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Case Report

Traumatic periimplant fracture after nail arthrodesis of the knee in a limb reconstruction case☆

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ABSTRACT

Many principles of bone reconstruction were successfully applied in this unique case of a 1.92m (6 ft 3 in.) tall 15 year old boy with intercalary leg amputation. This patient suffered from a 26 cm (10.2 in.) bone loss of his left distal femur and severe soft tissue damage with an irreparable extensor mechanism after motor cycle accident.

After periimplant fracture below the knee arthrodesis nail, definite treatment consisted of implant exchange to an 870 mm (34.3 in.) long custom made nail, which is to our knowledge the longest implanted arthrodesis nail in literature.

Therefore the aim of the study was to present our treatment strategies and pitfalls after traumatic periimplant arthrodesis nail fracture in an unusual case of limb reconstruction.

Introduction

Periimplant fractures after knee arthrodesis nails are very rare [1] and challenging to treat [2]. Especially high energy trauma is the main risks for these injuries in young patients [3] resulting in complex surgeries [4]. Several different methods are described in literature solving this problem. Exchange of the knee arthrodesis nail to a longer one is the preferred method in most of the published cases [4–6]. However, in some cases (long nails, articular fractures) plating is necessary [2].

The aim of the presented case was to show a patient sustaining severe trauma with initially huge bone defect of 26 cm (10.2 in.), with periimplant fracture after nail arthrodesis, who was finally treated by renailing with an 870 mm (34.3 in.) knee arthrodesis nail. This is to our knowledge the longest ever used arthrodesis nail reported in literature.

Presentation of the case

Patient history

A 15 years old boy suffered from a severe motor-cycle accident resulting in intercalary amputation with a 26 cm (10.2 in.) bone defect and severe soft tissue contamination.

After bone reconstruction, a reamed knee arthrodesis nail (T2®, Stryker, Kalamazoo, MI, USA) was implanted [7].

Five years after the initial trauma the patient was injured in a second severe MVA (car accident), suffering from a tibial fracture

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Fig. 1. Radiological findings after the second MVA suffering from a tibial fracture below the arthrodesis nail (a.p. and lateral).

below the arthrodesis nail. Initial radiographs showed 1 cm (0.4 in.) of axial impaction (Fig. 1), a fibular fracture at a higher level and a fracture line combined with nail-bending at the level of the tibial bone regenerate.

The patient was sent to our department from abroad for further treatment in a lower leg cast, which was extended to an upper leg cast. The cast fixation was necessary for 6 weeks during planning and production of the implant.

Preoperative conventional radiographs showed malalignment of about 10° varus, dislocation of half shaft and impaction of about 1 cm/0.4 in. which could not be corrected preoperatively and had to be immobilized in the cast until definite surgery. This influenced the nailing procedure as removal of the distal bolt was difficult.

Surgical treatment

The patient was laid in supine position on an extension-table. The interlocking screws were removed. Open reduction of the fracture was necessary as the distal screw was covered by a bone fragment. Callus tissue around the fracture could be removed easily threw the same incision. After mounting the extraction instrument, the implant was removed without any complications. The retrieved nail (680 mm/26.8 in. length, 10 mm/0.4 in. dimeter) showed a kinking in the area of the visible fracture line around the knee arthrodesis. After staged reaming up to 12.5 mm the customized nail measuring 870 mm/34.3 in. length and 11.5 mm/0.45 in. in diameter was inserted and interlocked.

Partial weight bearing was permitted for 6 weeks.

At the first postoperative clinical examination, the patient showed clinically 5° of internal rotation of his left leg. Functional examination showed an active external rotation of about 5° an internal rotation of 45°. Movement in the ankle joint was unaltered with 5° dorsal flexion and 40° plantar flexion. The motion of the hip-joint was obviously impaired after his initial hip dislocation. Clinical gait analysis, revealed that the patient struck with his left foot against his right and had to turn his hip actively externally for a normal gait.

Therefore a rotational CT-scan was performed to measure the malalignment. The regions of interest were the hip-joint to assess the antetorsion angle of the femoral neck and the ankle joint.

The distal interlocking screws were removed, and the distal tibia externally rotated 20° and locked in the realigned position. Postoperatively six weeks of partial weight bearing with 2 crutches was allowed.

