Journal of Clinical and Nursing Research, 2026, Volume 10, Issue 1
http://ojs.bbwpublisher.com/index.php/JCNR
Online ISSN: 2208-3693
Print ISSN: 2208-3685

Application of Whole Slide Imaging Technology in Clinical Pathological Diagnosis

Zhenjie Wang, Jianguo Huai*

Department of Pathology, Wuhu No.1 People's Hospital, Wuhu 241000, Anhui, China

**Author to whom correspondence should be addressed.*

Copyright: © 2026 Author(s). This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY 4.0), permitting distribution and reproduction in any medium, provided the original work is cited.

Abstract: Whole Slide Imaging (WSI) technology, as a revolutionary digital technology in the field of pathology, is gradually changing the traditional clinical pathological diagnosis model. By converting traditional glass pathological sections into complete digital images through high-resolution scanning, it provides a new method for pathological diagnosis. Based on this, this paper studies the application of WSI technology in clinical pathological diagnosis, elaborates on its application value, analyzes the current application status, and proposes corresponding application countermeasures, aiming to provide reference for the standardized and popularized development of this technology in clinical pathological diagnosis.

Keywords: Whole slide imaging (WSI) technology; Clinical pathological diagnosis; Application value; Current status; Application countermeasures

Online publication: Feb 9, 2026

1. Introduction

With the rapid development of digital pathology, Whole Slide Imaging (WSI) technology has emerged. It converts traditional glass pathological sections into complete digital images through high-resolution scanning, opening a new chapter for pathological diagnosis work. This technology not only completely retains the original information of pathological sections but also breaks the time and space limitations of traditional optical microscopes with its digital, storable, and easily shareable characteristics [1]. Against the background of precision medicine and "Internet + Healthcare", WSI technology has shown enormous potential in improving the quality and efficiency of pathological diagnosis, optimizing the allocation of medical resources, and promoting medical education and scientific research. Therefore, this paper systematically sorts out the application value of WSI technology, objectively analyzes its current application status and existing bottlenecks, and discusses feasible application countermeasures accordingly, aiming to provide theoretical reference and practical ideas for promoting the deeper and wider application of this technology in clinical pathological diagnosis in China.

2. Application value of whole slide imaging technology in clinical pathological diagnosis

2.1. Conducive to improving diagnostic accuracy

Whole Slide Imaging technology achieves diagnostic upgrading through high-precision optical imaging systems, specific staining technologies, high-resolution digital conversion, and artificial intelligence-assisted diagnosis. The optical system ensures image clarity; technologies such as HE staining and immunohistochemistry make lesion areas easy to distinguish; digital imaging converts sections into efficiently processable digital signals; AI technology automatically identifies lesions through deep learning. Multiple links collaborate to lay the foundation for diagnostic accuracy [2]. In contrast, WSI technology can convert entire pathological sections into high-resolution digital images, allowing doctors to observe images comprehensively and multi-dimensionally on computer screens. Through image browsing software, doctors can easily zoom in, zoom out, and pan images without missing any subtle lesion features.

2.2. Conducive to conducting teleconsultation and academic exchange

In terms of teleconsultation, WSI technology plays an indispensable key role. By digitizing pathological sections and relying on high-speed and stable network transmission technology, these digital sections can be instantly transmitted to experts around the world. Experts can carefully observe and in-depth analyze digital sections anytime and anywhere through terminal devices such as computers and tablets, just like viewing pathological sections on-site [3]. The emergence of this teleconsultation model has greatly broken the time and space constraints of traditional consultation methods, providing patients with more convenient and efficient medical services. For example, when a hospital in a remote area encounters difficulties in diagnosing rare lymphoma, it can digitize and upload sections to a teleconsultation platform through this technology, and link with experts in big cities to complete accurate diagnosis and treatment plan formulation within hours. This effectively breaks the regional barriers of medical resources and improves the fairness and accessibility of medical services.

