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Short Commentary

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A primer on artificial intelligence combined with medical images in sports

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Abstract

Artificial Intelligence (AI) based on medical images has shown great potential in disease diagnosis and treatment. In the field of sports, AI combined with medical images has great potential. Using the methods of literature review and logical analysis, this paper examines the development history and current situation of AI+ medical images, and preliminarily explores its application in the field of sports. It is found that there are realistic challenges such as model generalisation ability, interpretability, data island and privacy protection. In future work, it is necessary to introduce more new technologies and theories, build an efficient and universal medical image AI, and actively promote the practical application of AI+ medical image in sports, especially sports injuries.

Introduction

Medical image artificial intelligence refers to the technology of analyzing and processing medical image data by using computer vision technology and deep learning algorithms to assist doctors in making disease diagnosis and treatment decisions. The rapid development of Artificial Intelligence (AI) technology is profoundly changing the medical and health field. Among them, the combination of AI and medical images is particularly eye-catching. Medical imaging has unique advantages in the diagnosis of some diseases, such as pulmonary nodules, pancreatic cancer [1,2] and cardiovascular diseases and so on [3]. This technology is becoming more and more popular in medical institutions at all levels, and it has also greatly improved the diagnosis and treatment level of the entire medical industry. Artificial intelligence can not only help doctors diagnose and treat more accurately, improve the quality and efficiency of medical care, but also find potential disease risks and treatment schemes by analyzing a large number of medical data, so as to prevent and intervene the occurrence of diseases in advance. The application of AI-based imaging has covered clinical stages such as lesion detection, pathological diagnosis, radiotherapy planning and postoperative prediction [4,8], and AI medical imaging diagnosis has emerged in many fields, showing great application potential.

In the field of sports, the application of AI medical imaging has just started, but its important value has begun to appear. In sports, the physical condition of athletes is directly related to their performance and career. It is very important for athletes to timely and accurately diagnose sports injuries and formulate personalized treatment and rehabilitation programs. With its high efficiency and accuracy, AI medical images show broad application prospects in sports injury diagnosis, sports performance analysis and preventive medical intervention.

Application of artificial intelligence in medical imaging

Development of AI combined with medical images

Since John McCarthy, an American scientist, put forward the concept of Artificial Intelligence (AI) in the 1960s, AI technology has gone through the stages of reasoning, knowledge, machine learning and deep learning. With the evolution of AI technology from machine learning to deep learning, its application in the field of machine vision has been rapidly developed and widely popularized. Medical images, because of their high similarity with natural images, have attracted the attention of many researchers and promoted their early research in this field. Traditional medical imaging department, as one of the important clinical departments in the hospital, is responsible for various imaging examinations of patients, such as X-ray, CT and MRI, to help doctors make diagnosis and treatment decisions. The introduction of artificial intelligence technology has brought many innovations and improvements to the traditional medical imaging department. Since 2015, with the continuous improvement of deep learning computing power and algorithms, the fusion of medical images and AI has shown a rapid development trend and is growing. Since 2016, the technology based on medical imaging and AI has been gradually applied to the screening of diseases such as pulmonary nodules [9] and diabetic retinopathy [10]. At present, the combination of medical imaging and AI has been extended to almost all parts and organs that can be touched by imaging equipment, and its application fields include but are not limited to image processing, auxiliary recognition, image diagnosis and many other aspects [11,12].

Current situation of AI combined with medical images

In terms of image processing, MR examination takes a long time, so it needs the high cooperation of the subjects, otherwise it is easy to appear motion artifacts. In order to speed up MR scanning, it is necessary to improve the hardware performance and optimize the imaging sequence. However, the progress of these technologies is limited by the decline of image quality caused by the increase of human physiological tolerance and acceleration times. Fortunately, the image super-resolution and recombination technology of deep learning is expected to improve the image signal-to-noise ratio while reducing the MR scanning time. For CT examination, reducing radiation dose is usually achieved by reducing tube current or tube voltage, but this will increase image noise. The traditional iterative reconstruction method has limited effect on improving image noise, while the image denoising technology based on deep learning can significantly improve the quality of ultra-low dose CT images and achieve good consistency among observers.

In terms of auxiliary identification, accurate segmentation of target organs and lesions is very important for radiotherapy planning, which can provide quantitative information on the existence of lesions. With the development of imaging technology and AI technology, AI segmentation technology is based on big data analysis, which has higher robustness, speed, accuracy and generalization ability compared with traditional methods. AI has also been applied in the challenging task of blood vessel identification and segmentation. For example, Wang et al. [13] combined semi-2D U-Net and 3D U-Net to improve the performance of cerebrovascular segmentation model. AI can also be used to identify vascular diseases, such as aneurysms, calcification of wall and stenosis of lumen. Accurate segmentation and recognition is the basis of improving the efficiency of image diagnosis and conducting rigorous scientific research.

