ABSTRACT

Transcranial magnetic stimulation is a neuromodulation technique that can be used as a

non-invasive method for treating various neurological disorders. The major principle of TMS is

the Faraday’s law stating that time varying magnetic field induces electric field in nearby

conductors. More specifically, magnetic field generated by TMS stimulator induces electric

current in the conductive brain tissue. Numerous studies have been done to explore the effects of

TMS, while the cellular and molecular mechanism underlying is not clear yet. In addition, coil

design is also a popular topic as the geometry of coil is able to alter the induced electric field

significantly. The work presented in this dissertation discusses the effects of TMS on neuronal

cells in vitro and the computational simulations modelling the stimulations delivered to the head.

A dopaminergic neuronal cell line is used to examine how TMS affects the proliferation of the

cells in vitro. The effects of TMS promoting the proliferation of neuronal cells have been

observed under two different cell culture environments. Furthermore, results of thousands of

computational simulations were presented in this dissertation. Two coils were placed at three

locations to investigate how the electric fields delivered to the cerebellum vary with coil

geometry and coil position. Moreover, the intensity and focality of the electric fields generated in

the brain by 16 commercial or novel coils were compared. All the coils were placed at the vertex

and 9 of them were placed at the dorsolateral prefrontal cortex of the head. Importantly, 50

heterogeneous head models were used in these simulations for each coil and position to explore

the role of anatomical variations in TMS.