A Fluid Actuator for Thin-Film Electrodes

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Background. Cochlear implants have become an accepted and successful treatment for profound sensorineural deafness in both children and adults. Essential to the effective and efficient localized stimulation of the auditory nerves, is the position of the implant electrode array stimulating sites within the scala tympani (ST). However, the small size, delicate internal structures and helical shape of the cochlear chambers complicate the matter of precise positioning of the implant electrode array. The design, fabrication process, and in vitro testing of a fluid actuator to steer a thin-film electrode array is presented. The application chosen to show feasibility is for a cochlear implant, however, the actuator might be used for cortical electrode arrays, for example. Method of Approach. The actuator functions by a change of internal fluid pressure within one or more flattened and curled polymer microtubes, expanding the highly elliptical cross section of each tube thereby stiffening it and causing a change in its curling radius. The straightening from an initially helical shape allows insertion of an attached electrode array into the basal end of the in vitro cochlea and as the insertion proceeds the pressure is decreased allowing the straightened electrode array to controllably return to its initial helical shape. The allowable envelope of the scala tympani of a guinea pig was determined from published data and the actuator was designed and fabricated accordingly. Results. Multiple actuators were fabricated and tested in vitro. The insertion tests helped to confirm the viability of using this type of actuation to facilitate the insertion of an electrode array into the ST. These tests were performed in a minimal amount of time and often on the first attempt. The actuator reached the furthest extent of the in vitro cavity and achieved a position adjacent to the modiolus. Conclusions. In vitro insertion tests show that the actuator can deliver a thin-film electrode array to a depth of more than one turn into the in vitro scala tympani within a few minutes under open-loop, manual control.