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A Bibliometric and Visualized Analysis of Research on Vessel Wall Magnetic Resonance Imaging in China

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Abstract: *This study employed bibliometric methods to visually analyze Chinese-language literature on vessel wall magnetic resonance imaging (VW-MRI), aiming to elucidate the current research status and emerging hotspots in China. Articles published from 2009 to May 2025 were retrieved from the China National Knowledge Infrastructure (CNKI), and CiteSpace 6.4.R1 was used to analyze co-occurrence and clustering of authors, institutions, and keywords. Annual publication trends, core research teams, and thematic developments were explored. A total of 255 valid articles were included, with publication volume increasing steadily and peaking in 2023. Author collaborations were primarily regional, and research was highly concentrated among a few authors and institutions. Frequently occurring keywords included "plaque," "stroke," and "intracranial artery." Nine thematic clusters were identified, covering ischemic stroke prognosis, atherosclerotic plaque analysis, and VW-MRI applications in aneurysms and arterial dissection. VW-MRI research in China is growing and expanding toward artificial intelligence-assisted diagnosis and personalized prediction. Future work should focus on promoting cross-institutional collaboration and integrating advanced technologies to accelerate VW-MRI's clinical translation and broader application in the early diagnosis and treatment of cerebrovascular diseases.*

Keywords: *Vessel Wall Magnetic Resonance Imaging; Bibliometrics; CiteSpace*

1. Introduction

Vessel wall magnetic resonance imaging (VW-MRI) is a high-resolution MR technique that enables direct visualization and assessment of vascular wall structures. It is widely utilized in the early diagnosis and mechanistic investigation of intracranial atherosclerosis, aneurysms, arteritis, and other conditions[1]. Compared to traditional luminal imaging, VW-MRI is noninvasive, offers high tissue contrast, and is suitable for long-term follow-up of high-risk populations, making it an increasingly vital tool in cerebrovascular research[2]. Although the number of related studies has grown steadily, a comprehensive summary of the field's overall development remains limited. Bibliometrics, as a research method for academic literature, facilitates systematic retrieval and in-depth analysis of literature within a specific discipline, thereby outlining the field's structure and evolution [3]. Given its broad applicability across disciplines, this study employed CiteSpace to perform a visualized bibliometric analysis of VW-MRI studies, summarizing research hotspots and trends to inform future research directions.

2. Methods

2.1 Data Source and Inclusion Criteria

Literature was retrieved from CNKI with the search terms " Vessel wall magnetic resonance imaging " OR " VW-MRI " covering the period from database inception to May 2025. A total of 569 Chinese-language articles were initially identified. After screening titles, abstracts, and full texts, invalid publications were excluded. Valid articles were exported in RefWorks format, deduplicated using CiteSpace, and 255 articles were ultimately included.

Exclusion criteria included: (1) conference papers, technological achievements, or case reports; (2) articles irrelevant to the topic; (3) duplicate publications.

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2.2 CiteSpace Parameter Settings

CiteSpace 6.4. R1 (64-bit) was used with the following settings: Time Slicing: From January 2009 to December 2025; Years Per Slice: 1; K=25; Pruning: Pathfinder. Other parameters were left as default. Nodes for authors, institutions, and keywords were selected, and corresponding visual maps were generated. Post-processing features of the software were used for visual enhancement.

3. Results

3.1 Annual Publication Trends

As shown in Figure 1, VW-MRI research in China began in 2009 and can be divided into three stages. The first stage (2009–2015) saw fewer than 10 publications per year. The second stage (2016–2023) featured a rapid increase, peaking in 2023. The third stage (2023–2025) showed a notable decline.

