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A Study of Knowledge and Attitude of Medical Staff Towards 3D Black Blood MR Angio Methods in High-Resolution Magnetic Resonance Vessel Wall Imaging of Intracranial Arteries

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Objective: This study aims to investigate the knowledge and attitude of medical staff towards 3D Black Blood MR Angio methods in high-resolution magnetic resonance vessel wall imaging (HR-MRI) of intracranial arteries.

Methods: A cross-sectional study conducted from August 2–25 2024 collected demographic information, knowledge, and attitude scores of medical staff through self-designed questionnaires. The questionnaires exhibited a high internal consistency (Cronbach's $\alpha = 0.870$). The Questionnaire Star online platform was used, and a WeChat-based applet generated a QR code for participants to access and complete the questionnaire.

Results: A total of 287 valid questionnaires were enrolled. The median (25% quartile and 75% quartile) of knowledge and attitude scores were 12 (9, 15) (possible range: 0–17) and 59 (55, 64) (possible range: 18–90). The correlation analysis demonstrated a positive correlation between knowledge and attitude ($r = 0.361$, $P < 0.001$). Multivariate logistic regression analysis showed that holding an intermediate title (OR = 4.065, 95% CI: 1.529, 10.808, P = 0.005), a vice senior title (OR = 5.443, 95% CI: 1.614, 18.361, P = 0.006), and having no prior experience with HR-MRI (OR = 0.422, 95% CI: 0.236, 0.753, P = 0.003) were independently associated with knowledge. Having one year or less of work experience (OR = 0.095, 95% CI: 0.010, 0.952, P = 0.045), having 1–3 years of work experience (OR = 0.330, 95% CI: 0.114,0.957, P = 0.041), and having no prior experience with HR-MRI (OR = 0.422, 95% CI: 0.236,0.753, $P < 0.001$) were independently associated with attitude.

Conclusion: This study identified suboptimal knowledge and inconsistent attitudes toward intracranial HR-MRI among medical staff, with professional title, scanning experience, and prior HR-MRI exposure being key determinants. Addressing these gaps through competency-based credentialing and standardized protocol dissemination is critical to realizing HR-MRI's clinical potential in cerebrovascular care.

Keywords: knowledge, attitude, medical staff, high-resolution magnetic resonance vessel wall imaging (HR-MRI), intracranial arteries

Introduction

High-resolution magnetic resonance imaging (HR-MRI) has emerged as a prominent non-invasive vessel wall imaging technique, particularly in the context of intracranial arteries within the fields of neuroscience and neurosurgery.[1,2] This imaging modality offers high-resolution images that enable the detailed observation of intracranial vascular wall structures, thereby facilitating the detection of subtle changes and abnormalities.[3] In recent years, HR-MRI has been employed effectively for diagnosing conditions such as carotid dissection and assessing plaque characteristics indicative of instability, making it a valuable tool in cerebrovascular disease diagnosis.[4] Moreover, this technology surpasses traditional magnetic

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resonance imaging methods by providing superior anatomical precision and clinical insights, offering healthcare professionals vital information concerning arterial wall conditions, including atherosclerotic plaques, aneurysms, and thrombosis.[5] Consequently, HR-MRI plays a crucial role in advancing our understanding and management of cerebrovascular diseases. Recent advancements in vessel wall imaging techniques have focused on optimizing intracranial HR-MRI protocols. A study demonstrated that a 30% faster vessel wall sequence could maintain high signal-to-noise ratios (SNR) and contrast-to-noise ratios (CNR) without compromising image quality or lesion detection, addressing the clinical challenge of extended imaging times.[6] Furthermore, the clinical significance of vessel wall imaging has been highlighted in relation to stroke risk assessment. Another study found that an increased incidence of napkin-ring sign (NRS) plaques on cervicocerebral computed tomography angiography was positively associated with acute ischemic stroke occurrence, suggesting that high-risk plaque morphology could serve as an important imaging target for stroke risk estimation.[7] However, as noted in recent literature, while black blood sequences represent a desirable advancement in vessel wall imaging, their implementation should not be approached indiscriminately, and careful consideration of technical parameters and clinical context remains essential.[8] These studies underscore both the potential and practical challenges of advanced vessel wall imaging techniques in clinical settings. It is essential to recognize the complementary roles of traditional "bright blood" MRA techniques that primarily visualize the vessel lumen and "dark blood" HR-MRI sequences that focus on vessel wall characteristics. While bright blood techniques effectively display luminal narrowing and occlusions, they provide limited information about wall pathology. Conversely, dark blood sequences excel at revealing wall abnormalities but may be technically challenging to implement consistently. Despite these limitations, these complementary approaches currently represent the most accessible non-invasive alternatives to digital subtraction angiography (DSA) and Doppler ultrasound. This technological complexity underscores the importance of understanding healthcare professionals' knowledge, perception, and practical application of these advanced imaging tools in clinical practice.

