INTRAMEDULLARY NAIL USE FOR CORRECTIVE SURGERY OF DIAPHYSEAL FOREARM FRACTURES

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ABSTRACT

The aim of this study is to evaluate the results after reoperation of radial- and ulnar diaphyseal fractures using an interlocking intramedullary nail. A cohort of 30 patients, who were treated with a ForeSight (Smith&Nephew, USA) intramedullary nail between the years 2000 and 2005, were included in the study. In total, pseudoarthrosis formation was seen in 21 patients, and forearm refractures were seen in 9 patients. The average length of time between trauma and resurgery was 15 months (range of 4 to 32 months). Postoperatively, early and late complications were evaluated, as well as radiological and functional results. During resurgery, a total of 42 intramedullary nails were used in 30 cases of forearm fracture. Radiological proof of healing was observed in all patients: this was seen in 25 patients after 6 months, 3 patients after 12 months, and in 2 patients after 18 months. The average duration of healing was 18.45 weeks. Ranges of movement of the wrist, the forearm, and the elbow were classified according to the Anderson method. Excellent results were achieved in 9 patients, good results in 13 patients, and sufficient results in 8 patients. No patient exhibited insufficient results or complete rigidity of the wrist or the elbow. The results of our study corroborate the possibility of using stabilised intramedullary nailing for revision surgery of the forearm. The corrective surgery indicated must take into account the type of pseudoarthrosis present for a specific therapy, continually respecting the essentials of osteosynthesis stabilisation. A selective operative technique, meticulous follow-up of infections, and promotion of bone healing are paramount.

INTRODUCTION

Nowadays, the standard of primary treatment of radial- and ulnar diaphyseal fractures is operative treatment using plate fixation [2, 8]. Complications in healing after the use of this

technique occur quite infrequently, and most contemporary studies note the incidence of pseudoarthrosis formation at under 5 % [11,15,18]. Non-union of a diaphyseal forearm fracture is usually associated with either a complex injury, a complication such as an infection, or inadequate internal fixation [11].

The other motive for revision surgery of antebrachial diaphyseal fractures are refractures after removal of the osteosynthetic material.

The treatment of such non-union fractures, which are most frequently pseudoarthrosis formation, includes restoration of the correct length and rotation of the forearm so as to allow a physiological range of movement. A cohort of patients, for whom reosteosynthesis was indicated using intramedullary nailing because of an unhealed forearm fracture or refracture, has been evaluated in this study.

MATERIALS AND METHODS

Between the years 2000 and 2005 we performed corrective surgery for diaphyseal forearm fractures using the ForeSight intramedullary nail (Smith&Nephew, USA) in 30 patients. All patients were operated on in one clinic, with 6 surgeons alternating. The following patients were excluded from the study: those with pathological fractures, those with rheumatoid arthritis, those with a history of chronic steroid use, and those patients who did not show up for follow-up examination (4 patients).

Criteria for inclusion in the study involved:
Type of injury

- *Pseudoarthrosis formation,* which developed as a complication of plate osteosynthesis, external fixation, intramedullary pinning, or conservative therapy after primary reposition using plaster casts;
- *Refracture* (mostly after plate removal);
- *Re-osteosynthesis* performed by intramedullary nailing;
- A minimum of 18 months' *follow–up.*

For the purposes of this study, an atrophic pseudoarthrosis (delayed union) was defined as an unstable fracture with no signs of healing after a minimum of 4 months following injury. A hypertrophic pseudoarthrosis is an unstable fracture with overproduction of the callus, without signs of progressed healing up to 12 months after trauma with marked clinical symptomatology. Furthermore, a refracture was defined as a new fracture after minimal trauma in the original fracture line or in the area of the screw canal after plate extraction.

Primary injury

Our patient cohort included 18 men and 12 women of an average age of 36.2 years (range 19–74 years). The fracture was present on the left forearm in 21 patients and on the right forearm in 9 patients. The dominant extremity was affected in 13 cases (43.3 %). The cause of injury was a motor vehicle accident in 13 patients, falls in 11 patients, work-related injury in 5 patients, and a gunshot wound in one patient.

The primary injury in 21 patients was a diaphyseal fracture of both forearm bones; in 7 patients, an isolated fracture of the radial diaphysis; and in 2 patients, an isolated fracture of the ulna.

