PROXIMAL TIBIA RESECTION WITH ENDOPROSTHETIC RECONSTRUCTION IN A 17-YEAR-OLD PATIENT. CASE REPORT

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Abstract

Resection is a limb-sparing option for low-grade bony sarcomas and most high-grade (stage II A or II B) sarcomas arising from the proximal tibia. In the past, several surgical and technical problems made it impossible to perform limb-sparing surgery for tumors at this site. These problems included anatomic constrains, difficult surgical approach, inadequate soft tissue coverage, vascular complications, and the need to reconstruct the patellar/extensor mechanism. Being aware of these challenges, most surgeons recommended above-knee amputations for these lesions.

The limb-sparing technique illustrated by this case allows a safe approach to the dissection of the popliteal vessels and to resection and replacement of the proximal one-third to two-thirds of the tibia. Preoperative evaluation of the tumor extent requires a detailed understanding of the anatomy and careful evaluation by computerized tomography (CT), magnetic resonance imaging (MRI), bone scintigraphy, and biplane angiography. The major contraindications to limb-sparing are a pathological fracture, neurovascular involvement, or contamination from a poorly positioned biopsy. One-half to two-thirds of the tibia was removed, along with a portion of all muscle inserting on the tibia and the entire popliteus muscle, in combination with an extra-articular resection of the proximal tibiofibular joint. The peroneal nerve was preserved. The surgical options for reconstruction are primary arthrodesis, prosthetic replacement, or allograft replacement. We preferred a prosthetic replacement; allograft replacement entails a high rate of infection, fracture, and local tumor recurrence. One key to the success of this procedure is the use of gastrocnemius muscle transfer to obtain reliable soft-tissue coverage that helps prevent skin flaps necrosis and secondary infections, and provides for reliable extensor mechanism reconstruction. Most patients with low-grade sarcomas and approximately half of those with high grade sarcomas can be treated by limb-sparing resection.

Keywords: primary bone sarcomas, endoprosthetic reconstruction, skip lesions, extensor mechanism, patellar tendon.

REZECŢIE TIBIALĂ PROXIMALĂ CU RECONSTRUCŢIE PRIN ENDOPROTEZARE LA UN PACIENT DE 17 ANI

Rezumat

Rezecţia tumorală cu salvarea membrului afectat este o opţiune în tratamentul sarcoamelor osoase (stadiul IIA, IIB) care afectează regiunea proximală a tibiei. În trecut chirurgia de salvare a membrului punea importante probleme de tehnică chirurgicală. Acestea includeau constrângeri anatomice, aborduri chirurgicale greoaie cu obţinerea unor lambouri musculare insuficiente pentru a putea acoperi o eventuală proteză, complicaţii vasculare şi o insuficientă cunoaştere a refacerii aparatului extensor al genunchiului. Din aceste motive majoritatea chirurgilor recomandau pentru tratamentul acestor tumori amputaţia efectuată deasupra genunchiului.

Tehnica de salvare a membrului utilizată în cazul prezentat permite un abord chirurgical în condiţii de siguranţă a disecţiei, în special a pachetului vasculonervos

popliteal, urmată de rezecţia formaţiunii tumorale şi înlocuirea treimii proximale a tibiei. Evaluarea preoperatorie a extinderii formaţiunii tumorale presupune o amănunţită cunoaştere a anatomiei regiunii ce trebuie coroborată cu rezultatele CT, ale rezonanţei magnetice, scintigrafiei osoase şi a angiografiei. Contraindicaţiile majore ale acestei chirurgii reconstructive sunt: fracturile pe os patologic, prinderea de către tumoră a pachetului vasculonervos şi contaminarea regiunii printr-o biopsie prost plasată. Între o jumatate şi două treimi din tibie au fost rezecate împreună cu muşchii sateliţi şi cu muşchiul popliteu în totalitatea sa, fară a se deschide nici articulaţia genunchiului şi nici articulaţia tibioperonieră proximală, cu păstrarea nervului peronier. Pentru reconstrucţia zonei rezecate puteam opta fie pentru artrodeza, fie pentru endoproteza tumorală, fie pentru utilizarea unei alografe osoase. Am optat pentru utilizarea endo-protezei, ştiut fiind faptul că utilizarea alografei osoase este frecvent însoţită de complicaţii: infecţii, fracturi pe os patologic. Cheia succesului acestei tehnici este de a crea un lambou muscular din gastrocnemianul medial care se răstoarnă proximal, ajutând, în acest fel, la acoperirea protezei şi poate participa la refacerea mecanismului extensor al genunchiului. De asemenea, lamboul muscular vascularizat previne apariţia infecţiei locale. Majoritatea pacienţilor diagnosticaţi precoce cu sarcoame osoase pot beneficia de chiurgie reconstructivă cu salvarea membrului afectat.

