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Is Single Locking Of Intramedullary Nails Effective In The Treatment Of Long Bone Fractures?

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Abstract
Introduction *interlocked intramedullary nailing has long been considered the standard treatment for femoral and tibia shaft fractures, with various techniques and debates surrounding optimal practices. This prospective study conducted in a nigerian orthopaedic centre aimed to compare the efficacy of single locking versus interlocked intramedullary nails in the fixation of femoral and tibia shaft fractures.*
Methodology *twenty-eight patients were included, with fractures fixed using the sing nail system by the same surgeon. Variables assessed included fracture type, time to radiological and clinical union, and weight-bearing status.*
Result *the study found no significant differences in outcomes between single locking and interlocked groups in terms of fracture healing, ambulation duration, or weight-bearing status. Despite variations in surgical details, such as operation time, the choice of locking technique did not significantly impact treatment outcomes.*
Conclusion*: the findings suggest that single locking of intramedullary nails is as effective as interlocked methods in managing long bone fractures while also reducing surgical duration and associated morbidity. This highlights the potential for simplification and streamlining of surgical techniques without compromising patient outcomes in the management of femoral and tibia shaft fractures.*
Keywords: *intramedullary nailing, single locking, fracture fixation, treatment outcomes*

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I. Introduction

Interlocked intramedullary nailing of the femur and tibia have become the gold standard for the treatment of femoral and tibia shaft fractures.[1] the femur is the longest bone in the body with the femoral shaft or diaphysis, a lengthy, straight section at its core. The overall incidence of tibial shaft fractures stands at 16.9 per 100,000 person-years. Among males, this rate increases to 21.5 per 100,000 person-years, with the highest occurrence observed between the ages of 10 and 20. Conversely, for females, the incidence is slightly lower at 12.3 per 100,000 person-years, with the peak frequency happening later in life, between the ages of 30 and 40.[1][7] in poland the incidence of femur fracture was 10.5 per 100.000 of the population.[2]. In nigeria , 50% of femoral fractures are shaft fractures.[3]

These fractures may manifest as closed or open often categorized by fracture line morphology: transverse (short and horizontal), oblique (straight but not horizontal), spiral (coiled shape), or comminuted (fragmented). There are several classifications of long bone fracture which include the winquist-hansen's classification, the ao/ota system, a widely used classification scheme, further divides femoral shaft fractures into categories (a, b, c) and 27 patterns based on fracture pattern and location [4][5][6]

Femoral shaft fractures sometimes coincide with polytrauma (multiple injuries affecting three or more body parts), potentially life-threatening. Such fractures can lead to severe and lasting disabilities like limb shortening and leg rotational deformity. Common complications include infection, persistent pain, delayed union, and non-union.[8][16]

A plethora of intramedullary nail types and associated surgical techniques exist, fueling debates on optimal practices [9]. Controversies include the approach of nail insertion: retrograde (via the knee canal, pushing upwards) versus antegrade (via the hip canal, pushing downwards),[10] along with disputes over entry points (piriformis fossa versus greater trochanteric entry) and the use of reaming . Moreover, disagreement persists over the efficacy of various methods of surgery, such as interlocking nails versus single nailing, reamed versus unreamed, and locked versus unlocked.[1][11][12][13][17]

Intramedullary nailing aims to preserve fracture site anatomy and foster an optimal environment for healing, thus potentially improving function and mitigating long-term complications like arthritis-induced pain. Additionally, this technique aids in minimizing soft tissue damage during surgery, preserving blood supply, and facilitating fracture healing.[8]

While interlocked intramedullary nails have been standard practice, concerns arise regarding surgery duration due to distal screw insertion. Prolonged surgeries could lead to surgeon fatigue, increased blood loss, extended anaesthesia times, and patient anxiety.[15]

There have been comparisons with locked and unlocked intramedullary nails and locked nails versus locked plates. However, there is a paucity of data on single locking of intramedullary nailing of shaft fractures.[20][21][22]

The aim of the study was to investigate the effectiveness of proximal-only locking of intramedullary nails for consecutive femoral shaft fractures as compared with interlocked fractures.