2.3. Conducive to promoting teaching and scientific research

In medical education, WSI technology has created a digital learning database, breaking the form of relying on a few physical specimens. Students can freely view digital samples of common and rare cases using computer equipment, and use tools such as zooming and annotation to independently explore the nature of abnormalities, so as to enhance their ability to observe and solve problems [4]. From a scientific perspective, such a large number of digital samples can provide basic data for cancer research. For example, scientists can further explore the morphology, growth rate of cancer cells and their relationship with surrounding tissues by viewing digital samples, which can be used as a reference for early diagnosis and precise treatment of cancer; in drug development research, images of the experimental group and control group in clinical trials can be compared to better understand the effects of drugs on biological cells and possible adverse consequences, accelerating the research and development process of new drugs and improving the success rate.

3. Current application status of whole slide imaging technology in clinical pathological diagnosis

3.1. Limited application scope

At present, the application scope of WSI technology in clinical pathological diagnosis is still relatively

limited. Although the technology has been recognized to a certain extent in the pathological community, its main application scenarios are concentrated in the diagnosis and analysis of a small number of difficult cases and typical teaching cases, and it has not been widely integrated into every link of daily pathological diagnosis work [5]. At the technical specification level, there is a lack of unified industry standards. There are differences in image acquisition parameters, storage formats, transmission protocols, etc. The performance of equipment from different manufacturers varies, and the quality and compatibility of digital sections are difficult to guarantee, which hinders the wide application of the technology.

3.2. Technical and equipment issues

Slow scanning speed is a prominent problem. Scanning a single section in high-resolution mode takes 10–30 minutes, which is difficult to meet the needs of processing a large number of sections in pathological laboratories and affects the timeliness of diagnosis. Image quality is affected by sample preparation and equipment performance. Uneven section thickness, poor staining, or defects in the optical system can easily lead to blurred digital sections, artifacts, and other problems, reducing diagnostic value. Data storage and transmission face challenges. A single high-resolution digital section can reach tens of GB to hundreds of GB, requiring large-capacity storage equipment. Moreover, network bandwidth limitations lead to slow transmission, increasing management costs and complexity [6]. When existing computer hardware and software process large-scale pathological image data, there are problems such as slow operation speed and limited analysis functions, which are difficult to meet the clinical requirements for real-time and accurate data processing.

3.3. Doctors' habits and acceptance

Doctors' reliance on microscope diagnosis stems from the intuitive operational experience accumulated during long careers. Operations such as fine-tuning the focal length and moving sections can quickly focus on regions of interest. This traditional model has been integrated into their work thinking and skill system. During technology promotion, doctors' acceptance is not high. On the one hand, they are worried that digital sections may affect image authenticity after conversion and processing, leading to the omission of pathological information; on the other hand, some doctors have weak computer foundations and face difficulties in learning new operational skills, reducing their willingness to accept [7]. It is necessary to change doctors' concepts through strengthened publicity and training, making them recognize the advantages and complementarity of digital sections; at the same time, carry out systematic training covering computer basics, software operations, etc., to help doctors master new technologies and improve their application confidence and capabilities.

4. Application countermeasures of whole slide imaging technology in clinical pathological diagnosis

4.1. Consolidate hardware and software foundations and build a stable and efficient digital platform

The application of technology is inseparable from a solid foundation. In the application of WSI technology, it is necessary to solve the problems of hardware setup and software construction to promote the effective application of the technology. First, select and configure scanning equipment. According to the workload of pathological examination in the hospital (such as the number of pathological sections per day), inspection types (such as

smears, biopsy sections, surgical frozen sections, etc.), and diagnostic accuracy requirements, select equipment supporting combinations with different speeds and analysis capabilities. For large-scale testing in big cities or routine disease inspection and diagnosis, high-throughput rapid scanning machines can be selected first; but at the same time, high-quality scanning instruments can be prepared for the processing of difficult cases and scientific research; for hospitals in small cities, start with a medium-speed scanning machine and gradually expand. The key is to ensure that the resolution of scanned images meets the diagnostic accuracy requirements, avoiding the risk of misdiagnosis due to poor scanned image quality. Second, upgrade storage and network systems. Given that each individual WSI image file is very large (several GB or even dozens of GB), how to efficiently store, manage, and quickly access massive information is crucial [8]. Solutions include: building an efficient and scalable data server and Storage Area Network (SAN) system; implementing hierarchical storage, placing images requiring current diagnosis on high-speed storage media, and transferring previous data to relatively cheap low-speed storage media. In addition, it is necessary to improve the hospital's internal network speed to ensure that pathologists do not experience delays or pauses when browsing digital sections on computers, with an experience close to observing with a microscope [9]. Third, integration and interoperability of software systems. Digital sections should not be information islands. The WSI information system should be automatically integrated into the hospital's Hospital Information System (HIS), Laboratory Information System (LIS) of the inspection system, and Pathology Information System (PIS) database. The software should have a user-friendly operation interface, a large number of image analysis functions (such as calculating length, area, cell count, etc.), and support standard formats (such as DICOM) and databases, laying the foundation for future data research and the application of artificial intelligence [10].

