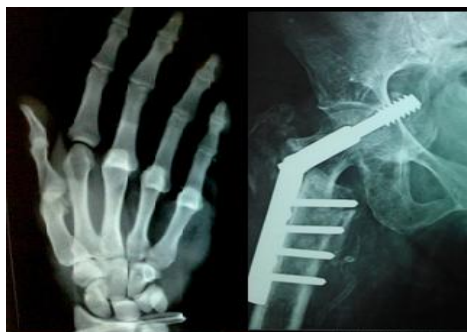




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Mechanical failures of osteosynthesis in Cotonou

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Abstract

Introduction: Mechanical failures of osteosynthesis encompass permanent deformations, breakage of the osteosynthesis implant, and/or loosening of the fixation. The aim of this study was to analyze cases of mechanical failure of osteosynthesis in our practice to identify the causes and thus prevent them.

Material and Method: This retrospective study included all patients treated surgically for a fracture between January 2007 and December 2014, who experienced a mechanical failure of their osteosynthesis. Patients had to have complete clinical and radiological records. Septic complications, arthroplasties, external fixators, isolated screw/pins fixation were excluded.

Results: 28 cases of mechanical failure of osteosynthesis were identified, representing an annual incidence of 3.5. The average age was 46.18 years (25-73 years). There was a male predominance with a sex ratio of 2.11. Failures occurred in the osteosynthesis of 4 simple fractures (14.3%) and 24 complex or comminuted fractures (85.7%). They primarily affected the lower limb (17 cases, 60.71%), and most commonly the femur (15 cases, 53.57%), followed by the humerus (5 cases, 17.86%). There were 13 plate breakage, 3 plate bending, 6 plate removal, 4 nail breakage, and 2 isolated screw loosening. Plate breakage primarily occurred in younger patients (under 40 years), and plate removal due to screw loosening occurred in older patients (over 55 years). The identified causes included nonunion (17 cases), technical error (5 cases), and premature weight-bearing (6 cases). Bone healing was achieved in 5 cases after simple immobilization, and in 4 cases after additional immobilization and restricted weight-bearing. Re-operation was performed in 19 cases.

Conclusion: The causes of mechanical failure of osteosynthesis are multifactorial, involving the patient, the fracture, the quality of the implant, and the quality of the osteosynthesis procedure itself, which is directly attributable to the surgeon. Taking these factors into account would help reduce this complication.

Keywords: Osteosynthesis, failure, implant, femur, screw-plate fixation

Introduction

Osteosynthesis is the treatment of choice for fractures today ^[1]. It involves stabilizing the fracture site using metal implants ^[2]. Osteosynthesis carries the risk of mechanical complications, among other potential issues. These mechanical complications, or failures of the osteosynthesis procedure, can be defined as permanent deformation, fracture or breakage of the osteosynthesis material, and/or loosening of the implant fixation [2-6]. Manufacturing defects, which were previously a common cause of these problems, are now less frequently observed due to improvements in manufacturing techniques and are virtually nonexistent today ^[7, 8]. Along with postoperative infection, mechanical failure is a major concern for orthopedic surgeons.

The aim of this study was to analyze cases of mechanical failure of osteosynthesis in our practice to identify the underlying causes and thus develop strategies for their prevention.

Materials and Methods

Our study was conducted at the Department of Trauma, Orthopedics and Reconstructive Surgery of the National Teaching Hospital Hubert Koutoukou Maga (CNHU-HKM) in Cotonou. It was a retrospective, descriptive, and analytical study covering the period from January 2007 to December 2014. It included all patients who underwent surgical treatment for a fracture during this period and who subsequently experienced mechanical failure of their

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osteosynthesis device. Patients had to have complete clinical and radiological records and be followed up for at least one year. Septic complications, arthroplasties, external fixators, isolated screw fixation, and pin fixation were excluded from this study. The study was based on data extracted from hospital records and the medical files of the selected patients. Over eight years, 1062 osteosyntheses procedures (excluding external fixators, pins, and isolated screw fixation) were performed in the department, of which 205 involved the upper limb and 857 the lower limb. These included 364 intramedullary nailing procedures (245 femoral nails, 113 tibial nails, 6 humeral nails); 480 diaphyseal plates (160 tibial plates, 94 femoral plates, 69 humeral plates); and 207 metaphyseal plates (158 Condylar Blade Plates 95°, 28 Dynamic Hip Screw plates, 16 Dynamic Condylar Screw plates). The nails were of the Kuntcher nail for simple diaphyseal fractures of the mid-shaft and locking nail for other fractures. The plates used were AO-type.

