Un certain intérêt est porté actuellement à l'utilisation de nouveaux matériaux pour la fabrication des implants dentaires. Aujourd'hui, le titane est majoritairement utilisé sous l'impulsion de Branemark, précurseur de l'implantologie, ayant mis en évidence il y a plus de 30 ans au travers d'études scientifiques poussées les propriétés d'ostéointégration de ce matériau. Cependant, la recherche s'est aussi penchée vers l'utilisation de matériaux non métalliques pour répondre à la sensibilité de certaines personnes au métal. Les implants sont de plus en plus utilisés en association avec des constructions prothétiques fixées formant un assemblage relativement rigide. Jusqu'à ce jour, les incidences biomécaniques des différentes constructions prothétiques n'ont pas été étudiées sur des supports biologiques déformables et mobiles reproduisant fidèlement les arcades dans leur fonction.

L'objectif de cette étude est d'analyser l'incidence de la déformation élastique de la mandibule due à la fonction masticatoire sur l'intensité et la répartition des contraintes supportées par l'implant et les pièces de l'assemblage prothétique. Pour ce faire, nous utiliserons un modèle de mandibule très perfectionné. Récemment mis au point, il reproduit fidèlement la distortion subie par la mandibule et pourrait servir de base à l'élaboration ultérieure de modèles numériques pour la validation des projets prothétiques.

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Mandibular Biomechanics and Development of the Human Chin

ABSTRACT

The development of the chin, a feature unique to humans, suggests a close functional linkage between jaw biomechanics and symphyseal architecture. The present study tests the hypothesis that the presence of a chin changes strain patterns in the loaded mandible. Using an anatomically correct 3-D model of a dentate mandible derived from a CT scan image, we analyzed strain patterns during incisal and molar biting. We then constructed a second mandible, without a chin, by 'defeaturing' the first model. Strain patterns of the second model were then compared and contrasted to the first. Our main finding was that chinned and non-chinned mandibles follow closely concordant patterns of strain distribution. The results suggest that the development of the human chin is unrelated to the demands placed on the mandible during function.

KEY WORDS: mandible, chin, hominid evolution, FEA.

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INTRODUCTION

The chin, or *mentum osseum*, defined as an inverted T-shaped elevation in the midline of the mandibular symphyseal region, flanked by 2 variable scallop-shaped depressions on either side of a central keel, is thought to be unique to humans (Aiello and Dean, 1990; Schwartz and Tattersall, 2000). While some early studies have pointed to non-mechanical explanations for the evolution of the human chin (Weidenreich, 1941; Riesenfeld, 1969), several authors have proposed that the emergence of the chin in early anatomically modern humans may in fact be explained in biomechanical terms (Robinson, 1913; DuBrul and Sicher, 1954; Daegling, 1993; Dobson and Trinkaus, 2002). Evidence for this view comes from 3 sources. First, the *in vivo* studies of mandibular loading in anthropoids (Hylander, 1984; Hylander *et al.*, 2000) show that the anthropoid mandible experiences predictable patterns of twisting and shearing throughout the power stroke of mastication. These include wishboning (lateral transverse bending), dorsoventral shear, and vertical bending in a coronal plane. Second, comparative studies of the mandibular symphysis in hominoid primates (Daegling, 1993, 2001) suggest that symphyseal morphology is functionally linked to the biomechanics of wishboning of the mandibular corpus. Third, Dobson and Trinkaus (2002) showed that there are important biomechanical consequences to structural changes in the mandibles of late-Pleistocene humans, particularly in the resistance to vertical bending. However, they also showed that the development of a chin appears to be independent of resistance to wishboning. This, together with the fact that the chin emerged at a time of decreased dental use and mandibular shortening (Ackermann and Cheverud, 2004), suggests a more complex causation than previously proposed.

The objective of the present study was to test the hypothesis that the presence of a chin changes the strain pattern in the loaded mandible.

MATERIALS & METHODS

Mandibular Modeling and Meshing

We developed a 3-D model of an adult dentate mandible from a CT scan image (Siemens Somaton Plus Imager) set to 1-mm slice thickness with 0.5 interpolations, yielding a stack of 117 slices. The skeletal specimen was obtained under the standard protocol of the New Zealand Anatomy Act. Using in-house software and based on the grayscale analysis of the slices, we generated initial meshes for the cortical bone and teeth. We achieved the solid conversion by patching the meshes with rational surfaces (NURBS) using a generic 3D CAD package (Rhinoceros 3D modelling for Windows, v 3.0, Robert McNeel & Assoc., Seattle, WA, USA). To create socket spaces, we subtracted the root shapes of the teeth from the volume of the cortical and medullary bone. The periodontal ligament was not represented. As in previous such studies, parameters of our model were determined by measurements on a single skull

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