

Osteosynthesis of Proximal Femoral Fractures Using DHS Screw-Plate: Predictive Factors of Mechanical Failures in the Orthopedic Department of Aristide Le Dantec Hospital

Malick Diop^{1*}, Mohamed Daffé¹, Badara Dembélé¹, Mayoro Sow¹, Andre Daniel Sané¹, Charles Bertin Dieme²

¹National Hospital Center Dalal Jamm, Guediawaye, Dakar, Senegal

²National Hospital Center Aristide Le Dantec, Dakar, Senegal

Email: *malickfatydiop@gmail.com

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Abstract

Introduction: The DHS screw-plate remains indicated in our settings. It provides good anatomical and functional results. However, mechanical failures are complications that may arise. **Materials and Methods:** A retrospective, descriptive, and analytical study was conducted over a two-year period (January 2017 to December 2018) at Aristide Le Dantec Hospital. Predictive factors related to the patient, the fracture, and the surgical technique were investigated. **Results:** A total of 110 patients underwent surgery during the study period. Sixty-three (63) cases were included, among which 8 mechanical failures (12.69%) occurred. The average age of patients with mechanical failure was 70 years (range: 45 - 86 years). Pre-fracture autonomy ($p = 0.009$) and a TAD < 20 mm ($p = 0.023$) were considered predictive factors. According to Baumgartner's criteria, the reduction was considered good in 38 patients, among whom 3 experienced failures. Two patients, including one failure, had a frontal PRM between 0.67 and 1 (superior position). One patient had a sagittal PRM between 0.67 and 1 (anterior position) and experienced failure. **Conclusion:** To reduce mechanical failure, the surgical technique must be well-mastered. Fracture reduction should be as anatomical as possible. The TAD should range between 20 and 25 mm.

Keywords

Proximal Femoral, DHS Screw-Plate, Predictive Factors, Mechanical Failure

1. Introduction

Fracture of the proximal femoral is one of the most frequently encountered injuries in trauma care. It often occurs in elderly, osteoporotic individuals following low-energy trauma, thereby affecting both their functional and, more importantly, vital prognosis. The increasing number of such fractures in patients often in poor general condition, bedridden, or with multiple comorbidities remains a major challenge for trauma departments. A multidisciplinary approach to the management of proximal femur fractures is therefore essential [1] [2].

Osteosynthesis using a DHS screw-plate is one of the techniques used in the treatment of proximal femoral fractures and, when stable, allows for early mobilization. However, this technique is not free from complications, including mechanical failures, which are the subject of this study.

2. Objective

To study the predictive factors of mechanical failure in osteosynthesis of femoral proximal fractures treated with DHS screw-plate.

3. Materials and Methods

We conducted a retrospective, descriptive, and analytical study over a two-year period (January 2017 to December 2018) at Aristide Le Dantec Hospital. All patients operated on for a proximal femoral fracture using a DHS screw-plate were included in the study. Patients with incomplete or unusable medical records, as well as those lost to follow-up, were excluded (N = 47).

A total of 63 medical records were analyzed, including 8 cases of mechanical failure.

Data collection was carried out using hospital admission registers, clinical records, and surgical protocols. Data were entered using Sphinx Plus software and analyzed with SPSS version 24.0. The Chi-square test was used to assess correlations (significant if $p \leq 0.05$).

The predictive factors for mechanical failure investigated were:

- **Patient-related factors:** age, sex, consultation delay, pre-fracture autonomy using the Parker Mobility Score (**Table 1**).
- **Fracture-related factors:**
 - **Bone quality**, assessed using Singh's index [3] [4], based on the evaluation of trabecular patterns on frontal radiographs.
 - **Fracture location:** femoral neck, trochanteric, or subtrochanteric region.
- **Surgical technique-related factors:**
 - **Time to surgery**
 - **Reduction quality**, assessed on post-operative radiographs using the Baumgartner method [5] [6], which evaluates two criteria (alignment and displacement) on both frontal and lateral views:

Alignment is defined as a cervico-diaphyseal angle of 120° to 135° on the frontal view, or one comparable to the contralateral side, and an angulation of less than

20° on the lateral view.

Displacement or interfragmentary gap must be less than 4 mm in both views.

