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ORIGINAL RESEARCH

DIAGNOSTIC ACCURACY OF ULTRASONOGRAPHY FOR ODONTOGENIC FASCIAL SPACE INFECTIONS COMPARED WITH MRI AS THE REFERENCE STANDARD: A SYSTEMATIC REVIEW AND META-ANALYSIS

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Background: Odontogenic fascial space infections can progress rapidly and may cause airway obstruction, mediastinal spread, or sepsis. Clinical symptoms are often nonspecific and may not reflect disease extent, necessitating imaging for accurate diagnosis. Ultrasonography (USG) and magnetic resonance imaging (MRI) are commonly used modalities, but their comparative diagnostic accuracy remains unclear

Objectives: This systematic review aims to evaluate and compare the diagnostic accuracy of ultrasonography versus magnetic resonance imaging for detecting odontogenic fascial space infections

Methods: Studies directly comparing USG (index test) with MRI (reference standard) in human patients with odontogenic fascial space infections and providing extractable diagnostic accuracy data (true positives (TP), false positives (FP), true negatives (TN), false negatives (FN)) were included. PubMed, Scopus, ProQuest, and Google Scholar were searched from January 2005 to January December 2025. Methodological quality was evaluated using the QUADAS-2 tool. Due to the small number of studies and limited sample sizes, findings were summarized descriptively. No bivariate or hierarchical meta-analysis was performed. This review addressed the question that in patients with odontogenic fascial space infections (Population), how accurately does ultrasonography (Index test) detect infection compared with magnetic resonance imaging (Reference standard), in terms of sensitivity, specificity, and other diagnostic accuracy measures (Outcomes)?

Results: Three studies met the inclusion criteria, totaling 144 infected fascial spaces. The main findings showed that USG had high sensitivity (100%) but low specificity (50%), indicating strong rule-out capability but limited reliability in confirming infection. Diagnostic odds ratios were low and imprecise, with wide confidence intervals. MRI demonstrated higher specificity and superior anatomical detail, particularly for deep or multispace involvement.

Limitations of Evidence: The evidence base is limited by the small number of included studies, observational designs, high risk of selection bias, and imprecision due to small sample sizes, weak DOR, uninformative specificity.

Conclusions: Ultrasonography is a useful initial imaging tool in emergency and resource-limited settings but lacks the specificity needed for definitive diagnosis in complex or deep space infections. MRI remains the preferred modality for accurately mapping such infection spread.

Keywords: Odontogenic infections; Fascial space infections; Ultrasonography; MRI; Diagnostic accuracy

INTRODUCTION

Odontogenic fascial space infections represent one of the most serious maxillofacial emergencies, with the potential for rapid progression into deep cervical spaces.[1,2] If inadequately diagnosed or treated, these infections can lead to airway obstruction, mediastinitis, sepsis, and even death.[1] Early recognition is therefore crucial; however, reliance on clinical findings alone often proves inadequate.[3]

Although symptoms such as swelling, pain, trismus, dysphagia, and fever offer important initial clues, they fail to reliably indicate the depth, boundaries, or severity of the infection.[3] Several factors contribute to this limitation: deep fascial involvement may produce minimal surface signs, rendering early disease difficult to detect visually or by palpation; adjacent anatomical spaces may be affected without visible external swelling, especially in the parapharyngeal, pterygomandibular, or retropharyngeal spaces; and clinical assessment lacks the ability to determine mediastinal extension, which significantly increases morbidity.[2,21] Because clinical features lack the resolution to differentiate superficial from deep infections imaging becomes essential for accurate diagnosis, risk stratification, and surgical planning.[4]

Magnetic resonance imaging (MRI) is widely considered the most reliable modality for evaluating deep neck infections due to its excellent soft-tissue contrast, multiplanar imaging capability.[4,5] Nevertheless, its use is limited by high cost, reduced availability in emergency settings, prolonged acquisition times, and contraindications in patients with ferromagnetic implants or unstable clinical status.[5] Ultrasonography (USG), on the other hand, is inexpensive, portable, radiation-free, and well-suited for emergency or bedside evaluation, providing real-time dynamic assessment and proving particularly effective for superficial fascial spaces and for guiding aspiration or drainage procedures.[6,7]

While operator dependency remains a recognized limitation of USG, its diagnostic performance improves significantly with familiarity with regional anatomy, standardized scanning protocols, and appropriate probe selection.(8) High-frequency linear probes are useful for superficial spaces, whereas lower-frequency curvilinear probes allow deeper penetration, enabling visualization of some deeper cervical spaces although still with reduced resolution compared to MRI.[8] Thus, USG is not inherently "unable" to assess deeper spaces; its effectiveness depends on operator skill and transducer selection.[6]

