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Comparative Study of Tibial Diaphyseal Fractures Treated with Reamed Intramedullary Nail Versus Unreamed Intramedullary Nail

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Early infection, Reamed, Un-reamed nailing, Tibial diaphyseal fracture

1. Abstract

1.1. Introduction: Long bone fractures account for a vast majority of trauma related emergency surgeries. Tibia is the most commonly fractured long bone with the incidence of tibial shaft fracture being16.9/100,000/year. intramedullary nailing is a common method for treatment of tibial shaft fractures.' Intramedullary rods are secured within the bone by screws both above and below the fracture

1.2. Objective: To compare the frequency of early infection after reamed versus un-reamed nailing in treatment of tibial diaphyseal fractures.

1.3. Material and Methods: This Randomized Controlled Trial study was carried out in the Department of Orthopedics Surgery, Lady Reading Hospital, Peshawar In this study on a total of 566 (283 each groups) patients were observed to compare the frequency of early infection after reamed versus un-reamed nailing in treatment of tibial diaphyseal fractures. Sampling technique was non-probability consecutive sampling from September 2020 December 2021.

1.4. Results: In our study total 566 patients were enrolled, 283 patients in each group. Age was comparable in both group, p-value 0.061. There were 51.2% males in group A and 48.8% in group B, females were 46.7% in group A and 53.3% in group B, p-value 0.341. Physical parameters were similar in both group p-value for weight was 0.66, height 0.279 and BMI 0.739. Infection rate was significantly greater in group A i.e. 18% and 10.6% in group B, p-value 0.012.

1.5. Conclusion: Un-reamed intramedullary nail has less infection rate as compared to reamed intramedullary nailing.

2. Introduction

Long bone fractures account for a vast majority of trauma related emergency surgeries. Tibia is the most commonly fractured long bone with the incidence of tibial shaft fracture being16.9/100,000/year. [1] Intramedullary nailing is a common method for treatment of tibial shaft fractures. [2] Intramedullary rods are secured within the bone by screws both above and below the fracture. The metal screws and the rod can be removed if they cause problems, but can also be left in place for life. [3] The ideal intramedullary nail for optimizing tibial shaft fracture healing has intramedullary nail to tibial canal diameter ratio between0.8 and 0.99. [4] Use of a nail diameter /reamer diameter between0.80 and0.99 favors union and prevents hardwarebreakage.5 Intramedullary nailing might be reamed or unreamed and both of these methods are frequently used for managing tibial shaft fractures.' Infection after intramedullary nailing is one of the complications. The risk of infection significantly increases according to the open grading, the fractures' classification, time until antibiotic administration, and time until nailing. Gustilo type I fractures present a higher rate of infection than expected, explained by a longer delay before surgery. [5, 6] Similarly no antibiotics prescription in emergency service and a transverse fracture pattern are also predictors of infection. A study comparing the effects of reamed versus unreamed locked intramedullary nailing on cortical bone blood flow in a fractured sheep tibia model suggested that cortical circulation is spared to a greater degree by unreamed nailing. [7] Another study that aimed to construct a computational model of the biomechanical performance of reamed versus unreamed intramedullary tibial nails showed that the interlocking bolts, in general, were subjected to higher stresses in the unreamed tibial nail than in the reamed one; thus the former stabilization technique is more likely to fail due to fatigue. [8] Yet another study demonstrated that optimum outcome was achieved for reamed intramedullary nailing in case of vast majority of tibial diaphyseal fractures. [9] A study published in 2017 in "International Journal of Orthopedics;" showed that 4 out of 25 patients having reamed intramedullary nailing developed 2 out of 25 patients having unreamed intramedullary nailing developed infection. [6] My study aims to compare the rates of infection between the two groups in our local population of patients with tibial diaphyseal fracture presenting to our hospital. The data obtained from this study will help in deciding which procedure is suitable for our local patient population.

