Reconstruction after wide resection of the entire distal fibula in malignant bone tumours

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Abstract In this study we present a series of patients ($n=11$) with resection of the entire distal fibula in the case of sarcoma or metastasis. Moreover, we describe a new method to restore ankle stability with a tibiototalcalcaneal arthrodesis using a retrograde hindfoot nail ($n=4$) in contrast to tibiotalar arthrodesis with screws ($n=5$). The screw fixation failed in two patients due to osteoporotic bone. The crucial benefits of an arthrodesis with a retrograde nail are a stable arthrodesis, intramedullary stabilisation of the tibia and avoidance of extrinsic material in the wound area. An arthrodesis with a retrograde nail is a good alternative for reconstruction after a wide distal fibula resection. The additional arthrodesis of the subtalar joint was not associated with worse functional results in the MSTs and TESS scores.

Introduction

Tumours of the distal fibula are very rare. Fortunately, in most cases limb sparing surgery is possible. Wide resection of the entire distal fibula presents a challenge for the

orthopaedic surgeon. Loss of stability and critical soft tissue condition require reconstruction of a stable ankle joint and sufficient skin coverage of this area. Due to the rarity, and even fewer case reports, quite different solutions for different tumour entities have been described. Some authors simply perform a resection of the distal fibula without [1–4] reconstruction of the lateral side of the ankle. Yadav and Durak simply attached the remaining lateral ligament to the tibia [5, 6]. Complex reconstruction of the lateral malleolus using the fibular head was described by Carrell et al. [7], Herring et al. [8] and de Gauzy et al. [9]. An allograft reconstruction [10] and a reconstruction with the iliac crest bone graft have also been described [11]. An alternative method is an arthrodesis of the tibiotalar joint [1, 12].

In the following study we present a series of 11 patients with resection of the entire distal fibula. Moreover, we describe a new method to restore ankle stability with a tibiototalcalcaneal arthrodesis using a hindfoot nail (Figs. 1 and 2). The cartilage was removed from the ankle and subtalar joint. The hindfoot was fixed in 0–5° dorsal extension and 5° valgus. Partial weight bearing was required for three months because of delayed union during the adjuvant chemotherapy or radiation therapy.

Materials and methods

In a retrospective study we analysed the clinical outcome of 11 patients and the functional outcome of nine patients with tumours of the distal fibula treated between 1992 and 2008 (Table 1). Preoperative, local X-ray, MRI, staging with CT scan of the chest and bone scintigraphy were performed. The patients' ages ranged between 12 and 64 years (median 23 years). Indications for surgery were in one case a

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Fig. 1 Patient number 10. A 12-year-old boy with an osteosarcoma of the distal fibula. A wide distal resection with adjacent tibia was necessary. **a, b** Before surgery, T1 weighted magnetic resonance imaging showing the contact of the distal fibula tumour with the tibia. **c** Before surgery, X-ray findings show osteolytic lesion with typical periosteal reaction

metastasis of a hypernephroma, in four cases osteosarcoma and in five cases Ewing-sarcoma. There were two female and nine male patients. All tumours had an extraskeletal tumour component. The surgical stage of patients with primary sarcoma was IIB in all cases according to the system of the Musculoskeletal Tumour Society [13]. The resection lengths of the distal fibula ranged from 12 to 21 cm (median 16 cm). All patients with Ewing-sarcoma and osteosarcoma received chemotherapy according to the corresponding protocol. One patient with high grade osteosarcoma did not receive neoadjuvant chemotherapy because in the initial biopsy a low grade osteosarcoma had been diagnosed. Five patients with Ewing-sarcoma received local radiation therapy. The follow-up ranged between 14 and 155 months (median 50). The functional evaluation was performed without a brace at the most recent follow-up examination using the MSTS score (Musculoskeletal Tumour Society) [14] and TESS score (Toronto Extremity-Salvage Score) [15]. The patients with an amputation were excluded from questioning. One patient

Fig. 2 Patient number 10. X-ray findings at the last follow-up (15 months) showing consolidation of the arthrodesis and the defect after partial resection of the adjacent distal tibia

