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Treatment of femoral diaphyseal non-unions: Our experience

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ABSTRACT

Despite the continuous advances of surgical solutions, still 1–7% of fractures develop non-unions. The delays in fracture healing increase the period of incapacity of the patient with major consequences, on the psychological and functional recovery, but also on the direct and indirect health-related costs.

In particular, femoral diaphyseal non-unions are often characterised by a challenging and long-lasting period of healing. The clinician treating these complex cases has to consider amongst other parameters, the condition of the soft tissue envelope, the adequacy of any pre-existing fixation, the alignment and length of the affected limb, the potential presence of an infection, as well as the general condition of the patient.

Open reduction and plate fixation of femoral diaphyseal non-unions offers a valid alternative of stabilisation and if applied to carefully selected cases, can give optimal results.

Introduction

Recent advances made in osteosynthesis techniques have not managed to eliminate the incidence of fracture non-unions. The incidence of diaphyseal long bone non-unions is estimated to be in the region of 7%.[11,24,30] However, for femoral shaft fractures a rate of less than 5% has been reported.[11,33]

The impact of femoral non-unions on the functional recovery of the patients and the allied socioeconomic implications can be momentous.[8,15] At a best case scenario Kanakaris and Giannoudis[18] recorded the direct medical costs of treating femoral non-unions to be higher than those of the other long bones (tibia and humerus). Taking into account that the concurrent indirect costs (associated to reduced quality of life and psychosocial consequences) represent the 80% of the total costs,[4] the burden of monetary costs, health system workload, and patients' psychosomatic problems are still underestimated.

Consequently, the constant pressure for increased efficacy in the management of long bone fracture non-unions, including the femoral ones, fuelled clinical research in order to optimise the methods of treatment. Although good results are reported with the use of intramedullary nailing methods,[16,17,23,24,29] there is also evidence advocating for other solutions.[1,2,7,8,24,31]

The aim of this study was to present the experience of our institution in the management of aseptic femoral diaphyseal non-unions, with the use either of exchange nailing or and plate fixation, as well as to compare the recorded clinical outcome to the published results of other authors.

Patients and methods

A retrospective analysis of the outcome (union or non-union) of all femoral diaphyseal fractures treated over a period of 8 years (between 2002 and 2009) to our university clinic was carried out. Non-union was defined as the absence of complete radiological healing (three out of four bridged cortices in two planes of plain X-rays) over a period of 6 months, as well as local pain over the fracture area while weight bearing. All non-unions were classified using the Weber and Cech criteria.[32] As diaphyseal fractures/non-unions we considered lesions positioned at least 5 cm distal from the level of the lesser trochanter, or 5 cm proximal from the adductor tubercle.

From this dataset of consecutive patients, the ones that developed non-union of the femoral diaphysis and were treated operatively formed the study group of this cohort study. All cases where a local infection was suspected were excluded from this study as well as all non-unions of pathological fractures. In order to exclude septic non-unions, all patients were evaluated clinically including specific laboratory tests (ESR, CRP, blood count, dosage procalcitonin). Besides the standard plain X-ray control (anteroposterior and lateral), further imaging studies (CT-scan) were used in three selected cases for pre-operative planning of the surgical approach. Bone scintigraphy (99mTc) was performed in four patients to assess bone metabolism locally and to define and classify the type of non-union.[3,27]

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Table 1
Dataset of diaphyseal femoral fractures managed at our unit between the years 2002–2009.

Diaphyseal femoral fractures				
	Number of frxs	Gender ♂/♀	Age mean (range)	Side right/left
Total	125, (123 pts)	88/35	39.7 years (2–92)	61/64
Open	9, 7.2%	7/2	31.6 years (16–53)	5/4
Pathological	3, 2.4%	2/1	83 years (73–92)	2/1
Non-operative management	17, 13.6%	11/6	6.1 years (2–10)	9/8
Operative management	108, 86.4%	76/32	40.1 years (5–91)	52/56
IMN	77, 61.6%	58/19	41.2 years (15–59)	42/35
Plate fixation	29, 23.2%	18/11	57.8 years (20–92)	8/21
Wire/screw fixation	2, 1.6%	0/2	9.5 years (6–13)	2/0

Abbreviations: frxs, fractures; IMN, reamed intramedullary nailing; pts, patients.

All non-union cases were reassessed after the revision surgery with clinical and radiographic examinations on a monthly basis, until the first evidence of radiographic healing and afterwards every 3 months.

The collected data for the cases enrolled to this study included details related to demographics, methods of initial fracture treatment, presence or not of implant failure, timing of secondary intervention, type of revision surgery, use or not of bone graft, post-revision rehabilitation, final outcome over a minimum period of 12 months.

Descriptive statistical methods were applied in order to compare the different methods of revision surgery for the femoral diaphyseal aseptic non-unions, and to present our results in a comprehensive manner. Statistical significance was assumed when $p < 0.05$.

Results

From the cohort of 125 consecutive femoral diaphyseal fractures (123 patients), 11 of them developed an aseptic non-union (incidence 8.8%, over a period of 7 years) (Table 1). There were nine men and two women, with an age range between 26 and 78 years (mean 48). Seven of them (64%) represented referral cases, initially operated in other institutions. The primary treatment was reamed intramedullary nailing (IMN) in seven cases and plating (ORIF) in four cases. Implant failure (breakage of elements of the nailing system or of the plate) was recorded in four cases (two cases of each different method of fixation) (Figs. 1a, b and 2a, 2b). One case of femoral non-union also developed severe deformity consisting of varus angulation. Limb length discrepancy was evident in six of the cases (55%), with a maximum shortening of 3 cm. The average time which elapsed from the first surgery to the revision was 11.6 months (6–22 months).

Revision surgery included the use of open reduction – plate fixation with an LCP® plate (Synthes) in seven cases and exchange nailing in four cases (two Grosse Kempf® nails Stryker, and two T2® Stryker) (Table 2). The initial intramedullary nail was left in place and a plate was used as additional fixation to achieve greater stability in a single case (Fig. 3).

In all cases where open reduction plate fixation was used, autologous iliac crest bone graft was also inserted at the non-union site. In three cases additional biological stimulation was applied by implanting in association with the autologous iliac crest bone graft autologous platelet rich plasma (PRP),[6] bone marrow aspirate-mesenchymal stem cell concentrate (BMAC),[5] and BMP-7 (Osigraft® Stryker)[9,19,21] (each one to a different patient respectively).

The post-revision rehabilitation protocol included immediate supervised assisted mobilisation, non-weight bearing for at least 30 days, knee continuous passive motion (CPM) and isometric muscle strengthening exercises for the first 30 days, Subsequently, isotonic exercises were added to the rehabilitation programme, as well as progressive increase of the weight bearing status, depending on the radiographic evolution of callus formation.

Fig. 1. (a) Male, 40 years old, 17 months after initial treatment with an intramedullary nail. Non-union, with implant failure (breakage of distal static locking screw. (b) Consolidation at 6 months after treatment with a locking periarticular distal femoral plate.