II. Materials And Method

This was a prospective study of twenty-eight femoral and tibia shaft fractures conducted in a tertiary orthopaedic centre in awka, nigeria.

All the patients presenting with long bone fractures whether fresh injury, delayed union or non-union, were recruited in this study between june 2019 and june 2021. They were assessed, and suitability for the use of intramedullary nails was determined.

The femoral shaft fractures were fixed with either antegrade or retrograde methods of intramedullary nail fracture fixation.

All the fixations used the sing nail system, and the procedures were performed by the same surgeon.

The procedure followed the standard of intramedullary nail fixation

The 9 consecutive patients had interlocked intramedullary nailing while the rest had the single locked procedure.

Several variables were examined, including whether the fracture was open or closed, the type of locking, the time of radiological union, clinical union, and full weight bearing.

III. Result

A prospective study involving 28 subjects was conducted to investigate the effectiveness of single locking of intramedullary nails in the treatment of long bone fractures.the findings are as follow

Table 1: socio-demographic characteristics

Variable	Median (iqr)	Range (min-max)
Age (years)	35.5 (25.75)	16.0-86.0
	Frequency (n)	**Percentage (%)**
Gender		
Male	15	53.6
Female	13	46.4
Marital status		
Married	15	53.6
Single	13	46.4
Occupation		
Business	12	42.9
Civil servant	9	32.1
Student	7	25.0

Table 2: fracture outcome, management and ambulation status

Variable	Frequency (n)	Percentage (%)
Clinical timeline		
Median time since injury (weeks)	0.21 (0.0-11.25)	0.0-54.0
Fracture information		
Type of fracture		
Femur	14	50.0
Tibia	14	50.0
Site of fracture		
Proximal 1/3	11	39.3
Distal 1/3	10	35.7
Middle 1/3	7	25.0
Fracture outcome		
Fresh fracture (<6 weeks)		
Yes	19	67.9
No	9	32.1

Was the fracture open?		
Yes	12	42.9
No	16	57.1
Surgical details		
Median duration of surgery	98.0 (64.0-130.0)	22.0-279.0
Type of intramedullary nailing		
Antegrade nailing	17	60.7
Retrograde nailing	11	39.3
Was the nail locked?		
Yes	28	100.0
Was it locked proximally?		
Yes	28	100.0
Was it locked distally?		
Yes	9	32.1
No	19	67.9
Treatment outcome		
Treated elsewhere before?		
Yes	14	50.0
No	14	50.0
Delayed union (6-12 weeks)		
Yes	1	3.6
No	27	96.4
Non-union (>12 weeks)		
Yes	8	28.6
No	20	71.4
Median radiological union time (weeks)	8.0 (8.0-10.0)	7.0-12.0
Ambulation status		
Median duration Before ambulation (days)	3.0 (2.0-7.25)	1.0-84.0
Partial weight bearing		
Yes	22	78.6
No	6	21.4
Full weight bearing		
No	28	100.0
Non-weight bearing		
No	26	92.9
Yes	2	7.1
Median commencement Of full weight bearing (weeks)	32.0 (30.0-36.5)	30.0-42.0

Table 3: relationship of socio-demographic profile across locking preference

	Locking pattern			
	Single	**Interlocked**	**Total**	**P-value**
Patient Characteristics				
Age	35.00 (26.00-43.00)	36.00 (25.00-49.00)	35.50 (25.75-47.50)	0.961
Gender				
Female	7 (36.8)	6 (66.7)	13 (46.4)	0.284
Male	12 (63.2)	3 (33.3)	15 (53.6)	
Marital status				

