THE ANALYSIS OF THE THERMAL STRUCTURE CONJUGATED PROBLEM OF PERCUTANEOUS LASER DISC DECOMPRESSION

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ABSTRACT

This study is to discuss the variation of different surgical conditions while PLDD is processing. The multiphysics analysis algorithm is used to understand the temperature and stress distribution of the whole domain and heat transfer phenomena under the different kinds of laser heating rate and patients. In this study, the effect of thermal conductivity related about the patient’s age will be illustrated. In addition, the temperature profile is predicted as the heat transfer phenomena can be handled on the surgical process. In future, we expect that this result can be used to handle the PLDD in the pre-surgical simulation.

INTRODUCTION

This study is to obtain the thermal structure conjugated phenomena under the different surgical conditions while percutaneous laser disc decompression (PLDD) is processing. PLDD is a minimal invasive surgery which through the laser vaporizes the herniation of disc. By this technology, we can remove or release the compression on nerve root and reduce the volume of herniation to decompression. The 3D thermal structure conjugated model of COMSOL is used in this study. We discuss the parameters of the PLDD, such as laser power, laser moving speed and the content of water. The temperature profile of the intervertebral disk is obtained and reveals the relations among these parameters. These results are expected to be a pre-surgical analysis to benefit the PLDD processing.

In the past, it makes an overlarge wound, much bleeding and long recovery time when the traditional surgical operator is used. In 1986, Choy and Ascher developed PLDD which uses laser to heat the herniation of the nucleus pulposus, and the part of herniation will be vaporized to relief the intervertebral pressure [1]. Choy concludes the clinical application of PLDD. After 1986, PLDD is widely used. There are no deaths, ligament damaged and nerve root damaged after surgery [2]. PLDD was recommended as the first therapy of disc herniation from 1987. Zell et al. use PLDD for twenty patients, and there are sixteen patients have been improved [3]. Many previous researches have studied the cases and the improvement of the PLDD. Base on Choy’s experiment, the Nd-YAG Laser of PLDD can decompress 55% compression of disc. According to the MacNab standard, the success rate of PLDD is 89%-90%. The high success rate and low-risk of PLDD is the reason that it is recommended for the best treatment of the herniation of the intervertebral disk. Based on the above illustrations, PLDD will become the important methods in the clinical operation of the intervertebral disk herniation in the future indeed. In 2006, Gupta et al. [4] evaluate the efficacy of PLDD in treatment of contained herniation of lumbar discs and long term follow up results. It take 40 patients with contained herniation of lumbar discs on MRI and who do not respond to 6 weeks conservative treatment are subjected to PLDD. Gupta et al. conclude that there are still 20% patients feel pain after operation, and 15% need re-treatment. Therefore, the current technology of PLDD still has to improve.

For understanding the different phenomena while the PLDD is processing under the different kind of conditions further, the results of the thermal structure conjugated phenomena are demonstrated to handle the accuracy of the PLDD. In this study, the complex realistic temperature and stress distributions of the intervertebral disc are obtained. We expect that these results can build a useful database to compare with the data of clinical operation in future. Therefore, these simulations will become a major preoperative simulation of the PLDD to enhance clinical safety and accuracy.

MATHMATICAL MODEL

This study discusses the thermal structure conjugated phenomena of bio-tissue in the intervertebral disc. To obtain the temperature evolution and the deformation of the heated disc and achieve a more realistic analysis by the multiphysics analysis package are the purposes of this study. We expect the results could be used in the clinical application of thermal therapy.