Cuvinte cheie: sarcoame osoase primitive, reconstrucţie prin endoprotezare, leziuni la distanţă, mecanism extensor, tendon rotulian.

INTRODUCTION

The proximal tibia is the second most common site for primary bone sarcomas [1]. Because of several particular surgical problems, and the difficulty of reconstruction, this site is a difficult area in which to perform a safe limb-sparing resection that preserve the function. There have been only a few reports of limb-sparing resection for high-grade sarcomas of the proximal tibia [2,3,4,5,6]. Most surgeons still recommend above-knee amputations despite good results, widespread acceptance, and varied techniques for limb-sparing resections of bony sarcomas [3,5,7,8,9,10,11,12].

The difficulty in performing a successful resection for a high-grade sarcoma of the tibia arises from the local anatomy, rather than from any inherent properties of the tumor. In fact persons with osteosarcomas of the proximal tibia have a higher rate of survival than those with tumors of the distal femur [13,14,15]. The surgical and technical problems include intimate anatomic relation-ships, a difficult surgical approach, inadequate soft tissue coverage, and vascular complications. Moreover, unique to an arthroplasty of the proximal tibia is the need to reconstruct the patellar tendon. Finally, one must deal with a second adjacent joint, the proximal tibio-fibular joint. These difficulties have often led to a high rate of early postoperative complications, foremost among which is failure reconstruction. The ultimate result was a poor functional outcome and/or secondary amputations.

This case report describes the technique that we used to perform the reconstruction, which permitted a safe and easy access to the popliteal vessels resection and reconstruction of a large segment of tibia and knee joint, and a method of patellar/extensor mechanism reconstruction and soft-tissue coverage that utilizes a transferred gastrocnemius muscle.

INDICATIONS AND CONTRAINDICATIONS

Indications for proximal tibia resections include low-grade bony sarcoma (usually chondrosarcoma) [11], recurrent aggressive benign tumors (giant-cell tumor) and carefully selected high-grade osteosarcoma.

Contraindications to resection include a pathological fracture, extensive contamination from a poorly positioned biopsy, tumor penetration through the skin, and local sepsis. Relative contraindications include a large posterior extra osseous component and immature skeletal age. Expandable prostheses are used in younger patients in the hope of avoiding future problems related to leg-length discrepancy.

CASE HISTORY

Our case report subject is a 17-year-old boy referred to our centre. He complained of spontaneous pain in the proximal third of his right tibia. On the first admission it was not possible to emphasize any clinical local alterations, and his X ray exam was within normal limits (fig. 1, fig. 2).

At 7 days from his first visit at the hospital he returned with tumefaction in the proximal third of his right tibia, mild visible collateral venous circulation, mild tumefaction, and the x ray exam evidenced a tumor-like mass in his proximal third of the right tibia (fig. 3).

Manuscript received: 06.08.2012
Received in revised form: 18.09.2012
Accepted: 20.09.2012
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Fig. 1. **Fig. 2.**

Fig. 1. Knee X-ray anteroposterior. View at the first presentation.
Fig. 2. Knee X-ray lateral view at the first presentation.

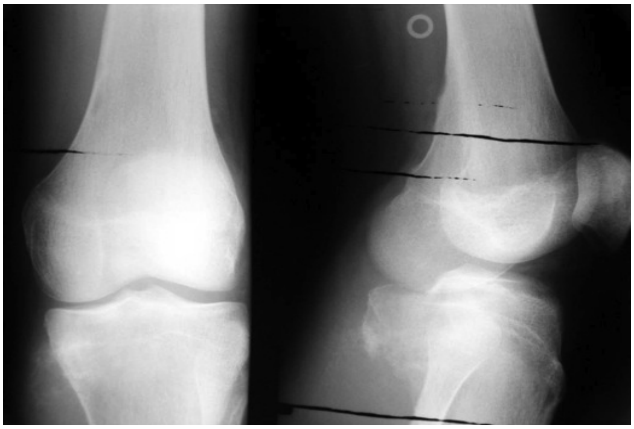

Fig. 3. Knee X-ray, Antero-posterior and lateral views at hospital admission.

