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Anatomical and functional results of cervicomedullary nailing of fractures of the trochanteric region

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Abstract
Introduction: Fractures of the trochanteric region are often encountered in young people in sub-Saharan Africa. The aim of this study was to evaluate the anatomical and functional results of cervical-medullary nailing of fractures of the trochanteric region. To identify prognostic factors in correlated with anatomopathology of the lesions.
Patients and Methods: A multicenter, multioperator, prospective series of 65 fractures of the trochanteric region, including 43(66%) men and 22(34%) women, a sex-ratio of 1.95. Mean age 50.33 years; public road accidents are the predominant etiology (61.53%). Fractures were more unstable 52(80%) according to EVANS classification.
Results: Bone fixation consisted of Gamma type cervico-medullary nailing (standard/intermediate, long) after reduction and reaming under scopic control, 51(78.46%) times closed focus versus 14(21.54%) open focus. An average consolidation time of 5 months (extreme 3 to 6 months).
Radiological results were satisfactory 46 (71%), acceptable 13 (20%). Functional results were excellent or good 50 (77%), fair 10 (15%). Complications (iatrogenic fracture, implant malposition, cervical screw sweep, implant removal, pseudarthrosis, avascular osteonecrosis of the femoral head) were recorded.
Conclusion: Fractures of the trochanteric region occur due to high-energy trauma in young subjects in our series. Unstable lesions (complex pertrochanteric, intertrochanteric, subtrochanteric and trochanterodiaphyseal fractures) were found. Gamma type cervicomedullary nailing osteosynthesis is the treatment of choice for trochanteric fractures. These fractures were consolidated with good radiological and functional results according to the PMA score.

Keywords: Fracture, trochanteric region, cervicomedullary nailing, results, Togo

1. Introduction
Fractures of the trochanteric region are breaks in bone continuity that extend from the line that separates the femoral neck to 2.5 cm below the lesser trochanter [1]. These pathologies are common in elderly osteoporotic subjects following minor trauma. It poses a functional and vital prognosis problem [2]. Fractures of the trochanteric region represent approximately 65% of all fractures of the upper end of the femur [3]. They are likely to increase due to the aging of the world population [4].
The costs of their care have been estimated at approximately 446.3 billion US dollars by 2050 [6]. In sub-Saharan Africa, fractures of the trochanteric region are often encountered in young people and pose a problem for urgent treatment [7, 8]. Research has been carried out to improve their treatment; osteosynthesis with cervicomedullary nailing, gamma nail type, represents one of the latest improvements in implants intended for the treatment of these fractures [9]. Research has been carried out to improve their treatment; osteosynthesis with cervicomedullary nailing, gamma nail type, represents one of the latest improvements in implants intended for the treatment of these fractures [9].
Since the advent of closed endomedullary osteosynthesis for fractures of the trochanteric region in Lomé in 2015, few studies [10] have reported the results of the operative technique for these fractures in our context. The objective of our study was to evaluate the anatomical and functional results of surgical treatment of fractures of the trochanteric region using a Gamma type cervicodiaphyseal nail.

2. Patients and Methods

2.1 Patients: This was a prospective, descriptive, multicenter and multioperator study carried out from January 1, 2019 to April 30, 2022 on patients with a fracture of the trochanteric region and treated with a gamma cervicomedullary nail in Lomé. Were included in this study patients aged over 15 years, presenting either closed trochanteric, subtrochanteric, trochantero-diaphyseal fractures, stepped fractures with proximal trochanteric line and other associated injuries. There were 65 patients: 43 (66%) men and 22 women (34%) whose median age was 50 years (19-86). Public road accidents were the predominant cause 61.53%. All patients had an X-ray of the traumatized hip face and profile supplemented by an X-ray of the face pelvis (Fig1).

Fig 1: (A) Facial pelvic X-ray; (B) Left thigh x-ray, face and profile

Unstable fractures classified by EVANS [11] and associated injuries were listed (Table 1).

Table 1: Results of anatomopathological data according to the Evans classification and associated lesions

		N	Percentage
	Type I	5	7.70
	Type II	8	12.31
	Type III	7	10.76
EVANS	Type IV	13	20
	Type V	24	36.92
	Type R	8	12.31
Stable fracture		13	20
Unstable fracture		52	80
	Tibial plateau fracture	1	1.53
	Patella	1	1.53
Associeted lesions	Leg fracture	2	3.07
	Fracture 02 forearm	1	1.53
	Wrist fracture	2	3.07
	Bimalleolar fracture	1	1.53
	Humeral palet fracture	1	1.53
	TCE + PCI	3	4.61
	Pathological fracture	2	3.07

PARKER index [12] was good 61(93.84%), poor 4(6.16%)
During hospitalization, all patients benefited from a pre-anesthetic consultation after carrying out a pre-operative biological assessment.

