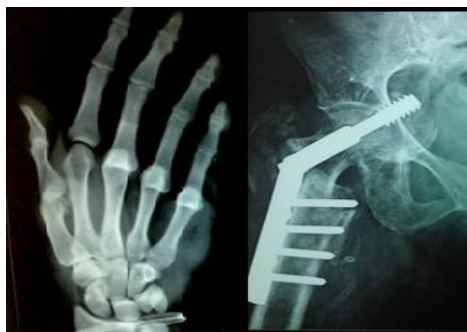




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Intramedullary fixation of distal radius fracture: first study and preliminary report in Togo

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Abstract

Objective: To describe the results of the internal fixation of FRD by intramedullary nail.

Materials and Methods: This was a retrospective single-center study with a prospective component conducted from February 2014 to December 2019. The study included 9 patients who were treated with locked intramedullary nailing (Nail-O-Flex® nail) for distal radius fractures. The lesions were classified according to the AO classification system. Radiological outcomes were assessed using the radiological score of Castaing. Functional outcomes were evaluated using Patient-Rated Wrist Evaluation (PRWE) and Disabilities of the Arm, Shoulder and Hand (DASH) scores.

Results: The sample consisted of 6 men and 3 women, with a male-to-female ratio of 2:1. The mean age was 46 years. Traffic accidents were the primary etiology, with a predominance of sports accidents among men. Type B1 injuries were most common according to the AO classification. Short-term radiological results were very good according to radiological indices. One poor result (11%) was noted according to the radiological scoring system. For functional assessment, the mean follow-up was 26.78 months, with patients reporting complete satisfaction (67%) and moderate satisfaction (33%). The average PRWE score was 7.89, and the average DASH score was 15.55. One case of stiffness (11%) was recorded as a complication.

Conclusion: Surgical management of distal radius fractures by locked intramedullary nailing is minimally invasive and provides satisfactory results. However, assessment of outcomes in a larger sample would be beneficial to establish correlations between different factors influencing therapy and the prognosis of distal radius fractures.

Keywords: Intramedullary nailing, distal radius fractures, Nail-O-Flex, West Africa

Introduction

Distal radius fractures are highly heterogeneous in their mechanisms and pathological varieties. The surgical treatment goals include restoration of radial length, alignment, and radial inclination, as well as reduction of articular step-offs at the radiocarpal and distal radioulnar joints [1]. Open reduction and internal fixation using volar locking plates has become the most widely used surgical technique for distal radius fractures. However, this approach requires extensive surgical exposure and soft tissue dissection [2]. Volar plate fixation has limitations when treating certain distal radius fractures, particularly severely comminuted fractures, posteromedial or anteromedial ulnar fragments, and dorsal shear fractures [3]. The desire to improve the strength of the assembly and minimize iatrogenic damage and thus early functional recovery has led to the development of new fixation technique in FRD. These techniques include: minimal invasive technique using volar plate, intramedullary nail, intramedullary cage, palmar PEEK (polyether etherketone) locked plate, bone graft substitutes partial distal radius arthroplasty [3].

The concept of the intramedullary nail was initially applied to the radial shaft [4]. It was then improved recently in literature since 2005 [5]. Recent systematic reviews and meta-analyses have shown that intramedullary nailing provides comparable long-term functional outcomes to volar plate fixation, with potential advantages in operative time and short-term clinical outcomes [6, 7]. These new approaches in distal radius fracture management can be costly for patients in low-income countries with limited equipment in public health centers.

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However, the potential for quicker recovery and return to work makes it worthwhile to consider these new techniques for suitable patients. This first study in Togo and West Africa aims to introduce the availability of new techniques in our context and report preliminary results of intramedullary nailing for distal radius fractures.

Materials and Methods

Patients and center of study

The study was conducted at the "Clinique Chirurgicale de Lomé" (CCL) in Lomé, Togo, from February 2014 to December 2019. This was a retrospective single-center study with a prospective component.

Inclusion criterias were: Patients aged 18 years and older, closed distal radius fractures, fractures suitable for intramedullary fixation, minimum follow-up of 6 months. Exclusion criterias were: Open fractures, patients with cognitive impairment preventing proper evaluation, previous ipsilateral wrist surgery, pathological fractures. The AO / OTA classification was used to described fractures patterns: A = extra-articular; B = partial articular; C = complex articular.