On the plain films there is evidence for the malignant character of the tumoral mass: cortical breakthrough and parosteal response. We decided to further investigate the case through extensive imaging studies in order to elucidate the nature of the lesion and to establish its staging.

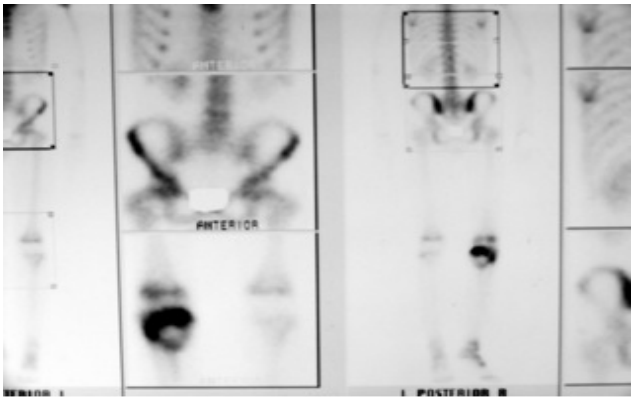

Fig. 4. Bone scan.

STAGING STUDIES

Bone scintigraphy

Bone scintigraphy is done to find skip lesions and to determine the extent of local intraosseous tumor. The site of the resection is 3-5 cm distal to the area of abnormality. At least one third of the tibia must appear normal (fig. 4). Our patient presented one lesion, probably metastatic at the base of the right lung.

CT and MRI

CT and MRI are useful to determine intra osseous and extra osseous extension of the primary tumor. MRI can also reveal skip lesions and soft-tissue extension. Attention is paid to the possibility of posterior extension and tibio-fibular joint and intra-articular knee involvement.

Both preoperative CT scan and MRI showed an extracompartment extension of the tumor without involvement of the posterior vascular-nervous package. Intra-articular extension of the tumor required care for oncologic resection limit, including the distal third of the femur.

MRI frontal and horizontal studies which emphasize the extent of the tumor and the noninvolvement of the proximal tibio-fibular joint (a tumor character that stresses a great surgical challenge that we already mentioned in our report) (fig. 5, fig. 6).

Fig. 5. MRI frontal plane.

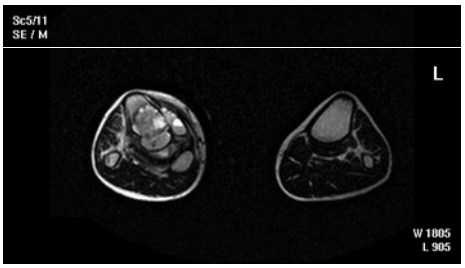

Fig. 6. MRI horizontal plane.

To establish the indications, according to the protocol of the Bologna (Prof Mercuri) it is essential to determine the tumor extension on MRI [16].

At pulmonary CT examination we discovered a single lesion (fig. 7).

Fig. 7. Pulmonary CT scan.

Angiography

At the time of the patient's admission, the angiography was not available in our service. The angiographic studies are useful for local arterial evaluation especially if the CT scan has revealed posterior soft tissue extension. Of particular relevance is the presence or absence of the involvement of the posterior tibial artery, which may be the sole blood supply to the leg after resection. The popliteus muscle often separates a posterior tumor mass from the vessels. Ligation of the posterior tibial artery is almost always required. The peroneal artery may be involved by tumors with a large posterior compartment. Two of the major vessels may be ligated in a young patient without jeopardizing the possibility of a viable and functional extremity [2,17,18,19,20].

Biopsy

The biopsy before starting chemotherapy (first step in treating any bone malignancy) satisfies incisional biopsy rules [21].

Extreme caution must be taken to minimize contamination of the anterior muscles, peroneal nerve, pattelar tendon, and knee joint when biopsy is performed. The biopsy site must be placed along the line of the definitive incision (antero-medial aspect of the tibia). A small core biopsy of the extra osseous tumor component is optimal. The biopsy is performed under CT or fluoroscopic guidance. There is no need to open the cortex unless no extra osseous component is easily accessible. If the cortex must be opened, a tourniquet is used to decrease the local contamination. We did not need to open bone cortex since the soft tissues were involved by the tumor. The macroscopic aspect of the biopsy piece was like fish meat (appearance is consistent with the diagnosis of osteosarcoma). The extemporaneous exam was also consistent with osteosarcoma. The imunohystochemical assay also proved that the tumor was an osteosarcoma.

