*Ethiopian Medical Journal 2024, 62(supplement 1)*

*ISSN 0014-1755 eISSN 2415-2420* *Bekele et al.*

## Original Article

# Correlation of Tibial Nail Length with Olecranon to Fifth Metacarpal Head Measurement : A Facility Based Cross-Sectional Study

Anteneh Bekele[1]*, Biniyam Dagnaw[1], Samuel Tesfaye[1], Biruk Lambisso Wamisho[1], Yordanos Girma[1]

[1]Tikur Anbessa Specialized Hospital, Ethiopia

Corresponding authors*: antenehbekele@gmail.com

**Abstract**

***Background:*** *The gold standard of care for a tibial shaft fracture is an intramedullary nail. When selecting the correct nail size, it is crucial to assess the length of the tibial bone before surgery. This study aimed to evaluate the feasibility of using the length of the olecranon to the fifth metacarpal head as an alternative method for determining the appropriate length of a tibial nail in situations where measurements using the contralateral tibia are not possible.*

***Method:*** *A Cross-sectional study was conducted at Tikur Anbesa Specialized Hospital, involving 150 volunteers aged 18 or older attending the orthopedics outpatient department as patient's attendant. Two observers conducted measurements using a tape meter. The length of the tibial nail was estimated by measuring the distance from the tibial tuberosity to the medial malleolus (TMD). Forearm measurement was obtained from the tip of the olecranon to the tip of the fifth metacarpal head, with the wrist in a neutral position and the hand clenched (OMD). Pearson's correlation test was used to assess the correlation between the two measurements. Hierarchical regression analysis was conducted to examine the impact of age, gender, and BMI on these measure- ments and their associations.*

***Result:*** *A significant positive correlation between TMD and OMD was observed (Pearson correlation coefficient of (r) 0.927 ($p < 0.001$). The mean OMD measurement was 34.19 cm, while the TMD measurement was 34.1 cm. A hierarchical regression analysis revealed age, gender and BMI did not have statistically significant influence on these measurements and their correlation.*

***Conclusion:*** *The study suggests that tibial nail length can be estimated using forearm measurement in situa- tions where contralateral tibia measurement is not possible.*

***Keywords****: Tibial Nail Length, Olecranon to metacarpal head, Forearm, correlation*

***Citation :*** *Bekele A, Dagnaw B, Tesfaye S et al. Correlation of Tibial Nail Length with Olecranon to Fifth Meta carpal Head Measurement : A Facility Based Cross-Sectional Study Ethiop Med J 62 (supplement 1) 99-103*

***Submission date :*** *5 November 2023 Accepted: 29 January 2024 Published: April, 2024*

## Introduction

Fracture of the tibia shaft are the most commonly occurring long bone fractures in in both developed and developing countries [1, 2]. According to research conducted at the Tikur Anbessa specialized Hospital has revealed that tibia fracture accounts for 15.4% of all fractures reported at the hospital [3]. The intramedullary nail is the standard of treatment for majority of diaphyseal tibial bone fractures, which gives a stable construct with minimal soft tissue damage, and important for early mobilization [4, 5].

It is essential to estimate tibial nail length preoperatively for satisfactory outcomes. It helps to prepare the correct nail size range preoperatively, avoid unnecessary delay in the operating room and avoid revision surgeries. Using a shorter nail may lead to malreduction, short working length and implant failure. Similarly, the removal of a short nail can pose challenges if it is buried too deeply. A longer nail may cause fracture site distraction, impingement of the patellar tendon, and penetration of the nail to the ankle joint [6]. Tibial nail length measurement can be assessed both before the surgery and during the surgery. Intraoperative estimation is the most precise method; however, it may lead to extended surgical durations and heightened radiation exposure. The intraoperative methods include two guide wires -technique, the nail-against-limb technique, and using a radiographic ruler [6-8]. The preoperative radiological techniques outlined include the krammer splint technique, scanograms, spotograms, templating, and direct measurements obtained from radiographs of the contralateral limb [9, 10]. There are different anthro-

pometric methods to measure preoperatively [11-13]. This encompasses measurements from olecranon to fifth metacarpal head, medial knee joint line to ankle joint line, medial knee joint line to medial malleolus, tibial tuberosity to the ankle joint, tibial tuberosity to medial malleolus and body height. The tibial-tubercular-medial malleolus distance (TMD) has proven to be a simple, inexpensive, and accurate method for the preoperative evaluation of the tibial nail length. Most of the above methods necessitate an intact contralateral tibia for measurements, making them unsuitable for cases of bilateral tibia fracture [9-14]. This study aims to determine whether olecranon to the fifth metacarpal head (O-MH) length can serve as a reliable alternative method to measure nail length of tibia in cases when indirect measurements using the contralateral tibia are not feasible.