Surgical technique

All procedures were performed using the Nail-O-Flex® intramedullary nailing system [8]. The surgical approach involved a minimally invasive technique with fluoroscopic guidance. After closed reduction, the nail was inserted through a 1cm incision at Lister's tubercle. The nail was inserted through a 1cm incision at Lister's tubercle. and distal locking was performed.

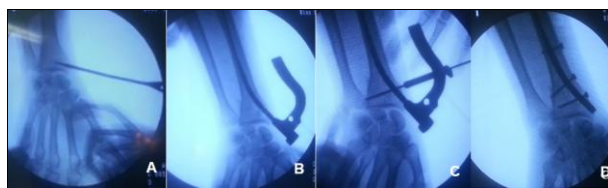


Fig 1: A: entry point by the square tip at proximal to radio scaphoid joint under fluoroscopic control. B: image showing the aspect the nail inserted. C: fluoroscopic control after the nail insertion. D: final aspect with fluoroscopy

To complete the reduction, the sliding mass is positioned to pull the nail, allowing for adjustment of the radial length and thereby correcting parameters such as radial ulnar variance (RUV), radial inclination (RI), and volar tilt (VT). Once this adjustment is achieved, and the proximal part of the nail is secured with two or three additional screws. Postoperatively, a removable splint is used to temporarily support the wrist for analgesic purposes for a period of 15 days. Wrist rehabilitation begins 48 hours post-surgery, but forceful pronation and supination movements are discouraged for the first 30 days to prevent undue stress on the healing structures.

Outcome assessment

Socio-demographic and clinical parameters were studied. The follow-up was clinical, radiological postoperatively at 04 weeks, 06 weeks, 03 months, and after 12 months.

Functional assessment was performed using PRWE score (Patient-Rated Wrist Evaluation) (9) and DASH (Disabilities of the Arm, Shoulder and Hand) scores suitable for distal radius fractures [9]. Patients' satisfaction was assessed by a following response: completely satisfied, moderately satisfied, not very satisfied, or not satisfied.

The radiological outcomes were assessed by: Castaing radiological score (table 1), assessment of radial length, radial inclination (RI), and volar tilt (VI), radio ulnar variance (RUV). which measures three radiological parameters.

Table 1: Radiological Castaing score

Cotation	RI (°)	VT (°)	RUV (mm)
4	$\geq 23^\circ$	$3^\circ \text{ à } 10^\circ$	$\geq + 2 \text{ mm}$
3	$19^\circ \text{ à } 22^\circ$	$+ 2^\circ \text{ à } - 5^\circ$	$+ 2 \text{ mm à } - 2 \text{ mm}$
2	$15^\circ \text{ à } 18^\circ$	$- 6^\circ \text{ à } - 10^\circ$	$- 3 \text{ mm à } - 5 \text{ mm}$
1	$< 15^\circ$	$> - 10^\circ$	$\leq - 6 \text{ mm}$

RI: radial inclination. VT: volar tilt. RUV: radio-ulnar variance.

- **Very good (restitution ad integrum):** All parameters are normal to 4.
- **Good (slight anatomical deformation):** The parameters are subnormal ≥ 3 .
- **Average (notable anatomical deformation):** One parameter at 2; the others ≥ 3 .
- **Poor (significant anatomical deformation):** One parameter at 1 or several at 2

Statistical analyses

Statistical analyses were performed using EPI Info for Windows, Version 7.2.4.0. Categorical variables were analyzed using the chi-square (χ^2) test or Fisher's exact test when expected cell frequencies were less than 5. Continuous data are expressed as mean $\pm$ standard deviation (SD) for normally distributed variables. Categorical data are presented as frequencies and percentages (%). A p-value < 0.05 was considered statistically significant for all analyses.

Results

Demographics and Fracture Characteristics

The study included 9 patients: 6 men (67%) and 3 women (33%), resulting in a male-to-female ratio of 2:1. The mean age was 46 years (range: 28-65 years). There were 06 men (67%) and 03 women (33%), ie a sex ratio of 2 in favor of men. The right wrist was affected in 05 patients ($n = 5$; 56%) and the left wrist in 04 patients ($n = 4$; 44%). The dominant side was affected in 08 cases. The circumstances were traffic accidents (4 cases), sports accidents (4 cases), and domestic accidents (1 case).

