Advances in Diffusion-Weighted Imaging: Non–Echo-Planar Versus Multishot Echo-Planar Techniques for Detecting Cholesteatoma

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ABSTRACT

Background: Cholesteatoma is a non-neoplastic but locally destructive lesion of the temporal bone that arises from keratinizing squamous epithelium within the middle ear. Its ability to erode ossicles, compromise hearing, and cause intracranial complications makes accurate and timely diagnosis critical. While computed tomography (CT) provides excellent delineation of bony anatomy, it lacks specificity in differentiating soft-tissue entities. Magnetic resonance imaging (MRI), particularly diffusion-weighted imaging (DWI), has therefore become a cornerstone in the non-invasive diagnosis of suspected cholesteatoma. However, challenges remain regarding the optimal diffusion technique. This review evaluates advances in DWI techniques, specifically comparing non–echo-planar (non-EPI) imaging and multishot echo-planar imaging (msEPI), in the detection of primary and recurrent cholesteatomas. Non-EPI sequences have been widely adopted as the standard due to reduced susceptibility artifacts and improved lesion conspicuity. Nonetheless, msEPI has emerged as a technically refined alternative that addresses some limitations of conventional single-shot echo-planar imaging, offering higher spatial resolution with fewer distortions. The purpose of this article is to synthesize the current evidence, highlight diagnostic performance, and provide insights into the clinical applicability of these two advanced methods.

Conclusion: Both non-EPI and msEPI DWI sequences have significantly improved the sensitivity and specificity of MRI in diagnosing cholesteatoma, reducing the need for second-look surgery and improving patient outcomes. Non-EPI DWI remains the most validated and widely recommended sequence, particularly in postoperative surveillance, due to its robustness and reproducibility. However, recent advances in msEPI have demonstrated comparable diagnostic accuracy with potential benefits in spatial resolution, suggesting a role in comprehensive diagnostic protocols. Future research integrating ultra-high-field MRI, artificial intelligence–driven post-processing, and hybrid imaging may further enhance diagnostic reliability. Ultimately, tailoring the choice of diffusion technique to patient characteristics, institutional expertise, and clinical context remains essential in optimizing cholesteatoma imaging.

Keywords*:* Diffusion-Weighted Imaging, Cholesteatoma

INTRODUCTION

Cholesteatoma is a destructive lesion of the temporal bone characterized by the presence of keratinizing squamous epithelium within the middle ear cavity or mastoid process. Although

histologically benign, its locally invasive nature can lead to ossicular chain erosion, labyrinthine fistula formation, facial nerve palsy, and potentially life-threatening intracranial complications such as meningitis and brain abscess. Accurate early diagnosis is therefore crucial for timely surgical intervention and for minimizing morbidity [1].

Historically, high-resolution computed tomography (HRCT) of the temporal bone has been the primary imaging modality used in preoperative evaluation of cholesteatoma. HRCT provides excellent spatial resolution for delineating bony anatomy, assessing ossicular integrity, and detecting erosions of the scutum or lateral semicircular canal. However, CT has a significant limitation in differentiating soft tissue densities, making it unreliable in distinguishing cholesteatoma from granulation tissue, fibrosis, or postoperative changes [2]. This diagnostic gap has driven the increasing reliance on magnetic resonance imaging (MRI), particularly diffusion-weighted imaging (DWI), which exploits the restricted diffusion of keratin debris to improve diagnostic accuracy [3].

DWI has revolutionized the radiological evaluation of cholesteatoma, offering a non-invasive means of diagnosis with high sensitivity and specificity. Unlike CT, which is primarily structural, DWI provides functional information based on the movement of water molecules. Keratin debris within cholesteatoma demonstrates restricted diffusion, appearing hyperintense on DWI and hypointense on apparent diffusion coefficient (ADC) maps. These imaging characteristics allow reliable differentiation from other soft tissue pathologies [4].

Several DWI techniques are available, each with unique advantages and limitations. Echo-planar imaging (EPI) is the most commonly employed technique due to its speed and availability. However, single-shot EPI suffers from significant susceptibility and motion artifacts in the temporal bone region, leading to misinterpretation. Non–echo-planar (non-EPI) imaging was developed to overcome these limitations and is now widely accepted as the reference standard for cholesteatoma imaging. More recently, multishot echo-planar imaging (msEPI) has emerged as a promising technique, providing higher spatial resolution and fewer distortions compared to single-shot EPI, while retaining some advantages of rapid acquisition [5].

