

Real-time Raman spectroscopy in margin analysis of head and neck squamous cell carcinoma patients

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Aim

To evaluate the use of real time Raman spectroscopy in margin analysis of head and neck squamous cell cancer patients undergoing surgical resection.

Methods

12 HNSCC patients (Demographics in Table 1) who are scheduled for transoral surgery (with or without the DaVinci robot) were accrued with informed consent. Following induction of general anesthesia, the oral cavity and oropharynx were exposed using a Crow Davis or McIvor mouth retractor. A miniaturized fiberoptic Raman probe was used to map the intended resection margins (1.0 to 2 cm) around the tumor; and Raman signals were collected on both the tissue margins and main tumor (Fig. 1(a) and (b)). Margins were deemed positive if cancer cells were identified at the specimen margin; close if they were within 2-4 mm from the tumor and clear if they were 5 mm or more from the tumor edge. These Raman signatures were correlated with final histopathology following tumor extirpation. For each of the patient, we established a partial-least-squares linear-discriminant (PLS-LDA) model and validated using leave-one-tissue site-out cross-validation (LOOCV).

Table 1. Patients Demographics

Patient No.	Gender	Age	Locations	T stage	N stage	M stage	Pathology Findings
1*	M	62	Base of Tongue	T2	N1	M0	p16 - SCC, margins clear
2	F	59	Oral tongue	T4a	N1	M0	SCC, margins clear, previous RT
3	M	53	Base of Tongue	T4	N1	M0	P16 - SCC, margins clear
4	F	44	Oral tongue	T1	N0	M0	SCC, margins clear
5	M	68	Base of Tongue	T2	N1	M0	p16+, SCC margins clear
6*	F	69	Base of Tongue	T1	N0	M0	P16- SCC, margins clear, Previous RT
7	M	45	Oral tongue	T1	N0	M0	SCC, margins clear, previous RT
8	F	35	Oral tongue	T4a	N2c	M0	SCC, margins close
9	F	75	Oral tongue	T3	N2	M0	SCC, margins clear
10	M	22	Oral tongue	T3	N0	M0	SCC, margins clear
11	F	57	Oral tongue	T1	N0	M0	SCC, margins clear
12	M	71	Oral tongue	T2	N2b	M0	SCC, margins clear

* Transoral surgery with DaVinci robot



Figure 1. Real-time Raman spectroscopy measurement of OSCC patient on (a) tumor, and (b) resection margin.

Figure 2. Resected OSCC tumor

Results

12 OSCC patients were accrued; and 150 tissue sites on the tongue tissue (tumor n = 35, surgical negative margin n = 115) were surveyed using the miniaturized fiberoptic Raman probe. Using the final histopathology results for comparison, a mean accuracy of 93.3 % with sensitivity of 94.29 % and specificity of 93.04 % was achieved (Fig.3). These results indicated clear bio-molecular differences between the cancer tissue and surrounding normal tissues (margins).

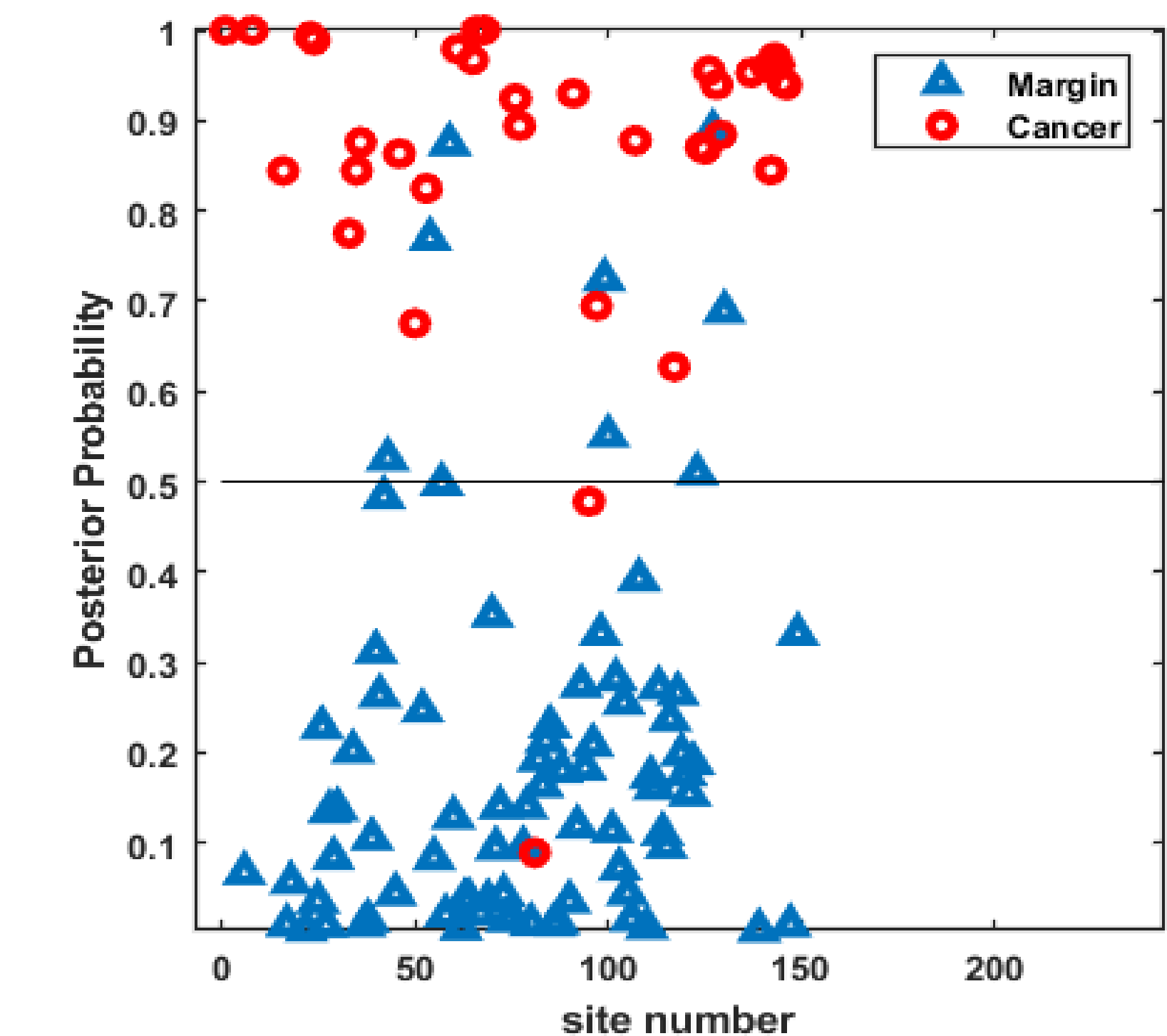


Figure 3. Posterior probability plot of PLS-LDA-LOOCV model for OSCC tumor and margin diagnosis

Conclusion

We demonstrate that fiberoptic Raman spectroscopy could serve as an intraoperative optical biopsy technique for the quick real-time surgical margin assessment. Future work validating this method as an alternative to intra-operative frozen section margin evaluation in head and neck cancer is underway.

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