Results

Out of 1062 osteosynthesis procedures, 28 cases of mechanical failure of the osteosynthesis were recorded, representing a frequency of 2.64% and an annual incidence of 3.5. The average age of our patients was 46.18 years, with a range from 25 to 73 years; patients aged 40-50 years were most affected, with 12 cases (42.9%), and only 7 patients (25%) were over 50 years old. There was a male predominance, with 19 men and 9 women, giving a sex ratio of 2.11. Regarding occupation, manual laborers were the most frequent, with 14 cases (50%), followed by office workers (12 cases, 42.9%), and 2 patients (7.1%) were retired. Osteopenia was identified as a pre-existing condition in 7 patients (25%). The osteosynthesis procedures involved 4 simple fractures (14.3%) and 24 complex or comminuted fractures (85.7%). The average time from injury to treatment was 15.14 days, with a range from 2 to 60 days. Twelve patients (42.9%) were treated within the first 7 days, 12 patients in 8-29 days and 4 patients (14.3%) after 30 days. The lower limb was more frequently affected by osteosynthesis failure (17 cases, 60.71%) than the upper limb (11 cases, 39.28%). The femur was the most common site of these failures, with 15 cases (53.57%), followed by the humerus and clavicle with 5 cases (17.86%) and 3 cases (10.71%) respectively. Furthermore, the radius, ulna, and tibia were affected in 2 cases (7.1%), 1 case (3.6%), and 2 cases (7.1%), respectively, as shown in Figure 1. Plate breakage (Figure 3) was the most frequently observed failure, occurring in 13 cases (46.4%), while isolated screw loosening was the least frequent, occurring in 2 cases (7.1%). It should be noted that screw loosening was also associated with plate loosening, breakage, or plate bending (Figure 2) in 14 cases (Table I). Plate breakage primarily occurred in patients under 40 years of age (9/14 cases), and plate removal due to screw loosening primarily occurred in patients over 55 years of age (5/6 cases). The average time to full weight-bearing was 93.37 days. Early weight-bearing (without medical authorization) occurred in 6 patients (21.42%). The main etiological factor was nonunion, found in 17 cases (60.71%). Other etiological factors included technical error in 5 cases (17.86%) and early weight-bearing in 6 cases (21.42%). Osteoporosis was associated with these factors in 7 cases. In 5 cases (17.86%), failure of the osteosynthesis implant led to fracture healing (Figure 3) after simple unloading, with subsequent removal of the osteosynthesis device. Healing was achieved in 4 cases (14.29%) after additional immobilization and unloading of the limb. In 19

cases (67.86%), failure of the osteosynthesis device necessitated revision surgery after removal of the initial osteosynthesis device, treatment of the nonunion, and bone grafting. The fixation implants used after revision surgery consisted of screw plates (9 cases, or 47.37%), condylar Blade Plates 95° (5 cases, or 26.32%), Dynamic Hip Screw plates (2 cases, or 10.53%), and locking nails (3 cases, or 15.79%).

Discussion

The failure rate in our series was 2.64%. In the literature, Moyikoua in Congo reported a 7% failure rate for osteosynthesis in the lower limb [4], and Essakdi in Morocco reported 6 to 18% mechanical complications with femoral plate fixation [5]. Our rate considers not only lower limb injuries, which are the most frequent (60.71% in our series), but also upper limb injuries, which are less common, thus lowering the overall failure rate. The etiological factors identified in our series are of several kinds and sometimes interrelated.

Patient-related factors

The average age of our patients was 46.18 years, and 7 patients (25%) were over 50 years old. Advanced age and osteoporosis often go hand in hand; it is easy to understand the tendency for screw loosening and plate removal in elderly patients, as seen in our series (5/6 cases). This was confirmed by the results of Essakdi [5], Gogoua [3], Morvan [9], and Arlettaz [10]. This can be explained by the thinning of the cortical bone due to osteoporosis or osteopenia. The use of locking plate systems, which offer better stability in porous bone, could help prevent these complications [6], although they also have their limitations [11, 12]. However, these locking plate systems are unfortunately expensive and not readily available in our practice. Delaying full weight-bearing and/or rehabilitation is therefore an alternative to preventing failures in elderly patients. Manual laborers constituted the largest group in our series, representing 50% of the cases; Their low level of education and the desire to resume their professional activities early led 6 patients (21.42%) to prematurely bear weight on the affected limb (without medical authorization), causing failure of the fixation device, most often in cases of complex fractures. This premature weight-bearing was also cited as a contributing factor in the literature by Gogoua [3], Moyikoua [4], Batchom [13], and Essakdi [5]. Early weight-bearing on a fracture site of the lower limb that has been surgically stabilized but not yet fully healed can lead to bending or fatigue fracture of the implant. This bending or fracture is more likely to occur when the fracture is complex and the bone fragments are not in good contact; in such cases, all the stress is concentrated on the implant, which will then be more likely to fail.