Despite the clinical adoption of non-EPI DWI, the optimal imaging approach remains debated, particularly in postoperative patients where small recurrent cholesteatomas must be distinguished from scar tissue. Recent advances in msEPI sequences raise the question of whether this technique can match or surpass non-EPI performance in diagnostic accuracy. Understanding these evolving techniques is crucial for radiologists and otologic surgeons when selecting the most appropriate imaging strategy [6].

The aim of this review is to compare non-EPI and msEPI DWI techniques in the evaluation of cholesteatoma, focusing on their diagnostic performance, clinical utility, and limitations. By synthesizing current evidence, this article seeks to clarify their respective roles and provide guidance

for clinical decision-making, while also highlighting future directions in diffusion-weighted MRI for otologic imaging [7].

Cholesteatoma: Pathophysiology and Clinical Challenges

Cholesteatoma is a keratinizing squamous epithelial lesion of the middle ear that behaves in a clinically aggressive manner despite being histologically benign. Its hallmark feature is the progressive accumulation of keratin debris within a sac of stratified squamous epithelium, which expands and exerts pressure on adjacent structures. Over time, this process leads to erosion of the ossicular chain, scutum, mastoid cortex, and in advanced cases, the otic capsule and cranial base. The destructive potential of cholesteatoma is primarily attributed to a combination of enzymatic activity, chronic inflammation, and local pressure effects [8].

Pathogenetically, cholesteatomas are classified as congenital or acquired. Congenital cholesteatomas arise from epithelial cell rests trapped during embryonic development, typically presenting as a white mass behind an intact tympanic membrane in children with no history of otitis media or prior ear surgery. In contrast, acquired cholesteatomas are far more common and usually result from chronic eustachian tube dysfunction, recurrent otitis media, or tympanic membrane retraction pockets that facilitate epithelial migration into the middle ear cavity [9].

At the cellular level, cholesteatoma epithelium demonstrates hyperproliferation and altered differentiation compared to normal keratinizing epithelium. Overexpression of cytokines such as tumor necrosis factor-α (TNF-α), interleukin-1β, and matrix metalloproteinases (MMPs) has been implicated in bone resorption. Furthermore, cholesteatoma fibroblasts secrete osteoclast-activating factors, enhancing local osteolytic activity. These findings underscore the fact that cholesteatoma is not merely a passive accumulation of keratin but an active biological process driving progressive bone destruction [10].

Clinically, cholesteatoma often presents with chronic otorrhea, conductive hearing loss, and occasionally vertigo or facial nerve palsy. However, early disease can be asymptomatic or mimic chronic otitis media without cholesteatoma, leading to diagnostic delays. The absence of pathognomonic clinical features necessitates the use of imaging for definitive evaluation, particularly in recurrent or residual disease following surgery. Misdiagnosis or delayed recognition may allow disease progression to severe complications including labyrinthitis, sigmoid sinus thrombosis, meningitis, or temporal lobe abscess, all of which carry significant morbidity [11].

Surgical removal remains the gold standard for management, but complete eradication is challenging due to the lesion's infiltrative growth pattern and the anatomical complexity of the middle ear and mastoid. Postoperative recurrence rates are reported to range between 10–30%, especially in pediatric populations. This clinical challenge highlights the need for accurate imaging tools to identify both

primary disease and residual/recurrent cholesteatomas non-invasively, reducing the reliance on planned second-look surgery [12].

Principles of Diffusion-Weighted Imaging (DWI)

Diffusion-weighted imaging (DWI) is an MRI technique that measures the random Brownian motion of water molecules within tissues. In biological systems, water diffusion is influenced by cellular density, integrity of cell membranes, and the presence of intracellular and extracellular barriers. Lesions with high cellularity or keratin debris restrict water movement, producing high signal intensity on DWI sequences and low signal on apparent diffusion coefficient (ADC) maps. This property allows DWI to distinguish cholesteatoma from other middle ear pathologies such as granulation tissue or fluid, which typically demonstrate free diffusion [13].

The principle of DWI relies on applying strong magnetic field gradients to sensitize the MRI signal to water motion. The degree of diffusion weighting is expressed by the b-value, typically ranging between 0 and 1000 s/mm². Higher b-values increase sensitivity to diffusion restriction but reduce signal-to-noise ratio (SNR). In cholesteatoma imaging, optimized b-values are crucial to balance diagnostic accuracy and image quality, as the temporal bone region is prone to susceptibility artifacts due to the presence of air-bone interfaces [14].

