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RESEARCH ARTICLE

Evaluation Of Humeral Cortical Index In Patients Over 65 Years With Proximal Humerus Fractures

Enver Kiliç,[1] Atahan Durgal[1]

[1]Department Of Orthopaedics And Traumatology, Ankara City Hospital, Ankara, Turkiye

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ORCIDs of the authors:
EK : 0000-0001-5475-8966
AD : 0000-0002-6980-6745

Abstract

Introductıon: The aim of our study is to evaluate the effect of humeral cortical index (CI) on proximal humerus fracture (PHF) risk in patients over 65 years.

Methods: Patients over 65 years who had PHF due to injury being a fall from less than standing height and were treated surgically between January 2019 and December 2023 were included in group 1. Patients over 65 years who applied to the hospital and had a shoulder anterior-posterior radiography were included in group 2. Neer classification was used to classify PHF. CI measurements were performed for all patients.

Results: In group 1, 54 male and 36 female patient were evaluated. In group 1, 42 right and 48 left humeral CI measurements were performed. The average age of group 1 was 72.87±6.65. In group 2, 49 male and 37 female patient were evaluated. The average age of group 2 was 70.9 ±4.79. No significant difference was determined between group 1 and group 2 for gender, age and side. (p=0.684, p=0.236, p=0.128 respectively). For group 1, the mean humeral CI was 0.304±0.06 and 0.380 ±0.07 for group 2. A significant difference was determined between group1 and group 2 for humeral CI. (p>0,001) No significant difference was determined between Neer type 2 patients and Neer type 3-4 patients for age, gender and humeral CI. (p=0.373, p=0.15, p=0.451 respectively) The risk of PHF increased 3.2 times in patients with humeral CI lower than 0.3267.

Conclusion: Humeral CI is a good parameter in determining the risk of PHF in the population over 65 years. However, humeral CI does not affect the severity of PHF.

Correspondence Address: Üniversiteler Mahallesi 1604. Cadde No: 9 Çankaya Ankara - Türkiye
Phone: +90 505 206 28 18/ **e-mail:** enwerkilic@gmail.com

Introduction

Proximal humerus fractures (PHF) are one of the most common fractures of the upper extremity, especially in the elderly population.[1] And 70% of all PHF occur in osteoporotic patients.[1,2] Recent studies have shown that PHFs are increasing in the elderly population and a 250% increase in the proximal humerus fractures incidence is expected in the next 30 years for the population over 75 years.[3,4] In elderly population, PHF is the third most common fracture.[5,6] Most of the patients can be treated conservatively.[7] PHF is more common in women in the elderly population.[8] This may be explained by poor bone quality and increased risk of falling.[9] It has been claimed that osteoporotic proximal humerus fractures are more complex fractures.[10]

Fragility fractures occur after low-energy trauma, usually after falling from standing height or less. Fragility fractures are associated with osteoporosis.[11] Osteoporosis causes decreased bone density and bone quality. Therefore, it increases the risk of fragility fractures. Bone quality is affected by cortical and trabecular bone structure and bone turnover. Trabecular bone loss and cortical thinning are predisposing for fragility fractures. Fractures in the trabecular bone site generally result of defects in the cortical bones.[12]

Previous studies have shown that changes in anteroposterior radiographs of long bones can be used to evaluate bone quality.[13] Thickness of cortex, shape of medullary canal and width of canal at diaphyseal part evaluated are some of the parameters used in bone quality evaluation in anterior posterior radiographs. Different indices have been defined to evaluate bone quality. One of them is cortical index(CI).

In our study, we evaluated the humeral CI. We hypothesized that PHF occurs more frequently in patients with lower humeral CI. The aim of our study is to evaluate the effect of humeral CI on PHF risk in patients over 65 years

Material and Methods

Approval for the study was granted by the institutional review board of the authors' affiliated institutions (Project number: TABED 1/177/2024, Date: 08.05.2024). All of the researchers signed the most recent version of the Helsinki Declaration.

In this retrospective study, between January 2019 and December 2023, medical records of our institution were reviewed and patients who underwent open reduction and internal fixation for PHF were included in the study. And patients who applied to the hospital and had anterior-posterior shoulder radiography were included in the study. All patients included in the study were over 65 years.

Patients under 65 years, patients with bilateral PHF, multiple fractures, old PHF, pathological fractures, malignancy, neurovascular deficits and cerebrovascular disease were excluded from the study.