Factors related to fractures

Fractures were complex or comminuted in 24 cases (85.7%). This rate is higher than those observed by Gogoua and Moyikoua in their series, which were 12% and 54.5% respectively [3, 4].

In Burny's series, the presence of a comminution was the main cause of mechanical failures [7]. Indeed, the presence of a comminution or a diastasis subjects the implant to bending stresses, which expose it to plastic deformation and then to fatigue breakage. For this reason, it is recommended to fill bone defects with corticospontaneous grafts [1, 14].

Nonunion was implicated in 17 cases (60.71%) in our series. It was also implicated in the series of Gogoua [3], Essakdi [5], and Burny [7] with 50%, 54.5%, and 20.9% respectively.

Nonunion would act by the same mechanism as comminution of the fracture site, by increasing the stresses on the implant. The femur was the most common site of these failures with 15 cases (53.6%), followed by the humerus with 5 cases (17.9%). This is also found in Gogoua's series with 46.1% and 19.2% for the femur and humerus respectively [3]. The significant stresses generated by the muscle masses of the thigh and arm during flexion and extension of the leg and forearm could explain this frequency [15]. Furthermore, osteosynthesis of the femur is generally the most common procedure.

Factors related to implants

Mechanical failures of plates (22 cases, including 13 fractures) were more frequent than those of nails (4 fractures). This predominance of mechanical failures in plate fixation compared to nail fixation was also observed by Moyikoua, Tekpa, and Benoit in their studies [4, 16, 17]. Indeed, plate fixation with screws requires precise anatomical reduction and cannot tolerate any inaccuracies [14]. The presence of a gap or even a comminuted fracture subjects the plate to bending stresses [7, 14], which can lead to fatigue and ultimately breakage. Comminution, which was frequent in our series, contributed significantly to these failures. Regarding the nails, these were generally simple intramedullary nails, most often used for simple fractures. Their diameter and length were frequently inadequate, which leads to premature failure due to fatigue. In the studies by Gogoua [3] and Moyikoua [4], nail bending was observed for the same reasons. Therefore, it is essential to use nails whose diameter adequately fills the medullary canal to limit abnormal movement at the fracture site, which is responsible for these failures.

Technique-related factors

This primarily concerns the choice of implant. Indeed, nowadays, diaphyseal fractures should be treated more often with intramedullary nails than with plate fixation [1, 2]. However, it should be noted that until recently, the intramedullary nail was not part of our standard treatment options; diaphyseal fractures were therefore treated with simple nails and often with plate fixation.

Furthermore, factors that can generally contribute to failure include an interfragmentary gap greater than 3 millimeters, and an unstable fixation [18, 19]. For plate fixation, excessive periosteal stripping, repeated drilling, and the use of a drill bit of inappropriate size or with a blunt tip can also be implicated [6, 18]. For nail fixation, an inappropriate length or diameter can quickly lead to migration, angulation, or fracture [4, 20].

Fractures with significant comminution should ideally require bone grafting from the outset [5, 21], which was not often the case in our series. Technique-related factors alone do not explain all failures; however, when combined with other factors, they increase the risk of complications.

Table 1: Distribution of patients according to different types of implant failure

	Number	Percentage
Plate breakage	13	46,4
Plate bending	03	10,7
Plate removal	06	21,4
Nail breakage	04	14,3
Isolated screw loosening	02	7,1
Total	28	100,0

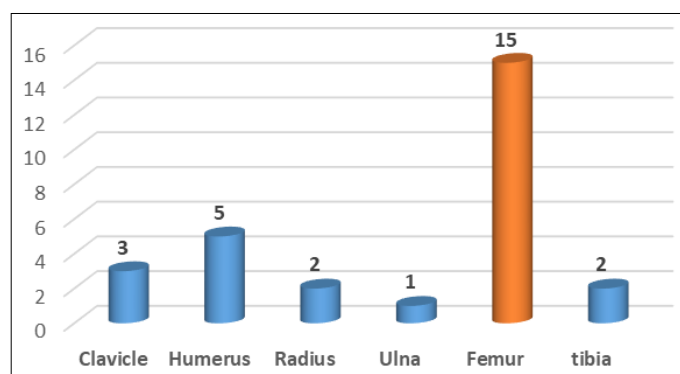


Fig 1: Distribution of failures by location



Fig 2: Bending of dynamic condylar screw plate



Fig 3: Fracture healed despite the screw plate breaking.
~ 19 ~

Conclusion

Mechanical failures of osteosynthesis generally have a multifactorial etiology. Among these factors are the patient, the fracture itself, the quality of the implant, and the quality of the osteosynthesis, which is directly attributable to the surgeon. An almost anatomical reduction of the fracture site, combined with stable fixation, can promote good bone healing, thus reducing the risk of mechanical failure.

Conflicts of interest: None

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