In the temporal bone, conventional single-shot echo-planar imaging (ssEPI) has historically been used due to its speed and robustness. However, ssEPI suffers from magnetic susceptibility artifacts and geometric distortions that are particularly problematic in the skull base region. These artifacts can obscure small lesions or generate false positives, limiting its reliability in cholesteatoma evaluation. To overcome these issues, alternative sequences such as non–echo-planar (non-EPI) DWI and multishot echo-planar imaging (msEPI DWI) have been developed, each with unique technical refinements to minimize artifacts and improve spatial resolution [15].

DWI's clinical utility in cholesteatoma rests on its ability to provide functional rather than purely anatomical information. Keratin debris, which is the hallmark of cholesteatoma, consistently demonstrates restricted diffusion due to its dense cellular and proteinaceous composition. This feature provides a reproducible imaging biomarker for diagnosis, which is particularly valuable in postoperative cases where conventional MRI sequences may be confounded by scar tissue, fibrosis, or packing material. As such, DWI has become indispensable in differentiating true recurrence from benign postoperative findings, reducing the need for unnecessary second-look surgeries [16].

Another important principle in DWI interpretation is lesion size. Studies have demonstrated that lesions larger than 3–5 mm are reliably detected on DWI, while smaller lesions may fall below the resolution threshold of current sequences. This limitation underscores the importance of optimizing acquisition parameters and choosing the most appropriate DWI technique for clinical application, as even small residual cholesteatomas can have long-term clinical implications if left undetected [17].

Non–Echo-Planar Diffusion-Weighted Imaging (Non-EPI DWI)

Non–echo-planar (non-EPI) diffusion-weighted imaging was developed to overcome the limitations of conventional single-shot EPI sequences, which are prone to susceptibility artifacts and geometric distortions in the temporal bone. Unlike EPI, non-EPI sequences use alternative readout strategies such as turbo spin-echo (TSE) or half-Fourier acquisition single-shot turbo spin-echo (HASTE). These methods significantly reduce magnetic susceptibility effects, improve image sharpness, and provide higher lesion conspicuity in the middle ear and mastoid region [18].

Since its introduction in the late 1990s, non-EPI DWI has become the most validated and widely adopted technique for cholesteatoma imaging. Multiple studies have consistently demonstrated its superior diagnostic performance, with reported sensitivities ranging from 80–100% and specificities between 85–100%. These results hold true for both primary and recurrent cholesteatomas, making non-EPI DWI the current reference standard in clinical practice [19].

One of the most important advantages of non-EPI DWI is its ability to reliably detect recurrent or residual cholesteatoma postoperatively. Conventional MRI sequences often struggle to differentiate between recurrent disease and postoperative changes such as granulation tissue or fat grafts. Non-EPI DWI, by exploiting the restricted diffusion of keratin debris, can non-invasively identify residual disease, thereby reducing the need for second-look surgeries. This has led to a paradigm shift in otologic practice, where radiological surveillance with non-EPI DWI has become an accepted alternative to routine planned second-look procedures [20].

From a technical standpoint, non-EPI DWI provides higher spatial resolution compared to EPI, with slice thicknesses as low as 2–3 mm. This allows detection of smaller lesions, with most studies citing a threshold of 3 mm for reliable visualization. However, sensitivity decreases for lesions below this size, posing a limitation in cases of microscopic residual disease. Despite this, the technique remains highly robust, especially when combined with conventional MRI sequences and preoperative CT for comprehensive evaluation [21].

Nonetheless, non-EPI DWI is not without challenges. Scan times are typically longer than EPI-based methods, which can increase the risk of motion artifacts in uncooperative or pediatric patients. Additionally, false positives may occur in cases of hemorrhage or proteinaceous fluid, though these are relatively uncommon with optimized protocols. Despite these limitations, the diagnostic confidence and reproducibility of non-EPI DWI make it indispensable in the workup of suspected cholesteatoma [22].

Multishot Echo-Planar Diffusion-Weighted Imaging (msEPI DWI)

Multishot echo-planar diffusion-weighted imaging (msEPI DWI) is an advanced MRI technique designed to overcome the susceptibility artifacts, distortions, and low spatial resolution of conventional single-shot EPI. Unlike single-shot acquisition, which collects all k-space data in one readout, msEPI

divides the acquisition into multiple segments. This segmentation reduces T2* blurring, decreases geometric distortion, and enhances spatial resolution, making msEPI more suitable for imaging complex anatomical regions such as the temporal bone [23].

