

Report of “Research Award of Oral Sciences”

Major: Oral Sciences

Grade: 3

Department: Periodontology and Endodontology

Name: Raras Ajeng Enggardipta

Title: Effect of Chitosan and Chitosan Derivatives as Antibacterial Agent Combining with Electromagnetic Stimulation on *Enterococcus faecalis* Biofilm

1. Aim of research and results obtained:

Various alternative antimicrobial irrigating solutions have been studied for years to optimize biofilm eradication and increase the success of endodontic treatment. One of the potential materials is chitosan as a biopolymer with various molecular weights that has promising exploitable materials in endodontic treatment due to its broad spectrum of antimicrobial properties including activity against Gram-positive bacteria such as *Enterococcus faecalis*. Trimethyl chitosan (TMC) is the most abundantly explored and the simplest form of quaternized chitosan derivative. It possesses a positive charge, high solubility in water over a wide range of pH, exhibits superior antibacterial efficacy than chitosan, and low toxicity. Considering the properties of TMC, it might be suitable for irrigating root canals in endodontics treatment. The use of electromagnetic wave stimulation (EMS) has been proposed as a combined technique with chemical disinfection in complex regions of root canals. Previous studies indicated the use of EMS with saline has an antibiofilm effect against *E. faecalis* when compared with saline alone. This finding guides us to the follow-up studies as the EMS has potential in the development of use for root canal disinfection and sterilization in combination with chemical technique using chitosan. My research aims to clarify the effects of chitosan nanoparticles (CNPs) formed from various molecular weights including the TMC, as an irrigating solution combined with EMS on the elimination of *E. faecalis* biofilms.

The sizes of CNPs made from low molecular weight (LMW) and high molecular weight (HMW) chitosan were 157.2 ± 10.37 nm and 200 ± 14.5 nm, respectively. Both CNPs prepared in this study showed spherical morphology confirmed by scanning electron microscope (SEM). The preliminary study was done to evaluate the effects of different concentrations and different treatment times of CNPs on 2-week-old *E.*

faecalis biofilm. From this preliminary study, the 30 seconds of treatment time was effective in reducing the bacterial viability and the viable numbers of *E. faecalis* bacteria. The CNPs formed from HMW chitosan significantly showed a reduction in bacterial viability (CFU/mL), especially the 30% HMW CNPs. The SEM observation also showed less biofilm density on the surface of the hydroxyapatite (HA) plates from the 30% HMW CNPs group compared with 30% LMW CNPs. Although the 30% CNPs was effective in reducing bacterial viability, the viscosity was high, which must be considered as an irrigating solution. Further study was performed to evaluate the 0.5% CNPs and 0.5% TMC on 2-week-old *E. faecalis* biofilm, which showed that both CNPs and TMC have a high capacity for reducing the bacterial viability of the 2-week-old *E. faecalis* biofilm. In the study that compared TMC in various concentrations, it was revealed that TMC exhibited an antibacterial effect on *E. faecalis* biofilm by reducing bacterial viability in a concentration-dependent manner. The preliminary experiment of the EMS on *E. faecalis* biofilm showed that the EMS reduced the bacterial viability numbers (CFU/mL) and under the SEM observation, we found the bacteria cell wall in the stimulated group was ruptured. Within the limitations of these studies, it is suggested that chitosan and its derivative combined with EMS have the potential to be used as novel irrigating methods in root canal treatment.

2. Self-evaluation of research achievement:

To date, through research, I have learned a lot. I realized that in research, attention to basic technical details, no matter how simple, cannot be underestimated. The more I work on this research, the more things catch my attention, and I hope to find answers to the questions that arise. My research has not always been smooth and rewarding, but I am confident that persistence and perseverance will lead to a success ending. I also realize that the success of my research is inseparable from the guidance and support of the supervisor and the help of the lab members. Their support means a lot to me, therefore I would like to express my deepest gratitude to them.

3. Meeting presentation:

The presentations with this award's support:

- ① Comparison of Chitosan with Different Molecular Weights as Possible Antibiofilm Materials Against *Enterococcus faecalis* Biofilm. The 22nd

Scientific Congress of Asian Pacific Endodontic Confederation 2023, NTUH International Convention Center Taipei, Taiwan, August 25-27, 2023, Raras Ajeng Enggardipta, Minato Akizuki, Tomoko Sumitomo, Kazumitsu Sekine, Kenichi Hamada, Hiromichi Yumoto. Oral Presentation.

- ② Antibacterial activity of chitosan nanoparticles and trimethyl chitosan on *Enterococcus faecalis* biofilm. The 159th Meeting of the Japanese Society of Conservative Dentistry, Act City Hamamatsu, Japan, November 11-12, 2023, Raras Ajeng Enggardipta, Minato Akizuki, Hiromichi Yumoto. Poster Presentation.

4. Journal publication:

There is no publication with this award's support.