

Study of Relationship between Bone Mineral Density in Ipsilateral Proximal Femur and Severity of Osteoarthritis of Knee

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ABSTRACT

Introduction: Osteoarthritis (OA) of the knee is the most common rheumatic disease that is characterized by degradation of articular cartilage, subchondral bone alteration, meniscal degeneration, synovial inflammatory response, and overgrowth of bone and cartilage. In severe OA, the reduced mobility caused by pain can increase bone loss and reduction of bone mineral density leading to osteoporosis. **Objective:** To examine the possible relationship between severity of osteoarthritis (OA) and bone mineral density (BMD) by evaluating the bone mineral density in ipsilateral proximal femur and radiographic grading of knee OA in the Indian population. **Methods:** In this cross-sectional observational study, 100 subjects diagnosed with OA knee using ACR criteria were enrolled. Severity of OA knee was assessed using Kellgren-Lawrence scale (1 to 4) on weight-bearing radiographs. The BMD, T-score, and Z-score of the ipsilateral proximal femur was measured by dual-energy X-ray absorptiometry. Pearson's correlation coefficient was used to test the association of severity of OA knee with BMD. **Results:** Among 100 subjects, there were 51 females and 49 males with mean age 59.94 ± 6.67 . Maximum patients were with K-L grade 2 (42%) followed by grade 3 (30%) and grade 4 (22%). There was statistically significant ($p < 0.0001$) association between BMD and severity of OA knee. BMD decreased as the K-L grade of OA knee increased from 1 to 4. Similar statistically significant association was observed in T-score and Z-score. **Conclusion:** The study concluded that BMD of ipsilateral proximal femur decreases with severity of OA knee. These data support the fact that the two conditions may be related to each other and primary care physicians must look for these two conditions in coexistence. Primary prevention of either of the two conditions should be advised, if the other condition coexists in the same patient.

Keywords: Bone mineral density, DXA scan, osteoarthritis, osteoporosis

Introduction

Osteoarthritis (OA) of the knee is a common rheumatic disease that is characterized by degradation of articular cartilage, subchondral bone alteration, meniscal degeneration, synovial inflammatory response, and overgrowth of bone and

cartilage.^[1] OA knee is the leading cause of musculoskeletal pain and disability with an estimated prevalence of 3.28% in Delhi population aged over 18 years.^[2] The incidence of OA knee in India is as high as 12%. According to the Community Programme for Control of Rheumatic Disease (COPCORD) studies published in International Journal of Rheumatic disease 2011, conducted in India, there is a significantly higher prevalence of knee pain in the rural (13.7%) compared to urban (6%) community.^[3,4] The risk of having OA is higher with age older than 45 years, women, obesity, bone deformity, joint injuries, and certain occupations with repetitive stress on particular joints.

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Mechanism of increased bone mass related to increased loading of articular cartilage resulting in to cartilage damage has been proposed as an independent risk factor for development of OA.^[5] In contrary, due to OA, the reduced mobility caused by pain can increase bone loss and reduction of bone mineral density (BMD) at proximal femur^[6] and lead to osteoporosis (OP).^[5] OP consists of a heterogeneous group of syndromes in which bone mass per unit volume is reduced in otherwise healthy bone, resulting in fragile bone. Though the literature is inconclusive about the relation between BMD and OA, there are continuous series of studies being published to evaluate the effect of antiresorptive medications used in the treatment of OP on the incidence or progression of OA.^[7] So, this study was undertaken to evaluate the relationship between BMD in ipsilateral proximal femur with severity of OA of knee. The learnings from this study may also be useful in formulating and understanding treatment options, which address both the conditions simultaneously.

Methodology

This cross-sectional observational study was conducted in the Department of Physical Medicine and Rehabilitation (PMR), VMMC & Safdarjung hospital, New Delhi, from October 2017 to March 2019. Institutional ethical approval was taken on 30/10/2017. Subjects were included in the study after obtaining informed written consent and satisfying the inclusion and exclusion criterion. Those who were diagnosed with OA knee according to American College of Rheumatology (ACR) criteria^[8] using history, physical examination, and radiographic findings were included in the study. Those with secondary OA knee, local malignancy, pregnancy, history of fracture of pelvis or femur, joint replacement surgery of hip or knee, clinically obvious congenital disorder of lower limb and inability to transfer to the scanning table were excluded from the study. With these criterion, hundred knees were finally included in the study. Each knee was considered separately and ipsilateral hip bone density was evaluated for this study. Subjects were advised to undergo x-ray of weight-bearing knee in AP view, which were graded using Kellgren-Lawrence grading scale (K-L grade 1–4).^[9] They also underwent Dual Energy X-ray Absorptiometry (DXA) scan using OSTEOCORE-3 machine (Digital 2D Densitometer) for BMD (g/cm²) assessment of ipsilateral proximal femur.