2.2 Therapeutic protocol

2.2.1 Surgical technique

The patients were operated under spinal anesthesia 52 (80%) sometimes converted to general anesthesia when necessary. The installation was controlled by the operator. The patient is placed on an orthopedic table, in a supine position, with a stop between the thigh, the foot of the fractured limb is fixed in a boot to the orthopedic table.
The trunk is inclined towards the contralateral side and held by a thoracic support, so that the operator has good access to the trochanteric region. The contralateral lower limb is placed on an abducted support to allow the installation of one or two image intensifiers, one for the frontal view, the other for the profile view (Fig.2).

Fig 2: Patient installation on orthopedic table

The skin incision was longitudinal, lateral supratrochanteric, approximately 5 to 8 cm. We proceed to open the fascia lata and the fibers of the gluteus medius in their axis. The entry point is located at the junction between the anterior third and the posterior two thirds of the top of the greater trochanter. A scopic check can then be carried out in order to visualize the correct positioning of the guide. The medullary canal is reamed then the nail is introduced with positioning of the cervical screw.

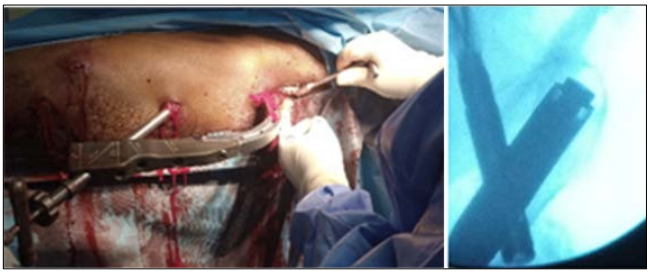

Fig 3: Installing the locking screw

The distal locking can be double but generally only the first screw is placed. The procedure ends with a scopic front and profile check. Closure is done plane by plane on a suction drainage at the level of the subtrochanteric approach.

2.2.2 Postoperative cre and follow-up

In the immediate postoperative period, control x-rays of the pelvis and the operated hip, face and profile, were requested, as well as those for follow-ups on the 45th day and the 3rd month until consolidation. The duration of the intervention and the type of gamma nail were re-specified (Table 2)
Immediate weight bearing protected by a pair of canes was authorized in 45 (69.23%) patients; weight bearing delayed to the 45th day in 15 (23.08%) patients and wheelchair placement in 5 (7.69%).

Table 2: Results of intraoperative data

		N	Percentage
Duration of the intervention	0 à 60	45	69.23
	60 à 120	20	30.76
Scopic controle	Closed hearth	51	78.46
	Open hearth	14	21.54
Gamma nail	Standard/intermédiaire	45	69.23
	Long	20	30.77
Screw diameter	10mm	22	33.85
	11mm	43	66.15
Long. Cervical screw	85mm	12	18.46
	90mm	15	23.08
	95mm	30	46.15
	100mm	8	12.31
ACD	125°	28	43.08
	130°	37	56.92
Distal locking	01 Screw	24	36.92
	02 Screw	41	63.08

Consolidation was defined by the presence of a radiographic bone callus.
Functional results were assessed according to the Postel and Merle d'Aubigné (PMA) hip function rating [13].

The data were entered and analyzed on a microcomputer using Word 2013 and Epi Info software in version 7.1.5.0. The graphs were created using the Excel 2013 spreadsheet.

3. Results

3.1 Anatomical results

The results were anatomical, acceptable and poor (Fig.4). Average TAD "tip-apex distance" equal to 18 mm (range 8 to 32 mm). Less than 25mm 59 (90.77%) and greater than 25mm 6 (9.23%).

