Detection of Malignancy-Associated Changes Due to Precancerous and Oral Cancer Lesions: A Pilot Study using Deep Learning

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Introduction

- Oral cancer is increasing and is effecting younger individuals.
- PAP-smear based screening has successfully been used to decrease the incidence of cervical cancer.
- Detection of malignancy associated changes (MAC) among all cells in the vicinity of a lesion from patients with pre-cancerous and cancerous lesions shows promise as a basis for screening.
- Convolutional neural networks has been successfully used for cervical cancer screening.
- We have carried out a small pilot study to explore if similar methods can be used for oral cancer screening.

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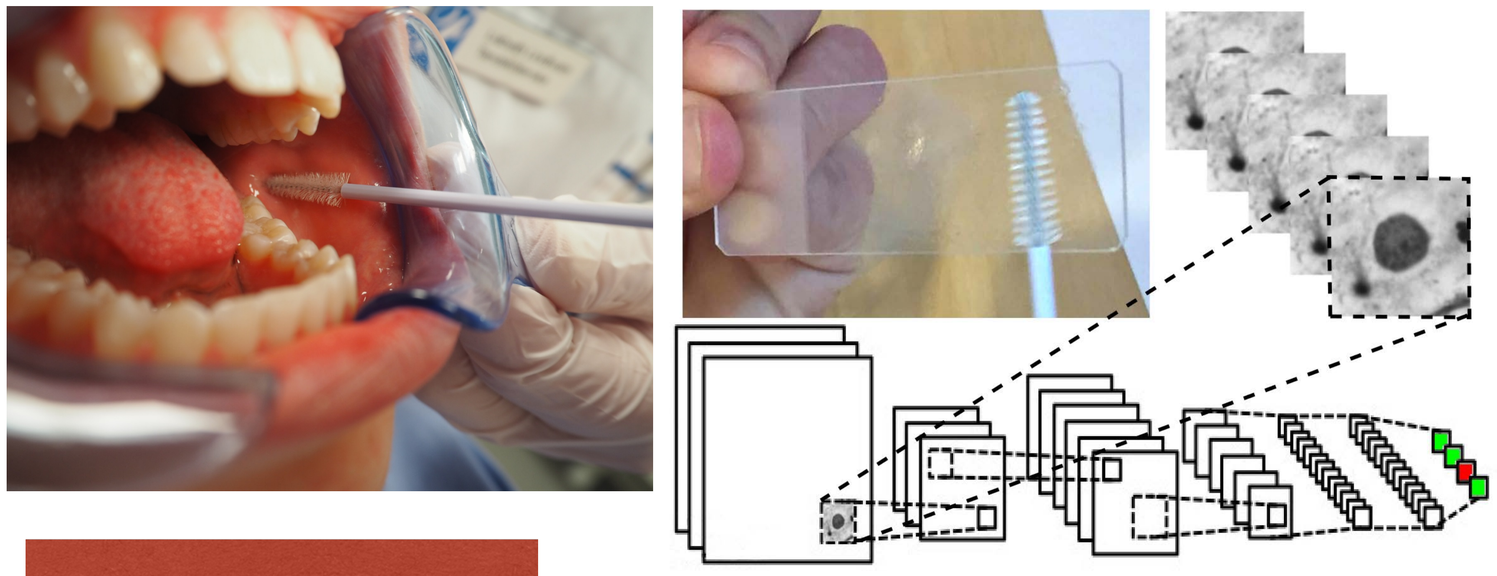


