because it is an attractive alternative to the amputation of the extremity (6,40). This has been possible thanks to the response of the tumor to the management with current adjuvant chemotherapy protocols and the exact knowledge of the local extension as well as surrounding soft tissue and bone marrow seen through an MRI(6,36).

The term limb salvage generally refers to the type of surgical technique which has been developed for restoring the skeletal continuity after a local resection of the bone tumor. Surgery offers a local control of the conventional osteosarcoma while chemotherapy provides a general control of the disease(microscopic metastases)(6).

MRI is the most accurate method of evaluating the intramedullary extent of bone tumors and for demarcating the soft tissue component and its relationship to major neurovascular bundles(15)(1,37).

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This diagnostic tool assures that the resection and reconstruction can be more accurately planned and executed by the surgeon. Other fundamental factors include the perfection of different surgical techniques of reconstruction, current concepts of staging and grading of these neoplasms(15), and closer interrelation of medical radiology, oncology, pathology, radiation therapy and orthopaedic surgeon.

The effectivity of the limb salvage procedure is evaluated by the percentage of local recurrence. The usual interval to recurrence after wide aggressive surgical procedures is 12 to 24 months; if a recurrence has not occurred within 2 years, it is unlikely.

After local resection it should be possible to accomplish reconstruction that gives a superior function than the one obtained by amputation; if there is a compromise of neurovascular bundles, and following the reconstruction the limb is not functional, limb salvage is contraindicated and amputation is suggested (42)(32).

The main objective of limb salvage is local control of the tumor. It is clear that no compromise should be made in the excision to permit a particular type of reconstruction. The risk of local recurrence due to an inadequate margin increases when a wide resection is not obtained by the oncologic procedure.

In younger patients(< 12 years) skeletal immaturity can contraindicate a limb salvage(12)(21). This is particularly true when the resection of one or more epiphyseal plates is required, because an inequality in limb length greater than 10 cm at the end of growth is not functional. In this situation amputation may be an alternative, although rotation plasty or the use of an expandable prosthesis can be considered to preserve the limb(12- 41).

When shorthening of less than 5 cm can be expected it can be corrected by an epiphysiodesis of the contralateral extremity; if the shorthening is between 5-10 cm a delayed lengthening can be performed.

Tumors about the knee present one of the greatest opportunities for limb salvage, beacuse this is the region most usually affected by the osteosarcoma and because it is the joint where reconstruction is practical to achieve after limb salvage resection(29)(39)(12)(10,38). p73 Approximately 60-80% of osteosarcomas are located around the knee(40)(05).

Although osteosarcomas of distal femur are said by some to have less chance of survival than those found in the proximal tibia, they are more amenable to limb salvage because the reconstruction is much easier technically than those located in the proximal tibia(25)(28).

The problem that exists in proximal tibia reconstruction are: difficulty in reattaching the quadriceps or patellar tendon, inadequate coverage by the soft tissue, skin necrosis and vascular complications. Some author proposed a primary amputation when the patellar tendon can not be reattached(8).

However, with the increased use of local muscle flap and microvascular techniques(free myocutaneous flaps) soft tissue coverage has been improved. However tumors of the proximal tibia have characteristics often make them low risk candidates for resection.

They are small, with little extraosseous extension at the time of diagnosis; in addition, posterior extension with neurovascular bundle involvement is rare because the popliteus muscle is a barrier to extracompartmental spread of the tumors(16).

METHODS OF RECONSTRUCTION

Various reconstruction procedures have been described in the literature for the defects produced by limb salvaging resection of tumors around the knee.

Osteoarticular allograft.

The first total knee replacement was performed in 1908 with an allograft. In 1925, Lexer reported the implantation of 34 total and partial knee replacements, the allografts being obtained from cadavers(27). After 20 years he published his results: a 50% success rate and these results were not repeated until this decade.

However because of the development of osteoarthritis, particularly with poor articular congruency or ligamentous instability, the late results deteriorate in a significant number of patients(about 40%). The indications for osteoarticular allograft are the same of those for prosthetic arthroplasty, although it should be recommended in young patients who are not physically active.

