Vertebral Changes Evaluated by Hounsfield Units Following Spinal Fusion Surgery with Concomitant Bone Anabolic Agents’ Drugs

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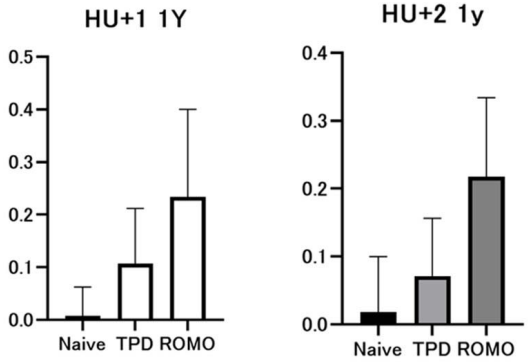
INTRODUCTION: Spinal fusion surgery is one of the most performed procedures in orthopedic surgery. In recent years, it has been reported that initiating osteoporosis management preoperatively may reduce the incidence of such complications. Osteoporosis is commonly assessed using dual-energy X-ray absorptiometry (DEXA) or computed tomography (CT) Hounsfield unit (HU) values. Although CT-HU values are not a complete substitute for DEXA, they have been reported to be useful for assessing bone quality. However, there are still few studies that have evaluated vertebral bone changes before and after surgery according to specific osteoporosis medications.
In the present study, we focused on the perioperative period of spinal fusion surgery and divided patients into three groups: osteoporosis treatment-naïve, teriparatide (TPD)-treated, and romosozumab (ROMO)-treated. We investigated the rate of change in HU values from the preoperative period to one year postoperatively.

METHODS: This study included 115 patients who underwent spinal fusion surgery at our institution and its affiliated facilities between December 2021 and July 2023. Patients who had already started osteoporosis treatment at a previous institution, as well as those who began treatment after surgery, were excluded.
The patients were divided into three groups: the naïve group, the TPD group, and the ROMO group. The primary outcome was the rate of change in HU values at one year postoperatively, compared to preoperative HU values. HU values were measured at the vertebra one level above the uppermost instrumented vertebra (HU+1) and two levels above (HU+2). For each vertebral body, three regions—the superior, middle, and inferior portions—were assessed, and the average of these three measurements was calculated. The rate of change in HU values was calculated using the one-year HU value, relative to the preoperative HU value as the baseline.

RESULTS:
A total of 115 patients were included in this study. The median age was 74 [67–78] years. The background characteristics of each group are presented in Table. There were 49 patients in the naïve group, 29 in the TPD group, and 37 in the ROMO group. The ROMO group included significantly more female patients compared to the naïve groups ($p < 0.001$). Preoperative T-scores of the spine and femoral neck were significantly higher in the naïve group than in the TPD and ROMO groups (Spine: $p = 0.003$ and $p < 0.001$; Femoral neck: $p = 0.039$ and $p < 0.001$, respectively). The ROMO group had a significantly lower total hip T-score compared to both the naive and TPD groups ($p < 0.001$ and $p < 0.012$, respectively). There were significant differences in pre-treatment HU values for both HU+1 and HU+2, with the ROMO group showing lower HU values compared to the naive group ($p=0.022$ and $p=0.03$, respectively). Intergroup comparisons of HU change rates are shown in Figure. At one year postoperatively, HU+1 showed significant differences among all three groups. Both the TPD and ROMO groups demonstrated significantly greater variation rates compared to the naïve group ($p = 0.027$ and $p < 0.001$, respectively; Figure). Furthermore, the ROMO group showed significantly higher HU variation rates than the TPD group ($p = 0.014$). For HU+2 at one year postoperatively, the ROMO group also showed significantly greater HU variation rates than both the naïve and TPD groups ($p < 0.001$ and $p = 0.017$, respectively; Figure).
DISCUSSION AND CONCLUSION: HU values have been reported to show moderate to strong correlations with BMD and mechanical bone strength, making them a useful method for bone quality assessment. While HU values cannot fully replace DEXA, they offer several advantages in the context of spinal surgery: they can be easily and simultaneously measured from preoperative CT scans. Anabolic agents of osteoporosis have been reported to induce a rapid increase in BMD. TPD has traditionally been considered the first-line treatment in the context of spinal fusion surgery; however, recent studies have increasingly highlighted the rapid and robust BMD-increasing effects of ROMO. Based on this background, we compared TPD and ROMO with a treatment-naïve group in the present study. While the naïve group showed no change in HU values at one year postoperatively, both the TPD and ROMO groups demonstrated increases in HU variation at one year from baseline. These findings suggest that both TPD and ROMO can induce positive changes in the bone environment following spinal fusion. However, ROMO resulted in significantly greater HU variation rates than TPD at 1-year postoperative time points, indicating that ROMO may provide a more rapid and potent improvement in bone quality. Nevertheless, it is important to consider that TPD is typically administered for a two-year course, whereas ROMO is limited to a one-year treatment regimen. Therefore, comparisons at two years postoperatively may yield different results, and further long-term studies are warranted.

In conclusion, the ROMO group demonstrated significantly greater increases in HU values compared to the TPD group at one year postoperatively. These findings suggest that ROMO may be more suitable for enhancing the bone environment in the early phase surrounding spinal fusion surgery.



Factor	Naïve (n=49)	TPD (n=29)	ROMO (n=37)	p.value
SEX: Male (%)	35 (71.4%)	13 (44.8%)	7 (18.9%)	<0.001
SEX: Female(%)	14 (28.6%)	16 (55.2%)	30 (81.1%)	
Spine T.score	1.5 [0.40, 3.50]	0.2 [-1.60, 0.75]	-0.65 [-2.02, 1.07]	<0.001
FN T.score	-1.55 [-2.05, -0.27]	-2.3 [-3.20, -1.25]	-2.95 [-3.40, -1.98]	<0.001
TH T.score	0.2 [-0.92, 0.98]	-0.8 [-1.70, 0.50]	-2.2 [-2.68, -0.83]	<0.001
Pre-HU level of HU+1	107.33 [91.67, 155.00]	103.00 [62.33, 140.67]	89.33 [74.00, 106.33]	0.042
Pre-HU level of HU+2	112.67 [90.33, 162.33]	105.33 [71.67, 146.67]	92.33 [77.00, 109.00]	0.046
1Y-HU level of HU+1	106.67 [88.00, 142.33]	92.67 [64.33, 150.33]	112.00 [84.67, 150.67]	0.719
1Y-HU level of HU+2	112.33 [89.33, 163.33]	102.33 [70.00, 148.33]	112.33 [93.00, 158.00]	0.605
Duration from Initiation of Treatment to Surgery (D)	NA [NA, NA]	62 [39.50, 101.50]	73 [29.75, 112.25]	0.487
Age (old)	71 [66.00, 77.00]	75 [71.00, 79.00]	75 [69.00, 79.00]	0.032