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ORIGINAL ARTICLE

Treatment of Pediatric Femoral Shaft Fractures by Using Plating Vs Flexible Nail Comparative Study

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Abstract

Background: ***Femoral shaft fractures are prevalent diaphyseal injuries in childhood, occurring at an estimated incidence of 2–20 fractures per 100,000 kids annually in the United States of America.***

Aim: ***To compare the results of pediatric femoral shaft fracture treatment by Nancy nail versus plate fixation regarding radiological and functional outcomes.***

Patients and methods: ***This prospective research was performed on 20 cases (10 in each group) separated into two groups: Group I: Nails group & Group II: Plates group operated at El Sahel Teaching Hospital and Al Azhar University Hospitals (El Hussein Hospital & Sayed Galal Hospital).***

Results: ***There was no statistically significant variance among both groups regarding follow-up of 6 months, limb length discrepancy (LLD), pain, side and mechanism of injury, correlated injury, type of fracture, intraoperative time (min), blood loss (ml), rotational deformity, rotational deformity and Flynn score. The number of complications requiring re-operation to Non-complications requiring re-operation in the Nails Group was 3:7, while it was 1:9 in the Plates Group, which was statistically insignificant.***

Conclusion: ***Nancy nail and plate fixation can be viable pediatric femoral shaft fracture treatment options. However, some trends favoured the Nancy nail group regarding functional and radiological outcomes, although these variances did not reach statistical significance.***

Keywords: Femoral Shaft Fractures; Nancy nail fixation; Plate fixation; Flynn score

1. Introduction

Femoral shaft fractures are prevalent diaphyseal injuries in childhood, occurring at an estimated incidence of 2–20 fractures per 100,000 kids annually in the United States. [1,2]

The femur is considered the longest bone in the body. It is not straight but has an anterior bow. The narrowest portion of the femur is called the Isthmus. Older individuals have more giant femoral shaft cortical diameter and cortical thickness. It represents a site of origin and insertion to important muscles that move the knee and hip joints. [3,4]

Age is an essential factor in choosing the appropriate method of treatment. However, the age group between 6-12 years is still debatable. There are several options to manage femoral shaft fractures, including conservative treatment; and Operative treatment by internal fixation by plate and screws or elastic intramedullary nail insertion. [5]

Every modality has its pros and cons. Nancy Nails has the advantages of being minimally invasive, using closed reduction methods, having no disruption of fracture haematoma, less bleeding and being relatively easy to use. However, it needs intraoperative radiation and a period of postoperative immobilization. On the other hand, internal fixation by plate offers anatomical reduction and stable fixation that allow active exercise after surgery with less radiation exposure. However, it disrupts the fracture hematoma and increases the risk of infection and bleeding. [6,7]

Vehicle accidents and falls account for approximately two-thirds of femoral fractures among children and adolescents. Child abuse is attributed to approximately thirty percent of fractures observed in kids below the age of four.[8]

Our research aimed to compare the radiological and functional outcomes of treating pediatric femoral shaft fractures using Nancy nail versus plate fixation.

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2. Patients and methods

This prospective research was performed on 20 patients (10 in each group) separated into Group I: Nails group and Group II: Plates group, operated at El Sahel Teaching Hospital and Al Azhar University Hospitals (El Hussein Hospital and Sayed Galal Hospital).

Study Period: Till completion of the study with regular follow-up for an average of 6 months between 2021 and 2023.

Inclusion criteria: Age between 6 and 12 years, femoral shaft fracture, closed fracture and normal muscles, isolated femur fracture, unilateral fracture and simple fracture.

Exclusion criteria: cases younger than six years old, patients older than 12 years old, open fractures, bone disease and paralytic cases, polytrauma, bilateral fractures, segmented or highly comminuted fractures.

