人工牙根穩固度檢測儀之設計與驗證

The design and verification of stability detecting device for dental implants

中文摘要

歷年來已有多個人工牙根植體穩固度(stability)檢測與成功率之研究，但大多是感測器(sensor)設備較複雜或只做離體先期實驗，無法瞭解生物感測器(biosensor)在生物體內真正的成效，亦無法得知並進而評估人工牙根植入後，骨邊界變化的情形及骨癒合(osseointegration)狀態。本研究利用自然頻率檢測法設計穩固度檢測儀，並配合理論模擬與實際臨床需求，加以修正改良，期能得到更精準、更敏銳的穩固度檢測值，以便對植體臨床手術提供最佳輔助診斷工具。本研究之新型檢測儀設計方向：裝置本體以小型化為機構設計的主軸，以低電壓電磁閥控制衝擊槌敲擊人工牙根，達到非人工手動敲擊的目的，利用衝擊法激發人工牙根共振，並以非接觸式的麥克風接收共振訊號，利用傅立葉轉換程式分析振動響應，可有效偵測人工牙根自然頻率。本研究利用標準音叉 (f = 600Hz) 進行驗證實驗，量測結果為 588.375±0.84 Hz。再利用虎鉗挾持人工牙根以模擬人工牙根植入後之穩固度變化狀態進行量測，當挾持力由 2 Kgf.cm~10 Kgf.cm 增量變化時，量測自然頻率結果平均值為 5885.0±5.59 ~ 7420.0±11.18 Hz。另將人工牙根以電木材質為包埋材，植入後外露高度分別設定為 7mm ~ 11mm，而量測自然頻率結果為 3727.5±18.5 ~ 2470.0±21.4 Hz。依此三種先期體外研究實驗可以驗證此新型人工牙根穩固度檢測裝置的訊號靈敏度及精確度。

英文摘要

More and more researchers pay attention to the area of stability and detecting method on dental implant. But most of the research works are categorized to invitro preliminary study or experiment with heavy sensor facility. None of the related study can verify the performance if biosensor installed in human body. It can still hardly to detect the osseointegration condition of dental implant on the tooth bone boundary. The current study presents a new clinical technology to detect the stability of dental implant precissively by using natural frequency detection methodology. The study also designs and sets up a compact dental implant stability detector for verifying the theoretical prediction and its usefulness. The proposed device adopts micro size low voltage electro magnetic servo valve insteading of using hammer manually to beat the dental implant for providing the uniform and stabilized input signal. The following process is to retract the vibration resonance signal by using non contacting acoustic receivers. The fast Fourier transform (FFT) method is also applied to analyze the resonance signal for providing the clinical inspection information.In order to verify

the practicability of the proposed device. Three experiments have been implemented for illustration. The natural frequency of the tested dental implant is measured as 588.375±0.84 Hz, which is verified by using standard tonometer (f=600 Hz). While in the stability test, the average natural frequency is measured as 5885.0±5.59 Hz~7420.0±11.18 Hz, when the dental implant is clamped by vise with force increasing from 2 Kgf-cm~10 Kgf-cm. The third experiment is to examine the stiffness of the dental implant. The dental implants are fixed in the bakelite cube with different outside length from 7 mm to 11 mm. The measured data of natural frequency are varied from 3727.5±18.5 Hz~2470.0±21.4 Hz. As checking the verified data from the three invitro preliminary experiments, the stability and sensitivity of the dental implant detector proposed by he study are approved.