Introduction: Several previous studies have reported bone mineral density (BMD) loss around femoral implant after total hip arthroplasty, particularly in the proximal part of the femur. This BMD loss is confirmed to be related with implant design and mechanical stress distribution. In previous study, we confirmed the effect of alendronate administration for this BMD loss. While the percentage of BMD loss decreased by alendronate administration, it still decreased especially in medial proximal region from baseline. Also in lumbar BMD, significant decrease is recognized after THA without alendronate administration. Teriparatide has been recognized as an effective agent which increases BMD by stimulating bone formation. We assumed that intermitted teriparatide administration may be effective for the prevention of BMD loss after THA, possibly more effective than alendronate. The purpose of our study was to compare the effects of teriparatide and alendronate on BMD loss around the femoral implant and in the lumbar spine after THA.

Methods: Our study included 46 patients with osteoarthritis of the hip who had undergone a primary cementless THA. Forty females and 6 males with a mean age of 65.1 years (40-82) were randomly assigned to administration with teriparatide (group A: n=16), alendronate (group B: n=14), or no medication (group C: n=16). Drug administrations were performed by subcutaneous injection for teriparatide (20μg/day), oral administration for alendronate (35mg/week), beginning on postoperative week 2 and continuing until week 48. The periprosthetic BMD in the femur was measured at 1 week after surgery as a baseline reference, followed by subsequent measurements at 12, 24, and 48 weeks postoperatively with use of dual-energy x-ray absorptiometry (DEXA). The periprosthetic zones described by Gruen (figure.1) were used for region of interest (ROI) of DEXA measurement. The BMD of lumbar spine was also measured for L2 to L4 by DEXA. In addition, as biochemical markers, procollagen type 1 N-terminal propeptide (P1NP) was measured as a marker of bone formation and serum N-terminal telopeptides of type-1 collagen (NTx) was measured as a marker of bone resorption.

Results: Figure 2 shows change of BMD in ROI 7 for each group. At 48 weeks after surgery, all groups showed significant reduction in ROI 7, and Comparison of the BMD among groups revealed that teriparatide and alendronate significantly prevented loss of periprosthetic BMD (p<0.05). In three group, the group C showed significant bone loss in ROI 1, 2, 6, and 7, with values of 83% ± 7%, 87% ± 17%, 81% ± 7%, and 64% ± 13%, respectively, at 48 weeks after surgery. At 48 weeks after surgery, the periprosthetic BMD in ROI 1,2,6, and 7 was 106% ± 15%, 94% ± 14%, 100% ± 25%, and 89% ± 16%, respectively, in group A; and 99% ± 17%, 99% ± 10%, 97% ± 17%, and 84% ± 19%, respectively, in group B. Though the group A and B showed significant bone loss in ROI 7, they didn’t show significant bone loss in ROI 1, 2, and 6.
Figure 3 shows the change of lumbar BMD measured in lateral side in each group. Both the A-P and lateral side of lumbar spine BMD in group A and B were higher than that in group C at all periods. At 48 weeks after surgery, the A-P side of lumbar spine BMD in group A, B, and C was 106% ± 6%, 101% ± 5%, and 100% ± 5%, respectively, and the lateral side of lumbar spine BMD in these groups was 109% ± 4%, 103% ± 5%, and 98% ± 10%, respectively. The A-P side of lumbar spine BMD in group A was significantly higher than that in group C, and the lateral side of lumbar spine BMD in group A was significantly higher than that in both group B and C at 48 weeks after surgery.

The levels of the bone-formation marker (P1NP) at 12, 24, and 48 weeks were 410% ± 276%, 429% ± 400%, and 352% ± 347%, respectively, in group A; 169% ± 72%, 111% ± 71%, and 90% ± 80%, respectively, in group B; and 187% ± 118%, 114% ± 39%, and 112% ± 88%, respectively, in group C. The levels of P1NP in group A increased significantly at all periods compared with that in group B and C. The levels of the bone-resorption marker (NTx) at 12, 24, and 48 weeks were 162% ± 63%, 176% ± 77%, and 152% ± 43%, respectively, in group A; 106% ± 21%, 92% ± 30%, and 107% ± 27%, respectively, in group B; and 121% ± 33%, 115% ± 50%, and 120% ± 69%, respectively, in group C. The levels of NTx in group A increased at all periods compared with that in group B and C, and the level of NTx in group A were significantly higher than that in other two groups at 24 weeks after surgery.

Discussion: Teriparatide prevented the periprosthetic BMD loss with the same level as alendronate, while it significantly increased the lumbar spine BMD in lateral side compared with alendronate at 48 weeks after surgery. Previous studies have shown that periprosthetic BMD loss occurs in all ROIs after THA, with a notably significant bone loss observed in ROI 7. Alendronate administration prevents this periprosthetic BMD loss and increases the lumbar spine BMD after THA. Our data for the alendronate group and the control group were generally consistent with those in other reports.

It is obvious that teriparatide therapy increases the BMD of trabecular bone by increasing both bone formation and bone resorption for the osteoporosis treatment. In the present study, teriparatide showed an acceptable effect for the preventing BMD loss in proximal femur at the same level as alendronate, while it showed a higher effect on the lumbar spine BMD than alendronate.

Previous studies have shown some advantages of teriparatide administration for implant fixation, mechanical strength, or histological bone formation around implant, comparing with bisphosphonate. In this term, it may be reasonable to select a teriparatide after THA, rather than alendronate. Considering the level of P1NP in the teriparatide group in the present study, teriparatide may bring earlier bone ingrowth than alendronate after THA.

Moreover, teriparatide followed by combination treatment with bisphosphonate is considered to maximize early increases in BMD for osteoporosis patients. In this regard, the following administration of alendronate after teriparatide may show a notable effect on the periprosthetic and lumbar spine BMD after THA. In conclusion, teriparatide prevented the periprosthetic BMD loss with the same level as alendronate and significantly increased the lumbar spine BMD compared with alendronate at 48 weeks after surgery. Further investigations are needed to reveal the difference of long term effect between teriparatide and alendronate for the patients after THA.

Significance: Teriparatide prevented the periprosthetic BMD loss with the same level as alendronate, while it significantly increased the lumbar spine BMD compared with alendronate at 48 weeks after surgery.
Figure 2

Changes in BMD (%)

Weeks after surgery
- Teriparatide (A)
- Alendronate (B)
- No medication (C)

p<0.05  p<0.001

Figure 3

Changes in BMD (%)

Weeks after surgery
- Teriparatide (A)
- Alendronate (B)
- No medication (C)

p<0.05

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