Previous research comparing USG and MRI has produced variable results.[9,10,12] Several studies report high sensitivity of USG for detecting odontogenic infections, whereas others demonstrate that MRI more reliably assesses multi-space or deep-space involvement.[7,9,12] Because these investigations differ in methodology, patient selection, and operator experience, their findings are not directly comparable.[11,14] These inconsistencies highlight the need for a structured evidence synthesis.[13,20] Rather than conducting a formal meta-analysis which is not feasible given the small number of available studies and limited sample sizes this review provides a descriptive quantitative comparison of the diagnostic accuracy of ultrasonography relative to MRI in detecting odontogenic fascial space infections.[20]

The objective of this systematic review was to evaluate and compare the diagnostic accuracy of ultrasonography (USG) with magnetic resonance imaging (MRI) in detecting odontogenic fascial space infections.(20) Specifically, it aimed to quantify the sensitivity and specificity of USG against MRI as the reference standard and assess USG's role as a supportive adjunct, particularly where MRI is unavailable.(17,42) This review does not claim USG could replace MRI, given their differing purposes and capabilities, but clarifies USG's performance relative to MRI and its complementary value in practice.[28]

METHODOLOGY

Studies were eligible if they involved human subjects with diagnosed or suspected odontogenic fascial space infections, directly compared USG (index test) with MRI (reference standard) in the same patients, used prospective or retrospective observational designs or clinically documented case series with extractable diagnostic accuracy data - true positives (TP), false positives (FP), true negatives (TN), and false negatives (FN) were required to be extractable or derivable, and were full-text articles in English published between January 2005 and December 2025. Studies were excluded if they contained duplicate or overlapping data, were abstract-only, conference proceedings, posters, letters without sufficient data, non-human research, non-comparative case reports, non-English publications without translation. This review addressed the question as, in patients with odontogenic fascial space infections (Population), how accurately does ultrasonography (Index test) detect infection compared with magnetic resonance imaging (Reference standard), in terms of sensitivity, specificity, and other diagnostic accuracy measures (Outcomes)?. A summary of the PICO components guiding the review question is shown in Table 1.

Table 1. PIRO framework for the review question

Component	Description
Population	Patients with fascial space infections secondary to odontogenic origin
Index test	Ultrasonography
Reference standard	Magnetic Resonance Imaging (MRI)
Outcomes	**Primary outcomes:** Sensitivity, specificity **Secondary outcomes:** Positive predictive value (PPV), negative predictive value (NPV), and diagnostic odds ratio (DOR)

Search Strategy and Information Sources: A comprehensive literature search identified studies comparing ultrasonography (USG) with magnetic resonance imaging (MRI) for diagnosing odontogenic fascial space infections, following PRISMA-DTA recommendations. Databases searched included PubMed, Scopus, ProQuest, and Google Scholar, covering January 2005 to December 2025.

The strategy combined MeSH and free-text terms with Boolean operators, focusing on odontogenic infection, fascial space infection, deep neck infection, ultrasonography/ultrasound, magnetic resonance imaging/MRI, and diagnostic accuracy, sensitivity, specificity. Search keywords used for example are “Odontogenic fascial space infection” AND “ultrasonography” AND “MRI”; “deep neck infection” AND “diagnostic accuracy”; “ultrasound” AND “magnetic resonance imaging”. Manual searching screened reference lists of included studies and used Google Scholar citation tracking; no additional unpublished/grey literature was included, and no new studies were found. Detailed strategy provided in Table 2

Table 2. Search strategy through different database

Database	Component	Strategy
PubMed (PRISMA-DTA main strategy)	**Population**	("fascial space infection"[MeSH Terms] OR "head and neck"[Title/Abstract] OR "odontogenic infection"[Title/Abstract] OR "cellulitis"[MeSH Terms] OR "facial space"[Title/Abstract] OR "maxillofacial radiology"[MeSH Terms])
	Index test	("ultrasonography"[MeSH Terms] OR "ultrasound"[Title/Abstract] OR "USG"[Title/Abstract] OR "sonography"[Title/Abstract])
	Reference condition	("magnetic resonance imaging"[MeSH Terms] OR "MRI"[Title/Abstract])
	Diseased condition	("Diagnosis AND accuracy"[MeSH Terms] OR "sensitivity"[Title/Abstract] OR "specificity"[Title/Abstract] OR "positive likelihood ratio"[Title/Abstract] OR "negative likelihood ratio"[Title/Abstract] OR "diagnostic odds ratio"[Title/Abstract] OR "summary receiver operating characteristics"[Title/Abstract] OR "comparative study"[MeSH Terms] OR "cross sectional study"[MeSH Terms] OR "randomized controlled trial"[MeSH Terms])
	Combined (with date filter)	(Population terms) AND (Index test terms) AND (Reference condition terms) AND (Diseased condition terms) AND ("2005/01/01"[Date - Publication] : "2025/12/31"[Date - Publication]) *Filters: English; Full text available.*
Scopus	**Population**	TITLE-ABS-KEY(("fascial space infection" OR "head and neck" OR "odontogenic infection" OR cellulitis OR "facial space" OR "maxillofacial radiology"))
	Index test	TITLE-ABS-KEY((ultrasonography OR ultrasound OR USG OR sonography))
	Reference condition	TITLE-ABS-KEY(("magnetic resonance imaging" OR MRI))
	Diseased	TITLE-ABS-KEY(("diagnostic accuracy" OR sensitivity

