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Changes of Bone Mineral Density Following Total Knee Arthroplasty

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ABSTRACT: **Purpose:**In the patients having degenerative osteoarthritis, we evaluated the BMD changes preoperatively and postoperatively about osteoporosis group and non-osteoporosis group after total knee arthroplasty,and evaluated the BMD changesaccording to osteoporotic medication postoperatively.
Material and method: We investigated the BMD of lumbar spine and femur neck in 139 patients retrospectively to identify the changes of BMD after total knee arthroplasty preoperatively and from 1 year to 3year post-operatively using DEXA. We prescribedbisphosphonate to the patientswith T-score under -2.5 to check up the BMD every year postoperatively. We analysed the changes of BMD among the 3 groups including osteoporoticwith medication or not and non-osteoporotic group. And we analysed the changes of BMD preoperatively and postoperatively.
Result: The average age at theoperation was 69.4, thediagnosed patients with osteoporosis was 101 peroperatively, and 38 patients was checked not to have osteoporosis. Medication group was 76 among the osteoporotic group, non-medication group was 25. Among the patients with medication, we observed the significant increase in the lumbar BMD in both groups including osteoporotic and nonosteoporotic group comparing into the pre-and postoperatively with each other 1 year postoperatively. Afterthe 1styear of operation, there is no significant difference in BMD of femur neck and lumbar spine.
Conclusion: In the degenerative osteoarthritis patients, there is continuous increase of BMD in lumbar spine after osteoporotic medication analyzingBMD pre-and postoperatively after TKR, but there is no significant difference in femur neck. There is no continous increase of BMD among the non-medicaton group not relevant to BMD score. And Comparing to femur neck , BMD of lumbar spine was changedsensitively among all 3 groups.

KEYWORDS: Bone Mineral Density, Total knee arthroplasty.

I. INTRODUCTION

Osteoporosis and degenerative osteoarthritis (OA) are highly prevalent in elderly population[1,2], especially in postmenopausal women. High incidences of fragility fractures among them are responsible for significant morbidity and economic burden among old age people.[3,4,5,6] Data from literature demonstrated inverse relationship between osteoarthritis and osteoporosis.[7,8] Degenerative osteoarthritis patients have significantly higher bone mineral density (BMD) in the axial and peripheral skeleton as compare to healthy individuals matched for age, sex and body mass index (BMI). However this inverse relationship is prominent till middle age, with aging and progressive OA there is decreased ambulatory activity leading to increased bone loss in OA in old age.[8,9]

Spine and femoral neck is the most common site for fragility fractures and decreased bone mineral density (BMD) of these locations is the most responsible for incidences of these osteoporotic fractures.[5,6] Treatment of osteoporosis is essential to reduce the future fracture risk, although many agents have been suggested for treatment, many prospective randomized control studies have reported better efficacy with oral bisphosponate medication[10,11,12].Devogelaer et al reported significant increase in mean BMD of spine (7.2%) and mean BMD of femoral neck (5.5%) over 3 years after oral bisphosponate medication.[11]

On the other hand, total knee arthroplasty (TKA) has proven to be the most successful procedure for degenerative osteoarthritis; to relive knee pain and increase ambulation.[13,14] Several prospective studies have reported significant (up to 40%) decrease in BMD of periprosthetic area after TKA due to stress shielding during initial post-

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operative period.[15,16,17,18,19] Soininrarra et al. and Prieto-alhambra et al. have described treatment with oral bisphosphonates has potential to prevent this loss in the periprosthetic BMD,([20,21] however all these studies were done to access osteointegration of TKA or THA prosthesis.

Till now few studies have been done to monitor the changes of BMD of hip & spine after TKA, which are best predictor of future, osteoporotic vertebral & femoral neck fractures. Yoshinori Ishii et al. has reported the nonsignificant increase in BMD of 45% of ipsilateral and 59% of contralateral hips, by 2 years after TKA[22], but Lee JK et al. has described persistent loss in axial BMD after TKA during first post operative year and no effect of supplemented bisphophonate therapy[23].

