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Kevin Parfait Bienvenu Bouhelo-pam
1. Department of Orthopaedic surgery and Traumatology, University Hospital of Brazzaville, Congo
2. Faculty of Health Sciences, Marien N'GOUABI University, Congo

Arnauld Sledje Wilfrid Bilongo-bouyou
1. Department of Orthopaedic surgery and Traumatology, University Hospital of Brazzaville, Congo
2. Faculty of Health Sciences, Marien N'GOUABI University, Congo

Paul Yèlai Ikounga
1. Department of Orthopaedic surgery and Traumatology, University Hospital of Brazzaville, Congo
2. Faculty of Health Sciences, Marien N'GOUABI University, Congo

Marc Fabrice Nkoua
Department of Orthopaedic surgery and Traumatology, University Hospital of Brazzaville, Congo

Richard Ngobo
Department of Orthopaedic surgery and Traumatology, University Hospital of Brazzaville, Congo

Moïse Radam Ellah
Department of Orthopaedic surgery and Traumatology, University Hospital of Brazzaville, Congo

Marius Monka
1. Department of Orthopaedic surgery and Traumatology, University Hospital of Brazzaville, Congo
2. Faculty of Health Sciences, Marien N'GOUABI University, Congo

Corresponding Author:
Kevin Parfait Bienvenu Bouhelo-pam
1. Department of Orthopaedic surgery and Traumatology, University Hospital of Brazzaville, Congo
2. Faculty of Health Sciences, Marien N'GOUABI University, Congo

Osteosynthesis of femoral shaft fractures at Brazzaville University Hospital: Nail versus screw plate

Kevin Parfait Bienvenu Bouhelo-pam, Arnauld Sledje Wilfrid Bilongo-bouyou, Paul Yèlai Ikounga, Marc Fabrice Nkoua, Richard Ngobo, Moïse Radam Ellah and Marius Monka

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Abstract
Introduction: Fractures of the femoral shaft are serious traumatic conditions frequently encountered in hospital. The aim of our study was to compare two different surgical techniques for their treatment: anterograde centromedullary nail and compression plate.
Materials and Methods: From September 2018 to August 2023, 208 femoral shaft fractures were recorded out of 3236 hospitalizations, i.e. 6.42%. Two groups of patients were selected: group 1 with 122 patients treated with anterograde nails and group 2 with 49 patients treated with screw plates. These two groups were compared according to fracture type (AO/OTA), time to surgery, follow-up and consolidation, and complications. Data were processed in Excel and SPSS 19.0 with significant p-value when less than or equal to 0.05.
Results: The time to surgery was 29.11±1.13 days for group 1 and 27.74±2.41 days for group 2 (p=0.0005). Most of the patients were treated in the middle third (78.68% in group 1 and 65.3% in group 2). Bone consolidation was achieved at 4.91±0.52 months for group 1 and 5.72±0.34 months for group 2 (p=0.000007). The main complication was limb length inequality in 6 cases (4.92%) in group 1 and 9 cases (18.36%) in group 2.
Discussion: Although our study was monocentric, it was carried out in the largest hospital in the country. The middle third was the most frequent site for us, as it was for most authors. This is the area most exposed to high-energy trauma and torsional forces. Complications are due to delayed surgery and unfavourable operating conditions.
Conclusion: Comparing the two main surgical techniques, the results are better for the anterograde femoral centromedullary nail. The choice of implant depends on the type of fracture, the surgeon's habits and the implants available.