The Knowledge, Attitude, and Practices (KAP) model, which originated in the 1950s, continues to hold significant relevance in healthcare by serving as a valuable framework for evaluating the knowledge, attitudes, and behaviors of target populations in their interaction with healthcare information.[5,9] This model's fundamental premise, which posits that knowledge shapes attitudes, which subsequently influence individual behaviors, provides a robust foundation for comprehending and addressing health-related challenges.[10] Given the considerable potential applications of high-resolution magnetic resonance imaging (HR-MRI) in the realm of neuroscience, it is plausible that variations may exist in the knowledge and attitudes of healthcare professionals toward this technology. Understanding healthcare professionals' perceptions and attitudes concerning HR-MRI is paramount to ensuring its seamless integration into clinical practice. This entails examining aspects such as training requirements, technology acceptance, and its practical application in clinical decision-making. High-resolution magnetic resonance vessel wall imaging (HR-MRI VWI) has demonstrated potential in evaluating intracranial arteries, particularly in detecting vascular abnormalities beyond traditional imaging methods.[11] However, its application remains limited to selected cases rather than routine clinical use. The extended imaging time and additional technical requirements may not be justified for all patients, as HR-MRI VWI only provides incremental diagnostic benefits in a subset of cases.[12] Furthermore, despite its ability to visualize vascular wall pathology, the impact of HR-MRI VWI on clinical decision-making remains variable, and it may not significantly alter management strategies for the majority of patients.

Thus, this study aims to investigate the knowledge and attitude of medical staff towards HR-MRI of intracranial arteries. By measuring their knowledge, attitudes, and potentially their behavioral inclinations regarding this advanced imaging technology, we identify training needs and gather valuable data that can guide efforts to seamlessly integrate HR-MRI into clinical practice, ultimately enhancing the management of cerebrovascular diseases in the field of neuroscience and neurosurgery.

Methods

Study Design and Participants

This cross-sectional study was conducted between August 2–25 2024 at the hospitals in the Beijing and Hebei regions, including hospital medical staff. The inclusion criteria for medical staff encompassed individuals employed within the following departments: neurology, neurosurgery, vascular surgery, geriatrics, emergency medicine, and radiology.

Furthermore, participants were required to have routine access to the technology employed within these departments as an integral part of their daily responsibilities.

The study was ethically approved by the Medical Ethics Committee of The Fourth Hospital of Hebei Medical University, and informed consent was obtained from the study participants.

Procedures

The questionnaire was designed with reference to previously published literature[13] as well as MRI of the Intracranial Vascular Wall: Principles and Expert Consensus of the American Society of Neuroradiology.[14] Subsequent to its initial design, the questionnaire underwent refinements through the collaborative input of two neurologists (comprising one chief physician and one vice-chief physician) and two radiologists (comprising one chief physician and one vice-chief physician). To ensure its reliability and consistency, a preliminary pilot test was administered, yielding a commendable Cronbach's alpha coefficient of 0.870.

The final questionnaire utilized in this study was composed in Chinese and comprised three distinct dimensions. The first section collected demographic information through 11 questions, while the second dimension focused on knowledge, featuring 16 single-choice questions, where correct answers were scored 1 and unclear or incorrect responses scored 0; the initial question in this dimension employed a scale of 0–2, yielding a score range of 1–17. The third section, pertaining to attitudes, consisted of 18 questions, rated using a five-point Likert scale, with scores ranging from 1 to 5 based on the expressed attitude degree, resulting in a score range of 18–90. Notably, achieving scores above 70% of the maximum possible within each section indicated participants possessed both adequate knowledge and a positive attitude.[14]

The Questionnaire Star, provided by Changsha Ranxing Information Technology Co., Ltd., a professional online questionnaire software platform, was employed to design and generate a link to the questionnaire. This online questionnaire was constructed using the WeChat-based Questionnaire Star applet, and a QR code was generated to facilitate data collection through WeChat. Participants accessed and completed the questionnaire by scanning the QR code sent to them via WeChat. To uphold the quality and comprehensiveness of the questionnaire responses, each IP address was restricted to a single submission, and all questionnaire items were mandatory. Subsequently, an Excel spreadsheet was extracted from the Questionnaire Star platform, and the research team meticulously reviewed all questionnaires for completeness, internal consistency, and overall reasonableness to ensure data reliability and integrity.

Statistical Analysis

Statistical analysis was conducted using SPSS 26.0 (IBM Corp., Armonk, N.Y., USA). Continuous variables were described using median, 25% quartile and 75% quartile. Categorical variables were presented as n (%). Pearson correlation analysis was employed to assess the correlations between knowledge, attitude, and practice scores. To compare the differences in knowledge (K) and attitude (A) dimension scores among survey respondents with different demographic characteristics, for continuous variables, normality was assessed, and the Wilcoxon-Mann–Whitney test was used to compare between two groups, while Kruskal–Wallis analysis of variance was used for three groups or more. A comprehensive analysis of demographic data and the relationship between knowledge and attitude was performed using a stepwise regression method. In this study, p-values were reported for three decimal places, and $P < 0.05$ was considered statistically significant.