As bone mass turnover is extremely slow during old age, the measured changes in BMD would not be great in short term, rather could be substantial if accumulated over a number of years. Also many peri-operative factors influence the BMD change during initial post TKA period, so a long follow up is required to report the change in bone mass after TKA. Moreover, these trials were carried out with small subject group and without control, which made it difficult to isolate the effects of TKA and bisphosphonate medication on the change in BMD after TKA.

So we carried out prospective cohort of large subject group (148 patients) along with the control, over 3 years and the purpose was to study the changes of

BMD of lumbar spine as well as femoral neck after TKA and the effect of oral bisphophonate medication on it and to access the other factors affecting these changes. We hypothesized that BMD of femoral neck and lumbar spine would increase after TKA due to increase ambulatory activity, bisphosphonate medication group would have more increase in BMD than other groups and pre-operative BMD status of patients would not influence BMD changes.

II. MATERIAL AND METHODS

This was a single institute prospective cohort study. Out of 225 subjects, who underwent TKA from March 2014 to May 2021 at United CigmaHospital,Aurangabad and JIIUs IIMSR medical college-Noor Hospital, Jalna, 148 patients were selected for this study

We had excluded

1) patients with systemic diseases like Rheumatoid arthritis, hemophilic disease, malignancy and infection which affect BMD

2) Patients on continuous medication affecting BMD like antiepileptic, steroids etc.

3) Patients with medication possession ratio (MPR) of <80%.

MPR is used to determine compliance. It measures the percentage of time a patient has access to medication.

4) Alcoholic & smoker

There were 140 Female and 8 Male and mean age of the subjects was 69.6 years with mean postmenopausal age in females was 20 ±2 yrs.

All of patients underwent cemented TKA, either unilateral (71) or staged bilateral total knee arthroplasty (77). All TKA surgeries were done at same institute (Kyung-Hee university hospital) by same surgeon. Postoperatively all the patients have had same rehabilitation protocol

We measured BMD of ipsilateral femoral neck and lumbar spine of all included subjects with dual energy X- ray absoptionmetry.(DEXA scan)(24)scanner preoperatively and postoperatively annually for 3 years.

A few patients with prior hip implants, we measured BMD of contra-lateral femoral neck & patients with prior spine fusion surgery, spine BMD were measured at vertebrae adjacent to level of fusion site. (Table no-1)

BMD changes were analyzed among following groups.

Group A) Osteoporotic group with post operative bisphosphonate medication (n= 76 patients)

Osteoporotic group of patients with T score <-2.5, who were taking oral bisphosphonate therapy in the post-operative period.

Medication- 70mg/week of Alendronate along with Vitamin D derivatives-…….and calcium compounds -……

Group B) Osteoporotic group without bisphosphonate medication (n= 25 patients)

Osteoporotic group with T score <-2.5 with no medication

Group C) Non-osteoporotic group (n=38)

Non osteoporotic group with T score >-2.5

This study was approved by institutional review board & ethical committee of JIIUs IIMSR Medical college and Hospital. And all patients provided written informed consent.

III. STATISTICAL ANALYSIS-

Data were summarized using descriptive statistics: frequency and percentage for categorical variables and mean and standard deviation for continuous variables.

Differences in study participants' clinical characteristics were compared across subgroups

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with chi-square test for categorical variables and ANOVA (analysis of variance) with Tukey-Krammer post-hoc test for continuous variables. Paired t test was employed for comparison between time points and baseline. P values lower than 0.05 were considered statistically significant.