SURGICAL TECHNIQUE

There are three major steps involved in successful resection and reconstruction of tumors of the proximal tibia:

1. Resection of the tumor (fig. 8):

Fig. 8. Tumor after resection.

2. Reconstruction of the skeletal defect and knee joint with a modular prosthesis (fig. 9):

Fig. 9. Prosthesis assembley.

3. Reconstruction of the extensor mechanism and soft tissue envelope:

a. Incision

A long medial incision is made from the medial parapatellar to the distal one third of the leg posteriorly and medially. Thick fasciocutaneous flaps must be developed to avoid skin necrosis (fig.10, fig.11). We had to deal with a 5 cm long incision secondary to the biopsy site, which was included in the area of dissection.

Fig. 10. Preoperative plan. Incision.

Fig. 11. Preoperative plan. Biopsy zone excision.

b. Early popliteal exploration

The popliteal trifurcation must be explored early to determine if the tumor is operable, especially if it is in a posterior location. The popliteal space and trifurcation are exposed by detaching the medial gastrocnemius muscle and splitting the soleus muscle. A key to successful approach to the popliteal trifurcation is to first expose the popliteal space by identifying and detaching the origin of the medial gastrocnemius muscle and the insertion of the medial hamstrings muscles. The popliteal artery is easily identified in normal tissue and be traced distally around the popliteus muscle (fig. 12).

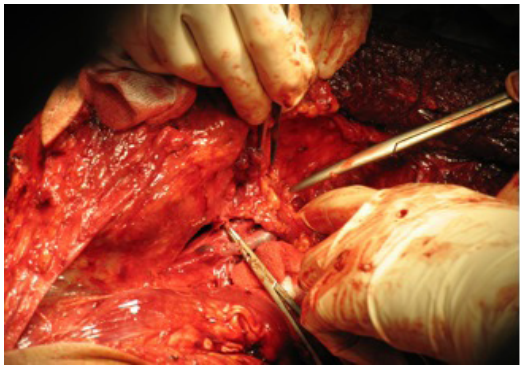

Fig. 12. Vascular package dissection.

c. Tibiofibular joint resection

This resection is performed through the same incision, a lateral flap is developed to permit the exposure of the proximal fibula. The peroneal nerve must be exposed and retracted prior to resection.

d. Exposure of the knee joint

The capsule is transected circumferentially approximately 1 cm away from the tibia and the patellar tendon, to avoid contamination. The cruciate ligaments are visually explored. If there is evidence of tumor nodules, the femoral condyle is later resected en-block with the proximal tibia. We preferred a safer transpatellar approach, which allowed the resection of the proximal tibia and the distal one third of the femur without opening the knee joint (fig. 13, fig. 14).

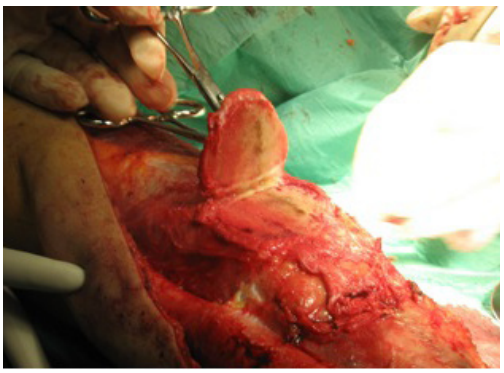

Fig. 13. Patella and patellar tendon spliting.

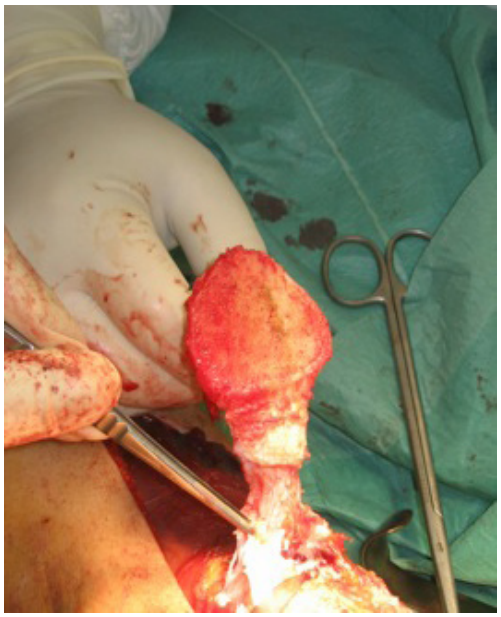

Fig. 14. Remaining patellar tendon and patella.

e. Soft-tissue and extensor reconstruction

The medial gastrocnemius is used for reconstruction. This provides a safe and reliable method of reconstructing the extensor mechanism as well as a coverage for prosthesis, which is essential for preventing early or late infections [22].

