

老年人不佳骨質(第四型骨質)之人工牙根研發與分析

Analysis, research and development of dental implant for poor bone quality and quantity (class IV) of geriatric patients

計畫編號： NSC 101-2314-B-039-022-MY3 第 1 年

執行期間：2012 年 8 月 1 日至 2013 年 7 月 31 日

黃恆立(Heng-Li Huang)¹ 傅立志(Lih-Jyh Fuh)^{1,2} 張銀祐(Yin-Yu Chang)³

¹中國醫藥大學 牙醫系 (School of Dentistry, China Medical University)

²中國醫藥大學附設醫院 牙科部 (Department of Dentistry, China Medical University Hospital)

³虎尾科技大學 機械與電腦輔助工程系 (Department of Mechanical and Computer-Aided Engineering, National Formosa University)

摘要:

本期中報告區分三個研究方向，進行討論，1. **高齡國人之上、下顎骨中前、後牙區之緻密骨後度與鬆質骨密度**：由於患者選擇為高齡患者(數量較少)，且全口無牙或局部缺牙之老年人病患的電腦斷層掃描影像資料並不多，截至目前為止(2013 五月中旬)，收集到約 12 位患者之數據，進行初步分析。2. **前期研究—市售之小直徑植體之體外實驗分析**：本研究主要探討小直徑植體之不同支台體與植體的結合型態，與植體材質，包含外六角接合 vs.內六角接合與純鈦金屬 vs.鈦合金，對人工牙根的初始穩定度與周圍骨質應變值的影響。3. **人工牙根植體之支台體的抗菌鍍膜之研發之一—Zr-C-N 鍍膜**：本研究探討 Zr-C-N 鍍膜之抗菌性分析與生物相容性測試，抗菌性分析以 Syto 螢光染色，生物相容性以 MTT test 與 RT-PCR 為主，測試細菌株為金黃色葡萄球菌，測試細胞為人類口腔纖維母細胞。

關鍵字：高齡患者、顎骨之緻密骨厚度與鬆質骨密度、小直徑植體的接合型態與材質、Zr-C-N 鍍膜、抗菌性、生物相容性。

Abstract—In the present of this report, there are three topic of researches in the first year research project. 1.) **The determination of cortical bone thickness and trabecular bone density in the jaw region for Taiwanese elder patient**: Due to the limitation of the number of the CT images of the partial or over edentulous patients, we have only collected and evaluated the CT images from 12 patients. We still carry on the work until 40 patients' CT images which have been collected and evaluated. 2.) **Prior study-biomechanical experimental test of small diameter of dental implant**: This study evaluated the effects of the implant material and the implant-abutment

connection designs on the primary stability (included Insertion torque value (ITV), implant stability quotient (ISQ), and Periotest value (PTV)) and the marginal bone strain of small-diameter implant subject to immediate loading. 3.) **Prior study of the development of the antibacterial coating for dental implant—Zr-C-N coating**: The purpose of this study was to verify the antibacterial performance and cell proliferation activity of zirconium (Zr)—carbon (C)—nitride (N) coatings on commercially pure titanium (Ti) with different C contents.

Keywords: elder patient, cortical bone thickness and trabecular bone density of jaw bone, connected type and materials of small diameter dental implant, Zr-C-N coating, antibacterial, biocompatibility.

研究目的:

1. **高齡國人之上、下顎骨中前、後牙區之緻密骨厚度與鬆質骨密度**：與中國醫藥大學附設醫院放射科部合作，分析全口無牙或局部缺牙之老年人病患的電腦斷層掃描(CT)影像資料，統計高齡國人上、下顎骨中前、後牙區的齒槽骨的緻密骨後度與鬆質骨密度，截至目前為止(2013 年 5 月)，已經收集約 12 位患者之數據，目前仍在努力中，期望達到 IRB 人體試驗計劃書所標註之目標：40 位。此數據將為第二年研究計劃初期之 a.) 建構符合高齡骨質之有限元素模型與 b.) 建構符合高齡骨質之體外 sawbones 模型之參考。

2. 前期研究—市售之小直徑植體之體外實驗分析:

The present study used an in-vitro model to examine the effects of the implant material and the implant-abutment interface on the marginal bone strain of immediately loaded small-diameter implants. The primary implant stability (included

insertion torque value (ITV), implant stability quotient (ISQ), and Periotest value (PTV)) was also determined.

