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BONE ADAPTATION PROCESS OF THE HUMERUS TO RESURFACING AND STEMLESS IMPLANTS: A COMPUTATIONAL ANALYSIS

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Summary: The shoulder arthroplasty has undergone evident advances over the last years. However, several complications still limit its success. The introduction of an implant into the bone changes the load environment, which may cause adverse changes in the bone structure, and thus compromise the long-term stability of the implant. Resurfacing and stemless implants are novel implant designs that have been developed to improve the long-term outcomes of the shoulder arthroplasty and to provide an improved bone quality in revision operations. The objective of this work is to analyze the bone adaptation process of the humerus due to resurfacing and stemless implants, based on the Global C.A.P. and the Sidus Stem-Free systems, respectively. The geometry of the humerus was generated from the Visible Human Project, while the geometries of the two implants were modelled in Solidworks. The bone remodeling model applied is based on an optimization criterion that considers a balance between structural stiffness and the metabolic cost of bone maintenance. Six load cases, related to different positions of abduction in the frontal plane and anterior flexion in the sagittal plane, are considered, being the applied muscle and joint forces estimated by a multibody model of the upper limb. Healthy and poor bone quality conditions were simulated. The bone adaptation process is evaluated by comparing the bone density distribution predicted for the humerus without an implant and that obtained for the implanted humeri. For comparable regions of the humeral head, similar levels of bone resorption were observed for the resurfacing and stemless implants. However, for the stemless implant, the reduction in bone stock at the implant fixation was smaller, which suggests that the stemless implants may be better supported in the long-term. For the poor bone quality condition, the amount of resorption increased for both implants, which supports the limited performance of these implants under reduced bone stock conditions.