Reduction was considered: “**Good**” if both criteria were met, “**Acceptable**” if only one was met and “**Poor**” if neither was met.

- **Position of the cervical screw**, based on:

- **Tip Apex Distance (TAD)**: Sum (in mm) of the distances from the tip of the cervico-cephalic screw to the apex of the femoral head on both frontal (X_{ap}) and lateral (X_{lat}) views. $TAD = X_{ap} + X_{lat}$ [1] [5] [6]
- **Parker Ratio Method (PRM)**: Defined as the ratio $AB/AC \times 100$ on each view: AC = diameter of the femoral head at the equator/ AB = distance from the inferior/posterior (or superior/anterior) pole to the center of the screw crossing line AC (**Figure 1**).

Screw position classification: 0 - 0.33 (inferior/posterior position); 0.34 - 0.66 (central position); 0.67 - 1 (superior/anterior position).

Table 1. The parker score mobility.

| Parker Mobility Score Score 0 - 9 | | |
|-----------------------------------|---|--|
| Able to get about the house | <input type="radio"/> No difficulty (3 points) <input type="radio"/> With help from another person (1 point) | <input type="radio"/> With an aid (2 points) <input type="radio"/> Not at all (0 point) |
| Able to get out of the house | <input type="radio"/> No difficulty (3 points) <input type="radio"/> With help from another person (1 point) | <input type="radio"/> With an aid (2 points) <input type="radio"/> Not at all (0 point) |
| Able to go shopping | <input type="radio"/> No difficulty (3 points) <input type="radio"/> With help from another person (1 point) | <input type="radio"/> With an aid (2 points) <input type="radio"/> Not at all (0 point) |

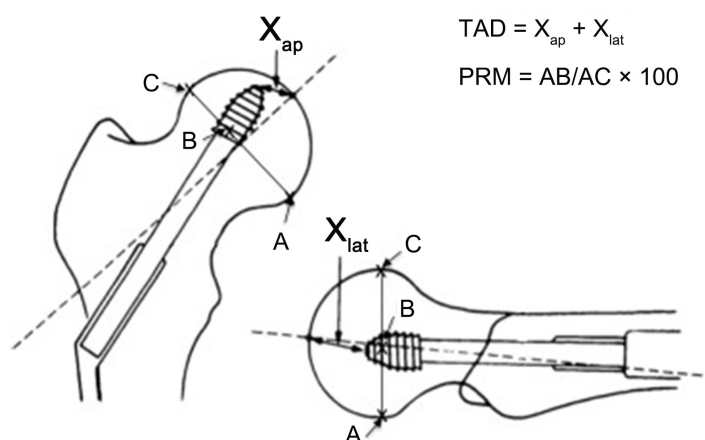


Figure 1. Measurement method for TAD and Parker Ratio: $TAD = X_{ap} + X_{lat}$, $PRM = AB/AC \times 100$.

4. Results (Table 2)

With a mean follow-up of 4.86 months (range: 3 to 14 months), the mechanical failures observed were as follows: 3 cases of screw “cut-out” (screw migration), 3 cases of cut-out associated with varus collapse of the fracture (**Figure 2**), 2 cases of screw extrusion (**Figure 3** and **Figure 4**).

Table 2. Summary of risk factors for mechanical failure.

