Original Research Article

Prediction of risk of fracture neck femur even without any radiation exposure simply by measuring the inter- epicondylar distance with the help of sensitive calipers

Subodh Kumar

[1]Associate Professor, Department of Anatomy. Nalanda Medical College Patna, INDIA.
Email: subodh.nmc@gmail.com

Abstract

Fracture neck femur is an important health related problem causing considerable morbidity and sometimes mortality. A number of radiologically measurable variables viz. the neck shaft angle, neck length and neck circumference of femur have been found to have relationship with the risk of fracture neck femur. **Methods:** Our study conducted at the department of Anatomy, Nalanda Medical College Patna, attempted to search for a correlation if any, between such variables and clinically measurable ones like interepicondylar distance and the distance between greater trochanter to lateral epicondyle of femur. After a careful screening, 50 properly seasoned and dry femora were selected in this study, during the period of april 2017 to march 2018. **Results:** All variables were skewed by Kolmogorov-Smirnoff goodness of fit test and right and left femoral groups did not differ significantly for any variable under study. No positive or negative correlation was detected amongst the variables measurable only radiologically and the clinically measurable variables. **Conclusion:** A screening test and subsequent prophylactic measures could have been suggested to prevent the fracture. However, at the end of the study, no suitable alternative to the radiological assessment was detected. Nevertheless, the wide applicability of such a procedure, if ever developed, warrants a quest for other anthropometric variables that can serve the purpose and future studies may be undertaken accordingly.

Key Word: neck femur, epicondylar, greater trochanter, goniometer, calipers

Address for Correspondence:
Dr. Subodh Kumar, Associate Professor, Department of Anatomy. Nalanda Medical College Patna, INDIA.
Email: **subodh.nmc@gmail.com**
Received Date: 08/10/2018 Revised Date: 15/11/2018 Accepted Date: 20/12/2018
DOI: https://doi.org/10.26611/1001911

Access this article online	
Quick Response Code:	Website: www.medpulse.in
	Accessed Date: 03 January 2019

INTRODUCTION

Femur is the longest and strongest bone of the body having two ends and an intervening shaft and helps in transmission of body weight from hip bone to tibia in standing position. Proximal end of femur consists of head, neck and two trochanters. Femoral neck is a constricted part connecting head with shaft at an angle of about 125°-known as angle of inclination or neck shaft angle (NSA); this facilitates the movement of hip joint enabling the limb to swing clear of pelvis. Length of femur is associated with a striding gait and its strength with weight and muscular forces[1]. In standing position the alignment of femora are oblique-their head separated by the pelvic width, their shaft converging downwards and medially to where the knees almost touch. Femoral obliquity varies-it is greater in women due to wider pelvis and shorter femora in comparison to male. Abnormal femoral neck angle (FNA) may be associated with various clinical problems ranging from harmless in toeing gait in childhood to disabling osteoarthritis in adults[2]. Angle of femoral inclination is greatest at birth (almost straight) and gradually diminishes (become more acute) until adult angle is reached (125° approx). The angle is less in female due to wider pelvis and greater obliquity of shaft. The neck is also laterally rotated with respect to shaft-angle of ante-version which is about 10°-15°.There

How to cite this article: Subodh Kumar. Prediction of risk of fracture neck femur even without any radiation exposure simply by measuring the inter- epicondylar distance with the help of sensitive calipers. *MedPulse – International Journal of Anatomy.* January 2019; 9(1): 01-05. http://www.medpulse.in/Anatomy

may be racial variation in angle of ante-version[1]. The neck of femur is narrowest in the midpoint and widest laterally and contour of neck is rounded[1]. The greater trochanter is a large quadrangular projection from junction of neck and shaft. Its postero-superior region projects supero-medially and overhangs the adjacent post surface of neck. The apex or highest point of greater trochanter can be felt sub-cutaneuoslyi.e palpable when muscles are relaxed. The proximal border of femur is about a hand's breadth below the iliac tubercle. The distal end of femur is widely expanded for transmission of weight to tibia having two massive condyles -medial and lateral which are partly articular. Anteriorly the condyles unite and are continiuos with the shaft, posteriorly the are separated by a deep inter-condylar fossa. The lateral condyle is less prominent but more massive than medial condyle and more directed in line with femoral shaft and hence transmits more weight to tibia. The most prominent points on medial and lateral condyles are the two epicondyles which are palpable. The lateral epicondyle gives attachment to fibular collateral ligament. The medial epicondyle liesantero-inferior to adductor tubercle and gives attachment to tibial collateral ligament.

MATERIALS AND METHODS

Study Type: Observational study

Study Place: Our study was conducted at the department of Anatomy, Nalanda Medical College Patna.

