SUMMARY

Elderly people are at a significantly higher risk of suffering a bone fracture as a result of a fall than the ambient population. Accurate prediction of fracture risk allows for preventative intervention and reliable advice on lifestyle. Traditionally, dual energy X-ray absorptiometry (DXA) is used to assess fracture risk. This technique allows the calculation of areal bone mineral density (aBMD), T-score and geometric parameters commonly used to assess risk of fracture. However, these measures may not fully exploit the information content available in DXA images regarding risk of fracture as there are still several limitations to the way images are currently analysed. First, aBMD is not an accurate measurement of true bone mineral density because it measures area rather than volume of bone. Second, bone density is averaged over the entire image or over specified regions of interest (ROI) and ignores local information. Third, only a few discrete geometric measures are usually considered rather than full shape information. Finally, density and geometric information are analysed separately.

In this study, an active shape model (ASM) and an active appearance model (AAM) were used to allow a quantitative characterization of the shape and gross structure of the proximal femur. These models provide a level of risk assessment comparable to conventional risk measures such as BMD and T-score. In order to improve risk assessment, these methods were augmented with image texture analysis methods, including Gabor filters and textons applied to various ROI. Texture methods allow quantification of structure patterns that have not been considered previously in assessing risk of bone fracture. To evaluate these methods, we analysed hip DXA scans from the Osteoporosis Centre of Southampton General Hospital. The data consisted of 29 DXA scans from subjects with a history of fragility fracture and 90 DXA scans from subjects with no known fractures. Feature selection was used to determine which method, or combination of methods, was best to discriminate between the fracture and control groups. The data was separated into two, roughly equal sets, each containing similar ratios of fracture and non-fracture examples. One set was used to develop a new scheme for estimating risk of fracture and the other set was used to measure performance of the risk scheme.

Results showed that by including texture information based on Gabor filters and focusing on a specific region of the image (the whole femoral neck), better risk assessment was possible than using either aBMD or T-score alone. Thus the main conclusion of this work is that DXA scans include more information regarding fracture risk than is normally exploited and, in particular, that including texture information has the potential to improve estimates of fracture risk.