The fractures were all closed and included according to AO classification: types A2 ($n = 2$; 22%), type B1 ($n = 6$; 67%), and type C ($n = 1$; 11%). The concomitant injuries were: a distal radioulnar dislocation ($n = 3$; 33%); the ulnar styloid avulsion fracture ($n = 4$; 44%); a polytrauma comprising ($n = 1$) an ipsilateral acromioclavicular dislocation and an acute subdural hematoma. The average time before surgery was 6.33 ± 6.59 [0 - 17] days. The average duration for surgery was 38 ± 11.55 [27 - 60] min. Three patients ($n = 3$; 33%) were operated on without tourniquet. No immediate or secondary complications were recorded. There was a late complication of wrist stiffness ($n = 1$; 11%). The nail was removed in all patients after fracture union and the average delay of 11.67 ± 4.7 [8 - 17] months.

Radiological outcomes

The radiological outcomes at 6 weeks according to Castaing's score were: very good ($n = 6$), good ($n = 2$), and poor. ($n = 1$) due to loss of reduction. (Fig 2).

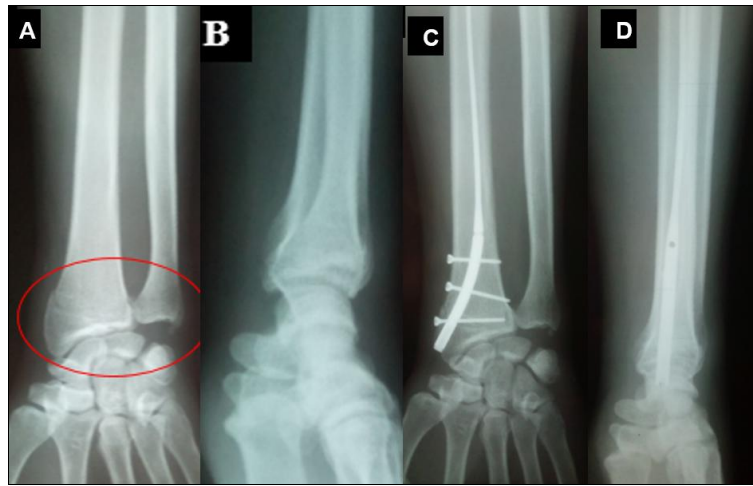


Fig 2: X-ray post-operative control. A + B: showing AP and lateral view of articular distal radius fracture. C+D showing post-operative aspect after nailing

Mean radial length was restored to within 2mm of the contralateral side in 8 (89%) patients. Radial inclination and

volar tilt were adequately maintained in all cases with successful reduction (Table 2)

Table 2: Average value of radiological index

	RI (°) ± SD		VT (°) ± SD		RUV (mm) ± SD		RH (mm) ± SD	
	Before	After	Before	After	Before	After	Before	After
Index values	18.56±4.33	24.11±6.0	8.56±6.02	11.44±5.59	-2.22±3.41	0.44±0.72	9.33±2.82	12.56 ±/- 3.12

RI: radial inclination. VT: volar tilt. RUV: radio-ulnar variance. RH: radial height

Functional outcomes

The average follow-up was 26.78 ± 12.46 [9 - 46] months. The values of the range of motion at the last follow-up were reported in Table 3. Functional assessment revealed (fig 3): the PRWE score mean of 7.89 (range: 1-42), indicating excellent functional outcomes; the DASH score mean of 15.55 (range: 2-23), demonstrating good to excellent function. The functional assessment revealed (Fig 3): the PRWE score mean of 7.89 (range: 1-42), indicating excellent functional outcomes; the DASH score mean of 15.55 (range: 2-23), demonstrating good to excellent function. The range of motion (fig 3) of flexion-extension arc of 130° (85% of contralateral side). Patient satisfaction was: totally satisfied (n = 6; 67%) and moderately satisfied (n = 3; 33%). Residual pain was noted in 06 cases (67%). And when present, it was mild to moderate pain with an average VAS intensity of 2.5 [1.2 - 5].

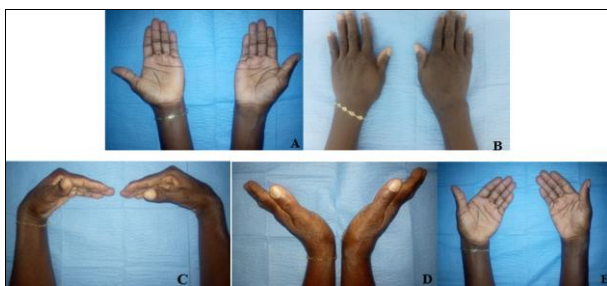


Fig 3: Clinical aspect showing the amplitudes of the wrist at the final outcome of the operated right wrist. A = supination (60 °). B = pronation (85 °). C = flexion (70 °). D = extension (40 °). E = ulnar tilt (30 °). PRWE score = 1. DASH = 15

Complications

One patient (11%) developed wrist stiffness requiring physiotherapy. No cases of tendon rupture, nerve injury, infection, or implant failure were observed. No patients required revision surgery during the follow-up period.

