Application of Raman Spectroscopy for Ovarian Cancer Detection: Comparative Analysis of Fresh, Formalin-Fixed, and Paraffin-Embedded Samples

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Abstract : Ovarian cancer, also known as the silent killer, is the fifth most common cancer among women worldwide, and its death rate is higher than that of other gynecological cancers. The low survival rate of women with high-grade serous ovarian carcinoma highlights the critical need for the development of new methods for early detection and diagnosis of the disease. The aim of this study was to evaluate if Raman spectroscopy combined with chemometric methods such as Principal Component Analysis (PCA) could differentiate between cancerous and normal tissues from different types of samples, such as paraffin embedding, chemical deparaffinized, formalin-fixed and fresh samples of the same normal and malignant ovarian tissue. The method was applied specifically to two critical spectral regions: the signature region (860-1000 cm^(-1)) and the high-frequency region (2800-3100 cm^(-1)). The mean spectra of paraffin-embedded in normal and malignant tissues showed almost similar intensity. On the other hand, the mean spectra of normal and cancer tissues from chemical deparaffinized, formalin-fixed, and fresh samples show significant intensity differences. These spectral differences reflect variations in the molecular composition of the tissues, particularly lipids and proteins. PCA, which was applied to distinguish between cancer and normal tissues, was performed on whole spectra and on selected regions—the PCA score plot of paraffin-embedded shows considerable overlap between the two groups. However, the PCA score of chemicals deparaffinized, formalin-fixed, and fresh samples showed a good discrimination of tissue types. Our findings were validated by analyses of a set of samples whose status (normal and cancerous) was not previously known. The results of this study suggest that Raman Spectroscopy associated with PCA methods has the capacity to provide clinically significant differentiation between normal and cancerous ovarian tissues.

Keywords : Raman spectroscopy, ovarian cancer, signal processing, Principal Component Analysis, classification
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