Identifying Tissue Types in MR Imaging of Benign Prostatic Hyperplasia

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Aim

Our aim is to devise analysis methods that can be used to distinguish between stromal and non-stromal Benign Prostatic Hyperplasia from magnetic resonance images. Our results show that measures of image texture based on grey-level co-occurrence matrices provide classifications that are equivalent to qualitative assessment based on previously published criteria.

Introduction

Benign Prostatic Hyperplasia (BPH) is a non-cancerous enlargement of the prostate that affects 80% of men over the age of 40 and 95% of men over 80. The enlargement can cause constriction of the urethra, which runs through the prostate, resulting in obstruction of urinary flow. In 25% of men aged 80, the symptoms are sufficiently severe to require treatment by transurethral resection of the prostate. However, this treatment has high cost, morbidity (16%) and mortality (2.01%), so alternative treatments are sought. There are two principal components of BPH: glandular and muscular or stromal. Ishida et al [1] observed that, in T2-weighted MR images, some areas of the prostate show a variety of heterogeneous and nodular patterns associated with BPH, and other studies have also made qualitative descriptions of enhanced tissue heterogeneity in BPH [2] (see figure 1). These observations may be associated with differing proportions of stromal and muscular tissue present. Measurement of the degree of tissue inhomogeneity may not only provide a useful biomarker to identify the severity of disease, but may permit differential diagnosis, with consequences for pharmaceutical treatment. For example α-blockers may be effective at treating patients with a large percentage of stromal growth, while predominantly glandular BPH may be more appropriately treated with 5-α-reductase inhibitors [3]. Accurate classification into the two types currently requires biopsy followed by histological examination. Ishida et al [1] showed that the histological type of BPH could be accurately determined by visual inspection of T2-weighted MR images using a set of semi-quantitative criteria involving the heterogeneity of the *central gland* (CG)and the relative volumes of the central gland and *peripheral zone* (PZ) (see fig. 1). In this work we seek to explore the possibility of objective image-bases assessment of the class of BPH with a view to making differential diagnosis without the need for biopsy.

Methods

Imaging: We have used T2-weighted fat suppressed images as these result in good separation of the prostate from most surrounding tissue and enhanced distinction between CG and PZ compared to T2 or T1 weighting. Images were collected from 19 patients using a Philips Gyroscan Intera, software version NT8.11, 1.5T with synergy body coil, slice thickness of 2mm and in-plane resolution of 1.0mm.

Image Analysis: The images were manually segmented to provide the boundaries of the whole prostate and the central gland. The texture of the central gland was assessed using grey-level co-occurrence matrices [4]. To account for the varying size of texture elements and the isotropic nature of the texture in the images, co-occurrence values were calculated over a circular region around each pixel in each of the slices close to the central region of the prostate. A range of offset distances from 1 to12 pixels was used to provide a number of scale-sensitive texture features (contrast, correlation, energy and homogeneity [4]). The number of slices included in the texture measure was an experimental parameter. Images were ranked visually and classified into two groups in two different ways: *texture groups* (homogeneous and inhomogeneous) and *histological groups* (stromal and non-stromal) using Ishida's criteria [1], which supplement the texture assessment. The significance of the texture measures for classification of the groups was assessed using a t-test or a Mann-Whitney test, following a Lilliefors hypothesis test for normality of the measured values.

Results

Many texture measures were evaluated, combing different slice configurations and combinations of texture feature derived from the co-occurrence matrices. Several of these showed significant separation at the 5% level in both the texture and histological groups, t-test significance values ranging from 0.014 to. 0.041.

Discussion and Conclusions

We have demonstrated that image feature values can be measured that are capable of distinguishing the appearance of stromal and non-stromal BPH in fat-suppressed T2-weighted MR images. The classification produced by these measures coincides closely with that generated using published criteria that have been shown to accurately determine the histological classification of the disease. An important point to note is that *only* texture measures were used in making this assessment, whereas other image-based measures, such as the volume ratio of the PZ to the CG could provide additional classification features, but these features were not assessed in this study. These results raise the possibility of making automatic, quantitative assessment of tissue type from MR images, which may be of considerable benefit in differential diagnosis of BPH.

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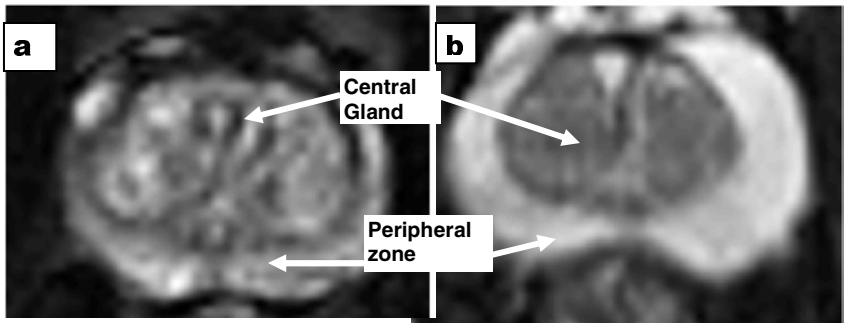

Figure 1. Central slices through T2 fat-suppressed MR images of the prostate showing: (a) the granular, inhomogeneous appearance of the central gland and compressed peripheral zone in glandular (non-stromal) BPH; (b) the more homogeneous appearance of the central gland and larger peripheral zone in stromal BPH

References

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