Study Period: April 2017 to March 2018.

Study Population: 50 dry femora.

Place of data collection: Dept of Anatomy of Nalanda Medical College Patna.

Study Variables:

- Neck shaft angle or femoral neck angle of femur
- Neck length of femur
- Neck circumference of femur
- Inter-epicondylar distance of femur
- Distance between lateral epicondyle and greater trochanter of femur

Inclusion criteria:

- Properly seasoned and preserved dry femora
- No broken or distorted ends
- No gross deformity
- All bony landmarks well preserved

Exclusion criteria

- Broken bone
- Eroded bone
- Deformed bone

Procedure of data collection

Instruments Used

- Vernier calipers
- Metric tape
- Goniometer

Dry femora were collected from the departments of Anatomy of various medical colleges following the inclusion and exclusion criteria. Bones with visible abnormalities like degeneration, decalcification and loss of bone tissue due to manipulation were excluded. The following measurements were taken from each femora meticulously -neck-shaft angle, neck-length, neck-circumference, inter-epicondylar distance and distance between lateral epicondyle and highest point of greater trochanter. When the plan of the study was undertaken the neck – circumference and the distance between lateral epicondyle and highest point of greater trochanter were not in the proposal. Nevertheless, during the process of data collection it was realized that these variables may also be useful to search for a co-relation among anthropometric parameters. Each parameter was measured thrice and then mean was calculated. All parameters were measured by same observer. The neck-shaft angle was measured by goniometer. The inter-epicondylar distance and the neck length were measured by calipers. The neck circumference and distance between greater trochanter and lateral epicondyle were measured by the metric tape[3]. For measurement of the neck shaft angle the respective bone was first held in its anatomical position, then the two limbs of the goniometer were made to align along the axis of neck and shaft. The angle between the two limbs of goniometer gives the value of the corresponding neck-shaft angle of femur.

Circumference of femoral neck: Measured at midpoint between base of femoral head and inter-trochanteric line with the help of metric tape. For denoting the mid-point of the neck the neck length was first measured and then divided by two. The distance thus obtained is measured either from the inter trochanteric line or from base of head. The point is demarcated with the help of pencil.

Neck shaft angle: Angle between major axis of shaft and major axis of neck (measured at posterior surface of neck).

Length of femoral neck: Distance between inferior region of base femoral head and lower end of inter-trochanteric line on the anterior aspect of femur measured with the help of metric tape.

Inter-epicondylar distance: Distance between medial and lateral epicondyles which are the most prominent points on medial and lateral condyles respectively. The two ends of calipers are fixed on the two epicondyles and distance in between the two ends of calipers gives the value of inter-epicondylar distance.

Distance between lateral epicondyle and greater trochanter: Distance between highest point on greater trochanter to the lateral epicondyle measured by the metric tape.

RESULTS

Table 1: Descriptive statistics of numerical variables Whole cohort. LL = lower limit, UL = upper limit)

	Valid N	Mean	95%CI LL	95%CI UL	Median	Min	Max	Lower Quartile	Upper Quartile	Std. Dev.
NeckLength	50	3.75	3.72	3.79	3.81	3.12	4.23	3.61	3.89	0.213
NeckCirc	50	9.71	9.64	9.79	9.83	8.52	10.50	9.40	10.15	0.481
NeckShaftAngle	50	127.10	126.70	127.49	127.75	118.50	133.50	125.35	128.87	2.489
InterEpiDist	50	5.49	5.43	5.55	5.55	4.58	5.98	5.23	5.80	0.360
GrTrocLatEpiDis	50	35.03	34.95	35.12	34.99	33.47	35.98	34.82	35.43	0.540

Table 2: Descriptive statistics of numerical variables – Left cohort [n =27]

	Valid N	Mean	95%CI LL	95%CI UL	Median	Min	Max	Lower Quartile	Upper Quartile	Std. Dev.
NeckLength	27	3.74	3.69	3.79	3.77	3.12	4.23	3.59	3.89	0.220
NeckCirc	27	9.75	9.64	9.87	9.87	8.53	10.50	9.47	10.15	0.511
NeckShaftAngle	27	126.84	126.23	127.44	127.89	118.50	133.40	124.90	128.82	2.804
InterEpiDist	27	5.45	5.37	5.54	5.51	4.58	5.98	5.15	5.80	0.383
GrTrocLatEpiDis	27	34.99	34.88	35.11	34.96	33.47	35.98	34.82	35.24	0.531

Table 3: Descriptive statistics of numerical variables – Right cohort [n = 23]