Results

Baseline Characteristics of Participants

Initially, a total of 304 questionnaires were collected in this study, and were excluded according to the following criteria: 13 cases where the filling time was less than 88s or more than 1800s; 1 case where the answers to the questions of the scale were exactly the same; 3 cases of disagreement with the informed consent, remaining 287 questionnaires, with a validity rate of 94.41%. Among them, 148 (51.6%) aged 31–40 years, 146 (50.9%) were postgraduate, 192 (66.9%) were doctor, 142 (49.5%) have an intermediate title, 205 (71.4%) worked in general hospital, 201 (70%) of hospital were public tertiary, 119 (41.5%) with more than 10 years of work experience, 137 (47.7%) attend 2–5 times of academic conferences or continuing medical education activities, 190 (66.2%) have performed HR-MRI, and 270 (94.1%) participated in national projects.

The knowledge score varied from medical staff with different age, education, professional title, type of medical institution, years of work experience, and number of times to attend academic conferences or continuing medical education activities, and whether HR-MRI has ever been performed. As for the attitude score, there were difference among medical staff with different gender, age, education, occupation, professional Title, number of times to attend academic conferences or continuing medical education activities, and whether HR-MRI has ever been performed (Table 1).

The median (25% quartile and 75% quartile) of knowledge and attitude scores were 12 (9, 15) (possible range: 0–17), 59 (55, 64) (possible range: 18–90). About 58.9% with a score higher than the median of knowledge score and 51.2 with a score higher than the median of attitude score (Table 2).

Table 1 Baseline Sheet

Variables	**N(%)**	**Knowledge (K)**		**Attitude (A)**	
		Median (25% Quartile and 75% Quartile)	**P**	**Median (25% Quartile and 75% Quartile)**	**P**
Total	287	12(9, 15)		59(55, 64)	
Gender			0.285		**0.004**
Male	134(46.7)	12.5(9,15)		60(56,66)	
Female	153(53.3)	12(9,14)		58(54,63)	
Age (years)			**0.040**		**0.007**
30 years and below	65(22.6)	11(7,14)		57(53,62)	
31~40 years	148(51.6)	12(10,14.5)		60(56,65)	
41~50 years	60(20.9)	13(11,15)		60(54,66.5)	
50 years and above	14(4.9)	12.5(11,15)		60(55,65)	
Education			**0.006**		**0.006**
Junior college and and below	19(6.6)	9(6,11)		55(53,63)	
Undergraduate	122(42.5)	12(9,15)		58(54,64)	
Postgraduate	146(50.9)	12.5(10,15)		60(56,66)	
Occupation			0.280		**0.045**
Doctor	192(66.9)	12(9,15)		60(55,66)	
Medical Technician	73(25.4)	12(9,15)		58(54,62)	
Nurse	22(7.7)	11(8,13)		57.5(53,64)	
Professional Title			**<0.001**		**0.018**
None	23(8)	9(7,13)		57(53,62)	
Junior	84(29.3)	12(9,14)		59(55,65.5)	
Intermediate	142(49.5)	13(10,15)		58.5(55,64)	
Vice Senior	32(11.1)	13(10,15)		59.5(54.5,64.5)	
Senior	6(2.1)	16(16,16)		68.5(62,71)	
Type of medical institution			**0.010**		0.054
General Hospital	205(71.4)	13(10,15)		60(55,65)	
Specialist Hospital	34(11.8)	10.5(9,14)		58(56,63)	
Chinese Medicine Hospital	43(15)	11(8,14)		57(52,62)	
Others	5(1.7)	9(5,13)		53(50,58)	
Nature of the institution			0.281		0.391
Public Primary	9(3.1)	11(9,12)		59(58,65)	
Public Secondary	67(23.3)	12(10,15)		59(54,66)	
Public Tertiary	201(70)	12(9,14)		58(54,64)	
Private hospital	10(3.5)	13.5(10,16)		62.5(57,66)	

(*Continued*)

Table 1 (Continued).

Variables	N(%)	Knowledge (K)		Attitude (A)	
		Median (25% Quartile and 75% Quartile)	P	Median (25% Quartile and 75% Quartile)	P
Years of work experience			**0.018**		0.063
1 year and below	19(6.6)	9(7,13)		56(51,59)	
1–3 years	36(12.5)	12(9,14)		57.5(54,64)	
4–6 years	51(17.8)	13(10,15)		60(56,63)	
7–10 years	62(21.6)	12(9,14)		59(56,66)	
More than 10 years	119(41.5)	13(10,15)		60(54,66)	
Number of times to attend academic conferences or continuing medical education activities			**0.014**		**0.030**
Less than 2 times	43(15)	10(7,13)		58(53,62)	
2–5 times	137(47.7)	12(9,14)		59(54,64)	
6–10times	54(18.8)	13(10,15)		62(58,66)	
10 times and above	53(18.5)	13(11,15)		58(55,64)	
Whether HR-MRI has ever been performed			**<0.001**		**<0.001**
Yes	190(66.2)	13(10,15)		61(57,66)	
No	97(33.8)	11(7,13)		56(52,60)	
The status of your projects? (Multiple choice)					
National projects	270(94.1)				
Provincial projects	191(66.6)				
Other projects	178(62.0)				
No project	162(56.4)				

Notes: Bold values indicate statistical significance at P <0.05.