IV. RESULTS

Preoperatively, -(Table no-1)

Mean baseline BMD of spine & femoral neck of non osteoporotic group(C) was significantly higher than that of Osteoporotic group (B) and osteoporotic with medication, group (A)

Baseline mean BMD of spine & femoral neck of group (B) and group (A) were statistically equal

A=B<C

Table- 1 : Patients' baseline characteristics

Variable	**Overall**	osteoporotic patients **Medication (1)**	osteoporotic patients **Non-medication (2)**	non-osteoporotic patients **Non-medication (3)**	**P value**	**Post-hoc test**
All patients	**148 (100.0)**	**78 (52.7)**	**27 (18.2)**	**43 (29.1)**		
Sex						
male	8 (5.4)	3 (3.8)	2 (7.4)	3 (7.0)	0.674	
female	140 (94.6)	75 (96.2)	25 (92.6)	40 (93.0)		
Site						
1	79 (53.4)	42 (53.8)	15 (55.6)	22 (51.2)	0.931	
2	69 (46.6)	36 (46.2)	12 (44.4)	21 (48.8)		
Age						
mean±SD	69.6±6.9	70.8±6.9	69.5±4.9	67.6±7.7	0.054	
Preoperative BMD(g/cm^2)						
Neck	0.685±0.120	0.631±0.085	0.679±0.089	0.786±0.130	<.0001	1=2<3
SPINE(L1)	0.785±0.154	0.793±0.158	0.765±0.105	0.785±0.183	0.775	
SPINE(L2)	0.845±0.198	0.858±0.198	0.794±0.102	0.862±0.201	0.339	
SPINE(L3)	0.914±0.181	0.918±0.188	0.873±0.134	0.942±0.199	0.417	
SPINE(L4)	0.983±0.209	0.970±0.201	0.968±0.236	1.023±0.205	0.526	

Postoperative Changes:-

(Table no -2) and (Table -3)

Spine BMD

Spine BMD of osteoporotic with medication (A) group was increased significantly during each post –operative year. (P values were 0.03, 0.002 and < 0.001 for first, second and third year respectively). However spine BMD in other groups (B and C) was increased significantly only during 1st post-operative year (P vaue-0.033 and 0.001respectively), but further, during 2nd and 3rd post-operative years it showed non- significant changes (P value >0.05).

Finally spine BMD of groups A, B and C was increased by 8%, 7% and 0.2% respectively over 3 years.

Femoral BMD

Femoral neck BMD of all groups had non-significant changes (P value>0.05), except in osteoporotic with medication (A) group, which had significant increase in femoral BMD (P value 0.004) during 2nd post-operative year.

Finaly femoral neck BMD of groups A, B and C was decreased by 0.9%,6% and 4% respectively over 3 years

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Table-2: BMD measurements on first, second and third post-operative years

		Osteoporotic Patients Medication (1)		Osteoporotic Patients Non-Medication (2)		Non-Osteoporotic Patients Non-Medication (3)	
Location	**Variable**	**n**	**mean±SD**	**n**	**mean±SD**	**n**	**mean±SD**
Spine	**BMD(g/cm²)**						
	baseline	78	0.699±0.103	27	0.747±0.086	43	0.957±0.147
	1 yr	61	0.723±0.115	16	0.791±0.115	14	1.032±0.159
	2 yrs	40	0.742±0.125	13	0.743±0.105	20	0.953±0.170
	3 yrs	33	0.759±0.089	6	0.822±0.125	14	0.959±0.166
Neck	**BMD(g/cm²)**						
	baseline	76	0.631±0.085	27	0.679±0.089	42	0.786±0.130
	1 yr	59	0.627±0.082	16	0.696±0.102	14	0.781±0.114
	2 yrs	40	0.636±0.077	13	0.672±0.072	19	0.767±0.154
	3 yrs	33	0.625±0.087	6	0.622±0.054	12	0.748±0.086

Table-3 : Changes of BMD of spine and femoral neck from baseline.

Location	**Variable**	**Osteoporotic Patients Medication (1)**			**Osteoporotic Patients Non-Medication (2)**			**Non-Osteoporotic Patients Non-Medication (3)**		
		n	**mean±SD**	**P value**	**n**	**mean±SD**	**P value**	**n**	**mean±SD**	**P value**
Spine	BMD(g/cm^2)									
	baseline		Ref.			Ref.			Ref.	
	1 yr	61	0.023±0.079	0.030	16	0.046±0.079	0.033	14	0.037±0.046	0.011
	2 yrs	40	0.048±0.089	0.002	13	-0.010±0.155	0.824	20	-0.011±0.121	0.679
	3 yrs	33	0.051±0.062	<.0001	6	0.093±0.171	0.242	14	0.058±0.134	0.129
Neck	BMD(g/cm^2)									
	baseline		Ref.			Ref.			Ref.	
	1 yr	59	-0.002±0.047	0.796	16	-0.001±0.043	0.936	14	-0.003±0.048	0.829
	2 yrs	39	0.019±0.038	0.004	13	-0.015±0.038	0.193	18	0.002±0.131	0.946