Eleven patients had a primarily opened fracture that was classified according to Gustillo-Anderson as stage I in 2 patients, stage II in 6 patients, and stage III in 3 patients.

Four patients had a concomitant injury of the ipsilateral upper extremity (two fractures + elbow subluxation, one diaphyseal fracture of the humerus, and one fracture of the distal humerus). Two patients had radial nerve paralysis: in one patient, this was due to an ipsilateral humeral diaphyseal fracture, and in the other patient, the paralysis occurred after primary osteosynthesis done at another clinic. In our study, no vascular injury was observed.

Primary therapy included plating in 17 cases, intramedullary stabilisation using Kirschner wires in 6 cases, external fixation in 2 cases, and plaster casting in 5 cases. Twenty-six patients were originally treated elsewhere (86.7%). A deep-seated infection occurred postoperatively in 4 patients, and this was treated by repeat debridement and parenteral antibiotic administration. Upon reoperation, no clinical or biochemical signs of active inflammation were observed.

Twice, a rupture of the extensor pollicis longus muscle tendon was noted after primary surgery. This complication was resolved during the corrective surgery by transposition of the tendon of the extensor indicis proprius muscle.

At the time of resurgery, 25 of 30 patients had had at least one previous surgery on the ipsilateral forearm. The following implants were selected during primary surgery:

- 3 plates unsuitable for the fracture type (1 – one-third tubular plate, 2–4.5mm-sized autocompressive plates);
- 3 plates of unsuitable length (only 2 screws inserted into one side of the fracture);
- 2 incorrectly placed screws (the screws crossed the fracture line).

The aforementioned patients, and those who had primarily stabilisation using intramedullary Kirschner wires (6 patients) or after primary reduction by plaster casting (5 patients), are considered by us to constitute the group of patients with suboptimal primary fixation (in total, 19 patients /63.3 %/).

Corrective procedure

Pseudoarthrosis or refracture was present at the time of reoperation in both forearm bones in 12 cases. These complications were isolated to the radius and the ulna in 13 and 5 cases,

Table 1
Patients with pseudoarthrosis – data

Patient (No.)	Age	Gender m/f	AO classification (primary fracture)	Surgical treatment	Type of pseudoarthrosis	Time of resurgery (months)
P1	27	f	C.2, closed	2x plate (3.5 mm)	atrophic PSA – both	12
P2	30	m	B.3., closed	2x plate (3.5 mm)	atrophic PSA – radius	15
P3	43	f	B.3., open G-A III	fixateur externe	atrophic PSA – ulna	4
P4	19	m	C.3., closed	2x plate (3.5 mm)	atrophic PSA – radius	8
P5	40	m	A.2., closed	1x plate (4.5 mm)	atrophic PSA – radius	10
P6	56	m	B.3., closed	2x plate (3.5 mm)	atrophic PSA – ulna	12
P7	48	f	A.2., open G-A II	1x 1/3 tub. plate (3.5 mm)	atrophic PSA – radius	21
P8	61	m	C.1., closed	2x plate (3.5 mm)	atrophic PSA – both	12
P9	74	f	B.2., closed	conservative, cast 14 w.	hypertrophic PSA – radius	15
P10	33	m	B.3., open G-A II	2x Kirschner wires	hypertrophic PSA – both	12
P11	44	m	C.3., closed	2x Kirschner wires	hypertrophic PSA – both	15
P12	27	m	A.2., G-A III stage	fixateur externe	hypertrophic PSA – radius	12
P13	29	f	C.2., closed	2x plate (3.5 mm)	hypertrophic PSA – both	15
P14	32	m	A.1., open G-A I stage	2x Kirschner wires	hypertrophic PSA – ulna	16
P15	27	m	C.1., closed	2x plate (3.5 mm)	hypertrophic PSA – both	18
P16	36	m	C.3., closed	conservative, cast 12 w.	hypertrophic PSA – both	13
P17	25	f	B.3., closed	2x plate (3.5 mm)	hypertrophic PSA – radius	15
P18	20	m	B.3., closed	conservative, cast 14 w.	hypertrophic PSA – both	12
P19	24	f	C.2., open G-A II	2x Kirschner wires	hypertrophic PSA – both	16
P20	22	f	A.2., closed	2x plate (3.5 mm)	hypertrophic PSA – radius	14
P21	40	m	C.3., open G-A II	2x Kirschner wires	hypertrophic PSA – radius	14

respectively. The length of time between trauma and reoperation was on average 15 months (range of 4–32 months).
In total, 21 patients had pseudoarthrosis formation (Table 1) and 9 patients had refractures (Table 2) of the forearm (4 fractures crossed the fracture line of the previous fracture and occurred after minimal trauma, while in 5 patients refracture occurred in the screw canal) (Figures 1a-f, 2a-e).

