

Clinical Validation of Intelligent Recognition of Internal Orifice of Anal Fistula and Surgical Path Planning Assisted by Artificial Intelligence

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Abstract: Clinical validation results of the application of artificial intelligence in identifying the internal opening of an anal fistula and planning surgery are presented in this paper. Artificial intelligence can find the internal opening of an anal fistula and suggest a surgical route for some cases; it has been verified that it is accurate, safe and effective compared with traditional methods. The results show that artificial intelligence can accurately find the internal opening of an anal fistula and effectively plan a surgical route; thus, it can reduce surgical trauma and complications and provide a new technical way and clinical foundation for the precise treatment of anal fistula surgery.

Keywords: artificial intelligence; internal opening of anal fistula; intelligent recognition; surgical pathway planning; clinical validation

1. Introduction

Anal fistula is a common gastrointestinal tract disease. Traditional surgery depends on the doctor's experience, and if the internal opening position is incorrect, there will be surgical failure and recurrence. With the progress of artificial intelligence technology, many applications have begun to emerge in medical image recognition and other areas[1]. Artificial intelligence can be used to find the internal opening of anal fistulas and plan the surgical route more accurately; therefore, the surgery will be safer. Clinical validation will be carried out in this paper to evaluate the application value of artificial intelligence in this field and determine whether it can actually improve treatment effects after anal fistula surgery.

2. Research Background and Objectives

2.1 Characteristics of Anal Fistula Disease

Anal fistula is a relatively common disorder of the colon. It is mainly caused by the rupture or incision and drainage of the surrounding abscess of the anal canal and rectum, and it fails to heal properly. The first is the formation of an abnormal fistula tract between the anal canal, rectum and perianal skin. The internal opening is at the place of the original lesion, generally near the anal verge. It is a chronic, relapsing disease that is difficult to treat effectively. If not dealt with promptly and uniformly, it may result in a serious condition called complex fistula, which has many branch fistulas and involves important tissues such as the perianal sphincters; this will severely impair the patient's anal control and defecation function and quality of life. Anorectal infection and other reasons may be associated with the occurrence of an anal fistula. There are many divisions in the clinic, and complex anal fistula is one of the most difficult to diagnose and treat because its course is hidden, and the internal opening cannot be found.

2.2 Limitations of Traditional Surgical Methods

The general method for opening the internal opening and dealing with the fistula tract in traditional surgery for anal fistulas is based on clinical experience. The two are fistula incision and thread therapy. There are some defects. The position of the inner opening is generally known from probe exploration, digital inspection and other auxiliary images. It is likely to be affected by the doctor's experience and the hiding of the lesion, so its location and completeness of removal may be inaccurate, and thus the risk of postoperative recurrence will be high[2]. Surgical path planning does not have an exact quantitative basis and is based on empirical operation; thus, it may damage the normal tissues and anal sphincter in the perianal area, leading to anal incontinence and other problems. At the same time, traditional surgery cannot comprehensively check all the complex branches of the fistula tract, the operation time is long, the postoperative recovery period is extended, and the ideal state of clinical diagnosis, treatment efficacy and safety is not achieved.

2.3 Expected Research Goals

The purpose of this paper is to investigate the clinical application value of artificial intelligence technology in the intelligent identification of the internal opening of an anal fistula and planning of surgical routes to address the shortcomings

of the traditional diagnosis and treatment model[3]. By building an artificial intelligence-assisted system for the diagnosis and treatment of anal fistulas, it is possible to accurately determine the location of the internal opening, fistula tract course and branches of anal fistula to improve the accuracy and efficiency of lesion location. According to the system, customised surgical path planning schemes can be developed to optimise the course of surgery, reduce damage to normal tissues and the anal sphincter in the perianal region, and decrease the occurrence and recurrence of postoperative complications.

Table 1. Core research objectives and expected value

Research dimension	Specific objectives;concrete goals	expected clinical value
Smart positioning	Accurately identify the internal orifice, the course of the fistula, and its branches.	Improve positioning accuracy and efficiency
Scheme planning	Develop individualized surgical pathways	Optimize the surgical procedure, reduce normal tissue damage
improved	Reduce postoperative complications and recurrence rate	Protect anal sphincter function and improve prognosis.