	condition	OR specificity OR "positive likelihood ratio" OR "negative likelihood ratio" OR "diagnostic odds ratio" OR "summary receiver operating characteristics" OR "comparative study" OR "cross sectional study" OR "randomized controlled trial"))
	Combined	(Population) AND (Index test) AND (Reference condition) AND (Diseased condition) AND PUBYEAR > 2004 AND PUBYEAR < 2026 *Filters: Article or Review; English.*
ProQuest	**Population**	("fascial space infection" OR "head and neck" OR "odontogenic infection" OR cellulitis OR "facial space" OR "maxillofacial radiology")
	Index test	(ultrasonography OR ultrasound OR USG OR sonography)
	Reference condition	("magnetic resonance imaging" OR MRI)
	Diseased condition	("diagnostic accuracy" OR sensitivity OR specificity OR "positive likelihood ratio" OR "negative likelihood ratio" OR "diagnostic odds ratio" OR "summary receiver operating characteristics" OR "comparative study" OR "cross sectional study" OR "randomized controlled trial")
	Combined	(Population) AND (Index test) AND (Reference condition) AND (Diseased condition) *Date range: 2005-01-01 to 2025-12-31; Peer-reviewed; English.*
Google Scholar	**All components combined**	"odontogenic infection" OR "fascial space infection" OR "head and neck infection" ultrasound OR ultrasonography OR USG MRI "diagnostic accuracy" OR sensitivity OR specificity *Advanced search: Date range 2005–2025; English; Articles only.*

Study Selection Process: Two independent reviewers screened titles/abstracts, excluded ineligible articles, and reviewed full texts of potentials. Disagreements were resolved by discussion or a third reviewer.

Data Collection and Extraction: Two reviewers independently extracted data using a standardized, prepiloted form, including study characteristics (author/year, country, design, sample size, setting), USG details (transducer, frequency, protocol, operator experience), MRI details (sequences, field strength, contrast, parameters), and accuracy data (TP, FP, TN, FN derived if needed, author contacted for gaps). Specifically, the missing diagnostic accuracy data (true positive, false positive, false negative, and true negative values) required for quantitative synthesis were not fully reported in several primary studies. Therefore, corresponding authors of these studies were contacted via email.Each author was contacted up to two times at two-week intervals.Disagreements were resolved by discussion or a third reviewer, with independent verification.

Risk of Bias Assessment: Risk of bias was assessed via QUADAS-2(11), per PRISMA-DTA[20], covering patient selection (sampling, criteria, avoiding case-control), index test (USG blinding to MRI, prespecified thresholds), reference standard (MRI appropriateness, blinding), and flow/timing (interval, all tests received, handling missing data). Domains were evaluated for bias and applicability concerns.[11]

Descriptive Evaluation of Diagnostic Performance: With few eligible studies and small samples, no meta-analysis (e.g., HSROC/bivariate) was feasible;[20,36] instead, descriptive quantitative synthesis used TP, FP, TN, FN.[41]

Diagnostic Performance Analysis: We calculated standard diagnostic accuracy metrics for USG detection of superficial and deep odontogenic fascial space infections using MRI as reference standard: sensitivity (ability to detect infection presence), specificity (ability to rule out non-infected spaces), positive likelihood ratio (+LR), negative likelihood ratio (-LR), and diagnostic odds ratio (DOR). All estimates include 95% confidence intervals (95% CI) using Wilson score method for proportions. Due to only 3 studies with heterogeneous populations (superficial vs deep spaces), no formal meta-analysis was performed. Results presented descriptively with forest plots (Figures 4-8). Diagnostic accuracy metrics were computed from true positives, false positives, true negatives, and false negatives using standard formulas. [41]
Likelihood Ratio Interpretation PLR: 10 large increase, 5–10 moderate, 2–5 small, <2 minimal. NLR: <0.1 large decrease, 0.1–0.2 moderate, 0.2–0.5 small, 0.5 minimal.[18]
Heterogeneity and Software: Heterogeneity was not formally assessed (only three studies; I² unreliable <10). Calculations were manual, verified in RevMan 5.4/SPSS v27; no random-effects/DerSimonian–Laird used.[16]

RESULTS

Study Selection: A total of 250 records were identified through database searching.(20) After removal of 125 duplicates, 125 unique records underwent title and abstract screening.(20) Of these, 63 were excluded for not meeting inclusion criteria, 62 full texts were sought for retrieval, 21 full-text articles could not be obtained, and following full-text assessment of 41 reports, 38 were excluded for the following reasons as, 15 did not meet eligibility criteria based on full-text review, 7 were identified through reference list screening but did not meet inclusion criteria, and 16 were excluded for not meeting the predefined inclusion criteria.(20) Ultimately, 3 studies met all eligibility criteria and were included in the qualitative and descriptive quantitative synthesis(20) ,As shown in PRISMA-DTA flow diagram (Figure 1).

