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Research Paper
Imaging

Three-dimensional analysis of dentolabial relationships: effect of age and sex in healthy dentition

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Abstract. Morphological changes in three-dimensional (3D) dentolabial relationships during ageing were assessed in healthy individuals. 38 subjects with healthy dentition were analysed. They were divided into a youthful group (21–34 years, mean 26 years, SD 4) and an older group (45–65 years, mean 53 years, SD 5). Stone labial and dental models were made, digitized and 3D virtual reproductions of dentolabial morphology were obtained. From the digital reconstructions, the relative positions of the labial commissure and of the maxillary dental clinical crowns in the vertical direction were obtained. Sex and age effects were compared using two-way analysis of variance. Lip position relative to the teeth was significantly different in youthful and older subjects ($P < 0.01$). No statistically significant effects of sex in dentolabial relationship were demonstrated, but a sex × age effect was found in the anterior labial segments ($P < 0.05$). The perioral soft tissues drop down in older subjects and the soft tissue descends on the entire labial arch. These differences may help the clinician when estimating, planning and evaluating surgical, orthodontic and prosthetic treatments.

Key words: Three-dimensional; Lips; Digital anthropometry.

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The position of the upper incisors and canines is a key factor in oral rehabilitation.[1] The arrangement of dental and soft tissues influences the appearance of the smile,[2] phonetic,[3] and functional balance.[4] Knowledge of teeth position, dimension, and shape, is essential when estimating, planning and evaluating surgical and orthodontic treatments, oral rehabilitation and aesthetic dentistry. The effect of age on facial soft tissues[5–8] influences the dentolabial relationship,[9,10] and should be taken into consideration to obtain successful rehabilitation. Different methods (aesthetic, phonetic, morphological and radiographic) are being used to establish the relationship between hard and soft tissues and the best vertical maxillary incisal edge-position, but the lack of a shared and reliable method is evident.[10–16] According to Waliszewski,[16] tooth position is based on which aesthetic concept the patient and dentist have chosen; indeed new reference data should be collected, guiding prosthetic rehabilitation or orthodontic treatment in adult patients.

Despite the use of several three-dimensional (3D) methods of facial evaluation, such as laser scanning, stereophotogrammetry, magnetic resonance[17,18] and radiography, no single method has found practical application in the analysis of dentolabial relationships.[5] Anatomical

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and morphological parameters may be useful to help clinical assessment in prosthetic design or in orthodontic dental repositioning.

In a previous study, the authors developed a non-invasive method for the 3D analysis of labial characteristics related to the supporting dental tissues.[5,19] The method allowed a detailed analysis of soft-tissue labial characteristics in all three dimensions, and morphological changes in the lips during ageing were quantified.

The aim of the current study was to identify differences in dentolabial vertical spatial relationships in youthful and older people with healthy dentition. The effect of sex, and the possible different ageing patterns in the two sexes, were also evaluated. Using a non-invasive protocol, morphological parameters that might help the clinician to improve anterior teeth positioning were analysed.

Materials and methods

38 healthy volunteers were divided into two groups: a youthful group comprising 10 women and 12 men, aged 21–34 years (mean 26 years, SD 4); and an older group comprising 7 men and 9 women, aged 45–65 years (mean 53 years, SD 5). The subjects had no history of craniofacial trauma, surgery or dental rehabilitation (cast restoration or cuspal coverage), had a sound, full, permanent dentition, including the first molars (at least 24 teeth in occlusion, i.e. with complete eruption), with bilateral angle class I first permanent molar and canine relationship overjet and overbite ranging from 2 to 4 mm, no anterior cross-bite, no parodondal problems, no previous or current orthodontic treatment, no temporomandibular or craniofacial disorders and no congenital anomalies. All procedures were carried out with minimal disturbance to the subjects, who were previously informed about the procedures and gave written consent to the investigation, according to the principles outlined in the Declaration of Helsinki.