Table 1 Patient data

Pat. No.	Age (years)/gender	Diagnosis	Surgical stage	Chemotherapy (neo-/adjuvant)	Radio-therapy (Gy) (neo-/adjuvant)	Resection length (cm)	Technique	Additional surgery (months)	Complications (months)	Follow-up (months)	Oncological results (relapse, months)	MSTS score	TESS Score
1	64/m	Nephroblastoma metastasis	-	-	-	8	Reconstruction with peroneal tendon	-	-	30	Died of pancreatic carcinoma (35)	93%	-
2	15/m	Ewing-sarcoma	IIB	EICESS 91 (+/+)	54 (-/+)	15	Reconstruction with ipsilateral proximal fibula	Amputation (6)	Intralesional resection	155	CDF	-	-
3	15/m	Ewing-sarcoma	IIB	EURO-E.W.I.N.G. 99 (+/+)	54 (+/-)	13	Tibiotalar arthrodesis with three screws and fibula autograft	-	-	81	CDF	93%	96%
4	38/m	Osteosarcoma	IIB	COSS 96 (+/+)	-	12	Tibiotalar arthrodesis with three screws	Muscle flap (2); Resection of lung metastasis (48)	Delayed wound healing	84	AWD (lung metastasis, 48)	80%	83%
5	32/m	Ewing-sarcoma	IIB	EURO-E.W.I.N.G. 99 (+/+)	54 (-/+)	20	Tibiotalar arthrodesis with three screws	-	-	48	AWD (multiple metastasis, 22)	93%	91%
6	15/m	Ewing-sarcoma	IIB	EURO-E.W.I.N.G. 99 (+/+)	-	17	Tibiotalar arthrodesis with three screws	-	-	16	CDF	100%	100%
7	18/m	Osteosarcoma	IIB	COSS 96 (-/+)	-	19	Tibiotalar arthrodesis with three screws	Stabilisation with fixateur externe (17); Pseudarthrosis revision with spongiosa (24); Removal of fixateur externe and brace (27); Amputation (35)	Pseudarthrosis with talipes equinus; Deep infection	49	CDF	-	-
8	15/w	Osteosarcoma	IIB	EURAMOS 1 (+/+)	-	13	Tibiotolocaneal arthrodesis with retrograde nail	Implant removal (10)	-	14	CDF	90%	95%
9	16/m	Ewing-sarcoma	IIB	EURO-E.W.I.N.G. 99 (+/+)	55 (-/+)	19	Tibiotolocaneal arthrodesis with retrograde nail	-	Fracture (8)	22	CDF	93%	99%
10	12/m	Osteosarcoma	IIB	EURAMOS 1 (+/+)	-	21	Tibiotolocaneal arthrodesis with retrograde nail	-	-	18	CDF	76%	93%
11	12/w	Ewing-sarcoma	IIB	EURO-E.W.I.N.G. 99 (+/+)	45 (-/+)	21	Tibiotolocaneal arthrodesis with retrograde nail	-	Delayed wound healing	27	CDF	93%	96%

CDF continuous disease free, AWD alive with disease, DOD died of disease

died of disease; thus the TESS-score could not be evaluated. Statistic evaluation was done using Sigma Plot (version 11). The Mann-Whitney U test was used to compare the differences between the means of the MSTs and TESS scores.

Results

A simple resection and reconstruction with the peroneal tendon was done in patient number 1, who had a metastasis of a hypernephroma. The ankle was stabilised in a brace for the first two months without weight bearing, and thereafter for one month with step-wise partial weight bearing. The patient died due to an additional pancreatic carcinoma 35 months later. A complex reconstruction with an ipsilateral proximal fibula was done in patient number 2. Unfortunately, in the final histopathology examination intralesional margins were found and an amputation for oncological reasons was necessary.

A tibiotalar arthrodesis with screws was successfully performed in four cases. The ankle was immobilised between eight and 16 weeks (median 12 weeks). Afterwards, a step-wise weight bearing was undertaken. All patients were doing well at the most recent follow-up.

Patient number 7, who was reconstructed with a tibiotalar arthrodesis, developed a persisting superinfected pseudarthrosis. After the initial operation he was immobilised without weight bearing for 16 weeks. Afterwards, an orthosis was fitted. Radiologically a persisting pseudarthrosis was seen. Additionally, he developed a talipes equinus. Despite revisions he developed a superinfected persisting pseudarthrosis. An amputation was necessary because of debilitating pain in the ankle. Afterwards, an exoprosthesis could be fitted easily. In patient number 11 a tibiotalar arthrodesis with screws was planned. Intraoperatively the bone was so osteopenic that the distal tibia fractured when the screws were inserted. A retrograde hindfoot nail was used as a salvage procedure. A cast was applied for six weeks because of the large bone defect in the distal tibia. Partial weight bearing was needed until the end of the chemotherapy (24 weeks). Additionally, the patient developed delayed wound healing during local radiation therapy. Furthermore, the patient developed claw toes a few months after the initial operation and a tenotomy was necessary at the end of chemotherapy. At the time of the last examination the arthrodesis was completely consolidated and the skin was unremarkable.