	3 yrs	33	0.016±0.074	0.228	6	0.002±0.025	0.862	12	-0.037±0.108	0.258

V. CONCLUSION

This was a prospective cohort study with a large number of patients (148) and long term follow up for 3 years, which allowed studying the short term as well as long term change of BMD at lumbar spine & femoral neck after TKA. Analysis of the BMD changes among three groups postoperatively over 3 years helped to evaluate the isolated effect of TKA, oral bisphophonate medication and preoperative BMD status on these changes.

The significant rise of spine BMD in all groups during 1st post-operative year showed the positive effect of TKA on spine BMD. TKA relives knee pain of degenerative osteoarthritis and significantly increases ambulatory activity of patient, which increase physiological loading on spine and hip. This could be the possible explanation and it is supported by meta-analysis done by Berard et al which demonstrated significant positive effect of physical activity like walking on lumbar spine BMD in post menopausal women.[25,26]. However further nonsignificant spine BMD changes in group B and C during 2nd and 3rd postoperative years suggested that significant positive effect of increased ambulation was limited to first post-operative year, short term only and unable to increase bone mass of spine consistently in long term period.

Spine BMD of osteoporotic with medication (A) group was increased significantly during each post –operative year. It concluded that the simultaneous bisphosphonate medication along with TKA in old patient had synergistic action on spine BMD and produced persistent rise in bone mass of spine even in late post operative period

Postoperatively, femoral neck BMD in group B and C had non- significant changes and over 3 years femoral neck bone loss was 6% and 4% respectively. Many longitudinal studies reported, physiological bone loss at proximal femur after age 65 years is between 0.7% to 2.85% annually.[15,22,28]. So the loss of BMD of femoral neck in group B & C over 3 years was within the maximum limit of expected physiological age related bone loss, which suggested the weaker inhibitory effect of ambulatory activity after TKA on physiological bone loss of femoral neck.

Many authors have stated, increased physiological loading and biphosphonate medication has more positive effect on trabecular bone than cortical bone and spine has more trabecular bone than femoral neck, it could explain, why the rise in spine BMD was much more than the femoral neck BMD.[11,27]

Surprisingly, group A (osteoporotic with medication) had significant increase in femoral neck BMD during 2nd year post TKA followed by non-significant rise during 3rd year. Femoral bone mass loss was limited to 0.9%, over 3 years which strongly confirmed the synergistic effect of supplemented bisphophonate therapy with TKA, which could increase the femoral neck bone mass significantly in long term period

BMD changes at spine & femoral neck of group B (osteoporotic without medication) and group C (Non osteoporotic) after TKA in short-term as well as log-term were similar, which suggested that, the BMD change was not affected by preoperative BMD of subject. So it concluded, post-TKA change of bone mass is not influenced by BMI & knee score of included patients.

As BMD is a best predictor of future fracture (osteoporotic) risk, specifically for each standard deviation by which BMD is lower, the individual osteoporotic fracture risk approximately doubles.[29] So early intervention with TKA for indicated old patients along with oral bisphosponate medication decreases the risk of osteoporotic fractures, significantly in old age population.

This analytical study was for 3 years, so optimum duration of oral bisphosphonate treatment after TKA could not be suggested. However, Henry G. Bone et al, in his 10 years experience with alendronate for postmenopausal osteoporosis, suggested continuous bisphosphonate treatments for 10 year was associated with sustained therapeutic effect on BMD, and sustained antifracture efficacy. And discontinuation of the drug resulted in gradual diminution of effect. So we support the longest duration of treatment, as possible with oral bisphosphonate medication after TKA.