Preoperative Evaluation: The primary assessment, Initial attention should focus on vital signs and resuscitation (ABCD). During the secondary survey, physical examination follows the sequence of maxillofacial structures, head, cervical spine, and pelvis. Then, History taking, general examination and laboratory and radiological investigations (X-ray of femur AP/Lat)

Operative details:

Regarding Nancy nail: Without traction, the patient was positioned supine on a fracture table, exhibiting radiolucency. The entry sites were positioned 2–3 cm in the sagittal plane, in the middle of the femoral shaft, proximal to the growth plate. Commence a distal skin incision measuring three centimetres from the site of entry. perforate the near cortex perpendicular to the bone by affixing the awl or drill onto the bone. After inserting the awl or drill into the medullary canal, lower it forty-five degrees relative to the shaft axis. By advancing it through oscillating motions, an oblique canal can be created. With the apex of both nails aligned at the location of the fracture, precontour them. Utilizing an oscillating motion, introduce the initial nail into the intramedullary canal via the lateral entry point and guide it in the direction of the fracture site.

Using the same method, insert the second nail into the medial entry site

Assessment of rotational alignment

Before affixing the second fragment, perform clinical and radiographic assessments to validate the rotational alignment of the femur. This can be accomplished through the following methods: fluoroscopy of the fracture site (lesser trochanter profile), comparison of internal and external rotation to the contralateral side (while also preparing and draping the uninjured side), and internal and external rotation to the contralateral side.

Regarding the plate, plate fixation and reduction are by femur size. An incision is made on the lateral aspect of the thigh when performing open procedures while the patient is in lateral passion under general anaesthesia. An incision should be made along the length of the femur, specifically along the line between the lateral femoral epicondyle and the greater trochanter, as determined by the fracture pattern. Parallel to the skin incision, divide the fascia lata along its fibres using scissors after making an incision with a scalpel. The fascia over the vastus lateralis should be exposed. The vastus lateralis and fascia lata should be separated using abrupt dissection. Using a periosteal elevator, detach the muscle from the lateral intermuscular septum and the Linea aspera. Recognize the bundles of perforating vessels and cauterize them. Following extraperiosteal exposure of the lateral aspect of the femur, employ bone reduction instruments, manual traction, or a traction table to execute direct reduction. Younger children may utilize a small fragment set measuring 3.5 millimetres. A broad fragment plate, which was usually 4.5 millimetres in width, may be employed for older kids and adolescents. Choose a plate with sufficient length for three bicortical fasteners per main fragment. Position the plate in a lateral position concerning the femur. Near the site of the fracture, insert the first screw. Verify the position of the plate about the fragment prior to affixing the second screw. Three screws remain to be inserted on each side.

Assessment of rotational alignment:

Before affixing the second fragment, ensure that the rotational alignment of the femur has been validated through clinical and radiographic assessments. Effective methods for achieving this objective included direct visualization of the fracture site, utilization of fluoroscopy to examine the fracture site, comparison of internal and external rotation relative to the contralateral side, and fluoroscopy of the proximal femur, specifically the lesser trochanter profile.

Postoperative protocol:

Hospital stay: Cases were observed for one day before being discharged.

Follow up: Follow up X-ray 6, 12 weeks and six months.

Mobilization:Early mobilization and the cases ambulating with crutches. We Started range-of-motion exercises for the knee. We did not use hip spica postoperatively.

The final assessment uses:

Flynn score: The Flynn scoring system assesses the existence of leg length inequality, pain, and malalignment, as well as minor & significant complications, including fractures that necessitate surgical intervention through internal fixation using elastic devices, screws, plates, or screws.[9]

Ethical Considerations: Every patient gave consent to the research, and ethical issues regarding patient names were considered.

Statistical Analysis:

The collected, revised, coded, and entered information was all gathered in version 20 of the Statistical Package for the Social Sciences (IBM SPSS). When the distribution of quantitative data was determined to be parametric, it was expressed as means, standard deviations, and ranges, whereas qualitative data were presented as numbers and percentages. The chi-square test was employed to compare qualitative data from two groups. Alternatively, the Fisher exact test was utilized in lieu of the chi-square test in cases where the expected count in any given cell was less than 5. The independent t-test used parametric distribution and quantitative data to compare two independent groups. The accepted margin of error was five per cent, and the confidence interval was established at ninety-five per cent. The p-value was deemed significant in a subsequent manner: A p-value greater than 0.05 indicates non-significance (NS). S = significant (P < 0.05). P < 0.001 indicates HS (highly significant).

3. Results

Table 1 presented the results indicating that sex, age, earlier radiological union at twelve weeks, after surgery length of stay, analgesia requirements at twenty-four &forty-eight hours, & blood transfusion didn't differ statistically significantly among both groups. However, a highly significant variance was observed in relation to open reduction.