4.2. Optimize diagnostic workflow to achieve a balance between efficiency and safety

The introduction of WSI technology is not simply replacing microscopes with computer screens, but requires optimizing and adjusting the entire pathological diagnosis workflow. First, reset the diagnosis and review processes. Strategies such as "digital first, then work" and "using both digital and microscope" can be implemented. For general pathological examinations, junior doctors can immediately make judgments on digital sections, and senior doctors can verify and confirm them online to improve review efficiency. For complex problems, digital sections can be fully used to gather many experts for centralized or decentralized remote discussions to pool ideas. Second, strengthen quality control links. Before section scanning, a strict quality control position should be set up to inspect the quality of prepared glass sections (such as depth, thickness, presence of folds, presence of stains, etc.), and only qualified sections can participate in the scanning process. After scanning, special personnel should check the digital photos to see if they are fully covered and free of blurriness. These two quality control steps are the first pass to ensure the accuracy of digital diagnosis [11].

4.3. Carry out relevant technical training to improve doctors' operational capabilities

Training doctors on WSI technology is an important measure to promote the wide application of the technology. Medical institutions should attach importance to technical training, introduce WSI technology training into the continuing education and training system for doctors, and formulate comprehensive and systematic training plans. The training should include two stages: theoretical knowledge teaching and practical operation, to ensure a comprehensive overall understanding of this new technology, familiarity with its methods, means, and principles [12]. Theoretical training should explain its scientific mechanism, advantages, applicable scenarios, and advantages compared with conventional methods, aiming to help doctors clearly understand the application

value and eliminate doubts; in the practical operation stage, there should be independent venues and equipment, and professional technical personnel should personally guide the operation. Through the application of specific cases, doctors can familiarize themselves with scanning, processing, analysis, and other steps. Practical operation is the most important stage. Medical institutions should independently set up a training venue and equipment to ensure that doctors have sufficient experience opportunities. Technical personnel composed of experts provide real-time guidance and training to assist doctors in mastering the use and skills of image acquisition equipment and image optimization software. Doctors can personally experience the shooting, image processing, recognition, interpretation, and other skills in practical applications, thereby improving their ability to conduct pathological evaluation on the digital platform. A series of practice cases can be designed to help doctors gradually accumulate application experience and proficiently master the skills of using the new technology [13].

4.4. Expand diversified application scenarios and release the great potential of digital pathology

The value of WSI technology is far more than simulating microscopes, and its extended applications should be actively expanded. First, develop telepathology and consultation. Establish regional pathological diagnosis centers to provide real-time remote diagnosis services for medical cooperation member units through the Internet, narrowing the regional differences in medical quality. Second, promote teaching and scientific research innovation. In terms of teaching, a standard digital section teaching resource library can be established to allow students to learn anytime and anywhere. In the field of scientific research, a large amount of WSI data is a valuable resource, which can be used for quantitative research on disease morphology, mining of disease prognostic indicators, and providing huge data support for the development and training of artificial intelligence algorithms [14]. Third, introduce artificial intelligence-assisted diagnosis. AI can automatically identify tumor locations in digital images, perform pathological classification (such as Gleason scoring), calculate the number of favorable cells, etc., becoming a “partner” of physicians, improving diagnostic consistency and efficiency, and reducing physicians’ repetitive labor. Pathology departments should adopt an open attitude to evaluate and verify the effectiveness of AI tools for clinical applications together with AI development teams [15].