At the last clinical and radiological follow up seven months after the last surgery the patient was very satisfied and full weight-

Fig. 2. Clinical findings 5 months after the periimplant fracture shows good functional result.

bearing. Equal external rotation was evident. (Figs. 2–4).

Results

The functional results consisted of painless walking, full weight bearing and acceptable joint motion. The patient recovered in his daily life and was very satisfied with his result. He works as an electrician, is able to carry heavy objects and can climb on a ladder. Only working on the floor or at a lower height is limited.

Despite complications as non-union at the docking-site, periimplant fracture after adequate trauma, nail-bending, internal rotational malalignment all of them were solved successfully in this unique case.

The final external foot position was symmetric and subjectively better than before the second accident. The evaluated SF 36 (life quality score) revealed acceptable results. (Table 1).

There was no hitting or stumbling of the foot and no obvious pelvic skew. Hip rotation resulted in 60° external- and 20° internal rotation. Finally the ROM in the ankle joint was 40° plantarflexion and 5° dorsiflexion. Radiologically all fractures showed significant callus formation. Clinically the same limb length was achieved as before the periimplant fracture. (Fig. 2).

Discussion

High energy trauma has been reported as the main risks for periimplant fractures in young patients [3] resulting in complex surgeries [4]. The method of choice after periimplant fractures treated with intramedullary nailing appears to be to exchange of the initially implanted nail to a longer device, which was performed in the majority of the published cases [4–6]. However, in some cases with articular fractures plating had been necessary [2]. To our opinion, intramedullary nailing accomplishes the goals of s stabilizing a periimplant fracture after intramedullary knee arthrodesis, maintaining length and rotation as well as saving the bone regenerate according to the nailing after lengthening principles in this specific case. Plating, external fixation or casting are theoretically alternative treatment options, which are inadequate in this type of fracture with their specific risks and possible complications.

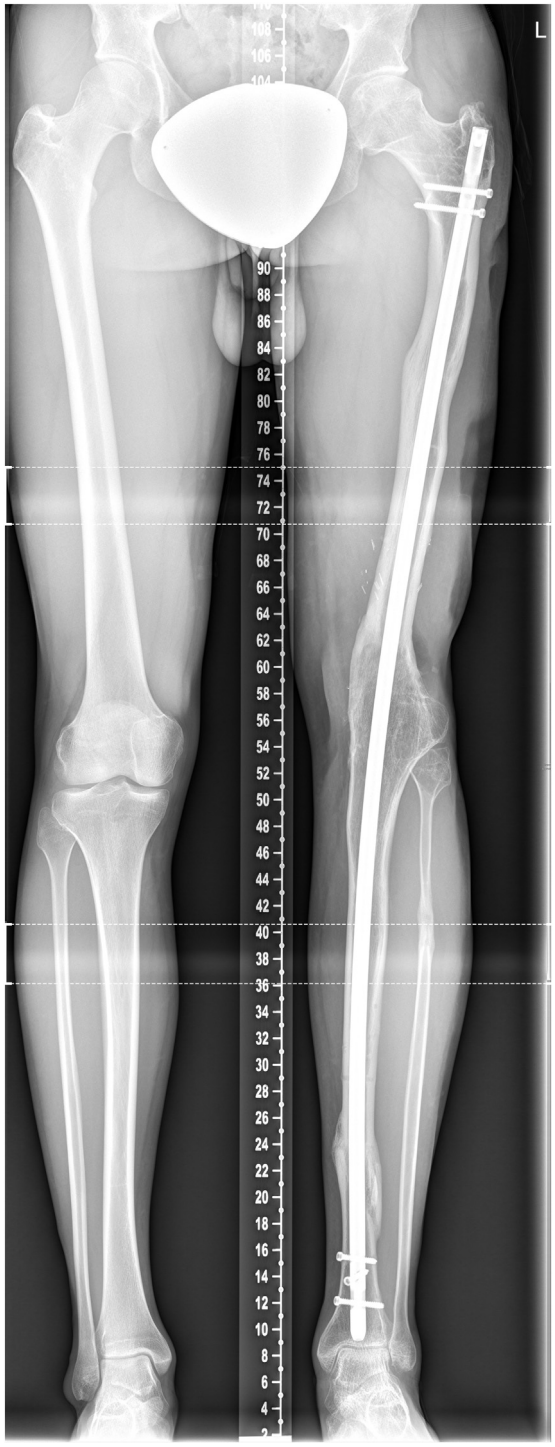

Fig. 3. Radiographic long leg standing alignment views 9 months after periimplant fracture and 7 month after the last surgery (a.p. and lateral view).

