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Intra-operative point-of-procedure delineation of oral cancer margins using optical coherence tomography

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Background:

Margin delineation for oral cancers prior to surgical excision is essential for patient prognosis. Remaining tissue beyond the boundary of resection should be histologically normal. The current method for determining these margins is a clinical examination supplemented by histological frozen section. However, 5-17% of resections have positive margins, increasing the risk for re-emergence of tumour growth.

Objective:

Optical coherence tomography (OCT) can be used to generate images of oral tissue, returning measurements of tissue structure relevant to pathological diagnosis. We are evaluating the feasibility of a handheld OCT device which can be used during operation without biopsy. We are implementing an automated diagnostic algorithm to accurately map the field cancerization around a tumour for accurate delineation of surgical margins. Our goal is to determine whether OCT can outperform clinical examination in accuracy of determining surgical margins.

Methods:

We used OCT to capture 125 images from multiple zones around the tumour of oral cancer patients (n = 14). We compared the diagnosis produced by OCT to the gold standard of histopathology diagnosis. We determined surgical margins using the diagnostic results of OCT and compared them to the margins identified clinically by a surgeon, blinded to OCT results.

Results:

OCT showed significant concordance (kappa, ĸ = 0.922), with histological diagnosis of malignancy (100% specificity and sensitivity). OCT was less effective at identifying mild dysplasia, showing moderate concordance (ĸ = 0.59) with histopathology at distinguishing between varying degrees of dysplastic lesions. OCT outperformed clinical evaluation at detecting dysplastic lesions around tumour margins, identifying malignancy in areas which were clinically deemed normal.

Conclusion:

The current challenges associated with clinical delineation of surgical margins could be improved with intra-operative OCT imaging. OCT can identify microscopic tumour at the surgical margins and demonstrated the feasibility of mapping of field cancerization around the tumor. Accurate, intra-operative diagnosis of malignancy and severe dysplastic lesions can improve oral prognosis and care.

Original:

Objectives: Surgical margin status is a significant determinant of treatment outcome in oral cancer. Negative surgical margins can decrease the loco-regional recurrence by five-fold. The current standard of care of in- traoperative clinical examination supplemented by histological frozen section, can result in a risk of positive margins from 5 to 17 percent. In this study, we attempted to assess the utility of intraoperative optical coherence tomography (OCT) imaging with automated diagnostic algorithm to improve on the current method of clinical evaluation of surgical margin in oral cancer.

Materials and methods: We have used a modified handheld OCT device with automated algorithm based diag- nostic platform for imaging. Intraoperatively, images of 125 sites were captured from multiple zones around the tumor of oral cancer patients (n = 14) and compared with the clinical and pathologic diagnosis.

Results: OCT showed sensitivity and specificity of 100%, equivalent to histological diagnosis (kappa, ĸ = 0.922), in detection of malignancy within tumor and tumor margin areas. In comparison, for dysplastic lesions, OCT- based detection showed a sensitivity of 92.5% and specificity of 68.8% and a moderate concordance with his- topathology diagnosis (ĸ = 0.59). Additionally, the OCT scores could significantly differentiate squamous cell carcinoma (SCC) from dysplastic lesions (mild/moderate/severe; p ≤ 0.005) as well as the latter from the non- dysplastic lesions (p ≤ 0.05).

Conclusion: The current challenges associated with clinical examination-based margin assessment could be improved with intra-operative OCT imaging. OCT is capable of identifying microscopic tumor at the surgical margins and demonstrated the feasibility of mapping of field cancerization around the tumor.