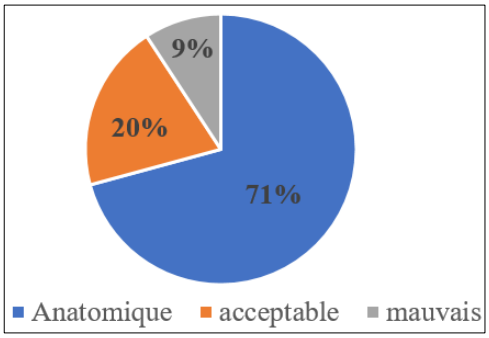

Fig 4: Reduction results

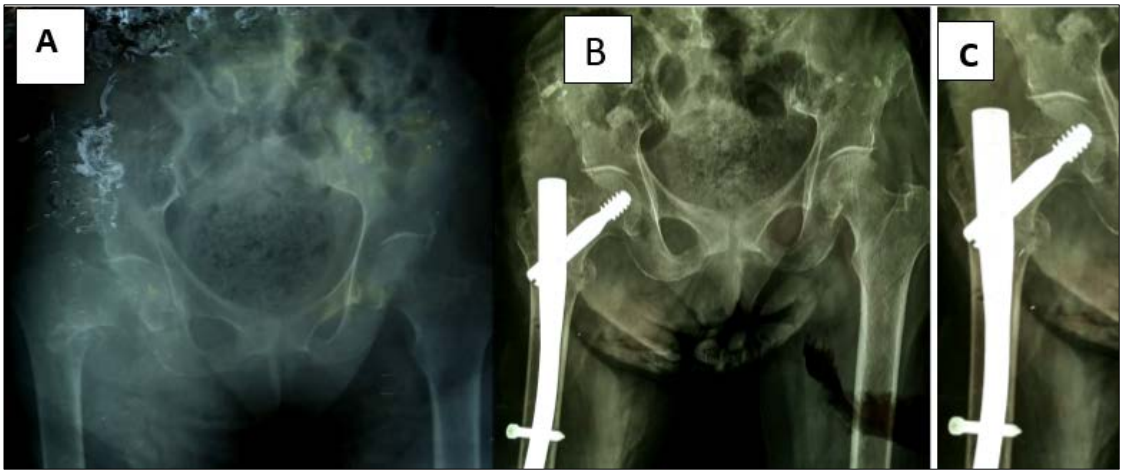

Fig 5: X-ray of the pelvis, side A, showing a consolidated right pertrochanteric fracture

3.2 Functional results

The overall functional result was excellent in 77% (Fig. 6).

At the last follow-up, the functional score was satisfactory and listed (Table 3).

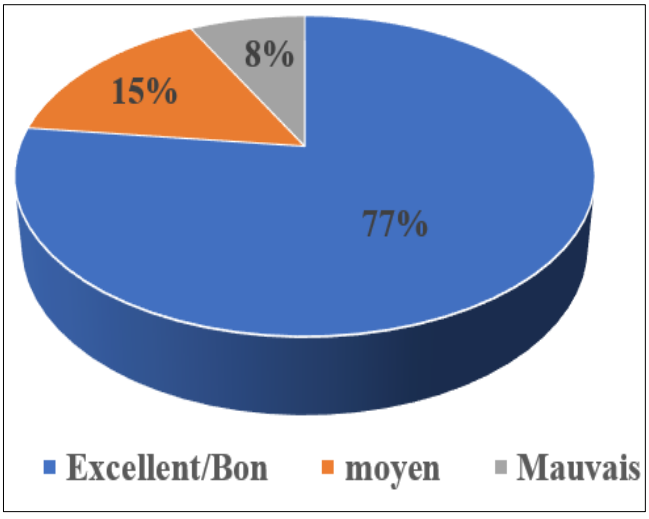

Fig 6: Functional assessment result according to PMA [13]

Table 3: Functional score and follow-up in months for each patient

S. no.	Pain	Mobility	Walking	Score total	Assessment	Month of follow-up
1	5	6	6	17	Excellent	32
2	5	6	5	16	Good	56
3	5	5	5	15	Good	42
4	5	6	5	16	Good	44
5	4	4	4	12	Average	33
6	3	3	2	8	Bad	22
7	6	6	6	18	Excellent	54
8	5	6	5	16	Good	24
9	5	6	5	16	Good	42
10	5	6	6	17	Excellent	28
11	4	5	4	13	Average	18
12	5	5	5	15	Good	24
13	4	5	4	13	Good	26
14	5	6	6	17	Excellent	38
15	4	3	4	11	Average	54
16	5	4	5	14	Good	44
17	5	5	4	14	Good	34
18	3	3	2	8	Bad	11
19	5	5	5	15	Good	34
20	5	6	5	16	Good	40
21	5	6	6	17	Excellent	44
22	6	6	6	18	Excellent	72
23	4	4	4	12	Average	64
24	5	5	5	15	Good	56
25	5	5	4	14	Good	60
26	5	4	3	12	Average	29
27	5	6	5	16	Good	48
28	5	5	5	15	Good	50
29	6	6	5	17	Excellent	57
30	5	6	5	16	Good	53
31	6	5	5	17	Excellent	34
32	5	5	4	14	Good	16
33	3	3	2	8	Bad	24
34	5	5	5	15	Good	54
35	5	6	5	16	Good	28
36	5	6	6	17	Excellent	45
37	5	5	5	15	Good	35
38	4	4	4	12	Average	44
39	5	6	5	16	Good	28
40	5	5	4	14	Good	12
41	2	2	2	6	Bad	14
42	5	5	4	14	Good	18
43	5	6	5	16	Good	6
44	4	4	3	11	Average	14
45	5	5	5	15	Good	36
46	5	5	4	14	Good	10
47	5	6	6	17	Excellent	24
48	4	4	4	12	Average	20
49	5	6	5	16	Good	16
50	4	5	4	13	Good	42
51	5	6	6	17	Excellent	22
52	5	4	5	14	Good	26
53	4	4	4	12	Average	44
54	4	5	4	13	Good	30
55	6	6	6	18	Excellent	34
56	5	5	5	15	Good	42
57	5	4	4	13	Good	34
58	5	6	6	17	Excellent	28
59	4	4	4	12	Average	15
60	3	2	2	7	Bad	12
61	5	5	5	15	Good	14
62	4	4	4	12	Average	13
63	5	6	5	16	Good	22
64	4	3	4	11	Average	34
65	5	4	5	14	Good	26

