ASEC 2025 Conference

The 6th International Electronic Conference on Applied Sciences

09–11 December 2025 | Online

Multichannel Plasmonic Point-of-Care Device for Salivary Detection of Periodontal MIP-1α: Analytical Comparison with ELISA

Annunziata M[1], Arcadio F[2], Stampone E[3], Bencivenga D[3], Cecoro G[1], Marzano C[2], Piccirillo A[1], Della Ragione F[3], Cennamo N[2]*, Zeni L[2], Borriello A[3]*, Guida L[1]*

[1] Multidisciplinary Department of Medical-Surgical and Dental Specialties, University of Campania "Vanvitelli", Naples, Italy

[2] Department of Engineering, University of Campania "Vanvitelli", Aversa, CE, Italy

[3] Department of Precision Medicine, University of Campania "Vanvitelli", Naples, Italy

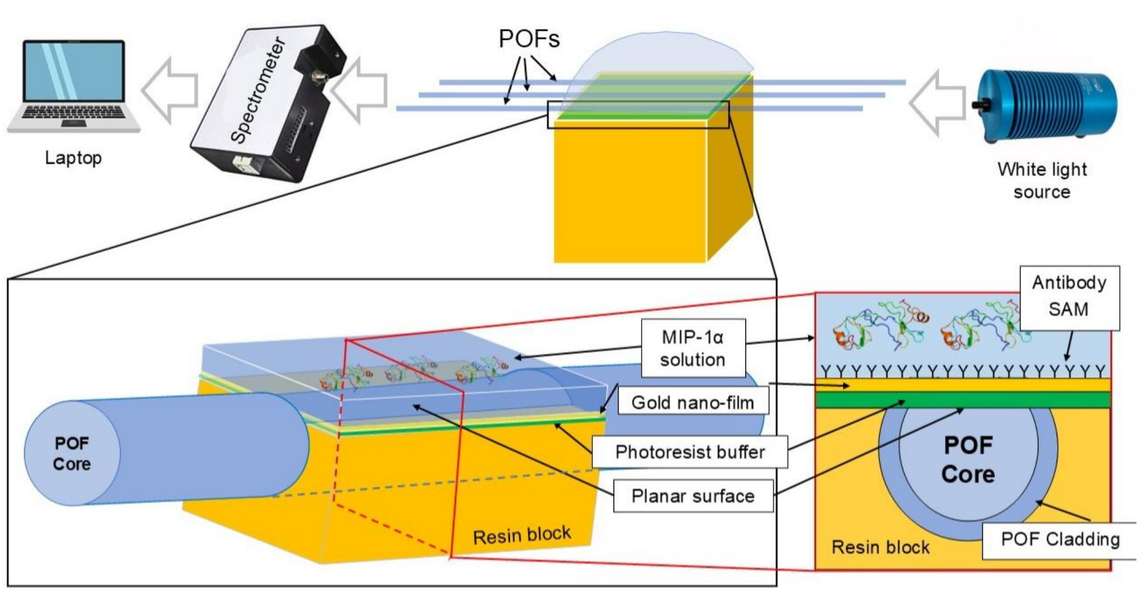
INTRODUCTION & AIM

Salivary biomarkers hold promise as effective tools for the early detection of periodontitis. This study evaluated the analytical capabilities of a multiplexed, plasmonic, optical-fiber-based point-of-care testing (POCT) device for the identification and quantification of salivary macrophage inflammatory protein-1 alpha (MIP-1α), using enzyme-linked immunosorbent assay (ELISA) as the reference method.

METHOD

Three modified plastic optical fibers (POFs) were functionalized with a self-assembled monolayer (SAM) of anti-MIP-1α antibodies. These fibers were positioned between a light source and a spectrometer to monitor refractive index changes at the POF-SAM interface, induced by surface plasmon resonance (SPR) following antibody-analyte interaction (Fig. 1). A Langmuir binding curve was established using MIP-1α dilutions ranging from 0.25 to 10 pM. Saliva samples from 50 consecutively recruited individuals were analyzed with both the SPR-POF biosensor and ELISA, and their results were compared using Spearman's rank correlation. Differences in MIP-1α concentrations across groups stratified by age, sex, and periodontal status were examined via the Mann-Whitney U test.

a)



b)