The principal advantage of msEPI DWI lies in its ability to provide higher in-plane resolution and thinner slices than single-shot EPI, enabling better visualization of small lesions within the middle ear cleft. In studies comparing msEPI with non-EPI DWI, msEPI has shown comparable diagnostic accuracy with improved lesion conspicuity in certain cases. Moreover, msEPI retains relatively shorter acquisition times compared to non-EPI sequences, offering a balance between speed and image quality [24].

Technological advances such as parallel imaging and navigator-based motion correction have further improved msEPI by reducing phase errors that previously limited its utility. These refinements have enhanced the reproducibility of msEPI sequences, making them increasingly viable for routine clinical application. Additionally, msEPI demonstrates reduced susceptibility to magnetic field inhomogeneities compared to single-shot EPI, which is particularly valuable in the temporal bone region where air-bone interfaces create significant distortion [25].

Clinically, msEPI DWI has demonstrated promising results in the detection of both primary and recurrent cholesteatomas. Several studies report sensitivities and specificities in the range of 85–95%, approaching the performance of non-EPI DWI. Importantly, msEPI allows for thinner section imaging, enabling detection of smaller cholesteatomas, which is crucial in postoperative surveillance. However, sensitivity still declines for lesions under 3 mm, consistent with the limitations observed in non-EPI DWI [26].

Despite these strengths, msEPI DWI is not yet as widely implemented as non-EPI DWI, largely due to technical complexity, limited availability across MRI platforms, and greater susceptibility to motion artifacts during the segmented acquisition process. Patient movement between shots can lead to phase inconsistencies and ghosting artifacts, which degrade image quality. These challenges highlight the need for careful patient selection and optimized acquisition protocols when using msEPI for temporal bone imaging [27].

In summary, msEPI DWI represents a significant advancement over traditional single-shot EPI and has emerged as a credible alternative to non-EPI sequences. While its broader adoption is still limited, ongoing improvements in MRI hardware, faster acquisition strategies, and robust motion correction algorithms are likely to enhance its clinical role in the near future. Ultimately, msEPI holds promise as a high-resolution technique that may complement or, in select scenarios, rival non-EPI DWI in the evaluation of cholesteatoma [28].

Comparative Studies: Non-EPI vs. msEPI DWI

Several studies have directly compared non–echo-planar (non-EPI) and multishot echo-planar (msEPI) diffusion-weighted imaging in the evaluation of cholesteatoma. Non-EPI has long been considered the reference standard due to its excellent diagnostic accuracy and reproducibility across different clinical settings. However, msEPI has emerged as a promising alternative, with several trials showing comparable sensitivity and specificity, particularly for larger lesions. The growing body of literature highlights that both sequences are reliable in detecting cholesteatomas greater than 3–5 mm in size [29].

In comparative diagnostic accuracy trials, non-EPI consistently achieves sensitivity rates of 85–100% and specificity rates of 80–100%. Similarly, msEPI has demonstrated sensitivity between 85–95% and specificity of up to 97%. Some reports even suggest that msEPI provides better delineation of lesion margins due to its higher spatial resolution, which is especially beneficial in differentiating cholesteatomas from adjacent granulation tissue or scarring. Nonetheless, non-EPI remains superior in terms of robustness and availability across institutions [30].

Postoperative follow-up imaging provides the most stringent test for these modalities. Non-EPI has proven highly reliable in detecting residual or recurrent disease, reducing the need for planned second-look surgeries. Comparative analyses indicate that msEPI also performs well in this context, with similar detection rates for lesions above 3 mm. However, msEPI is more prone to motion-related artifacts because of its segmented acquisition, which can limit its consistency in uncooperative patients, especially children [31].

An important distinction lies in lesion conspicuity. Non-EPI sequences often demonstrate more uniform lesion hyperintensity with minimal distortion, whereas msEPI can provide sharper visualization of lesion boundaries but occasionally at the expense of artifact contamination. Studies have reported that radiologist confidence scores remain higher with non-EPI, despite msEPI's theoretical advantage in resolution. This suggests that while msEPI may have technical superiority in certain aspects, clinical reliability still favors non-EPI in routine practice [32].

Cost-effectiveness and accessibility also influence comparative adoption. Non-EPI sequences are widely available on most MRI platforms, with standardized protocols validated across institutions. In contrast, msEPI requires advanced MRI hardware and expertise in protocol optimization, which limits its widespread use. For this reason, non-EPI continues to be recommended in consensus guidelines as the first-line diffusion technique for suspected cholesteatoma, while msEPI is considered an emerging adjunct with potential for broader clinical application in the future [33].