3. Materials and Methods

This Randomized Controlled Trial study was carried out in the Department of Orthopedics Surgery, Lady Reading Hospital, Peshawar In this study on a total of 566 (283 each groups) patients were observed to compare the frequency of early infection after reamed versus unreamed nailing in treatment of tibial diaphyseal fractures. Sampling technique was non-probability consecutive sampling from September 2020 December 2021. Non-probability consecutive sampling technique was used. All patients of both genders with age ranging from 40 to 80 years who are admitted with closed tibial diaphyseal fractures diagnosed on Plain radiograph were included in the study while patients with poly-trauma having fracture of more than one bone, with pathological fractures, Patients with known diabetes, Patients taking a prescription of steroids and Patients taking oral contraceptive pills were also excluded from the study. The study was conducted after getting approval from hospital ethical and research committee. The patients meeting the inclusion criteria in the Orthopedics Surgery unit, Lady Reading Hospital, Peshawar were recruited in the study after taking written informed consent. The diagnosis of tibial fracture was made based upon the criteria mentioned in the operational definitions above. The purpose of the study and what this study entails was explained to all the recruited patients at the start of the study before enrolling them. These patients had their weight measured using a digital electronic balance and height measured using a stadiometer. Body mass index was calculated from the height and weight using the formula BMI = Weight in kilograms/Square of height in metres. Demographic data including age and gender of the patient was noted. History was taken from the patient to find out the duration since the injury. Routine baseline investigations were performed and these patients were prepared for surgery. The surgery performed was intramedullary nailing which was reamed in half of the patients and unreamed in the other half. The patients having reamed intramedullary nailing and those undergoing unreamed intramedullary nailing were randomly allocated and computer generated table of random numbers used for the process of randomization. After the surgery, the patients were followed up at two weeks for the development of any signs of infection. Development of infection waw labeled according to the criteria mentioned in the operational definition above. All the data was recorded on a predesigned proforma for subsequent analysis.

The data was analyzed using SPSS version 23. Frequencies and percentages will be used to describe categorical variables such as gender, development of infection after reamed intramedullary nailing and development of infection after unreamed intramedullary nailing. Mean and standard deviation will be calculated for the numerical variables for example age, height (measured using a stadiometer), weight (measured using a digital electronic balance), BMI and duration from the injury causing fracture. Chi squared test was used to compare the rates of infection in the two groups and a p-value of ≤ 0.05 was taken as significant. The difference of the rates of infection in the two groups was stratified according to different age groups, gender, height, weight, BMI and duration from the injury causing fracture.

4. Results

In our study total 566 patients were enrolled, 283 patients in each group. Age was comparable in both group, p-value 0.061 (Table 1). There were 51.2% males in group A and 48.8% in group B, females were 46.7% in group A and 53.3% in group B, p-value 0.341 (Table 2). Physical parameters were similar in both group p-value for weight was 0.66, height 0.279 and BMI 0.739 (Table 3). Duration of injury was similar in both group, p-value 0.311 (Table 4). Infection rate was significantly greater in group A i.e. 18% and 10.6% in group B, p-value 0.012 (Table 5).

Data stratification was done for age groups was significant, p-value 0.001 and 0.006 for younger age group and elder age group respectively (Table 6). Data stratification was done for gender, p-value 0.114 and 0.014 for male and female patients respectively (Table 7). Data stratification was done for height groups, p-value 0.134 and 0.014 for short height and long height group respectively (Table 8). Data stratification was done for weight groups, p-value 0.222 and <0.001 for low weight and increased weight respectively (Table 9). Data stratification was done for BMI groups was significant, p-value 0.006 and 0.009 for normal BMI and obese patients (Table 10). Data stratification was done for duration of injury was significant, p-value <0.001 and 0.028 for shorter and longer duration of injury younger age group and elder age group respectively (Table 11).

Table 1: Age of sampled population

	Group	N	Mean	Std. Deviation	Std. Error Mean	p-value
Age	Group A (Reamed intramedullary nailing)	283	55.86	11.263	0.67	0.061 not significant
	Group B (Unamed intramedullary nailing)	283	58.33	11.596	0.689	

Table 2: Frequency of gender

			Group		Total
			Group A (Reamed intramedullary nailing)	Group B (Unamed intramedullary nailing)	
Gender	Male	Count	213	203	416
		% within Gender	51.20%	48.80%	100.00%
	Female	Count	70	80	150
		% within Gender	46.70%	53.30%	100.00%
p-value 0.341 not significant					

Table 3: Physical parameters of sampled population

	Group	N	Mean	Std. Deviation	Std. Error Mean	p-value
Weight (kg)	Group A (Reamed intramedullary nailing)	283	71.91	12.494	0.743	0.66 not significant
	Group B (Unamed intramedullary nailing)	283	76.25	13.071	0.777	
Height (cm)	Group A (Reamed intramedullary nailing)	283	152.65	14.068	0.836	0.279 not significant
	Group B (Unamed intramedullary nailing)	283	153.92	13.914	0.827	
BMI (kg/m2)	Group A (Reamed intramedullary nailing)	283	29.2018	6.40867	0.38096	0.739 not significant
	Group B (Unamed intramedullary nailing)	283	29.3855	6.68403	0.39732	