	Valid N	Mean	95%CI LL	95%CI UL	Median	Min	Max	Lower Quartile	Upper Quartile	Std. Dev.
NeckLength	23	3.77	3.72	3.82	3.83	3.23	4.11	3.68	3.90	0.204
NeckCirc	23	9.67	9.56	9.77	9.72	8.52	10.33	9.29	9.95	0.441
NeckShaftAngle	23	127.40	126.92	127.87	127.58	121.97	133.50	125.88	128.87	2.041
InterEpiDist	23	5.53	5.46	5.61	5.65	4.85	5.97	5.23	5.80	0.329
GrTrocLatEpiDis	23	35.08	34.95	35.20	35.15	33.75	35.92	34.82	35.50	0.550

Table 4: Comparison of numerical variables between Right and Left – Mann-Whitney U test

	Rank Sum	Rank Sum	U	Z	p-level	Valid N	Valid N
NeckLength	6474.500	6086.500	2819.500	-0.987	0.324	85	73
NeckCirc	7170.000	5391.000	2690.000	1.439	0.150	85	73
NeckShaftAngle	6647.000	5914.000	2992.000	-0.385	0.700	85	73
InterEpiDist	6475.000	6086.000	2820.000	-0.985	0.325	85	73
GrTrocLatEpiDist	6470.500	6090.500	2815.500	-1.001	0.317	85	73

Table 5: Correlation between neck length and inter epicondylar distance

Sample size	50
Spearman's coefficient of rank correlation (rho)	0.00753
Significance level	P=0.9252
95% Confidence Interval for rho	-0.149 to 0.163

Table 6: Correlation between neck length and greater trochanter to lateral epicondylar distance

Sample size	50
Spearman's coefficient of rank correlation (rho)	0.0522
Significance level	P=0.5151
95% Confidence Interval for rho	-0.105 to 0.207

Table 7: Correlation between neck shaft angle and inter epicondylar distance

Sample size	50
Spearman's coefficient of rank correlation (rho)	0.0316
Significance level	P=0.6935
95% Confidence Interval for rho	-0.125 to 0.187

Table 8: Correlation between neck shaft angle and greater trochanter to lateral epicondylar distance

Sample size	50
Spearman's coefficient of rank correlation (rho)	0.0633
Significance level	P=0.4297
95% Confidence Interval for rho	-0.0938 to 0.217

Correlation coefficient 0 to <0.3: No relationship; 0.3 to <0.5: Fair relationship; 0.5 to <0.7: Good relationship; >0.7 to 1: Excellent relationship. From the analysis it was revealed that no positive or negative correlation exists between the study variables. Therefore, it is not possible to predict the value of one or more of them from the magnitude of the other variable(s).

DISCUSSION

Osteoporotic fracture accounts for >90% of all fractures above 50 years of age with almost 25% mortality. Of the patients who survive more than 6 months following fracture only 60% regain their pre-fracture walking ability and 50% regain their pre-fracture activities of daily life. In elderly patients hip fracture mainly results due to fall from height or tipping over any obstacle but in younger patients high energy trauma like road traffic accident may be the cause. Pathological fracture may occur at any age associated with metastasis, hyper-parathyroidism, osteogenesis imperfecta, Paget"s disease, steroid and alcohol use or infection. However osteoporosis remains the major cause of fracture which occurs mostly in elderly patients with low bone mineral density and risk of fracture doubles every decade after 50 years of age. Old age especially female sex or associated with excessive caffeine use, smoking, dementia, visual impairment, obesity, physical inactivity, arthritis, low body mass index further aggravate the risk. In developing country like India risk is even higher due to vitamin-D or calcium deficiency specially in post-menopausal women. The mortality and morbidity associated with fracture neck femur imposes immense physical, mental, social and economic trauma to both the patient and the family. It has been documented in various literature that neck-shaft angle of femur, neck-circumference, neck length i.e. proximal femoral geometry is well associated with risk of fracture neck femur. Lower values of neck-circumference is associated with low bone-mineral density and hence higher risk of fracture. The proximal femoral geometry can be accurately measured by either DEXA scan or CT-scan. Hence risk of fracture can be predicted in a person by doing DEXA or CT scan. Once the high risk group is identified proper preventive measures can be undertaken like Vitamin-D or calcium supplementation, exercise to strengthen bone mass, visual aids for elderly. DEXA or CT scan exposes the patient to radiation hazard which may predispose the patient to risk of development of leukemia, breast cancer and other malignancy in later life. DEXA or CT scan is not only expensive but facilities are also not available at all medical centres specially in rural and remote areas where lack of awareness, illiteracy, nutritional deficiency are even more prominent. Hence there is a need for an inexpensive, authentic, safe, sensitive yet easy procedure to predict the risk of fracture neck femur. This study was undertaken to find co-relation between proximal and distal femoral geometry i.e. between neck-shaft angle, neck-length, neck-circumference with inter-epicondylar distance and distance between lateral epicondyle to greater trochanter. The inter-epicondylar distance and distance between lateral epicondyle to greater trochanter are easily measurable in an individual by a pair of sensitive calipers and a metric tape. However, a more precise measurement of the aforementioned parameters could have been done by using a rectangular dioptograph which was not available in the study setting. Moreover, Vernier calipers and metric tape were suitable instruments for use at the peripheral health centres if our study could find the study variables useful for the bigger purpose. Had there been an association between the clinically measurable parameters like interepicondylar distance or distance between greater trochanter to lateral epicondyle and the radiologically measurable parameters associated with a risk of fracture neck femur viz. neck shaft angle, neck length or neck circumference, it would have been very useful to predict the risk of fracture in an individual by simply measuring the first two parameters clinically instead of exposing the patient to radiation hazard associated with DEXA or CT scan. This simple measurements can be even taken by para-medical staff or other health workers since it does not require much of expertise. After meticulous collection and analysis of data, it was revealed that there is no statistically significant association between the aforementioned clinical and radiological parameters. Therefore, for an estimation of the risk of fracture neck femur, radiological assessment cannot be replaced as yet. However, in view of the necessity and utility of a clinical procedure that can possibly be applied to a large population, future studies may be undertaken with a wide array of other anthropometric parameters to search for an interrelationship amongst them.

