INTRODUCTION

• Targeted biopsy improves prostate cancer diagnosis. Accurate prostate segmentation on MRI is critical for accurate biopsy.

• Manual gland segmentation is tedious and time-consuming.

OBJECTIVE

• To develop a deep learning model (ProGNet) to rapidly and accurately segment the prostate on MRI and to evaluate this approach for MR-US fusion biopsy.

METHODS

• 916 subjects underwent MRI at 29 academic and private practice institutions followed by MR-US fusion biopsy at Stanford University.

• A urologic oncology expert with 7 yrs of experience segmented all MRIs.

• We trained a deep learning model, ProGNet, on 805 of the cases and tested it on an internal retrospective test set (n = 100) & on two external test sets (n = 26 & n = 30).

• We explored whether our model would improve performance over radiology technicians by comparing segmentation overlap with the urologic oncology expert using the Dice similarity coefficient (DSC).

• We compared ProGNet performance to two deep learning networks, the U-Net and the HED models.

• We worked with the biopsy vendor (Eigen, Grass Valley, CA) to enable model outputs to be usable on the clinical biopsy system and then utilized the model on a prospective 11 patient cohort of men undergoing biopsy.

RESULTS

Performance:

• ProGNet (DSC=0.92) outperformed U-Net and HED (DSC=0.85, p<0.0001 and 0.80, p<0.0001) in the retrospective test set.

• ProGNet performance was closer to expert segmentation compared to radiology technicians in both the retrospective (DSC=0.92 vs. 0.89, p<0.0001) and prospective (DSC=0.93 vs. 0.90, p=0.0004) test sets.

Speed of segmentation:

• ProGNet took just 0.5 seconds to segment each prostate on MRI. Radiology technicians averaged 10 minutes per case.

Clinical utilization:

• This is the first study to employ a deep learning model for prostate gland segmentation for MR-US fusion targeted biopsy in routine urologic clinical practice.

Subgroup analysis:

<table>
<thead>
<tr>
<th>Performance (mean ± SD) in the Retrospective Internal Test Set.</th>
<th>Scans acquired at Stanford (n = 88)</th>
<th>Scans acquired outside of Stanford (n = 12)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ProGNet</td>
<td>0.92 (±0.02) *</td>
<td>0.93 (±0.02) *</td>
</tr>
<tr>
<td>U-Net</td>
<td>0.84 (±0.07) *</td>
<td>0.89 (±0.04) *</td>
</tr>
<tr>
<td>HED</td>
<td>0.80 (±0.08) *</td>
<td>0.84 (±0.06) *</td>
</tr>
<tr>
<td>Radiology Technicians</td>
<td>0.89 (±0.05) *</td>
<td>0.91 (±0.03) *</td>
</tr>
</tbody>
</table>

* p<0.05