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DYNAMIC INTRAMEDULLARY OSTEOSYNTHESIS IN FRACTURES OF THE FEMORAL SHAFT

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In 1937 Rush & Rush introduced a method of osteosynthesis using a thin, round intramedullary pin. The dynamic intramedullary osteosynthesis, called Rush pinning, was finally elaborated during the 1940's (Rush & Rush 1939, 1949 a, b, Rush 1955), and has been widely used ever since.

Rush pinning is valued by many for the osteosynthesis of juxta-articular fractures, but there is some uncertainty as to whether it affords sufficient fixation of fractures affecting the shafts of the long bones. Most surgeons who deal with operative treatment of fractures of the femoral shaft appear to prefer apparently more solid, but also far more complicated methods of osteosynthesis (Palmer 1957, Madsen 1966, Tophøj et al. 1968, Ahlbäck & Felländer 1969, Blichert-Toft & Hammer 1970, Greiff 1970). And indeed, although Rush pinning has been in general use in this country for the past 10–15 years, there have been no major reviews in Scandinavian literature on its application to fractures of the femoral shaft. Accordingly, the treatment of 48 cases by the Rush method, with a follow-up on 42, seemed to merit publication.

MATERIAL AND METHODS

During the period 1962–1969 a total of 47 patients underwent operation for fracture of the femoral shaft. All the fractures affected the shaft proper, i.e. from 5 cm below the lower edge of the lesser trochanter to 6 cm above the articular line of the knee. A total of 48 fractures were treated, as in one case the fracture was bilateral. The age range was 15–83 years. Figure 1 shows the age distribution. The sex ratio was 41 males and 6 females. 19 fractures were right-sided and 29 left-sided. 44 were traffic injuries which had occurred in 26 of the cases on a 2-wheeled vehicle. 8 fractures were open and 40 closed. Table 1 gives the types and levels of the fractures. In 22 of the 48 cases the femoral fracture was associated with other serious injuries.

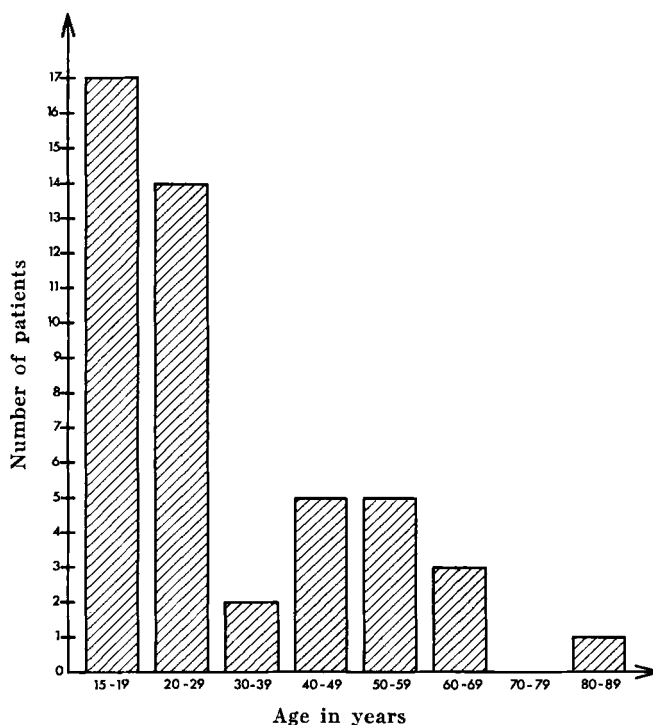


Figure 1. Age distribution of 47 patients operated upon for fracture of the femoral shaft by the method of Rush.

Eighteen fractures were treated by acute surgery, i.e. within the first 48 hours, whereas 20 patients had the operation 2-7 days after the accident and 10 more than 7 days after.

On the whole, the operations were performed according to the instructions given in Rush's atlas (1955).

For all the osteosyntheses we used Vitallium® pins of the dimensions 1/4 inch and 3/16 inch, corresponding to Rush pins No. 1 and No. 2. All the operations were carried out with the aid of an X-ray TV equipment. One 1/4-inch pin, driven in

Table 1. Distribution of types and sites of fracture in the femoral shaft in 48 Rush-pinned cases.