The high complication rate is a major concern in allografts. Principal complications include infection 10-22%(31)(32)(9)(14), fracture 11-19%(31)(14), nonunion or delayed union 14-23%(31)(14). Nonunion or delayed union can be solved with a vascularized autogenous bone graft thus shorthening the healing time in order to decrease the fracture risk(31)(37).

An important problem in all biologic reconstruction is the effect of chemotherapy retarding graft incorporation. The chemotherapy does not prevent the graft incorporation but it delays it(09). It has been demostrated that the formation of bone is decreased with methotrexate and adriamycin(07); the toxic effects of these drugs target osteoblasts and not osteoclasts, so more bone resorption and delayed union are expected.

It has been concluded that allografts can be used for reconstruction in patients who receive aggressive chemotherapy as there was no a statistically significant difference in the functional outcome of patients with and without chemotherapy(14).

Moreover, to date there is no convincing evidence that chemotherapy before surgery improves the p73 oncologic result. It is clear, however, that the tissue planes are better defined; tissue oedema is reduced and more muscle is saved, hence, this makes the surgery easier(37)(14,13).

In following patients with various reconstruction procedures it is known that recurrent tumor may cause bone graft resorption; when this complication occurs, a biopsy should be considered prior to therapeutic decisions because nonneoplastic resorption may closely mimic recurrent tumor.

Arthodesis.

The original arthrodesis using a large segmental bone grafts to retain length was first reported by Putti and Juvara(19)(20). It was later modified by Merle D Aubigne(33)(34), Campanacci(04), and Enneking(10).

Reconstruction is achieved with an autogenous free

cortical bone graft obtained from the ipsilateral or contralateral extremity and the stabilization of the limb with a custom made intramedullary rod and/or long plates.

Once the bone heals this reconstruction becomes very stable and it is the most durable reconstruction allowing for participation in noncontact sports in 85% of the cases.

However knee arthrodesis has significant functional limitations principally while sitting in small places (37)(10)(19,04)(FIGURES 1A and 1B).

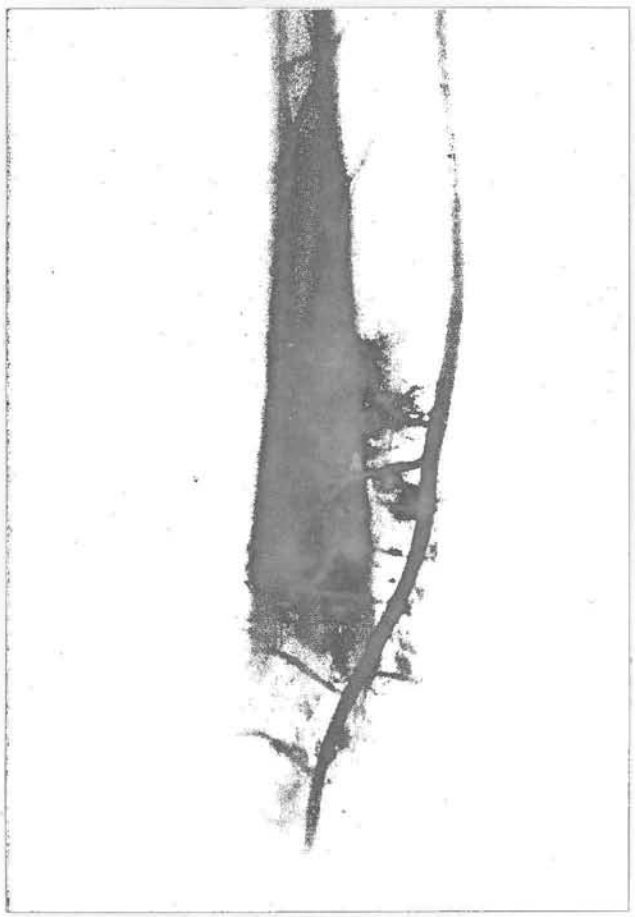

Figure 1. (A) - Angiography of a large, high-grade osteoblastic osteosarcoma arising in the distal femur of a 13-year old female .

Its principal indication is in young active patients to reconstruct the defect created from the intra- or extra-articular wide resection, when these patients accept the permanent stiffening of the joint.

