ORIGINAL ARTICLE

Bone Mass Density Assessment by Dual-Energy X-Ray Absorptiometry (Dexa) in Intertrochanteric Fracture of Femur Treated by Fixation

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ABSTRACT

Objective: To assess the differences in bone mass density (BMD) by Dual-Energy X-Ray Absorptiometery (DEXA) in intertrochanteric fractures before and after fixation.

Methods: This quasi experimental study was conducted in the department of Orthopedics and Traumatology, LUMHS. Jamshoro from June 2016 to Dec 2017, on 40 close Intertrochanteric femur fracture patients above 45 years. The fracture was diagnosed by plain X-ray, after confirmation, the first preoperative Bone Mass Density (BMD) was measured by Dual-energy X-ray Absorptiometry and result was kept on record. Then 06 weeks after fixation BMD was measured and after every 06 weeks of fixation BMD was measured up to 26 weeks. The data collected was statistically analyzed.

Results: The average age of the patients was 60.03 ± 11.21years. There were 22 (55%) males. Mean BMD was significantly reduced at 2nd, 8th, 14th, 20th and at 26th weeks after fixation as compared to before fixation ($p<0.001$). Pain was observed in all cases before fixation but reduced overtime after fixation. Wound condition was also observed and it was found that 3 to 5 wounds of patients were infected during 2 to 14 weeks while during 20 to 26 weeks, 1 case was found infected and 97.5% wounds were healed at 26 weeks after fixation. Pain and slight pain on weight bearing was reported in 100% cases during 2 to 8 weeks after fixation and reduced overtime with 95% cases reported no pain on full weight bearing and 5% reported slight pain 26 weeks after fixation.

Conclusion: DEXA is a quick, accurate, low-cost imaging method for the evaluation of bone mineral density.

Key Words: Bone Mineral Density; DXA Scan; Osteoporosis; Intertrochanteric Fractures

Article Citation: Kandhar AW, Shah SKA, Tunio ZH, Akhund MA, Khatri KK, Shaikh MF. Bone Mass Density Assessment by Dual-Energy X-Ray Absorptiometry (Dexa) in Intertrochanteric Fracture of Femur Treated by Fixation. J Peoples Uni Med Health Sci. 2018;8(2):37-42.

INTRODUCTION:

Intertrochanteric fracture is one of the most common hip fracture especially in the elderly having porotic bones, usually due to low-energy trauma like simple fall on hip or by indirect twisting injury.[1-3]

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The incidence of intertrochanteric fracture is gender and race dependent. Some factors were associated with patient sustaining an intertrochanteric rather than femoral neck fracture, include advancing age, increased number of co-morbidities, increased dependency in daily activities and history of other osteoporosis related fractures[4]. Women are more prone to intertrochanteric fracture than men due to slightly wider pelvis, being less active, early osteoporosis onset, and longer life than men.[5]

Intertrochanteric fractures in younger individuals are result of a high-energy injury, like motor vehicle accident (MVA) or fall from a height, in elderly it may occur after a simple fall. The tendency to fall increases with patient age and is exacerbated by factors such as poor vision,

decreased muscle power, labile blood pressure, decreased reflexes, vascular disease, and co-existing musculoskeletal pathology.[6]

Osteoporosis is a long-term condition with asymptomatic onset and a life-long duration. As a result of mass survival into old age it is becoming much common. It is pathological condition, characterized by reduced bone mineral density (BMD) and deterioration of bone architecture resulting in increase bone fragility and consequently susceptible to fracture.[7,8]

The pathogenesis of osteoporosis is complex and partly unknown. A major determinant of BMD in older age is peak bone mass reached at young age. Later in life, bone resorption may begin to dominate over formation. The imbalance in bone turnover process results in bone loss, taking place especially as a result of estrogen deficiency in postmenopausal women. Estrogen has a central role in normal physiolo-gical remodeling and its deficiency after menopause results in a remodeling imbalance with a substantial increase in bone turnover, leading to progressive bone loss. Bone loss and]deterioration of bone structure may also occur in immobilization, diseases (secondary hyperparathyroidism, Paget's disease) or pharmaceutical intervention (e.g. Long-term corticosteroid treatment).[7] Postmenopausal osteoporosis characterized by excessive and disproportionate trabecular bone loss, involves a small subset of women in the early postmen-opausal period and associated mainly with vertebral fractures, whereas senile osteoporosis is characterized by proportionate loss of both cortical and trabecular bone, involves essentially the entire population of aging women and to lesser extent aging men and associated with hip fractures or vertebral fractures or both. Fractures of the proximal femur are perhaps the most serious consequence of osteoporosis. The risk of osteoporotic fractures is significantly higher in white women than in Asian or black women, who have a significantly shorter hip axis length[9,10].