	Transverse	Oblique	Comminuted	Total
Proximal third	10	4	1	15
Middle third	14	8	3	25
Distal third	2	5	1	8
Total	26	17	5	48

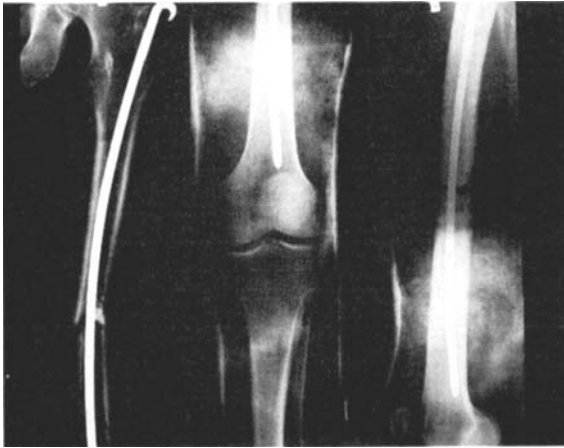


Figure 2. Osteosynthesis of a mid-shaft fracture using one pin.

from the greater trochanter to the lateral femoral condyle, afforded sufficient fixation in the majority of cases (Figure 2). However, the distal fractures were further fixed by a 3/16-inch pin inserted from below through the medial femoral condyle (Figure 3), or else they were treated by two 3/16-inch pins driven in through the medial and lateral femoral condyles. In 3 instances the procedure was supplemented by circular wires. In 26 of the earliest cases the reduction was closed and up to 30 kg traction was applied. We have now abandoned this method in favour of semi-closed reduction, meaning that through an approx. 5 cm long anterolateral incision at the level of the fracture, without exposing it, the reduction may be assisted



Figure 3. Osteosynthesis of a fracture through the distal third of the femoral shaft using two pins.

by a finger or two on the fracture, and only a negligible traction is now needed. It was only in a few cases that the fracture had to be exposed during the reduction.

Up to 1966 most patients were supplied with a plaster cast postoperatively, in most cases a hip cast for 6 weeks and thereafter a circular foot-lower leg-thigh cast for another 6 weeks, but after 1966 no plaster cast has been applied. 26 out of the 48 fractures were not put in plaster. In these cases the patients were instead positioned flat in the bed with an abduction splint between their legs, as recommended by Palmer (1961) and ambulated, with 2 English canes without weight-bearing on the operated leg, an average of 4 weeks after the operation. Weight bearing was not allowed until the fracture had healed, clinically and radiologically, and the patient could stand on the leg without feeling pain.

Anticoagulant medication was not used routinely, but all patients but four had prophylactic penicillin and streptomycin.

RESULTS

Primary Results

Serious postoperative complications did not occur. The primary mortality was nil. There was one case of superficial wound infection, but no deep infections, and no thrombo-embolic complications were recorded. The average duration of the stay in hospital is listed in Table 2.

Table 2. Mean duration of stay in hospital following dynamic intramedullary osteosynthesis in 47 cases of fractures of the femoral shaft. Standard deviation in parentheses.

	No. of patients	Days
Femoral fracture only	26	71 (27-185)
Multiple injuries	21	76 (28-169)

In a case of a fracture affecting the distal third of the femoral shaft treated by two 3/16-inch pins from below, re-operation had to be done 3 months after the primary osteosynthesis to drive in the medial pin which had got displaced 4 cm distally. One month later radiological union had been achieved. In another case a 30° rotation defect had to be corrected by a closed reduction two days after operation with a 1/4-inch pin *in situ*. Apart from these two cases no re-operations were carried out before removing the pins.

Out of the 48 operated fractures 45 were followed until primary union.

One patient with a pathological fracture died of her primary, malignant disease before the fracture had united. Another patient was

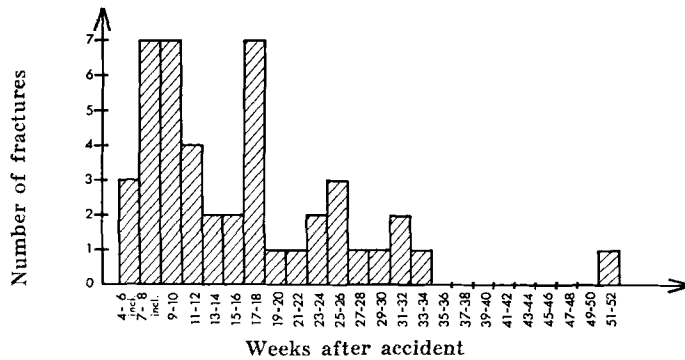


Figure 4. Healing times in 45 cases of Rush-pinned fractures of the femoral shaft.

transferred to a hospital abroad where the pin was removed a couple of weeks after the osteosynthesis, as it was believed that the fracture fixation was not sufficiently stable. The treatment was changed to wire traction until the fracture had united. Yet another patient who was transferred abroad before the fracture had united could not be traced.