3. 人工牙根植體之支台體的抗菌鍍膜之研發之一—Zr-C-N 鍍膜:

The purpose of this study was to determine the effect of the C content of Zr-C-N coatings on the antibacterial performance and cytocompatibility of pure Ti in medical applications. The cell proliferation and gene expression of the Zr-C-N coatings was investigated by applying the MTT assay and reverse transcriptase-polymerase chain reaction (RT-PCR) analysis to human gingival fibroblast (HGF) cells cultured on the deposited samples.

結果與結論:

1. 高齡國人之上、下顎骨中前、後牙區之緻密骨厚度與鬆質骨密度

a. 緻密骨厚度(單位為 mm): 上顎前牙區, 目前尚無數據; 上顎後牙區(n=16), 厚度為 2.08mm, 標準差為 0.72mm; 下顎前牙區(n=6), 厚度為 2.50mm, 標準差為 0.62mm; 上顎後牙區(n=20), 厚度為 2.39mm, 標準差為 0.57mm。

b. 鬆質骨密度(單位為 HU): 上顎前牙區, 目前尚無數據; 上顎後牙區(n=17), 密度為 467.58HU, 標準差為 115.26HU; 下顎前牙區(n=6), 密度為 483.33HU, 標準差為 116.48HU; 上顎後牙區(n=18), 密度為 311.17HU, 標準差為 115.73HU。所收集之影像, 其患者年齡之限制為 60 歲以上, 高齡患者其骨質狀況差異度高, 特別是上顎前牙區, 高齡患者較少無牙, 數據不好收集。此實驗仍繼續努力收集中, 期望提高樣本數, 讓數據更具參考性。此外, 本研究亦收集針對高齡患者之骨質之研究論文, 與本研究成果相比較, 並進行細部之分析探討。

2. 前期研究—市售之小直徑植體之體外實驗分析:

Due to the limitation of pages of the NSC reports, the detail description of the results and discussion of the present study will be shown in the SCI paper in the future. Within the limitations of this in-vitro experiment, the important conclusion can be shown that the implant material and implant-abutment interface design significantly influence the marginal bone strains around immediately loaded small-diameter implants. The peak value of marginal bone strain was lower for small-diameter implants made from cp titanium than for those made from titanium alloy. Also, the bone strain around the implant was lower for small-diameter implants with

an internal-hex connection than for those with an external-hex connection. Finally, the implant material and implant-abutment interface design did not influence the primary stability of immediately loaded small-diameter implants.

3. 人工牙根植體之支台體的抗菌鍍膜之研發之一—Zr-C-N 鍍膜:

Due to the limitation of pages of the NSC reports, the detail description of the results and discussion of the present study has already been published in the open assess of SCI paper -PloS One, 8(2): e56771, 2013. (SCI, Category: Biology: 12 / 84 \approx 14.3%, IF=4.092). The important conclusion can be shown that ZrN- and Zr-C-N-coated Ti plates exhibited comparable HGF cell viability and proliferation to the uncoated Ti plates. The Zr-C-N coating with the highest C content (21.7 at %) had the lowest bacterial retention and exhibited a short-term antibacterial effect. In summary, the application of Zr-C-N coatings with a high C content not only slightly increased the antibacterial ability against *S. aureus* but also met the requirement of HGF cell biocompatibility.

備註: 第 2 項之前期研究—市售之小直徑植體之體外實驗分析, 其詳細實驗過程、成果已接受於牙科 SCI 期刊 Clinical Oral Investigation (SCI, Category: Dentistry, Oral Surgery & Medicine: 19 / 82 \approx 23.1%, IF=2.2), 雖仍在刊出紙本且已開放電子下載。第 3 項之人工牙根植體之支台體的抗菌鍍膜之研發之一—Zr-C-N 鍍膜, 已於 2013 年 2 月刊登於開放式 SCI 期刊—國際公共圖書館期刊 PloS One (SCI, Category: Multidisciplinary Science: 7 / 56 \approx 12.5%, IF=3.73), 本計畫將繼續研究與開發, 除了累積抗菌鍍膜研發成果資料庫之外, 期望從中挑選出具發展的潛力之人工牙根植體之支台體的抗菌鍍膜。

參考文獻:

* Wu A YJ, Huang HL, Hsu JT, Chee W. Clinical Oral Investigations, Epub ahead of print, 2013.

**Chang YY, Huang HL, Hsu JT, Lai CH, Shieh TM, Wu A YJ, Chen CL. (2013) PloS One, 8: e56771, 2013.