Fracture is a stressful event and may result in consequences such as malunion or nonunion unless promptly treated. Fixation is usually undertaken for intertrochanteric fractures. It is important to recognize the BMD and its loss occurring in such patients to provide effective care to such patients. The aim of this study was to assess the differences in BMD by Dual-Energy X-Ray Absorptiometry in intertrochanteric fractures before and after their fixation.

METHODS:

This quasi-experimental study setting was undertaken at Department of Orthopedics and Traumatology of Liaquat University of Medical and Health Sciences, Jamshoro/Hyderabad after approval from Ethical Review Board. All the procedure was explained to the patients and informed consent was taken regarding publication of the data. Both male and female patients aged above 45 years having closed intertrochanteric femur fractures from June 2016 to December 2017 were included. Patients having closed intertrochanteric fractures aged less than 45 years, having fractures due to malignant disease or open fractures were excluded. Patients were enrolled through OPD and emergency department. The intertrochanteric fracture of femur was diagnosed by plain radiograph. After confirmation of fracture the first pre-operative BMD was measured by Dual-energy X-ray Absorptiometry (DEXA) and recorded. Then 06 weeks after fixation BMD was measured and repeated after every 06 weeks up to 26 weeks. Variables such as age, gender, mode of injury, date and time of injury, date and time of admission, date and time of operation, date and time of operation, time lapse between injury & admission, time interval between admission & operation, and stay in hospital were recorded on a proforma. All statistical analysis was performed using Statistical Packages for Social Science version 19 (SPSS Inc., Chicago, IL). Mean and standard deviation was computed for quantitative variables like age, weight, height, BMI, time lapse between injury and admission (days), time interval between admission and operation (days), time lapse between injury and operation (days), hospital Stay (days), BMD and t and z-score. Frequency and percentage were computed for categorical variables like gender, type of injury, procedure, examination of limbs and all follow-up observations like pain tenderness, weight bearing. Pair t- test was used to compare baseline mean BMD and postoperative procedure. $p \leq 0.05$ was considered as significant.

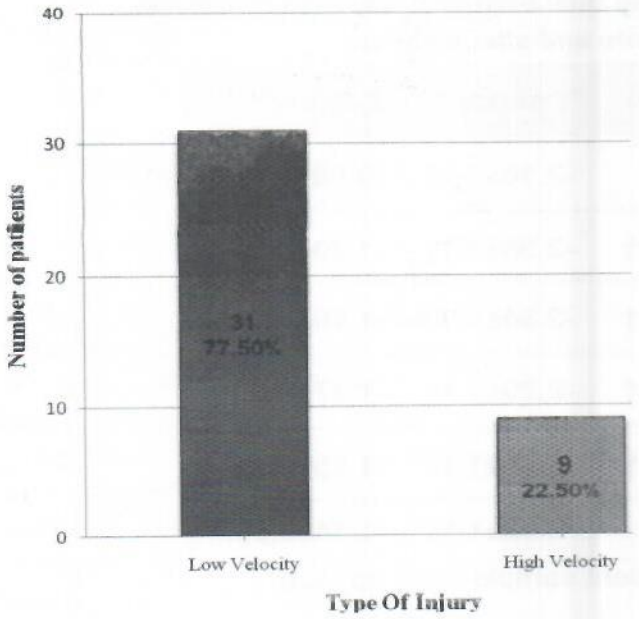

Fig I: Type of Injury of the Patients (n=40)

RESULTS:

A total of 40 patients with close Intertrochanteric fractures above 45 years were included in this study. The mean age of the patients was 60.03±11.21 years (95%CI: 56.44-63.61). There were 22 (55%) male and 18 (45%) female patients. Descriptive demographic statistics of the patients and mean serum calcium, phosphorus and alkaline phosphatase is given in table 1.