Table 1. Comparison between studied groups regarding Age (Years), Sex, earlier radiological union at twelve weeks, Open reduction, after surgery length of stay, Analgesia requirements at twenty four hours, Analgesia requirements at 48 hour & Blood transfusion.

		NAILS GROUP	PLATES GROUP	TEST	P-VALUE	SIG.
		No. = 10	No. = 10	VALUE		
AGE (YEARS)	Mean ± SD	7.95 ± 2.03	9.35 ± 2.08	-1.521•	0.146	NS
	Range	6 – 12	6 – 12			
SEX	Female	3 (30.0%)	2 (20.0%)	0.267*	0.606	NS
	Male	7 (70.0%)	8 (80.0%)			
EARLIER RADIOLOGICAL UNION AT 12 WEEKS	No	1 (10.0%)	3 (30.0%)	1.250*	0.264	NS
	Yes	9 (90.0%)	7 (70.0%)			
OPEN REDUCTION	No	6 (60.0%)	0 (0.0%)	8.571*	0.003	HS
	Yes	4 (40.0%)	10 (100.0%)			
POST-OPERATIVE LENGTH OF STAY	Mean ± SD	2.45 ± 1.21	3.10 ± 1.05	1.282•	0216	NS
	Range	0.50 – 4.0	1 – 4.5			
ANALGESIA REQUIREMENTS AT 24 (HOUR	Mean ± SD	0.63 ± 0.22	0.51 ± 0.17	-1.431•	0.169	NS
	Range	0.25 – 0.9	0.2 – 0.8			
ANALGESIA REQUIREMENTS AT 48 HOUR	Mean ± SD	1.19 ± 0.69	0.85 ± 0.29	-1.447•	0.165	NS
	Range	0.15 – 2.1	0.4 – 1.3			
BLOOD TRANSFUSION	No	9 (90.0%)	8 (80.0%)	0.392*	0.531	NS
	Yes	1 (10.0%)	2 (20.0%)			

P-value > 0.05: Non-significant (NS); P-value < 0.05: Significant (S); P-value < 0.01: highly significant (HS), *: Chi-square test, •: Independent t-test

Table 2 demonstrated that there wasn't statistically significant variance among both groups as regard side & mechanism of injury, correlated injury and type of fracture.

Table 2. Comparison among studied groups as regard side, associated injury & type of fracture & mechanism of injury.

		NAILS GROUP		PLATES GROUP		TEST	P-VALUE	SIG.
		No.	%	No.	%	VALUE*		
SIDE	Left	4	40.0%	7	70.0%	1.818	0.178	NS
	Right	6	60.0%	3	30.0%			
MECHANISM OF INJURY	FFH	5	50.0%	7	70.0%	0.867	0.648	NS
	FHO	2	20.0%	1	10.0%			
	RTA	3	30.0%	2	20.0%			
ASSOCIATED INJURY	Head injury	1	10.0%	1	10.0%	0.000	1.000	NS
	No	9	90.0%	9	90.0%			
TYPE OF FRACTURE	Oblique	2	20.0%	4	40.0%	1.744	0.418	NS
	Spiral	1	10.0%	0	0.0%			
	Transverse	7	70.0%	6	60.0%			

P-value > 0.05: Non-significant (NS); P-value < 0.05: Significant (S); P-value < 0.01: highly significant (HS), *: Chi-square test, •: Independent t-test

Table 3 showed that there wasn't statistically significant variance among both groups as regard follow-up of 6 months, limb length discrepancy (LLD), pain and complication. The number of complications requiring re-operation to non- complications requiring re-operation in nails group was 3:7, while it was 1:9 in plates group

Table 3. Comparison among studied groups regarding follow-up of 6 months, LLD, pain and complication.