Discussion

This preliminary study represents the first report of intramedullary nailing for distal radius fractures in Togo and West Africa. Our results demonstrate that this technique can achieve satisfactory functional and radiological outcomes with minimal complications.

Our functional outcomes, with mean PRWE and DASH scores of 7.89 and 15.55 respectively, compare favorably with published series of intramedullary nailing for distal radius fractures. Recent meta-analyses have shown that intramedullary nailing provides comparable long-term functional outcomes to volar plate fixation, with potential advantages in operative time and early recovery [10, 6, 11].

Our series revealed that the clinical, radiological, and functional outcomes were reported to be very good. We also founded significant improvement in the radial height, radial inclination, volar tilt and radio-ulnar variance postoperatively (table 3). This post-operative radiological findings in our series (table 3) were better than those reported by Calbiyek *et al* [12] and Chen *et al* [13]. This suggests that insufficiency of reduction and maintaining of chamber of impaction with Micronail and Sonomax [12]. The designer of this model reported that the first principle of a closed nailing is to recognize the existence of a “compaction chamber” and then surgical fixation technique aim should be to reopen this chamber and keep its banks [14]. The NOF nail acts as a central guardian without shear stress and behave like an internal distractor which allows direct reduction. However, the post-operative parameters were significantly higher in the Micronail group [12].

The low complication rate (11%) in our series is encouraging, particularly given that this represents our initial experience with the technique. Recent systematic reviews report complication rates ranging from 10-20% for intramedullary nailing, with tendon irritation and implant-related issues being the most common concerns [15].

The minimally invasive nature of intramedullary nailing

offers several advantages in our setting, including reduced soft tissue trauma, shorter operative times, and potentially lower infection rates. These benefits are particularly relevant

in resource-limited environments where prolonged operative times and extensive soft tissue dissection may increase morbidity.

Table 3: Comparison of radiological parameters in literature

	RI (°) ± SD		VI (°) ± SD		RUV (mm) ± SD		RH (mm) ± SD	
	Pré-op	Post-op	Pré-op	Post-op	Pré-op	Post-op	Pré-op	Post-op
Sonoma Wrx Vs Micronail® (16)	12.3±6.8	18.0±4.2	-13.4±10.4	7.7±4.1	1.7±1.4	0.7±0.8	3.2±2.0	6.8±2.4
	16.5±3.9	19.8±5.7	-14.1±12.3	6.9±6.3	2.5±1.7	1.1±0.9	3.3±2.9	9.5±1.8
Micronail® (17)	16.4±5.7	21.9±3.8	4.0±4.2	11.2±3.1	-	-	8.0±2.6	12.1±3.4
Nail-O-Flex® (Our study)	18.56±4.33	24.11±6.0	8.56±6.02	11.44±5.59	-2.22±3.41	0.44±0.72	9.33±2.82	12.56±3.12

RI: radial inclination. VT: volar tilt. RUV: radio-ulnar variance. RH: radial height

Limitations

This study has several limitations that must be acknowledged: small sample size (n=9), single-center experience, limited to specific fracture patterns suitable for intramedullary fixation.

Future Directions

Larger multicenter studies with longer follow-up periods are needed to establish the role of intramedullary nailing in the treatment algorithm for distal radius fractures in West Africa. Cost-effectiveness analyses would also be valuable given the economic constraints in our healthcare system.

Conclusion

Intramedullary nailing using the Nail-O-Flex® system provides a minimally invasive alternative for the treatment of selected distal radius fractures. Our preliminary results demonstrate good functional and radiological outcomes with acceptable complication rates. However, larger studies with longer follow-up periods are needed to establish definitive recommendations and identify optimal patient selection criteria for this technique in our population.

The introduction of this technique in Togo represents an important advancement in trauma care capabilities and provides patients with access to modern treatment options previously unavailable in the region.

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There is no conflict of interest.

Conflict of Interest

Not available.

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Not available.

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