Table 4: Duration of injury

	Group	N	Mean	Std. Deviation	Std. Error Mean	p-value
Duration	Group A (Reamed intramedullary nailing)	283	2.16	1.03	0.104	0.311 not significant
	Group B (Unamed intramedullary nailing)	283	2.33	1.06	0.281	

Table 5: Comparison of infection rate in both groups

			Infection		Total
			Yes	No	
Group	Group A (Reamed intramedullary nailing)	Count	51	232	283
		% within Group	18.00%	82.00%	100.00%
	Group B (Unamed intramedullary nailing)	Count	30	253	283
		% within Group	10.60%	89.40%	100.00%
p-value 0.012 significant					

Table 6: Data stratification for frequency of complication rates in both groups and age groups

Age groups				Infection		Total	p-value
				Yes	No		
40-60 years	Group	Group A (Reamed intramedullary nailing)	Count	51	152	203	0.001significant
			% within Group	25.10%	74.90%	100.00%	
		Group B (Unamed intramedullary nailing)	Count	20	152	172	
			% within Group	11.60%	88.40%	100.00%	
	Total		Count	71	304	375	
			% within Group	18.90%	81.10%	100.00%	
61-80 years	Group	Group A (Reamed intramedullary nailing)	Count	0	80	80	0.006 significant
			% within Group	0.00%	100.00%	100.00%	
		Group B (Unamed intramedullary nailing)	Count	10	101	111	
			% within Group	9.00%	91.00%	100.00%	
	Total		Count	10	181	191	
			% within Group	5.20%	94.80%	100.00%	

Table 7: Data stratification for frequency of complication rates in both groups and gender

Gender				Infection Yes	Infection No	Total	p-value
Male	Group	Group A (Reamed intramedullary nailing)	Count	31	182	213	0.144 not significant
			% within Group	14.60%	85.40%	100.00%	
		Group B (Unamed intramedullary nailing)	Count	20	183	203	
			% within Group	9.90%	90.10%	100.00%	
	Total		Count	51	365	416	
			% within Group	12.30%	87.70%	100.00%	
Female	Group	Group A (Reamed intramedullary nailing)	Count	20	50	70	0.014 significant
			% within Group	28.60%	71.40%	100.00%	
		Group B (Unamed intramedullary nailing)	Count	10	70	80	
			% within Group	12.50%	87.50%	100.00%	
	Total		Count	30	120	150	
			% within Group	20.00%	80.00%	100.00%	

Table 8: Data stratification for frequency of complication rates in both groups and height groups

Height groups				Infection Yes	Infection No	Total	p-value
Less than or equal to 150 cm	Group	Group A (Reamed intramedullary nailing)	Count	21	142	163	0.134 not significant
			% within Group	12.90%	87.10%	100.00%	
		Group B (Unamed intramedullary nailing)	Count	10	123	133	
			% within Group	7.50%	92.50%	100.00%	
	Total		Count	31	265	296	
			% within Group	10.50%	89.50%	100.00%	
More than 150 cm	Group	Group A (Reamed intramedullary nailing)	Count	30	90	120	0.014 significant
			% within Group	25.00%	75.00%	100.00%	
		Group B (Unamed intramedullary nailing)	Count	20	130	150	
			% within Group	13.30%	86.70%	100.00%	
	Total		Count	50	220	270	
			% within Group	18.50%	81.50%	100.00%	

Table 9: Data stratification for frequency of complication rates in both groups and weight groups

Weight Groups				Infection Yes	Infection No	Total	p-value
Less than or e qual to 70 kg	Group	Group A (Reamed intramedullary nailing)	Count	10	141	151	0.222 not significant
			% within Group	6.60%	93.40%	100.00%	
		Group B (Unamed intramedullary nailing)	Count	10	80	90	
			% within Group	11.10%	88.90%	100.00%	
	Total		Count	20	221	241	
			% within Group	8.30%	91.70%	100.00%	
More than 70 kg	Group	Group A (Reamed intramedullary nailing)	Count	41	91	132	<0.001 significant
			% within Group	31.10%	68.90%	100.00%	
		Group B (Unamed intramedullary nailing)	Count	20	173	193	
			% within Group	10.40%	89.60%	100.00%	
	Total		Count	61	264	325	
			% within Group	18.80%	81.20%	100.00%	

Table 10: Data stratification for frequency of complication rates in both groups and BMI