		NAILS GROUP	PLATES GROUP	TEST	P-VALUE	SIG.
		No. = 10	No. = 10	VALUE		
FOLLOW-UP OF 6 MONTHS	Mean ± SD	5.71 ± 1.34	5.32 ± 1.82	-0.545•	0.592	NS
	Range	3 – 7.5	2.5 – 8			
LLD	Poor (>2 cm)	0 (0.0%)	1 (10.0%)	1.053*	0.305	NS
	Excellent (<1 cm)	10 (100.0%)	9 (90.0%)			
PAIN	Poor (present)	1 (10.0%)	0 (0.0%)	1.053*	0.305	NS
	Excellent (none)	9 (90.0%)	10 (100.0%)			
COMPLICATION	Poor (major/ lasting morbidity)	1 (10.0%)	1 (10.0%)	1.000*	0.607	NS
	Satisfactory (minor)	4 (40.0%)	2 (20.0%)			
	Excellent (none)	5 (50.0%)	7 (70.0%)			

P-value > 0.05: Non-significant (NS); P-value < 0.05: Significant (S); P-value < 0.01: highly significant (HS), *: Chi-square test, •: Independent t-test

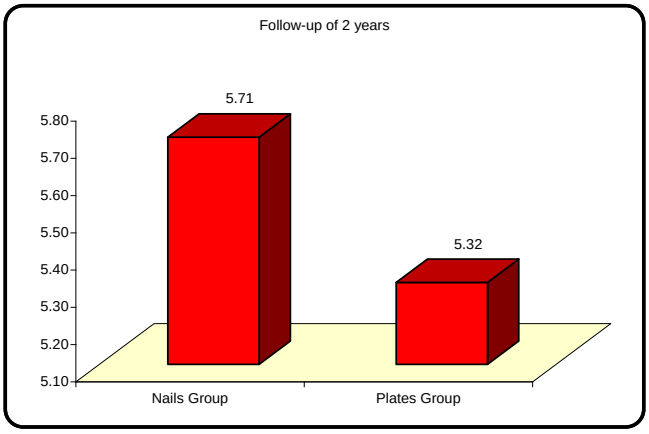


Figure 1. Comparison between studied groups regarding Follow-up of 6 months.

Table 4 showed that there wasn't statistically significant variance among the 2 groups as regard intra operative time (min), blood loss (ml), rotational deformity, rotational deformity and Flynn score

Table 4. Comparison among studied groups as regard to intra operative time (min), blood loss (ml), rotational deformity, rotational deformity and Flynn score.

		NAILS GROUP	PLATES GROUP	TEST	P-VALUE	SIG.
		No. = 10	No. = 10	VALUE		
INTRA OPERATIVE TIME (MIN)	Mean ± SD	68.05 ± 16.23	73.68 ± 17.39	0.749	0.464	NS
	Range	40 – 90	45 – 95			
BLOOD LOSS (ML)	Mean ± SD	68.15 ± 12.31	72.64 ± 15.07	-0.730	0.475	NS
	Range	49 – 90	49 – 90			
ROTATIONAL DEFORMITY	Below 2 cm	1 (10.0%)	0 (0.0%)	1.053	0.305	NS
	cm 0	9 (90.0%)	10 (100.0%)			
ROTATIONAL DEFORMITY	< 10 degrees	1 (10.0%)	0 (0.0%)	1.053	0.305	NS
	No	9 (90.0%)	10 (100.0%)			
FLYNN SCORE	Excellent	8 (80.0%)	7 (70.0%)	0.267	0.606	NS
	Satisfied	2 (20.0%)	3 (30.0%)			

P-value > 0.05: Non significant (NS); P-value < 0.05: Significant (S); P-value < 0.01: highly significant (HS), *: Chi-square test, •: Independent t-test

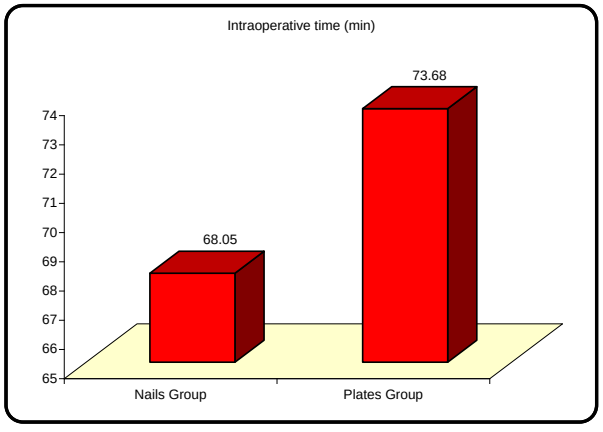
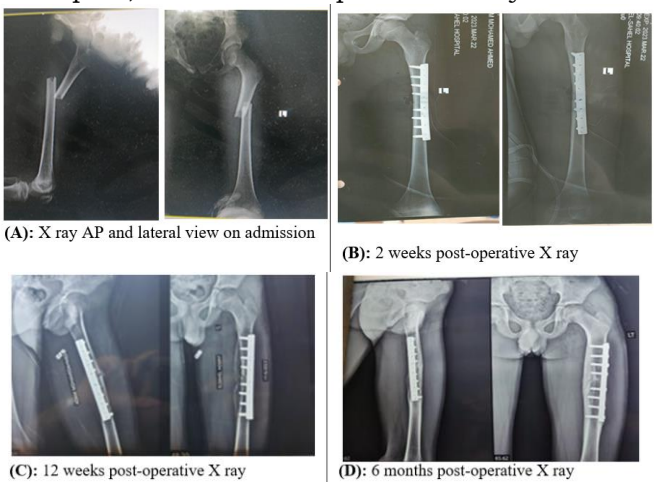