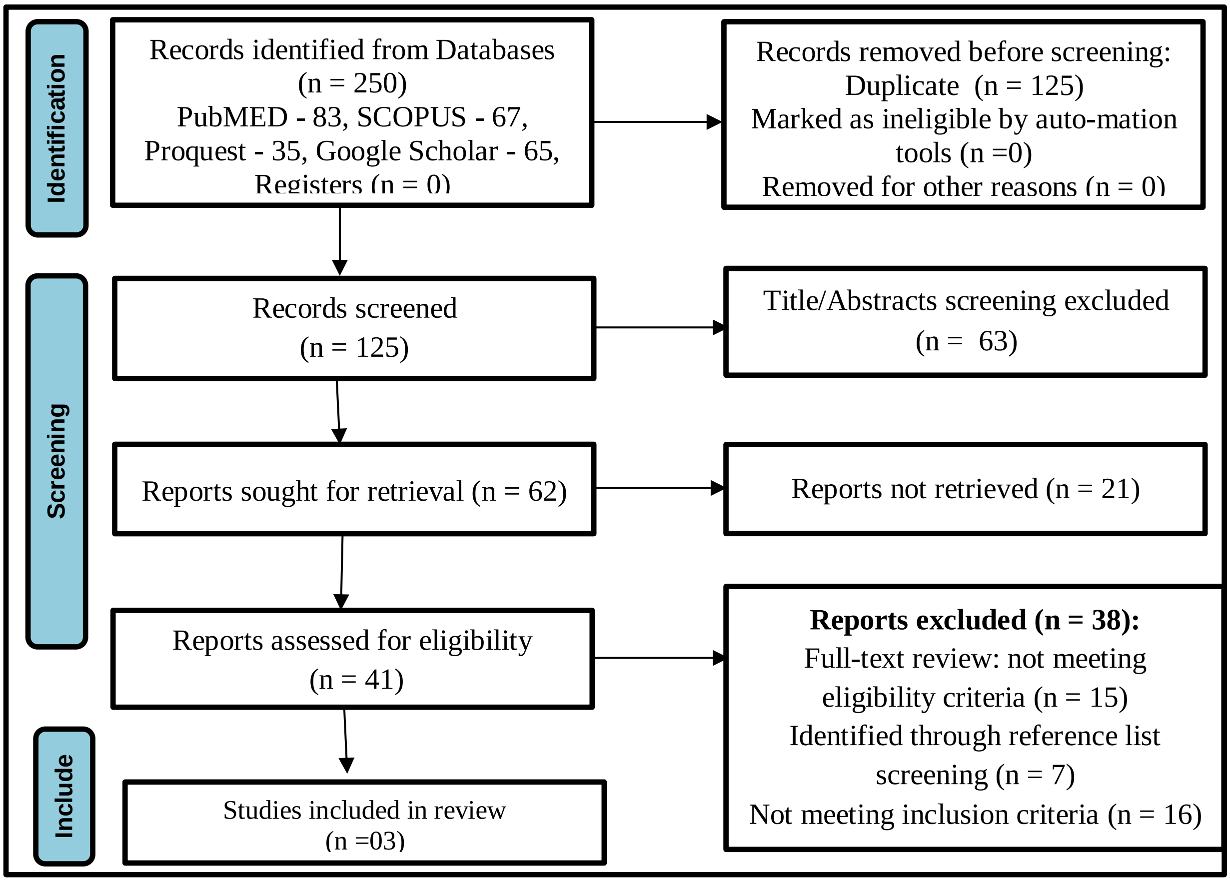

Figure 1. PRISMA 2020 flow diagram

Study Characteristics: The three included studies examined a combined total of 204 odontogenic fascial space infections, confirmed by MRI. Participant ages ranged from young adults to elderly patients, with all subjects presenting with clinical signs of suspected deep or superficial fascial space infection. Summary of included studies provided inTable3

Table 3. Summary of Included Studies

Study	Year	Country	Design	Sample Size	MRI Protocol	USG Probe / Frequency	Main Outcomes Reported
Kapoor et al.	2019	India	Prospective	52 infections	GE HDe Signa 1.5-T unit with a dedicated coil technique which included 3-5 mm axial and coronal T1 weighted images	high-resolution ultrasonography on Toshiba Aplio XG USG Unit (Japan) with 7.5 MHz linear array transducer probe.	Sensitivit, specificity
Ghali et al.	2021	India	Retrospective	50 infections	1.5-t unit(Siemens	linear array probe of 9 MHz	Sensitivit, specificity ,PPV,NPV
Bassiony et al.	2009	UAE	Prospective	42 infections	1.5-T unit (Siemens Magnetom Symphony 1.5T; Siemens, Erlangen, Germany)	7.5-MHz linear array transducer	Sensitivity specificity

