DIAPHYSO-EPIPHYSIAL RESECTION FOR BONE TUMOUR
AT THE KNEE

With Reports of Nine Cases

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Extensive diaphyso-epiphysial resection is advisable for bone tumours when amputation appears too drastic and local excision not sufficient.

Indications for resection

Resection is to be contemplated in the following cases.

Giant-cell tumours may demand resection in two circumstances: 1) recurrence after curettage once or twice, supplemented or not by radiotherapy; 2) as the primary treatment when bone destruction does not allow complete excision, or when clinical and radiological features, together with histological findings, show a probability of malignant evolution.

Certain malignant tumours (chondrosarcoma, fibrosarcoma, periosteal sarcoma) show a very slow evolution, making a decision about amputation particularly difficult and questionable.

Even in osteogenic sarcoma, amputation may be refused by the patient or his family, and may not always be justified by a much higher rate of survival.

Restoration of continuity after resection

For tumours at the knee (lower end of the femur and upper end of the tibia) resection is often rejected on account of the technical difficulties of restoring continuity of the bone.

Among the many procedures that have been advocated, those that try to preserve the mobility of the joint either by a prosthesis or by a massive homogenous graft still appear quite unreliable. Prostheses usually loosen or break after a time; they may be used when a very short survival is contemplated. Massive homogenous grafts fuse very slowly and always undergo aseptic necrosis with severe deformity. The experimental work of Herndon (1952) and the clinical work of Lexer (1925) showed clearly that they cannot give a lasting functional result.

The only safe procedures are those that bridge the gap caused by the resection with an autogenous graft strong enough to allow weight bearing.

Bridging by a simple or double tibial graft has been used by many authors. The cases published by Phemister (1945), Delannoy, Vernaeghe and Lagache (1950), Delannoy and Soots (1957) and Decoulx and Decoulx (1950) showed a great number of mishaps: non-union, fracture of the graft, with many iterative operations, very prolonged after-care, and a high proportion of failure. Juvara (1921) advised a massive graft obtained by frontal hemisection of the femur (for tumour of the tibia), or of the tibia (for tumour of the femur), but, even with this massive graft, failures are frequent. Twenty-four cases have been published, among which the late results are given only for nine. In one case (Grigorescu and Vasiliu 1934) union was present after five months; in seven cases the delays in obtaining bony union varied between two and five years, with a great number of operative attempts (Juvara 1921, Guilleminet 1950, Montant 1928, Operti 1954). These difficulties and failures probably explain why so few cases of resection are published.
Case 3. Figure 3—Three years after operation: fracture of graft and nail. Figure 4—Solid union eight months after heterogenous graft.
The procedure described in this paper aims at preventing non-union and fracture of the graft by adding to the Juvara massive graft an intramedullary nail and a massive homogenous graft filling the defect. Furthermore, in order to provide a quicker incorporation of the graft, the back of the patella is freshened and fixed to it; the preserved muscular pedicle of the patella provides a supplementary blood supply to the middle of the graft. This complete procedure was used only in the last five cases.

CASE REPORTS

The records of the patients show the progressive evolution of the technique.

**ROTATION TIBIAL GRAFT AND NAIL**

**Case 1.** *Osteolytic sarcoma of the lower end of the femur*—Woman aged forty-five years, accountant. December 1950—Resection of the lower third of the femur together with the patella: intramedullary nailing, bridging by the half tibia. Bony union after eight months. Walked with crutches. October 1952—Pulmonary metastasis; death. *Necropsy*—Local recurrence, multiple metastases, but solid union of the graft.

**ROTATION TIBIAL GRAFT, INTRAMEDULLARY NAIL, ACRYLIC PROSTHESIS BETWEEN STUMP OF FEMUR AND UPPER END OF TIBIA**

**Case 2.** *Chondrosarcoma with fracture of the lower end of the femur*—Man aged forty-one years, trader, in bad general state. March 1951—Wide resection, intramedullary nail, rotation tibial graft and acrylic prosthesis. Death the same day from cardiac failure.


In this case the fracture of the graft occurred exactly at its middle, at the level of the patella.