The healing times are shown in Figure 4. In all cases the union was confirmed clinically as well as radiologically. Two fractures did not unite until after the 32nd week. All had united spontaneously before the end of the 52nd week.

Follow-up

41 patients with 42 fractures were seen at follow-up 13 months to 8 years after the operation. The average follow-up period was 5 years. Six patients were not seen, 2 having died and 4, all residing abroad, being untraceable.

Out of the followed patients 5 were women, one with fractures of both femoral shafts, and 36 were men.

At follow-up the osteosynthesis material had been removed in 29 out of the 42 cases—as a rule because of pain around the head of the pin.

In 30 cases the period away from work could be analysed. In Figure 5 it is related to whether the patients had isolated femoral fracture or multiple injuries.

One patient had not yet started working 13 months after the operation. One patient obtained disablement pension because of chronic

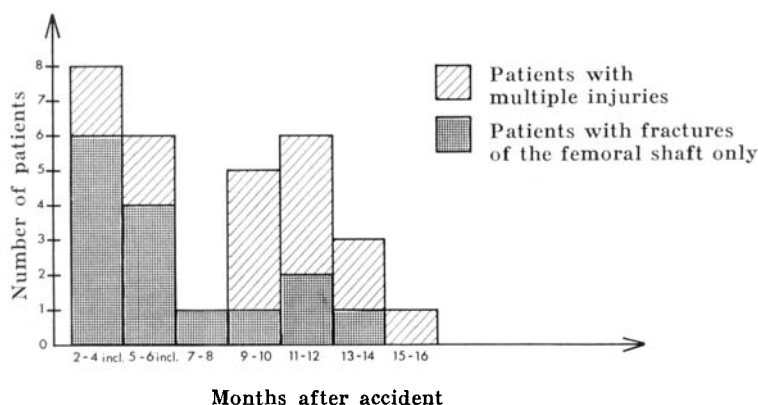


Figure 5. Period away from work for 30 patients operated upon for fracture of the femoral shaft by the method of Rush.

alcoholism shortly after being discharged. One patient, with fracture of both femora and of both lower legs, was awarded full disablement pension after the accident. One patient with a fracture of the femur and of the contralateral lower leg had applied for old age pension before the usual time. One patient had changed to lighter work. All the other patients had gone back to their former work.

Objective late sequelae are set out in Table 3. Only a few patients had major sequelae.

The patient who had less than 90° knee flexion had had a stiff knee after an operation for a loose body in the knee 43 years previously.

Table 3. Late sequelae following dynamic intramedullary osteosynthesis of 41 fractures of the femoral shaft.

No.	Atrophy of thigh		Shortening		Angulation		External rotation	Extension defect in knee joint
	≤ 2 cm	> 2 cm	≤ 2 cm	> 2 cm	≤ 15°	> 15°	0-20°	0-10°
	8	4	5	1	3	1	4	2
No.	Flexion in knee joint	Restricted mobility in hip and ankle joint		Lateral instability in knee joint		Tendency to oedema		Peroneal paresis
	< 90°	< 50 % of normal range		< 10°				
	1	0		2		3		1

Table 4. Ultimate results following dynamic intramedullary osteosynthesis of fractures of the femoral shaft, in 41 cases assessed by Dencker's criteria (1963).

Excellent or good	32
Satisfactory	6
Poor	3

One of the two patients with an extension defect in the knee joint had sustained homolateral fracture of the lateral tibial condyle at the same time as the femoral fracture. Both patients with lateral instability of the knee joint had been subjected to reduction with vigorous traction on the leg.

Radiological follow-up to detect osteoarthritis of the knee and hip joints was not done routinely.

The final result, assessed by Dencker's criteria (1963), is given in Table 4. Two of the three poor results are due to combined injuries. In the third case the osteosynthesis carried technical errors, having been done by a very short, almost straight pin which afforded such unsatisfactory fixation that a couple of days after the operation a 30° rotation defect could be corrected by closed reduction. After a plaster cast had been worn for 6 months the fracture had united clinically with 15° varus deformity and 15° recurvation. At follow-up this patient had pain in the knee on exertion and a walking distance of less than 1 km. There was a 10° extension defect in the knee joint. Radiography revealed signs of osteoarthritis in the knee. The patient had been re-educated for a sedentary job.

