開口運動對於不同形式的下顎植體支持式固定義之應力分佈影響 —;有限元素分析

Effect of implant-supported fixed prostheses on mandibular deformation during opening movement—;Finite element analysis

中文摘要

下顎在作開口運動時，會產生一形變現象，並導致下顎骨寬度的減少。當下顎欲以植體支持式固定義齒贋復時，由於骨頭與植體爲一堅硬連結，若以ㄧ單位式跨牙弓式贋復物加以連結時，會導致下顎形變現象的改變，並且將在植體與骨頭交接面，與贋復物上產生應力的集中，將來可能導致骨整合的失敗與贋復物的斷裂或鬆脫。
本實驗利用有限元素分析法，探討在進行開口運動時，植體支持式固定義齒對於下顎形變的影響。本研究分別比較擁有正常齒列之下顎骨及以五個不同設計的植體贋復物連結之下顎骨模型。分別是僅有八支植體之下顎模型及以一至四單位式贋復物連結之下顎模型，網格化後代入相同的邊界條件與肌肉施力後，計算並比較下顎的形變量與贋復物及植體的應力分佈情形。
實驗結果發現，擁有正常齒列的下顎骨及未以義齒連接的植體贋復下顎骨，在作張口運動時，其寬度變化在大臼齒區域分別爲 0.212 mm 與 0.249 mm，且變化量由後往前遞減，符合臨床上的觀察。比較不同贋復物對下顎形變的影響，結果發現贋復物若跨越下顎中心聯合處，則會造成下顎形變量變小，且跨越下顎中心聯合之贋復物越短，對下顎骨的形變限制越大。觀察不同贋復物在開口運動時對植體及贋復物的應力分佈影響，可發現較長且較彎曲的贋復物會產生較大的應力集中，而若在下顎中心聯合區域將贋復物分割，應力集中狀況則會有所改善；與一單位式贋復物比較，二、三、四單位式贋復物的應力分佈較爲分散。比較植體上的應力分佈，可發現開口運動時，會在以一單位式贋復物連接的遠心端植體頸部產生最大的應力集中，而四單位式贋復物的應力分布情形則較爲分散。
結果顯示，下顎若以不同形式的固定義齒連接植體，會影響下顎的形變，而且在植體與骨頭交界面產生應力集中。因此，以植體贋復作爲下顎全口無牙患者的治療，對贋復物的設計必須有完整且審慎的考量。

英文摘要

Clinical findings indicated that the geometrical shape of the mandible was deformed during mouth opening. This deformation results in a reduction in the width of the mandibular arch. According to the rigid connection of dental implant and bone tissue, some authors indicated that edentulous mandible treated with implants supported fixed partial denture and connected by a one piece cross-arch superstructure could

generate dangerous stresses both at bone-implant interface and prostheses superstructure, and high stress concentration might lead to failure of the osseointegration and the fracture or loosening of the prostheses.

In this study, a finite element method was used to evaluate the effect of different types of implant supported fixed partial dentures on the mandibular deformation. The mandible model with natural dentition and five mandible models with implants and prostheses were developed. Five mandible models treated with : only eight implants and eight implants connected by one, two, three and four-piece superstructures. Additionally, the same forces and orientations of masticatory muscles were considered to simulate opening movement in this study. Then, the stress distribution of the prostheses and implants in different designs of implant-supported prostheses were analyzed for discussion.

Our results demonstrated that the mandible models with natural dentition and implants presented a decrease in mandibular arch during opening. The changes in width between the mandibular molar area in the mandible model with natural dentition and the mandible model treated with eight implants but not connected by superstructure were 0.212 mm and 0.249 mm, and the dimensional changes were decreased from the posterior to the anterior area, and these results conform to the clinical studies. We also found that, stress concentrated at the symphyseal area of superstructure during opening movement, and separating the superstructure at the symphyseal area will decrease the stress concentration of implant prostheses. In comparison with one-piece cross arch superstructure, two, three and four sections of the superstructure will decrease the stress of implant prostheses. During opening movement, stresses were concentrated at the implant-bone interface close to the implant neck. Especially the most distal implant in the mandible model treated with a one- piece cross arch superstructure, and implants connected with four-unit superstructure present stress concentration more equally.

The results indicated that the mandibular deformation and the stress concentration on implant-bone surface and prostheses are related to the different superstructure designs of implant supported fixed partial dentures. Therefore, we suggest that, the dentists should pay more attention to prostheses design on implant supported prostheses in edentulous mandible.