Originally described by Malawer in the mid 80's, this technique is reliable and successful. The medial gastrocnemius muscle is based in the medial sural artery, which must be protected during the popliteal dissection and ligation of the geniculate vessels. The medial sural artery emerges from the popliteal artery in a medial and posterior direction. The medial gastrocnemius muscle can be rotated both transversely and proximally to cover large defects in both directions. An area of approximately 20 square cm can be covered. The patellar tendon can be sutured directly to the muscle as well as to the loops on the tibial prosthesis. In this fashion the reconstruction of the patellar tendon is both dynamic - patellar tendon to muscle flap and static to the loops of the prosthesis (fig. 15, fig. 16).

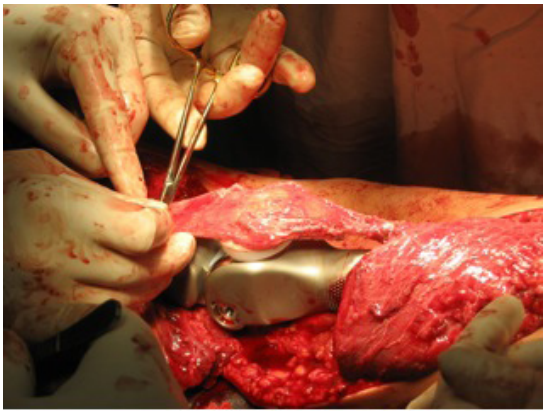

Fig. 15. Rebuilding of knee extensor tendon.

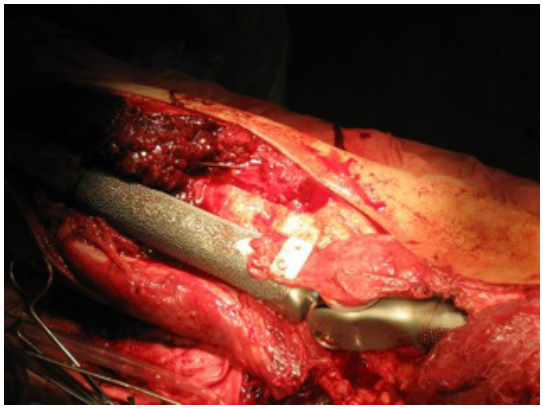

Fig. 16. Reinsertion of the patellar tendon.

POSTOPERATIVE MANAGEMENT

Large suction drains are used to prevent hematoma. The extremity is elevated for 5-10 days to prevent edema of the flaps. If the flaps develop areas of ischemia they are allowed to demarcate and are excised at 10 days after surgery, and the underlying muscles are covered with a split-thickness skin graft. Our patient was immobilized for three weeks in a long leg cast to permit the healing of the extensor mechanism to the gastrocnemius transfer. A long leg brace with the knee restricted to 0-30 grades was then fitted.

The patient received postoperative physiotherapy with progressive weight bearing. At 3 months post-operatively we authorized walking without support. Evaluation showed knee mobility: passive flexion 110 degrees, 5 degrees passive extension. Active flexion at 3 months was of 40 degrees and -15 degrees active extension. Muscle strength in the quadriceps was 4 (the patient did knee extension against a force applied to the front of the leg, but didn't perform full extension). 2 years postoperatively we consider the patient fully recovered locally with active knee flexion 90 degrees, 0 degrees active extension, muscle strength at 5 (normal). The time elapsed from surgery does not allow at this moment a prediction of vital prognosis nor the risk of local recurrence.

CONCLUSION

In conclusion, prosthesis bone replacement may be a solution even in cases when the tumor extension is extracompartment. The essential condition is that the posterior vasculonervous package is not caught in the tumor. To improve safety we recommend that in such cases (extracompartiment tumor with intra-articular extension) the surgical technique should avoid opening the knee joint. Thanks to the resolution of function, the comfort of life is significantly higher than for amputation or other techniques which abolish the knee joint.

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