Biophysical Validation of Electroporation as a Unique Method of Improving Oral Hygiene and Reducing Systemic Morbidity: Development of a Novel Electroporating Toothbrush (ePrush)

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Oral hygiene is linked with several systemic diseases. The dental biofilm/plaque, responsible for these pathologies, is often resistant to brushing, leaving a pressing need for innovative solutions to address this problem. Electroporation, which involves the creation of a non-thermal electric field, has successfully been used to destroy bacteria, but has not been tested in the oral cavity as a potential solution. Hypothesis: A prototype electroporation device will effectively destroy the dental biofilm with an effect additive to brushing. Procedure: Electrolysis and electroporation were completed on oral swabs and plaque samples. The samples were compared with controls after gram staining and microscopy to assess the no of bacteria and oral mucosal cells. An electroporation circuit was built for these assessments. A novel electroporation integrated toothbrush was also developed and initial testing was completed. Results: Initial phase electrolysis resulted in reduction of bacteria ($p=0.006$) leading to further experiments with electroporation at 10 microamps for 5 mins significantly reduced bacterial flora when compared with baseline and brushing (90% reduction, $p < 0.0001$). Combined brushing and electroporation resulted in a further reduction. There was also a significant reduction in both bacteria ($p < 0.001$) and the amount of matrix in plaque samples ($p=0.002$), which can be translated to systemic benefits with improved oral hygiene. A viable electroporation toothbrush was successfully developed and tested, showing promising preliminary results in a mouth model. Conclusion: Electroporation was found to significantly reduce oral bacteria and plaque without destruction of neighboring tissues. This led to the creation of a working prototype electroporation toothbrush