

Correlation of Femoral Length and Forearm Plus Little Finger Length for Measurement of Intramedullary Nail Length for Femoral Fracture Fixation

Atif Shahzad, Farooq Azam Khan, Nisar Ahmed, Jawad Asghar Chishti, Zahid Bashir, Zakria Tariq

ABSTRACT

Objective: To determine the correlation between the femoral length and the forearm plus little finger length for the measurement of intramedullary femoral nail length for the femoral fracture fixation.

Methodology: This cross-sectional study was conducted in the Orthopaedic Department of the Services Hospital, Lahore. The study was approved by the ethical committee of the institution. The study included 120 adults of either gender and age 18-50 years with femoral shaft fractures by nonprobability consecutive sampling technique. After taking informed written consent from the patients, their demographic profile was noted on proforma. The femoral length was recorded with the help of a measuring tape from the superior pole of the patella to the greater trochanter of the intact femur and recorded in centimeters. The forearm plus little finger length was measured with the help of a measuring tape from the olecranon process of the ulna to the tip of the little finger and recorded in centimeters. The length of the nail used was recorded as well. Data analysis was done by the Statistical Package for the Social Sciences (SPSS) version 23.

Results: In this study, the mean age of the patients was 33.12±10.65 years. There were 77(64.2%) male and 43(35.8%) female patients. According to body mass index, 29(24.2%) patients were obese and 91(75.8%) patients were non-obese. A total of 62(51.7%) patients had left-sided fracture and 58(48.3%) patients had the right side involved. In this study, the mean femoral length was 41.47±1.64 cm. The mean length of the forearm plus little finger was 41.47±1.71 cm. Correlation of femoral length and length of forearm plus little finger was positively significant ($r=0.885$, $p\text{-value}<0.00001$).

Conclusion: Measurement of the forearm plus little finger length is a convenient method to determine the femoral length for intramedullary nailing. In our study, a significant correlation is found between the forearm plus little finger length and the femoral length. It can also be used in patients with bilateral fractures of the femur. Hence, it can be implemented in clinical practice to avoid other expensive and possibly harmful means.

Keywords: Femoral fracture. Forearm plus little finger length. Femoral length. Intramedullary nail.

INTRODUCTION

Femoral shaft fractures account for the majority of the fracture of the lower limb. The incidence of diaphyseal femur fractures in adults is approximately 10 per 100,000 people annually.¹ The fractures of femoral shaft usually occur in males of age 15-24 years with increased incidence in elderly males and females.² The femoral shaft fractures are usually diagnosed clinically and the patient presents with an inability to bear weight, deformed shape of thigh and severe pain.³ Most of the fractures occur due to high-speed trauma with associated injuries.⁴

The fractures of the shaft of the femur were treated initially with the use of wooden splints, fabrics encased with wax, clay or gum stiffened bandages and plaster of paris.^{3,5} Presently, these fractures are not managed conservatively except in underdeveloped countries or war surgery.⁶

The most common operative treatment modality for

these fractures is intramedullary nailing.^{7,8} It is mandatory to evaluate the personality of fracture including its type, extent of the fracture, the status of soft tissue and comminution for the definitive procedure.^{9,10}

Intramedullary nailing provides a stable environment for osteosynthesis. It does not require external fixation and any special postoperative care. It allows early movement of the joint and weight-bearing.¹⁰ Its healing time is rapid with shorter hospitalization. Malunion and shortening of the limb are less common after intramedullary nailing.^{9,10} Preoperative femoral nail length can be measured by putting the nail over the other normal thigh and doing a radiograph. This method is mostly cost-ineffective and causes the necessary exposure to radiation. Patients can also be assessed by measuring the length from greater trochanter to the superior pole of patella but this method is inconvenient and painful.^{11,13} A new method of femoral length determination has been introduced which involves the measurement of the forearm length extending from olecranon tip to the end of the little finger.^{9,11-13}

The rationale of this study was to establish the correlation between the femoral length and the forearm plus little finger length for the measurement of intramedullary femoral nail length. This study has not been done in our population and there is no established

Sharif Medical and Dental College
Sharif Medical City Road, Off Raiwind Road, Jati Umra,
Lahore 54000, Pakistan.

