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厦 门 大 学  
硕 士 学 位 论 文

**-磷酸三钙水解法修复牙釉质龋的研究**

**Research of Restoration of Tooth Enamel Caries by Hydrolysis of  
-TCP**

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## 摘 要

龋病是口腔科的常见病和多发病,发病始于牙冠,如不及时治疗,最终结果是牙齿丧失。龋病是牙齿硬组织逐渐被破坏的一种疾病,在龋病形成的早期,牙釉质表面开始脱矿,溶解破坏,此时若给予积极的治疗能够有效的阻止龋病进一步发展。

本文发展了一种  $\beta$ -磷酸三钙( $\beta$ -TCP)水解法在牙釉质表面制备缺钙羟基磷灰石(CDHA)涂层的方法,修复早期的釉质龋;并对涂层的性能进行表征,探讨了不同的实验条件对涂层生长的影响;对  $\beta$ -TCP 及其水解液进行细胞毒性评价;设计了一种用于牙釉质及龈缘密闭给药的牙套,使这种简便修复龋损的方法,具有潜在应用前景。

本研究结果表明牙釉质表面的酸蚀能够提高牙釉质表面的表面能和亲水性,增强表面极性,有利于 CDHA 晶体的成核和生长。在 37℃ 条件下  $\beta$ -TCP 水解 6 h,即可在牙釉质表面制备厚约 20  $\mu\text{m}$  的 CDHA 涂层,此涂层与牙釉质表面结合紧密,晶体宽约 20 nm,排列规则,方向基本垂直于基底表面。涂层的硬度与正常牙釉质无明显的差异,并且具有良好的耐磨性。在牙釉质表面制备 CDHA 的最佳条件为:料水比 0.5 g/50 mL~0.5 g/100 mL、温度 37℃、水解时间 2~4 h,初始 pH 8~10。选用 L929 细胞通过细胞相对增殖率法进行细胞毒性评价,结果发现  $\beta$ -TCP 及其水解液的细胞毒性达到 0 级和 1 级,符合生物医用材料的标准。

该方法反应条件温和、安全、有效、简便,结合设计的牙套(能有效防止药物外流及唾液的稀释作用,尤其适于液体、凝胶和糊剂等牙表面及牙龈缘的密闭给药)有望在龋病预防和早期釉质龋治疗的普及中应用和推广。

关键词:牙釉质龋修复; $\beta$ -磷酸三钙;缺钙羟基磷灰石涂层

## Abstract

Dental caries is a common and frequent disease in department of stomatology, with gradually damage of oral hard tissue. The crown is affected first, if doesn't treat timely, the whole teeth will lost at last. At the early stage of dental caries, the enamel surface damage is began with by demineralizing and dissolving, active and positive treatment can prevent it from developing further.

A novel method involved the hydrolysis of  $\beta$ -TCP was developed to repair the early enamel lesions in this work. The properties of calcium deficient hydroxyapatite coating (CDHA) was characterized and studied on different experimental conditions. Cytotoxicity of  $\beta$ -TCP and its hydrolysis solution was evaluated. A tooth brace was designed to medicate on enamel surface and gingival edge. So the convenient method of repairing caries lesions has application prospect.

The results showed that the acid treatment improved the surface energy and hydrophilicity, and enhance the surface polarity, which are beneficial to generating and growing crystal. It was observed that after the hydrolysis of  $\beta$ -TCP for 6 h at 37 °C, a hydroxyapatite coating with the thickness of about 20  $\mu$ m was obtained on the enamel surface. The coating shows a tight contact to the substrate with a nearly perpendicular growth to the enamel surface. The microhardness and wear-resistance of the coating were determined by the Vickers microhardness tester and toothbrushing machine, respectively. The results indicated that the coating exhibites good wear-resistance and the Vickers microhardeness similar to the natural enamel. The best conditions of preparing CDHA coatings at 37 °C was: the ratio of materials to water were 0.5 g/50 mL~0.5 g/100 mL; reaction time was 2~4 h; the initial pH value was 8~10. The cytotoxicity of  $\beta$ -TCP and its hydrolysis solution was all under grade I by cell relative growth rate method using L929 cell, in accordance with criterion on biomaterials.

The hydrolysis of  $\beta$ -TCP has been suggested to be a gental, effective and



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