TREATMENT PLANNING FOR ELECTROPORATION-BASED THERAPIES

Bor Kos

University of Ljubljana, Faculty of Electrical Engineering, Trzaska cesta 25, SI-1000 Ljubljana, Slovenia

E-mail: bor.kos@fe.uni-lj.si

Electroporation is a phenomenon in which exposure of cells to short pulses of electric fields causes an increase in the permeability of the cellular membrane to ions, small, and large molecules (1). Currently, the two applications, which have the most clinical evidence and have been most intensely studied are electrochemotherapy (ECT) and irreversible electroporation (IRE) (2,3). For ECT the electric field pulses needed to achieve therapeutic effect are 8 pulses of 100 microseconds, while for IRE, 90 pulses of 70 to 100 microseconds are recommended.

The most important predictor of successful electroporation is the local electric field strength in situ (4). The electric field in tissue depends on the voltage applied to the electrodes, the number, geometry and position of the electrodes, and the tissue conductivity. The tissue conductivity of different tissues is markedly different, tumour tissue also typically has much higher conductivity than surrounding healthy tissue (5); tissue conductivity also transiently increases due to electroporation during the pulses (6). To realize patient-specific treatment planning the following steps are needed: tomographic image segmentation, electric field calculation and optimization of electrode positions and applied voltages (7). The final results of the optimization need to be presented in an understandable way, so that the patient-specific treatment plan can be successfully followed by the performing physician; this can also be achieved using navigation systems (8).

Acknowledgements: This work was in part supported by Slovenian Research agency and conducted in the scope of LEA EBAM.

References

1. Yarmush ML, Golberg A, Serša G, Kotnik T, Miklavčič D. Electroporation-Based Technologies for Medicine: Principles, Applications, and Challenges. Annu Rev Biomed Eng 2014;16(1):295–320.
2. Mir LM, Orlowski S, Belehradek J, Paoletti C. Electrochemotherapy Potentiation of Antitumor Effect of Bleomycin by Local Electric Pulses. Eur J Cancer 1991;27(1):68–72.
3. Davalos R, Mir L, Rubinsky B. Tissue Ablation with Irreversible Electroporation. Ann Biomed Eng 2005;33(2):223–31.
4. Miklavcic D, Beravs K, Semrov D, Cemazar M, Demsar F, Sersa G. The importance of electric field distribution for effective *in vivo* electroporation of tissues. Biophys J 1998;74(5):2152–8.
5. Peyman A, Kos B, Djokić M, Trotovšek B, Limbaeck-Stokin C, Serša G, et al. Variation in dielectric properties due to pathological changes in human liver. Bioelectromagnetics 2015;36(8):603–12.
6. Corovic S, Lackovic I, Sustaric P, Sustar T, Rodic T, Miklavcic D. Modeling of electric field distribution in tissues during electroporation. Biomed Eng OnLine 2013;12(1):16.
7. Pavliha D, Kos B, Županič A, Marčan M, Serša G, Miklavčič D. Patient-specific treatment planning of electrochemotherapy: Procedure design and possible pitfalls. Bioelectrochemistry 2012;87:265–73.
8. Groselj A, Kos B, Cemazar M, Urbancic J, Kragelj G, Bosnjak M, et al. Coupling treatment planning with navigation system: a new technological approach in treatment of head and neck tumors by electrochemotherapy. Biomed Eng Online 2015;14 Suppl 3:S2.