Average time laps between injury to admission and injury to operation was 2.20±2.03 days and 7.85±3.42 days while time interval between admission and operation was 5.70±2.65 days. The average hospital stay of the patients was 11.43±3.01 days. Regarding the type of injury, there were 77.5% cases with low velocity and 22.5% with high velocity injury (Figure 1). Diabetes mellitus was the common co-morbid of the patients i.e. 30% (12/40) and hypertension 37.5% (15/40). Asthma and IHD was found in 1 patient each.

As per classifications of intertrochanteric fracture of femur, type I fracture was observed in 87.5% (35/40) cases and type II was observed in 12.5% (5/34). Dynamic condylar screw (DCS) procedure was performed in 32.5% cases while dynamic hip screw (DHS) procedure was performed in 67.5% cases. Comparison of mean bone mass density by dual-energy X-ray absorptiometry in intertrochanteric fractures

Table I. Descriptive Statistics of Demographic of Patients

Variables	Mean ± SD	95% Confidence Interval for Mean		Median (IQR)
		Lower Bound	Upper Bound	
Age (Years)	60.03±11.21	56.44	63.61	60(20)
Weight (kg)	75.60±13.01	71.44	79.76	72(15)
Height (cm)	152.65±9.14	149.73	155.57	150(12)
Number of Children	3.78±2.20	3.07	4.48	3(3)
Serum Calcium (mg/dL)	8.8±1.97	8.16	9.43	9.2(1.15)
Phosphorus (mg/dL)	3.44±0.47	3.29	3.59	3.37(0.93)
Alkaline Phosphatase (U/L)	150.7±65.85	129.64	171.76	125.5(0.84)

before and after their fixation with T score and Z score is presented in table 2. Mean BMD was significantly reduced at 2nd, 8th, 14th, 20th and at 26 weeks after fixation as compare to before fixation ($p<0.001$). Pain was observed in all cases before fixation but after fixation rate of pain was reduced over the time. Pain and slight pain on weight bearing was reported in 100% cases during 2 to 8 weeks after fixation it was also decreased and at 26 weeks after fixation there were 95% cases reported no pain on full weight bearing and 5% reported slight pain as shown in table 3.

DISCUSSION:

DEXA bone density measurements are widely performed and accepted. They are easy to obtain, reliable and reproducible. The literature contains many DEXA studies that have examined the local change in bone density after a fracture[11,12], total hip or total knee replacement.[13-15] Studies have been published that have suggested that femoral DEXA measurements could be correlated with femoral strength[16]. Therefore, serial DEXA measurements of a fractured hip over time could

Table II. Comparison of Mean Bone Mass Density by Dual-Energy X-Ray Absorptiometery in Intertrochanteric Fractures before and after Fixation.

Time	BMD (g/cm²)	T score	Z-Score
Before Fixation (Pre-op)	0.619±0.132	-2.16±1.14	-0.96±0.92
2nd Weeks After Fixation	0.592±0.132†	-2.35±1.11	-1.20±0.91
8 Weeks After Fixation	0.594±0.134†	-2.34±1.12	-1.19±0.92
14 Weeks After Fixation	0.597±0.134†	-2.29±1.11	-1.17±0.90
20 Weeks After Fixation	0.599±0.135†	-2.28±1.11	-1.15±0.89
26 Weeks After Fixation	0.601±0.14†	-2.22±1.10	-1.14±0.90

† $p<0.001$ from before fixation Independent sample t test applied

Table III. Pain on Weight Bearing & Independent Weight Bearing with Respect to Follow-Up