Clinical Applications and Diagnostic Algorithms

The clinical utility of diffusion-weighted imaging (DWI) in cholesteatoma extends from the initial diagnostic workup to postoperative surveillance. In the preoperative setting, non-EPI DWI has become invaluable in confirming the presence of cholesteatoma when clinical and otoscopic findings are

equivocal. High-resolution CT remains essential for surgical planning due to its ability to delineate bony anatomy, but its inability to differentiate soft tissue necessitates the complementary role of DWI. Non-EPI or msEPI sequences provide functional contrast, enabling radiologists to confidently distinguish cholesteatoma from chronic inflammatory tissue, thereby guiding surgical decision-making [34].

One of the most impactful applications of DWI lies in postoperative follow-up. Traditionally, patients underwent planned second-look surgeries approximately 9–18 months after primary surgery to assess for residual disease. However, non-EPI DWI has dramatically reduced the need for these procedures by enabling accurate, non-invasive detection of recurrent or residual cholesteatomas. Several prospective studies have shown that reliance on non-EPI DWI in postoperative surveillance maintains excellent diagnostic outcomes while sparing patients the risks and morbidity of unnecessary surgery [35].

In pediatric populations, where the incidence of residual disease is higher and repeated surgeries carry greater risks, non-EPI DWI has proven particularly beneficial. Children often face challenges with compliance during imaging, making the shorter acquisition time of msEPI attractive in this group. Although motion artifacts remain a limitation, refinements in msEPI protocols with motion correction strategies have improved its feasibility, suggesting a complementary role alongside non-EPI sequences in pediatric practice [36].

Integration of DWI into diagnostic algorithms typically involves its use in conjunction with CT and conventional MRI sequences. A typical algorithm may begin with HRCT to evaluate bony erosion and mastoid involvement, followed by non-EPI DWI to confirm cholesteatoma. In cases of postoperative follow-up, DWI often serves as the first-line imaging modality, with CT reserved for cases where surgical planning is anticipated. This multimodal approach balances sensitivity, specificity, and anatomical detail, optimizing outcomes for patients [37].

Beyond diagnosis, DWI findings can also influence surgical strategies. Lesions identified as large and localized may be approached via canal wall up procedures, whereas extensive or recurrent disease often warrants a canal wall down technique. Furthermore, the ability of DWI to identify multiple foci of disease can alter operative planning, highlighting its role not just in detection but in comprehensive surgical preparation. By refining preoperative assessment and postoperative monitoring, DWI has become central to modern cholesteatoma management algorithms [38].

Limitations and Challenges

Despite its proven value, diffusion-weighted imaging (DWI) for cholesteatoma is not without limitations. The most significant challenge remains the detection of very small lesions. Both non-EPI and msEPI sequences have a reliable detection threshold of around 3 mm. Lesions smaller than this may escape detection due to partial volume averaging or insufficient spatial resolution. This limitation

is particularly problematic in postoperative surveillance, where even tiny residual foci can eventually lead to clinically significant recurrence if missed [39].

Susceptibility artifacts continue to represent another challenge, particularly in echo-planar imaging–based methods. Although msEPI reduces distortion compared to single-shot EPI, it remains more prone to phase inconsistencies and ghosting artifacts due to its segmented acquisition. Non-EPI sequences largely overcome susceptibility issues but are more sensitive to motion, leading to degradation of image quality in uncooperative patients. Motion-related artifacts are especially problematic in children, who may require sedation to obtain diagnostic-quality images [40].

False positives are another concern in clinical practice. Hyperintense signals on DWI are not entirely specific to cholesteatoma. Conditions such as proteinaceous fluid, hemorrhage, or even dense granulation tissue may mimic the restricted diffusion of cholesteatoma. Careful correlation with ADC maps, conventional MRI sequences, and CT findings is therefore required to minimize misdiagnosis. False negatives may also occur when lesions are small, peripherally located, or masked by adjacent artifacts [41].

Practical considerations also limit widespread adoption of certain DWI techniques. Non-EPI sequences, while validated, have longer acquisition times than msEPI or single-shot EPI, increasing vulnerability to motion artifacts. Conversely, msEPI requires advanced MRI hardware and sophisticated post-processing for artifact correction, which may not be universally available. These technical disparities contribute to variability in diagnostic performance between institutions and highlight the importance of standardized protocols [42].