**Methods and Materials**

This is a hospital-based descriptive cross-sectional study conducted from June 2023 to July 2023 at TASH. After department level ethical clearance were obtained, a simple random sampling technique was employed to select 150 healthy volunteers (patient attendants) who were 18 years or older and had visited TASH orthopedics outpatient department during the study period.
Sample size is determined using single population proportion formula:

$$\frac{n=(P)(1-p)(Z\alpha/2)^2}{d^2}$$

Where n= Total number of participants who participated in the study

P = prevalence of tibia fracture 10% in research conducted in Tikur Anbessa Speciallized Hospital[1].

Z= at 95% confidence interval is 1.96 d= margin of error which is taken as 5%

The calculated result is **138**. By adding 10% non-response rate, the total sample size becomes **150**. People who had previous tibial shaft fracture, forearm fracture, metacarpal bone fracture, congenital or traumatic limb deformity, limb amputation and age less than 18 years old were excluded from the study.
Age, sex and Body Mass Index of all the patients were recorded using a standardized questionnaire. Two observers independently conducted measurements using a tape meter, and the average of their recorded values were determined. The length of the tibial nail was estimated by measuring the distance from the most prominent point of tibial tuberosity to the most prominent point of the medial malleolus (TMD), as depicted in Figure 1. Forearm measurement was obtained from the tip of the olecranon to the tip of the fifth metacarpal head, with the wrist in a neutral position and the hand clenched (OMD), as depicted in Figure 2.

**Figure 1** OMD measurement

**Figure 2** TMD measurement

**Results**

The result of the study showed the following. All the data were normally distributed. Among the 150 volunteers involved in the study, 81 (56%) were males and 69 (46%) were females. More than 70% of participantsare between age of 20-40 years. The average BMI was 23.4kg/$m^2$.

The mean TMD length was 34.1 cm and the mean OMD were 34.19 cm, the results are summarized in table 2. Liner scatter plot of TMD and OMD observed as seen in figure 4. The result showed a significant positive correlation between TMD and OMD, as evidenced by a Pearson correlation coefficient of (r) 0.927 ($p < 0.001$).

A hierarchical regression analysis was conducted to examine the impact of age, gender and Body Mass Index on these measurements and their associations, as summarized in table 3.

The results of this analysis revealed none of these variables exerted a statistically significant influence on these measurements and their correlation.

Table 1: Mean measurements of height, weight and BMI

| Variables | Mean | Std, Deviation |
|---|---|---|
| Height in meters | 1.65 | .088 |
| Wight in kilo gram | 64.04 | 12.4 |
| BMI | 23.44 | 4.05 |

Table 2: Descriptive TMD and OMD measurements

| Variables | OMD in cm | TMD in cm |
|---|---|---|
| Mean | 34.19 | 34.1 |
| Minimum | 27.5 | 27.5 |
| Maximum | 38.7 | 39 |
| Std. Deviation | 2.17 | 2.19 |

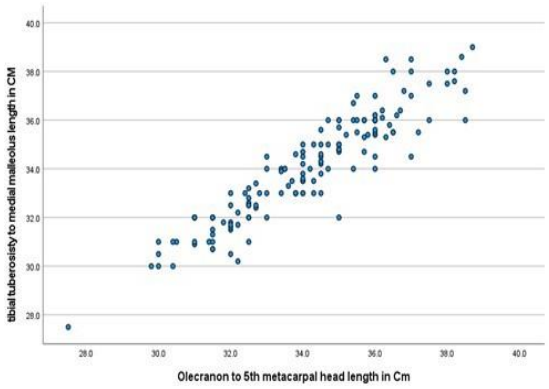


**Figure 4** Liner scatter plot

**Discussion**

Our study's descriptive analysis showed that mean TMD measurement was 34.19 cm, while the mean OMD was approximately 34.1 cm. In contrast, a prior study conducted by Blair S. at Doncaster Royal Infirmary using similar forearm referencing technique reported slightly different values, with mean TMD 34.2 cm and OMD 35.2 cm. In his paper no case was the TMD longer than the OMD. However, in our study, we observed a difference; the average TMD measure- ment was longer than OMD compare to his paper[15]. Our study revealed a significant positive correlation between TMD and OMD, as evidenced by a Pearson correlation coefficient (r) of 0.927 (P< 0.001). This strong correlation suggests that OMD is a relia- ble alternative measurement for estimating tibial nail length, especially when TMD measurement not feasible or accurate. The result also indicated that age, gender and Body Mass Index have no statistically significant effect on these measurements and association.This finding aligns with previous research and further supports the use of OMD as a valuable preoperative measurement. In A. Hegde et al.'s study (2019), they found a strong correlation between TMD and OMD through Pearson's correlation test (r = 0.966). Similar to our study, they also discovered that age, gender,and Body Mass Index did not have a significant im- pact on these measurements and their correlation. Re- search conducted in Khartoum, Sudan, by Hassan El- bahri (2021) revealed that the statistical analysis indicates a significant positive correlation between OMD and TMD (with a significance level of less than 0.01),which is consistent with the findings in our study [16].