One of the main problems in periimplant fractures is to find an available new internal fixation device. Arthrodesis nails in a length up to 750 mm (29.5 in.) are available off-the-shelf [8], but in specific cases of tall patients customized nails are necessary. In the previous arthrodesis surgery, we used the longest available nail on the market. To our opinion, there is no need to place the tip of the nail in the metaphysis of the distal tibia. Modular arthrodesis nails are even shorter and a longer nail would have caused a more complicated articular distal tibial fracture or nail breakage. An earlier removal of the interlocking bolt would just have simplified nail

Fig. 4. Radiological findings 9 months after periimplant fracture and 7 months after the last surgery with solid callus formation and intact locking bolts (a.p. and lateral view).

removal.

In our case we had to wait 6 weeks for this very expensive implant of about 4600 Euros (5250 Dollar). This was the time for planning and production. During this time we immobilized the fracture in a long leg cast. The technical challenges were the impaction of the fracture and shortening of the tissue making the removal of the distal bolt very difficult. Callus tissue in the fracture gap influenced this as well. However, no other complications were caused by delay of treatment.

Challenges in planning are to find the appropriate nail length and diameter. This has to be performed exactly, as a too long nail would impinge at the hip joint and a too short nail would stabilize the fracture insufficiently. Furthermore the impaction of the

Table 1
SF36 scoring over time.

	pfi	rolph	rolem	Social	mhi	Pain	Vital	ghp
pre-OP	100	100	100	87.5	84	100	85	100
Fixateur	0	0	0	25	48	12	40	45
Nail I	50	25	33.33	62.5	80	74	70	67
Nail II	5.5	0	66.67	25	64	31	45	62
Final	50	25	66.67	62.5	80	74	70	62

ghp: general health perceptions index; mhi: mental health index; pain: bodily pain index; pfi: physical function index; rolem: role-emotional index; rolph: role physical index; social: social functioning index; vital: vitality index.

fracture, the bending of the nail and the interlocking hole position has to be considered. In our case these interlocking holes were planned individually and a thicker nail diameter was chosen.

In the previous arthrodesis surgery, we used the longest available nail on the market. To our opinion, there is no need to place the tip of the nail in the metaphysis of the distal tibia. Modular arthrodesis nails are even shorter and a longer nail would have caused a more complicated articular distal tibial fracture or nail breakage. An earlier removal of the interlocking bolt would just have simplified nail removal. However, using the lengthening measurement of our PACS software showed a nail length difference of 50 mm (2 in.) to the actual implanted nail. Therefore we had to perform additional “old school” measurements with the C-arm and a yard stick.

The nail exchange in our case was performed without any technical complications, even though a slight bending was seen in the middle third of the nail. Larger Studies as presented by Fenton et al. revealed only one periimplant fracture in 52 patients of tibiotalo-calcaneal nail fusion [5]. Smaller studies do not report any fractures in their series [8]. Hinarejos et al. [4] described one case of periimplant fracture above and below a modular knee arthrodesis nail after a minor fall, which was replaced by a solid custom-made tibiofemoral nail [4]. Woods et al. described two cases of periimplant fractures after tibiotalocalcaneal fusion with a retrograde femoral nail [1]. Altogether periimplant fractures remain a rare complication.

Other complications as pain, non-union, delayed union, infection or intra-operative fracture were reported [9,10]. In our case following complications had to be dealt with: periimplant fracture of an arthrodesis nail was treated by renailing and malrotation by derotation and locking screw exchange.

Malrotation is not uncommon in intramedullary fracture treatment [11], various aspects affect the rotational outcome [11]. The use of a fracture table and complex fractures incline to an internal rotation tendency [11,12] which were both seen in our case. A further surgery can be avoided in the operation theatre by demounting the fracture table devices after finishing surgery and evaluating foot alignment in a supine position.

Conclusion

Unexpected events as periimplant fractures after nail arthrodesis of the knee are rare and require optimal pre-surgical planning and an adequate treatment method to achieve good results. The method of choice in these cases seems to be the exchange of the initially implanted nail to a longer implant when possible. These implants, however are custom made and not available anytime. Surgeons have to be aware of rotational failures or planning pitfalls in such cases.

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