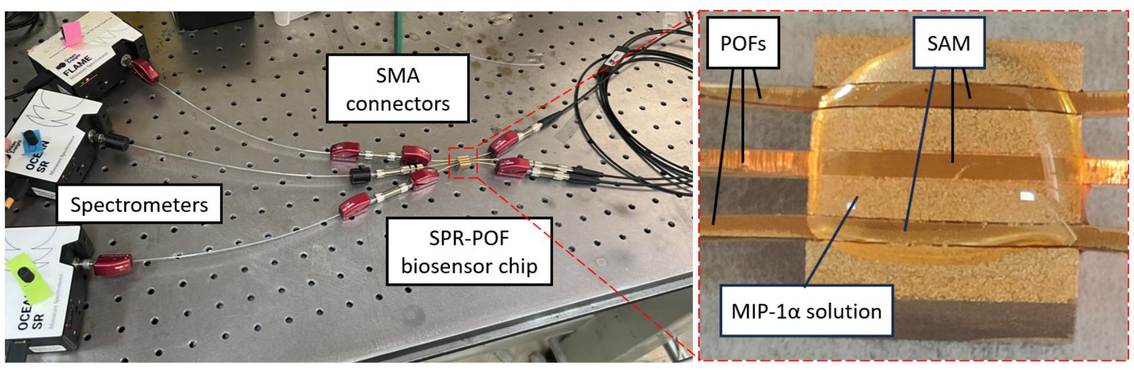
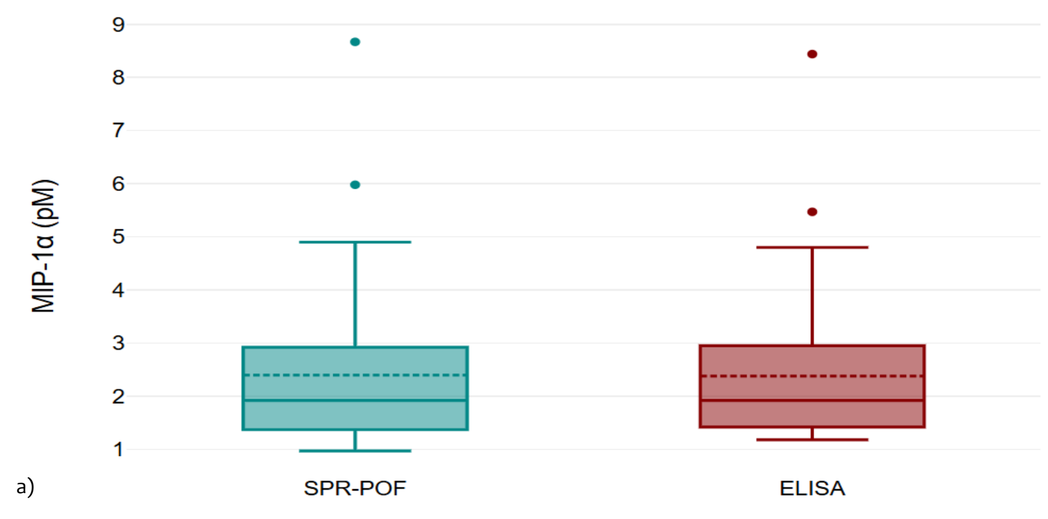


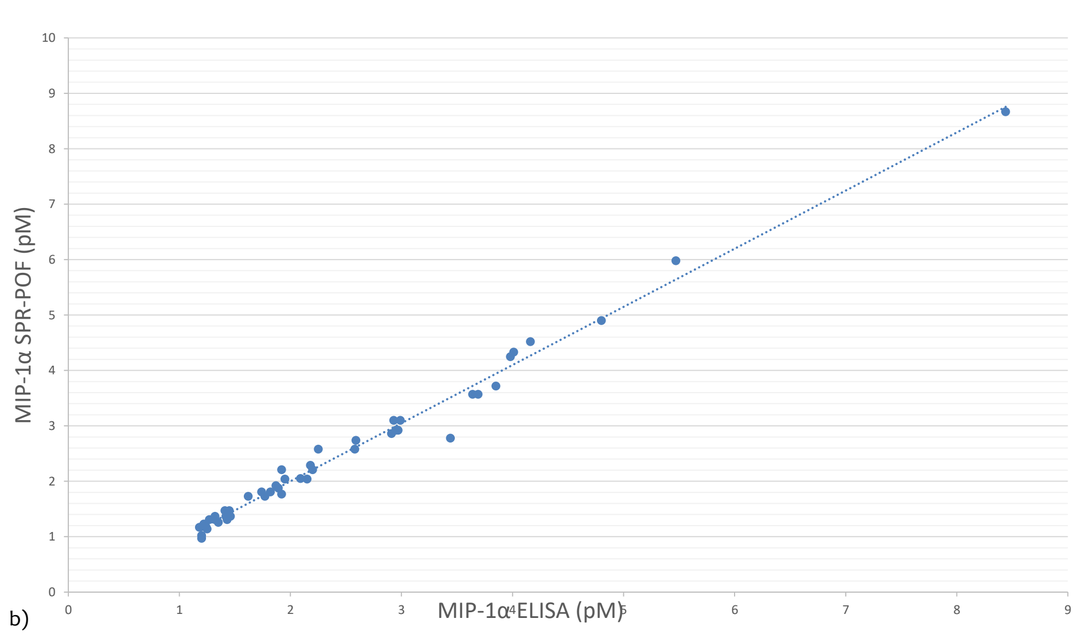
Fig. 1. Schematic outline (a) and image (b) of the experimental setup with a magnification of the three-arm structure covered by the MIP-1α solution.

