

New diagnostic tools in orthodontics

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The discipline, science, and art of orthodontics are concerned with the face and our ability to modify its growth. Orthodontists achieve their goals by manipulating the craniofacial skeleton, with particular emphasis on modifying the dentoalveolar region, the temporomandibular joint, and the sutures. In a few patients, external orthopedic forces are applied that mirror some techniques used in medical orthopedics. Most treatments, however, focus on modifying the occlusion and controlling dentoalveolar development and abnormal vertical growth.

Underlying the varied techniques that orthodontists use is the confounding but important factor of the soft tissues, particularly the facial and mandibular muscles. Orthodontists know that the lip, facial, tongue, jaw-opening, and large jaw-closing muscles are relevant to the clinical outcome for their patients. How these muscles affect the face depends on the region of the craniofacial skeleton. Although the craniofacial skeleton can develop completely during the fetal stage without muscle contraction or tension, the form of the individual bones changes (domed vault, high and flat zygomatic arch, mandible bent dorsoventrally, and no temporomandibular joint spaces).¹ Postnatally, the relative effect of muscle on bone depends on the region of the craniofacial skeleton and the stage of development. Mandibular muscles modify the craniofacial skeleton through 3 mechanisms: direct tension on the attached bone that extends beyond the attachment site of the muscle; developing forces on the dentition, which in turn modify the underlying and adjacent bone; and reactive forces and stresses on the condyle of the temporomandibular joint. These muscle and soft tissue forces are real. Weakening of the systemic muscles in a

young child with muscular dystrophy results in a highly retrognathic mandible.² Normal muscle function is needed to maintain a normal face.

In the 3 articles that follow, we discuss some ideas that we think will affect the future of orthodontics. In the first one, by Adams et al, we compare traditional 2-dimensional cephalometry and a new 3-dimensional approach. Orthodontics is on the threshold of applying cone-beam computerized tomography analysis that complements other imaging approaches that have so far been too expensive or too high in radiation exposure for routine application. We believe that 3-dimensional imaging will become a reality with the new rapid conical computed tomography systems.³ In the second article, by Nakano et al, we report on the use of microcomputed tomography to learn more about how the condyle changes in an asymmetrical, growing mandible in an experimental animal model. In the third article, by Usui et al, we explore what the field of advanced human robotics has to offer to orthodontics. This article emphasizes the effect of muscle tension on the mandible, evaluating many sites both buccally and lingually during simulated chewing.

Future techniques in orthodontics will include calculating how modifying the occlusion during orthodontic treatment affects the direction and loading of the condyle. This could prove to be an effective method for predicting the direction of condylar and mandibular growth. Some of our own work has been evaluating how cortical bone develops its maximum mineralization in regions that are stiffest to the continued bending, torquing, compressing, and tensile changes that develop daily in a working mandible.⁴⁻⁶ The mandible is a living, vibrant bone that undergoes continued spatial distortion, loading of multiple sites in the dentoalveolar and temporomandibular joint regions, and varied strains as it functions.⁷ Some day, the effect of the complex forces developed by bilateral muscle groups might be as evident to us in the pattern of bone mineralization as in a lateral headfilm.

Along with these intriguing methods in mechanical engineering are the new imaging techniques in 3 dimensions. We are on the threshold of a major change in orthodontics, as clinicians learn how to effectively use 3-dimensional imaging as a normal diagnostic

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method. These imaging approaches, combined with concepts in mechanical engineering, will allow the clinician to calculate the forces developed on the newly positioned dentition and the resulting forces on the condyles.

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