Interventions
The standard surgical approach involves an indirect closed reposition of the fracture. This technique was used primarily in refractures that had occurred after plate extraction, in pseudoarthrosis formation following conservative measures, or after intramedullary osteosynthesis using Kirschner wires. The procedure is performed on a radiolucent hand table, and the correct length and shape of the nail is confirmed using an X-ray intensifier and two malleable templates (radius – dorsoradial curvature, ulna – s-shaped curvature). The nailing of the ulna is accomplished through a port made in the proximal olecranon. The entry point for the nailing of the radius is made on the radial side of Lister's tubercle beneath the extensor carpi radialis brevis tendon. The ulna is nailed in the antegrade direction first, providing a more stable forearm for retrograde nailing of the radius.
Consequently, the medullary cavity of the fractured bone is gently manually reamed, and the medullary canal is widened to a length of between 0.5 and 1.0 mm greater than the selected nail diameter. After reaming, the nail is inserted.
In general, we perform bilateral interlocking as the standard for corrective surgery. Unilateral nailing is possible only in cases of "press-fit" nailing into the thin part of the medullary cavity (middle and distal third of the ulna; middle and proximal third of the radius). The fracture line should be simple, with optimal impaction, and the peripheral bone fragment must be long enough to secure a favourable rotational stability (minimum of 5 cm). Peroperative control of the rotational stability is essential. From the standpoint of stability, the high risk area is predominantly the proximal radius, where the deep branch of the radial nerve closely approximates to the neck of the radius. For this fact alone, unilateral stabilisation of the radius is recommended. The actual stabilisation is done using a free-hand technique.

Table 2
Patients with refractures – data

Patient (No)	Age	Gender m/f	AO classification (primary fracture)	Treatment	Time of removal (months)	Time delay of fracture after removal (months)	Adequate trauma	Fracture line
R1	54	f	A.3., open G-A II	2x Kirschner wires	6 months	8 months	fall from a tree	original fracture line
R2	19	m	B.3., open G-A III	conservative, cast 6 w.	0	14 months	minitrauma, walking	original fracture line
R3	25	f	A.2., closed	1x plate (3.5 mm)	18 months	4 months	minitrauma, bathroom	original fracture line
R4	20	m	B.3., open G-A I	conservative, cast 14 w.	0	12 months	regular fall	original fracture line
R5	41	m	A.2., closed	1x plate (3.5 mm)	12 months	20 months	bike accident	through the screw canal
R6	59	f	A.2., closed	1x plate (4.5 mm)	18 months	3 weeks	minitrauma, bathroom	through the screw canal
R7	40	m	C.3., open G-A II	2x plate (3.5 mm)	20 months	1 months	minitrauma, walking	through the screw canal
R8	22	f	B.3., closed	2x plate (3.5 mm)	12 months	3 months	minitrauma, home	through the screw canal
R9	45	m	B.1., closed	1x plate (3.5 mm)	15 months	5 months	regular fall	through the screw canal

To eliminate the risk of nerve damage, we adhere to the following approach:
After selecting the point of skin incision, blunt dissection with scissors and a forceps is used to prepare a canal for drilling. The drill bit is inserted with its protective sleeve into the soft tissue canal. Under radiological guidance, the drill bit is centred onto the bone and only then is pressure applied to the bone with the protective sleeve on the soft tissue. Damage to the deep branch of the radial nerve has not been observed using this technique.
An alternative surgical technique involved extraction of the failed implant, debridement of the sclerotic and devascularised bone, local removal of inflammatory and fibrous tissue, decortication of the principal fragments, and subsequent renewal of the length and rotation of the dislocated bone. Intramedullary nails were used for the stabilisation. In cases of atrophic pseudoarthrosis formation or with segmental bony defects, spongioplasty was performed. Autogenous spongious transplantation was used for the donor bone, and was taken from the crest of the iliac bone on the ipsilateral side. We did not use a bone-graft substitute in this study.

