Modelling the Influence of Mechanical Factors on the Growth Plate

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Longitudinal bone growth in the skeletons of vertebrates is carried out mainly by the processes of growth and ossification in the growth plate. The growth plate is the layer of hyaline cartilage between metaphysis and epiphysis of the bone. During bone growth two processes occur simultaneously: the increase in length of the cartilage plate and the ossification when cartilage cells transform into bone cells. Bones stop to grow when the growth plates close. It is known that these processes are governed, besides genetic, hormonal, metabolic, vascular, also by mechanical factors (see, e.g. [1]).

The growth plate is modeled by a layer of width \( h \) located in an infinite medium both composed of isotropic non-linear materials. The evolution of the volumetric growth is described by the kinetic equation connecting the rate of volumetric growth with pure biological growth due to intrinsic genetic and hormonal regulation, and mechanical contribution [1]. We study the influence of the volumetric growth in the cartilage and external loading on the position of the equilibrium interface between the bone and the cartilage under finite-strain approach [2–4]. We also examine the stability of the equilibrium states basing on the procedure developed in [5, 6]. We demonstrate that the premature closure of the growth plate can be related with the loss of the stability.

References


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