Married	9 (47.4)	6 (66.7)	15 (53.6)	0.582
Single	10 (52.6)	3 (33.3)	13 (46.4)	
Occupation				
Business	9 (47.4)	3 (33.3)	12 (42.9)	0.623
Civil servant	5 (26.3)	4 (44.4)	9 (32.1)	
Student	5 (26.3)	2 (22.2)	7 (25.0)	

Table 4: fracture profile across locking preference

	Locking pattern			
	Single	**Interlocked**	**Total**	**P-value**
Clinical timeline				
Time since injury (weeks)	0.14 (0.00-6.72)	6.07 (0.00-28.00)	0.21 (0.00-11.25)	0.412
Fracture information				
Type of fracture				
Femur	9 (47.4)	5 (55.6)	14 (50.0)	0.999
Tibia	10 (52.6)	4 (44.4)	14 (50.0)	
Site of fracture				
Proximal 1/3	7 (36.8)	4 (44.4)	11 (39.3)	
Middle 1/3	4 (21.1)	3(33.3)	7 (25.0)	0.567
Distal 1/3	8 (42.1)	2 (22.2)	10 (35.7)	
Fracture outcome				
Fresh fracture (<6 weeks)				
No	5 (26.3)	4 (44.4)	9 (32.1)	0.599
Yes	14 (73.7)	5 (55.6)	19 (67.9)	
Was the fracture open?				
No	10 (52.6)	6 (66.7)	16 (57.1)	0.770
Yes	9 (47.4)	3 (33.3)	12 (42.9)	

Table 5: management profile and ambulation status across locking preference

	Locking pattern			
	Single	**Interlocked**	**Total**	**P-value**
Treatment outcome				
Treated elsewhere before?				
No	**8 (42.1)**	**6 (66.7)**	**14 (50.0)**	
Yes	**11 (57.9)**	**3 (33.3)**	**14 (50.0)**	**0.418**
Delayed union (6-12 weeks)				
No	**18 (94.7)**	**9 (100.0)**	**27 (96.4)**	**0.999**
Yes	**1 (5.3)**	**0 (0.0)**	**1 (3.6)**	
Non-union (>12 weeks)				
No	**15 (78.9)**	**5 (55.6)**	**20 (71.4)**	**0.406**
Yes	**4 (21.1)**	**4 (44.4)**	**8 (28.6)**	
Radiological union time (weeks)	**8.00 (7.00-10.00)**	**10.00 (9.00-10.00)**	**8.00 (8.00-10.00)**	**0.081**
Surgical details				
Duration of surgery (minutes)	**89.05 ± 40.20**	**139.07 ± 68.45**	**105.13 ± 55.06**	**0.022****
Type of intramedullary nailing				
Antegrade nailing	**10 (52.6)**	**7 (77.8)**	**17 (60.7)**	**0.391**
Retrograde nailing	**9 (47.4)**	**2 (22.2)**	**11 (39.3)**	
Ambulation status				
Duration before ambulation (days)	**2.00 (1.00-6.00)**	**4.00 (3.00-8.00)**	**3.00 (2.00-7.25)**	**0.062**
Partial weight bearing				
No	**4 (21.1)**	**2 (22.2)**	**6 (21.4)**	**0.999**
Yes	**15 (78.9)**	**7 (77.8)**	**22 (78.6)**	

Non-weight bearing				
No	**17 (89.5)**	**9 (100.0)**	**26 (92.9)**	**0.822**
Yes	**2 (10.5)**	**0 (0.0)**	**2 (7.1)**	
Commencement of Full weight bearing (weeks)	**32.00 (32.00-35.00)**	**32.00 (30.00-38.00)**	**32.00 (30.00-36.50)**	**0.841**
***statistically significant**				

