Laser-induced fluorescence in dentistry

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Abstract: This fluorescence study gives the information regarding photosensitizer uptake and retention by gingival mucosa which is necessary to choose an adequate protocol for antimicrobial photodynamic therapy of mild and moderate periodontitis with chlorine e6-based photosensitizer.

Keywords—fluorescence spectroscopy; photodynamic therapy; photosensitizer; dentistry; periodontitis

I. Introduction

A search for alternative antimicrobial treatments is an important problem of the present-day dentistry caused by the emergence of antibioticresistant strains. Antimicrobial photodynamic therapy (APDT) is considered as the promising alternative treatment of inflammatory diseases of periodontium [1]. Development of an adequate APDT protocol requires the necessary information regarding uptake and retention of the photosensitizing agent by affected and non-affected gingival mucosa depending on the way of its introduction and time of its exposition in oral cavity. The aim of this study was to obtain such information on the base of laser-induced fluorescence study of gingival mucosa after topical application of domestically produced chlorine e6 photosensitizer.

II. Patients and methods

Totally 30 patients were involved in this trials including 10 volunteers and 20 patients with mild and moderate periodontitis. Photosensitizer (PS) (chlorine e6) was topically applied in gel form and was insulated at gum of upper or lower jam with an individual kappa or Diplen film. PS’s exposition times varied from 5 to 50 min. Fluorescence examination involved fluorescence visualization and local fluorescence spectroscopy (LFS) of gingival mucosa. Uptake of the PS by gingival mucosa and its distribution in mucosa of oral cavity were studied in vivo by LFS at 636 nm excitation (diode laser, 0.5 mW). Spectra were measured in 650-750 spectral range. In the group of volunteers spectra were measured from gingival mucosa in three control points of upper and lower jams. In the patients group spectra were measured from affected and non-affected gingival mucosa. Visual fluorescence estimations were performed at 400 nm excitation (LED, 400±10 nm, 250 mW) before, after PS topical application before and during APDT session and during follow-up control after each PDT session.

III. Results

Autofluorescence emission of oral mucosa was negligibly small at 636 nm laser excitation. Fluorescence spectra measured from local points of oral mucosa after PS application has the broad line with maximum at 673 nm which coincided with fluorescence spectrum of PS solution at this laser excitation. Exogenous fluorescence of PS was detected in all areas of oral cavity independently on the place of its application (upper or lower jam) as well as exposition time. PS fluorescence from control points of gingival mucosa was up to 4 times higher after insulation with an individual kappa than after that with a Deplin film at all times of exposition. After a kappa insulation PS uptake was faster by affected gingival mucosa then by non-affected one. FS fluorescence intensity in affected mucosa reached maximum after 15-20 min exposition against 45 min exposition in the case of healthy mucosa. FS fluorescence intensity in affected mucosa was 5-10 times higher than in non-affected one. The results of spectral measurements agreed completely with the fluorescence visualization of oral cavity: inflammations exhibited bright “red” fluorescence of chlorine e6 against “green” fluorescence of non-affected mucosa. Fluorescence measurements confirmed the complete clearance of oral mucosa 24 h after PS application.

IV. Conclusion

This fluorescence study permitted to choice an adequate protocol for chlorine e6-mediated APDT of inflammatory diseases such as mild and moderate periodontitis. The principal points of this APDT protocol included the PS topical application by means of an individual kappa, 15-30 min exposition after topical application and visual fluorescence control of oral mucosa before, during and after APDT treatment. It was shown that chlorine e6 exhibited high affinity to inflammation tissue. Fluorescence visualization of oral mucosa is very useful tool that helps a dentist to detect all affected areas of gingival mucosa including their boundaries by bright “red” fluorescence of the PS and to control its bleaching during laser irradiation.