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Artificial intelligence for Gleason grading in prostate cancer

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Introduction & Objectives: In the recent years there has been a great interest in artificial intelligence (AI) methods for diagnostic purposes. Developing algorithms which would automate, standardize and speed up diagnosis of prostate cancer can help improve patients wellbeing and save healthcare costs. Over the last three years we have been developing an algorithm, based on convolutional neural networks, which aims to detect cancer areas on prostate biopsies.

Materials & Methods: A training cohort consisting of 476 biopsy slides from 119 patients was scanned and annotated by two specialist pathologists to identify areas of Gleason 3 (GS3), 4 (GS4) and 5 (GS5). The annotations were used to construct the original algorithm. An additional subset of 222 slides from further 55 patients was used to retrain the algorithm. Validation was performed on a separate cohort of 37 biopsies from 21 patients. The slides were blinded and uploaded for the two pathologists to annotate. Annotations drawn by the pathologists and by the final algorithm were extracted and compared with linear regression.

Results: The algorithm was in concordance with the pathologists in detecting cancer versus benign areas (r^2=0.96 with both pathologists) as well as detecting GS3 (r^2>0.86) and GS4 (r^2>0.73) but not GS5 (r^2<0.57). Overall accuracy of the final ISUP grade compared to at least one of the pathologists was 78%. The sensitivity of detecting cancer by the algorithm was 100% with specificity of 64%. The sensitivity/specificity was 100%/75% for GS3, 93%/83% for GS4 and 100%/91% for GS5.

Conclusions: The algorithm is highly sensitive in discriminating between cancer and non-cancer areas and identification of GS3 and GS4 but it still has difficulties to appropriately identify GS5. An extended study with a large volume of prostate cancer biopsies is needed for re-training in order to further improve the algorithm.