In, summary, enhanced physical activity after TKA, increases the bone mass of spine & slow down the physiological bone loss at hip in old age people, however effect was prominent mainly during early post operative period. If oral bisphosphonate medication were supplemented along with TKA, BMD increases significantly not only at spine but also at femoral neck and even in long term period, which significantly decreases the risk of future osteoporotic fractures. Pre-operative bone mass & knee score do not influence the BMD change after TKA.

CONCLUSION

In conclusion, this prospective study revealed that increased ambulatory activity in old patients after TKA along with oral biphosphonate supplementation increases bone mass of spine & slow down the physiological bone loss at hip, synergistically in old age people and significantly decreases the risk of osteoporotic fractures in old age population. It can recommend routine supplementation with oral biphosphonate medication after TKA in osteoporotic individual.

REFERENCES

[1]. Choi YJ, Oh HJ, Kim DJ, Lee Y, Chung YS. The prevalence of osteoporosis in Korean adults aged 50 years or older and the higher diagnosis rates in women who were beneficiaries of a national screening program: the Korea National Health and Nutrition Examination Survey 2008-2009. J Bone Miner Res. 2012 Sep;27(9):1879-86

[2]. Inje Kim,1 Hyun Ah Kim,1 Young-Il Seo,1 YeongWook Song,2 Jin-Young Jeong,3 and Dong Hyun Kim3. The Prevalence of Knee Osteoarthritis in Elderly Community Residents in Korea.J Korean Med Sci. 2010 February; 25(2): 293–298.

[3]. Hye-Young Kang, PhD,1,2 Sung-Eun Park, MS,3 DaeRyong Kang, PhD,4 Ji Yoon Kim, PhD,2 Estimating Medical Expenditure Associated with Osteoporotic Hip Fracture in Elderly KoreanWomen Based on the National Health Insurance Claims Database 2002–2004vhe_volume 12 supplement 3, 2009.

[4]. O. Johnell, J.A. Kanis, A. Odén, et al.Mortality after osteoporotic fractures.OsteoporInt, 15 2004),pp.38-42

[5]. Soo Lim · Bo Kyeong Koo · Eun Jung Lee · Jin Ho Park. MyoungHee Kim · Kun Hong Shin · Yong Chan. Incidence of hip fractures in Korea.J Bone Miner Metab (2008) 26:400–4

[6]. Cummings SR, Melton LJ..Epidemiology and outcomes of osteoporotic fractures. Lancet. 2002 May 18;359(9319):1761-7.

[7]. D J Hart, I Mootoosamy, D V Doyle, et al.The relationship between osteoarthritis and osteoporosis in the general population: the Chingford Study.doi: 10.1136/ard.53.3.158.Ann Rheum Dis 1994 53: 158-162

[8]. ValentinaŽivković, BojanaStamenković, Jovan Nedović, AleksandarDimić, Bone Mineral Density in Osteoarthritis.. Scientific Journal of the Faculty of Medicine in Niš 2010;27(3):135-141

[9]. Arden NK,Crozier S, Smith H, et al.. Knee pain, knee osteoarthritis, and the risk of fracture. Arthritis Rheum 2006; 55: 610–615.

[10]. Joseph R. Tucci,MD,, Richard P. Tonino,MD, Ronald D. Emkey, MD, FACR,,Christine A. Peverly, ,for the U.S.Alendronate Phase Ill Osteoporosis Treatment Study Group, * Providence, Rhode Island. Effect of Three Years of Oral Alendronate Treatment in Postmenopausal Women with Osteoporosis . Am J Med. 1996;101:488-,501

[11]. J. P. DEVOGELAER, 1 H. BROLL, 2 R. CORREA-ROTTER, 3 D. C. CUMMING, 4 C. NAGANT DE DEUXCHAISNES,Oral Alendronate Induces Progressive Increases in Bone Mass of the Spine, Hip, and Total Body Over 3 Years in Postmenopausal Women With Osteoporosis . Bone vol.18, No-2, February 1996:141-150

[12]. Henry G. Bone, M.D., David Hosking, M.D., Jean-Pierre Devogelaer, M.D., for the Alendronate Phase III Osteoporosis Treatment Study Group. Ten Years' Experience with Alendronate for Osteoporosis in Postmenopausal Women. N Engl J Med 2004;350:1189-99.