Follow-up	PAIN ON WEIGHT BEARING		
	Yes	No	Slight Pain
2nd Weeks After Fixation	27(68%)	0(0%)	13(33%)
8 Weeks After Fixation	20(50%)	0(0%)	20(50%)
14 Weeks After Fixation	22(55%)	3(8%)	15(38%)
20 Weeks After Fixation	4(10%)	31(78%)	5(13%)
26 Weeks After Fixation	0(0%)	38(95%)	2(5%)
Follow-up	INDEPENDENT WEIGHT BEARING		
	Not Allowed	Walker Allowed	Full Allowed
2nd Weeks After Fixation	17(43%)	23(58%)	0(0%)
8 Weeks After Fixation	5(13%)	35(88%)	4(10%)
14 Weeks After Fixation	3(8%)	35(88%)	0(0%)
20 Weeks After Fixation	0(0%)	17(43%)	23(58%)
26 Weeks After Fixation	0(0%)	2(5%)	38(95%)

reflect changes in bone strength as the hip healed. Bone metabolism at a fracture site may have a direct effect on BMD at the fracture site. Systemic factors such as vitamin D, hormones, and traumatic stress have been implicated as factors that influenced BMD measurements. Authors have also described pre-injury bone mass, systemic illness, changes in patient's activities of daily living, and changes in the patient's activities factors that affect BMD measurements.[17]

Local factors have also been described that can affect BMD measurements. Local factors may include the fracture pattern with overlapping fracture fragment or a bone defect. Local soft tissue ossification, callus formation, bone resorption, disuse osteopenia, deformity induced changes in the weight-bearing axis, and biochemical effect of stabilization devices are some local factors that can influence BMD measurements.[18]

The local and systemic factors that influence BMD are very complicated. Additionally, the local and systemic factors that affect BMD will not have an identical influence on all regions of a bone. The authors recognized that each region of the femur is unique and factors that influenced BMD measurements would have a different effect on different regions of the femur some local factors that can influence BMD measurements.[18]

The local and systemic factors that influence BMD are very complicated. Additionally, the local and systemic factors that affect BMD will not have an identical influence on all regions of a bone. The authors recognized that each region of the femur is unique and factors that influenced BMD measurements would have a different effect on different regions of the femur and lumbar vertebrae. Therefore, the authors measured the bone density in the greater trochanter, lesser trochanter, femoral diaphysis and lumbar vertebrae[18].

In this study there were 55% male and 45% female. Diabetes mellitus was the common co-morbid of the patients i.e. 30% & hypertension 37.5%. Mean BMD was significantly reducing gradually at 2nd, 8th, 14th, 20th and at 26 weeks after fixation as compared to before fixation in present study. The authors observed a different pattern of bone density ratio for the greater and lesser trochanters three years after surgery. The authors have not identified the reasons for the different BMD measurements after three years between the greater and lesser trochanters. However, it may be a function of the fracture callus remodeling under the influence of physiological stress loading on these regions. It appears that remodeling of the greater trochanter occurs approximately three years after surgery and remodeling in the lesser trochanter requires a longer period. Continued research will be necessary to obtain a more precise definition of the factors that influence the observed measurements over time.

Ulivierli[19] studied bone density in patients with fractured legs. Uliveri measured the BMD at the distal region of the fracture site with the passage of time and reported that regardless of when loading of the fracture was initiated the BMD continued to decrease until 120 days after the injury. Van Der Wiel[20] reported that in patients with tibial fractures femoral BMD of the ipsilateral side was diminished even after loading was started, and the BMD did not recover even one year after the injury.

In a study by Iida et al[21] the BMD in the femoral diaphysis gradually decreased during the three-year period after injury. Three years after the fracture the femoral diaphyseal bone density ratio remained significantly suppressed when compared with the control measurements. It is reported that factors which may influence the BMD include the local tissue injury with fracture, the trauma of surgical management of the fracture, alteration in the loading of the femur both from intrinsic aspects of the bone and extrinsic ambulatory aids[22].

DEXA scans are widely accepted to investigate osseous integration after total hip arthroplasty (THA) using different stem designs. Evaluation of bone remodeling in conventional implants according to Gruen can easily be adapted to the evaluation in short stem designs. Factors like gender, age and body weight were found to have certain influence on BMD but these seems to be a consensus of the fact that stem design and mode of fixation remain the major factors[23,24].

CONCLUSION:

The bone mass density by dual-energy x-ray absorptiometry was significantly reduced in intertrochanteric fractures after their fixation. It appears that the different pattern of physiological stress loading contributed to the difference of remodeling of these regions. DEXA is a quick, accurate, low-cost imaging method for the evaluation of bone mass density.

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