Keywords: Fracture, femoral shaft, radiography, osteosynthesis, Brazzaville

Introduction
Fractures of the femoral shaft are a major public health problem in the world in general and in low- income countries in particular. Its average incidence is estimated at around 10/100,000 people, and varies according to gender and age [1]. Its frequency is due to the growing increase in road traffic accidents and accidents involving firearms [2]. It is defined as a break in the continuity of the femoral bone between a horizontal line 2.5 cm below the lesser trochanter and a horizontal line 5 cm above the knee joint space [2]. Treatment is exclusively surgical in adults because of the large muscle mass around the femoral shaft [3] and the high risk of secondary displacement caused by the fracture. Several surgical techniques have been described for its treatment, but anterograde centromedullary nailing remains the osteosynthesis technique of choice [4]. This is due to its high stability, the possibility of locking the implant [5] and advances in reaming the shaft, which allows the implant to be better adapted to the bone anatomy [4]. The compression plate is another therapeutic method that is also indicated [6], allowing anatomical reduction of the fracture site. Ideally, surgical fixation should be performed within the first 10 hours following the accident [7, 8]. After 24 hours, there is a risk of post-traumatic fat embolism syndrome, which is the most serious complication and is life-threatening [9].

The aim of our study was to establish a comparison between the screw plate and the anterograde centromedullary nail in the treatment of femoral shaft fractures.

Materials and Methods

Our retrospective cross-sectional series concerned patients hospitalized for femoral shaft fractures in the Traumatology-Orthopaedics Department of Brazzaville University Hospital, during the period from September 2018 to August 2023. Among the 3,236 patients hospitalized during this period, femoral shaft fractures were recorded in 208 patients, or 6.42% of all hospitalizations. A femoral shaft fracture was considered to have occurred when the fracture line was located between 2.5 cm below the lesser trochanter and 5 cm above the knee joint line. Only patients over 17 years of age who had undergone surgery using an anterograde centromedullary nail or a compression screw plate were included. Patients excluded were those with a history of homolateral femoral shaft fracture, those with no pre- or post-operative radiological images, and those who had undergone simultaneous bilateral osteosynthesis. Two patients who had both femurs operated on at the same time were removed. Bone lesions were classified radiographically according to AO / OTA (Association for osteosynthesis / Orthopedic Trauma Association) [10]. Road traffic accidents were the most common aetiology in 85.09% of cases (Table I). The median age was 33 (range 17-82), with a peak in the 20-39 age group (59.61%). Males predominated in 77.41% of cases. The choice of implants was made by the surgeons on the basis of their personal practices and the type of lesion. Two groups of patients were identified:

- Group 1 of patients treated with anterograde femoral nailing: 122 patients. In this group, patients underwent locked anterograde centromedullary nailing (Sharma). The nail, as described by Gerhardt Küntscher in 1940 at the German Surgical Congress [11], was inserted after progressive reaming of the shaft. The nail was introduced at the top of the greater trochanter and then guided through the femoral medullary canal towards the distal metaphyseal region without crossing the femorotibial joint space. An image intensifier was used during the operation to monitor fracture reduction and stabilisation, and to assess implant positioning. Static or dynamic locking of the nail with lateromedial screws was performed according to the technique described by Grosse, Lafforgue and Kempf in 1978 [5]. Locking was static in 83 patients (68.03%) and dynamic in 39 patients (40.17%).
- Group 2 of patients treated with a screw-retained compression plate: 49 patients. The screw- retained plate was a straight compression plate (DCP) placed after open reduction of the fracture and screwed in with 4.5 mm cortical screws on either side of the fracture.

All patients were operated on on an ordinary surgical table, in dorsal recumbency with a log under the buttock of the operated limb. Fracture reduction was achieved by external manoeuvres performed by a surgeon's assistant. Patients were admitted to hospital two to five days after surgery. They were followed up for an average of one year, at three, six and 12 weeks, then at 6 months and 1 year. Preoperative radiographs of the thigh in front and in profile were used for surgical planning and implant selection. Post-operative radiographs were used to assess the quality of the reduction, the quality of stabilization, bone consolidation and complications. The groups of patients were compared in terms of hospitalization and surgical time, radiological stage of the fracture, operating time, bleeding, time to bone consolidation, functional assessment, quality of reduction, and post-operative complications. Consolidation was defined as the absence of pain on resumption of weight-bearing walking, and the presence of a radiological callus with no signs of infection. Functional recovery was considered to be the resumption of walking and the recovery of knee and hip range of motion homolateral to the operated thigh. Quadricipital amyotrophy was defined as a decrease in cm in the circumference between the operated thigh and the opposite thigh, 10 cm above the patella. All patients underwent a standard rehabilitation protocol immediately post-operatively when standing and/or weight-bearing was authorised. Data were processed using an Excel spreadsheet and SPSS version 19.0 software. Means were compared using the t-student test when the distribution was normal and the Mann-Whitney test when the distribution was abnormal. The Chi² test was used to check the independence of two characteristics in the two populations considered: group A and group B. The significance threshold was p less than or equal to 0.05.

