

传递现象

血液灌注和代谢产热温度依赖性对低温手术过程组织温度场的影响

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收稿日期 2006-6-16 修回日期 2006-11-4 网络版发布日期 2007-5-29 接受日期

摘要 基于已有实验数据,建立了人体血液灌注率和代谢产热在冷热处理区内(-175~75℃)的温度依赖关系式。通过数值模拟,研究了人体血液灌注率和代谢产热的温度依赖性对于低温手术过程组织瞬态温度场的影响。结果表明,忽略其温度依赖性,将会导致低温手术过程组织内部相界面和临界等温面被过小估计,从而在临床实际低温手术过程中导致过多正常组织损伤。低温手术过程的优化设计,必须充分考虑人体血液灌注率和代谢产热的温度非线性。

关键词 [低温手术](#) [冷刀](#) [温度场](#) [血液灌注](#) [代谢产热](#)

分类号

Effect of temperature dependent blood perfusion and metabolic heat generation on heat transfer problem in cryosurgery

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Abstract

The formulas describing the dependence of blood perfusion rate on temperature were set up for the whole temperature range from hypothermia to hyperthermia. The influence of the temperature dependent blood perfusion rate and metabolic heat generation on the transient thermal field and thermal gradient field were studied by using finite element analysis. The enthalpy method was used to solve the thermophysical nonlinear and multidimensional phase change problem in cryosurgery of the target tissue, and the tissue was treated as non-ideal materials freezing over a temperature range. Theoretical simulation indicated that without full consideration of the thermal dependence of blood perfusion rate and metabolic heat, the transient temperature of the typical point or the temperature along the typical path inside the tissue would both be overestimated, the temperature difference even reached about 5°C; the thermal gradients of the typical points inside the tissue or on the cryoprobe surface were also overestimated. Besides, the thermal gradient of the typical point on the cryoprobe surface was much larger than that of the point inside the tissue, and this might have certain relation to the often appearing cracks or ruptures inside the tissue closely tied to the cryoprobe surface during cryosurgical process. This study suggested that the thermal dependence of blood perfusion rate and metabolic heat generation should be fully incorporated into the analysis of the heat transfer problem in cryosurgery and should be fully considered for the design/optimization of the cryosurgical procedure and cryoprobe.

Key words [cryosurgery](#) [cryoprobe](#) [thermal field](#) [blood perfusion rate](#) [metabolic heat generation](#)

DOI:

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