Statistical analysis

Categorical variables were presented in number and percentage (%) and continuous variables were presented as mean \pm SD and median. Normality of data was tested by Kolmogorov-Smirnov test. If the normality was rejected, then non-parametric test was used. Quantitative variables were compared using ANOVA/Kruskal Wallis test (when the data sets were not normally distributed) between the groups. Qualitative variables were correlated using Chi-Square test. Pearson's correlation coefficient was used to assess the association of KL grade with BMD. A *P* value of < 0.05 was considered statistically significant. The data was entered in MS EXCEL spreadsheet and analysis was done using Statistical Package for Social Sciences (SPSS) version 21.0.

Results

Our study involved 100 knees of which 51 knees are from female subjects and 49 knees are from male subjects with age ranging from 50 to 75 years [Table 1]. The average age in study was 59.94 ± 6.67 years. Out of 100 knees, maximum numbers were K-L grade 2 (42%), followed by K-L grade 3 (30%), K-L grade 4 (22%), and least were K-L grade 1 (6%).

In our study, the mean BMD observed in K-L grade 1 was 0.95 ± 0.13 , in K-L grade 2 was 0.92 ± 0.17 , in K-L grade 3 was 0.75 ± 0.17 , and in K-L grade 4 was 0.49 ± 0.07 [Table 2 and Figure 1]. The mean T-score [Table 2 and Figure 2] in K-L grade 1 was -0.47 ± 1.17 , in K-L grade 2 was -0.96 ± 1.12 , in K-L grade 3 was -2.12 ± 1.29 , and in K-L grade 4 was -3.75 ± 0.46 . The change in BMD with the K-L grade of OA knee was statistically significant with *P* value (< 0.0001) when evaluated for each grade from grade 1 to 2, 2 to 3 and 3 to 4 as shown in Table 2 and Figure 1.

Discussion

The most common joint of the lower extremity that is affected by OA is knee.^[10] The proximal femur fractures in the elderly are associated with significant pain, morbidity, and mortality.^[11] In OP, the connectivity of trabecular bone network structures is poor and bone microstructure are severely damaged as compared to OA.^[12] Generally, high BMD can lead to increased incidence of knee OA with increased stiffness of the subchondral bone creating an inverse relationship between OP and OA.^[13,14] However, continuous pain and inactivity due to OA will lead to a local decrease in BMD with progression of OA.^[15]

In our study, the mean BMD found from grade 1 to grade 4 OA knee progressively declined from 0.95 ± 0.13 to 0.92 ± 0.17 to 0.75 ± 0.17 to 0.49 ± 0.07 g/cm², respectively, and this decline had a *P* < 0.0001 . Im *et al.* (2014)^[6] conducted a study on 195 female subjects to see the relationship between the BMD of the proximal femur and severity of radiological knee OA in the ipsilateral side based on the cross-sectional data in a Korean

Table 1: Demographic data

Total number of knees	100
Knees in male patients	49
Knees in female patients	51
Mean age (years)	59.94 \pm 6.67

Table 2: BMD, T-score and Z-score in various grades of OA knee

	KL Grade				<i>P</i>
	I	II	III	IV	
No of subjects	6	42	30	22	<.0001
Mean BMD	0.95 \pm 0.13	0.92 \pm 0.17	0.75 \pm 0.17	0.49 \pm 0.07	
Mean T Score	-0.47 \pm 1.17	-0.96 \pm 1.12	-2.12 \pm 1.29	-3.75 \pm 0.46	
Mean Z Score	-0.45 \pm 1.04	-0.12 \pm 1.05	-1.2 \pm 1.35	-2.47 \pm 0.72	

population. They concluded that higher K-L grade was associated with lower BMD of proximal femur ($p < 0.05$). Linde *et al.*^[16] evaluated 450 patients having knee OA grade 1–4, prior to knee arthroplasty. They reported that T-score was lower with grade 3 and 4 in comparison to grade 1 and 2 OA knee patients with $P = 0.02$. They concluded that bone mineral density was lower with severity of knee OA. In our study, the mean T-score in grade 1 was -0.47 ± 1.17 , in grade 2 it was -0.96 ± 1.12 , in grade 3 it was -2.12 ± 1.29 , and in grade 4 OA knee it was -3.75 ± 0.46 . Thus, we observed that as the severity of OA knee increased, the T-score at proximal femur decreased. The same affliction was found in terms of Z-score in our study. Similar results were noted in the study of Choi *et al.*^[17] when they did relationship between bone mineral density and different K-L grades of OA knee. They compared BMD of the non-OA group with mild OA group as well as mild OA with moderate to severe OA group. In their study, they concluded that BMD as well as T-score at lumbar spine and total hip are lower in moderate to severe OA group when compared to non-OA and mild OA group.

