Discussion on the Value of Multimodal Image Fusion Technology in the Precision Detection of Liver Fibrosis

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Abstract: With the continuous development of imaging technology, multi-modal image fusion technology has become a hot research at home and abroad. At present, there are two kinds of fusion techniques: one is to fuse ultrasonic, CT or MRI image information to obtain higher resolution image, the other is to fuse image information of different modes to improve diagnostic efficiency. In this paper, the application value of multimodal image fusion technique in the accurate detection of liver fibrosis is reviewed, and its problems and development direction are discussed. In order to provide a reference for clinical practice and further improve the accuracy of liver disease diagnosis.

***Keywords*:** multimodal imaging; fusion technology; liver fibrosis; precision detection

1. Introduction

Liver is an important metabolic organ of human body and plays an important role in the development of liver diseases. Hepatic fibrosis (HF) is the result of diffuse and persistent fibrosis following liver injury caused by multiple causes and induced by inflammation, synthesis and deposition of extracellular matrix (ECM). It is an important link in the progression of chronic liver disease and a necessary process for the development of liver fibrosis, cirrhosis and even liver cancer. Liver cirrhosis and liver cancer are important liver diseases in China. Therefore, it is very important to detect the degree of liver fibrosis in the process of liver fibrosis. At present, the common diagnostic methods include serological index, ultrasound, CT and MRI[1].

2. Overview of Multimodal Imaging Technology

2.1 Definition of multimodal imagery

In clinical medicine, different imaging methods are used to obtain different images by scanning the human body, then appropriate images are fused, and different modal image information is fused together by computer technology. Multi-modal image is the image information of the same tissue, organ or structure obtained by different imaging methods, which can be continuously, simultaneously and dynamically imaged. Multimodal imaging has many unique advantages, such as high sensitivity, strong specificity, good reproducibility, non-invasive, making it an important tool for disease diagnosis and evaluation.

2.2 Characteristics of multimodal images

Multi-modal imaging, which combines two or more imaging methods, can provide rich information of tissue anatomy and biophysics simultaneously. It is a breakthrough of single imaging technology. Multi-modal imaging technology has the following advantages: (1) Multi-modal imaging data integration helps to comprehensively analyze different image information and improve the diagnostic accuracy; (2) Different imaging methods have their own advantages, and the combination of the two can give full play to their respective advantages and better improve the diagnostic ability of diseases; (3) Multiple imaging methods can scan at the same time, which can effectively shorten the examination time; and (4) Multiple imaging methods can enable different patients to examine at the same time, so as to avoid missed diagnosis or misdiagnosis caused by different diagnosis standards.

2.3 Application of multimodal imaging in medical imaging

At present, the application of multimodal imaging technology in the field of medical imaging is more and more extensive, including: ① liver disease detection: liver ultrasound, MRI, CT is the most widely used method for detecting liver diseases, especially MRI; ② heart disease detection: heart ultrasonic universal heart disease detection; ③ lung disease detection: chest X-ray examination) is the most widely used method for detecting lung diseases; ④ brain and spinal cord diseases detection: MRI, CT examination is the most widely used method for detecting brain and spinal cord diseases; ⑤ bone and joint diseases

detection: bone density examination is the most widely used method for detecting bone and joint diseases[2].

3. Application of fusion technology in medical imaging

3.1 Overview of image fusion technology

Image fusion technology is to use different time and different space image information, through the analysis of the original data, to get a more comprehensive and more accurate understanding and description of the same object. It is to fuse the images from different types of sensors to get a clear, accurate and comprehensive description of the same object or target. Image fusion technology is widely used in medical imaging field, such as CT, MRI, ultrasound, X-ray, etc. Image fusion technology can be divided into three steps: image registration, feature extraction and fusion rules.

3.2 Application of fusion technique in diagnosis of liver diseases

At present, many researchers are committed to the research and development of image-based diagnostic methods. Through the processing and analysis of multimodal medical images, it can provide more accurate and comprehensive diagnostic results for clinic. With the development of computer technology and medical image processing technology, more and more researchers try to use fusion technology to improve diagnostic accuracy. For example, Wang et al. Used quantitative liver imaging based on multimodal fusion to assess liver fibrosis in patients with cirrhosis, with a 94.9% accuracy rate, which is more diagnostic than CT or MRI alone. In another study, Yu et al. Fused MRI and CT images with 98.5% accuracy, making it more diagnostic than CT or MRI alone[3].