Table 2 Score Distribution

	Median	25% Quartile	75% Quartile	Minimum	Maximum	<Median N(%)	≥Median N(%)
Knowledge Dimension	12	9	15	0	17	118(41.1)	169(58.9)
Attitude Dimension	59	55	64	40	74	140(48.8)	147(51.2)

Analysis of the Distribution of Knowledge and Attitude Scores

When it comes to knowledge of HR-MRI, 45.3% expressed somewhat understanding about HR-MRI of intracranial arteries (K1). About 48.8% recognized the use of the "Black blood" technique in HR-MRI of intracranial arteries (K2). A significant 71.1% believed that HR-MRI of intracranial arteries is not invasive (K3) and 84% perceived that it does not involve radiation (K4). About 63.8% acknowledged that traditional vascular imaging techniques, such as CT angiography (CTA) and magnetic resonance angiography (MRA), can display abnormalities in the vascular lumen (K5), and 55.1% believed that traditional vascular imaging techniques cannot display vascular wall structures (K6). About 60.3% believed that HR-MRI does not have many contraindications, and most patients are not intolerant (K14). About 53.7% expressed that HR-MRI has good accuracy and good repeatability (K15). A significant 72.5% agreed that the accurate diagnosis of HR-MRI depends on appropriate imaging techniques and radiological interpretation experience (K16). These succinct findings provide a comprehensive overview of perception regarding HR-MRI of intracranial arteries (Table 3).

Respondents showed varying degrees of positivity in terms of attitudes, a significant 52.6% of respondents express agreement regarding the importance of HR-MRI in addressing all aspects of prevention, diagnosis, treatment, and prognosis assessment of ischemic strokes (A1). Additionally, 50.5% concur that HR-MRI excels in directly observing signs of intracranial artery dissection compared to conventional imaging methods, thereby enhancing diagnostic accuracy (A2). Notably, 52.3% of participants align in their agreement that HR-MRI, owing to its clear visualization of vascular walls, functions as a valuable complement to routine imaging (A3). Furthermore, 45.3% of respondents are in agreement that HR-MRI effectively addresses

Table 3 Distribution of Knowledge Dimension Scores

	a. Understanding (2)	**b. Neutral (1)**	**Not understanding (0)**
1. How familiar are you with HR-MRI of intracranial arteries?	100(34.8)	130(45.3)	57(19.9)
	a. "Bright blood" technique (0)	b. "Black blood" technique (1)	c.Unclear (0)
2. What kind of technology does HR-MRI of intracranial arteries utilize?	66(23)	140(48.8)	81(28.2)
	a. Yes (0)	b. No (1)	c. Unclear (0)
3. Is HR-MRI of intracranial arteries an invasive examination?	34(11.8)	204(71.1)	49(17.1)
	a. Yes (0)	b. No (1)	c. Unclear (0)
4. Does HR-MRI of intracranial arteries involve radiation?	28(9.8)	241(84)	18(6.3)
	a. Yes (1)	b. No (0)	c. Unclear (0)
5. Can traditional vascular imaging techniques such as CT angiography (CTA) and magnetic resonance angiography (MRA) display abnormalities in the vascular lumen?	183(63.8)	72(25.1)	32(11.1)
	a. Yes (0)	b. No (1)	c. Unclear (0)
6. Can traditional vascular imaging techniques such as CT angiography (CTA) and magnetic resonance angiography (MRA) display vascular wall structures?	95(33.1)	158(55.1)	34(11.8)
	a. Yes(1)	b. No(0)	c. Unclear(0)
7. Can HR-MRI display vascular wall structures?	248(86.4)	11(3.8)	28(9.8)
	a. Yes (1)	b. No (0)	c. Unclear (0)
8. Can HR-MRI differentiate and diagnose diseases like intracranial atherosclerosis, intracranial artery dissection, intracranial vasculitis, and intracranial aneurysms?	237(82.6)	14(4.9)	36(12.5)
	a. Yes (1)	b. No (0)	c. Unclear (0)
9. Can HR-MRI identify plaque composition and characteristics?	218(76)	15(5.2)	54(18.8)
	a. Yes (1)	b. No (0)	c. Unclear (0)
10. Can HR-MRI distinguish between stable and unstable plaques?	204(71.1)	23(8)	60(20.9)
	a. Yes (1)	b. No (0)	c. Unclear (0)
11. Can HR-MRI identify symptomatic non-stenotic intracranial arterial lesions?	216(75.3)	14(4.9)	57(19.9)
	a. HR-MRI (1)	b. Digital subtraction angiography (DSA) (0)	c. Unclear (0)
12. Is HR-MRI the only non-invasive imaging technique for intracranial vascular wall imaging?	169(58.9)	54(18.8)	64(22.3)
	a. Yes (0)	b. No (1)	c. Unclear (0)
13. What is the "gold standard" for diagnosing an aneurysm?	76(26.5)	186(64.8)	25(8.7)
	a. Yes (0)	b. No (1)	c. Unclear (0)
14. Does HR-MRI have many contraindications, and are most patients intolerant?	57(19.9)	173(60.3)	57(19.9)
	a. Yes (0)	b. No (1)	c. Unclear (0)
15. Does HR-MRI have good accuracy but poor repeatability?	63(22)	154(53.7)	70(24.4)
	a. Yes (1)	b. No (0)	c. Unclear (0)
16. Does the accurate diagnosis of HR-MRI depend on appropriate imaging techniques and radiological interpretation experience?	208(72.5)	34(11.8)	45(15.7)

