

RESECTION AND RECONSTRUCTION FOR BONE TUMOURS

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For the surgical treatment of tumours in long bones a technique in which the resected bone segment is autoclaved and replaced is described.

The results in three patients who had undergone this operation 7 to 11 years previously, one for chondrosarcoma and two for giant cell tumour, are reported. In all three cases sound union has been achieved. The advantages of boiled autografts are the immediate availability and the excellent fit of the graft. In order to avoid the problem of slow union of the autoclaved bone segment rigid fixation with long-term stability, preferably with a Küntscher nail and the use of supplementary fresh autogenous bone, is necessary.

Two patients with traumatic bone loss from the femoral shaft treated in a similar way are reported from the literature.

Key words: autoclaved bone; bone transplant; bone tumours; dia-epiphyseal resection; knee arthrodesis

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Extensive diaphyso-epiphyseal resection is advisable for bone tumours in long bones when amputation appears to be too drastic and local excision insufficient. This kind of treatment is indicated in the malignant type of giant cell tumours and in chondrosarcomas. Even in special cases of osteogenic sarcoma, local resection seems justified.

Among the many procedures that have been advocated are the insertion of a prosthesis or a massive homograft in an attempt to preserve the mobility of the joint. A hemi or total joint prosthesis is only good therapy for patients with a relatively short life expectancy; it is not an acceptable treatment for those who are at middle age or younger and need a strong leg.

In this paper a description is given of three patients in whom the bone segment containing the tumour was resected. Reconstruction

of the continuity of the bone was achieved by replacement of the bone segment, after autoclaving, and addition of free fresh autogenous bone chips.

OPERATIVE PROCEDURE

A tourniquet is used. The tumour-bearing portion of the femur or tibia is resected to a sufficient distance on either side of the tumour so as to include healthy bone. If there is destruction of the cortex of the bone by the tumour the adjoining soft tissues are taken away. Also the scar of a previous biopsy is excised. Next the resected bone segment is autoclaved at 120°C for 15 minutes. After this treatment the bone segment can be easily freed of soft tissues such as periosteum, parts of joint capsule and tendons and all the bone that is weakened by tumour growth.

The next step in the operation is reconstruction of the continuity of the bone. In order to arthrodesis the knee the joint surfaces are sawn

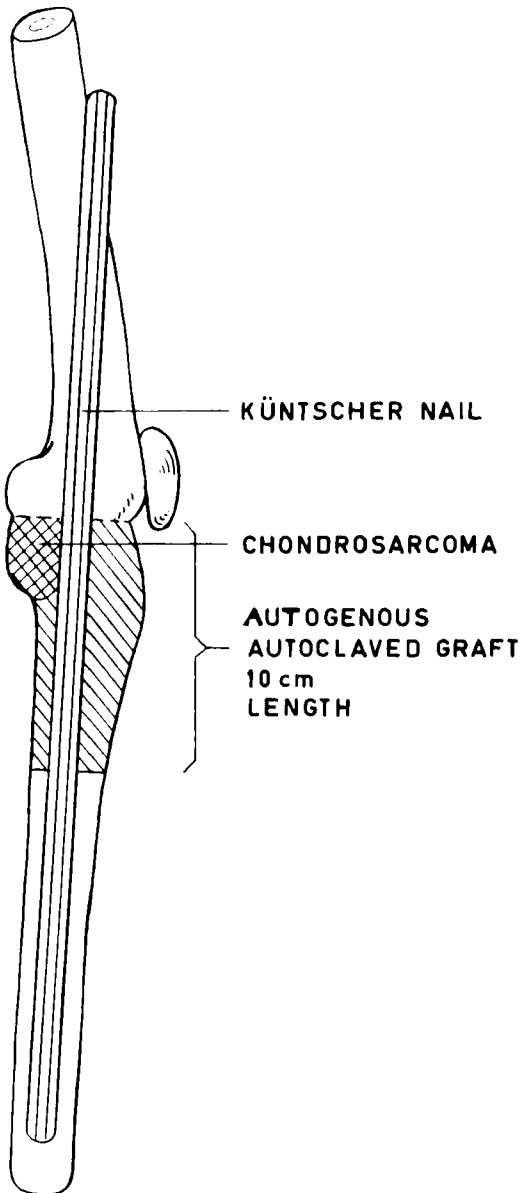


Figure 1. Diagram of the operative procedure

off. Then the autoclaved bone segment is replaced in its original bed and fixed with an extra long Küntscher nail (Figure 1).

To stimulate union and fill the tumour cavity fresh spongy autogenous bone chips from the patella and the resected joint surfaces are used. For the same reason it is advisable to bridge the autoclaved bone segment by one or two fresh cortical tibial grafts from the opposite leg or spongy bone chips from the ileum.

CASE REPORTS

This operative procedure was performed in three patients.

Case 1

In December 1962 a male aged 26 years was admitted to the hospital complaining of pain in his left knee. Radiological examination showed an osteolytic lesion in the proximal end of the left tibia (Figure 2).