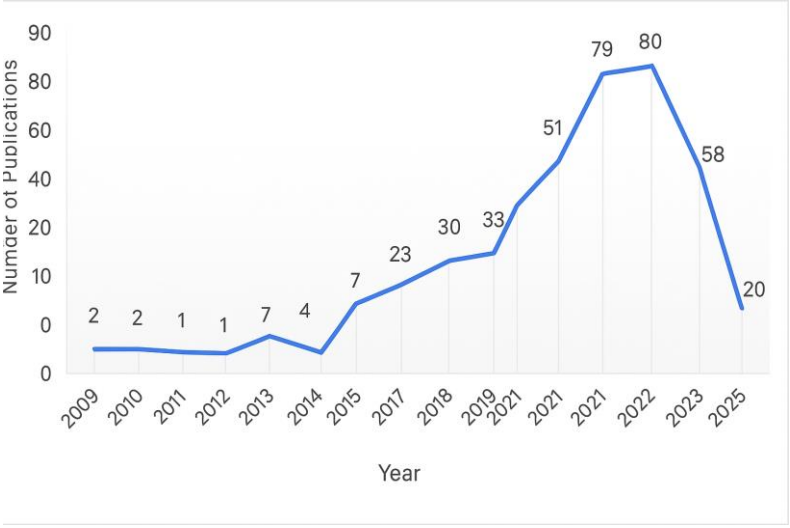

Figure 1 Annual Number of Publications on VW-MRI in the CNKI Database from 2010 to 2023

3.2 Author Collaboration Network

Co-occurrence analysis of authors yielded 353 nodes and 468 links, indicating contributions from 353 scholars (Figure 2). Based on Price's Law ($N=0.749\sqrt{Nmax}$), the core author threshold was approximately three papers. Twenty-one core authors were identified, with Jia Wenxiao, Yu Yan, and Wang Yunling being the top contributors. Table 1 lists the top 10 most prolific authors in VW-MRI research based on publication volume.

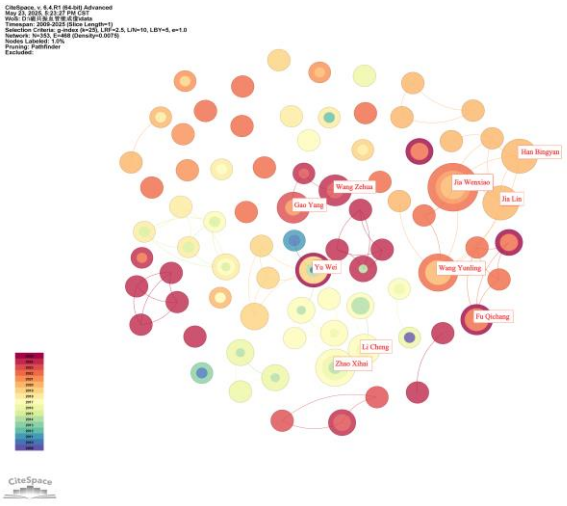

Figure 2 Visualization Map of Author Co-occurrence in VW-MRI Publications Based on CNKI Data

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Table 1 Top 10 Most Prolific Authors in the Field of VW-MRI Research in China

Order	Publication Count	Author
1	10	Jia Wenxiao
2	6	Zhao Xihai
3	6	Wang Yunling
4	5	Jia Lin
5	5	Yu Wei
6	5	Han Bingyan
7	4	Gao Yang
8	4	Wang Zehua
9	4	Fu Qichang
10	4	Li Cheng

3.3 Institutional Collaboration Network

Institutional co-occurrence analysis generated 246 nodes and 113 links (Figure 3). The top three institutions by publication volume were Xinjiang Medical University (17 papers), Southeast University (10), and Inner Mongolia Medical University (8). As shown in Table 2, the institutions with the highest publication output include Xinjiang Medical University, Southeast University, and Inner Mongolia Medical University.

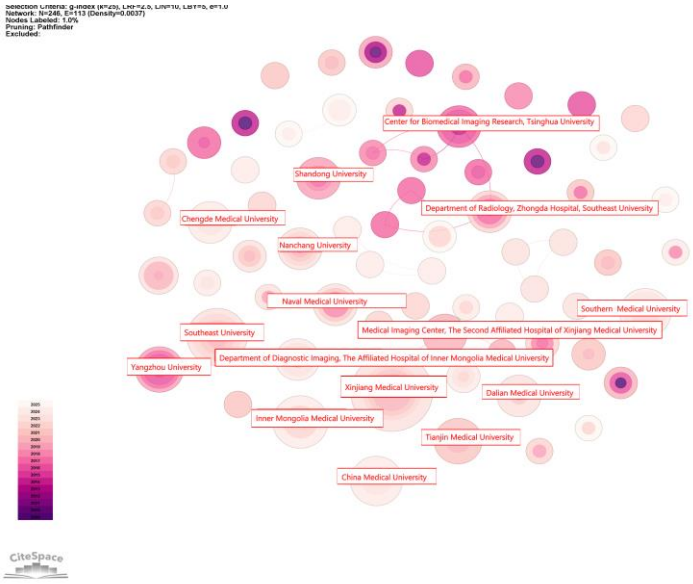

Figure 3 Institutional Co-occurrence Network Based on CNKI Data

Table 2 Top 10 Institutions in China by Number of Publications in the Field of VW-MRI