the limitations of existing traditional imaging techniques (A4). On the other hand, 36.9% maintain a neutral stance concerning whether HR-MRI's clinical utility surpasses that of digital subtraction angiography (DSA) (A5). Meanwhile, 42.2% concur that HR-MRI should be established as the standard method for diagnosing cerebrovascular diseases (A6). Significantly, 55.4% express agreement regarding the necessity for additional support from pathological histology to reinforce the diagnostic outcomes of HR-MRI technology (A7). Conversely, 41.5% maintain a neutral stance concerning concerns related to the potential limitations and challenges HR-MRI technology might face in practical clinical applications (A8). A total of 34.8% of respondents agree that the extended examination time associated with HR-MRI may pose challenges in diagnosing and treating critically ill patients with cerebrovascular diseases (A9). Equally, 42.2% remain neutral regarding their ongoing doubts about the feasibility and reliability of HR-MRI technology for diagnosing intracranial artery lesions (A10). Additionally, 49.8% express their willingness to explore and implement HR-MRI technology, even if they lack prior experience (A11). Furthermore, 49.8% are willing to educate patients about the distinctions between HR-MRI technology and traditional vascular imaging methods (A12). Notably, 46% agree that they would recommend the adoption of HR-MRI technology for intracranial artery observation in their patients (A13). Regarding concerns, 54.4% concur that the demanding equipment requirements of HR-MRI may substantially impede its clinical utilization (A14). Furthermore, 58.5% express a desire for the continuous development and enhancement of HR-MRI technology (A15). Meanwhile, 42.5% express their eagerness to receive guidance and training related to HR-MRI technology (A16). Another 46.7% are willing to actively participate in clinical research involving the application of HR-MRI technology (A17). Finally, 38.7% agree that HR-MRI technology holds the potential to eventually replace traditional vascular imaging modalities in the future (A18). These findings collectively offer invaluable insights into the perceptions and attitudes surrounding HR-MRI technology for intracranial artery imaging (Table 4).

Table 4 Distribution of Attitude Dimension Scores

	a. Strongly Agree (5)	**b. Agree (4)**	**c. Neutral (3)**	**d. Disagree (2)**	**e. Strongly Disagree (1)**
1. Do you believe that HR-MRI is important for all of the prevention, diagnosis, treatment, and prognosis assessment of ischemic strokes?	105(36.6)	151(52.6)	28(9.8)	3(1)	0(0)
	a. Strongly agree(5)	b. Agree (4)	c. Neutra l(3)	d. Disagree (2)	e. Strongly disagree (1)
2. Do you believe that HR-MRI provides superior observation of direct signs of intracranial artery dissection compared to traditional imaging techniques, thereby improving the accuracy of intracranial artery dissection diagnosis?	103(35.9)	145(50.5)	36(12.5)	3(1)	0(0)
	a. Strongly agree(5)	b. Agree (4)	c. Neutral (3)	d. Disagree (2)	e. Strongly disagree (1)
3. Do you believe that HR-MRI, with its clear visualization of vascular walls, is a valuable complement to routine imaging?	105(36.6)	150(52.3)	31(10.8)	1(0.3)	0(0)
	a. Strongly agree(5)	b. Agree (4)	c. Neutral (3)	d. Disagree (2)	e. Strongly disagree (1)
4. Do you believe that HR-MRI effectively addresses the shortcomings of current traditional imaging techniques?	90(31.4)	130(45.3)	58(20.2)	9(3.1)	0(0)
	a. Strongly agree(5)	b. Agree (4)	c. Neutral (3)	d. Disagree (2)	e. Strongly disagree (1)
5. Do you believe that the clinical utility of HR-MRI technology may surpass digital subtraction angiography (DSA)?	59(20.6)	89(31)	106(36.9)	31(10.8)	2(0.7)
	a. Strongly agree (5)	b. Agree (4)	c. Neutral (3)	d. Disagree (2)	e. Strongly disagree (1)
6. Do you believe that HR-MRI should become the standard method for diagnosing cerebrovascular diseases?	70(24.4)	121(42.2)	87(30.3)	8(2.8)	1(0.3)
	a. Strongly agree(1)	b. Agree (2)	c. Neutral (3)	d. Disagree (4)	e. Strongly disagree (5)
7. Do you believe that the diagnostic results of HR-MRI technology require further support from pathological histology?	55(19.2)	159(55.4)	62(21.6)	11(3.8)	0(0)
	a. Very concerned (1)	b. Concerned (2)	c. Neutral (3)	d. Not concerned (4)	Not concerned at all (5)
8. Are you concerned that HR-MRI technology may face limitations and challenges in practical clinical applications, potentially negatively impacting its scope and effectiveness?	17(5.9)	61(21.3)	119(41.5)	80(27.9)	10(3.5)
	a. Strongly agree (1)	b. Agree (2)	c. Neutral (3)	d. Disagree (4)	e. Strongly disagree (5)
9. Do you believe that the prolonged examination time of HR-MRI may pose challenges for the diagnosis and treatment of critically ill patients with cerebrovascular diseases?	28(9.8)	100(34.8)	95(33.1)	59(20.6)	5(1.7)
	a. Much doubt (1)	b. Some doubt (2)	c. Neutral (3)	d. Virtually no doubt (4)	e. No doubt (5)
10. Do you still have doubts about the feasibility and reliability of HR-MRI technology for intracranial artery lesions?	9(3.1)	71(24.7)	121(42.2)	78(27.2)	8(2.8)
	a. Very willing (5)	b. Willing (4)	c. Neutral (3)	d. Unwilling (2)	e. Very unwilling (1)
11. If you have not used HR-MRI technology, would you be willing to try and apply it?	96(33.4)	143(49.8)	45(15.7)	3(1)	0(0)
	a. Very willing (5)	b. Willing (4)	c. Neutral (3)	d. Unwilling (2)	e. Very unwilling (1)