In terms of image diagnosis, it includes the detection and identification of lesions and the judgment of benign and malignant. Because of the phenomenon of "different shadows of the same disease" and "different shadows of the same disease" in the image, imaging doctors rely on personal experience to judge the lesions, which may lead to deviation from pathological results or observers. AI analyzes medical images through its perception and cognitive ability, extracts key information, and provides support for inexperienced imaging doctors, thus improving the efficiency of reading films. In addition, integrating a large number of image data and clinical information through machine learning and training AI system to make it have the ability to diagnose diseases will help reduce the missed diagnosis rate of imaging doctors. Compared with the existing working mode of imaging department, AI system can maintain an efficient and continuous working state, free from external factors, which is helpful to improve the efficiency and quality of imaging doctors' reading. During the COVID-19 epidemic, chest X-ray or CT combined with AI technology played an important role in disease classification and prognosis prediction [14]. This shows that AI can not only assist in promoting the diagnosis and treatment process of conventional diseases, but also respond quickly to public health emergencies, which is helpful to improve the work efficiency of imaging doctors in an emergency and establish an early diagnosis, monitoring and prognosis evaluation system for new diseases.

Application of AI combined with medical images in sports

Application of AI combined with medical images in sports injury diagnosis

Sports injury is a common problem for athletes, and its timely and accurate diagnosis is very important for treatment and rehabilitation. However, due to the huge amount of image data and complex damage characteristics, it is difficult to achieve comprehensive and efficient image information analysis simply by relying on doctors' experience. AI medical image diagnosis technology can automatically identify the injury features in images, such as fractures and soft tissue injuries, and classify and locate them, thus significantly improving the accuracy and efficiency of diagnosis. In addition, due to the limitation of professional knowledge and experience, doctors may miss diagnosis and misdiagnosis in the process of diagnosis, especially in primary medical institutions with relatively scarce medical resources. AI medical image diagnosis can be used as an auxiliary tool to help doctors identify easily overlooked injury details and provide diagnostic suggestions, thus reducing the risk of missed diagnosis and misdiagnosis and improving the diagnostic level of primary medical institutions. In formulating individualized treatment plan, the treatment of sports injury should be based on the injury and individual differences of athletes. AI medical imaging diagnosis can analyze the imaging characteristics, clinical symptoms, past medical history and other multimodal data of athletes, provide comprehensive diagnostic information for doctors, assist in formulating personalized treatment and rehabilitation programs, and improve the treatment effect.

Application of AI combined with medical images in athletes' health management

AI medical image diagnosis has multiple application values in the field of sports injuries. First of all, through the analysis of the historical image data of athletes, AI can identify the risk factors that may lead to sports injuries, such as abnormal anatomical structure and sports mode defects, so as to realize early warning of injuries. This function is of great significance for implementing preventive intervention measures and reducing the incidence of sports injuries. Secondly, AI medical image diagnosis is not limited to injury diagnosis, but also can analyze athletes' sports performance. With the analysis of sports video and other image data, AI can evaluate athletes' technical movements, reveal potential efficiency loss and injury risk, and provide scientific basis for optimizing sports performance. Finally, in the rehabilitation stage of athletes after injury, AI medical imaging diagnosis can regularly evaluate the rehabilitation process, monitor the injury healing status and functional recovery level, and adjust the treatment plan in time according to the evaluation results, so as to ensure the rehabilitation effect and athletes' back in the game as soon as possible.

Challenges in the application of AI combined with medical images in sports

Model generalization ability

Generalization ability refers to the ability of the model to maintain good performance on unseen data, which is very important to ensure the reliability and effectiveness of AI system. The generalization of AI model is very important for its clinical application of sports injury [15]. To put it simply, the generalization of the model is reflected in two aspects: (1) reproducibility, which reflects the performance of the prediction model on similar distribution data; (2) Mobility, reflecting the performance of the prediction model on different distributed data [16]. The difference here refers to its ability to accurately analyze and explain new and unknown injury cases among different patients, imaging modes (such as MRI and CT scanning) and sports injury types. In order to improve the accuracy and generalization ability of AI model in identifying and predicting sports injuries, a large number of diverse and representative data sets must be used for training. If the training data is limited to specific types of sports injuries or specific people, the generalization ability of the model will be limited. In addition, the annotation of medical image data needs to be highly professional and accurate, and any inconsistency or error in the annotation process will directly affect the learning effect and generalization ability of the model. When constructing AI model, improper feature selection may cause the model to fail to capture the key information of damage, and then affect its generalization ability. In view of the fact that the types and severity of sports injuries may change with time, environment and individual differences, AI combined with medical images model should have the ability to adapt to these changes to ensure stable performance in different situations.