Due to the poor results of arthrodesis with screws, we started to use a retrograde hindfoot nail in three recent cases. Postoperatively, the patients undertook partial weight bearing for between six and eight weeks (median seven weeks). So far

there has been only one method associated problem. Patient number 8 had a local irritation of the plantar fascia. There was good consolidation of the arthrodesis ten months after the initial operation, and the implant could be removed. After implant removal no more problems occurred. None of the patients had a significant limb length discrepancy. Patient number 9 had a proximal tibia fracture, not related to the method, when he was playing soccer. The fracture healed without any difficulties after six weeks of immobilisation in a brace.

The MSTs score was elevated in nine cases and the TESS score in eight cases; two cases were excluded because of an amputation. The MSTs score in patients with tibiotalar arthrodesis range from 80% to 100% (mean 92%), and the TESS score ranged from 83% to 100% (mean 93%). In patients with tibiototalcalcaneal arthrodesis, the MSTs score ranged between 76% and 93% (mean 88%) and the TESS score ranged between 93% and 99% (mean 96%). There was no significant difference between the patients with tibiotalar and tibiototalcalcaneal arthrodesis.

At the final oncology follow-up, one patient had died of an additional pancreatic carcinoma, two patients were alive with disease and eight patients continued to be disease free.

Discussion

Different techniques for reconstruction of the distal fibula after wide tumour resection have been described. All methods have different advantages and disadvantages, especially if local radiation therapy is needed. In distal fibular resection without reconstruction, the stabilising effect of the lateral malleolus is lost [16]. Soft-tissue reinforcement, even when it is possible, cannot fully compensate for the loss of stability. Resection of the lateral ankle can cause a varus instability or a collapse into valgus [17]. Norman-Taylor reported a substantial valgus deformity in three of five patients [3]. In cases of reconstruction with an ipsilateral proximal fibula the donor site morbidity must be considered. Loss of the proximal fibula can cause lateral knee instability or a damage of the peroneal nerve [18, 19]. Another disadvantage of this technique is the incongruity of the fibula head with the articulating talus and the risk of pseudarthrosis, especially when radiation therapy is needed. Due to the missing lateral ligament at the distal part of the fibula, instability of the ankle can occur despite reconstruction. Some authors recommend an arthrodesis of the ankle joint [1, 12]. A disadvantage of this technique is the limited range of motion and the development of a non-union. In cases of arthrodesis for degenerative diseases the

rate of pseudarthrosis ranges between 0% and 12% [20, 21]. In our series tibiotalar arthrodeses were done with screws in most of the cases. We had one major complication of a superinfected pseudarthrosis resulting in an amputation. One special reason for that pseudarthrosis could be the osteopenic bone of patients on chemotherapy [22] as seen in all our patients intraoperatively. In another patient, an arthrodesis with screws was planned, but intraoperatively proved impossible. A large distal tibia fracture occurred when the screws were inserted. By using a retrograde hindfoot nail a solid fixation could be achieved. Due to these two cases and the good results of patients with tibiotalocalcaneal arthrodesis using a retrograde nail in degenerative diseases [23, 24], we adopted this method for reconstruction after wide tumour resection of the distal fibula.

Another problem after wide resection is that a partial resection of the adjacent distal tibia is often needed. Therefore, an internal stabilisation of the remaining tibia is beneficial. The crucial advantage of an internal osteosynthesis is that long immobilisation in a cast, as in tibiotalar arthrodesis with screws, can be avoided. In our series all patients could manage partial weight bearing directly after the operation. Another advantage of this technique is that extrinsic material is not placed in the operating field. Thus, wound healing problems related to extrinsic material can be avoided. A disadvantage of a retrograde nail for limb salvage is that a primary arthrodesis of the subtalar joint is needed. However, long-term results of isolated ankle fusion showed that the motion of the subtalar joint is often severely limited and mostly nonexistent at follow-up [25, 26]. A reason for this could be that prolonged postoperative immobilisation after ankle arthrodesis can result in fibrous ankylosis of the subtalar joint [27]. Moreover, CT guided analyses of the possible hindfoot disturbance showed that a severe limitation follows after isolated tibiotalar arthrodesis [28].

In our clinic we had good results after tibiotalar arthrodesis with screws as well as after tibiotalocalcaneal arthrodesis with a retrograde nail. An important advantage of a tibiotalar arthrodesis is the preservation of the subtalar joint. Nevertheless, an arthrodesis of the subtalar joint is an acceptable disadvantage in our clinical experience. The crucial improvements of an arthrodesis with a retrograde nail are a stable arthrodesis, intramedullary stabilisation of the tibia and avoidance of extrinsic material in the wound area. Especially in osteopenic bone good fixation is easy to achieve. Partial weight bearing is possible and prolonged immobilisation in a cast can be avoided as well. Results of the MSTs and TESS scores affirm the equivalence of arthrodesis with screws and a retrograde nail. An

arthrodesis with a retrograde hindfoot nail is a good alternative for reconstruction after a wide distal fibula resection.

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