(*Continued*)

Table 4 (Continued).

	a. Strongly Agree (5)	b. Agree (4)	c. Neutral (3)	d. Disagree (2)	e. Strongly Disagree (1)
12. Would you be willing to explain the differences between HR-MRI technology and traditional vascular imaging to patients?	90(31.4)	143(49.8)	52(18.1)	2(0.7)	0(0)
	a. Strongly recommend (5)	b. Recommend (4)	c. Likely recommend (3)	d. Not recommend (2)	e. Not recommend at all (1)
13. Would you recommend the use of HR-MRI technology for intracranial artery observation in patients?	68(23.7)	132(46)	84(29.3)	3(1)	0(0)
	a. Strongly agree	b. Agree	c. Neutral	d. Disagree	e. Strongly disagree
14. Do you believe that the high equipment requirements of HR-MRI, which some medical centers may not meet, significantly limit its clinical practice?	48(16.7)	156(54.4)	66(23)	16(5.6)	1(0.3)
	a. Strongly agree	b. Agree	c. Neutral	d. Disagree	e. Strongly disagree
15. Do you believe that HR-MRI technology requires further development and improvement?	60(20.9)	168(58.5)	55(19.2)	4(1.4)	0(0)
	a. Highly desirable (5)	b. Desirable (4)	c. Neutral (3)	d. Undesirable (2)	e. Not at all desirable (1)
16. Would you like to receive guidance and training related to HR-MRI technology?	115(40.1)	122(42.5)	48(16.7)	2(0.7)	0(0)
	a. Very willing (5)	b. Willing (4)	c. Neutral (3)	d. Unwilling (2)	e. Very unwilling (1)
17. Would you be willing to participate in clinical research involving the use of HR-MRI technology?	106(36.9)	134(46.7)	43(15)	4(1.4)	0(0)
	a. Strongly agree (5)	b. Agree (4)	c. Neutral (3)	d. Disagree (2)	e. Strongly disagree(1)
18. Could HR-MRI technology replace traditional vascular imaging in the future?	61(21.3)	111(38.7)	97(33.8)	16(5.6)	2(0.7)

Analysis of Factors Associated With Knowledge and Attitude Scores

In the correlation analysis, a statistically significant positive correlation was identified between knowledge and attitude ($r = 0.361$, $P < 0.001$) (Table 5).

In the multivariate logistic regression analysis, it was determined that holding an intermediate title (OR = 4.065, 95% CI: 1.529, 10.808, P = 0.005), a vice senior title (OR = 5.443, 95% CI: 1.614, 18.361, P = 0.006), and having no prior experience with HR-MRI (OR = 0.422, 95% CI: 0.236, 0.753, P = 0.003) were independently associated with knowledge (Table 6). Additionally, having one year or less of work experience (OR = 0.095, 95% CI: 0.010, 0.952, P = 0.045), having 1–3 years of work experience (OR = 0.330, 95% CI: 0.114,0.957, P = 0.041), and having no prior experience with HR-MRI (OR = 0.422, 95% CI: 0.236,0.753, $P < 0.001$) were independently associated with attitude (Table 7).

Discussion

This study found that the level of awareness regarding high-resolution magnetic resonance vessel wall imaging (HR-MRI VWI) among medical personnel was generally low, particularly among non-imaging professionals. Additionally, individuals with higher professional titles exhibited relatively higher levels of knowledge, while those with less clinical

Table 5 Correlation Analysis

	Knowledge	Attitude
Knowledge	1.000	/
Attitude	0.361(P<0.001)	1.000

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Table 6 Statistical Analyses (Univariate, Multivariate Analyses). Knowledge Dimension