Interpretability

Interpretability plays a vital role in AI model, which requires the model to provide a clear and transparent basis for its decision-making. In the medical field, especially in the process of diagnosis of sports injuries, doctors and patients have a common need to understand how the AI model draws the diagnosis conclusion. This understanding helps to build trust in the model and promote medical decision-making based on sufficient information. However, many cutting-edge AI models, such as deep learning neural networks, are often regarded as "black boxes" because of the complexity of their internal structures and the nonlinearity of their relationships. This opacity makes their decision-making process difficult to be intuitively understood and explained, thus posing a significant challenge in clinical application. Specifically, the non-interpretability of models may weaken doctors' confidence in the diagnosis results of AI, and then hinder the wide application and adoption of these models in actual medical scenarios.

In addition, the mining of medical image biomarkers is almost entirely driven by data, and the biomarkers reflecting the occurrence and progress of sports injuries are explored by deeply mining the relationship between image characteristics and sports injury events. However, when there is a lack of biological interpretability, the medical image AI system is difficult to be applied in practice [17]. Therefore, exploring the biological significance of medical image AI model will be a key step for its independent auxiliary clinical diagnosis and treatment. Because the traditional manual features of imageology have a complete formula and definition, which is closely related to the semantic features of lesion description in medical imaging diagnostics, it can be used to approximately explain the potential biological significance of imageology features.

Data islanding and privacy protection

Athletes' injury data involves personal privacy, and its collection and use must comply with relevant laws and regulations. How to make full use of medical image data while protecting the privacy of athletes is an important challenge for AI medical image diagnosis. In the past decade, Artificial Intelligence (AI) has shown great potential in achieving efficient and large-scale social applications, with the surge of data, the progress of algorithms and the popularity of high-performance computing devices. In the field of sports, AI-based system has attracted much attention because of its great potential value in assisting the diagnosis and treatment of sports injuries, and has become a research focus of academia and industry. However, medical image data presents a significant feature of long tail effect, that is, except for a few common high-risk diseases, which have relatively sufficient data, most diseases have relatively small available data. Medical image data often involve athletes' personal information, including but not limited to their identity and medical history, and these data resources are often stored in the image storage systems of various departments of different medical institutions, lacking effective interconnection mechanisms, thus forming many isolated "data islands" [18]. With the continuous improvement of relevant laws and regulations and the increasing public awareness of data privacy protection, it is increasingly difficult to integrate information scattered in various "data islands" into a centralized big data resource library. This challenge not only stems from the legal and technical constraints, but also reflects the rising demand for social ethics and privacy protection, which further aggravates the complexity and difficulty of data integration [19]. Although there are some relevant laws and regulations to regulate the use of medical image data, in practice, the abuse of such data is still repeated, and data privacy and security issues are still the main obstacles to the application of medical image Artificial Intelligence (AI) technology in the field of sports injury diagnosis and treatment.

Conclusion

Although AI medical image diagnosis is in the initial stage in the field of sports, its high efficiency and accuracy are in line with the high standard of health management in sports. In the future, the application of AI medical image diagnosis in sports field will develop towards multimodal fusion and intelligence. Mainly for the following aspects: (1) Develop a deep learning model specially designed for medical images to overcome the differences between medical images and natural images in simplicity and dimensional complexity. The existing models, such as ResNet and GoogleNet, are not satisfactory in medical images, so it is necessary to optimize the model structure and algorithm. (2) Actively explore and apply advanced technologies and methods in the field of machine vision, such as transfer learning, weak supervised learning and unsupervised learning. However, when applying these methods to medical images, it is necessary to fully consider the unique properties of medical images to ensure that they can surpass the traditional strongly supervised learning methods in effect. (3) Committed to establishing a standardized and standardized medical image database, which is the key to promote the development of AI+ medical images in the sports field. At present, the lack of open database resources of medical images limits the performance of the pre-training model. Therefore, large research institutions and hospitals should work together to create high-quality medical image data sets, which will provide a solid foundation for the development of AI combined with medical images technology. To sum up, with the technical progress and application accumulation, AI medical imaging will definitely bring revolutionary influence to athletes' injury prevention, sports performance improvement and health management optimization, and promote the development of sports to a higher level.

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