Order	Publication Count	Institution
1	17	Xinjiang Medical University
2	10	Southeast University
3	8	Inner Mongolia Medical University
4	7	Southern Medical University
5	7	China Medical University
6	6	Tianjin Medical University
7	6	Yangzhou University
8	5	Nanchang University
9	5	Naval Medical University
10	5	Dalian Medical University

3.4 Keyword Co-occurrence Analysis

A total of 196 nodes and 296 links were identified for keyword co-occurrence (Figure 4). High-

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frequency keywords included “plaque,” “stroke,” and “intracranial artery.”

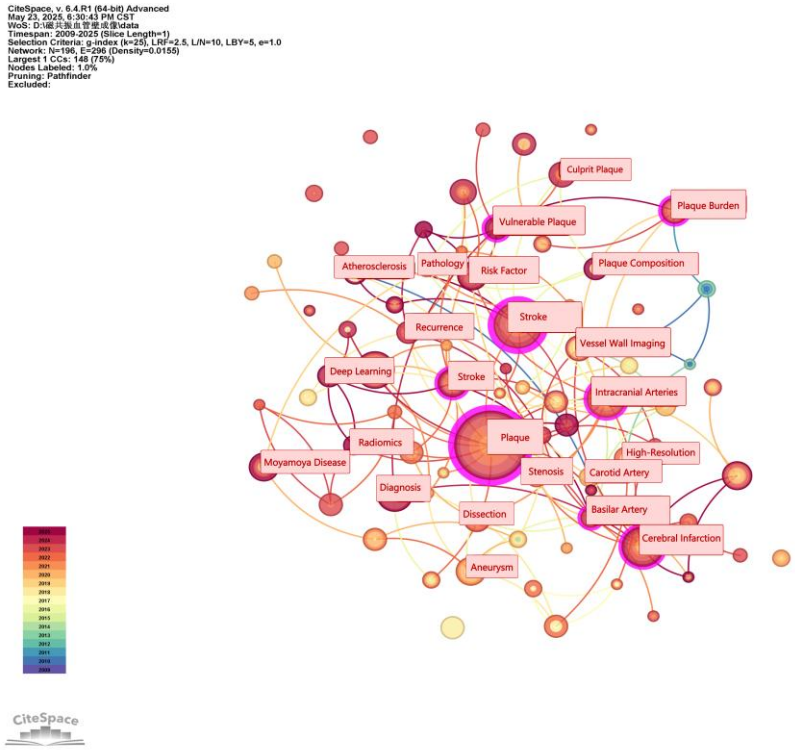

Figure 4 Visualization Map of Keyword Co-occurrence in VW-MRI Research

3.5 Keyword Clustering Analysis

The LSI algorithm clustering resulted in nine clusters (Figure 5). A modularity (Q) value > 0.3 and a silhouette (S) value > 0.7 indicate significant and reliable clustering. Here, Q = 0.6051 and S = 0.8596, confirming robustness.