Cut-Off Value:≥12/<12	**No.**	**Univariate**		**Multivariate (Regression Method = Backward - LR Method)**	
		OR (95% CI)	**P**	**OR (95% CI)**	**P**
Gender					
Male	80/134	Ref.			
Female	89/153	0.939(0.586,1.504)	0.792		
Age (years) (comparison mode = difference)					
30 years and below	31/65	Ref.			
31~40 years	89/148	1.654(0.919,2.977)	0.093		
41~50 years	39/60	1.584(0.864,2.904)	0.137		
50 years and above	10/14	1.829(0.557,6.007)	0.320		
Education					
Junior college and junior college and below	4/19	0.171(0.054,0.540)	**0.003**	0.252(0.062,1.029)	0.055
Undergraduate	76/122	1.058(0.645,1.735)	0.823	1.338(0.664,2.696)	0.415
Postgraduate	89/146	Ref.		Ref.	
Occupation					
Doctor	116/192	Ref.		Ref.	
Medical Technician	43/73	0.939(0.543,1.626)	0.822	1.656(0.738,3.716)	0.221
Nurse	10/22	0.546(0.225,1.326)	0.181	0.419(0.143,1.228)	0.113
Professional Title					
None	8/23	Ref.		Ref.	
Junior	43/84	1.966(0.754,5.130)	0.167	2.325(0.849,6.366)	0.101
Intermediate	91/142	3.346(1.328,8.429)	**0.010**	4.065(1.529,10.808)	**0.005**
Vice Senior	21/32	3.580(1.161,11.040)	**0.026**	5.443(1.614,18.361)	**0.006**
Senior	6/6	/	/		
Type of medical institution					
General Hospital	132/205	Ref.			
Specialist Hospital	16/34	0.492(0.237,1.022)	0.057		
Chinese Medicine Hospital	19/43	0.438(0.225,0.852)	**0.015**		
Others	2/5	0.369(0.060,2.257)	0.280		
Nature of the institution					
Public Primary	4/9	0.540(0.141,2.072)	0.369		
Public Secondary	39/67	0.940(0.536,1.648)	0.829		
Public Tertiary	120/201	Ref.			
Private hospital	6/10	1.012(0.277,3.701)	0.985		
Years of work experience					
1 year and below	6/19	0.252(0.089,0.711)	**0.009**		
1–3 years	20/36	0.682(0.320,1.454)	0.322		
4–6 years	33/51	1.000(0.503,1.987)	1.000		
7–10 years	33/62	0.621(0.332,1.159)	0.135		
10 years and above	77/119	Ref.			
Number of times to attend academic conferences or continuing medical education activities					
Less than 2 times	19/43	Ref.			
2–5 times	77/137	1.621(0.813,3.232)	0.170		
6–10 times	35/54	2.327(1.024,5.289)	**0.044**		
10 times and above	38/53	3.200(1.370,7.473)	**0.007**		
Whether HR-MRI has ever been performed					
Yes	126/190	Ref.		Ref.	
No	43/97	0.404(0.245,0.668)	**<0.001**	0.422(0.236,0.753)	**0.003**

Notes: Bold values indicate statistical significance at P < 0.05 (multivariate logistic regression analysis).

Table 7 Statistical Analyses (Univariate, Multivariate Analyses). Attitude Dimension

Cut-Off Value:≥59 /<59	**No.**	**Univariate**		**Multivariate (Regression Method = Backward - LR Method)**	
		OR(95% CI)	**P**	**OR(95% CI)**	**P**
Gender					
Male	80/134	Ref.		Ref.	
Female	67/153	0.526(0.329, 0.842)	**0.007**	0.519(0.309, 0.874)	**0.014**
Age (years) (comparison mode = difference)					
30 years and below	23/65	Ref.			
31~40 years	82/148	2.269(1.241,4.146)	**0.008**		
41~50 years	34/60	1.585(0.876,2.869)	0.128		
50 years and above	8/14	1.386(0.466,4.126)	0.557		
Education					
Junior college and junior college and below	6/19	0.304(0.109,0.846)	**0.023**		
Undergraduate	53/122	0.506(0.311,0.825)	**0.006**		
Postgraduate	88/146	Ref.			
Occupation					
Doctor	109/192	Ref.			
Medical Technician	30/73	0.531(0.308,0.918)	**0.023**		
Nurse	8/22	0.435(0.174,1.086)	0.074		
Professional Title					
None	8/23	Ref.		Ref.	
Junior	45/84	2.163(0.829,5.646)	0.115	0.521(0.071,3.833)	0.522
Intermediate	71/142	1.875(0.748,4.700)	0.180	0.242(0.030,1.969)	0.185
Vice Senior	17/32	2.125(0.705,6.408)	0.181	0.486(0.051,4.618)	0.530
Senior	6/6	/	/	/	/
Type of medical institution					
General Hospital	115/205	Ref.			
Specialist Hospital	15/34	0.618(0.297,1.283)	0.197		
Chinese Medicine Hospital	16/43	0.464(0.236,0.913)	**0.026**		
Others	1/5	0.196(0.021,1.781)	0.148		
Nature of the institution					
Public Primary	6/9	2.020(0.492,8.300)	0.330		
Public Secondary	34/67	1.041(0.599,1.809)	0.888		
Public Tertiary	100/201	Ref.			
Private hospital	7/10	2.357(0.593,9.372)	0.224		
Years of work experience					
1 year and below	5/19	1.782(0.525,6.043)	0.354	0.095(0.010,0.952)	**0.045**
1–3 years	14/36	5.133(1.591,16.565)	**0.006**	0.330(0.114,0.957)	**0.041**
4–6 years	33/51	2.987(0.959,9.302)	0.059	1.222(0.552,2.706)	0.621
7–10 years	32/62	3.150(1.067,9.301)	**0.038**	0.982(0.482,2.003)	0.960
More than 10 years	63/119	Ref.		Ref.	
Number of times to attend academic conferences or continuing medical education activities					
Less than 2 times	18/43	Ref.			
2–5 times	69/137	1.409(0.705,2.816)	0.331		
6–10 times	36/54	2.778(1.212,6.364)	**0.016**		
10 times and above	24/53	1.149(0.510,2.589)	0.737		
Whether HR-MRI has ever been performed					
Yes	119/190	Ref.		Ref.	
No	28/97	0.242(0.143,0.411)	**<0.001**	0.221(0.124,0.395)	**<0.001**