| Factor | Failures (n) | Non-failures (n) | p-value | Total |
|-----------------------------|--------------|------------------|---------|-------|
| Sex | | | | |
| Male | 3 (10.7%) | 25 (89.3%) | 0.966 | 28 |
| Female | 5 (14.3%) | 30 (85.7%) | | 35 |
| Age | | | | |
| Adults (17 - 64 yrs) | 1 | 19 | 1 | 20 |
| Older adults (65 - 74 yrs) | 3 | 19 | 0.398 | 22 |
| Elderly (≥ 75 yrs) | 4 | 17 | 0.481 | 21 |
| Time to consultation | | | | |
| <6 h | 2 | 12 | | 14 |
| 6 - 24 h | 2 | 13 | 1 | 15 |
| >24 h | 4 | 30 | | 34 |
| Prefracture autonomy | | | | |
| Autonomous | 5 | 53 | 0.009 | 58 |
| Semi-autonomous | 3 | 2 | | 5 |
| Singh index | | | | |
| Type 3 | 1 | 4 | 1 | 5 |
| Type 4 | 0 | 7 | 0.707 | 7 |
| Type 5 | 3 | 6 | 0.140 | 9 |
| Type 6 | 4 | 38 | 0.503 | 42 |
| Fracture site | | | | |
| Femoral neck | 1 | 6 | | 7 |
| Trochanteric | 5 | 35 | 1 | 40 |
| Subtrochanteric | 2 | 14 | | 16 |
| Time to surgery | | | | |
| ≤ 96 h | 1 | 18 | 0.451 | 19 |
| >96 h | 7 | 37 | | 44 |
| Reduction quality | | | | |
| Good | 3 | 35 | 0.305 | 38 |
| Acceptable | 2 | 13 | | 15 |
| Poor | 3 | 7 | 0.202 | 10 |
| TAD | | | | |
| <20 mm | 4 | 22 | 0.023 | 26 |
| 20 - 25 mm | 2 | 20 | 0.815 | 22 |
| >25 mm | 2 | 13 | | 15 |
| PRM (Frontal) | | | | |
| 0 - 0.33 (inferior third) | 1 | 19 | 0.398 | 20 |
| 0.34 - 0.66 (central) | 6 | 35 | 0.815 | 41 |
| 0.67 - 1 (superior third) | 1 | 1 | 0.595 | 2 |

Continued

| PRM (Lateral) | | | | |
|----------------------------|---|----|-------|----|
| 0 - 0.33 (posterior third) | 3 | 10 | 0.427 | 13 |
| 0.34 - 0.66 (central) | 4 | 45 | 0.116 | 49 |
| 0.67 - 1 (anterior third) | 1 | 0 | 0.258 | 1 |

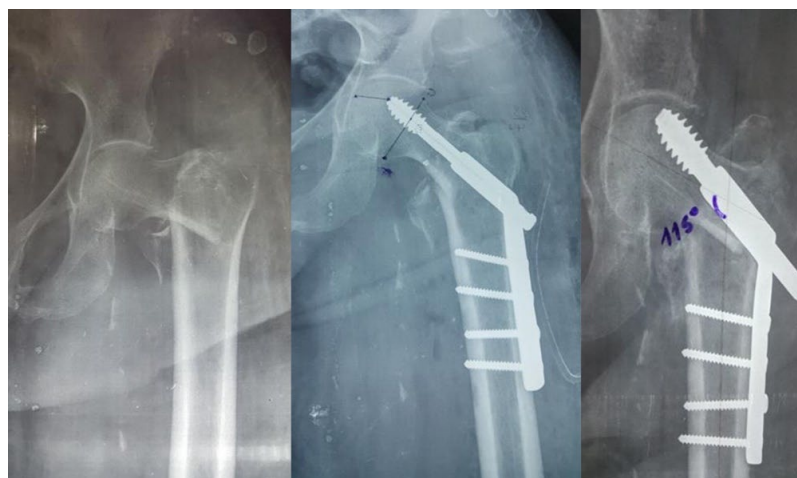


Figure 2. Screw cut-out with varus collapse.



Figure 3. Screw extrusion with varus collapse of the femoral neck.

4.1. Patient-Related Factors

- **Age:** The average age was 62.8 years (range: 17 - 94). For patients with mechanical failure, the average age was 70 years (range: 45 - 86).
- **Sex:** Among 35 women, 5 experienced failures. Among 28 men, 3 experienced failures.
- **Time to consultation:**
 - 14 patients consulted within 6 hours → 2 failures
 - 15 patients between 6 - 24 hours → 2 failures
 - 34 patients after 24 hours → 4 failures
- **Pre-fracture autonomy:** 5 patients were semi-autonomous, of whom 3 had mechanical failure with significant association ($p = 0.009$).

