Orginal Article

Correlation Between Tibia Nail Length and Tip of Olecranon to Fifth Metacarpal Head Measurement

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Introduction: Tibial shaft fractures, constituting nearly 2% of all adult fractures, are frequently managed with intramedullary (IM) nails, necessitating precise nail sizing for optimal outcomes. While various preoperative and intraoperative methods for tibial nail length measurement exist, anthropometric approaches offer promising alternatives. This study investigates whether the distance from the tip of the olecranon to the fifth metacarpal head (O-MH) can reliably estimate tibial nail length, compared to the established tibial tuberosity to medial malleolus (TT-MM) measurement.

Methods: A prospective, single-center observational cross-sectional study was conducted at Kathmandu Medical College and Teaching Hospital (KMCTH), Kathmandu, Nepal, from July 1, 2023, to June 30, 2024. Ethical clearance was obtained. Participants included individuals aged over 18 with tibial shaft fractures. Exclusion criteria encompassed severe fractures, prior injuries, congenital deformities, and hereditary bone diseases. Measurements of TT-MM and O-MH were taken, and Spearman's rank correlation was used to assess the relationship between these measurements. Regression analysis further evaluated their predictive power.

Results: The study involved 96 patients, predominantly male (72.9%). The Spearman's rank correlation coefficient between TT-MM and O-MH was 0.802 ($p = 0.000$), indicating a strong positive correlation. Regression analysis revealed that O-MH significantly predicts tibial nail length, with a coefficient of 0.920 and a Beta of 0.808.

Conclusion: The O-MH measurement demonstrates a strong correlation with TT-MM and effectively predicts tibial nail length. This method provides a reliable alternative for preoperative estimation, particularly in cases where direct measurements are challenging.

Keywords: *Intramedullary nails, olecranon to fifth metacarpal head, preoperative assessment, tibial shaft fractures, tibial tuberosity to medial malleolus*

Introduction

In modern day Orthopaedics, long bone fractures are major constituents with fracture patterns becoming more complex than ever before.[1] Tibial shaft fractures encompass nearly 2% of all adult fractures and it is one of the most common type of long bone fracture.[1] Various methodologies to measure the length are already in vogue.[2] Intramedullary (IM) nails are the most commonly used method for stabilization in the treatment of unstable acute tibia and femur fracture.[3] The choice of the correct nail size is very important for acceptable outcomes.[3] Intramedullary nails, which are shorter can lead to a suboptimal working length with resultant malreduction or loss of rotation.[4] Correspondingly, a shorter nail can become problematic

during extraction if submerged totally.[4] The longer nails result in fracture gap, disruption, impingement of the neighboring tendon or projection into the adjacent joint.[4] Tibial nail length measurement can be assessed both before the surgery and during the surgery.[5] Various procedures have been mentioned in the literature for estimation of the accurate nail size.[5,6] The intra operative approaches include the two-guide wire technique, nail-against-limb technique and using a radiographic ruler.[5,6] The preoperative radiological methods described are krammer splint technique, templating, scanograms, spotograms and direct measurement from radiographs of the contralateral limb.[7,8] Anthropometric measurements have also been used to estimate the correct nail size in tibia and femur preoperatively by measuring the length in the opposite leg and thigh respectively.[9] The simplest method is to measure the distance from tibial tuberosity to medial malleolus.[10] It has proven to be a simple, inexpensive, and accurate method for the preoperative evaluation of the tibial nail length.[10] The preoperative assessment of nail size has the prospective to decrease the intra-operative errors, operative time and radiation exposure.[11]

This study aims to explore the relationship between anthropometric measurements and length of tibia and find out whether olecranon to 5th metacarpal head (O-MH) distance can serve as a reliable alternative method to estimate tibial nail length in cases where indirect measurements using contralateral tibia cannot be used.

Methods

A prospective single-center observational cross-sectional study was conducted on patients undergoing nailing procedures for tibial shaft fractures at the Department of Orthopedics, Kathmandu Medical College and Teaching Hospital (KMCTH), Sinamangal, Kathmandu, Nepal, from July 1, 2023, to June 30, 2024. Ethical clearance was obtained from the Institutional Review Committee of KMCTH (reference number: 12052023/11). Inclusion criteria included (1) Patients over 18 years of age (2) Skeletally matured individuals (3) Shaft of tibia fracture (4) Both closed and open (GA I, II and IIIA) fractures. Exclusion criteria included (1) Patients having fractures with bone loss and severe comminution (2) Patients with previous fractures of tibia, forearm, metacarpals (3) Patients with congenital limb length shortening (4) Patients with hereditary bone diseases. Non-probability convenience sampling method was used. The sample size was calculated using the following formula:

$n = z^2p(1-p)/e^2$

$z=1.96, p=0.5, e=0.1$

$n = 1.96^2 * 0.5* (1-0.5)/ 0.1^2 = 96.04$

$n= 96$

Where,

z = confidence level at 95% (standard value of 1.96)

p = estimated prevalence = 50% (according to a previous study)[12]

e = margin of error = 10%

The tip of olecranon to fifth metacarpal head (O-MH) measurement was taken from tip of olecranon to the tip of 5th metacarpal head with wrist in neutral position and hand clenched. (Figure 1)