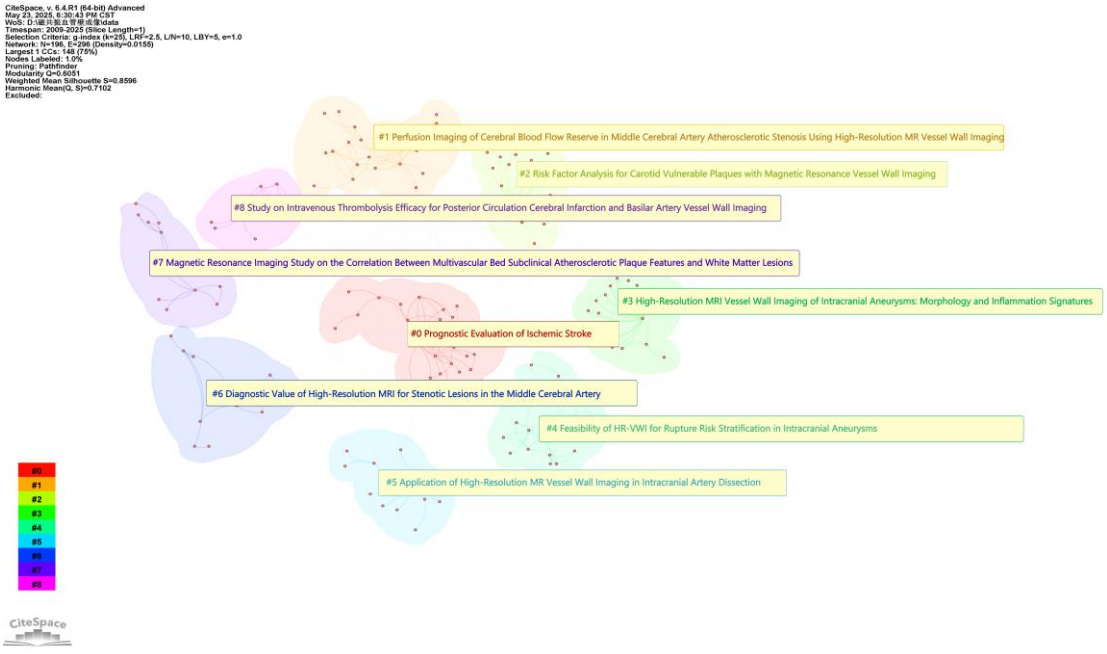

Figure 5 Visualization Map of Keyword Clustering in VW-MRI Research 4. Discussion

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4. Discussion

4.1 Overview of VW-MRI Research

VW-MRI is a noninvasive imaging technology that allows visualization of vascular walls and quantification of plaque characteristics. It can evaluate luminal stenosis, characterize atherosclerotic plaques, and aid in the differential diagnosis of arterial dissection, vasculitis, and aneurysms. The number of Chinese publications has increased since 2009, peaking in 2023 with 80 papers, reflecting growing domestic interest. The recent decline may relate to shifting research priorities. Due to retrieval timing, 2025 trends are not fully observable.

In the author and institutional collaboration networks, the most prolific core author is Jia Wenxiao from Xinjiang Medical University, which also ranks first among institutions in terms of publication volume. This indicates that Jia and his affiliated institution hold considerable influence in the field of VW-MRI research. However, the co-occurrence network analysis of authors and institutions reveals relatively few connections between nodes, suggesting limited collaboration among research teams. The field remains dominated by regionally concentrated, single-institution studies, with a lack of high-density,cross-regional collaborative mechanisms.

4.2 Keyword Visualization Analysis

Keywords play a crucial role in academic literature, as they succinctly and effectively convey the core themes of a study. Keyword co-occurrence analysis can be employed to investigate current research hotspots within the field [4]. Using CiteSpace software, a keyword analysis was conducted in the field of VW-MRI. After merging synonymous terms, the most frequently occurring keywords included "plaque," "stroke," "intracranial artery," "vulnerable plaque," and "plaque burden." As a high-resolution magnetic resonance imaging technique, VW-MRI provides unique advantages in visualizing the structure of vascular lumens. It is currently applied primarily to intracranial arteries, including the carotid artery, basilar artery, and middle cerebral artery. Atherosclerosis is characterized by the formation of fibrofatty lesions within the arterial wall and is a major underlying cause of most myocardial infarctions and strokes [5]. Accumulating evidence indicates that the rupture of unstable atherosclerotic plaques and subsequent thromboembolism are key pathophysiological mechanisms leading to cerebral infarction [6]. Therefore, the evaluation of atherosclerotic plaques has become a critical factor in assessing the risk of stroke. VW-MRI offers unique advantages in characterizing vulnerable plaques by identifying plaque composition, distribution, enhancement patterns, remodeling types, and plaque burden. It also enables longitudinal monitoring of therapeutic effects and provides valuable insights for predicting the risk of future cardiovascular events [7]. Plaque burden is recognized as a critical quantitative indicator in the evaluation of atherosclerotic plaques using VW-MRI. According to certain studies, a threshold of plaque burden greater than 40%—calculated as PB = (Total Vessel Wall Area − Lumen Area) / Total Vessel Wall Area × 100%—is considered diagnostic for the presence of a plaque [8]. Numerous researchers have reported a positive correlation between increasing plaque burden and the risk of recurrent stroke. This reinforces the predictive value of plaque burden as a robust and clinically significant marker for assessing the likelihood of stroke recurrence [9,10]. Consequently, VW-MRI emerges as a promising imaging modality for ischemic stroke risk stratification and recurrence prediction. Guiding individualized treatment strategies contributes to more targeted interventions and better clinical benefits for patients.

