Mathematical analysis of some bone remodelling problems

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Abstract. Bone remodelling aims to understand the relationship between the morphology of the bone and the applied mechanical loads, and it is based on the fact that the bone has the ability to adapt itself to the load conditions to which it is bearing. This adaptation process, including modelling and remodelling mechanisms, has an enormous effect on the overall behaviour and health of the entire body. For instance, it is well argued that normal and daily activities generate damage in the form of tiny microcracks throughtout bone tissue.

Since the first mathematical analysis of a bone remodelling model presented in [1], many papers have been reported in the literature, most of them based on the qualitative observations provided by Julius Wolf in 1892. Moreover, recently there has been great interest in understanding the piezoelectric behaviour of bone and its impact in bone remodelling (see [2]). For instance, Fukada and Yasuda demonstrated in 60's that dry bone is piezoelectric in the classical sense.

In this talk, we will present some of the results obtained by our research group in the study of the bone remodelling models introduced by Cowin and Hegedus ([1]) or Weinans, Huiskes and Grootenboer ([3]), and also the results obtained in the modelling and simulation of the piezoelectric behaviour of the bone using the law by Weinans et al.

References

[1] Cowin, S.C.; Hegedus, D.H. Bone remodeling I: theory of adaptive elasticity. *J. Elasticity* **6** (1976), no. 3, 313–326.

[2] Isaacson, B. M.; Bloebaum, R. D. Bone bioelectricity: what have we learned in the past 160 years?. *J. Biomed. Mater. Res.* **95** (2010), no. 4, 1270-1279.

[3] Weinans, H.; Huiskes, R.; Grootenboer, H.J. The behaviour of adaptive bone-remodeling simulation models. *J. Biomechanics* **25** (1992), no. 12, 1425–1441.