Bone mineral density and static markers of bone turnover in patients undergoing surgery for hip fracture repair

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INTRODUCTION: Bone mineral density (BMD) measured through dual-energy x-ray absorptiometry (DXA) is the established standard for the assessment of bone, but it does not consider bone architectural features and markers of bone turnover, mineralization, and volume, which are known contributors to fracture risk. Therefore, we evaluated correlation of hip T-scores and BMD measured prior to hip fracture with static markers of bone turnover in patients undergoing surgery for hip fracture repair.

METHODS: Among 50 patients with hip fracture who were 18 years or older and recruited to our study from December 2020-November 2024, we collected BMD measurements from DXA scans completed 2 days to 10 years prior to hip fracture. We also performed static histomorphometry for bone turnover markers in femoral heads from these patients according to methods previously described.[1, 2, 3] We used Spearman correlation coefficients to determine whether BMD (g/cm^2) and T-scores in the left and right femoral neck and total hip were correlated with static histomorphometry markers of bone turnover. This project was approved by the Institutional Review Board.

RESULTS: Average age of these 50 patients was 79 +/- 11 years and 68% were female. Among the cohort, 10% had recorded DXA scans for BMD measurement prior to their fracture. Median [25th percentile, 75th percentile] T-score and BMD for the Left Femoral Neck was -3.2 [-3.5, -2.9] and 0.61[0.56, 0.70], respectively; Left Total Hip was -3.0 [-3.2, -2.8], and 0.62 [0.61, 0.66], respectively; Right Femoral Neck was -3.3 [-3.7, -2.8] and 0.59 [0.58, 0.67], respectively; and Right Total Hip was -3.5 [-3.6, -2.9] and 0.58 [0.56, 0.68], respectively. We observed a strong inverse correlation of Left and Right Total Hip BMD with bone sclerostin, bone volume (BV/TV), and trabecular thickness (Tb.Th); and a strong positive correlation of Left and Right Total Hip BMD with eroded surface (ES/BS) and trabecular separation (Tb.Sp), although these correlations were not statistically significant. (Tables 1 and 2)

DISCUSSION: Among 50 patients with hip fracture in this cohort, only 10% had recorded DXA scans for bone density measurements prior to their fracture. While we were limited by such a small number of patients with DXA, potentially due to underreporting as well as lack of completion, we demonstrated that BMD was correlated with bone sclerostin, bone volume (BV/TV), eroded surface (ES/BS), trabecular thickness (Tb.Th) and separation (Tb.Sp).

SIGNIFICANCE/CLINICAL RELEVANCE: While DXA cannot replace bone histomorphometry in the evaluation of bone turnover, mineralization, and volume, the correlation of BMD measurements on DXA may provide insight into these bone turnover markers. Given our limited sample size, this analysis needs to be completed in a larger cohort.

REFERENCES:
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Table 1. Spearman Correlation Coefficients for T-Scores for BMD and Static Histomorphometry Parameters

	Left Femoral Neck (n=5)	P-value	Left Total Hip (n=5)	P-value	Right Femoral Neck (n=5)	P-value	Right Total Hip (n=4)	P-value
Osteoblast Surface/Bone Surface (Ob.S/BS), %	0.67	0.22	-0.03	0.97	0.34	0.57	-0.63	0.37
Osteoid Thickness (O.Th), um	0.40	0.60	0.00	1.00	0.32	0.68	-0.50	0.67
Osteoid Volume / Bone Volume (OV/BV), %	0.10	0.87	0.10	0.87	0.67	0.22	-0.20	0.80
Osteoid Surface / Bone Surface (OS/BS), %	0.00	1.00	0.21	0.74	0.67	0.22	-0.20	0.80
Osteoclast Surface / Bone Surface (Oc.S/BS), %	0.67	0.22	0.29	0.64	-0.06	0.93	-0.21	0.79
Eroded Surface / Bone Surface (ES/BS), %	0.90	0.04	**0.67**	0.22	-0.41	0.49	**0.80**	0.20
Trabecular Separation (Tb.Sp), um	-0.10	0.87	**-0.05**	0.94	-0.05	0.93	**1.00**	0.001
Sclerostin / Bone Area (Sclerostin / B.Ar)	0.50	0.39	**0.21**	0.74	-0.15	0.80	**-0.80**	0.20
Bone Volume / Tissue Volume (BV/TV), %	-0.30	0.62	**0.21**	0.74	-0.10	0.87	**-0.80**	0.20
Trabecular Thickness, (Tb.Th) um	-0.30	0.62	**-0.15**	0.80	-0.10	0.87	**-0.80**	0.20
Sclerostin / Tissue Area (Sclerostin / T.Ar)	0.30	0.62	**0.21**	0.74	-0.10	0.87	**-0.80**	0.20

Table 2. Spearman Correlation Coefficients for BMD (g/cm^2) and Static Histomorphometry Parameters

	Left Femoral Neck (n=6)	P-value	Left Total Hip (n=4)	P-value	Right Femoral Neck (n=5)	P-value	Right Total Hip (n=4)	P-value
Osteoblast Surface/Bone Surface (Ob.S/BS), %	0.27	0.60	-0.63	0.37	-0.11	0.86	-0.63	0.37
Osteoid Thickness (O.Th), um	-0.10	0.87	-0.50	0.67	-0.20	0.80	-0.50	0.67
Osteoid Volume / Bone Volume (OV/BV), %	0.31	0.54	-0.20	0.80	0.80	0.10	-0.20	0.80
Osteoid Surface / Bone Surface (OS/BS), %	-0.09	0.87	-0.20	0.80	0.60	0.28	-0.20	0.80
Osteoclast Surface / Bone Surface (Oc.S/BS), %	0.33	0.52	-0.21	0.79	-0.45	0.45	-0.21	0.79
Eroded Surface / Bone Surface (ES/BS), %	1.00	0.001	**0.80**	0.20	0.30	0.62	**0.80**	0.20
Trabecular Separation (Tb.Sp), um	0.31	0.54	**1.00**	0.001	0.60	0.28	**1.00**	0.001
Sclerostin / Bone Area (Sclerostin / B.Ar)	0.09	0.87	**-0.80**	0.20	-0.70	0.19	**-0.80**	0.20
Bone Volume / Tissue Volume (BV/TV), %	-0.66	0.16	**-0.80**	0.20	-0.70	0.19	**-0.80**	0.20
Trabecular Thickness, (Tb.Th) um	-0.66	0.16	**-0.80**	0.20	-0.70	0.19	**-0.80**	0.20
Sclerostin / Tissue Area (Sclerostin / T.Ar)	-0.20	0.70	**-0.80**	0.20	-0.70	0.19	**-0.80**	0.20