Patients who had PHF due to injury being a fall from less than standing height and were treated surgically were evaluated in group 1. Patients over 65 years who applied to the hospital and had a shoulder anterior-posterior radiography were evaluated in group 2. Demographic characteristics of the patients were evaluated. Such as gender, side age…

In our study, the Neer classification was used to classify PHF. In this classification, the proximal humerus is divided into 4 main parts: the humeral head, the greater tuberosity, the lesser tuberosity and the humeral shaft.[14,15] These segments are considered part if there is more than 1 cm displacement or more than 45 degrees of angulation. Neer classification is useful in the evaluation and investigation of PHF.[16] However, it also has limitations such as poor inter-observer agreement and difficulty in evaluation on radiography.[17]

Cortical index (CI) measurements were performed for all patients in group 1 and group 2. CI was measured 5cm below of the surgical neck.[18] CI was determined by proportioning the difference between the outer diameter and the inner diameter of the humerus to the outer diameter of the humerus at 5 cm below of the humeral surgical neck.

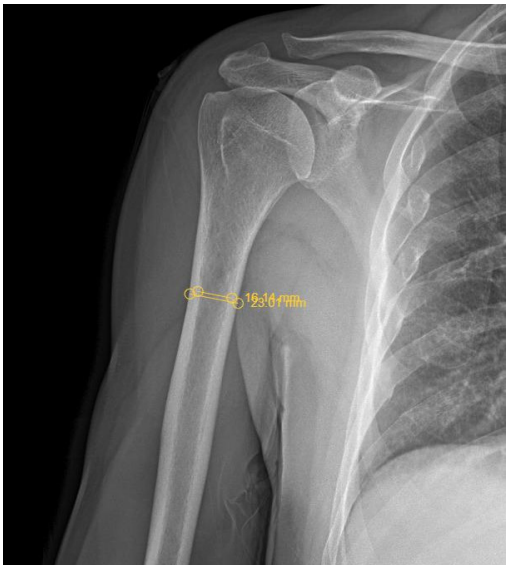

Figure 1 : Cortical index measurement

Results

Ninety-three patients were operated for PHF. Three patients whose follow-up data could not be obtained were excluded from the study. In group 1, 54 male and 36 female patient were evaluated. In group 1, 42 right and 48 left humeral CI measurements were performed. The average age of group 1 was 72.87±6.65. Eighty-six patients were included in group 2. In group 2, 49 male and 37 female patient were evaluated. The average age of group 2 was 70.9 ±4.79. In group 2, 50 right and 36 left humeral CI measurements were performed. No significant difference was determined between group 1 and group 2 for gender, age and side. (p=0.684, p=0.236, p=0.128 respectively). For group 1, the mean humeral CI was 0.304±0.06 and 0.380 ±0.07 for group 2. A significant difference was determined between group1 and group 2 for humeral CI. (p>0,001) (Table 1)

Table 1: Demographic characteristics of the patients

	Group 1 (n=90)	Group 2 (n=86)	P value
Gender			0.684
Female	54; 60%	49; 50.3%	
Male	36; 40%	37; 35.7%	
Age	72.87±6.65	66.9 ±4.79	0.236
Side			0.128
Right	42; 46.7%	50; 58.1%	
Left	48; 53.3%	36; 41.9%	
Humeral CI	0.304±0.06	0.380 ±0.07	0.001

CI: cortical index

PHFs were classified according to the Neer classification. In group 1, 65 of the patients were type 2, 25 of the patients were type 3 and type 4. The mean age of patients with Neer type 2 was 72.48±6.56. And the average age of patients with Neer type 3-4 was 73.88±6.91. The mean humeral CI was 0.301±0.06 for group 1 and 0.312 ±0.06 for group 2. Thirty-six female and twenty-nine patients had Neer type 2 PHF. And 18 female and 7 male had Neer type 3-4 PHF. No significant difference was determined between Neer type 2 patients and Neer type 3-4 patients for age, gender and humeral CI. (p=0.373, p=0.15, p=0.451 respectively) (Table 2)

Table 2: The effect of age, gender and humeral CI on Neer classification

	Neer type 2 (n=65)	Neer type 3-4 (n=25)	P value
Gender			0.15
Female	36; 55.4%	18; 72%	
Male	29; 44.6%	7; 28%	
Age	72.48±6.56	73.88 ±6.91	0.373
Humeral CI	0.301±0.06	0.312 ±0.06	0.451

CI: cortical index

All patients were evaluated and the cut-off value for humeral CI was determined as 0.3267. The risk of PHF increased 3.2 times in patients with humeral CI lower than 0.3267.

