Evaluation of Chitosan/β-TCP/Platelet-Rich Plasma Microspheres to Bone Repairing Materials

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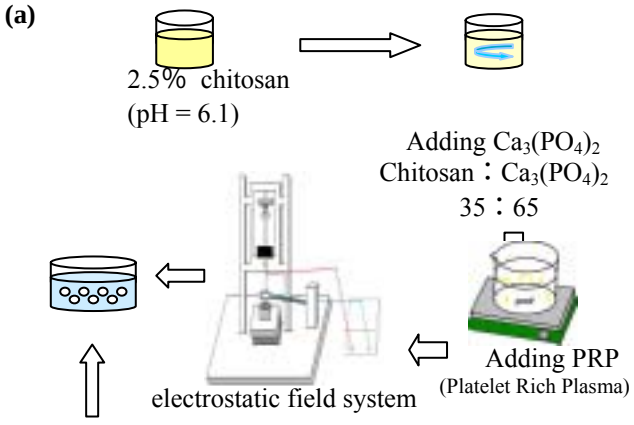
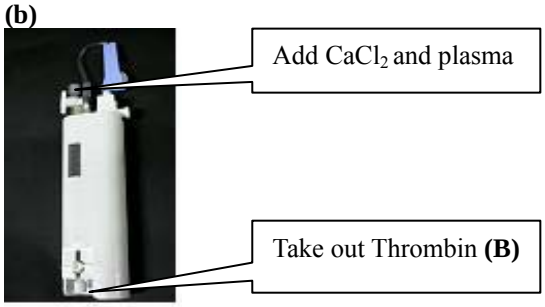
Introduction

When the platelet is activated by thrombin (the coagulation factor II of plasma), a gel structure of this mixture will form and simultaneously begin to release some inductive growth factors from the α granule of platelet, such as PDGF, TGF-β, VEGF and EGF. These growth factors play significant roles during the process of hard tissue healing. However, the releasing of these growth factors last out for about 7 days. In order to expand the potentials and usefulness of this platelet gel, we encapsulated this platelet gel and prepared chitosan/β-TCP /platelet gel microspheres. Chitosan and β-TCP, here, were biocompatibile, biodegradable and able to be fabricated into particulte form and strengthen the microspheres. Furthermore, the extra osteoinductive characteristics of these two materials were also beneficial to the tissue healing.

Methods

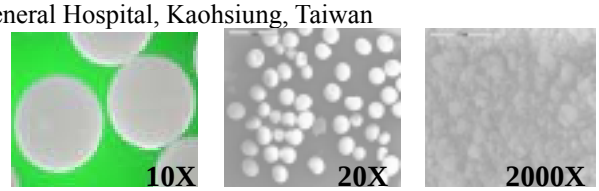
Chitosan/ β -TCP/platelet gel microspheres were prepared by using the electrostatic field system (Fig.1).





Results and Discussion

Due to microspheres could provide a larger surface area for cell growth and possess an easier estimation of diffusion and mass transfer behavior. We fixed four preparing parameter to fabricate this chitosan/β-TCP /platelet gel microsphere, which were the applied voltage 4.2kV, pump rate 3.6 ml/hr, the cross-linking reagent NaOH ： $Na_5P_3O_{10}$ ＝ 1:4 (volume ratio) and 2-h cross-linking reaction time.



(a) (b) (c)

Fig.2 chitosan/β-TCP /platelet gel microspheres, (a) optical micrograph (b)(c) SEM observations

As can be seen, the chitosan/β-TCP /platelet gel microspheres showed good sphericity and were in the range of 185.8±13.8 μm to 380.9±11.5 μm in diameter.

In order to find out the feasibility of the microspheres as a growth factors carrier, we used albumin as model molecule to simulate the permeability of thrombin across the microspheres membrane. Fig.3 showed the albumin molecules could penetrate into the microspheres after about 500 minutes. This result could indirectly infer that thrombin could also permeate into the chitosan/β-TCP /PRP microspheres, and the platelets encapsulated in the microspheres would be activated by the penetrated thrombin and thereafter to release growth factors.

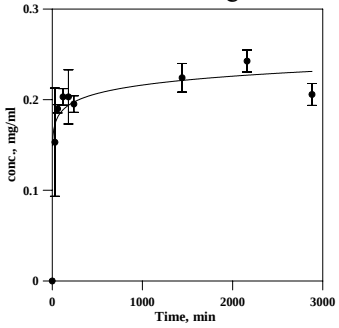


Fig.3 The permeability profile of albumin from chitosan/β-TCP /PRP microspheres.

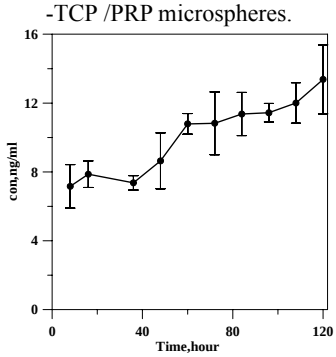


Fig. 4 The releasing profile of human TGF-β1 from the chitosan/β-TCP /PRP microspheres microspheres.

Fig.4 showed the real releasing of TGF-β1 from the prepared chitosan/β-TCP /PRP microspheres by reacting with thrombin. As can be seen, the TGF-β1 indeed able to releasing from the prepared microspheres.

Conclusion

To date, we are able to produce different size of chitosan/β-TCP /platelet gel microspheres and control the releases of growth factors by treating with different reaction reagents.

References

Anitua E. Thromb Haemost 2004;91:4-15.