Results

Epidemiology

We studied 171 patients during the study period.

In group 1 of 122 patients, the mean hospital stay was 41.34±2.07 days (Range 21 to 207 days), and the mean time to surgery was 29.11±1.13 days (range 10 to 200 days). In group 2 (49 patients), the mean hospital stay was 46.18±3.38 days (Range 17 to 301 days), while the mean time to surgery was 27.74±2.41 days (Range 6 to 246 days). The differences were significant for hospitalisation time (P=0.00003) and surgery time (p=0.0005) respectively (Table II).

Lesion

The fracture site was predominantly the middle third, with 96 cases (78.68%) in group 1 and 32 cases (65.3%) in group 2. The most common type of fracture was type A3 in group 1 and type C3 in group 2 (Figure 1). Associated lesions were fractures of other sites in 7 cases (5.74%) in group 1 and in 4 cases (8.16%) in group 2 (Table II).

Therapeutic data

An additional implant was required in 2 patients in group 1 (Steel wire cerclage) and in 6 patients in group 2, including steel wire cerclage in 4 cases, and a screwed blade-plate in 2 cases. Revision surgery for lack of stability was necessary in 1 case in group 1 and in 2 cases in group 2.

Evolution

The mean follow-up time for patients was 9.66±0.74 months (Range 3 to 38 months) for group 1 and 8.97±1.01 months (range 2 to 41 months) with a significant difference (p=0.00001). Bone consolidation was achieved within a mean time of 4.91±0.52 months (Range 3 to 15 months) for group 1 and 5.72±0.34 months (Range 3 to 18 months) for group 2, with a significant difference (p=0.000007) (Table II). 107 patients (87.7%) in group 1 and 34 patients (69.38%) in group 2 achieved full functional recovery within variable timeframes (p=0.06).

In group 1, complications were dominated by inequality of lower limb length (ILMI) in 6 cases (4.92%) and thromboembolism in 5 cases (4.1%). In Group 2, the predominant complications were ILMI in 9 cases (18.36%)

and surgical site infection in 8 cases (16.32%) (Table II). At one year follow-up, quadricipital amyotrophy was found in six patients (4.92%) in group 1 and in nine patients (18.36%) in group 2. Knee stiffness was noted in 13 patients (10.65%) in group 1 and 11 patients (22.45%) in group 2 (p=0.81), with secondary functional recovery in 7 patients (5.73%) in group 1 and 5 patients (10.2%) in group 2 (p=0.002). One death (0.82%) occurred in group 1.

Discussion

Fractures of the shaft of the femur are common in our series. They rank 19e of all fractures, i.e. approximately 0.9% [12]. They accounted for 36.2% in the series by Aza M *et al.* [13] and 23.9% in that of Diallo S *et al.* [6]. The frequency (6.42%) is underestimated in our study, as we considered only the records of patients hospitalized at our facility. Although the monocentric nature of our study is limiting, it was conducted in the largest centre in the country's health pyramid. This is the main site for the management of traumatic pathologies, because of the specialist staff and equipment available. Patients with bilateral osteosynthesis were removed to avoid bias in the comparison of data.

The majority of our patients were aged between 20 and 39 years (59.61%). For most authors, the patients were young [14, 15]. They represent the most active social stratum and therefore the most exposed.

