不同模擬形式與程度的齒槽骨缺損對牙齒動搖度之共振響應分析

Resonance Frequency Analysis of the Influence of Various Simulated Types and Degree of Alveolar Bony Defects on Tooth Mobility

中文摘要

本研究利用有限元素模型，來模擬幾種不同牙周變化及齒槽骨缺損的情形，藉由共振頻率的計算，了解並釐清不同齒槽骨缺損形式與程度對不同牙齒共振頻率及動搖度的影響。本研究建立上顎正中門齒、上顎犬齒及上顎第一大臼齒之三維有限元素模型，在模擬牙周病所可能發生之水平式及垂直性齒槽骨吸收的情形下，計算不同程度與方向齒槽骨缺損的共振頻率值及減少率。研究結果顯示共振頻率值會隨著牙周附連高度下降而減少，並呈現一個線性關係。且不同位置與型態的牙齒，其不同側邊的齒槽骨缺損對於其共振頻率的影響也不盡相同。在上顎正中門齒方面，當模擬唇側、舌側、近心側與遠心側單側齒槽骨缺損時，共振頻率減少的比率分別爲 8.2 %、14.1 %、12.7 %及 11.7 %。即上顎正中門齒在近心側齒槽骨缺損與遠心側齒槽骨缺損時對牙齒動搖度的影響相當，但舌側齒槽骨缺損對牙齒動搖度的影響卻大於唇側齒槽骨缺損。而在上顎犬齒方面，模擬唇側、舌側、近心側與遠心側的單側齒槽骨缺損時，共振頻率減少的比率分別爲 2.3 %、1.4 %、11.8 %及 9.3 %。即上顎犬齒在近心側齒槽骨缺損與遠心側齒槽骨缺損時對牙齒動搖度的影響相當，且舌側齒槽骨缺損對牙齒動搖度的影響和唇側齒槽骨缺損時相同。上顎第一大臼齒在模擬頰側、顎側、近心側與遠心側單側齒槽骨缺損時，共振頻率減少的比率分別爲 5.5 %、2.3 %、17.2 %及 23.1 %。即遠心側齒槽骨缺損時大於近心側齒槽骨缺損對牙齒動搖度的影響，但顎側齒槽骨缺損對牙齒動搖度的影響卻小於頰側齒槽骨缺損。且牙根分叉處齒槽骨對第一大臼齒牙齒動搖度的影響扮演了一個重要的角色。本研究結果也顯示，利用共振頻率的方法將可以作爲研究牙齒動搖度的一種輔助工具。

英文摘要

To assess the influence of various simulated types and degrees of alveolar bony defects on tooth mobility, 3-D finite element models of the human maxillary central incisor, canine and first molar were established. To simulate periodontal attachment loss, the bone elements of these models were deleted between 3mm to 10mm in 1mm decrement from cementum-enamel junction (CEJ). Resonance frequency values (RFV) of simulated one-side, two-side and three-side bony defects were calculated for comparison and discussion. The results showed that RFV of teeth was closely related to their surrounding bone level. When the horizontal bone loss was simulated, the RFV of the teeth demonstrated liner relationships with their attachment levels. On the other hand, when the vertical bony defect was simulated using these three tooth

models, different effects of surrounding bone on the mobility of the teeth were observed. For the model of upper central incisor, the resonance frequency decreasing ratio (RFDR) with the bony defect at facial side, lingual side, mesial side and distal side were 8.2%, 14.1%, 12.7% and 11.7%, respectively. This means that the alveolar bone at the lingual side contributed more effect on the mobility of incisor than that of the facial side. However, the effect of alveolar bone of the mesial side was closely to the distal side. Different phenomena were observed in the model of canine, the RFDR with bony defects at facial side, lingual side, mesial side and distal side were 2.3%, 1.4%, 11.8% and 9.3%, respectively. This means that the alveolar bone at lingual side contributed similar effects on the mobility of incisor to that at facial side, and the effect of alveolar bone of mesial side was also similar to that at distal side. For the model of upper first molar, the RFDR with bony defects at buccal side, palatal side, mesial side and distal side were 5.5%, 2.3%, 17.2% and 23.1%, respectively. That is, the alveolar bone at buccal side contributed more effect on the mobility of molar than at palatal side. However, the effect of alveolar bone at mesial side demonstrated more effect on the mobility of molar than at distal side. Another noted finding is that the furcation of alveolar bone played a major role on the tooth mobility of first molar. These results suggested that vibration analysis method could be a useful, auxiliary clinical tool in the diagnosis of periodontal attachment loss.