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Numerical Simulation for predicting the Effect of Electrode Array Position in Cochlear Implants

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ABSTRACT

The cochlea is an organ responsible of making the sense of hearing, through the movement of hair cells in the Organ of Corti. It works transforming the sound into an electrical pulse to be transmitted by the neurons to the auditory nerve fibres. When a degeneration of hair cells occurs, the solution goes through cochlear implants (CIs) which are electronic devices, formed by an electrode array. The electrode array is normally placed in two positions; perimodiolar position (fixed to the auditory nerve fibre), or lateral position (opposite side) to discuss its effect on the neural response.

This work is based on a model which is customized with patient's data by the neural response telemetry (NRT) amplitude. The object of this model is to reproduce the behaviour of auditory nerve stimulated by a CI. The clinical data has been provided from some patients implanted with the perimodiolar electrode array. The NRT is a clinical technique which records the evoke compound action potential (ECAP) when neurons are activated by the stimulated electrode.

The method involves two types of FEM models [1]. One computes the current densities that extend to the virtual neurons (VNs) when an electrode is stimulated. When a membrane current intensity is propagated along the neuron, a potential extends to the electrode, being the simulated NRT. After that, the parameters, that reduce the error between real and simulated NRT, are adjusted by the differential evolution algorithm (DEA).

The conclusions achieved, are the model predicts of the behaviour of the displacement of the electrode array and the capacity of focalization.

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