Discussion

In the current study, we determined that humeral CI is a good parameter in determining the risk of PHF in the population over 65 years. The risk of PHF increased 3.2 times in patients with humeral CI lower than 0.3267. However, there is no relationship between humeral CI and severity of PHF.

All over the world, life expectancy is increasing with the development of health care. In the United States, life expectancy was 69.9 in 1959. But it increased to 78.9 in 2016.[19] Khatip et al showed that PHF incidence increased %28 from 1990 to 2010. No significant increase in the incidence of PHF was determined in patients under 65 years, but a significant increase was determined in patients over 65 years.[20] The increase of the incidence is associated with the aging of the population. Han et al demonstrated that in elderly population, the most common used treatment for PHF is nonoperative treatment. And the most common used treatment in patients undergoing surgery is open reduction and internal fixation (ORIF). In our study, patients who underwent ORIF due to PHF were evaluated.

Cortical thickness is an important parameter for evaluating bone quality. Tingart et al. determined a strong relationship between cortical thickness of the proximal humerus and bone mineral density.[21] Hepp et al. used the cortical index to determine the risk of reoperation in PHF treated with locking plate fixation. They determined a correlation between cortical thickness and bone mineral density measured by dual-energy X-ray absorptiometry (DXA) scan.[22] Spross et al. used the deltoid tuberosity index to evaluate patients' risk of osteoporosis.[23]

The deltoid tuberosity index was compared with the cortical index and it was determined that there was a correlation between the two measurement methods. In our study, we compared the cortical index of patients with PHF and patients without fracture in the population over 65 years. And we observed that the cortical index of patients with PHF was significantly lower.

There are different studies indicating the risk of osteoporosis or PHF using different measurement methods in the proximal humerus. Hepp et al. determined 0.4 as the cut-off cortical index value for PHF.[22] In another study, it was stated that a cortical index value ≤ 0.378 was a predictor of osteoporosis.[24] In the current study, we observed that the risk of PHF increased 3.2 times in patients with humeral CI lower than 0.3267. However, there is no relationship between humeral CI and PHF Neer classification types.

There are different studies, evaluating the low CI and PHF relationship. The fact that PHF is more common in patients with low CI suggests that a more complex fracture may occur in patients with lower CI. Osterhoff et al. reported in their study that there was no relationship between CI and severity of PHF in the elderly patient population.[25] In our study, trauma mechanism of the patients was falling from less than standing height. And there was no relationship between humeral CI and severity of PHF like Oserhoff et al.'s study. There are studies in the literature indicating that more complex PHF is seen in older patients.[10] In our study, the severity of PHF is not affected by age in elderly population.

Our study have some limitations. Firstly, the sample size of our study was small. Secondly, we did not use any positioning tool while taking radiographs. Thirdly, the body mass index (BMI) of the patients was not evaluated. The fact that radiography is cheaper than other imaging methods makes our study cost effective. The relationship between cortical index and PHF can be better clarified with further studies and larger patient groups.

Conclusion

Humeral CI is a good parameter in determining the risk of PHF in the population over 65 years. The risk of PHF increased 3.2 times in patients with humeral CI lower than 0.3267. However, humeral CI does not affect the severity of PHF.

