

Abstract

In-Ear Energy Harvesting: Source Characterization and Mechanical Simulator (Part I) [†]

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Abstract: During daily activities, such as chewing, eating, speaking, and so forth, the human jaw moves, and the ear canal is deformed by its anatomic neighbor called the temporomandibular joint (TMJ). Given the frequency of those jaw joint activities, the ear canal dynamic movement is a promising source of energy in close proximity to the ear, and such energy can be harvested by using a mechanical–electrical transducer dubbed energy harvester. However, the optimal design of such micromachine requires the characterization of the TMJ’s range of motion, its mechanical action on the ear canal, and its mechanical power capability. For that purpose, this research presents two methods for analyzing the ear canal dynamic movements: first, an in situ approach based on the measurement of the pressure variation in a water-filled earplug fitted inside the ear canal, and second, an anatomic-driven mechanism in the form of a chewing test fixture capable of reproducing the TMJ kinematics with great precision. The pressure earplug system provides the ear canal global dynamics, which can be derived as an equivalent displaced volume, while the chewing test fixture provides the discrete displacement along the ear canal wall. Both approaches are complementary and contribute to a better analysis of the interaction between the TMJ and ear canal. Ultimately, knowledge of the maximum displacement area and the derived generated power within the ear canal will lead to the design of a micromachine, allowing for the further investigation of in-ear energy harvesting strategies.

Keywords: TMJ; ear canal dynamic motion; anatomic coupling; power capability

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Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: Data supporting reported results can be found in CRITIAS:DB open database repository and can be requested from <https://critias.etsmtl.ca/CRITIAS-DB>.