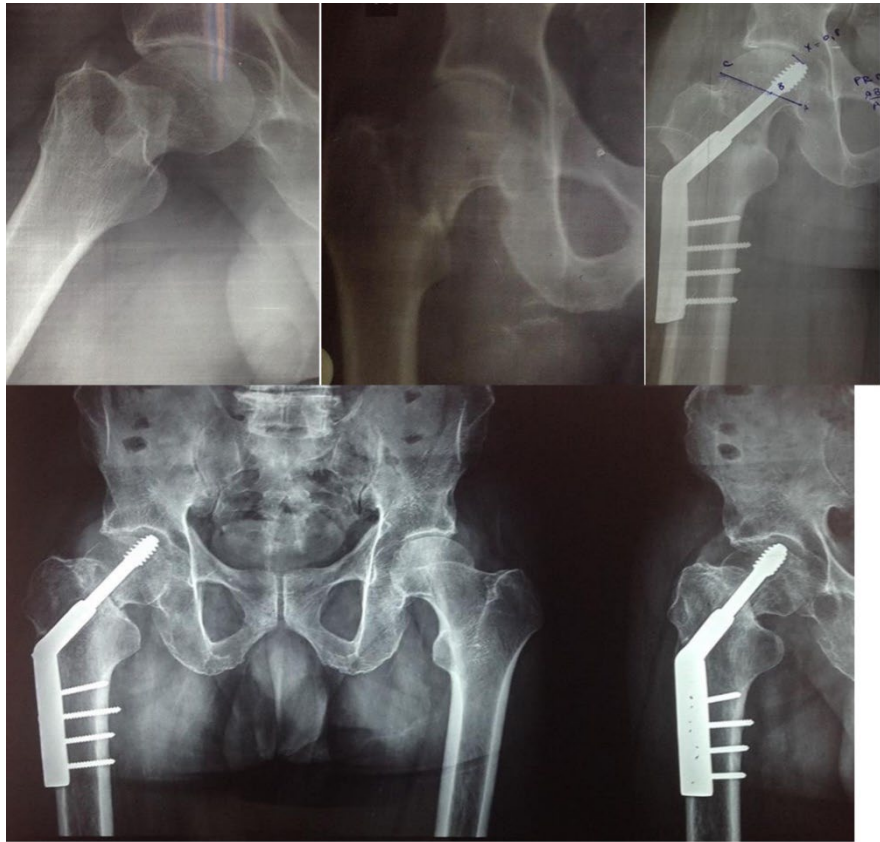


Figure 4. Screw extrusion with varus collapse of the femoral neck.

4.2. Fracture-Related Factors

- **Singh index (bone quality):**
 - Type 6 (normal): 40 patients (4 failures)
 - Type 5: 9 patients with 3 failures
 - Type 3: 5 patients with 1 failure
- **Fracture site:**
 - Trochanteric region: 40 cases (5 failures)
 - Subtrochanteric region: 16 cases (2 failures)
 - Femoral neck: 7 cases (1 failure)

4.3. Surgical Technique-Related Factors

- **Time to surgery:** The average time from admission to surgery was 6 days (range: 1 - 21 days). Of the 37 patients operated after 96 hours, 7 experienced failures.
- **Reduction quality (Baumgartner criteria):**
 - Good: 38 patients → 3 failures
 - Acceptable: 15 patients → 2 failures
 - Poor: 10 patients → 3 failures
- **Tip Apex Distance (TAD):**
 - <20 mm: 26 patients with 4 failures (significant $p = 0.023$)

- 20 - 25 mm: 22 patients with 2 failures
- 25 mm: 15 patients with 2 failures
- **Parker Ratio Method (PRM):**
 - **Frontal view:**
 - Inferior third (0 - 0.33): 20 patients → 1 failure
 - Central (0.34 - 0.66): 41 patients → 6 failures
 - Superior (0.67 - 1): 2 patients → 1 failure
 - **Lateral view:**
 - Posterior third (0 - 0.33): 13 patients → 3 failures
 - Central (0.34 - 0.66): 49 patients → 4 failures
 - Anterior (0.67 - 1): 1 patient → 1 failure

5. Discussion

5.1. Patient-Related Factors

The relationship between age and the occurrence of osteosynthesis failure remains controversial. Several authors found no correlation between these two variables [7] [8]. In our study, no association was found between age and mechanical complications.

Women appear more exposed to proximal femur fractures. Bone loss accelerates in women immediately after menopause, increasing the risk of fractures related to calcium-phosphorus metabolism disorders. SHANG-WEN [9] identified female sex as a statistically significant predictive factor for screw cut-out ($p = 0.001$).