The male sex was the most represented in our series. This may be explained by the greater exposure of men to violent trauma and accidents. A predominance of men has been clearly reported before the age of 35, with a M/F sex ratio of 5.5 [16]. Male predominance has also been found by Weiss *et al.*, with a frequency of 92% [17]. Women are thought to have less capacity to increase the transverse diameter of their femur, with a consequent lower resistance to trauma [18, 19]. Road traffic accidents were the most frequent aetiology in our case.

The middle third was the most frequently encountered site. The middle third is more exposed to high- energy trauma, particularly torsional forces [20]. Deepak *et al.* found a frequency of 56.66% [21].

In developing countries, the choice of treatment is often influenced by a lack of financial resources [22]. In our country, as in other low-income countries, the choice of treatment method has sometimes been guided by the availability of low-cost implants. The nail certainly offers better therapeutic results in terms of consolidation and fewer complications. This explains the differences with series in developed countries, where these fractures are treated immediately by closed-focus nailing. There are also problems related to the periodic lack of surgical infrastructure, namely the orthopaedic table, the image intensifier, sterilization, ancillary equipment and implant sets. This equipment needs to be renewed and maintained, which is not always done in these facilities. The lack of qualified human resources can also explain the therapeutic choices made. Screw plates are less restrictive and more easily renewable.

Functional results were satisfactory overall, and better in patients operated on using a nail (Group 1). We recommend surgery using an anterograde centromedullary nail, but the choice depends above all on the type of lesion, the operating conditions, the availability of the implant and the skill of the surgeon who is called upon to monitor his patient. Difficulties in functional recovery may be explained by the delayed timing of surgery and by the fact that patients were immobilised by temporary transosseous traction. Complications were notable in our series. Fracture comminution, the distal nature of the fracture, the patient's young age, installation on a standard table and technical errors are factors that favour complications such as ILMI, malunion and pseudarthrosis [23-25]. Knee joint stiffness, which is frequently encountered, has been recovered in some patients by preoperative joint mobilization after anaesthesia. Post-operative functional re-education was systematic for all patients. It helps to improve joint mobility and strengthen muscles [26, 27]. However, it should be started as soon as possible after the operation and continued for 4 to 6 months. Full weight-bearing of the pelvic limb is authorized after radiological consolidation at around 90 days. There was one fatality in group 1. The patient had a prolonged operation and died on the first day after the operation from anaemic shock.

Table 1: General presentation of the study population.

	Number (N=208)	Percentage
Gender		
Men	161	77.41%
Women	47	22.59%
Age groups		
17 - 19	13	6.25%
20 - 39	124	59.61%
40 - 59	45	21.64%
60 - 79	22	10.58%
80 - 99	4	1.92%
Causes		
Traffic accidents	177	85.09%
High fall	18	8.66%
Sport	4	1.93%
Pathological	9	4.32%
Profession		
Civil servant	34	16.34%
Retailer	17	8.17%
Military	9	4.33%
Pupil / student	28	13.47%
No	120	57.69%
Treatment		
Anterograde medullary nail	122	58.65%
Compression screw plate	49	23.56%

External fixer	11	5.29%
95° / 120° plate blade	20	9.62%
Condylar plate	2	0.96%
Retrograde medullary nail	1	0.48%
Not operated	3	1.44%