Clinical conclusions
Postoperatively, all early and late complications were studied, as well as the radiological and functional results.

Results
The average period of follow-up was 23 months (range of 18–42 months). An intramedullary nail was used in 30 forearm fractures, and a total of 42 nails were implanted (Table 3). Bilateral interlocking of the nail was done in 29 cases (69.0 %); unilateral interlocking, in 13 cases (31.0 %). Closed reposition was performed in 21 cases (50.0 %), mini-incision open reposition in 13 cases (30.9 %), and open reposition was done in 8 cases (19.1 %). The average length of surgery was 83 minutes (range of 30 to 180 minutes).

Adjuvant spongioplasty was performed in 8 patients. A supportive plaster cast was applied in 6 patients and was left in place for 4 weeks.

Healing
Radiological confirmation of healing (complete remodelling of the fracture with no gap between fragments) was seen in all patients (Table 4). This was observed in 25 patients within 6 months, in 3 patients within 12 months, and in 2 patients within 18 months (Table 5). The average length of time to healing was 18.45 weeks.

Complications
The following peroperative complications were noted:

Table 3
Type of corrective surgery and healing

Patient (No.)	Surgery	Spongiosaplasty	Locking screws	Cast (weeks)	Time of healing (radius + ulna/months)
P1	2x nail	*	bilat.	0	4 + 5
P2	1x nail	*	bilat.	0	6
P3	1x nail	0	bilat.	0	18
P4	1x nail	*	bilat.	0	4
P5	1x nail	*	bilat.	0	6
P6	1x nail	0	unilat.	0	3
P7	1x nail	*	unilat.	4	6
P8	2x nail	*	bilat.	0	5 +5
P9	1x nail	0	unilat.	4	3
P10	2x nail	0	bilat.	0	4 + 8
P11	2x nail	0	unilat.	0	4
P12	1x nail	0	bilat.	0	4
P13	2x nail	0	unilat.	4	5 + 6
P14	1x nail	0	bilat.	0	4
P15	2x nail	0	bilat.	0	14 + 4
P16	2x nail	0	bilat.	0	3 + 3
P17	1x nail	0	unilat.	0	4
P18	2x nail	0	bilat.	0	3 + 4
P19	2x nail	0	unilat.	4	2 + 2
P20	1x nail	0	unilat.	0	3
P21	1x nail	0	unilat.	0	4
R1	1x nail	0	bilat.	0	9
R2	2x nail	0	bilat.	0	3 + 3
R3	1x nail	0	unilat.	4	4
R4	2x nail	0	unilat.	0	3 + 3
R5	1x nail	*	bilat.	0	5
R6	1x nail	0	bilat.	0	5
R7	1x nail	0	unilat.	0	8
R8	2x nail	0	unilat.	4	4 + 3
R9	1x nail	*	bilat.	0	5

Table 4
Healing after resurgery according to individual types of fractures

	Number of patients	Average age	Average time to healing (weeks)
Refracture (of the original fracture line)	4	29.5	14.42
Refracture (of the screw canal)	5	41.5	21.30
Atrophic pseudoarthrosis formation	8	40.5	17.8
Hypertrophic pseudoarthrosis formation	13	33.3	19.56
Total number of patients	30	36.2	18.45

Table 5

Data of patients with impaired healing after corrective surgery. Three patients had delayed healing (8;8;9 months). A further 2 patients showed healing after 14 and 18 months. The time to complete healing is related to pseudoarthrosis formation. Healing occurred with no additional surgical intervention

Gender	Age	Reason for reoperation	Procedure	Bone	Time of healing (months)
M	40	Refracture in the screw canal after plate extraction	Nail, unilateral interlocking	Radius	8
F	54	Refracture in the previous fracture	Nail, bilateral interlocking	Ulna	9
F	43	Pseudoarthrosis formation	Nail, bilateral interlocking	Ulna	18
F	27	Pseudoarthrosis formation	Nail, bilateral interlocking	Radius + ulna	14 + 4
M	33	Pseudoarthrosis formation	Nail, bilateral interlocking	Radius + ulna	4 + 8

Table 6

Functional results according to range of movement

Anderson score	No. (%)
Complete range of movement*	9 (30.0)
Slight restriction in movement**	13 (43.3)
Severe restriction in movement ***	8 (26.7)
Complete rigidity	0 (0)