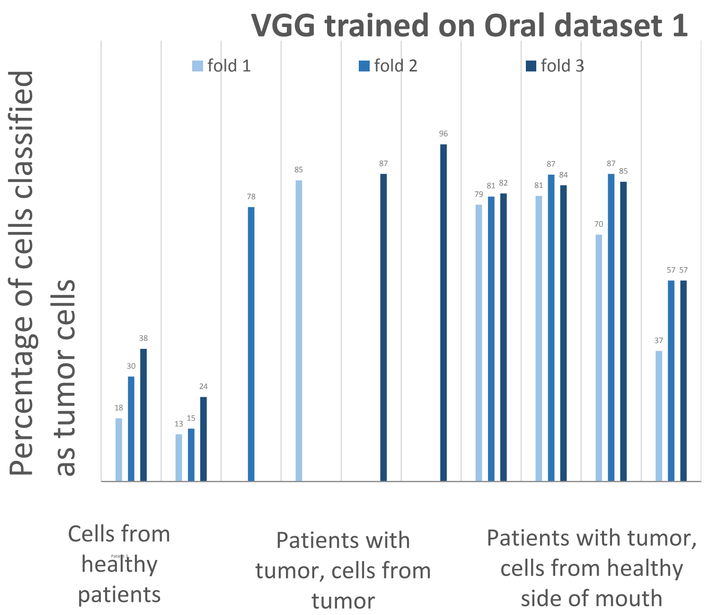
Methods

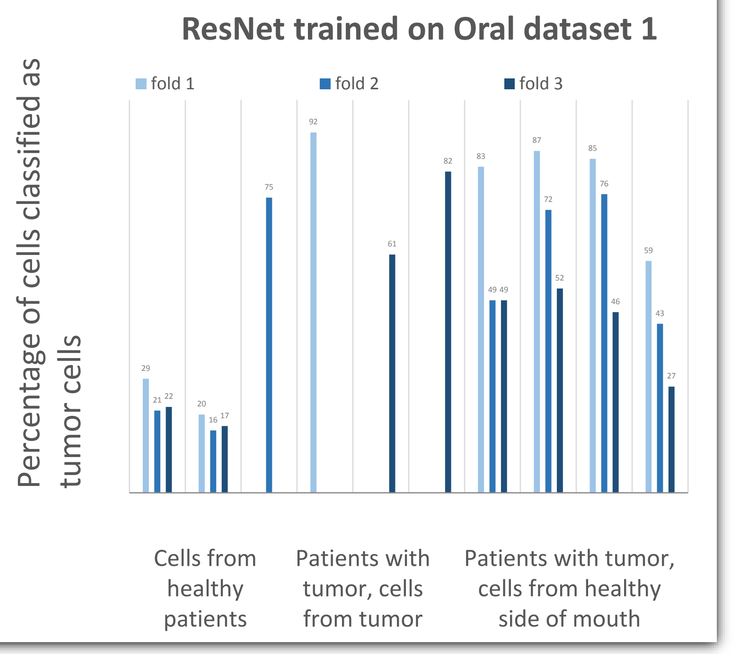
- Samples were collected with a brush in the oral cavity and prepared according to standard PAP procedures.
- Digitized with a 0.35 micron pixel size using focus stacks with 15 levels 0.4 micron apart.
- Between 245 and 2123 cell images were manually selected for each of 14 datasets, usually 2 datasets for each of the 6 cases.
- No efforts at specifically selecting diagnostic, abnormal looking cells, i.e. no use of ground truth on the cell level, only on the patient level.
- An image of 100x100x5 pixels was cropped around each nucleus at the best and two adjacent focus levels on each side.
- Two sets of neural networks, created according to the ResNet and VGG architectures were trained on subsets of images. The datasets were augmented through mirroring and 90 deg rot.
- Ground truth was provided only on the patient level, not on the cellular level.

Results

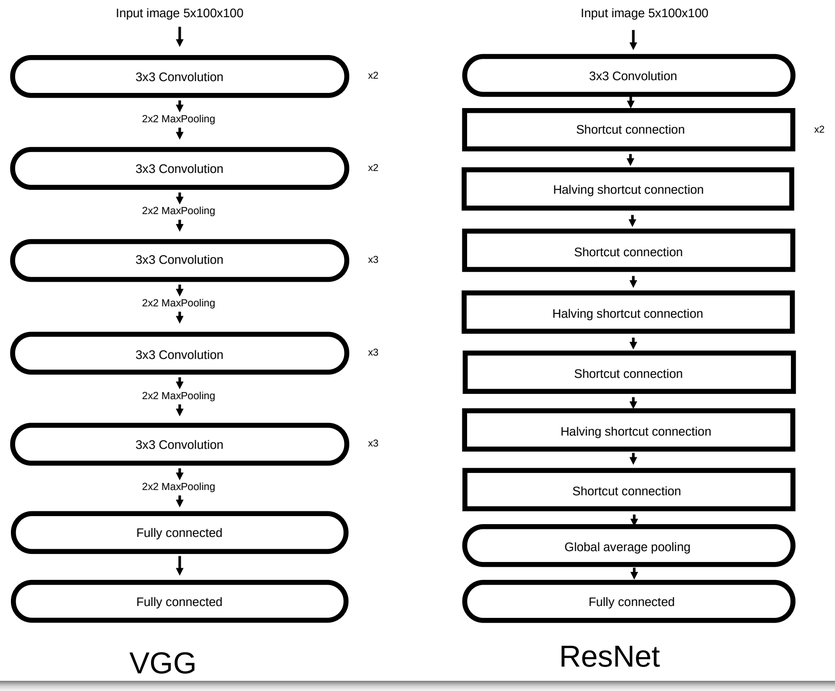
- The data was split into two different sets and the training and testing was done in several folds. Typical results were as follows:.
- The results were expressed as the percentage of cell nuclei that the neural networks called positive.
- Healthy persons in the range 31% to 38%. Patients with lesions were in range 61% to 96%.

Network	Accuracy	Precision	Recall	F-score
VGG	80.66±3.00	75.04±7.68	80.68±3.05	77.68±5.28
ResNet	78.34±2.37	72.48±4.46	79.00±3.37	75.51±3.17





Network Architectures



Conclusion

- Our small pilot study indicates that convolutional neural networks can be trained to detect precancerous or cancerous lesions based on cell samples brushed from the oral cavity.
- The network seems to be able to detect malignancy associated changes among the cells since a significantly larger percentage of cells from patients are classified as “malignant” than from healthy.
- The results presented above were based on six individuals, we have collected materials from another five persons from different clinics and labs and additionally tried some different network architectures. The results are similar.

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- The result are still based on a very small material, only 6 patients and 5 healthy individuals, so it needs to be confirmed on a much larger number of cases. We are currently collecting and digitizing more samples.

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