Table 2: Delays, associated lesions and complications by group

	Group 1 (N=122)	Group 2 (N=49)	Value of p
Time to hospital	41.34±2.07 days	46.18±3.38 days	0.00003
Time to surgery	29.11±1.13 days	27.74±2.41 days	0.0005
Follow-up time	9.66±0.74 months	8.97±1.01 months	0.00001
Consolidation period	4.91±0.52 months	5.72±0.34 months	0.000007
Fracture site			
Upper third	7 (5.74%)	5 (10.2%)	NS
Average third	96 (78.68%)	32 (65.3%)	NS
Lower third	15 (12.3%)	9 (18.38%)	NS
Multifocal	4 (3.28%)	3 (6.12%)	NS
Associated lesions			
Skin opening	3 (2.46%)	0	
Fractures in other locations	7 (5.74%)	4 (8.16%)	NS
Vascular lesion	0	1 (2.04%)	NS
Nerve damage	0	1 (2.04%)	NS
Head / facial trauma	4 (3.28%)	2 (4.08%)	NS
Abdominal trauma	2 (1.64%)	1 (2.04%)	NS
Thoracic trauma	2 (1.64%)	1 (2.04%)	NS
Evolving complications			
Surgical site infection	3 (2.46%)	8 (16.32%)	0,02
Anaemic shock	1 (0.82%)	3 (6.12%)	NS
Thrombo-embolism	5 (4.1%)	1 (2.04%)	NS
Secondary movement	1 (0.82%)	2 (4.08%)	NS
ILMI*	6 (4.92%)	9 (18.36%)	0.0009
Vicious callus	3 (2.46%)	2 (4.08%)	NS
Pseudarthrosis	3 (2.46%)	5 (10.2%)	NS
Deaths	1 (0.82%)	0	NS

*ILMI: inequality of length of the lower limb
*NS: not significant

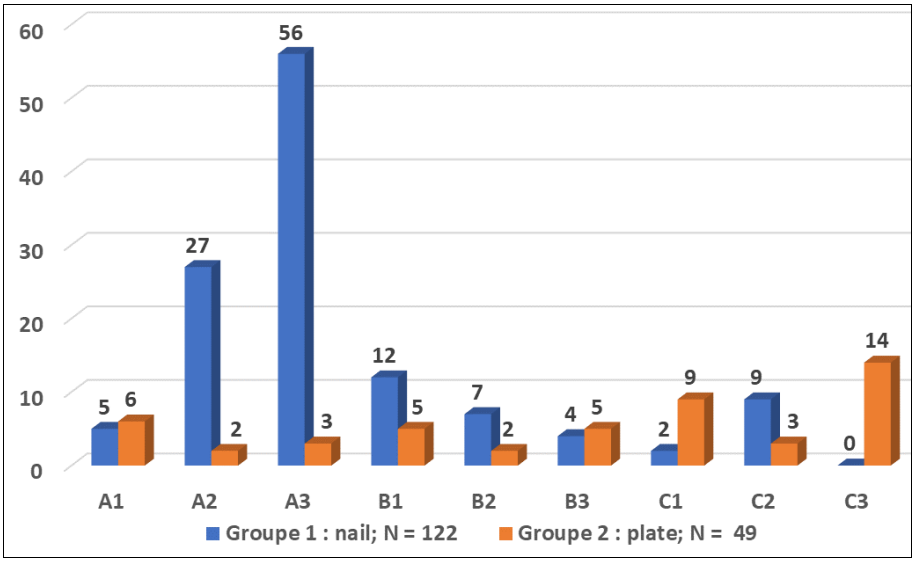

Fig 1: Distribution of patient groups according to fracture stage (AO /OTA)

Fig 2: Stabilisation of an old B3 femur fracture using a statically locked anterograde nail in a 37- year-old patient

Fig 3: 43-year-old patient with radiological bone consolidation and significant callus of a femoral shaft fracture stabilised by an anterograde nail

Fig 4: 27-year-old female femoral shaft fracture stabilised by compression plate, with extensive callus and radiological consolidation

Conclusion

Fracture of the femoral diaphysis is a frequent traumatic pathology in our context. This frequency is tending to increase due to demographic growth, the frequency of road traffic accidents and accidents involving firearms. The aim of our study was to compare the therapeutic and evolutionary results after surgery using an anterograde centromedullary nail or a straight screw plate with compression. Although the results are better for the anterograde femoral nail, the advantages of each implant remain valid depending on the local situation. It is important that the choice of treatment is discussed, taking all the parameters into account. Delays in treatment increase the frequency of complications. A prospective multicentre study on a national scale would provide a clearer picture of the indicators to be monitored.

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