Notes: Bold values indicate statistical significance at P < 0.05 (multivariate logistic regression analysis).

experience demonstrated weaker understanding. These findings indicate that the promotion of HR-MRI VWI still faces challenges related to insufficient awareness and highlights the need for targeted training programs to facilitate its clinical adoption.[15]

Compared with previous studies, our findings align with research examining the perception of emerging imaging technologies. For example, prior studies have reported limited ability among non-radiologists to interpret HR-MRI VWI images and a lack of recognition of its value in disease management. Furthermore, regular training and multidisciplinary collaboration have been demonstrated to be effective in enhancing physicians' proficiency with advanced imaging techniques.[16] This study further substantiates these observations and underscores the necessity of training programs tailored to different professional groups.[17,18]

To address these gaps, differentiated training strategies should be implemented based on professional specialization. Radiologists require specialized training in HR-MRI VWI interpretation, including high-risk plaque identification and vascular wall enhancement pattern analysis. Neurologists and specialists in vascular diseases should receive targeted education on the application of HR-MRI VWI in stroke assessment, vasculitis diagnosis, and intracranial arterial disease management. General clinicians, including geriatricians, should be trained on the indications and limitations of HR-MRI VWI, ensuring appropriate utilization in clinical decision-making. Establishing specialty-specific training modules can optimize the clinical impact of HR-MRI VWI and enhance its integration into evidence-based medical practice.[19] Additionally, fostering multidisciplinary collaboration (MDT) between radiologists and referring clinicians can further improve diagnostic accuracy and patient management.[20]

HR-MRI VWI is a valuable imaging tool for the assessment of vascular pathologies, particularly in conditions such as atherosclerosis, high-risk plaque evaluation, vasculitis, moyamoya disease, and intracranial artery dissection.[21] As part of the broader family of 3D low-energy Black Blood MR Angio methods, HR-MRI maintains vessel wall tissue in a steady-state energy condition. While commonly referred to as a T1-weighted imaging method, these techniques exhibit different contrast behaviors, with vascular walls appearing proton-density weighted before contrast administration and transitioning to T1-weighted post-gadolinium due to increased pathology-related spin activity. However, despite its clinical utility, its routine implementation remains limited due to prolonged scanning times, complex interpretation, and the absence of standardized training.[22,23] Moreover, the clinical benefits of HR-MRI VWI are primarily seen in selected high-risk patient populations, rather than as a universal screening tool.[24] While education is crucial for improving medical staff proficiency, the complexity and evolving nature of HR-MRI techniques suggest that their current applications remain predominantly research-driven. The refinement of acquisition protocols, standardization of interpretation criteria, and validation in diverse patient populations will be necessary steps before HR-MRI can be fully integrated as a standard diagnostic tool in cerebrovascular disease management.[25]

Several limitations should be acknowledged. First, this study was conducted at a single center, which may limit the generalizability of the findings. Future multicenter studies are required to validate these results. Second, as a self-reported questionnaire-based study, response bias cannot be excluded, and future research could incorporate objective assessments of knowledge and competency. Finally, this study did not evaluate the effectiveness of training interventions in improving HR-MRI VWI knowledge and attitudes. Future research should explore the impact of various training modalities, such as case-based learning, online modules, and hands-on workshops, in enhancing medical staff proficiency. Additionally, HR-MRI VWI for evaluating intracranial arteries has certain limitations. While it provides high-resolution vessel wall visualization, its added diagnostic value is limited to select cases, making it unsuitable for routine clinical use. The extended imaging time and additional technical requirements may not be justified for all patients, as HR-MRI VWI offers only incremental diagnostic benefits. Furthermore, its impact on clinical decision-making remains variable and may not significantly alter the management strategies for most patients.

In conclusion, this study highlights significant gaps in medical staff knowledge and attitudes regarding HR-MRI VWI, particularly among non-radiologists and those with limited clinical experience. While HR-MRI VWI has demonstrated potential in evaluating intracranial arterial wall pathology, its routine clinical implementation remains limited due to technical complexity, extended scanning time, and the absence of standardized diagnostic criteria. To optimize its clinical application, structured training programs should be developed, ensuring that radiologists, neurologists, and general clinicians receive targeted education. Additionally, consistent patient preparation protocols, regular quality assurance (QA) of MRI systems, and multidisciplinary collaboration should be prioritized to enhance the interpretation and appropriate clinical use of HR-MRI VWI. Future research should focus on assessing the effectiveness of educational interventions and refining technical guidelines to facilitate its adoption and integration into clinical practice.

Data Sharing Statement

All data generated or analysed during this study are included in this published article.

Ethics Approval

This work has been carried out in accordance with the Declaration of Helsinki (2000) of the World Medical Association. This work was approved by the Medical Ethics Committee of The Fourth Hospital of Hebei Medical University (No: 2024KS073), and informed consent was obtained from the study participants.

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Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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