Deep neural network as a decision support tool for the detection of lymph node metastases of colorectal cancer

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Background

The identification of lymph node metastases in colorectal cancer specimens can be a time-consuming and challenging task for pathologists. The aim of this study was to develop a deep learning-based segmentation algorithm for the detection of cancer foci in digitalized histological sections of lymph nodes and evaluate its performance as a diagnostic tool.

Methods

Algorithm performance

Figure 1: Evaluation of analytical performance of deep neural network* (DNN)

Decision support

A randomized 2x2 cross-over study on whole slides images (WSI) was performed by two senior pathologists without (unassisted) and with (assisted) help of the algorithm. Recording the time needed for the evaluation of each lymph node, any presence of macrometastases (>2 mm), micrometastases (0.2-2 mm), isolated tumor cells (<0.2 mm) or tumor deposits (metastatic tissue without identifiable lymph node) were documented.

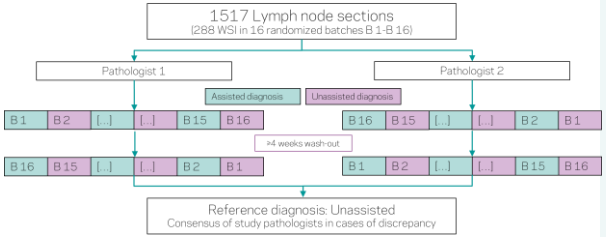

Figure 2: Study conduct to test algorithm as decision support tool

Results

Algorithm performance

The deep neural network (DNN) achieved a median pixel-level accuracy of 0.952 on cancer slides and 0.996 on benign slides.

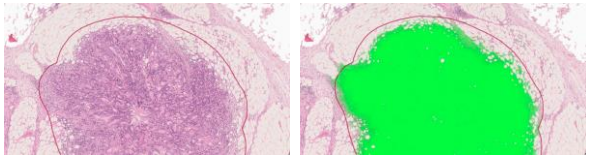

Figure 3: Tumor deposit with cancerous areas annotated by a pathologist (left) and predicted by the DNN (right)

Decision support

When using the algorithm as decision support tool (DST), the time needed for the evaluation was significantly shortened.

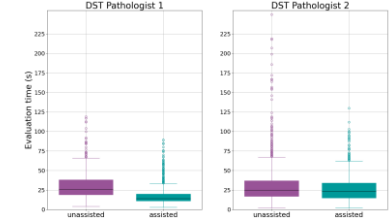

Figure 4: Significantly faster evaluation with DST (median (lower quartile, upper quartile) for pathologist 1: 26s (19s, 38s) vs. 14s (11s, 20s), p<0.001; pathologist 2: 25s (17s, 37s) vs. 23s (15s, 34s) , p<0.001)

Diagnostic discrepancy between the pathologists was found in 15 cases: 13 lymph nodes with isolated tumor cells and 2 with micrometastases. In these cases, the algorithm missed to highlight the tumorous area in 6 lymph nodes with isolated tumor cells and in 1 node with micrometastasis.

Conclusions

A deep neural network can identify metastatic cancer foci on digitalized histological sections of colorectal lymph nodes, with at least the same accuracy as pathologists. Using the algorithm as a decision support tool can significantly shorten the time needed for the assessment of the lymph nodes.

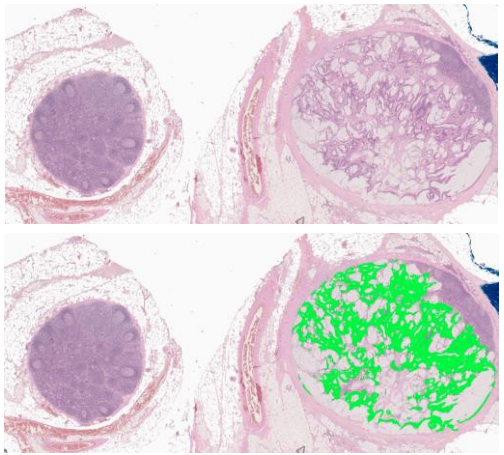

Figure 5: Examples of benign lymph node (left) and lymph node with metastasis (right) with cancerous areas predicted by the DNN (lower) and without predictions (upper)

*The deep neural network used in this study was developed by ContextVision