L.11: A Comparative Evaluation of Raman and Fluorescence Spectroscopy for Optical Diagnosis of Oral Neoplasia

Effective management of oral cancer requires detection of early neoplastic changes of oral mucosa. It is now well recognized that optical spectroscopic technology is well suited for this application. Of the various optical spectroscopic techniques, fluorescence spectroscopy was one of the first to be developed for oral cancer detection. Recently, Raman spectroscopy has drawn considerable interest in this context because of its intrinsic ability to provide biochemical information in a tissue at the molecular level. We carried out a comparative evaluation of the relative performances of fluorescence and near-infrared Raman spectroscopy for in vivo discrimination of various oral tissue pathologies in a clinical setting.

The in vivo fluorescence and Raman spectra were acquired from the oral cavity of the patients undergoing routine medical examination of the oral cavity at the Out Patient Department of Tata Memorial Hospital (TMH), Mumbai. Compact and portable fluorescence and Raman spectroscopy systems assembled in-house were used for this purpose. While the fluorescence system uses a N_2 laser for inducing tissue fluorescence, the Raman system utilizes a 785nm diode laser as the excitation source. From each tissue site, fluorescence and Raman spectra were measured sequentially. The different tissue sites investigated belonged to either of the four histopathologic categories: 1) squamous cell carcinoma (SCC), 2) oral sub-mucosal fibrosis (OSMF), 3) leukoplakia (LP), or 4) normal squamous tissue. Autofluorescence and Raman spectra were recorded from a total of 251 SCC sites from 92 patients, 73 OSMF sites from 19 patients, 82 LP sites from 27 patients and 268 Normal sites from 26 healthy volunteers.

Probability based multivariate statistical algorithms capable of direct multiclass classification [1] were developed to analyze the diagnostic content of the measured n vivo fluorescence and Raman spectra of oral tissues. Table 1 shows a comparison of the classification results yielded by the fluorescence and Raman spectroscopic diagnostic algorithms.

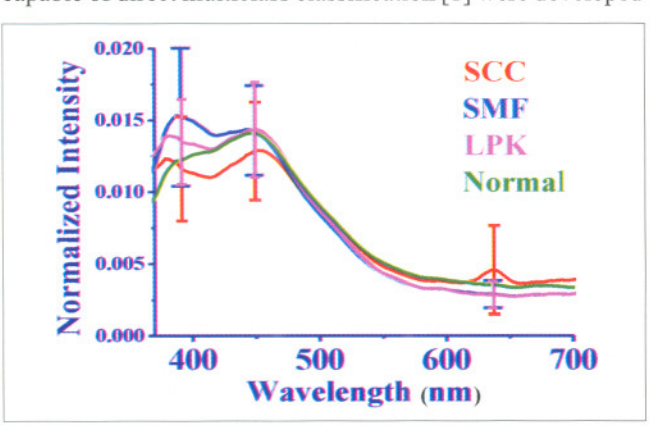

Fig.L.11.1: Mean autofluorescence spectra of human oral tissues belonging to different pathology categories.

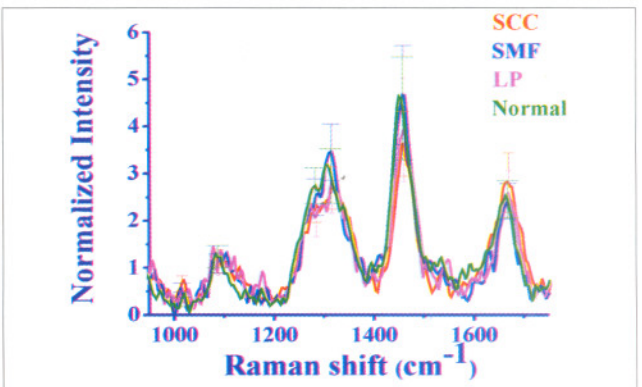

Fig.L.11.2: Mean Raman spectra of human oral tissues belonging to different pathology categories.

The fluorescence spectra achieved an overall classification accuracy of 76%. It proved most adept at classifying OSMF tissues with a classification accuracy of 86%, though it fared worse in classifying other tissue types, and errors were spread among the various classes. SCC spectra were correctly classified in 76% of the sites, while LP and normal tissue spectra were classified correctly in 73% and 76% of the sites. In contrast, when Raman spectra were used as the input data, the overall classification accuracy was found to improve to 91% with the algorithm providing classification accuracies of 90%, 93%, 94%, and 89% for SCC, OSMF, LP, and normal oral tissues respectively.

Table1: Fluorescence and Raman diagnosis

Pathology Fluorescence Diagnosis

Diagnosis	N	SCC	OSMF	LP
N	76.1%	19%	3.4%	1.5%
SCC	21.1%	76.1%	2.8%	0%
SMF	8.2%	1.4%	86.3%	4.1%
LP	9.8%	12.4%	14.6%	73.2 %

Pathology	Raman diagnosis			
Diagnosis	N	SCC	OSMF	LP
N	89.1%	7.1%	1.9%	1.9%
SCC	8%	90%	0%	2%
SMF	4.1%	0%	93.2%	2.7%
LP	1.2%	0%	4.9%	93.9%

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