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SERS Liquid Biopsy Profiling of Serum for the Diagnosis of Kidney Cancer

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Abstract: Renal cancer (RC) represents 3% of all cancers, with a 2% annual increase in incidence worldwide, opening the discussion about the need for screening. However, no established screening tool currently exists for RC. To tackle this issue, we assessed surface-enhanced Raman scattering (SERS) profiling of serum as a liquid biopsy strategy to detect renal cell carcinoma (RCC), the most prevalent histologic subtype of RC. Thus, serum samples were collected from 23 patients with RCC and 27 controls (CTRL) presenting with a benign urological pathology such as lithiasis or benign prostatic hypertrophy. SERS profiling of deproteinized serum yielded SERS band spectra attributed mainly to purine metabolites, which exhibited higher intensities in the RCC group, and Raman bands of carotenoids, which exhibited lower intensities in the RCC group. Principal component analysis (PCA) of the SERS spectra showed a tendency for the unsupervised clustering of the two groups. Next, three machine learning algorithms (random forest, kNN, naïve Bayes) were implemented as supervised classification algorithms for achieving discrimination between the RCC and CTRL groups, yielding an AUC of 0.78 for random forest, 0.78 for kNN, and 0.76 for naïve Bayes (average AUC 0.77 ± 0.01). The present study highlights the potential of SERS liquid biopsy as a diagnostic and screening strategy for RCC. Further studies involving large cohorts and other urologic malignancies as controls are needed to validate the proposed SERS approach.

Keywords: renal cell carcinoma; Raman spectroscopy; SERS; liquid biopsy; machine learning

1. Introduction

Renal cancer (RC) represents 3% of all cancers, with a 2% annual incidence increase worldwide [1,2]. Renal cell carcinoma (RCC) is the most prevalent histologic subtype