* less than 10% restriction of wrist-dorsipalmar flexion, less than 25% restriction of pronosupination
** less than 25% restriction of wrist-dorsipalmar flexion, less than 50% restriction of pronosupination
*** more than 25% restriction of wrist-dorsoplantar flexion, more than 50% restriction of pronosupination

Table 7

Results of evaluation of pain

Pain evaluation	No. (%)
No pain	20 (66.6)
Pain upon weight stress	8(26.7)
Pain at rest	2 (6.7)
Pain requiring chronic analgesic therapy	0 (0)

- 1 occurrence of nail impaction in the diaphyseal cavity and subsequent damage to the fixation thread during extraction. This was peroperatively corrected by exchanging the nail for a thinner one.
- 1 occurrence of a "fausse route" during reaming.
- 1 occurrence where it was necessary to remove a shot pellet (in a gunshot wound) from the medullary canal via open surgery, which impeded nailing.

In 3 cases, a late complication of partial migration of the locking screw in the nail was observed.

A discrepancy in the length of the distal radioulnar joint of more than 2 mm was observed in 2 patients after osteosynthesis (6.66 %).

Functional evaluation

The range of movement of the wrist, the forearm, and the elbow were evaluated by the Anderson method [3] (Table 6). Excellent results were achieved in 9 patients, good results were achieved in 13 patients, and satisfactory results were seen in 8 patients. No patients ended up with poor results of healing or complete rigidity of the wrist or the elbow.

Pain was evaluated with respect to difficulties at rest, upon weight stress, and severity requiring analgesic medication (Table 7).

Figure 1
A 20-year-old patient after a fall from a tree treated conservatively by plaster casting for 14 weeks. Twelve months later, there was a refracture in the original fracture line after minimal trauma (a,b). Osteosynthesis of the forearm was done using a closed technique with intramedullary nailing (c). Follow-up X-rays after 8 weeks (d,e); complete healing after 12 weeks (f)