[13]. KozakLJ,OwingsMF,Hall MJ. National Hospital Discharge Survey: 2002 annual summary with detailed diagnosis and procedure data. Vital Health Stat 13 2005; 158: 1–199.

[14]. Ritter MA,CarrKD,KeatingEM,et al. Revision total joint arthroplasty: does medicare reimbursement justify time spent? Orthopedics 1996; 19: 137–139.

[15]. CL Levitz, PA Lotke, JS Karp. Long-term changes in bone mineral density following total knee replacement.ClinOrthop, 321 (1995), p. 68.

[16]. DD Robertson, CM Mintzer, BN Weissman et al. Distal loss of femoral bone following total knee arthroplasty.J Bone Joint Surg Am, 76 (1994), p. 66.

[17]. MM Petersen, C Olsen, JB Lauritzen et al..Changes in bone mineral density of the distal femur following uncemented total knee arthroplasty. J Arthroplasty, 10 (1995), p. 7.

[18]. MM Petersen, PT Nielsen, A Lebech et al. Preoperative bone mineral density of the proximal tibia and migration of the

tibialcomponent after uncemented total knee arthroplastyJ Arthroplasty, 14 (1999), p. 77.
[19]. P Seitz, P Ruegsegger, N Gschwend et al. Changes in local bone density after knee arthroplasty.J Bone Joint Surg Br, 69 (1987), p. 407.
[20]. T.A. Soininvaara,J.S. Jurvelin,H.J.A. Miettinen,O.T. Suomalainen,. Effect of Alendronate on Periprosthetic Bone Loss After Total Knee Arthroplasty: A One-Year, Randomized, Controlled Trial of 19 Patients . Calcified Tissue International December 2002, Volume 71, Issue 6, pp 472-477
[21]. Prieto-Alhambra D, Javaid MK, Judge A, Maskell J, Bisphosphonate use and risk of post-operative fracture among patients undergoing a total knee replacement for knee osteoarthritis: a propensity score analysis. Osteoporos Int. 2011 May;22(5):1555-71.
[22]. Ishii Y, Yagisawa K, Ikezawa Y. Changes in bone mineral density of the proximal femur after total knee arthroplasty. J Arthroplasty. 2000 Jun;15(4):519-22.
[23]. Lee JK, Lee CH, Choi CH. QCT .bone mineral density responses to 1 year of oral bisphosphonate after total knee replacement for knee osteoarthritis. Osteoporos Int. 2013 Jan;24(1):287-92.
[24]. Elliott ME, Binkley N. Evaluation and measurement of bone mass. Epilepsy Behav. 2004 Feb;5Suppl 2:S16-23.
[25]. Be rard A, Bravo G, Gauthier P (1997) Meta-analysis of the effectiveness of physical activity for the prevention of bone loss in postmenopausal women. Osteoporosis Int 7:331–337.
[26]. Bassey EJ, Ramsdale SJ (1995) . Weight-bearing exercise and ground reaction forces: a 12-month randomized controlled trial of effects on bone mineral density in healthy postmenopausal women. Bone 16:469–476
[27]. Simkin, A., Ayalon, J., Leichter, I. .Increased trabecular bone density due to bone-loading exercises in postmenopausal osteoporotic women. Calcified Tissue International Volume 40, Issue 2, 1987, Pages 59-63
[28]. Greenspan SL, Maitland LA, Myers ER, Krasnow MB, Kido TH. Femoral bone loss progresses with age: a longitudinal study in women over age 65. J Bone Miner Res. 1994 Dec;9(12):1959-65.
[29]. AasisUnnanuntana, MD,1 Brian P. Gladnick, BA,2 Eve Donnelly, PhD,3 The Assessment of Fracture Risk. J Bone Joint Surg Am. 2010 March; 92(3): 743–753..