Biomechanical evaluation of mandibular midline distraction osteogenesis by using the finite element method

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The aim of this study was to evaluate the biomechanical effects of mandibular midline distraction osteogenesis on the mandibular complex by using a 3-dimensional finite element model, whose construction was based on computer tomography scans of the mandible of a 22-year-old man. The computer tomography pictures were transferred and converted to the finite element model by means of a procedure developed for this study. The final mesh consisted of 1314 solid elements with 3076 nodes. The distraction was performed on the middle intersection point of the vertical and horizontal planes on the mandibular symphysis. The mechanical response in terms of displacement and von Mises stresses was determined by widening the mandible up to 5 mm on both sides. The results indicate that the mandible was separated almost in a parallel manner (4.45-5.0 mm separation from the mandibular incisors to the lower border of the mandibular symphysis and 4.09-4.92 mm from the mandibular canines to the symphyseal border at the canine region), superoanteriorly. Anteroposterior evaluation demonstrated that the greatest widening was achieved at the symphyseal region, and the widening effect gradually decreased from anterior to posterior. Viewed occlusally, the width of the mandibular bone at the symphyseal region increased remarkably, whereas the ramal and gonial regions of the mandible and the condyle had shown minimal displacement. Mandibular bone was displaced forward and slightly downward. The highest stress levels were observed bilaterally below the condylar areas. High stress levels were also observed in the ramal region of the mandible. (Am J Orthod Dentofacial Orthop 2004;125:706-15)