

Pneumoperitoneum Creation Assisted with Optical Coherence Tomography and Automatic Identification

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Abstract : For every laparoscopic surgery, a safe pneumoperitoneum creation (gaining access to the peritoneal cavity) is the first and essential step. However, closed pneumoperitoneum is usually obtained by blind insertion of a Veress needle into the peritoneal cavity, which may carry potential risks such as bowel and vascular injury. Until now, there remains no definite measure to visually confirm the position of the needle tip inside the peritoneal cavity. Therefore, this study established an image-guided Veress needle method by combining a fiber probe with optical coherence tomography (OCT). An algorithm was also proposed for determining the exact location of the needle tip through the acquisition of OCT images. Our method not only generates a series of "live" two-dimensional (2D) images during the needle puncture toward the peritoneal cavity but also can eliminate operator variation in image judgment, thus improving peritoneal access safety. This study was approved by the Ethics Committee of Taipei Veterans General Hospital (Taipei VGH IACUC 2020-144). A total of 2400 in vivo OCT images, independent of each other, were acquired from experiments of forty peritoneal punctures on two piglets. Characteristic OCT image patterns could be observed during the puncturing process. The ROC curve demonstrates the discrimination capability of these quantitative image features of the classifier, showing the accuracy of the classifier for determining the inside vs. outside of the peritoneal was 98% (AUC=0.98). In summary, the present study demonstrates the ability of the combination of our proposed automatic identification method and OCT imaging for automatically and objectively identifying the location of the needle tip. OCT images translate the blind closed technique of peritoneal access into a visualized procedure, thus improving peritoneal access safety.

Keywords : pneumoperitoneum, optical coherence tomography, automatic identification, veress needle

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