Figure 1: Olecranon to 5th metacarpal head (O-MH) measurement

The tibial tuberosity to medial malleolus (TT-MM) measurement was taken from the tibial tuberosity to the tip of medial malleolus with the patient in a supine position and the leg extended. (Figure 2)

Figure 2: Tibial tuberosity to medial malleolus (TT-MM) measurement

The data was entered and analyzed in SPSS version 26. Standard descriptive statistics were used. Since we found that the data is not normally distributed, we used non-parametric test, that is Spearman's rank correlation for correlation analysis Spearman's rank correlation coefficient assesses the strength and direction of association between two ranked variables. It does not assume normality in the data and is appropriate when data does not meet normal distribution assumptions. Spearman's rank correlation was used to assess correlation between Tibial TT-MM and O-MH measurements and regression analysis was done to establish a mathematical relationship between these variables.

Results

The study included a total of 96 participants. Among this cohort, there was a male preponderance, with 70 male patients (72.9%) compared to 26 female patients (27.1%). The age distribution among participants exhibited a mean age of 35.9013.17 years. The median age was 31.00 years, with a mode of 30 years. Age ranged widely from 17 to 88 years, reflecting the diversity of the participant cohort. The majority of injuries resulted from Road Traffic Accidents (RTA), accounting for 79 patients (82.3%). Falls from height were reported in 16 patients (16.7%), while physical assault was reported in 1 patient (1%).
The Spearman's rank correlation coefficient (□) between TT-MM and O-MH is 0.802, which indicates a strong positive monotonic relationship between these two variables. (Table 1)

Table 1: Spearman's Rank Correlation Coefficients Between TT-MM and O-MH Measurements

		TT-MM	O-MH
TT-MM	Correlation Coefficient	1.000	.802**
	Sig. (2-tailed)		.000
	N	96	96
O-MH	Correlation Coefficient	.802**	1.000
	Sig. (2-tailed)	.000	
	N	96	96
**. Correlation is significant at the 0.01 level (2-tailed)			

The p-value of 0.000 indicates that this correlation is statistically significant at the 0.01 level, suggesting that the observed correlation is unlikely to have occurred by chance.

We also performed regression analysis to establish a mathematical relationship between these variables. The coefficient (B) of O-MH is 0.920. This means that for every one unit increase in O-MH, nail length is expected to increase by 0.920 units, holding all other variables constant. The Beta coefficient (0.808) indicates the standardized effect size, showing that O-MH has a strong positive influence on nail length. (Table 2)

Table 2: Regression Analysis of O-MH on TT-MM Measurements

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	2.462	2.288		1.076	.285
O-MH	.920	.069	.808	13.289	.000

The results indicate that O-MH measurement significantly predicts tibial nail length. The positive coefficient suggests that as O-MH increases, nail length tends to increase as well.

Discussion

Numerous studies corroborate that the most accurate preoperative estimate of tibial nail length is obtained through direct or indirect measurement of the distance between the tibial tuberosity and the medial malleolus.[7-9] Our study aimed to compare the O-MH measurement with the TT-MM measurement, analyze the gender and age distribution of tibia fractures, and evaluate the mechanisms of injury leading to tibia fractures.

While preoperative anthropometric measurements of the contralateral tibia can provide a good estimate of tibial nail length, obtaining an accurate measurement may be challenging in cases of obesity, swollen limbs, bilateral tibial fractures, and congenital or acquired deformities. Therefore, an alternative measurement, particularly one taken from the upper limb, that closely correlates with the tibial tuberosity to medial malleolus measurement, would be highly useful in such scenarios.

According to Galbraith et al., intraoperative techniques such as the guide wire method and the radiographic ruler demonstrate an excellent accuracy rate of 94%.[12] Intraoperative techniques may be prone to inaccuracies due to eccentric C-arm placement, measuring from the lowest exposed part of the guide wire, or not positioning the radiographic ruler close and parallel to the tibia.[12] These methods are also inappropriate for comminuted tibia fractures, where normal leg length restoration requires comparison with the contralateral side.[12] Furthermore, they lead to increased fluoroscopic exposure for operating room personnel and longer operating times.[12] Despite their high accuracy, they provide no scope for preoperative planning and are not recommended in isolation for estimation of tibial nail length.[9, 12]

Our study revealed a strong correlation between the TT-MM and O-HM measurements. In a similar study done by Hegde et al in 2019, they also found a strong correlation between TT-MM and O-MH.[10] Similar correlation was found in another study by Bekele et al with a sample size that was considerably higher.[13]

A limitation of this study is the homogenous sample of volunteers from a single hospital. To validate these findings comprehensively, a multicentric study involving diverse ethnic populations is essential. In summary, the O-MH measurement emerges as a highly effective and accurate tool for preoperative estimation of tibial nail length. It demonstrates reliable applicability across different genders and age groups.

Conclusion

The results underscore the clinical relevance of O-MH measurements in predicting tibial nail length during orthopedic procedures. The strong correlation and predictive power observed highlight the potential utility of

O-MH as a reliable anatomical marker in surgical planning, contributing to more precise and tailored interventions.

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