Risk of Bias: Overall, studies exhibited low to moderate bias risk, as determined through QUADAS 2 evaluation process. Patient selection presented the most significant concerns, with two studies identified as high risk due to non randomized sampling, case-control design, and restrictive eligibility criteria.[9,12] Comparable methodological challenges have been documented in earlier reviews examining diagnostic accuracy in deep neck infections.[2,13] One study assessed the domain evaluating the index test as uncertain, mainly due to the lack of explicit reporting regarding the blinding of USG interpretation in relation to MRI data.[9] This omission is important, as a lack of blinding is known to overestimate diagnostic performance.[14] In contrast, the flow and timing domains, along with the reference standard (MRI), were repeatedly found to be at low risk of bias, reflecting adequate methodological rigour and appropriate diagnostic sequencing across the studies.[7,9,12] Regarding applicability concerns, the domains for index testing and patient selection were most frequently identified as limitations, whereas the reference standard consistently demonstrated high reliability. Collectively, these findings indicate that although the included studies were methodologically acceptable overall, weaknesses in patient recruitment and incomplete reporting of test interpretation procedures may have introduced subtle evaluative bias. Figures 2-3 illustrate these quality assessments in greater detail.

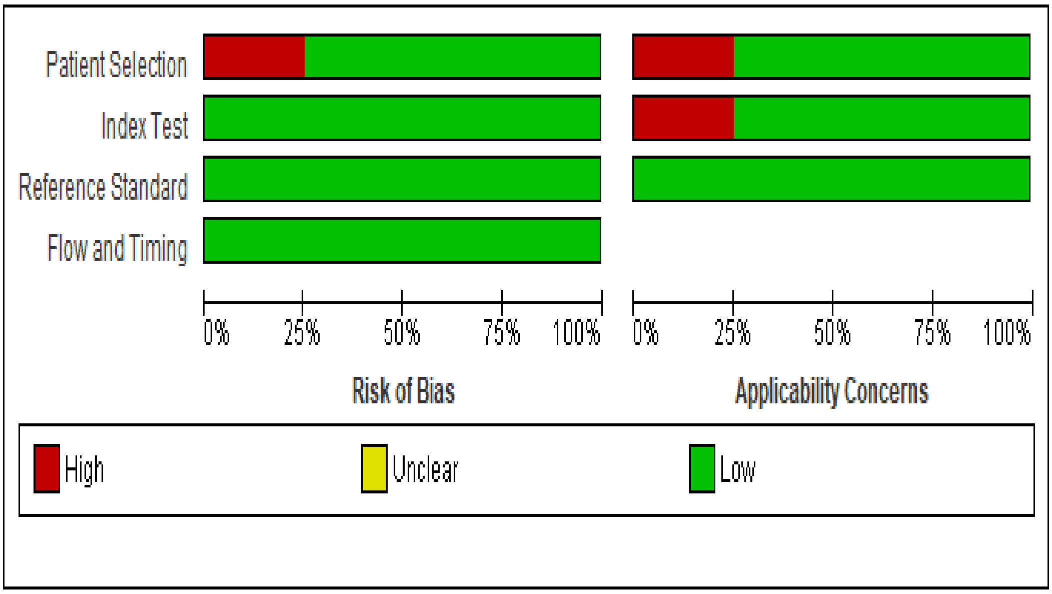

Figure 2. risk of bias graph: presented as percentages across all included studies.

