

MR perfusion imaging and spectroscopy helps predict rate of bone loss

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BACKGROUND: Current methods of diagnosing osteoporosis rely on recognizing bone loss. Once bone is lost, bone strength will not return to normal levels even with appropriate treatment. Therefore, in many respects, current methods diagnose osteoporosis too late. Being able to better predict and specifically target those most at risk of age-related bone loss will help prevent a considerable number of osteoporotic-related fractures [1]. Low bone mineral density (BMD) of the proximal femur is a strong predictor of hip fracture [2]. Cross-sectional MR-based studies have shown how low BMD is associated with decreased bone marrow perfusion and increased marrow fat content [3].

INTRODUCTION: We undertook this longitudinal study to:

- determine if MR perfusion indices measured by DCE-MRI or marrow fat content measured by proton MRS of the hip region at baseline were predictive of bone loss from the hip region at two and four years post-baseline.
- compare the predictive capacity of MR perfusion and fat content indices at baseline with currently applied risk factors such as age, weight, weight loss.
- assess whether MR perfusion and fat content indices at baseline could distinguish between fast and slow bone losers over the ensuing four years.

MATERIAL AND METHOD: At baseline, 120 post-menopausal female subjects underwent both BMD of the right hip together with MR perfusion imaging of the right femoral neck, acetabulum and adductor muscle as well as MR spectroscopy of the right femoral neck. Of these 120 subjects, 52 subjects were able to be followed-up with repeat BMD of the right hip at two and four years. Subjects were divided into those with above or below median perfusion indices or median marrow fat content index at baseline. The relationship between perfusion and marrow fat content indices at baseline was related to femoral neck BMD at two and four years.

RESULT: Subjects with below median perfusion indices or above median marrow fat content at baseline had a significantly greater percentage reduction in femoral neck BMD at two and four years post-baseline (even after adjusting for baseline BMD, age, weight and weight change) (Fig 1, 2, and 3). Most baseline MR parameters correlated better with the four-year reduction in BMD than traditionally applied risk factors. Acetabulum E^{slope} , femoral neck E^{max} , E^{slope} and marrow fat content at baseline had sensitivities of 89%, 81%, 75% and 72% respectively at distinguishing between fast (>1% / annum) and slow (<1% annum) bone losers over the ensuing four years.

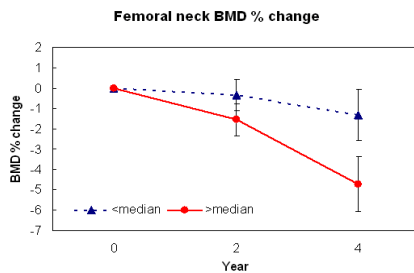


Fig. 1. Mean percentage reduction in femoral neck BMD over four year period in subjects with < or > the median fat content (=85.5%).

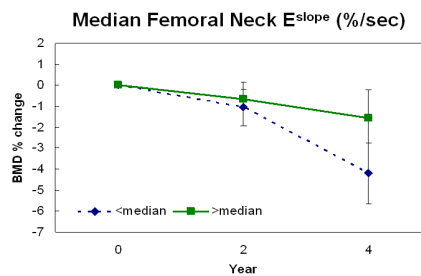


Fig. 2. Mean percentage reduction in femoral neck BMD over four year period in subjects with < or > the median E^{slope} (= 0.36 %/sec) at the femoral neck.

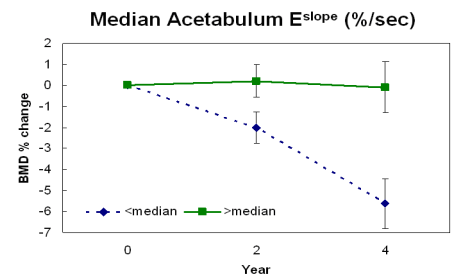


Figure 3. Mean percentage reduction in femoral neck BMD over four year period in subjects with < or > median E^{slope} (= 0.87 %/sec) at the acetabulum.

CONCLUSION: Post-menopausal female subjects with below median perfusion indices or above median fat content at baseline have increased femoral neck bone loss at four years. Perfusion indices and, to a lesser degree, marrow fat content can predict bone loss as well as currently applied risk factors. Selected perfusion indices also have a high sensitivity in distinguishing fast and slow bone losers.

References

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