DISCUSSION

The presupposition for obtaining a successful result of dynamic intramedullary osteosynthesis in fractures of the femoral shaft is that the pin is sufficiently long and that in the course of the operation it is made to curve in a way which affords a three-point fixation. The medially convex curvature of the flexible pin in the medullary cavity opposes the femoral adductors which would otherwise displace the fracture into varus, and the fairly solid contact of the pin with the cortical bone at both ends secures rotation. However, Palmer (1961) has warned against too great confidence in the dynamic principle of the method, although he appreciates that it is easy to handle. He recommends Rush pinning as a sensible way out, if Küntscher nailing cannot

be applied because of too narrow a medullary cavity. On the basis of their experience of Rush pinning in 14 femoral fractures, Barfod & Ohlsen (1961) recommend that the osteosynthesis always be performed by 2 pins on the grounds that if a single pin is to keep the fracture stable, it must be curved so much that it can only with difficulty be eased over the site of the fracture. We have seldom had any difficulty in making a heavily curved pin pass the site of the fracture. On the other hand, it has proved difficult, and often impossible, to make a pin with little curvature pick its way down into the femoral shaft after correct insertion anterolaterally into the trochanter. In most cases of fracture affecting the proximal two-thirds of the femur we have managed with one 1/4-inch pin, whereas fractures of the distal third were usually treated by 2 pins.

The original Rush pin is of stainless steel. We used Vitallium® pins with rounded end, dimensioned like Rush pins Nos. 1 and 2. There was no case of secondary deformation or breakage of the pin indicating metal fatigue.

Rush (1968) published a material of 211 femoral fractures treated by his method. The infection rate had been 1–2 per cent, the rate of non-union less than 1 per cent, and the average healing time 5–6 months. This is not essentially different from our results. We had no major infection or non-union, and the average healing time was just over 16 weeks. The low infection rate in both series is particularly worthy of note and must be ascribed to the relatively slight operative trauma that the method involves. In this connection it is of the utmost importance that a wide exposure of the fracture site be avoided and that the pin is of a dimension which causes but little damage to the medullary cavity and never gets stuck in the isthmus during its insertion. We have not had any infection problems since we switched over to semi-closed reduction. Since we abandoned the somewhat rough closed reduction with vigorous traction on the leg, we have not seen lateral instability of the knee joint at follow-up.

Prophylactic antibiotic medication was used as a routine in our material, but not in the one submitted by Rush.

While Küntscher nailing is suited only for transverse fractures or slightly oblique fractures of the middle third of the shaft (Palmer 1957), and while plating is not particularly suited for fractures of the distal third, because it may damage the extensor apparatus of the knee, Rush pinning, using 1 or 2 pins, is well suited for the treatment of fractures at any level in the femoral shaft. We have used it pre-

ferably for transverse fractures and slightly oblique and slightly comminuted fractures, whereas we have employed wire traction for steep spiral fractures, severely comminuted fractures, and double fractures.

We have abandoned postoperative plaster casts. This has facilitated post-operative treatment, in particular the training of joint functions. This alteration in post-operative treatment does not appear to have influenced the ultimate results.

CONCLUSION

Dynamic intramedullary osteosynthesis, as advocated by Rush, is a gentle treatment of fractures affecting the femoral shaft. In 48 operated cases we have had no complications, in particular no deep infections. When the principles of the method, as set out in Rush's atlas (1955) are observed, the fixation is sufficiently stable to secure primary union in a satisfactory position, and thereby a good ultimate result.

SUMMARY

Forty-seven patients with 48 fractures of the femoral shaft were treated by operation using modified Rush pinning. 40 fractures were closed and 8 were open. 44 of the fractures were sustained in road accidents. 18 fractures were treated by acute operation. No serious postoperative complications occurred—in particular no deep infections. 45 fractures were followed until primary union which occurred in an average of 16 weeks. Two fractures had not united at 32 weeks. All fractures had united spontaneously within 52 weeks. 41 patients with 42 fractures were seen at follow-up after an average period of 5 years. The ultimate results, assessed by Dencker's criteria, were as follows: 32 excellent or good, 6 satisfactory, and 3 poor. Two of the 3 poor results were found in patients with multiple injuries. In the third case insufficient fixation had resulted in delayed union and deformity. If the principles of the method are observed, the fixation has proved reliable, and no external fixation has been required.

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