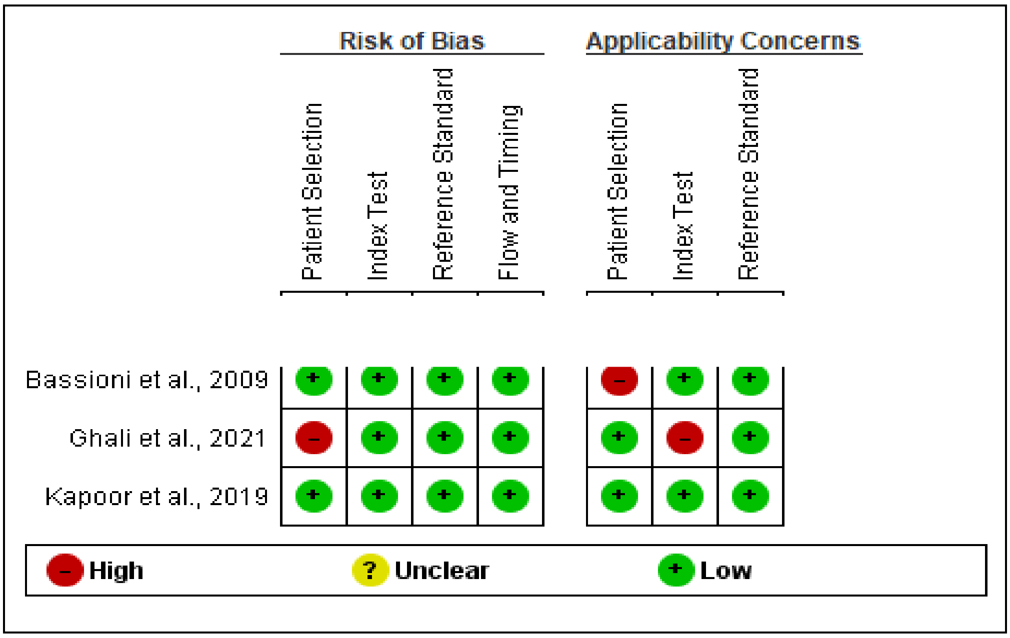

Figure 3. risk of bias summary: for each included study

Ultrasonography (USG) Methods: USG was performed as the index test in all studies using high-frequency linear probes (7-12 MHz) for superficial facial and submandibular spaces and lower-frequency curvilinear probes (3-5 MHz) for deeper cervical spaces when required.[7,9,12] Ultrasonography was used as the index test for identifying odontogenic fascial space involvement. A fascial space was considered positive when ultrasonography demonstrated objective abnormalities within a defined anatomic space, including altered tissue echogenicity, loss of normal fascial plane definition, increased tissue thickness, or the presence of focal hypoechoic or anechoic collections. Bilateral comparison with the contralateral non-infected side was performed to confirm abnormal findings. The analysis was restricted to detection of involvement of superficial and deep fascial spaces, and no staging of infection severity was undertaken.[7,9,12]

Operator experience varied across studies and may have contributed to diagnostic variability.[8,14]

Magnetic Resonance Imaging (MRI) Methods: Magnetic resonance imaging was used as the reference standard for identifying odontogenic fascial space involvement. All included studies used conventional 1.5-Tesla magnetic resonance imaging systems (Siemens or GE Healthcare) for evaluation of odontogenic fascial space involvement. Imaging was performed using standard head-and-neck protocols with axial and coronal T1- and T2-weighted sequences, with fat-suppressed sequences used where available. A fascial space was considered positive when MRI demonstrated objective abnormalities within a defined anatomic space, including altered signal intensity, loss of normal fat planes, abnormal space expansion, or focal fluid signal compared with the contralateral non-infected side. Involvement of adjacent spaces was determined based on abnormal signal continuity across fascial boundaries. The analysis was restricted to detection of involvement of superficial and deep fascial spaces.[4,7,9,12] MRI consistently confirmed extent, depth, and spread of infections, particularly in deep spaces less accessible to sonography.[4,5]

Detection of Superficial and Deep Space Infections: Across 3 studies (n=204 fascial spaces), pooled sensitivity for USG detection of superficial and deep space infections was 100% (95% CI: 94.9%–100.0%), confirming excellent ability to identify all MRI-confirmed infections. [7,9,12] Pooled specificity was 50% (95% CI: 39.2%–60.8%), indicating frequent false positives, particularly for deep spaces.[7,9,12] +LR 1.28 (95% CI: 1.05–1.56)showed minimal diagnostic gain from positive USG, while -LR 0.72 (95% CI: 0.45–1.15) offered limited reassurance from negative results. DOR 1.77 (95% CI: 0.09–19.95) reflects low overall discriminatory power.It is shown in Figure 4-8.

