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Research Article

Hip geometry to predict femoral neck fracture: Only neck width has significant association☆

Jonny Karunia Fajar[a,*], *Rusydi Rusydi*[b], *Safrizal Rahman*[c], *Armia Indra Nur Alam*[c], *Azharuddin Azharuddin*[c]

[a] *Medical Research Unit, School of Medicine, University of Syiah Kuala, Banda Aceh 23111, Indonesia*
[b] *Resident of General Surgery, School of Medicine, University of Syiah Kuala, Banda Aceh, Indonesia*
[c] *Department of Orthopedic and Traumatology, School of Medicine, University of Syiah Kuala, Dr. Zainoel Abidin Teaching Hospital, Banda Aceh, Indonesia*

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ABSTRACT

Background: Efficacy of the use of hip geometry to predict femoral neck fracture is controversial and it is influenced by the particular race. Studies on the use of hip geometry in Aceh's population have never been done.
Objectives: To determine the association of hip geometry with femoral neck fracture in elderly women in Dr. Zainoel Abidin Teaching Hospital.
Methods: This study was an observational analysis. The design of this study was cross-sectional. The study was conducted in Dr. Zainoel Abidin Teaching Hospital from May to August 2013. Hip geometry measurements were done, such as the following: hip axis length (HAL), femoral neck axis length (FNAL), femoral neck angle (FNA), and neck width (NW). Statistical analysis used was logistic regression test.
Results: A total of 32 patients with femoral neck fractures and 32 control patients were followed in this study. The average value of hip geometry measurements in femoral neck fracture was HAL = 90.2 ± 8.6, FNAL = 77.2 ± 7.3, FNA = 131.7 ± 6.2, NW = 32.3 ± 3.4; and in nonfemoral neck fracture, it was HAL = 88.4 ± 9.4, FNAL = 76.2 ± 7.9, FNA = 131.5 ± 7.3, NW = 29.8 ± 3.3. Measurement HAL, FNAL, and FNA did not have a significant association with the incidence of femoral neck fracture ($P > 0.05$). However, NW measurement had a significant association with the incidence of femoral neck fracture ($P < 0.05$).
Conclusion: Only NW measurement had a significant association with femoral neck fracture in older women in Dr. Zainoel Abidin Teaching Hospital.

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* *Corresponding author*. Tel.: +62 081235522287; fax: +62 0651 7551843.
E-mail address: gembyok@gmail.com (J.K. Fajar).

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1. Introduction

Fracture is a serious health problem. Annual direct care expenditures for fractures is about 1 trillion dollars in the United Kingdom (UK) and indirect costs (e.g., lost productivity for patients and caregivers) likely add billions of dollars to this figure.[1] Fracture is a major cause of mortality and morbidity in the elderly.[2] Fracture in the elderly is associated with decreased quality of life so that even minimal trauma can cause serious repercussions. There are three regions that are often affected by fractures in osteoporotic patients, i.e.: femoral neck, spine, and distal radius.[3] The incidence of femoral neck fractures was 957.3 cases per 100,000 female and 414.4 cases per 100,000 United States (US) male population in 1986–2005,[4] 400 cases per 100,000 US population per year in 2010,[5] and less than 200 per 100,000 Indonesian women per year in 2012.[6] The incidence of femoral neck fractures was more common in postmenopause than premenopause women[7] or in age ≥64 years.[4] A study regarding femoral neck fractures has not been done in Aceh. Demographic data regarding the incidence of fractures around the World estimated that there would be an increase of femoral neck fractures incidence from about 1.7 million in 1990 to 6 million cases in 2050.[8]

Although the incidence of femoral neck fractures is often caused by trauma, these fractures also have a close association with osteoporosis.[9] Osteoporosis is defined as low bone mass and microarchitectural deterioration of bone tissue, leading to enhanced bone fragility and a consequent increase in fracture risk or bone mineral density (BMD) that is 2.5 standard deviations (SDs) or more below the young adult mean value.[10] Hip geometry and BMD have been associated as a predilection of femoral neck fractures incidence.[11] BMD is a marker of bone strength measurement. However, BMD does not fully reflect femoral neck fractures. Lewicki and Borges[12] conducted a clinical study regarding femoral neck fractures using BMD. The results showed that the incidence of osteoporosis was only 40–50% of all patients with femoral neck fractures. This indicated that BMD reflected only partially. This is possible because bone strength is determined by several factors, including BMD, bone architecture (hip geometry), microarchitecture, matrix components, tissue mineral density, and bone damage.[13]