Clustering analysis of keywords resulted in the identification of nine distinct clusters. The cluster numbering is inversely related to size, with lower-numbered clusters encompassing a greater number of keywords [11]. Cluster #0 highlights the critical value of VW-MRI in the prognostic assessment of ischemic stroke. Notably, some studies have explored the integration of VW-MRI with serum miR-134 levels in predicting outcomes in patients with middle cerebral artery (MCA) stenosis. The results indicate promising predictive performance, suggesting its potential utility in clinical prognosis evaluation [12]; Cluster #1 focuses on the application of high-resolution VW-MRI in perfusion imaging to assess cerebral blood flow reserve in cases of MCA atherosclerotic stenosis. Integrating HR-VW-MRI with computational fluid dynamics, some researchers have analyzed the association between plaque steepness and local hemodynamics, concluding that plaques with greater steepness are more prone to precipitating ischemic stroke events [13]. Cluster #3 represents studies focused on the application of high-resolution vessel wall MRI in the assessment of intracranial aneurysms. Evidence suggests that VW-MRI plays an important role in identifying unstable aneurysms, thereby contributing to risk stratification and treatment decision-making[14]. Cluster #4 focuses on the feasibility of applying high-resolution vessel wall MRI to evaluate the rupture risk of intracranial aneurysms. While several studies have reported a reasonable

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degree of predictive accuracy for VW-MRI in identifying high-risk aneurysms, the technique is not without limitations, including potential false-positive findings and missed lesions [15]. Cluster #5 highlights the application of high-resolution vessel wall MRI in the diagnosis and evaluation of intracranial arterial dissection. Evidence indicates that VW-MRI is effective in characterizing dissection features and offers valuable insights for staging, thereby supporting clinical decision-making and disease management [16]. Cluster #6 focuses on studies investigating the diagnostic utility of high-resolution magnetic resonance imaging in detecting stenotic lesions of the middle cerebral artery (MCA). Researchers have employed high-resolution vessel wall MRI to assess plaque characteristics in patients with MCA stenosis and to examine their correlation with in-stent restenosis following stenting procedures [17]. Cluster #7 reflects research on the use of vessel wall magnetic resonance imaging (VW-MRI) to study the relationship between subclinical atherosclerotic plaque characteristics across multiple vascular beds and white matter lesions. Some studies have investigated the association between vulnerable carotid plaques and white matter hyperintensities (WMH), suggesting that vulnerable carotid plaques are an independent risk factor for WMH. Among various plaque features, intraplaque hemorrhage (IPH) in the carotid artery is significantly associated with the severity of WMH [18]. Cluster #8 encompasses studies utilizing VW-MRI to assess both the response to intravenous thrombolytic therapy in posterior circulation ischemic stroke and the vessel wall features of the basilar artery. High-resolution MR angiographic techniques allow for detailed visualization of blood flow dynamics and plaque morphology in patients with vertebrobasilar dolichoectasia. Moreover, vertebrobasilar artery classification based on imaging findings shows promising value in predicting the occurrence of multiple infarcts in the posterior circulation secondary to dolichoectasia [19].

5. Conclusion

In summary, the field of vessel wall magnetic resonance imaging (VW-MRI) in China has undergone a transition from its initial development stage to rapid expansion. In recent years, research output has continued to increase, accompanied by a diversification of research hotspots. Through bibliometric analysis, this study provides a comprehensive overview of the current research landscape, key contributors, and the thematic evolution within the VW-MRI domain, offering an objective reference for researchers to better understand its development trajectory.

The findings indicate that the assessment of atherosclerotic plaques and the prediction of stroke risk remain central themes in VW-MRI research. Meanwhile, emerging technologies such as artificial intelligence-assisted diagnosis and radiomics are gradually being integrated into the field. Looking ahead, it is essential to further promote cross-regional and multicenter collaborative studies and to incorporate cutting-edge technologies like AI to enhance the role of VW-MRI in early diagnosis, treatment monitoring, and prognosis prediction. Moreover, expanding its application to a broader range of diseases will be key to driving future breakthroughs in VW-MRI research.

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