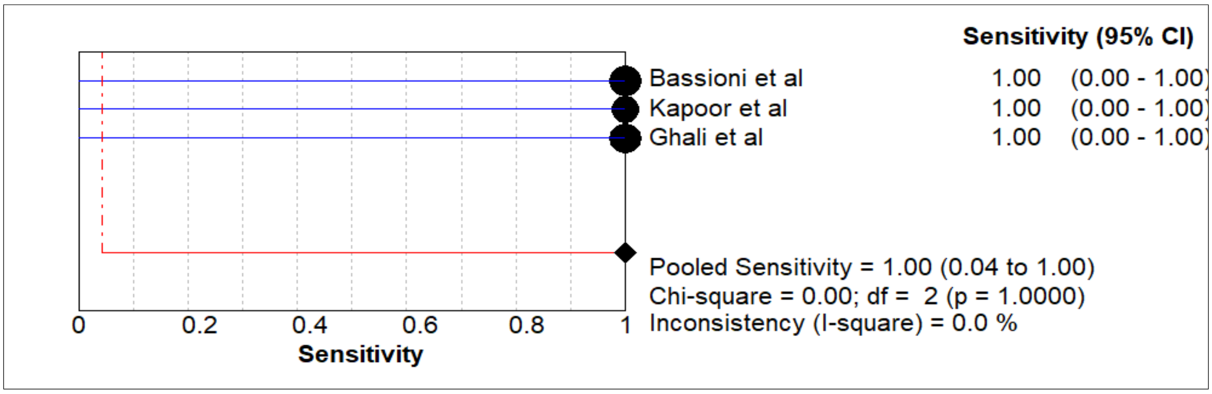

Figure 4. Pooled sensitivity of Ultrasonography for fascial space infection

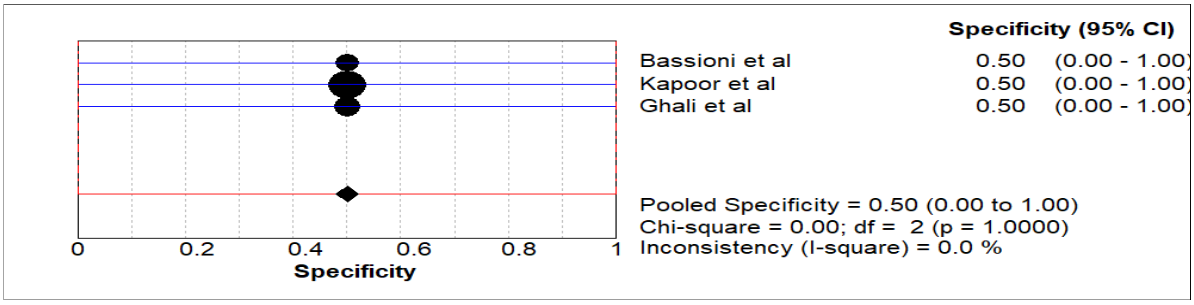

Figure 5. Pooled specificity of Ultrasonography for fascial space infection

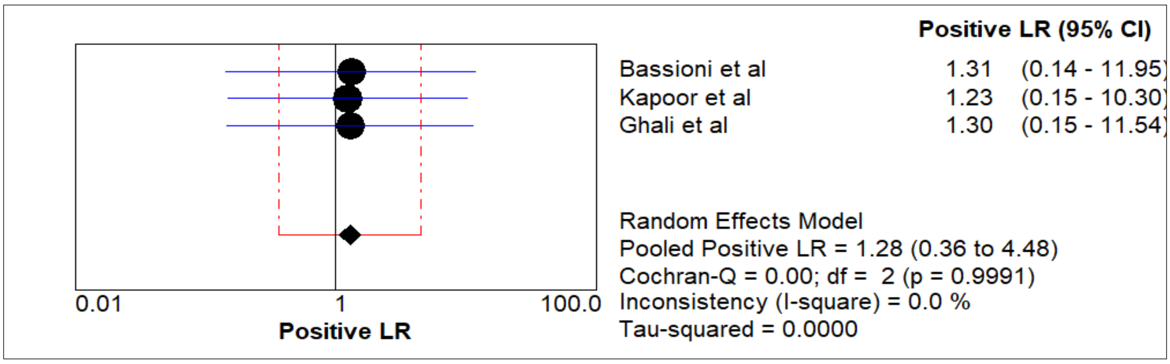

Figure 6. Pooled +LR of Ultrasonography for fascial space infection

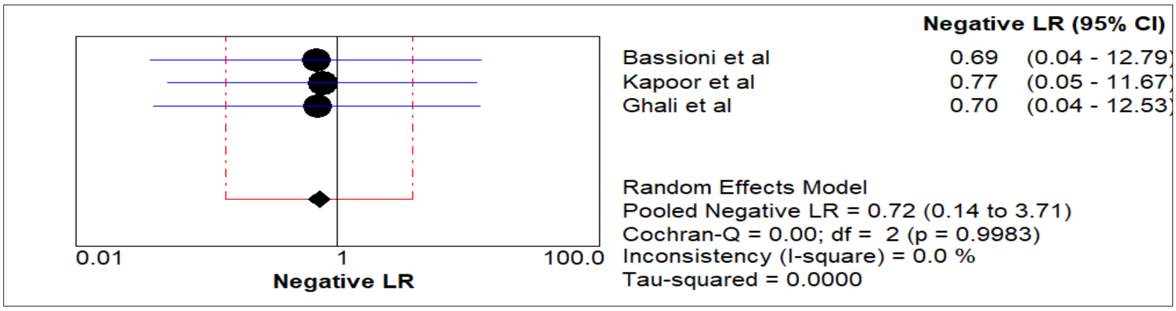

Figure 7. Pooled -LR of Ultrasonography for fascial space infection

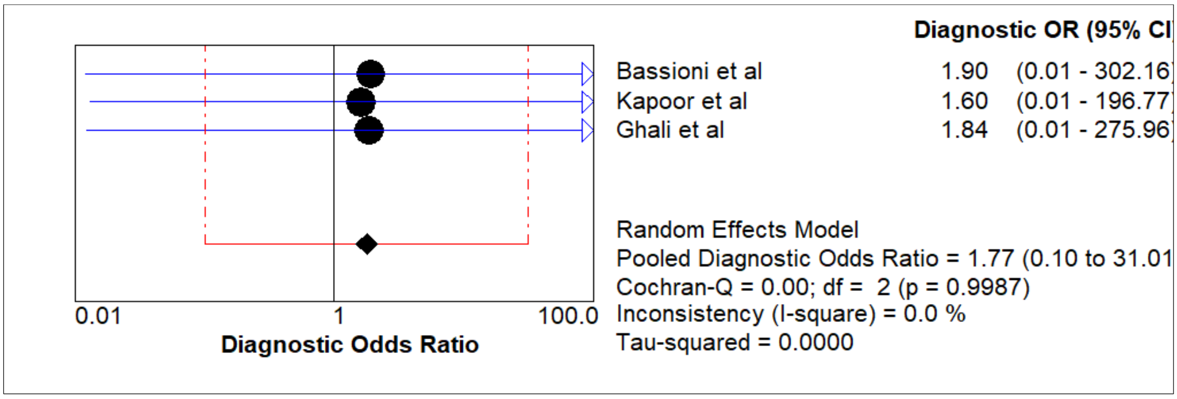

Figure 8. Pooled (DOR) of Ultrasonography for fascial space infections

Likelihood Ratios: The positive likelihood ratio (PLR) was 1.28,[18] representing a minimal increase in likelihood of infection following a positive USG result, while the negative likelihood ratio (NLR) was 0.72[18], representing a minimal decrease in likelihood of infection following a negative USG result. Thus, USG as a standalone test does not meaningfully change post-test probability of disease.(18) It is shown in Figure 6-7

Diagnostic Odds Ratio: The diagnostic odds ratio (DOR) was 1.77 (0.09–19.95)[41], indicating low diagnostic value with wide uncertainty.[41] It is shown in Figure 8

Diagnostic Accuracy Summary: The diagnostic performance of ultrasonography (USG) relative to magnetic resonance imaging (MRI) was synthesized descriptively from the three included studies.[20] MRI was used consistently as the reference standard for confirming infection, depth of involvement, and fascial space extension.[7,9,12]

Sensitivity and Specificity: Across all studies, sensitivity of USG was 100%(7,9,12), indicating that USG successfully identified all cases of confirmed infection [7,9,12], while specificity was 50% [7,9,12], meaning USG incorrectly classified half of non-infected cases as positive.[7,9,12] This pattern shows that USG is most effective as a rule-out tool but has limited ability to rule in infection due to the high false-positive rate.[18]

Predictive Values and Accuracy: Positive predictive value (PPV) varied widely across studies (57.7% to 84.0%)[7,9,12], reflecting differences in patient selection and operator experience.(14) Negative predictive value (NPV) was consistently high at 100% in all studies because sensitivity was perfect and no false-negative cases were reported.[7,9,12] Overall accuracy ranged between 70.3% and 86.2%, influenced primarily by false-positive results.[7,9,12] These findings indicate that USG is reliable for confirming absence of infection when negative, but less reliable when positive.(18) It is shown in Table 5.