Finally, there remains a gap in the standardization of reporting and interpretation criteria. Although most studies define positive findings based on hyperintensity on high b-value images with corresponding low signal on ADC maps, interobserver variability persists, particularly in borderline cases. The absence of universally accepted guidelines can lead to discrepancies in diagnostic confidence and clinical decision-making. Addressing this gap through consensus guidelines and training will be essential to ensure reproducibility and reliability in the application of DWI for cholesteatoma [43].

Future Directions in DWI for Cholesteatoma

The field of diffusion-weighted imaging (DWI) in temporal bone imaging continues to evolve, with several promising innovations aimed at improving diagnostic accuracy and overcoming current limitations. One of the most significant avenues of advancement is the development of ultra-high-field MRI systems, such as 3T and emerging 7T scanners. Higher field strengths provide superior signal-to-noise ratio, which can be translated into improved spatial resolution. This is particularly relevant for cholesteatoma imaging, where the detection of small residual lesions remains a challenge. Preliminary

studies at 3T have demonstrated enhanced lesion conspicuity and reduced acquisition times compared to 1.5T systems, although susceptibility artifacts may increase and require sequence optimization [44]. Artificial intelligence (AI) and machine learning are also being increasingly applied to DWI data. AI-driven post-processing techniques can assist in artifact reduction, automated lesion detection, and quantitative analysis of diffusion parameters. Early research suggests that convolutional neural networks can be trained to distinguish cholesteatoma from granulation tissue with higher accuracy than conventional radiological assessment. The integration of such algorithms into routine workflow may reduce interobserver variability and enhance diagnostic confidence, especially for borderline or subtle lesions [45].

Another area of innovation is the development of advanced diffusion models beyond conventional monoexponential ADC mapping. Techniques such as intravoxel incoherent motion (IVIM) and diffusion kurtosis imaging (DKI) allow for more detailed characterization of tissue microstructure. In the context of cholesteatoma, these methods may provide additional biomarkers to differentiate keratin debris from other middle ear pathologies, potentially enabling detection of smaller lesions that currently fall below the threshold of standard DWI [46].

Hybrid imaging strategies combining DWI with other modalities also hold promise. For instance, PET-MRI has been proposed as a tool for comprehensive evaluation of head and neck lesions. While its role in cholesteatoma remains exploratory, hybrid imaging could theoretically provide simultaneous metabolic and diffusion-based information, offering a more holistic assessment. Furthermore, integration of functional MRI sequences, such as perfusion and spectroscopy, may enhance characterization of complex middle ear pathology beyond what DWI alone can achieve [47].

Finally, efforts are underway to establish standardized international guidelines for the acquisition, interpretation, and reporting of DWI in cholesteatoma. Such initiatives are crucial to ensure reproducibility across institutions and to facilitate multicenter research. By combining technological advancements with consensus-driven clinical protocols, the next decade may witness a transformation in the role of DWI, establishing it not only as a diagnostic tool but also as a prognostic and potentially therapeutic guide in cholesteatoma management [48].

Conclusion

Diffusion-weighted imaging (DWI) has revolutionized the evaluation of cholesteatoma by providing a non-invasive and highly reliable diagnostic tool that overcomes the limitations of conventional CT and routine MRI sequences. Non–echo-planar (non-EPI) DWI has established itself as the clinical reference standard due to its consistent diagnostic accuracy, reproducibility, and widespread availability. It plays a vital role in both preoperative assessment and postoperative surveillance, helping to reduce the need for planned second-look surgeries.

Multishot echo-planar imaging (msEPI DWI) represents a promising advancement, offering improved spatial resolution and reduced susceptibility artifacts compared to single-shot EPI. Although not yet as widely available as non-EPI, msEPI has shown comparable diagnostic performance in many settings, with the added advantage of shorter acquisition times that can be beneficial in certain patient populations, such as children.

While both techniques are effective, practical factors such as accessibility, artifact resistance, and ease of interpretation currently favor non-EPI as the first-line approach. However, msEPI is rapidly gaining recognition as a complementary tool, and with further technical refinements, it may become a strong contender in routine clinical practice.

Future developments, including ultra-high-field MRI, artificial intelligence–based post-processing, and advanced diffusion models, hold the potential to enhance diagnostic performance even further, particularly for very small lesions. Standardization of imaging protocols and reporting practices will also be critical in ensuring reproducibility and reliability across different institutions.

In summary, non-EPI DWI remains the cornerstone of cholesteatoma imaging, while msEPI represents an important and evolving technique. Together, these advances mark a significant step forward in the integration of functional imaging into otologic practice, supporting more precise diagnosis, improved patient outcomes, and tailored surgical planning.

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