Electrophoretically Assembly of Silk Fibroin Coatings from Different Pre-assembled Nanostructures on Dental Abutment to Tune the Release of Antibiotics

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Abstract

Background and Aim: Constructing coatings on dental abutment surfaces via electrophoretic deposition (EPD) technique is highly appealing strategy to act as a reservoir to release therapeutic antibiotics for patients with serious periodontitis or diabetes who need implant placement. Previous studies attempt to incorporate various drug delivery vehicles into EPD matrix to control drug release. However, these methods lead to formation of new substances or use of additional chemicals, which could often cause concerns on biosafety and cost. Herein, a deposition of controlled pre-assembled nanostructures of EPD matrix, instead of silk fibroin (SF) molecule solution, is used to control over drug release.

Materials and Methods: 2% wt SF solution was obtained by dissolving cocoons in saturated LiBr solution. 2% wt SF nanospheres were synthesized via precipitation reaction. Different EPD matrix solutions were made by mixing SF molecule with SF nanospheres at different weight ratios of 100%, 50%, and 0%. We coated these EPD matrixes on titanium disks by EPD technique denoted SFN100, SFN50, and SFN0, respectively. We characterized the surface properties of these coatings, including conformations, topography, roughness, and wettability. Then, fibroblasts were cultured on coatings to evaluate their biocompatibility. Doxycycline was applied as a model antibiotic drug. The release kinetics of doxycycline from different coatings was monitored by means of high-performance liquid chromatography (HPLC). P.gingivalis of minimum inhibition concentration (MIC) tests were used to show antibacterial bioactivity of released doxycycline at different time points.

Results: With decreasing the weight ratio of nanospheres, the β -sheet content of SF conformation and the roughness of the coatings reduced, the wettability were comparable among three group; whereas, the biocompatibility of coatings were increased, the release rate of doxycycline accelerated from 0 day to 14 days. Additionally, the antibacterial bioactivity was consistent in 1 day for different weight ratios; SFN50 could anti-bacteria for 7 days, and SFN100 for 14 days.

Conclusions: We proposed a novel strategy to electrophoretically assembly SF coatings from different pre-assembled nanostructures. This strategy enhanced the control release capability of drug without formation of new substances or use of additional chemicals. This study constitutes a straightforward approach to control antibiotics' release from abutment to deal with different patient's conditions.

Results

Background and Aim

Peri-implant inflammation is a serious complication leading to loss of supporting marginal bone and implantation failure. Poor oral hygiene, a history of periodontitis, and diabetes have been identified as high risk factors for peri-implant diseases. Therefore, a prevention of peri-implant diseases by constructing coatings on dental abutment surfaces to release therapeutic antibiotics for patients with serious periodontitis or diabetes is very necessary.

Electrophoretic deposition (EPD) techniques - commonly-used incorporate various drug delivery vehicles controlling drug release – generated new substances or use of additional chemicals, which could often cause concerns on biosafety and cost. Herein, a deposition of controlled pre-assembled nanostructures of EPD matrix, instead of silk fibroin molecule solution, is proposed to control over drug release.

Conclusion

We proposed a novel strategy to electrophoretically assembly SF coatings from different pre-assembled nanostructures. This strategy largely enhanced the control release capability of drug without formation of new substances or use of additional chemicals. This study not only constitutes a straightforward approach to control antibiotics' release from abutment to deal with different patient's conditions, but also opens up a new insight for the development of EPD coating based drug release system.

Methods and Materials

The EPD matrix solutions were made by mixing SF molecule with SF nanospheres at different weight ratios of 100%, 50%, and 0%. These EPD matrixes were coated on titanium disks by EPD technique, and they were denoted as SFN100, SFN50, and SFN0, respectively. We characterized the surface properties of these coatings, including conformations, topography, roughness, and wettability. Fibroblasts were cultured on coatings to evaluate their biocompatibility. The release kinetics of doxycycline from different coatings was monitored by means of high-performance liquid chromatography (HPLC). P.gingivalis and minimum inhibition concentration (MIC) tests were used to show antibacterial bioactivity of released doxycycline from 0 to 14 days. Additionally, the biocompatibility was evaluated by culturing fibroblasts on coatings.

References

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