Bone marrow perfusion magnetic resonance imaging in patients with osteoporotic vertebral compression fractures: peak enhancement ratio is an independent predictor for intraosseous vacuum phenomena

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Introduction

Osteoporotic vertebral compression fractures (VCF) are common in routine medical practice and usually heal without neurologic complications. However, vertebral bodies that are severely osteoporotic and located in thoracolumbar junction are more susceptible to non-healing with resultant intravertebral cleft formation (1). Recently, dynamic contrast enhanced magnetic resonance imaging (DCE -MRI) has been used for the evaluation of bone marrow perfusion (2, 3).In this study, we prospectively investigate the relationship between intraosseous clefts and bone marrow perfusion using dynamic contrast-enhanced magnetic resonance images (DCE-MRI) in patients with osteoporotic vertebral compression fractures.

Material s and Methods

Forty subjects referred for evaluation of vertebral compression fracture underwent DCE-MRI from T8 to sacrum. Bone marrow perfusion, as measured using the DCE-MRI time-intensity curve from a non-injured vertebrae was developed using 2 distinct parameters including peak enhancement ratio (PER) (which indicates tissue perfusion) and enhancement slope (which reflects vascularity). The ratio of the well-enhanced to the poorly-enhanced zone of each injured vertebra was calculated. Multiple logistic regression analysis was used to evaluate the relationships between baseline clinical factors, parameters of DCE-MRI and presence or absence of intraosseous clefts.

Results and Discussions

Twenty-nine injured vertebrae (72%) had intraosseous clefts. The cleft group showed significantly lower PER (p = 0.001) (Fig. 1 and Fig. 2) and a less well-enhanced zone ratio (p = 0.049) than the 'no cleft' group. Lower PER of the non-injured vertebrae was associated with higher poorly-enhanced zone ratio of the injured vertebrae (γ = -0.362, p = 0.017). Multivariate logistic regression analysis identified lower PER (hazard ratio, 0.000; 95% confidence interval, 0.000-0.096; p = 0.009) as an independent predictor of intraosseous clefts. A PER value less than 0.57 had a sensitivity of 80% and specificity of 90% for predicting intraosseous clefts (Fig. 3).

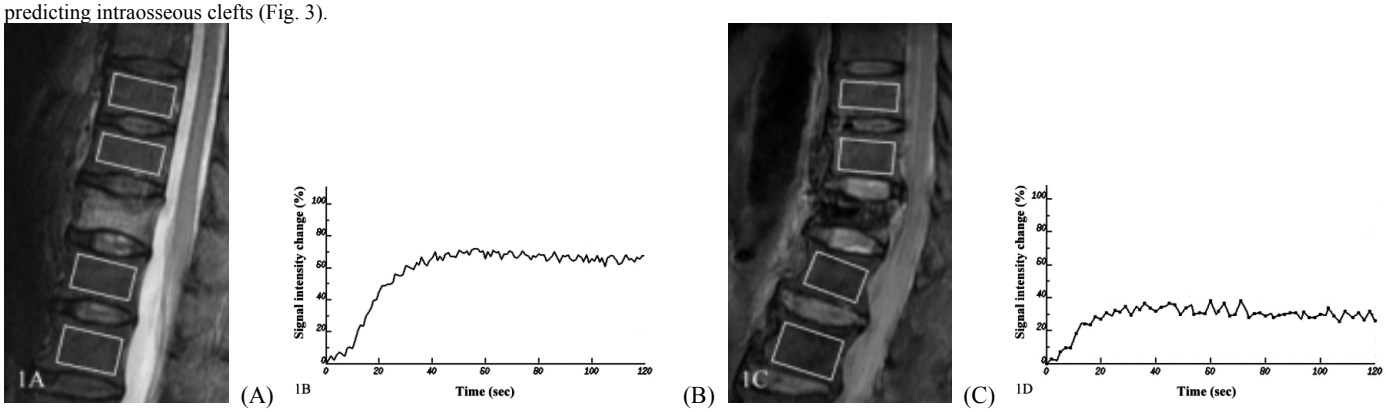

Figure 1. The time-intensity curves derived from DCE-MRI in a 79-year-old woman with a T12 compression fracture with no cleft (**A, B**) and from DCE-MRI in a 77-year-old woman with cleft at T12 compression fracture (**C, D**). There was a lower signal intensity change (PER) in the cleft patient.

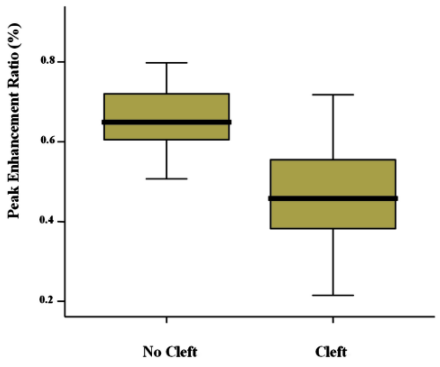

Fig.2 Scattergram and box plot of peak enhancement ratios in 40 subjects in the cleft and 'no cleft' groups with osteoporotic compression fractures.

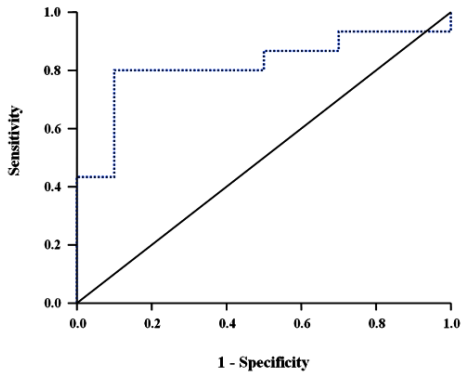

Fig 3.Receiver operating characteristic (ROC) curve for peak enhancement ratio.

Conclusions

The intraosseous cleft and the intravertebral fluid sign are characteristic findings of benign vertebral fractures (4). Although several theories have been proposed to explain the cause of the intravertebral vacuum phenomena, its pathogenesis remains indefinite. It is unclear whether ischemic osteonecrosis or vertebral collapse is the first step in the development process of an intraosseous cleft. In conclusion, bone marrow perfusion can be measured using DCE-MRI semi-quantitatively. It can independently predict the presence of intraosseous clefts in patients with osteoporotic VCF and its sensitivity and specificity were high. We believe DCE-MRI can help to identify the more frail patients after VCF in order to tailor their therapy. Further, it can also be applied to identify delicate osteoporotic patients for advance treatment before the occurrence of fracture.

References

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