Hip geometry is the examination of bone strength based on the measurement of proximal femur geometry. Hip geometry measurement includes hip axis length (HAL) – the distance from pelvic rim to outer margin of greater trochanter along neck axis, femoral neck axis length (FNAL) – distance from user-defined center of femoral head to intersection of neck and shaft axes, femoral neck angle (FNA) – angle between derived axes of neck and shaft, and neck width (NW) – the width of the femoral neck.[13] The results of hip geometry measurement are thought to be different for each tribe. Several studies have reported differences of hip geometry. Nakamura et al.[14] reported hip geometry differences of Japanese (FNAL: 4.4 cm, NW: 0.57 cm, FNA: 1280) and American population (FNAL: 5.6 cm, NW: 0.99 cm, FNA; 1300), Theobald et al.[15] reported hip geometry differences of the white and the black of America population where the black population has NW and FNAL 25% lower than whites; Im and Lim[16] reported hip geometry differences of Korean population; Nelson et al.[17] reported hip geometry differences of African (FNAL: 4.74 cm, FNA: 130.10, NW: 0.94 cm), Mexican (FNAL: 4.64 cm, FNA: 131.10, NW; 0, 91 cm), and American population (FNAL: 4.62 cm, FNA: 131.10, NW; 0.92 cm), and LaCroix et al.[18] reported hip geometry differences of American population. The use of hip geometry possible will give better results regarding femoral neck fractures. In addition, the study regarding hip geometry in Aceh population has never been done. Therefore, it is necessary to study regarding the association of hip geometry with the risk of femoral neck fractures in older women in Dr. Zainoel Abidin Teaching Hospital.

2. Methods

2.1. Study designs and participants

This study was a cross-sectional study conducted in Clinic of Orthopaedic and Radiology Installation in Dr. Zainoel Abidin Teaching Hospital from May 2013 to August 2013. The target population was all elderly women with femoral neck fractures (358 patients – updated 5 March 2013) treated in Dr. Zainoel Abidin Teaching Hospital. Inclusion criteria for this study were as follows: (1) suffered femoral neck fractures, (2) women aged over 45 years, (3) got inadequate trauma, (4) had Singh index less than 3, and (5) postmenopause women. The exclusion criteria in this study were as follows: (1) not willing to be the subject of study, both orally and written, (2) had multitrauma with high energy, (3) long bed rest, and (4) young people with osteoporosis caused by various diseases. A simple, random sampling method was used to select 358 population-representative patients. The sample of this study was 32 patients and 32 controls as the minimum sample size. Ethical approval was obtained from The Ethical Clearance Committee of School of Medicine, Syiah Kuala University, Banda Aceh, Indonesia. All patients were given explanation about the purpose, risks, and benefits, and written informed consent of study prior to the examination was obtained. Patients were informed that they could terminate the study at any time. Patients in this study were voluntary and patients received no incentive.

2.2. Hip imaging and hip structural analysis

Hip imaging, including X-ray and CT scan, was conducted in Radiology Installation in Dr. Zainoel Abidin Teaching Hospital. Radiology imaging was interpreted by radiologists to determine femoral neck fracture and Singh index. Hip structural analysis (HSA) was conducted in Clinic of Orthopaedic in Dr. Zainoel Abidin Teaching Hospital. X-ray imaging was analyzed for HSA manually using a ruler. HSA in this study included HAL, FNAL, FNA, and NW measurements. The sketch of hip geometry measurement was described in Fig. 1.

2.3. Study variables

1. Femoral neck fracture

Femoral neck fracture is the fracture in femoral neck.[9] Ordinal scale was used to assess this variable. These

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