Knee arthrodesis clearly provides more durable stability that an unstable prosthesis or an osteoarthritic allograft(13).

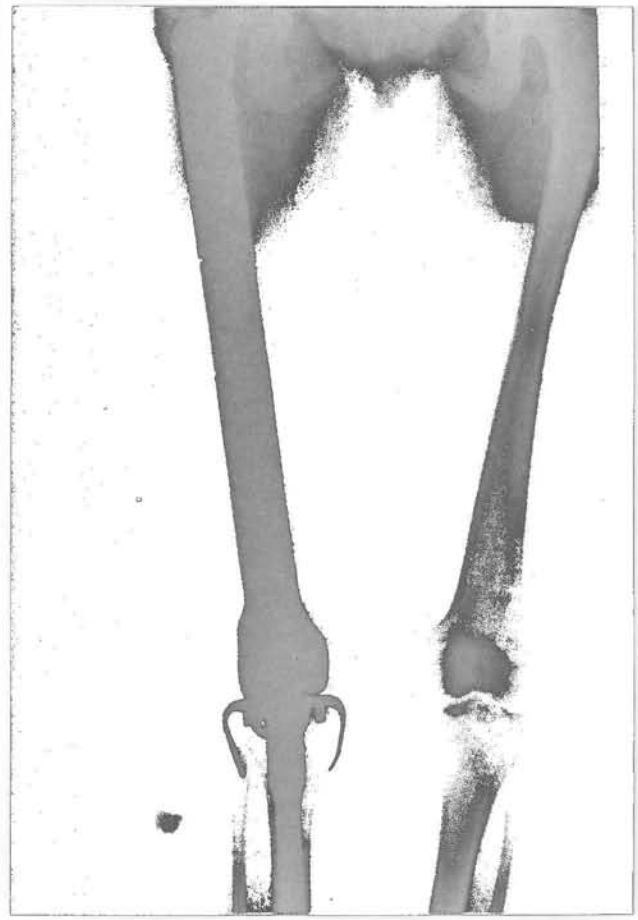

Figure 1. (B) - Roentgenogram after the resection of the involved bone and adjacent soft tissues and reconstruction with a Kotz's total hip and knee prosthesis.

Rotation Plasty.

This procedure was first described in 1932 by Borggreve(02) and was implemented by Van Nes in 1950(47) for the management of congenital defects of the femur. Kotz and Salzer were the first to use this type of reconstruction after the resection of the distal femoral tumors(24). It is a segmental intercalary extra- articular resection of the knee joint preserving the leg, ankle and foot in continuity with the neutovascular bundles.

It has rarely been indicated for reconstruction of proximal tibia defects. It has an advantage over other procedures in that the bone fixation is well covered by muscle and skin and obtains a much wider surgical margin of normal tissue, thus decreasing the local risk of recurrence.

The distal portion of the extremity is rotated 180 degrees, and the defect closed by fixing the rotated tibia

to the remaining femur. The patient is fitted with a knee prosthesis; he bears weight on the sole of the foot and there is no risk of neuroma formation or phantom pain.

There is less energy expended in walking by patients with this technique than in those patients who have had below thw knee amputations(03).

In more than 25% of patients psychological problems have been reported(23).

Expandable prostheses.

In young children, while limb salvage has a definitive role, problems arise for limb length discrepancy. This problem can be solved by the concept of an expandable growing prosthesis, but the concept has many problems in application; breakage or loosening with short longevity of this prosthesis being the principal one. However the number of other complications exceed those of any other technique.

This is a hinged total knee prosthesis in which the femoral component can be periodically lengthened through a small incision with a minor surgical procedure(12)(26).

A recent publication analyzed 31 patients with this type of prostheses over a 6-year period. There were 6 aseptic loosenings of the prostheses requiring revision.

The procedure remains a clinical research project and before wide application more research is required for long-term prostheses and the issue of loosening in these very young patients remains an unsolved question.

Arthroplasty.

The prostheses should be constrained total knee with a hinged device, because after performing wide resection of the tumor, the surgeon removes the soft tissues surrounding the joint, producing a significant lack of articular stability.

