New diagnostic approach to traumatic vertebral body fractures using Hounsfield unit values

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INTRODUCTION: Hounsfield unit (HU) values measured by CT relatively express the density of the imaged material. It has been reported that HU values are higher in cases of fracture due to the effects of bone marrow edema and hematoma. However, HU values are also affected by changes in bone density and bone quality caused by ageing, etc., and it is challenging to diagnose fractures based on HU values alone. In this study, we aimed to improve the accuracy of the diagnosis for new traumatic vertebral fractures using HU values.

METHODS: The study included 79 cases of new traumatic vertebral fractures who visited our hospital within one week of injury and received treatment, from January 2023 to December 2024. Cases of tumors, previous spinal surgery, and infections were excluded. Gender, age, and level of the fractured vertebrae were investigated, and HU values were measured at the pedicle level of each vertebra from the 10th thoracic vertebra (T10) to the 5th lumbar vertebra (L5). We compared the HU values of fractured vertebrae (FV) and non-fractured vertebrae (NFV). We investigated the relative value of FV (FV-Relative Value: FV-RV), which was calculated as the HU value of FV divided by the average of the sum of the HU values of the cephalocaudal NFVs. We also investigated the relative value of NFV (NFV-Relative Value: NFV-RV) calculated using the same method as FV-RV. Statistical analysis was performed using the Mann-Whitney U test and Spearman's correlation coefficient, with significance set at $p< 0.05$. This study was approved by the institutional review board of our hospital.

RESULTS SECTION: The study included 45 men and 34 women, and the mean age was 65.4 ± 19.7 years old (range 19-98). HU values were measured in 632 vertebrae, and FV was observed in 109 vertebrae (T10: 4, T11: 9, T12: 26, L1: 31, L2: 16, L3: 9, L4: 9, L5: 5). The HU values were 170.4 ± 78.6 in FV and 94.8 ± 52.7 in NFV, and were significantly higher in FV ($p< 0.01$). FV-RV was 2.02 ± 1.68, and NFV-RV was 1.01 ± 0.23, FV-RV was significantly higher than NFV-RV ($p< 0.01$). HU values showed a strong negative correlation with age, whereas FV-RV did not correlate with age. The cutoff value for HU values that can diagnose new vertebral fractures was 108.6 (AUC 0.8, sensitivity 0.68, specificity 0.83), and the cutoff value for FV-RV was 1.21 (AUC 0.963, sensitivity 0.88, specificity 0.93).

DISCUSSION: This study showed that the diagnostic method using FV-RV was more reliable than the method using HU for diagnosing new traumatic vertebral fractures. We consider that this result is explained by the fact that FV-RV is calculated based on the comparison with other vertebrae of the same individual. This method compensates for individual differences, and as a result, FV-RV can be used with less influence from age. FV-RV may be helpful in diagnosing new traumatic vertebral fractures.

SIGNIFICANCE/CLINICAL RELEVANCE: The relative value of FV (FV-Relative Value: FV-RV), which was calculated as the HU value of FV divided by the average of the sum of the HU values of the cephalocaudal NFVs, is a valuable method for detecting new traumatic vertebral fractures with compensation for individual differences. There is a high possibility of new vertebral fractures when FV-RV is 1.21 or higher (AUC 0.963, sensitivity 0.88, specificity 0.93).
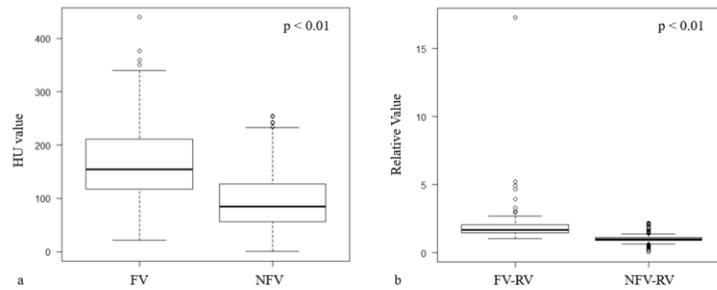

Figure 1: a) Comparison of HU values between fractured vertebrae (FV) and non-fractured vertebrae (NFV) . The HU value of FV was significantly larger than that of NFV. b) Comparison between FV-relative value (FV-RV) and NFV-relative value (NFV-RV). The FV-RV was significantly larger than the NFV-RV.
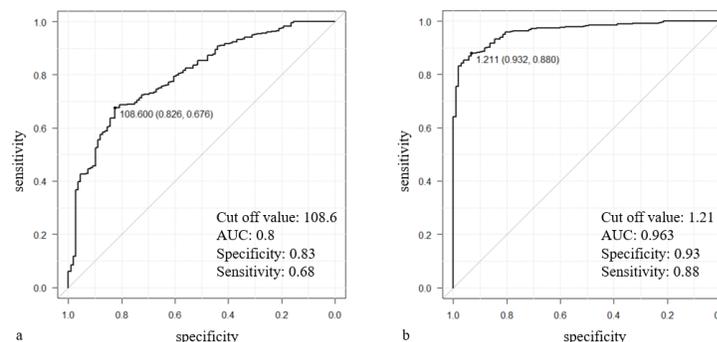

Figure 2: a) Cut-off values for distinguishing new vertebral fractures using HU values. The cutoff value was 108.6 (AUC 0.8, sensitivity 0.68, specificity 0.83). b) Cut-off values for distinguishing new vertebral fractures using FV-RV. The cutoff value was 1.21 (AUC 0.963, sensitivity 0.88, specificity 0.93).