Biomechanical view on the treatment of the congenital cleft of the hard palate

V. Lokhov, O. Dolganova

Perm National Research Polytechnic University, 29 Komsomolskii Prospect, 614990, Perm, Russia; Valeriy.Lokhov@yandex.ru

Abstract

The paper deals with the biomechanical analysis of the system “orthopaedic plate – palate fragment” for the case of two-sided palatal cleft considering growth strain. The latter is modeled by constitutive relation based on the hypothesis of Hsu (Journal of Biomechanics, 1968) taking into account genetic growth and stress influence on the growth rate. The genetic growth is represented by the spherical tensor; the tensile deformation stimulates growth process, compressive strain decreases the growth. Growth strain is considered as a partial case of eigenstrain and the technique of independent deformation control (stress-free deformation control) is applied and realized. The aim of control is the creation of desired palatal arch from two disjoined fragments of the hard palate. Due to symmetry, only one fragment is considered. Control algorithm is developed in the frame of finite-element model realized in the ANSYS and allows us to calculate the optimal orthopaedic forces and treatment time. The material properties are taken from the literature, and parameters of the growth strain model are calculated on the basis of experimental data obtained by Masich et al. (Russian Journal of Biomechanics, 2002). As a result of performed analysis of calculated optimal forces, the shape of stationary orthopaedic plate is suggested as well as installation parameters. Such plate can induce the necessary forces in the system and, consequently, the desired growth. The direct calculation of growth strain field induced by the suggested apparatus is done; the displacement field appears to be close to desired values.

Keywords: Cleft of the hard palate, accumulation of growth strain, displacement activator, independent control of stress and strain, finite element method