From a biopsy specimen a chondrosarcoma of a low degree of malignancy was diagnosed. This case was sent to the Dutch Bone Tumour Committee. Following the Committee's advice resection of the proximal end of the tibia was carried out. After autoclaving of the resected segment the knee was arthrodesed as is shown in Figure 1. This operation was carried out in February 1963. For the postoperative radiographs see Figure 3. In April 1967 the Küntscher nail was



Figure 2. Case 1: Chondrosarcoma in the upper end of the left tibia.



Figure 3. Case 1: Radiographs of the left knee 3 months after the operation.



Figure 4. Case 1: Radiographs 1–11 years after the operation.

extracted. In the same month spontaneous fracture developed in the area of the autoclaved segment. This fracture was stabilized with a massive cortical autogenous tibial graft and six screws. The radiographs of this case in the period from 1964 till 1974 are shown in Figure 4.

In July 1964, 17 months after re-implantation of the autoclaved segment a specimen from this segment was taken for microscopical examination.

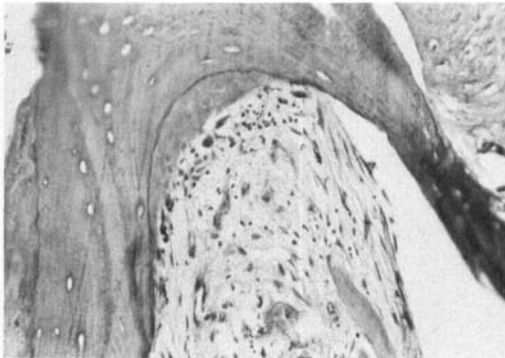


Figure 5. Case 1: Histological pattern of the autoclaved bone 17 months after re-implantation (270×). There is necrotic bone adjacent to highly vascularized fibrous tissue and osteoid tissue.



Figure 6. Case 2: Osteolytic lesion in the lower end of the femur: giant cell tumour of the bone.

The pathologist found necrotic bone surrounded by zones of revascularization and as yet unossified osteoid tissue (Figure 5).

Case 2

In October 1966 a female aged 53 years came to the hospital complaining of pain in her left knee of 6 months duration. Radiographs showed a radiolucent non-trabeculated area, 5 cm in diameter, in the lower end of the left femur (Figure 6). From a microscopic examination of a



Figure 7. Case 2: Radiographs of the left knee 2 months after the operation.

biopsy specimen the diagnosis of giant cell tumour was made.

Treatment consisted of excision of 12 cm of the lower end of the femur and re-implantation of the bone after autoclaving for 20 minutes.

The knee was then arthrodesed by removal of the articular cartilage, fixation with an intramedullary nail and supplementary grafting from the tibia of the same leg (Figure 7).

In 1968 a second giant cell tumour of the same histological pattern was diagnosed in the upper right femur and a third, later in 1968, in the upper left femur. A full description of this case was published elsewhere (Sijbrandij & de la Fuente 1973).

The radiological follow-up of the operated left knee is shown in Figure 8.

Case 3

In October 1967 a female aged 66 years attended the outpatient department because of a tumour in the proximal part of the left tibia (Figure 9). The histological pattern was that of a giant cell tumour. Treatment consisted of excision of 10 cm of the proximal end of the tibia and re-



Figure 9. Case 3: Osteolytic lesion in the upper end of the left tibia: giant cell tumour of the bone.

implantation of the bone segment after autoclaving for 20 minutes. The knee was then arthrodesed by resection of the articular cartilages and fixation with an intramedullary nail and two massive cortical grafts from the opposite tibia (Figure 10). The cavity that remained after removal of tumour tissue was filled with autogenous bone chips. In this case, within a year after the operation, fusion was sufficient for weight-bearing on the operated limb. The radiographs of the arthrodesed knee are shown in Figure 11.

The radiographs and the biopsy specimens of these three patients have been sent to the Dutch Bone Tumour Committee. The radiologists and pathologists of this Committee have classified and registered the lesions.

The three patients have no signs of relapse of the tumour and the knees operated upon show sound fusion.

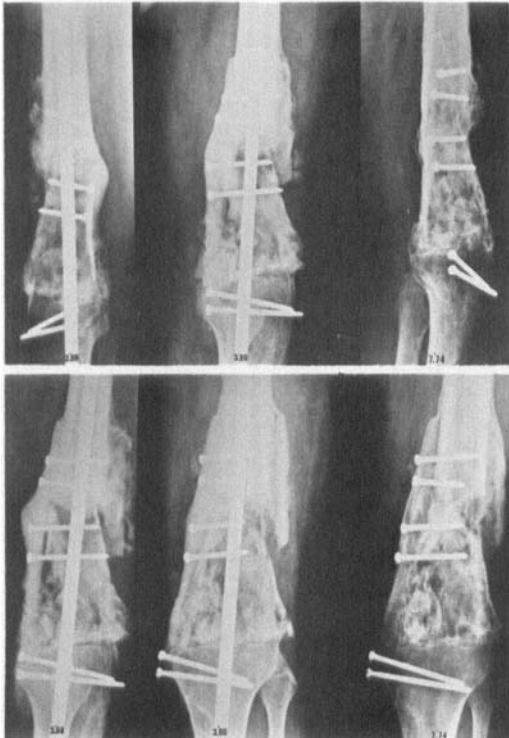


Figure 8. Case 2: Radiographs 1-7 years after the operation.