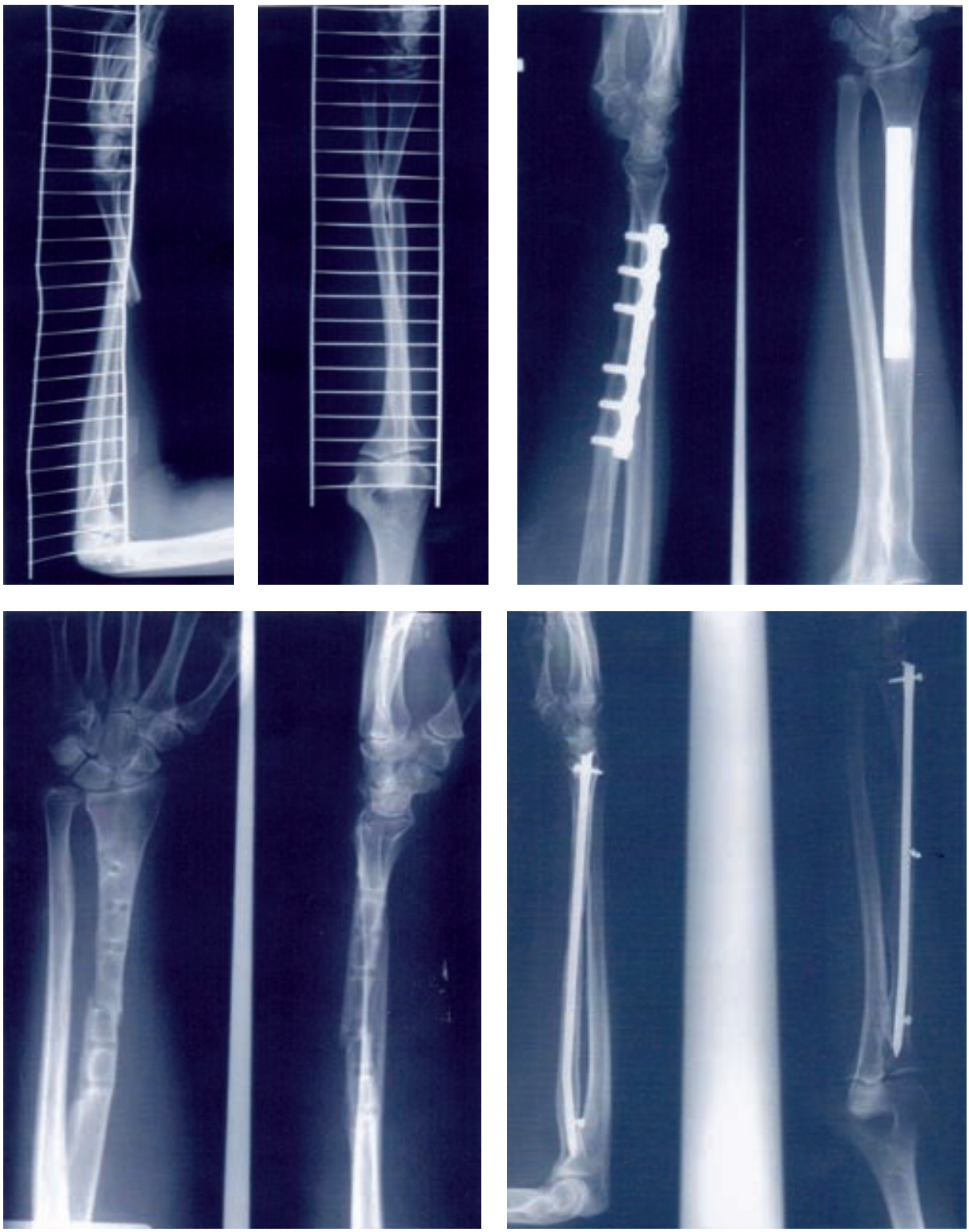

Figure 2
A 59-year-old patient after a motor vehicle accident with a Galleazzi fracture, type 22 – A2, according to AO classification (a,b). Treatment using plate osteosynthesis (c); extraction of the plate after 18 months; 3 weeks later, refracture in the screw canal after plating occurred after minimal trauma/fall in the bathroom, (d); Refracture was treated by nailing / X-ray healing after 5 months (e)

DISCUSSION

The notion of intramedullary osteosynthesis of the forearm was first published by Schon in 1913 [13]. The initial results were unsatisfactory, and even in 1957 Smith and Sage [14], in their analysis of 555 forearm fractures treated by a gamut of intramedullary implants (K wires, Rush-pins, …), noted a 20 % incidence of pseudoarthrosis formation [1]. This problem was justified on the grounds of insufficient angular and rotational stability of the implant materials used [12,14]. An improvement in the stability of the nail was forged by a change in the cross-section of the nail, and in later years various adjustments included the U-shaped Kuntscher nail, the triangular Save nail, the square-shaped Von Saal nail, and the quadratic Street nail. Further advancement of the rotational stability was achieved at the end of the 20th century, when the nail was supplemented with distal and proximal interlocking (i.e. ForeSight nail).

The incidence of disordered healing of diaphyseal forearm fractures is nowadays falling. The majority of contemporary studies cite a less than 5% incidence of pseudoarthrosis formation with the use of plates (11,15,18). Hence there are not many studies which evaluate corrective surgery of this area. One of the most comprehensive studies in English literature was published by Ring [11], who evaluated a cohort of 35 patients with diagnosed arthrotic ununited diaphyseal fractures of the forearm. He observed that the segmental bony defect was on average 2.2 cm in length (range between 1 and 6 cm). This was treated with the help of autologous spongious grafting and reoperation with plating. The period of healing was 6 months in all patients; the range of wrist movement was circa 2/3; the grip strength, in contradistinction to the opposite side, was on average 83 %. In evaluating the functional results according to Anderson, Rings achieved excellent results in 5 patients, good results in 18 patients, satisfactory results in 11 patients, and poor results (because of malunion) in 1 patient. Ring further noted that hypertrophic pseudoarthrosis formation does not typically occur in the forearm. An atrophic pseudoarthrosis formation with a segmental bony defect occurred more frequently. This opinion is however not shared by Babhulkar [2], who did not observe a majority of atrophic pseudoarthroses in his studies. In treating a total of 15 pseudoarthrosis formations of the radius and 21 cases of pseudoarthrosis formations of the ulna, he used plating (86.1 %) in favour over intramedullary nailing (13.9 %). The breakdown of individual types of pseudoarthrosis formations in our study more reflected those found by Babhulkar in that atrophic pseudoarthrosis more frequently arose in cases where the primary treatment involved an extensive approach and a gross injury to the periosteal vascular supply. In contrast, a higher incidence of hypertrophic pseudoarthrosis formation was observed after insufficient primary stability of the fracture area, which conferred a great degree of micromovement upon the local area (osteosynthesis using K wires, conservative measures, failure of plate fixation). A hypertrophic pseudoarthrosis formation is considered to be richly vascularised, and therefore quickly leads to bony healing after stable fixation and osteosynthesis. On the contrary, the atrophic pseudoarthrosis formation is poorly or inadequately vascularised, and is characterised by a low activity of osteoblasts, and bony healing is limited. This impediment requires resection of the dead tissue, as well as of the fibrous and inflammatory tissues, and the defect produced must be refilled with an autologous bony graft.