**ROTATION TIBIAL GRAFT, INTRAMEDULLARY NAIL, ACRYLIC PROSTHESIS, PATELLA FIXED ON THE GRAFT TO ACCELERATE REVASCULARISATION AND PREVENT THE FRACTURE**


**ROTATION GRAFT, INTRAMEDULLARY NAIL, HOMOGRAPHT IN THE DEFECT, PATELLA FIXED TO AUTOGRAPHT**


Case 5—Recurrent giant-cell tumour of tibia. Curettage and x-ray therapy five years previously. Figure 5—Before excision. Figure 6—Good result two and a half years after operation (excision, nail, tibial graft, homogenous graft, fixation of patella).

Case 8—Rapidly growing giant-cell tumour of lower end of femur. Figure 7—Before operation. Figure 8—Eight months after operation (excision, nail, autogenous tibial graft, homogenous graft, fixation of patella).
Case 9. Figure 10—One month after operation (excision, nail, autogenous graft, homogenous graft, fixation of patella). Union occurred but graft broke later. Figure 11—After regrafting.


RESULTS
This series allows a conclusion only on the value of the operative technique used for re-establishing continuity of the bone (Table I).

<table>
<thead>
<tr>
<th>Case number</th>
<th>Age (years)</th>
<th>Diagnosis</th>
<th>Type of operation</th>
<th>Early result</th>
<th>Late result</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>45</td>
<td>Osteosarcoma of femur</td>
<td>Excision. Tibial autograft and nail</td>
<td>Bony union</td>
<td>Death from dissemination at two years</td>
</tr>
<tr>
<td>2</td>
<td>41</td>
<td>Osteosarcoma of femur</td>
<td>Excision. Tibial autograft, nail, acrylic prosthesis</td>
<td>Death first day</td>
<td>—</td>
</tr>
<tr>
<td>3</td>
<td>32</td>
<td>Giant-cell tumour of femur</td>
<td>Excision. Tibial autograft, nail, acrylic prosthesis</td>
<td>Fracture of graft and nail after three years. Heterograft</td>
<td>United and symptom-free at seven years</td>
</tr>
<tr>
<td>4</td>
<td>25</td>
<td>Giant-cell tumour (grade II) of tibia</td>
<td>Excision. Femoral autograft, nail, acrylic prosthesis</td>
<td>Recurrence: amputation</td>
<td>Pulmonary metastases at three years; died</td>
</tr>
<tr>
<td>5</td>
<td>42</td>
<td>Recurrent giant-cell tumour of tibia</td>
<td>Excision. Femoral autograft, nail, massive homograft, and patella</td>
<td>Union. Walked at three months</td>
<td>Symptom-free at three and a half years</td>
</tr>
<tr>
<td>6</td>
<td>16</td>
<td>Fibrosarcoma of femur</td>
<td>Excision. Tibial autograft, nail, massive homograft and patella</td>
<td>Union. Walked at four months</td>
<td>Recurrence after two years: amputation</td>
</tr>
<tr>
<td>7</td>
<td>25</td>
<td>Infected recurrent giant-cell tumour of femur</td>
<td>Excision. Tibial autograft, nail, massive homograft and patella</td>
<td>Union but infection recurred</td>
<td>Fracture of graft at eight months. Amputation at one year</td>
</tr>
<tr>
<td>8</td>
<td>17</td>
<td>Giant-cell tumour (grade II) of femur</td>
<td>Excision. Tibial autograft, nail, massive homograft and patella</td>
<td>Union</td>
<td>United and symptom-free at fifteen months</td>
</tr>
<tr>
<td>9</td>
<td>28</td>
<td>Periosteal sarcoma of femur</td>
<td>Excision. Tibial autograft, nail, massive homograft and patella</td>
<td>Union. Walked at three months</td>
<td>Fracture of graft at eight months. United and symptom-free at one and a half years</td>
</tr>
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Early results (Table II)—In this series of nine patients one died on the day of the operation (Case 2), one had an early recurrence and underwent amputation (Case 4), one with infection also required amputation. All the others showed union and were able to walk freely with weight bearing after three or four months, but two of them sustained a secondary fracture of the graft and underwent regrafting, and one patient had a recurrence and has had the limb amputated.