3. Principles of Artificial Intelligence Technology

3.1 Image Recognition Algorithm

The foundation of artificial intelligence-assisted identification of the internal opening of an anal fistula is a deep learning image recognition algorithm based on convolutional neural networks. A few convolutional layers and pooling layers are employed to extract features from ultrasound and magnetic resonance images of anal fistulas, obtain necessary information such as the location of the internal opening, path and branches of the fistula tract, etc., and eliminate noise and irrelevant tissue images in the picture. With the help of transfer learning technology, an algorithm can be used to recognise many kinds of images of anal fistulas and improve the detection accuracy of hidden internal openings and complex branch fistulas[4-6].

3.2 Data Model Construction

The Construction of the Data Model is based on the core support of clinical anal fistula case data, and all kinds of imaging data, clinical diagnosis and treatment information, surgical pathology results, etc., are integrated to build a standardised data set. The dataset contains cases of simple anal fistula and complex anal fistula, various types of imaging data such as ultrasound and magnetic resonance, as well as corresponding annotations of the location of the internal opening, fistula tract course and surgical plans. Clean up and normalise the data; some of the invalid or irregular data have been removed to ensure that the dataset is accurate and representative. Based on the labelled data, train the artificial intelligence recognition model and the path planning model. Cross-validation and model optimisation were carried out to increase the recognition accuracy and planning rationality of the model.

4. Clinical Validation Design

4.1 Case Selection Criteria

Clinical validation should meet the following criteria for case selection: patients should have the diagnostic criteria for anal fistula, include both simple and complicated cases, be aged between 18 and 65 years old, not have severe heart, lung, liver, kidney, etc., organ dysfunction, show normal coagulation function, and be free from other surgical contraindications. Exclude patients with coexisting anal perianal malignant disease, active inflammatory bowel disease and those who have had surgery for an anal fistula but the lesion has not fully healed. All the included cases have been imaged, the quality of these images meets the recognition requirements for the artificial intelligence system, complete patient clinical data are available, and postoperative follow-up can be carried out.

4.2 Group Control Method

A Randomised Controlled Trial Design was chosen. Randomly assign the included cases to either the observation group or the control group. The baseline characteristics of the two groups were similar; that is, age, sex, type of anal fistula and duration of illness did not differ significantly. The observation group was helped by artificial intelligence to find the internal opening and plan a surgical route, and then surgery was performed according to the plan generated by the system; the control group received traditional surgery, and physicians decided where to place the internal opening and how to operate based on their own clinical experience[7]. Both groups of surgery were carried out by the same team of experienced doctors with extensive experience in the diagnosis and treatment of anal fistulas, and the postoperative care, anti-infection treatment, etc., were all the same; thus, non-experimental factors have been excluded from the validation results to ensure the scientificness

and objectivity of the clinical validation results.

