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Editorial: Computational modeling of various procedures in thermal therapy of human tumors

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Editorial on the Research Topic
Computational modeling of various procedures in thermal therapy of human tumors

Cancer is the leading cause in many countries, which lead to almost 10 million deaths in 2020 (Sung et al., 2021). In the meantime, the traditional cancer therapeutics including radiotherapy, chemotherapy, and surgery, all suffer from different side effects or limitations (Ren et al., 2022). Thermal therapy, commonly known as hyperthermia has been used to treat cancer and other diseases since at least 4,000 years ago (Hornback, 1989; Glazer and Curley, 2010). Hyperthermia cancer therapy involves subjecting a tumor (locally or regionally) to a temperature within 42°C–48°C for a duration of an hour to a few minutes depending on the temperature used. Due to its advantages of minimal- or non-invasive nature, it has attracted the interest of researchers worldwide. Thermal therapy can be characterized as photothermal therapy, ultrasound thermal therapy, radiofrequency thermal therapy, magnetic hyperthermia, etc., according to the heat generation methods (Khurana et al., 2022; Singh et al., 2022). In the context of photothermal therapy, an indirect heating strategy has been proposed in which the tissue around the tumor is heated instead of the tumor itself, which will reduce or even stop the oxygen supply of the tumor cells (Dombrovsky et al., 2012; Dombrovsky, 2022). Due to the development of nanotechnology, plasmonic nanoparticles are employed to enhance energy absorption during photothermal therapy, termed as plasmonic photothermal therapy, which is very popular in recent years. The most important Research Topic for thermal therapy is precise temperature control to kill the tumor cell selectively. Accurate numerical modeling of thermal therapy, especially the heat transfer process, is very important for the optimization and real time adjustment of thermal therapy procedure or pre-treatment planning before thermal therapy (Ren et al., 2022). This Research Topic aims to report the important development in the field of computational modeling of different kinds of procedures involved in thermal therapy, including but not limited to heat transfer, light propagation, blood flow, thermal damage, etc., which is very important to quantify the optimal thermal dosage for patient-specific settings.

In this Research Topic, Mariappan et al. has proposed a point source model to predict the power generated by the needle which does not require to obtain the complex electric field during radiofrequency ablation. The proposed model was applied to both two-dimensional and three-dimensional simulations and the obtained results were in good agreement with those predicted with the Joule heat model. The proposed point source model approximation would provide the source term to be utilized in the Pennes bioheat transfer equation without the need to actually solve (or coupling) the electric field model, leading to a significant reduction in the computational time for predicting the temperature distribution and ablation volume. It should be mentioned that blood flow plays an extremely important role in the heat transfer process within living tissue. However, this effect has been considered as a simplified blood perfusion rate term in the Pennes bioheat transfer equation, which accounts for volumetric heat transfer in organs containing large vessels. To get information about the local blood temperature, another model, named two coupled energy equations, has been proposed to take into account the spatial and time variations in arterial blood temperature (Xuan and Roetzel, 1997). It has also been extended and applied to solve the heat transfer problem during photothermal therapy (Dombrovsky et al., 2011; Dombrovsky et al., 2012).

In another article of this Research Topic, Tenorio et al. presented an *in silico* photothermal therapy system aimed at enhancing the efficacy of therapy in attaining complete tumor necrosis while restricting damage to the surrounding healthy tissue. An external temperature-tracking system, a real-time thermal damage predictor, a fuzzy logic or a PI controller, and a continuous wave laser is included in this system. A closed-loop feedback system was designed that would be able to modulate the input power delivered to the tissue on the basis of predicted thermal response in both target (tumorous) and healthy regions of the tissue, thus, providing a safe and effective thermal therapy.

Besides the above numerical work, this Research Topic also includes an experimental study by Li et al. related to the application of moxibustion in treating cancer-related fatigue in colorectal patients. Governor Vessel Moxibustion trials were conducted on 80 patients for a duration of 3 weeks. The presented results provide experimental evidence showing greater reductions in interleukin-6 and tumor necrosis factor-α levels, with no serious adverse events. Thus, highlighting the safety and effectiveness of Governor Vessel Moxibustion for alleviating cancer-related fatigue in colorectal patients.

The three research papers in this Research Topic cover a wide range of current state-of-the-art developments in the field of thermal therapy, from numerical to experimental works. In view of the rising interest in exploring safe and effective alternative therapies for cancer, more exciting work regarding numerical models and treatment strategies of thermal therapy is still expected.

Author contributions

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Conflict of interest

The authors YR, SuS, and SaS declared that they were an editorial board member of Frontiers, at the time of submission. This had no impact on the peer review process and the final decision.

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