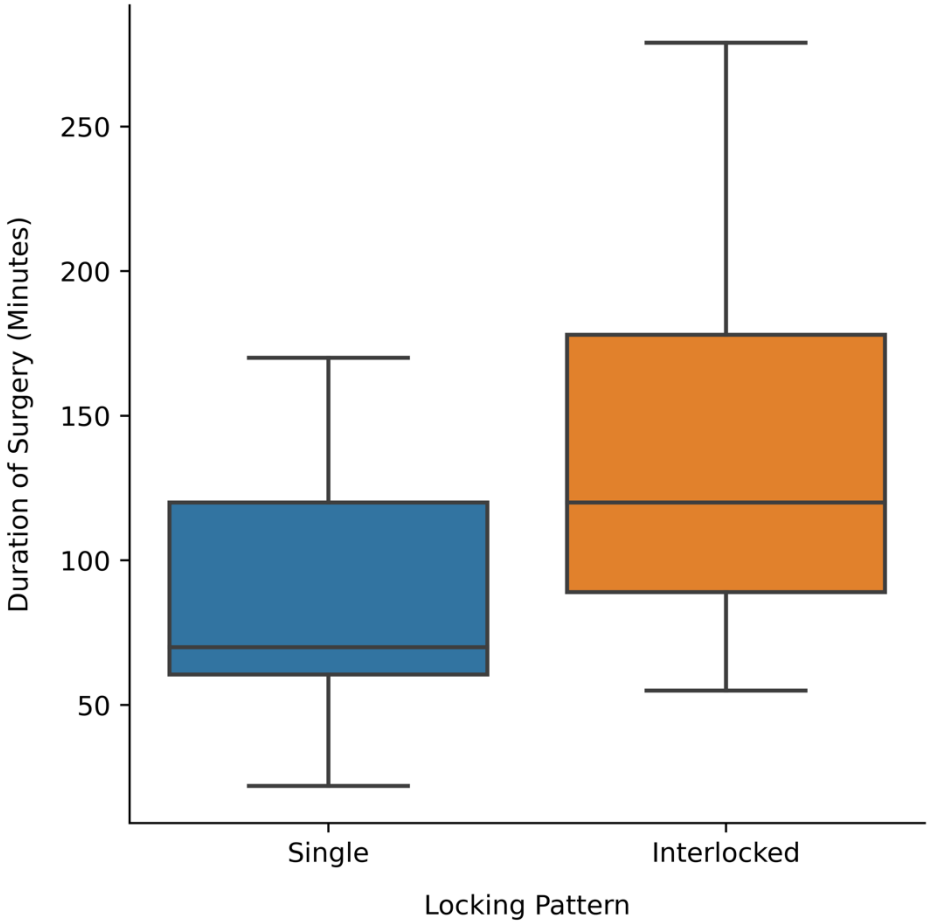

Figure 1: duration of surgery based on locking pattern

IV. Discussion

A prospective study involving 28 subjects was conducted to investigate the effectiveness of single locking of intramedullary nails in the treatment of long bone fractures.

Table 1 presents the socio-demographic characteristics of the study participants. The median age of the participants was 35.5 years, with an interquartile range (iqr) of 25.75 years. The age range varied from 16.0 to 86.0 years.

Regarding gender distribution, 53.6% of the participants were male, while 46.4% were female. The marital status of the participants showed an equal distribution, with 53.6% being married and 46.4% single.

In terms of occupation, the majority of participants were engaged in business (42.9%), followed by civil servants (32.1%) and students (25.0%).

Table 2 provides a comprehensive overview of fracture outcomes, management details, and ambulation status among the study participants.

The median time since injury was 0.21 weeks, with a wide range from 0.0 to 54.0 weeks, indicating variability in the duration from injury to treatment initiation.

Fractures were evenly distributed between the femur (50.0%) and tibia (50.0%). The majority of fractures occurred in the proximal third (39.3%), followed by the distal third (35.7%) and middle third (25.0%) of the bone.a substantial proportion of fractures were fresh (<6 weeks) at the time of treatment (67.9%). Open fractures were observed in 42.9% of cases.