BMI Groups				Infection Yes	Infection No	Total	p-value
Less than or equal to 25kg/m2	Group	Group A (Reamed intramedullary nailing)	Count	10	130	140	0.006 significant
			% within Group	7.10%	92.90%	100.00%	
		Group B (Unamed intramedullary nailing)	Count	0	102	102	
			% within Group	0.00%	100.00%	100.00%	
	Total		Count	10	232	242	
			% within Group	4.10%	95.90%	100.00%	
More than 25 kg/m2	Group	Group A (Reamed intramedullary nailing)	Count	41	102	143	0.009 significant
			% within Group	28.70%	71.30%	100.00%	
		Group B (Unamed intramedullary nailing)	Count	30	151	181	
			% within Group	16.60%	83.40%	100.00%	
	Total		Count	71	253	324	
			% within Group	21.90%	78.10%	100.00%	

Table 11: Data stratification for frequency of complication rates in both groups and duration of injury

Duration of injury				Infection Yes	Infection No	Total	p-value
Less than 2 weeks	Group	Group A (Reamed intramedullary nailing)	Count	40	101	141	<0.001 significant
			% within Group	28.40%	71.60%	100.00%	
		Group B (Unamed intramedullary nailing)	Count	10	152	162	
			% within Group	6.20%	93.80%	100.00%	
	Total		Count	50	253	303	
			% within Group	16.50%	83.50%	100.00%	
More than 2 weeks	Group	Group A (Reamed intramedullary nailing)	Count	11	131	142	0.028 significant
			% within Group	7.70%	92.30%	100.00%	
		Group B (Unamed intramedullary nailing)	Count	20	101	121	
			% within Group	16.50%	83.50%	100.00%	
	Total		Count	31	232	263	
			% within Group	11.80%	88.20%	100.00%	

5. Discussion

Long bone fractures account for a vast majority of trauma related emergency surgeries. Tibia is the most commonly fractured long bone with the incidence of tibial shaft fracture being16.9/100,000/year [1]. Intramedullary nailing is a common method for treatment of tibial shaft fractures.' Intramedullary rods are secured within the bone by screws both above and below the fracture the aim of this study was to determine frequency of infection after different types on intramedullary nailing.

In our study total 566 patients were enrolled, 283 patients in each group. Age was comparable in both group, p-value 0.061. There were 51.2% males in group A and 48.8% in group B, females were 46.7% in group A and 53.3% in group B, p-value 0.341. Physical parameters were similar in both group p-value for weight was 0.66, height 0.279 and BMI 0.739. Duration of injury was similar in both group, p-value 0.311. Infection rate was significantly greater in group A i.e. 18% and 10.6% in group B, p-value 0.012. Data stratification was done for age groups was significant, p-value 0.001 and 0.006 for younger age group and elder age group respectively. Data stratification was done for gender, p-value 0.114 and 0.014 for male and female patients respectively. Data stratification was done for height groups, p-value 0.134 and 0.014 for short height and long height group respectively. Data stratification was done for weight groups, p-value 0.222 and <0.001 for low weight and increased weight respectively. Data stratification was done for BMI groups was significant, p-value 0.006 and 0.009 for normal BMI and obese patients. Data stratification was done for duration of injury was significant, p-value <0.001 and 0.028 for shorter and longer duration of injury younger age group and elder age group respectively.

Our results were similar to other studies. A study comparing the effects of reamed versus unreamed locked intramedullary nailing on cortical bone blood flow in a fractured sheep tibia model suggested that cortical circulation is spared to a greater degree by unreamed nailing [7]. Another study that aimed to construct a computational model of the biomechanical performance of reamed versus unreamed intramedullary tibial nails showed that the interlocking bolts, in general, were subjected to higher stresses in the unreamed tibial nail than in the reamed one; thus the former stabilization technique is more likely to fail due to fatigue [8]. Yet another study demonstrated that optimum outcome was achieved for reamed intramedullary nailing in case of vast majority of tibial diaphyseal fractures [9]. A study published in 2017 in "International Journal of Orthopedic;" showed that 4 out of 25 patients having reamed intramedullary nailing developed infection and 2 out of 25 developed infection in unreamed intramedullary nail group [6]. El Maraghy et al [10] reported that reaming might destroy the nutrient artery and decrease bone blood flow in the diaphysis. Based on this, researchers predicted that bone blood supply that was reduced due to reaming damage could influence fracture healing and increase the risk of infection [11]. A metanalysis included seven trials with 952 patients (965 fractures), compared unreamed nailing with reamed nailing and found that unreamed nailing has significantly lower infections rate (RR 0.25, 95% CI 0.11-0.59, P = 0.002) [12].

6. Conclusion

Among other complication of the reamed interlocking nail infection is one of the most common complication while Unreamed intramedullary nailing has low infection rates as compared to reamed intramedullary nailing.

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