Correspondence: Dr. Atif Shahzad
Medical Officer Department of Orthopedic Surgery
Aziz Bhatti Shaheed Hospital, Gujrat
E-mail: atif293@gmail.com

Received: November 4, 2019; Accepted: December 3, 2019

local data on this correlation. This study can facilitate us to generate evidence about this correlation for the local population and we can use this correlation for the measurement of intramedullary femoral nails in patients with femoral shaft fractures especially in bilateral fractures and in places where the preoperative radiographic facility is not available.

METHODOLOGY

It was a cross-sectional study conducted in the Orthopaedic Department of Services Hospital, Lahore. The study was approved by the ethical committee of the institution. The study included 120 adults of either gender and age 18-50 years with femoral shaft fractures by nonprobability consecutive sampling technique. The diagnosis of femoral shaft fractures was confirmed on the radiograph. The exclusion criteria of the study was patients with open fracture of femur, ipsilateral fracture of neck of femur, pertrochanteric fracture & supracondylar fracture on radiographs, bilateral fractures of radius & ulna, carpal bones, 5th metatarsal & phalanges of little finger, congenital or traumatic deformity of forearm & hand and previous healed fracture of shaft of femur revealed by history and radiographs.

After taking informed written consent from the patients, their demographic profile was noted on proforma. All patients were examined by the orthopedic surgeon. The femoral length was recorded with the help of a measuring tape from the superior pole of the patella to the greater trochanter of the intact femur and recorded in centimeters. The measurement of the length of the forearm plus little finger was done using a measuring tape from the olecranon process of the ulna to the tip of the little finger and recorded in centimeters. The length of the nail used was recorded as well.

STATISTICAL ANALYSIS

The Statistical Package for the Social Sciences (SPSS)

version 23 was used for data analysis. Frequency and percentage were calculated for gender and body mass index (BMI). Mean and standard deviation (SD) were calculated for age, femoral length and forearm plus little finger length. The correlation of femoral length with forearm plus little finger length was calculated using the Pearson correlation coefficient (r) with a p-value of ≤ 0.05 taken as significant.

RESULTS

The study participants had a mean age of 33.12 ± 10.65 years. The age of the patients ranged from 18-50 years. Fifty two (43.3%) patients were < 30 years old and 68 (56.7%) patients were ≥ 30 years of age. There were 77 (64.2%) male and 43 (35.8%) female patients. According to BMI, 29 (24.2%) patients were obese and 91 (75.8%) patients were non-obese. A total of 62 (51.7%) patients had a left-sided fracture and 58 (48.3%) patients had the right side involved.

In this study, the mean femoral length was 41.47 ± 1.64 cm with a range of 36-45 cm. The mean length of the forearm plus little finger was 41.47 ± 1.71 cm with a range of 35-45 cm. Correlation of femoral length and length of forearm plus little finger was positively significant i.e. $r=0.885$, $p\text{-value} < 0.00001$ (Figure 1).

On stratifying data we found that the correlation of femoral length and length of forearm plus little finger was positively significant in patients aged < 30 years ($r=0.914$, $p\text{-value} < 0.00001$) as well as in patients aged ≥ 30 years ($r=0.842$, $p\text{-value} < 0.00001$). The correlation of femoral length and length of forearm plus little finger was found significant in both male ($r=0.686$, $p\text{-value} < 0.00001$) & female ($r=0.933$, $p\text{-value} < 0.00001$) patients. Correlation of femoral length and length of forearm plus little finger was positively significant in obese patients ($r=0.893$, $p\text{-value} < 0.00001$). Correlation was also found significant ($r=0.903$, $p\text{-value} < 0.00001$) in non-obese patients (Table 1).