RESULTS & DISCUSSION

A strong positive correlation was found between the SPR-POF sensor and ELISA measurements (Spearman's rs = 0.894, $p < 0.001$) (Fig. 2). The SPR-POF device achieved a lower limit of detection (LoD) of 0.15 pM, outperforming ELISA (0.78 pM). MIP-1α levels were significantly elevated in patients with periodontitis compared to those without ($p < 0.05$) (Fig. 3).



a)



b)

Fig. 2. a) Boxplot of salivary MIP-1α levels (pM) distribution in enrolled patients, each measured in replicate by both the three-arm SPR-POF biosensor and ELISA. b) Correlation scatterplot of salivary MIP-1α levels (pM) measured by both the three-arm SPR-POF biosensor and ELISA in all patients.

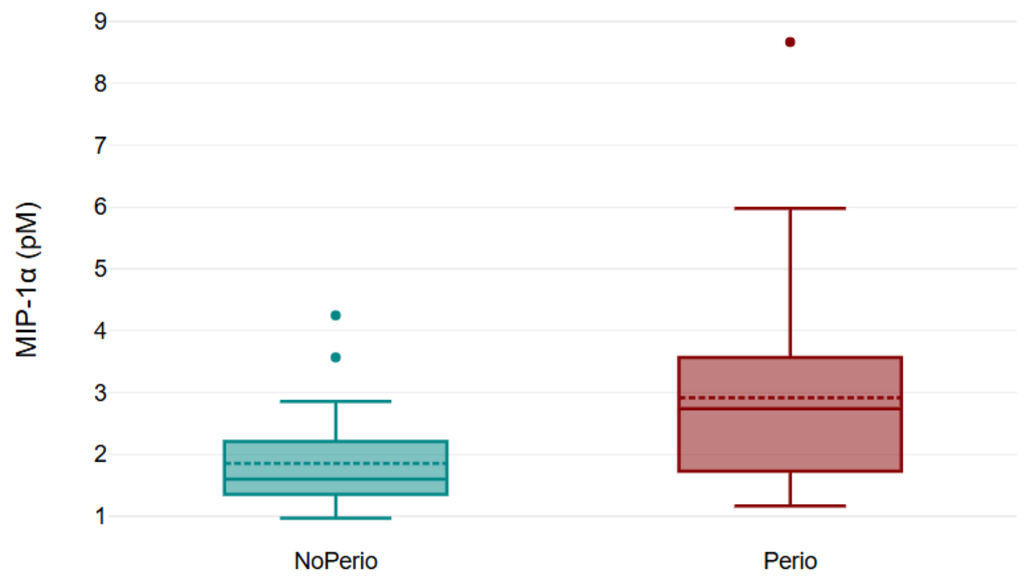


Fig. 3. Box plot of MIP-1α salivary levels (pM) of patients with and without periodontitis (Perio vs NoPerio) measured by three-arm SPR-POCT.

CONCLUSION

The three-arm plasmonic POCT demonstrated comparable accuracy and superior sensitivity to ELISA for detecting salivary MIP-1α. Its multiplexed configuration enhanced both measurement efficiency and reproducibility, suggesting its potential utility in periodontal diagnostics.

REFERENCES

- Annunziata M, Arcadio F, Stampone E, Bencivenga D, Cecoro G, Marzano C, Piccirillo A, Della Ragione F, Cennamo N, Zeni L, Borriello A, Guida L. Plasmonic Optical Fibre-Based Point-of-Care Test for Periodontal MIP-1α Detection: A Validation Study of a Multiplexed Biosensor Prototype. Int Dent J. 2025
- Annunziata M, Arcadio F, Borriello A, Bencivenga D, Piccirillo A, Stampone E, Zeni L, Cennamo N, Della Ragione F, Guida L. A novel plasmonic optical-fiber-based point-of-care test for periodontal MIP-1α detection. iScience. 2023