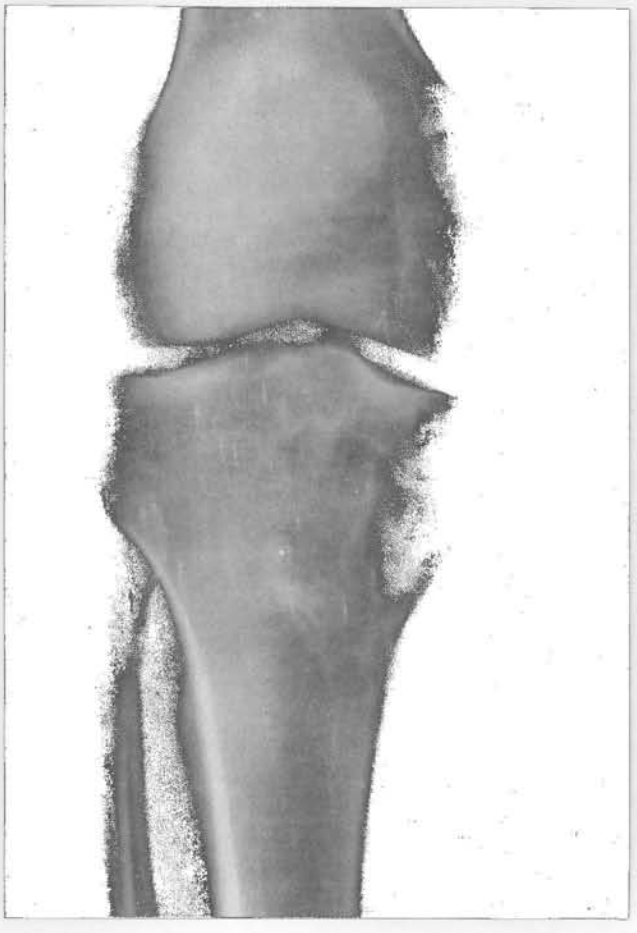

Figure 2. (A) - Osteosarcoma arising in the proximal tibia of a 38- year old male.

Figure 2. (B) - Roentgenogram after the resection of the involved bone and reconstruction by a Juvara's knee arthrodesis.

These devices can be fixed with or without cement and can be customized to make up for the length of the defect. The advantages of the prostheses are: retention of motion, a shorter rehabilitation period required, and fewer early complications(37).

Main indications are in elderly patients where a shorter rehabilitation time is important and the low demand on the reconstruction is a significant factor(14).

It is principally used in patients with osteosarcoma of the distal femur, because the reconstruction of proximal tibia has the problem of re-insertion of the patellar tendon; the arthroplasty demostrates better results in the reconstruction of the hip (18)(FIGURES 2A and 2B).

CONCLUSIONS

Controversy remains as to which is the better reconstructive procedure around the knee after limb salvaging resection of osteosarcomas; important factors are tumor location, lifestyle, patient preference, chemotherapeutic needs and the surgeon´s experience.

Knee arthrodesis is the recommended procedure for young and active patients because a stable and stiff knee is preferable to an unstable prosthesis or osteoarthritic allograft, rotation plasty is the recommended alternative to amputation for very young patients and customized prostheses are preferred for patients in which longevity is limited either because of age or tumor prognosis.

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Resumo

Procedimentos de salvamento dos membros nos osteosarcomas do joelho.

Diversas técnicas cirúrgicas foram desenvolvidas para recuperar a continuidade esquelética. Após ressecção de um tumor ósseo (técnicas para salvar os membros) de forma que revolucionaram o tratamento dos pacientes portadores de osteosarcomas do joelho.

Neste artigo os autores revisam os conceitos atuais de diversos procedimentos de reconstrução; entre eles: a artrodesis com aloenxerto; a plastia de rotação, as próteses expansíveis e a artroplastia de joelho.

Em resumo, sugerem que a artrodese do joelho é o procedimento de eleição para os pacientes jovens e ativos, que a plastia de rotação deve ser a alternativa à amputação nos pacientes muito jovens e que as próteses sob medida são preferíveis nos pacientes com longevidade limitada.