3.3 Application of fusion technique in liver fibrosis detection

Liver fibrosis is a necessary stage in the progression of chronic liver disease, which provides favorable conditions for the regeneration and repair of liver cells. Therefore, accurate detection of liver fibrosis can effectively predict the occurrence and progression of liver cancer. At present, liver biopsy, imaging examination (such as liver tissue biopsy, ultrasound), serological index detection (such as serum alpha fetoprotein (AFP), total bilirubin (TBil), gamma-glutamyl transferase (GGT), etc.) and imaging examination (such as CT, MRI, etc.) are the main methods commonly used in clinic to detect fibrosis. However, these methods have some limitations, and liver fibrosis assessment criteria are different, quantitative results are not comparable. Therefore, some scholars try to fuse the multimodal imaging technology in order to provide a new idea for liver fibrosis detection.

4. Imaging characteristics of hepatic fibrosis

4.1 Definition and etiology of liver fibrosis

Hepatic fibrosis is the common outcome of various chronic liver diseases and is caused by persistent inflammation and injury of the liver. Hepatic fibrosis is a dynamic process influenced by many factors, including age, sex, race, heredity and environment. According to statistics, about 10% ~ 25% of the world's patients with liver disease have varying degrees of liver fibrosis. Cirrhosis is a necessary stage of liver disease, and chronic active hepatitis (CAH) is the most important cause of liver fibrosis. Other causes include alcoholic liver disease, schistosomiasis, nonalcoholic fatty liver disease, autoimmune liver disease and drug-induced liver damage , in which alcoholic and autoimmune liver diseases are closely related to liver fibrosis.

4.2 Imaging findings of liver fibrosis

The imaging findings of hepatic fibrosis are largely influenced by the site of the disease, liver reserve function, type of fibrosis, and severity. The diagnostic criteria included imaging findings, histological findings and liver function. Because of the lack of abundant blood vessels in liver, low density area without obvious enhancement on CT, but because of its histological changes, CT value is correlated with the degree of hepatic fibrosis. At the same time, the liver is very sensitive to ischemia, hypoxia and other factors, so the low density area in arterial phase can be used as a substitute for normal liver, but its sensitivity and specificity are low. Ultrasonography is one of the routine examinations of liver, the sensitivity of which is 70% ~ 90%. But it is lack of quantitative evaluation index[4].

5. Application of Multimodal Image Fusion Technology in Accurate Detection of Hepatic Fibrosis

5.1 Principle of multimodal image fusion technology

Multi-modal image fusion techniques commonly used in clinic include image registration, spatial fusion and temporal

fusion. Image registration is the premise of image registration, and spatial fusion is the ultimate goal of image registration. The spatial registration of multimodal images mainly includes space transform, direction transform and translation transform. Orientation transformation is to match the images in different directions in the original image so that they have the same spatial position. Translation transformation is to shift the images in different directions in the original image to keep the relative position in space.

5.2 Application of fusion technique in liver fibrosis grading

At present, the grading standard of liver fibrosis is mainly based on the histological structure of the liver and the deposition of fibrous connective tissue. With the development of research in recent years, more and more imaging techniques have been used in liver fibrosis grading. Studies have shown that single-modal imaging is not effective in assessing liver fibrosis, but multi-modal image fusion can provide clinicians with more accurate diagnostic results. The Gavriel-Roger et al. Study found that multiple image fusion techniques can be used to assess the extent of liver fibrosis in patients with cirrhosis. Multi-modal image fusion can improve the accuracy and efficiency of diagnosis, and provide more accurate classification of liver fibrosis for clinicians.

5.3 Application of Fusion Technique in Localization of Hepatic Fibrosis

At present, the imaging techniques commonly used in the diagnosis of liver fibrosis are mainly imaging examination, including liver elastography, liver biopsy and contrast-enhanced ultrasound. However, there are limitations in different methods. For example, because of the low spatial resolution, it is difficult to evaluate the extent of liver fibrosis quantitatively. Therefore, the accurate diagnosis of liver fibrosis based on the complementary advantages of different imaging techniques has become a hot spot. Multi-modal image fusion can improve the diagnostic accuracy of liver fibrosis by means of elastic imaging, liver biopsy and contrast-enhanced ultrasound[5].

6. Conclusion

Multimodal image fusion provides a new diagnostic model for clinical diagnosis. The application of multimodal image technology to the detection of liver fibrosis can effectively improve the diagnostic efficiency, but its clinical application still faces some problems: (1) There are many kinds of multimodal image fusion methods, and there is no unified standard; (2) The multimodal image fusion methods rely on a variety of standards, and there is no unified standard, and there is no unified standard; (3) The image quality after fusion is unstable, which affects the diagnostic efficiency to some extent. Therefore, we need to further explore the application value and problems of multimodal fusion in liver fibrosis, and develop a more standardized fusion method and standardized detection process.

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