CONCLUSION

Our study attempted to find out if it was possible to predict the risk of fracture neck femur without exposing the subjects to radiation hazards associated with a radiological imaging. It would have also been very useful in developing countries with restricted resources, if a simple measurement procedure could estimate the value of parameters associated with a fracture risk and measurable only radiologically. A screening test and subsequent prophylactic measures could have been suggested to prevent the fracture. However, at the end of the study, no suitable alternative to the radiological assessment was detected. Nevertheless, the wide applicability of such a procedure, if ever developed,

warrants a quest for other anthropometric variables that can serve the purpose and future studies may be undertaken accordingly.

REFERENCES

1. Pelvic Girdle *and* Lower limb, In: Standring S, Borley NR, Collins P, Crossman AR, Gatzoulis MA, Healy JC, *et al*, editors. Gray's Anatomy. 40th ed. London: Churchill Livingstone; 2008: P. 1360-62.
2. Zalawadia A, Ruparelia S, Shah S, Parekh D, Patel S, Rathod SP, *et al*. Study Of Femoral Neck Anteversion Of Adult Dry Femora In Gujarat Region. NJIRM 2010; Vol. 1(3).July-Sept.7-11.
3. Gilligan I, Chandraphak S, Mahakkanukrauh P. Femoral neck-shaft angle in humans: variation relating to climate, clothing, lifestyle, sex, age and side. J Anat. 2013 Aug; 223(2):133-51.
4. Osorio H, Schorwer K, Coronado C, Delgado J, Aravena P. Proximal Femoral Epiphysis Anatomy in Chilean Population. Orthopedic and Forensic Aspects. Int. J. Morphol. 2012; 30(1):258-262.
5. Karlsson KM, Sernbo I, Obrant K, Johnell IR, Johnell O. Femoral neck geometry and radiographic signs of osteoporosis as predictors of hip fracture. Bone. 1996; 18: 327-330.
6. Yazar F, Imre N, Battal B, Bilgic S, Tayfun C. Is there any relation between distal parameters of the femur and its height and width? SurgRadiol Anat. 2012 Mar; 34(2):125-32.
7. Caetano EB, Serafim AG, Padoveze EH. Study of the Collo-diaphyseal Angle of the Femur of Corpses in the Anatomy Department of the PUC-SP Medical School.Int J. MorphoL. 2007; 25(2):285-288.
8. Mills HJ, Horne JG, Purdie GL. The relationship between proximal femoral anatomy and osteoarthrosis of the hip.Clinical Orthopaedics and Related Research. 1993; 288:205-208.
9. Tveit M, Rosengren BE, Nilsson JA, Karlsson MK. Exercise in youth: High bone mass, large bone size, and low fracture risk in old age. Scand J Med Sci Sports.2014 Aug 11.doi: 10.1111/sms.12305.
10. Pauyo T, Drager J, Albers A, Harvey EJ. Management of femoral neck fractures in the young patient: A critical analysis review. World J Orthop. Jul 18, 2014; 5(3): 204–217.

Source of Support: None Declared
Conflict of Interest: None Declared