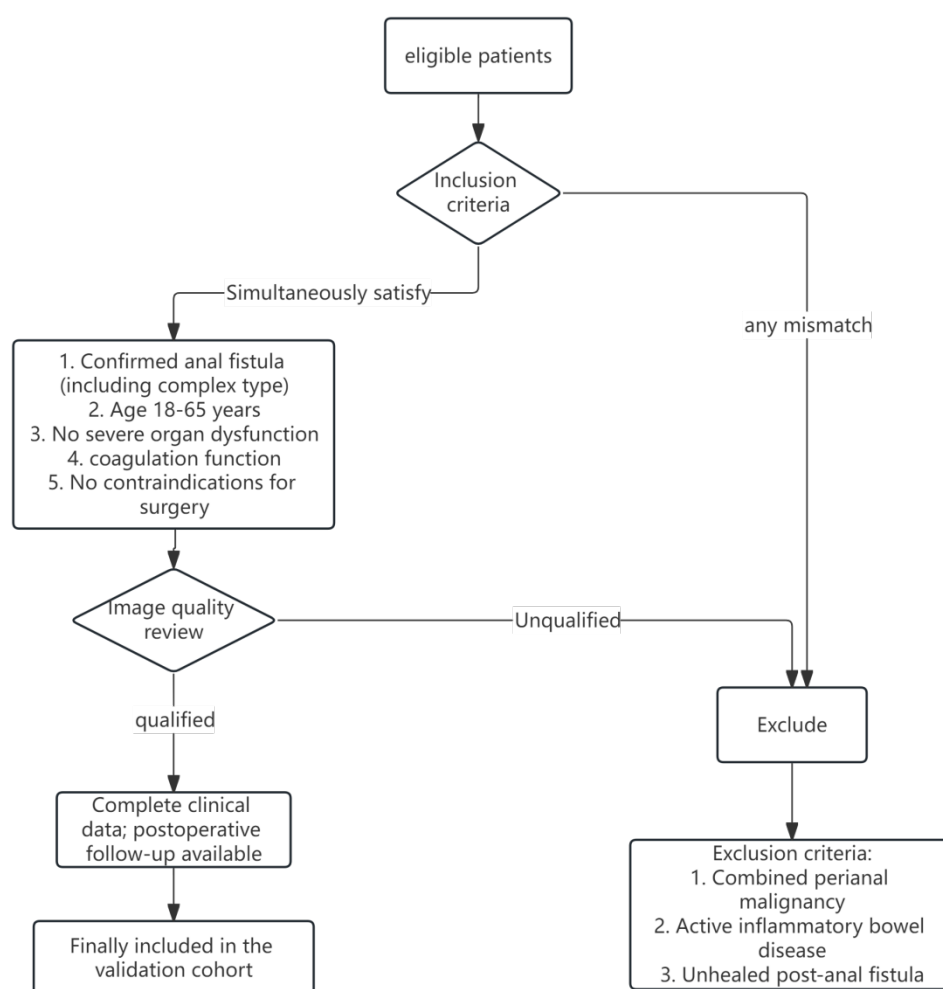


Figure 1. Clinical validation of the AI-assisted system for anal fistula—Case selection flowchart

5. Result Analysis

5.1 Accuracy of Internal Opening Recognition

According to the results of the clinical validation, the accuracy of the internal opening recognition for the observation group was significantly higher than that of traditional empirical recognition in the control group. Using many kinds of pictures and models, artificial intelligence can find the place of the inner opening accurately. It is quite good at detecting small concealed openings inside and various types of anal fistulas with multiple openings. The results of identification are in good agreement with the findings of surgical pathology. The control group will be led by the experience of doctors, and therefore may fail to find missed diagnoses in internal openings and deviations in position. The accuracy rate will be lower if the doctor is inexperienced or the disease is very serious.

5.2 Rationality of Surgical Path Planning

The rationality rate of artificial intelligence-assisted surgical path planning in the observation group was much higher than that of the traditional empirical planning method in the control group. According to the characteristics of the patient's lesion, the anatomy of the perianal area and the need to protect the sphincter, an artificial intelligence system can generate a personalised surgical plan. It can precisely avoid the important tissues in the perianal area and clearly show the range of fistula removal and the key points of surgical operation[8]. The former Path planning method is not accurate; it will likely have deviations in the path and cause damage to the tissue; it is also irrational. According to clinical evaluation, an optimised surgical plan can be obtained with the help of artificial intelligence to reduce the blindness of surgery, improve the

scientificness and feasibility of the surgical route, and provide strong support for effective and safe surgery.

6. Conclusion

Based on the clinical validation study, artificial intelligence-assisted intelligent identification of the internal opening of an anal fistula and surgical path planning have shown good results. They can improve the accuracy of the identification of internal openings and the rationality of surgical path planning to enhance the results of surgery. However, there are still some deficiencies at present, such as the application effect of the technology in complex cases needs to be improved further. In the future, more research investment will be needed to continuously improve the artificial intelligence algorithms and models, and multi-centre, large-scale clinical studies will be carried out to promote the widespread application of this technology in clinical practice and benefit more patients with anal fistulas.

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