5. Conclusion

In summary, Whole Slide Imaging technology has brought innovations to clinical pathological diagnosis, playing a key role in improving diagnostic accuracy, assisting teleconsultation and academic exchange, and promoting teaching and scientific research. In practical work, further study should focus on consolidating infrastructure, optimizing work processes, conducting systematic training, expanding application scenarios, and establishing unified standards to ensure diagnostic reliability, so as to break through the bottlenecks of technology application and release its potential in the field of pathological diagnosis. With the deepening of technological research and development, this technology should be continuously optimized and popularized to further improve diagnostic efficiency and medical quality, promote the normalization of teleconferences, and assist the development of medical teaching and research.

Disclosure statement

The authors declare no conflict of interest.

References

[1] Zhou G, Yang Y, Yang Y, et al., 2024, Research on the Pathological Diagnostic Value of Respiratory Optical Coherence Tomography in Lung Cancer. Chinese Journal of Respiratory and Critical Care Medicine, 23(05): 333–339.

[2] Ji S, Liu L, Peng X, et al., 2024, Impact of Dual-Source CT High-Pitch Flash Scanning Technology on Image Quality and Radiation Dose of Coronary CT Angiography in Patients with High Heart Rate. Chinese Journal of Public Health Engineering, 23(01): 106–108.

[3] Liu H, 2023, Effect and Clinical Value of Spiral CT Scanning Technology in the Clinical Diagnosis of Patients with Pulmonary Nodules. Marriage and Health, 29(09): 31–33.

[4] Yang Y, Yang H, Wang F, 2023, Clinical Value of MRI DWI Sequence Combined with Dynamic Contrast-Enhanced Scanning Technology in Differentiating Benign and Malignant Breast Space-Occupying Lesions. China Practical Medicine, 18(09): 75–78.

[5] Li Y, 2022, Research on the Clinical Value of Magnetic Resonance Imaging Technology and Multi-Slice Spiral CT Enhanced Scanning Technology in Evaluating Preoperative T Staging of Rectal Cancer. World Journal of Complex Medicine, 8(01): 24–28.

[6] Zheng H, Cheng M, Huang J, 2021, Application of CT Enhanced Delayed Scanning Technology in the Differential Diagnosis of Liver Tumors. Journal of Medical Forum, 42(17): 75–77 + 81.

[7] Huang Z, 2021, Clinical Application Value of Multi-Detector Spiral CT Small Bowel Angiography Scanning Technology in the Diagnosis of Small Bowel Diseases. Journal of Imaging Research and Medical Applications, 5(03): 47–48 + 54.

[8] Li P, 2021, Diagnostic Value of High-Resolution CT Target Scanning Technology for Ground-Glass Nodules of the Lung. Medical Equipment, 34(02): 8–10.

[9] Tan C, He X, Zhang X, et al., 2020, Impact of Optimized Scanning Technology on Image Quality of Combined Enhanced MRI of the Nasopharynx and Neck. China Medical Devices, 35(10): 131–134 + 138.

[10] Tang Z, Cui Q, Bao J, et al., 2020, Role of Whole Slide Imaging Technology in Quality Control of Pathological Sections. China Medicine and Pharmacy, 10(12): 33–38.

[11] Liu J, Yu X, 2020, Application Value of 18F-Fluorodeoxyglucose Positron Emission Tomography/Computed Tomography Combined with High-Resolution CT Scanning Technology in the Diagnosis of Lung Cancer. Medical Equipment, 33(09): 28–29.

[12] He J, Lu W, Liu L, 2020, Clinical Application of Lumbar Multi-Slice Spiral CT Volumetric Scanning Technology in the Diagnosis of Lumbar Disc Herniation Complicated with Spinal Stenosis and Its Guiding Value for Disease Treatment. Journal of Imaging Research and Medical Applications, 4(06): 114–115.

[13] Tang Z, Cui Q, Bao J, et al., 2020, Study on the Reproducibility and Correct Rate of Digital Film Reading in Pathological Diagnosis. China Modern Medicine, 27(03): 28–31.

[14] Tang Z, Cui Q, Yang L, et al., 2018, Application of Whole Slide Imaging Technology in Clinical Pathological Diagnosis. Journal of Hebei Medical University, 39(10): 1205–1209.

[15] Duan S, 2018, Study on the Application Effect of CT Enhanced Delayed Scanning Technology in the Differential Diagnosis of Liver Tumors. Journal of Imaging Research and Medical Applications, 2(17): 80–81.

Publisher's note

Bio-Byword Scientific Publishing remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.