AUTOMATIC R.E.N.A.L NEPHROMETRY SCORING USING MACHINE LEARNING

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Introduction

The R.E.N.A.L. Nephrometry score has been shown to be predictive of outcomes such as urine leak, warm ischemia time, estimated blood loss, length of hospital stay, and major postoperative complications in patients undergoing partial nephrectomy. Despite its proven utility, concerns about inter-observer variability and significant manual effort have limited its uptake in clinical practice. We propose an automated methodology to calculate the R.E.N.A.L. nephromtetry score and compare its performance with that of trained healthcare providers.

Methods

Each of the R.E.N.A.L score's criterion is unambiguously defined given a semantic segmentation of the lesion and affected kidney. Thus, we set out to automate kidney and tumor segmentation through the use of deep learning. We collected 76 preoperative contrast-enhanced CT scans of nephrectomy patients at our institution and manually delineated the kidneys and tumors. For 40 of these scans, three students manually computed their R.E.N.A.L. score. We then developed an algorithm to produce each of the R.E.N.A.L. components given a semantic segmentation. Finally, we trained a deep neural network to automatically perform this semantic segmentation task.

Results

We consider the R.E.N.A.L. components given by the manual delineations to be the ground truth. Given this, we compare the provenance of the student's manual scoring with the scoring given by running the automatic semantic segmentation through our scoring algorithm. Our results are shown in the below table.

	Manual Accuracy (%)	Automatic Accuracy (%)
R	76.7	57.1
E	59.3	71.4
N	62.7	60.0
A	78.0	68.3
L	68.6	54.3

Conclusions

Automation could address the largest barriers to the R.E.N.A.L. score's adoption. Additionally, semantic segmentation is inherently a transparent technique, which will help to prevent subtle and unexpected error modes. Further work must be done to expand the training database in order to improve the methodology, and this

approach must be validated on external data. Finally the performance must be compared to that of experienced radiologists and urologists on a large scale.

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Conflict of Interest and Disclosure Statement

Nothing

Category

Radiology

Keywords

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