Dental and labial stone casts were developed, digitized and reproduced virtually using a previously published protocol.[5,19] In brief, for each subject, a maxillary and mandibular dental reproduction was obtained, and cast with dental stone; the models were set in maximal intercuspidation. Using a moulding procedure, a 0.5 mm thick custom-fitted plastic tray (Plastiche Originali Brega, Effegi di Gelfiori F&C Sas, Sarmato, Italy) was built on the vestibular surface of each couple of dental models to obtain the labial mucosa impression (internal surface). Subsequently, the plastic mask was put in the oral vestibule, and the mucosal labial surface reproduction was obtained using silicon impression material (President Plus, Coltène Whaledent, Altstatten, Switzerland). To obtain the cutaneous impression (external lip surface), silicon impression material was placed on the skin within a pre-made metal mesh. After material hardening, the two parts of the impression were removed from the subject's mouth and skin.

The labial models were cast with a type 3 model dental stone (Elite Model, Zhermack SpA, Badia Polesine, RO, Italy); for each subject, the casts (labial plus dental models) were put in the correct anatomical relationship. Using a computerized electromechanical digitizer (Microscribe G2X, Immersion, San José, CA, USA), the cutaneous labial surface, mucosal labial surface, maxillary and mandibular vestibular dental surfaces of the models were reproduced digitally (Fig. 1).[5,19,20] The position of a 'cervical occlusal plane' (passing through the maxillary interincisive and mesial first molar papillae), and the facial axes of the clinical crown (FACC) of the maxillary anterior teeth were obtained.[19] The files of the 3D coordinates were elaborated using commercial

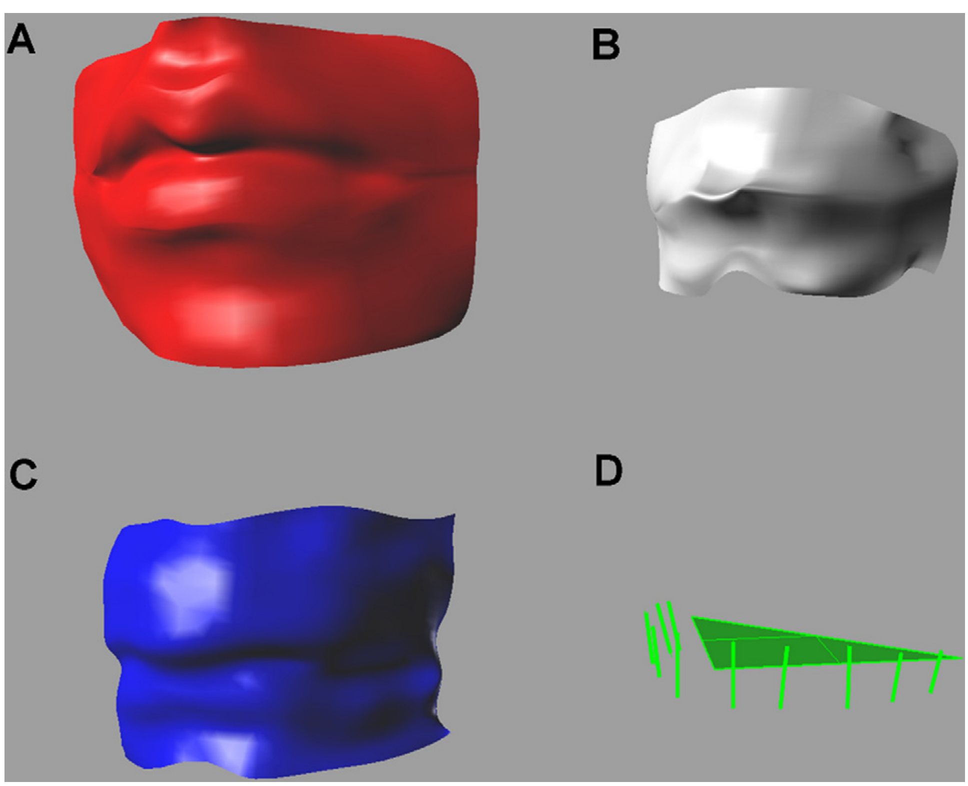

Fig. 1. Virtual labial reproduction: (A) labial cutaneous surface; (B) labial mucosal surface; (C) vestibular surface of teeth and gingival area; (D) cervical occlusal plane and FACC of maxillary incisors and canines.