Refractures after plate extraction correspond primarily with injury to the periosteal circulation due to the implant, which leads to a pathophysiological process that ends in cortical atrophy and skeletal porosis. This problem is then directly related to the question of optimal timing of plate extraction. A precise time cannot be unequivocally recommended, but it should be no shorter than 12 months [5, 7, 9].

Studies that have evaluated the use of intramedullary nailing in corrective surgery of the forearm are indeed singular [4, 6, 16]. Hofmann [9] evaluated the use of a stabilisation nail in 7 reoperations after fracture of the ulna. The nail was successfully used even when the defect in the area of the pseudoarthrosis was extensive. We believe that a centrally-placed implant affords a better alignment biomechanically, and this stability is also conferred in the frontal and sagittal planes. It must be stressed that the plate is locally exposed to relatively great forces, which may lead to plate shattering or to screw loosening. This problem was partially resolved by the newer types of Locking Compression Plates or a PC-Fix type plate, which have more favourable biological conditions for healing.

In our study, the nail was used in 30 patients, who had 42 forearm fractures. The intramedullary nail will certainly not replace plating when used for corrective surgery, but in many cases it is advantageous to use it. When applying the nail, further weakening of the bone at the level of the stabilisation screws inserted into the plate does not occur. In addition, repeated deperiostation of the fragments does not occur. When performing reoperation with a plate, it is often consequently necessary to perform deperiostation to a great extent. The anatomical malleability (radius – dorsoradial curvature, ulna – s-shaped curvature) of the nail is a necessity and leads to a renewal of the physiological shape of the forearm bones. Reaming in the area of sclerosis after the preceding nailing is often tricky, and must be performed carefully and steadily, so that breakage of the reamer does not occur. In rigid pseudoarthroses, which are prone to incorrect positioning, closed reposition may be impossible, and mini-incision repositioning is therefore required. Following insertion of the

nail, the result of repositioning and freedom of wrist and elbow movement, as well as forearm rotation are checked. Rotational control is possible thanks to the static bilateral locking inherent to nailing. Stabilisation of the contralateral side is done by a free-hand technique.

Hypertrophic pseudoarthrosis formations arise mostly from insufficient stability. One must ensure an adequate period of rest to enable full healing of this pathology. In this type of pseudoarthrosis formation it is beneficial to use an intramedullary nail that is inserted by closed technique. During its application, the periosteal callus is not disturbed and, furthermore, gentle reaming of the medullary cavity stimulates healing – the so-called internal spongioplasty. Contraindications in using nails may be either a narrow medullary cavity (less than 3 mm) or an open epiphyseal plate in adolescents. A relative disadvantage is its high cost. In contrast, one advantage presented is the possibility of using the nail for a locally poor state of the soft tissues surrounding the pseudoarthrosis. It is also beneficial in treating segmental fractures but, most importantly, there is a very small percentage of infectious complications after intramedullary nailing.

For complete healing, an *atrophic pseudoarthrosis* requires supportive measures to stimulate bony healing. An essential component of the operative procedure is local debridement and decortication of the pseudoarthrosis formation. In this study, we have demonstrated the possibility of using nails even for this type of pseudoarthrosis. An important step in this surgery is open bone grafting.

It is necessary to confirm that the angle of reduced forearm bones is correct in both types of pseudoarthrosis formations. Healing in the incorrect position (a malunion) annuls the merit of the corrective surgery.

In conclusion, the results of our study confirm that intramedullary nailing can be used in corrective surgery of the forearm. The planned corrective procedure must take into consideration the type of pseudoarthrosis formation, be tailored to the individual involved, and, most of all, it must respect the tenets of stable osteosynthesis. Other important considerations are a differentiated operative procedure, the follow-up of infections, and supportive measures for bony healing.

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