In this study, the 15 grade 4 OA knees from male subjects had BMD which was marginally less than the seven grade 4 OA knees from female subjects. The decrease in BMD with progression of OA was also more consistent in males than in females [Figure 3]. A population-based study done by Jeon *et al.*^[18] to see the association between BMD with development of knee OA in men and women found that BMD and OA knee severity relation varied with sex. In women there was positive association between femur neck and OA, whereas in men there was negative correlation between pelvis BMD and OA.

There are varying reports to establish a relationship between OA of knee joint with BMD of the individual patients. Thus, these varying reports draw our attention to the cause or effect relationship between the two conditions. While reduced BMD and reduced bone turnover may increase the risk of developing OA, severe grades of OA knee (grade 3 & 4) may itself reduce limb loading and physical activity, which are risk factors for development of further OP.^[15] In our study, we have noticed that the bone density (T-score & Z-score) has shown a significant reduction as the grades of OA knee progressed from grade 2 to 4 in ipsilateral hip. The possible mechanism should be pain and disuse of the affected limb, which may result in a local decrease in BMD of the proximal femur on ipsilateral side. We thus tend to observe that as the severity of OA increases, the degree of OP also increases.

Conclusions

In our study, we found that bone mineral density of ipsilateral proximal femur decreased as severity of OA knee increased. With such findings in our study and studies quoted in references, it may be safe to assume that all primary care physicians must look for these two conditions in coexistence in their day-to-day practice. It will also be worthy to recommend primary prevention of either of the two conditions by exercise, physical activities,

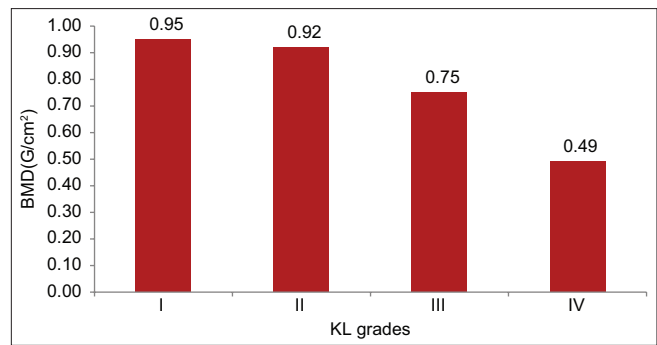


Figure 1: Correlation between BMD and OA knee severity

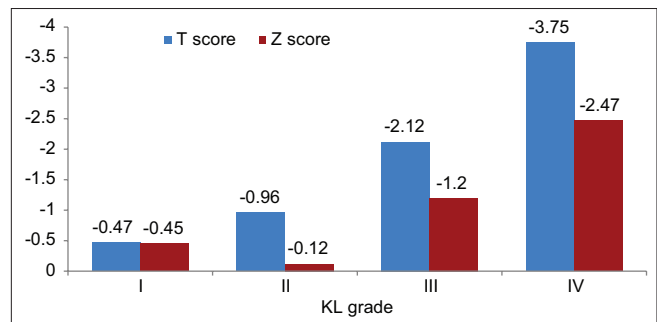


Figure 2: Correlation between T Score, Z Score and various KL grades

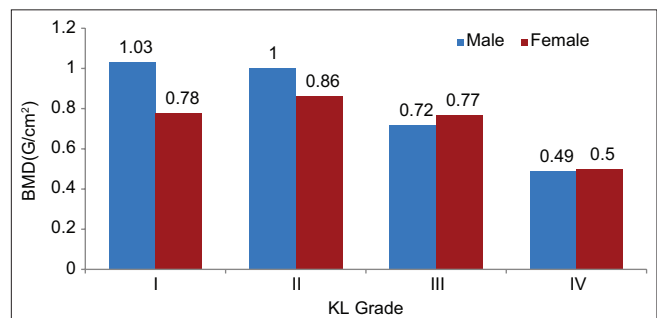


Figure 3: Correlation between BMD in male and female with KL grades

life style modifications and nutritional management, if the other condition coexists in the same patient.

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Conflicts of interest

There are no conflicts of interest.

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