In our study, no correlation was found between consultation delay and osteosynthesis failure. Medical literature does not seem to address the correlation between a patient's pre-fracture autonomy and mechanical failures. According to Langlais [10], patient autonomy is an important factor in postoperative outcomes. In our study, a statistically significant link was found between pre-fracture autonomy and the occurrence of mechanical complications ($p = 0.009$). However, a study with a larger number of patients may be necessary to confirm this association (47 patients were excluded from our study. This could bias the results).

5.2. Fracture-Related Factors

Some authors, like MORVAN [6] and BARRIOS [11], consider osteoporosis a risk factor for osteosynthesis failure. The risk of screw cut-out increases with the degree of osteoporosis. The more severe the osteoporosis, the less tolerant the implant is to poor positioning. The risk of osteosynthesis failure may depend on the degree of osteoporosis as assessed by Singh's index. Conversely, others such as NORDIN [12] found no correlation between osteoporosis and therapeutic failure. In our study, we also found no such association.

Mechanical complications occur both after osteosynthesis of fractures in the trochanteric region and those in the femoral neck. In his study, REINA [13] reported 2 cases (4%) of mechanical complications in femoral neck fractures. PAR-

KER [14] and SIKAND [15] reported similar complication rates. In our series, most failures were seen after osteosynthesis of trochanteric fractures, but no significant correlation was found.

5.3. Surgical Technique-Related Factors

In our study, the time between hospital admission and surgery was not identified as a predictor of failure. However, most mechanical failures (7 cases) occurred in patients operated on more than 96 hours after trauma.

The quality of fracture reduction was assessed using the criteria of BAUMGARTNER [5] [6]. The literature shows disagreement about the correlation between fracture reduction quality and the risk of mechanical failure. Some authors [7] [16] [17] believe that poor reduction increases the risk of implant failure. Others, such as KASHIGAR [18] and GELLER [19], found no statistically significant relationship.

MORVAN [6] observed that only 1 osteosynthesis out of 112 failed when the reduction was considered good, while over 12% of poorly reduced fractures experienced failure. However, this result should be interpreted cautiously. Poor reduction combines two criteria: interfragmentary displacement greater than 4 mm (often due to complex fractures) and a varus cervico-diaphyseal angle.

In our study, 3 failures were recorded in patients ($n = 7$) with poor reductions, but the association was not statistically significant ($p = 0.2$).

Most authors agree that TAD is a major predictive factor for osteosynthesis failure. A TAD > 25 mm significantly increases the risk of failure [5] [6] [20], whereas a TAD < 25 mm reduces it. It is currently the only statistically proven mechanical failure predictor for DHS fixation [6].

However, in our study, a TAD < 20 mm was also associated with increased risk of screw migration into the hip joint ($p = 0.023$), which is highly significant. A small TAD could be associated with intra-articular migration of the screw, especially in elderly osteoporotic subjects. Therefore, a normal TAD should be between 20 and 25 mm. A study with a larger cohort would be needed to confirm this assertion.

Coviello *et al.* [21] have proven that the findings suggest that if reduction parameters are adequately achieved, an increase in TAD cutoff does not appear to influence the risk of implant failure.

According to several authors, the optimal frontal screw position is the middle or inferior third of the femoral neck (PRM between 0 - 0.66) [5] [6] [9] [20]. In our study, the best positions were central or inferior. A superior screw position was associated with osteosynthesis failure in one of two patients.

As for the lateral view, PRM also defines screw position. Several authors [6] [8] [18] agree that the ideal lateral position is the middle third (PRM 0.34 - 0.66). Screws placed near the margins of the femoral head are more likely to fail, as noted by HSUEH [16]. Our results align with those found in the literature.

Recent studies have shown that the DHS plate screw still gives good anatomical

and functional results [22].

6. Conclusion

Osteosynthesis of proximal femur fractures using DHS screw-plate continues to be indicated, despite the existence of mechanical complications. In our study, two factors were identified as predictors of mechanical failure: pre-fracture walking autonomy, and a Tip Apex Distance (TAD) less than 20 mm.

Conflicts of Interest

The authors declare no conflicts of interest.

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