Figure 2. Comparison between studied groups regarding Intra operative time (min).

CASE PRESENTATION

Case (1)

Eleven years old male presented to us with closed 1t mid shaft femur fracture (32 A3) corresponding to classification after falling from height on admission clinical examination plain x ray & skin traction were done. The cases were prepared for operation at Elsahel Teaching Hospital, which was completed four days later.



(A): X ray AP and lateral view on admission

(B): 2 weeks post-operative X ray

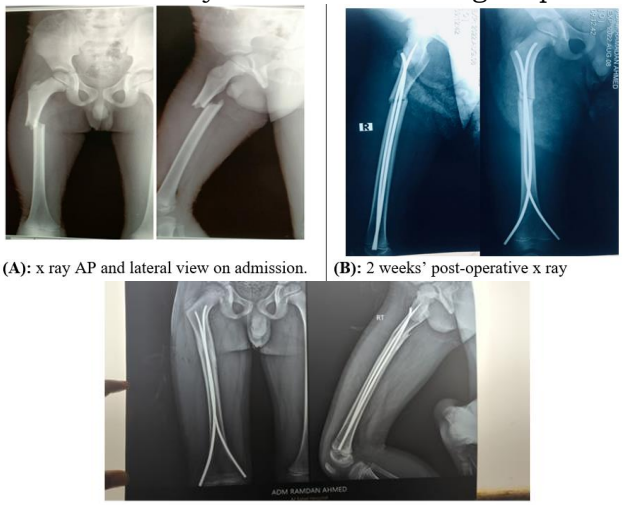
(C): 12 weeks post-operative X ray

(D): 6 months post-operative X ray

Figure 3. Photos of case 1

Case 2

Nine years old male presented to us with closed 1t mid shaft femur fracture (32 A3) according to classification after ART on admission clinical inspection plain x ray & skin traction were done. Patient prepared to operation which was done after 4 days at El sahel teaching hospital.



(A): x ray AP and lateral view on admission.

(B): 2 weeks' post-operative x ray

(C): X ray Six months' post-operative

Figure 4. Photos of case 2

4. Discussion

In this study, we aim to compare the radiological and functional outcomes of treating pediatric femoral shaft fractures using Nancy nail versus plate fixation.

This was prospective research conducted on twenty cases (10 in each group) operated at El Sahel Teaching Hospital and Al Azhar University Hospitals (El Hussein Hospital and Sayed Galal Hospital).

In this research, the mean postoperative length of stay for patients of the Nails Group was 2.45 ± 1.21, and it was 3.10 ± 1.05 for patients of the Plates Group, and this was statistically insignificant.

This agrees with the Meta-analysis study by Ganem et al.[10] which showed statistically insignificant data about hospital stays between both groups.

In this study, there was no statistically significant difference between the Nails Group and Plates Group regarding Rotational deformity. In the Nails Group, 80.0% of cases had an Excellent Flynn score and 20.0% had a Satisfied Flynn score, while in the Plates Group, 70.0% of cases had an Excellent Flynn score and 30.0% had a Satisfied Flynn score, and this was statistically insignificant.