Four patients now show strong bony continuity between the femur and the tibia, after seven years, three and a half years, eighteen months and fifteen months.

Late results (Table III)—Late results must be considered separately for sarcoma and giant-cell tumour.

Sarcoma—The results are bad. Out of four cases we find: one operative death (Case 2), one generalisation after two years (Case 1), one local recurrence after two years (Case 6), one patient symptomless after eighteen months (Case 9).

Giant-cell tumour—All the cases of this series were severe: three patients were treated for recurrence after curettage and radiotherapy (Cases 3, 5, 7); one patient’s tumour was growing rapidly and was clinically, radiologically and histologically suspect of malignancy (Case 8). These four patients are free from recurrence after seven years (Case 3), three and a half years (Case 5), one year (Case 7) and fifteen months (Case 8). One patient (Case 4) showed a malignant evolution of the tumour, with recurrence after local excision and after resection, and died from metastases after amputation.
Resection for tumour of the lower end of the femur (Fig. 12)—The patient is supine. A tourniquet is used. The skin incision is postero-lateral on the lower part of the thigh, antero-lateral on the knee and anterior on the leg. The tumour is dissected on its lateral and anterior aspects. The knee joint is widely opened. The ligaments, including the patellar ligament, are cut. The femoral shaft is divided four or five centimetres above the upper limit of the tumour. Dissection of the femur is completed; it is made easier by mobilisation of its lower end. Particular attention is given to the femoral vessels, but the dissection must be made at a distance from the tumour in sound muscular tissue. The lower end of the femoral shaft is cut in steps five or six centimetres long. The tibia is divided with the electric saw into two halves in a frontal plane, for its whole length except the lowest six or seven centimetres. A homogenous tibial or femoral graft is prepared; its length must be exactly the same as the defect between the femur and the tibia. Its anterior aspect is freshened. A long Küntscher nail must be available—seventy to eighty centimetres long according to the length of both tibia and femur, and nine to eleven millimetres in section according to the width of the medullary canals. This nail is hammered into the femoral medullary canal from the lower end upwards, brought out through the buttock, and then hammered down through the medullary canal of the homograft and the tibia. The massive tibial graft is fixed upside down by screws to the lower end of the femoral shaft, to the graft and to the upper end of the tibia. A homogenous graft may be fixed to reinforce the upper part of the tibia. The back of the patella, which has been preserved with its muscular attachment, is freshened and screwed to the front of the tibial autograft as close as possible to the middle of the defect. The skin is closed over a suction drain.
FIG. 14
Top—Approach to the tumour and lower end of femur. The patella is dissected with its muscular pedicle.
Bottom—Taking the femoral graft.

FIG. 15
The femoral graft is turned upside down. The back of the patella is freshened.
Resection of the upper end of the tibia (Figs. 13 to 16)—The operative technique is the same but reversed. Dissection of the tumour is accomplished after division of the shaft and opening of the joint. The massive graft is obtained by frontal hemisection of the lower part of the femur.

CONCLUSION AND SUMMARY

1. An operation to re-establish the continuity of the bone after resection of tumours of the lower end of the femur or upper end of the tibia is described.
2. Sound bony union may be obtained, allowing walking with weight bearing after three to four months.
3. The combination of a massive tibial or femoral graft (Juvara procedure) with an intramedullary nail, a massive homogenous graft, and fixation of the patella to the autograft to accelerate its revascularisation. has given constant and rapid bony union in five cases.
4. This possibility gives real value to wide resection in the treatment of severe cases of giant-cell tumours, especially those that are recurrent, osteolytic or suspect of malignancy.
5. Its value in the treatment of sarcoma cannot be assessed in so short a series.

REFERENCES

Decoulx, P., and Decoulx, J. (1950): Ostéosarcome traité par résection suivie d'enclouage et greffe osseuse. Lille Chirurgical, 5, 64.
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