Figure 10. Case 3: Radiographs of the left knee 1 month after the operation.

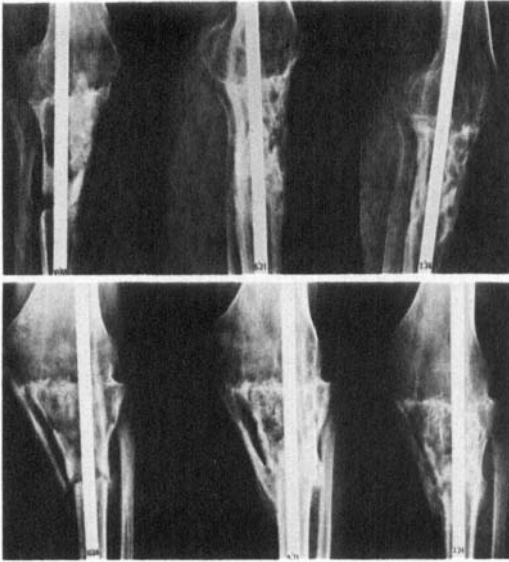


Figure 11. Case 3: Radiographs 1-6 years after the operation.

DISCUSSION

In the literature only a few descriptions of the use of autoclaved massive segmental autografts for reconstruction of long bones are given (Chapchal 1970). Thomson & Steggall (1956) reported a patient with chondrosarcoma in the proximal portion of the femur. They resected 16 cm of the femur, replaced the autoclaved bone segment and fused the hip joint. Six years after the first operation there was no recurrence and the femur was completely fused with a sound arthrodesis of the hip joint.

Smith & Simon (1975) studied eight patients who had resection and reconstruction for enchondrosarcoma. All patients had local resection. The excised bone segment was autoclaved and assembled with either an intramedullary nail or a long stem articular prosthesis and then replaced in its bed and fixed to the remaining distal segment of bone. All patients but one were alive and without metastases at follow-up after an average of 6.6 years.

Massive autoclaved autografts have been used not only in the treatment of bone

tumours but also in cases of trauma. Kirkup (1965) treated a patient with traumatic loss of 25 cm of the femoral shaft. He replaced the fragment after autoclaving and stabilized the femur with an intramedullary nail. Although he did not use fresh grafts there was extensive bone formation around the autoclaved bone segment 2 years later. Yet the segment itself was not completely incorporated in the femoral shaft.

A similar case of traumatic femoral bone loss is reported by Abell (1966). In his patient there was extrusion of 19 cm of the femoral shaft. It was successfully replaced after treatment of the extruded bone segment with zephiran chloride and fixation with a Küntscher nail.

Several other operative procedures for the same lesions are reported in the orthopaedic literature. Merle d'Aubigné (1958, 1966) uses massive autografts together with homo- or heterografts to bridge the defect after resection for bone tumours in the lower limb. Nilsson 1969, Ottolenghi (1972) and Volkov (1970) have reported cases of resection followed by massive homologous bone grafting including osteoarticular and meta-diaphyseal resection. The main factors associated with failure of the operation are infection, local recurrences of tumours and resorption of the graft. The good results demonstrate that resection and allogenic bone repair operations give satisfactory mobility and re-ossification of the graft, without loss of shape.

Wilson (1972) studied the biomechanical behaviour of massive autogenous and homogenous bone transplants used to reconstruct large bone defects in 10 patients. He stressed the importance of internal fixation with a long nail bridging the bone gap and extending intramedullarily into the adjacent bone ends.

Enneking & Shirley (1977) have reported 20 patients with malignant or potentially malignant tumours in the distal end of the femur or the proximal end of the tibia. They fuse the knee joint and bridge the gap in the diseased bone with a massive hemicylindrical

cortical autograft. The method provides a stable extremity in the uncomplicated cases within approximately 1 year.

Several authors have reported transplantation of dead bone (boiled bone, os purum, decalcified bone, ashed bone and frozen bone) both in experimental and clinical research (Lloyd Roberts 1952, Ehlert 1953, Chase & Herndon 1955, Williams 1964, Wilson & Lance 1965 and Parrish 1966).

It is generally accepted that fresh autogenous bone grafts fuse more quickly than all other kinds of bone transplants. To prevent non-union it is wise to bridge a massive autoclaved bone graft with fresh autogenous grafts to initiate rapid partial fusion. Nevertheless it is necessary to establish a rigid internal fixation with long-term stability. This can be realized with a long intramedullary nail and if necessary additional screws to neutralize torsional forces. It guarantees the stability of the bone structures till solid fusion has occurred. Boiled autografts are with regard to acceptance by the host and the period required for fusion, in our opinion, comparable with grafts from the bone bank (frozen homografts). The advantages of boiled autografts are:

- (a) The immediate availability, which is of special importance if there is no bank bone obtainable.
- (b) The excellent fit of the graft which facilitates the operative procedure.
- (c) Extensive use of bone from donor sites is not required.

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