References

1. Palvanen M, Kannus P, Niemi S, Parkkari J. Update in the epidemiology of proximal humeral fractures. Clin Orthop Relat Res 2006;442:87–92.
2. Bell J-E, Leung BC, Spratt KF et al. Trends and variation in incidence, surgical treatment, and repeat surgery of proximal humeral fractures in the elderly. J Bone Joint Surg Am 2011;93:121–131.
3. Obrant KJ, Bengne´r U, Johnell O, Nilsson BE, Sernbo I. Increasing age-adjusted risk of fragility fractures: a sign of increasing osteoporosis in successive generations? Calcif Tissue Int 1989;44:157–167.
4. Resch H. Proximal humeral fractures: current controversies. J Shoulder Elbow Surg 2011;20:827–832.
5. Yang GY, Xiang M, Chen H, Hu XC. Short-term clinical outcome of proximal humeral fractures using Multiloc proximal humeral nail. Chin J Orthop, 2016, 36: 103–112.
6. Passaretti D, Candela V, Sessa P, Gumina S. Epidemiology of proximal humeral fractures: a detailed survey of 711 patients in a metropolitan area. J Shoulder Elbow Surg, 2017, 26: 2117–2124.
7. Xiang M, Hu XC, Jiang CY. Pay attention to the whole concept and improve the diagnosis and treatment of proximal humeral fracture. Chin J Orthop, 2017, 37: 1313–1317.
8. Maravic M, Le Bihan C, Landais P, Fardellone P. Incidence and cost of osteoporotic fractures in France during 2001. A methodological approach by the national hospital database. Osteoporos Int 2005;16:1475–1480
9. Lee S, Dargent-Molina P, Bre´art G. EPIDOS Group. Epidemiologie de l'Osteoporose Study. Risk factors for fractures of the proximal humerus: results from the EPIDOS prospective study. J Bone Miner Res 2002;17:817–825
10. Court-Brown C, Garg A, McQueen M. The epidemiology of proximal humeral fractures. Acta Orthop Scand 2001;72:365–371
11. Kavuri V, Bowden B, Kumar N, Cerynik D. Complications Associated with Locking Plate of Proximal Humerus Fractures. Indian J Orthop. 2018 Mar-Apr;52(2):108-116
12. Bell KL, Loveridge N, Power J et al. Intracapsular hip fracture: increased cortical remodeling in the thinned and porous anterior region of the femoral neck. Osteoporos Int 1999;10:248–257
13. Baumgartner R, Heeren N, Quast D et al. Is the cortical thickness index a valid parameter to assess

bone mineral density in geriatric patients with hip fractures? Arch Orthop Trauma Surg 2015;135:805–810
14. Neer CS., II Displaced proximal humeral fractures. I. Classification and evaluation. J Bone Joint Surg [Am] 1970;52-A:1077-1089.
15. Carofino BC, Leopold SS. Classifications in brief: the Neer classification for proximal humerus fractures. Clin Orthop Relat Res 2013;471:39-43.
16. Matsumura N, Furuhata R, Seto T, Takada Y, Shirasawa H, Oki S, Kawano Y, Shiono S. Reproducibility of the modified Neer classification defining displacement with respect to the humeral head fragment for proximal humeral fractures. J Orthop Surg Res. 2020 Sep 23;15(1):438.
17. Brorson S, Hróbjartsson A. Training improves agreement among doctors using the Neer system for proximal humeral fractures in a systematic review. J Clin Epidemiol 2008;61:7-16.
18. Skedros JG, Mears CS, Burkhead WZ. Ultimate fracture load of cadaver proximal humeri correlates more strongly with mean combined cortical thickness than with areal cortical index, DEXA density, or canal-to-calcar ratio. Bone Joint Res. 2017 Jan;6(1):1-7.
19. Woolf S.H., Schoomaker H. Life expectancy and Mortality rates in the United States, 1959-2017. JAMA. 2019;322:1996–2016.
20. Khatib O., Onyekwelu I., Zuckerman J.D. The incidence of proximal humeral fractures in New York State from 1990 through 2010 with an emphasis on operative management in patients aged 65 years or older. J Shoulder Elbow Surg. 2014;23:1356–1362.
21. Tingart, M. J., Apreleva, M., von Stechow, D., Zurakowski, D. The cortical thickness of the proximal humeral diaphysis predicts bone mineral density of the proximal humerus. Journal of Bone and Joint Surgery British, 2003;85(4), 611–617.
22. Hepp, P., Theopold, J., Osterhoff, G., Marquass, B., Voigt, C. Bone quality measured by radiogrammetric parameter “cortical index” and reoperations after locking plate osteosynthesis in patients sustaining proximal humerus fractures. Archives of Orthopedic and Trauma Surgery, 2009;129(9), 1251–1259.
23. Spross, C., Kaestle, N., Benninger, E., Fornaro, J., Erhardt, J., Zdravkovic, V., et al. Deltoid tuberosity index: a simple radiographic tool to assess local bone quality in proximal humerus fractures. Clinical Orthopaedics and Related Research, 2015;473(9), 3038–3045.
24. Jain S, Arora S, Gupta S, Sharma S, Bansal N, Ranjan S. Assessment of Bone Quality Using Radiogrammetric Parameters of Proximal Humerus in India: Defining the Osteoporotic Fracture Risk Limit Value and its Reliability. Indian J Orthop. 2020 Aug 9;54(Suppl 2):307-315.
25. Osterhoff G, Diederichs G, Tami A, Theopold J, Josten C, Hepp P. Influence of trabecular microstructure and cortical index on the complexity of proximal humeral fractures. Arch Orthop Trauma Surg. 2012 Apr;132(4):509-15.