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Tactile Sensory Digit Feedback for Cochlear Implant Electrode Insertion

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Abstract : Cochlear Implantation (CI) which became a routine procedure for the last decades is an electronic device that provides a sense of sound for patients who are severely and profoundly deaf. Today, cochlear implantation technology uses electrode array (EA) implanted manually into the cochlea. The optimal success of this implantation depends on the electrode technology and deep insertion techniques. However, this manual insertion procedure may cause mechanical trauma which can lead to a severe destruction of the delicate intracochlear structure. Accordingly, future improvement of the cochlear electrode implant insertion needs reduction of the excessive force application during the cochlear implantation which causes tissue damage and trauma. This study is examined tool-tissue interaction of large prototype scale digit embedded with distributive tactile sensor based upon cochlear electrode and large prototype scale cochlea phantom for simulating the human cochlear which could lead to small-scale digit requirements. The digit, distributive tactile sensors embedded with silicon-substrate was inserted into the cochlea phantom to measure any digit/phantom interaction and position of the digit in order to minimize tissue and trauma damage during the electrode cochlear insertion. The digit has provided tactile information from the digit-phantom insertion interaction such as contact status, tip penetration, obstacles, relative shape and location, contact orientation and multiple contacts. The tests demonstrated that even devices of such a relative simple design with low cost have a potential to improve cochlear implant surgery and other lumen mapping applications by providing tactile sensory feedback information and thus controlling the insertion through sensing and control of the tip of the implant during the insertion. In that approach, the surgeon could minimize the tissue damage and potential damage to the delicate structures within the cochlear caused by current manual electrode insertion of the cochlear implantation. This approach also can be applied to other minimally invasive surgery applications as well as diagnosis and path navigation procedures.

Keywords : cochlear electrode insertion, distributive tactile sensory feedback information, flexible digit, minimally invasive surgery, tool/tissue interaction
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