3.3 Complications: However, we recorded mechanical complications of a technical and infectious nature (table 4).

Table 4: Summary of post-operative complications

Complications	N	Management
Failed lock	4	Surgical abstention
Iatrogenic fracture	2	Changing the nail length
Implant malposition	4	Surgical abstention and follow-up
Cut-out and disassembly MOS	4	Surgical revision
Infection	2	Dressing + antibiotic therapy and follow-up
Pseudarthrosis	3	Dynamization and pseudarthrosis
Vicious callus	4	Surgical abstention and follow-up
ONFT	2	Resumption by the PTH
Knee stiffness	1	Surgical arthrolysis
Shortening	5	Compensating sole

4. Discussion

The data collected made it possible to achieve the objectives of our study.

However, this study had certain difficulties and limitations which must be taken into account for a proper interpretation of the results.

5. Anatomical results

The radiological results were judged satisfactory 46 (71%), acceptable 13 (20%) and poor 6 (9%). Several authors [7, 8] have reported good radiological results for patients treated with gamma nails.

The majority of biomechanical studies are in favor of these implants, which give very good anatomical results.

TAD "tip-apex distance": the distance separating the top of the screw and the internal cortex of the head on the frontal image was measured on average at 18 mm (range 8 to 32 mm). It was judged to be less than 25 mm 59(90.76%). Baumgaertner [14] concluded that a TAD ≥25mm is a direct predictive factor for cervical screw scanning.

A rate of 16% cervicocephalic scanning has been reported in the literature; The cut-out in our series is linked to a technical fault in compression of the locking screw which caused the cervicocephalic screw to retreat.

PARKER index was considered better if the position of the cervical screw is lower on the anteroposterior and median lateral radiograph supporting the primary compression trabeculae. It was judged good 61 (93.85%), poor 4 (6.15%) by technical default of location in the median position on the frontal and posterior radiographs on the profile.

6. Functional results

In our series, osteosynthesis using a cervicomedullary nail type Gamma in the treatment of fractures of the trochanteric region gave excellent or good functional results (77%) according to the PMA numerical rating.

Our results are similar to the other series (Table 5).

Table 5: Functional results of the series according to the authors

Authors	Excellent and good result	Average result	Bad
Kempt [15]	69%	22.80%	8.20%
Calvert [16]	90%	10%	0%
Our series	77%	15%	8%

We recorded mechanical complications of a technical nature as described in the literature [17, 18, 19].

Iatrogenic fracture 2 (3.07%) found in our series was linked to the use of the hammer. Calvert [16] describes these fractures as secondary to technical errors:

We recorded 4 (6.15%) misdirections during distal locking [20].

The main mechanical complication is the dismantling of the osteosynthesis by varus collapse of the fracture and sweeping of the cervicocephalic screw through the femoral head.

In our series 4 (6.15%) cases of implant disassembly, a disassembly rate of 12% was found in the literature [21].

Haidukiewych reported a disassembly rate of around 12.7% for reverse obliquity fractures of the intertrochanteric region [22].

The removal of the gamma nail is of multifactorial origin: the oblique intertrochanteric line, the quality of the reduction, the TAD or the position of the screw.

We recorded 2 (3.07%) avascular osteonecrosis of the femoral head.

Avascular necrosis of the femoral head after a trochanteric fracture is a very rare complication [23, 24]. The cause of ONATF after a trochanteric fracture has not been clearly determined and several factors have been linked: a direct vascular injury, the fracture line more proximal than the classic fracture line, intertrochanteric fracture. Shih *et al*. described high-energy trauma in ONATF occurrence [23].

7. Conclusion

Fractures of the trochanteric region occur due to high-energy trauma in young subjects in our series. Unstable lesions (complex pertrochanteric, intertrochanteric, subtrochanteric and trochanterodiaphyseal fractures) were found.

Bone fixation with a Gamma nail promoted early support and allowed the patient to quickly regain independence. These fractures were consolidated with good radiological and functional results according to the PMA score.

However, we recorded mechanical complications linked to the technical defect. Other multicenter studies including a large number of patients with a view to generalizing the results in Togo.

8. Conflict of Interest

Not available

9. Financial Support

Not available

10. References

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