This agreed with Venkataraman et al.,[11] whose objective was to compare and contrast the radiological and functional outcomes of TENS and locking compression plate-treated pediatric femur diaphyseal fractures. In the initial group, eighty-nine per cent of participants reported excellent results, 7.5 per cent reported satisfactory results, and 3.5 per cent reported unsatisfactory results. Group two yielded satisfactory results in 16.2 percent of cases and outstanding results in 83.8 percent. According to a study by Xu et al.[12] the plating group achieved 67.8 percent excellent and 32.2 percent satisfactory results. In comparison, the TENS group achieved sixty-two percent excellent and thirty-eight percent satisfactory results.

In this study, 90.0% of cases in the Nails Group had Earlier radiological union at 12 weeks, while 70.0% of cases in the Plates Group had Earlier radiological union at 12 weeks, and this was statistically insignificant. Venkataraman et al.[11] reported that radiological union was seen in all the cases. They evaluated union rates statistically using the Chi-square test.

In this study, the mean intraoperative time (min) for patients of the Nails Group was 68.05 ± 16.23, and it was 73.68 ± 17.39 for patients of the Plates Group, and this was statistically insignificant. The mean Blood loss (ml) for patients of the Nails Group was 72.64 ± 15.07, and it was 68.15 ± 12.31 for patients of the Plates Group, and this was statistically insignificant.

According to the findings of Bastawisy and Hussein[13] the intraoperative parameters of intraoperative blood loss and the overall length of operation were compared. In the TENs group, the mean blood loss during the operation was 35 cc, and the total length of the operation was thirty-six minutes.

Regarding a separate investigation by Jolly et al.,[14] Although the operative duration was nearly

identical, there was a greater volume of blood loss. Comparing the operative duration in the compression plate group to the same previous study revealed a marginal increase associated with reduced blood loss.

In this study, 0.0% of cases in the Nails Group had poor LLD, and 100.0% had Excellent LLD, while in the Plates Group, 10.0% of cases had poor LLD, and 90.0% of cases had Excellent LLD, and this was statistically insignificant.

In their investigation of forty-nine pediatric femur fractures treated with TEN nails, Flynn et al.[15] found no cases of malalignment or limb length discrepancy exceeding 1 cm. A second retrospective analysis was conducted on sixty diaphyseal femoral fractures involving fifty-eight cases who underwent submuscular plate treatment. Every patient regained total activity following the recovery of every fracture. In this study, In the Nails Group, there were 10.0% of cases had poor Complication, 40.0% of cases had Satisfactory complications, and 50.0% of cases had Excellent Complication, while in the Plates Group, there were 10.0% of cases had poor Complication, 20.0% of cases had Satisfactory complications, and 70.0% of cases had Excellent Complication, and this was statistically insignificant Bastawisy and Hussein.,[13] Participants reported encountering complications, with wound healing complications being comparatively more prevalent in the group using compression plates. A case within the compression plate group requires surgical debridement of the incision due to the presence of a severe infection. Only three patients in the elastic nail group reported irritation at the nail insertion site. Malalignment complications were identified in two cases of the nail group. In comparison, two cases of the compression plate group suffered loss of reduction due to re-fall or early weight bearing.

In this study, the mean intraoperative time (min) for patients of the Nails Group was 68.05 ± 16.23, and it was 73.68 ± 17.39 for patients of the Plates Group, and this was statistically insignificant. The mean Blood loss (ml) for patients of the Nails Group was 72.64 ± 15.07, and it was 68.15 ± 12.31 for patients of the Plates Group, and this was statistically insignificant.

Venkataraman et al.[11] documented that group two experienced minimal during-surgery bleeding, minimal after-surgery scarring, less soft tissue damage, and more straightforward implant removal than group one. However, the extent of blood loss during the operation was not quantified. ESIN has shown less operative time than plate fixation with high statistically significant variation reported by Said et al.[16]

Limitations: Its small sample size, single-centre design, and short monitoring duration limited this research.

4. Conclusion

Nancy nail and plate fixation can be viable pediatric femoral shaft fracture treatment options. However, some trends favoring the Nancy nail group in terms of functional and radiological outcomes were observed, although these variations didn't reach statistical significance. more investigations with larger sample sizes may provide additional insights to inform clinical decision-making.

Disclosure

The authors have no financial interest to declare in relation to the content of this article.

Authorship

All authors have a substantial contribution to the article

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Conflicts of interest

There are no conflicts of interest.

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