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「プラズマの歯科治療応用-感染歯質の殺菌-」

Dental Application of LF Plasma Jet –Sterilization of Infected Dentin–

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◆ Objectives

In dental treatment, the control of infectious microorganisms is very important, however, effective sterilization methods for infected dentine have not been established yet. In the dental caries treatment, surface grinding alone does not eliminate the infected site, because multiplication of the remaining microbes which have invaded into the depths of dentine causes morbidity again. When caries progresses and reaches the pulp, the pulpitis develops and in order to save the tooth the pulp must be removed. However, even after this treatment, remaining bacteria in a root canal wall or the fine structure of the dentin may cause root canal infection again. Therefore, it is necessary to remove and sterilize the bacteria of root canal walls or dental tubules completely.

Generally, in the treatment of infected root-canals, caustic disinfectants such as H_2O_2 and sodium hypochlorite are used, but according to the systematic review published in 2007-2008, a failure rate, as high as 30% has been reported. One reason considered was the difficulty of disinfectant reaching the complicated fine structure of dentine. Therefore, we need to find a novel sterilizing method that is more effective than currently employed antiseptics. In the present study, we evaluated the bactericidal effect of low frequency atmospheric pressure plasma jets (LF plasma jet), which is expected to be having excellent sterilizing properties, osmotic strength and residual toxicity in comparison with the existing drugs. Generally, the sterilization in the liquid phase with LF plasma jet is difficult because it is not irradiated to bacteria directly, but adaptation of the reduced pH method [1] was expected effective against pathogens in the oral cavity.

◆ The sterilization test against oral bacterial suspension *in vitro*

In order to evaluate the sterilizing properties of plasma jet against, the oral pathogens including *Streptococcus mutans*, *Enterococcus faecalis* and *Candida albicans*, which are causes of dental caries and resistant root-canal infection, a sterilization test with CFU assay using each bacterial suspension of 1.0 x 10^6 CFU/mL was carried out. The results showed that the LF jet irradiation had bactericidal effects on oral

pathogens in liquid suspension when the pH was less than 4.5. As shown in Fig.1, after irradiation at pH 6.5, the number of viable cells was gradually reduced. On the other hand, no viable cells could be detected at pH 4.5 or 3.5, for 2 and 3minute irradiations, and it was significantly different from the control ($p<0.01$). For *E. faecalis*, the D values at pH 3.5, 4.5 and 6.5 were calculated to be 0.30, 0.47 and 2.00, respectively [2].

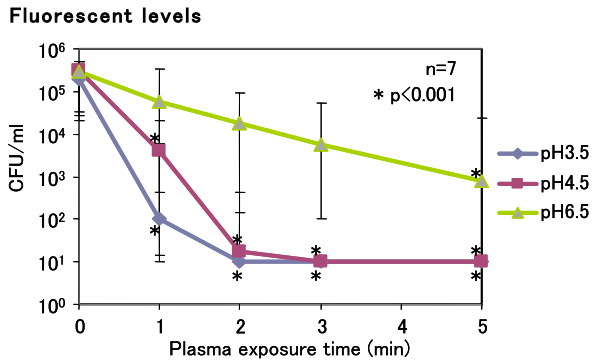

Fig. 1 CFU assay of *E. faecalis* in various pH solutions.

◆ The sterilization test using an infected tooth model *in vitro*

In a similar test using the infected model of hydroxyapatite pellets or dentine slice models, a significant bactericidal effect of 99-99.9% on *E. faecalis* was detected by metabolical REDOX indicator assay (Fig.2).

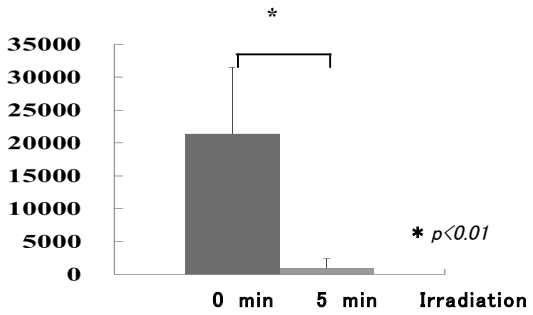

Fig 2. REDOX indicator assay after plasma irradiation on dentine infection models in the buffer of pH3.5

◆ The sterilization test of root canal infection model using Wistar rats

Under anesthesia, the pulp of mandibular first molar of Wister rats (Male, 8-10 weeks age) was extracted and then 1.0 x $10^{4\text{-}6}$ CFU/μL of *E. faecalis* was inoculated with filing. After washing with 0.2M citrate buffer (pH3.5), LF plasma jet was irradiated for 30 seconds on the canal. Subsequently, the root canal contents were collected with paper points and cultured in BHI broth. The results showed that the success rate of sterilization of root canal was around 50%.

◆ Conclusion

As results were obtained by *in vitro* sterilization tests, it was indicated that LF plasma jets might be applied to the clinical dentistry. For verification of the effective condition *in vivo*, the further trials using animal models should be conducted.

References

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