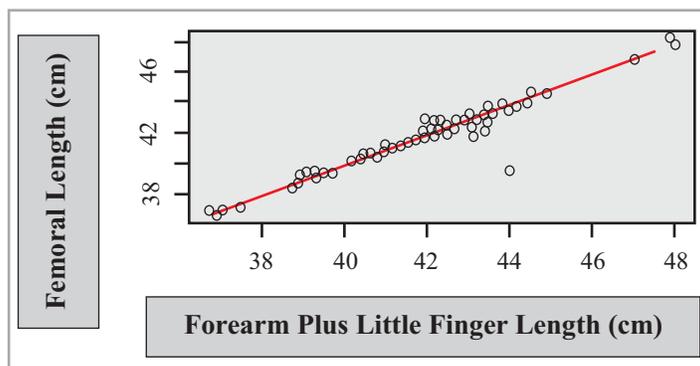


Figure 1: Scatter Graph Showing Linear Correlation of Femoral Length with the Forearm Plus Little Finger Length

Table 1: Correlation of the Femoral Length and Forearm Plus Little Finger Length with Respect to Demographic Variables

Demographic Variables		Pearson Correlation Coefficient (r)	p-value
Age	<30 years	0.914	<0.00001
	≥30 years	0.842	<0.00001
Gender	Male	0.686	<0.00001
	Female	0.933	<0.00001
BMI	Obese	0.893	<0.00001
	Non-obese	0.903	<0.00001

DISCUSSION

The femur is the main weight-bearing bone of the lower limb. It is the strongest tubular bone of the body.^{6,8} Femoral shaft fractures are fixed mostly with intramedullary nailing in adults.^{1,3} The method being used nowadays to determine femoral nail length is the measurement of the distance from the superior pole of the patella to the superior aspect of the neck of the femur.¹ The other common methods to determine femoral nail length are radiography, radio-opaque ruler, nail template or Kuntscher oximeter. All of these mentioned methods require an intact opposite femur for correct estimation. In case of bilateral femur fracture, this estimation becomes difficult, inaccurate and is done on less comminuted side.⁸

Estimation of the forearm plus little finger length from the olecranon process tip to the tip of the little finger is a new technique to determine the intramedullary nail length. This method is convenient, cost-effective and does not involve the exposure to the radiation.^{8,12}

In the current study, the patients had a mean age of 33.12±10.65 years with more male patients (64.2%) as compared to females (35.8%). Similar results were found in a study by Naik et al. in which the mean age of the patients was 35.8±9.2 years. Sixty eight patients were males and 32 were females.⁹

In this study, the mean femoral length was 41.47±1.64 cm with a range of 36-45 cm and the mean length of the forearm plus little finger was 41.47±1.71 cm with a range of 35-45 cm. Correlation of femoral length and length of forearm plus little finger was positively significant (p-value <0.001).^{9,13-15} Similar results were reported by other studies.

We found that the correlation of femoral length and length of forearm plus little finger was positively significant in patients of age <30 years as well as in patients of age more than 30 years. Similarly, this correlation was also significant in both male and female & obese and non-obese patients. So, there results indicated that there is no effect of age, gender and BMI of the patients on the correlation. Similar results were found in other studies with no significant association of demographic variables with the femoral length and length of forearm plus little finger.

In a study by Naik et al., the mean femoral length and forearm plus little finger length were 39.85±2.44 cm and 39.87±2.73 cm, respectively and the correlation of these values was significant (p<0.001). The patient's age, gender and BMI did not affect this correlation.⁹ A study conducted in Liverpool, the United Kingdom in 2018 also concluded that the length of the forearm plus little finger represents an ideal length for the nail of the femur. In this study, the mean length of the forearm plus little finger was 38.86±2.83 cm and the mean length of the intramedullary nail was 38.56±2.77 cm. Correlation between these two variables showed significant results with r=1.¹³ Another study conducted in India showed that the correlation between the femoral length and the forearm plus little finger length was significant (p<0.001) with no effect of age, gender and BMI.¹⁴

A study was conducted in Nepal in which preoperative assessment of K-nail length was done in 500 patients by three different methods and compared. The first method measured the length of K-nail from the tip of the greater trochanter to the medial joint line of the knee. In the second method, length from olecranon process tip to the end of the little finger was noted and 3rd measurement was taken from the greater trochanter tip to the superior pole of the patella. The mean length of all three measurements was analyzed and the length from the tip of the olecranon process to the end of the little finger was found more convenient and best method for assessment of intramedullary nail length.¹⁵

CONCLUSION

Estimation of the length of the forearm plus little finger is a convenient method to determine the femoral length for intramedullary nailing. In our study, a significant correlation is found between the forearm plus little finger length and the femoral length. It can also be used in patients with bilateral fractures of the femur. Hence, it can be implemented in clinical practice to avoid other expensive and possibly harmful means.