**Conclusion and Recommendation**

In conclusion, this study provides valuable insights into tibial nail length estimation and highlights theutility of OMD as an alternative measurement in case where TMD measurement may be challenging. This study also demonstrated its reliability across different genders, age groups, and BMI categories. Additional- ly, the strong correlation between TMD and OMD reaffirms the potential of OMD as a reliable preopera- tive measurement. This research contributes to the optimization of tibial nail length estimation and may ultimately lead to improved surgical outcomes and reduced intraoperative complications.

Building upon these findings, we recommend further investigations with larger and more diverse samples to validate the robustness of OMD as a reliable measurement for the tibial nail length estimation. Moreover, additional studies could explore the correlation of OMD measurement and tibial nail length measure-ment in a patient with tibial shaft fracture in a clinical setting.

**Limitation and strength**

The limitation of our study is the homogenous sample of volunteers from a single hospital. The strength of

**Table 3:** Hierarchical Regression analysis

| Model | t | Sig. |
|---|---|---|
| (Constant) | 1.960 | .052 |
| Olecranon to 5th metacarpal head length in Cm | 30.100 | <.001 |
| (Constant) | 1.331 | .185 |
| Olecranon to 5th metacarpal head length in Cm | 22.710 | <.001 |
| Age | -.794 | .429 |
| Gender | .502 | .616 |
| BMI | -1.519 | .131 |

our research in contrast to earlier studies, our re-search has larger sample size 150 volunteers.

**Ethical considerations**

Before conducting data collection, approval was obtained from Addis Ababa University and informed consent was taken from all the participants. The confidentiality of patient's medical information was maintained throughout the project.

**Conflict of interest**

The authors report no conflicts of interest in this work.

**Acknowledgement**

The authors would like to extend their gratitude to the Department of Orthopedics and trauma surgery at Tikur Anbessa Specialized Hospital (TASH).

**References**

1. Chalachew Tiuneh, G.S., Gemechs Regasa and B.L., Clinical profile and patterns of extremity fractures in orthopedics department in tikur anbessa specialized hospital. Ethiop Med J, ,, 2020. Vol. 58, No. 2
2. Biruk L.Wamisho, S.A., Alpha Seifu, Girma Seyoum,, Anatomical profile of musculoskeletal and neurological disorders among patients attending physiotherapy unit at tikur anbessa specialized hospital. Ethiop Med J, 2020. Vol. 58, No. 4.
3. Hailu, S., H. Gebre, and G. Alemayehu, , Orthopaedic injury patterns at a tertiary referral hospital in Ethiopia: a prospective observational study. Injury, . 2022. . 53(10): p. 3195-3200. .
4. Hegde, A., N. Mohammed, and N.R. Ahmed, Correlation between tibial nail length and olecrenon to 5th metacarpal head measurement: An anthropometric study. Chin J Traumatol, 2019. 22(6): p. 361-363.
5. Ahimed, E., outcome of SIGN Nail iniciative in treatment of long bone fractures in Addis Ababa, Ethiopia. . 2011. . ISSN 2073- ISSN 2073-9990. .
6. Hernandez-Vaquero, D., et al., Dynamisation and early weight-bearing in tibial reamed intramedullary nailing: its safety and effect on fracture union. Injury, 2012. 43 Suppl 2: p. S63-7.
7. Waldron, V.D., Predicting intramedullary nail length. Am J Orthop (Belle Mead NJ), 1998. 27(5): p. 383.
8. Krettek, C., et al., [Current status of surgical technique for unreamed nailing of tibial shaft fractures with the UTN (unreamed tibia nail)]. Unfallchirurg, 1994. 97(11): p. 575-99.
9. Colen, R.P. and D.W. Prieskorn, Tibial tubercle-medial malleolar distance in determining tibial nail length. J Orthop Trauma, 2000. 14(5): p. 345-8.
10. Mosheiff, R., et al., "Krammer splint technique" for immediate measuring of intramedullary nails. Am J Orthop (Belle Mead NJ), 1997. 26(5): p. 375.
11. Issac, R.T., et al., Preoperative determination of tibial nail length: An anthropometric study. Chin J Trau-

matol, 2016. 19(3): p. 151-5.
12. Galbraith, J.G., et al., Preoperative estimation of tibial nail length--because size does matter. Injury, 2012. 43 (11): p. 1962-8.
13. Jain RK, D.M., Bohra T, Jain N, Gulve M, , Correlation of Various Anthropometric Measurements with Tibia Interlocking Nail Length Measured Intra-Operatively. . Orthopaedic Journal of M P . , 2021. Vol. 27. (Issue 1. ).
14. Shrestha, S., et al., Preoperative Determination of Tibia Length Using Contralateral Tibial Tubercle-Medial Malleolar Distance (TMD) in Western Part of Nepal. Journal of Universal College of Medical Sciences, 2021. 9(01): p. 9-12.
15. Blair, S., Estimating tibial nail length using forearm referencing. Injury, 2005. 36(1): p. 160-2.
16. Elbahri, H.A., Mohamed, Abdelgadir, Riyad, Estimation of Femoral and Tibial Nail Length Using Forearm Plus Little Finger as Reference in Sudanese Patients. 2021