The median duration of surgery was 98.0 minutes, with a range from 22.0 to 279.0 minutes. Antegrade nailing was the predominant technique employed (60.7%), and while all nails were locked proximally, only 32.1% were locked distally.

Half of the participants (50.0%) had been treated elsewhere before presenting for treatment in the centre of this study. Delayed union (6-12 weeks) was rare (3.6%), while non-union (>12 weeks) occurred in 28.6% of cases. The median radiological union time was 8.0 weeks. The median duration before ambulation was 3.0 days, with a range from 1.0 to 84.0 days. Most participants were on partial weight-bearing (78.6%), while none were on full weight-bearing initially. The median commencement of full weight-bearing was 32.0 weeks.

Table 3 illustrates the relationship between socio-demographic characteristics and locking preferences among the study participants. The median age of participants in the single locking group was 35.00 years (iqr: 26.00-43.00), and in the interlocked group, it was 36.00 years (iqr: 25.00-49.00), with no statistically significant difference observed between the two groups ($p = 0.961$).

In the single-locking group, 63.2% of participants were male, while in the interlocked group, 66.7% were female. However, this difference was not statistically significant ($p = 0.284$).

There was no significant difference in marital status between the single-locking and interlocked groups. Approximately 47.4% of participants in the single-locking group were married, compared to 66.7% in the interlocked group ($p = 0.582$).

Similarly, no significant association was found between locking preference and occupation. The distribution of participants across different occupations (business, civil servant, and student) did not differ significantly between the two locking groups ($p = 0.623$).

Table 4 examines the fracture profile across different locking preferences among the study participants.

The median time since injury for participants in the single-locking group was 0.14 weeks (iqr: 0.00-6.72), whereas for those in the interlocked group, it was 6.07 weeks (iqr: 0.00-28.00). However, this difference was not statistically significant ($p = 0.412$).

There was no significant difference in the distribution of fracture types (femur and tibia) between the single-locking and interlocked groups. For both locking patterns, approximately 50.0% of fractures occurred in the femur and 50.0% in the tibia ($p = 0.999$).

Regarding the site of fracture, the distribution across proximal, middle, and distal thirds did not differ significantly between the two locking groups ($p = 0.567$).

No statistically significant difference was found in fracture outcome variables, including the presence of fresh fractures (<6 weeks) and open fractures, between the single locking and interlocked groups ($p = 0.599$ and $p = 0.770$, respectively).

Table 5 presents the management profile and ambulation status across different locking preferences among the study participants.

There was no statistically significant difference in the distribution of participants who were treated elsewhere before this study between the single-locking and interlocked groups ($p = 0.418$). Similarly, no significant differences were observed in the occurrence of delayed union ($p = 0.999$) or non-union ($p = 0.406$) between the two groups. However, there was a trend towards significance in the radiological union time, with a p-value of 0.081.

The mean duration of surgery was significantly shorter in the single-locking group (89.05 minutes ± 40.20) compared to the interlocked group (139.07 minutes ± 68.45), with a p-value of 0.022 (figure 1).[13][14]

The distribution of the type of intramedullary nailing (antegrade vs. Retrograde) did not differ significantly between the single locking and interlocked groups ($p = 0.391$).[11]

There was no statistically significant difference in the duration before ambulation between the single-locking and interlocked groups ($p = 0.062$). Additionally, no significant differences were observed in the proportion of participants on partial weight bearing or non-weight bearing between the two groups ($p = 0.999$ and $p = 0.822$, respectively). Similarly, there was no significant difference in the commencement of full weight bearing between the single locking and interlocked groups ($p = 0.841$).

These findings suggest that while there were some differences in surgical details, such as the duration of surgery, the choice between single-locking and interlocked intramedullary nails did not significantly affect treatment outcomes or ambulation status in the management of long bone fractures.

Conclusion: the single locking of intramedullary nail is as effective as interlocked counterparts in the treatment of long bone fractures.

It shortens the duration of surgery and reduces morbidity that follows prolonged surgery.

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