REFERENCES

1. Weiss RJ, Montgomery SM, Al Dabbagh Z, Jansson KA. National data of 6409 Swedish inpatients with femoral shaft

- fractures: stable incidence between 1998 and 2004. *Injury*. 2009 Mar; 40(3):304-8. doi:10.1016/j.injury.2008.07.017.
2. Hegazy AM. Surgical management of ipsilateral fracture of the femur and tibia in adults (the floating knee): postoperative clinical, radiological, and functional outcomes. *Clin Orthop Surg*. 2011 Jun; 3(2):133-9. doi:10.4055/cios.2011.3.2.133.
 3. Lassus J, Tulikoura I, Kontinen YT, Salo J, Santavirta S. Bone stress injuries of the lower extremity. *Acta Orthop Scand*. 2002 Jun; 73(3):359-68.
 4. Rezek Z. Indications for angiography in penetrating injuries of the extremities. *Rozhl Chir*. 2002; 81(6):293-6.
 5. Bono ES, Smolinski P, Casagrande A, Xu J. Three-dimensional trabecular alignment model. *Comput Methods Biomech Biomed Engin*. 2003; 6(2):125-31. doi:10.1080/1025584031000091687.
 6. Bingham CM, Ovaskainen ML, Tapanainen H, Lahti-Koski M, Sahi T, Paturi M. Nutrient intake and food use of Finnish conscripts in garrison, on leave, and in encampment conditions. *Mil Med*. 2009 Jul; 174(7):678-84.
 7. Weight M, Collinge C. Early results of the less invasive stabilization system for mechanically unstable fractures of the distal femur (AO/OTA types A2, A3, C2, and C3). *J Orthop Trauma*. 2004 Sep; 18(8):503-8.
 8. Powell J, DeGroote R, Seidel J, Buckley RE, McCormack R, Leighton R, et al. Nonunion following intramedullary nailing of the femur with and without reaming - results of a multicenter randomized clinical trial. *J Bone Joint Surg Am*. 2003 Nov; 85(11):2093-6.
 9. Naik MA, Sujir P, Tripathy SK, Goyal T, Rao SK. Correlation between the forearm plus little finger length and the femoral length. *J Orthop Surg*. 2013 Aug; 21(2):163-6.
 10. Kuntscher G. The intramedullary nailing of fractures. *J Orthop Trauma*. 2014 Aug; 28(8):S3-10.
 11. Nazir A, Roy S, Mathur K, Alazzawi S. Estimation of femoral length for intramedullary nail using forearm as reference. *Orthopaedic Proceedings*. 2009; 91(1):37.
 12. Karakas H, Harma A. Estimating femoral nail length in bilateral comminuted fractures using fibular and femoral head referencing. *Injury*. 2007; 38(8):984-7.
 13. Alao U, Liew I, Yates J, Kerin C. Correlation between the length from the elbow to the distal interphalangeal joint of the little finger and the length of the intramedullary nail selected for femoral fracture fixation. *Injury*. 2018 Nov; 49(11):2058-60. doi:10.1016/j.injury.2018.08.024.
 14. Singh G, Singh A, Upadhyay D. A study to evaluate importance of length from tip of olecranon to the tip of little finger in pre-operative assessment of K-nail in fracture shaft of femur in a tertiary care hospital of Bareilly district. *Int Surg J*. 2016 May; 3(2):751-3. doi: http://dx.doi.org/10.18203/2349-2902.isj20161149.
 15. Lakhey S, Pradhan RL, Bishwakarma M, Pradhan S, Pradhanaga S, Pandey BK, et al. Pre-operative assessment of K-nail length in fracture shaft of femur. *Kathmandu Univ Med J*. 2006; 4(3):316-8.