Likelihood Ratios: A continuity correction of 0.5 was applied to zero cells for calculation of likelihood ratios. The positive likelihood ratio (PLR) was 1.28[18], representing a minimal increase in the likelihood of infection following a positive USG result, while the negative likelihood ratio (NLR) was 0.72 [18], representing a minimal decrease in the likelihood of infection following a negative USG result. These values fall well below thresholds considered clinically meaningful, confirming that USG does not materially shift post-test probability.[18]

Diagnostic Odds Ratio: The diagnostic odds ratio (DOR) was 1.77 (95% CI: 0.09–19.95).[41] A DOR near 1 indicates no diagnostic effectiveness [41], and the extremely wide confidence interval further highlights the

instability of these pooled estimates.[16] This reflects the small sample size and limited number of studies.(20)
Interpretation: Collectively, these findings indicate that USG is best suited as an initial adjunctive tool for assessing suspected odontogenic fascial space infections.[7,9,12] It provides rapid, bedside assessment and can reliably confirm the presence of infection when negative, owing to its high sensitivity and high negative predictive value.[7,9,12,18] However, USG cannot be relied upon for definitive diagnosis because of poor specificity, minimal likelihood ratio impact.[17,18,42] MRI therefore remains the required modality for accurate mapping of infection extent, particularly in cases involving deep or multispace involvement.[4,5]

DISCUSSION

This systematic review evaluated the diagnostic accuracy of ultrasonography (USG) compared with magnetic resonance imaging (MRI) in detecting odontogenic fascial space infections.(20) Across the three included studies, USG demonstrated consistently high sensitivity, indicating that it reliably identified infected cases when the infection was present.[7,9,12] However, specificity was uniformly low, resulting in frequent false-positive findings.[7,9,12] This limits the utility of USG as a stand-alone diagnostic tool and highlights the necessity of interpreting its findings within the broader clinical context.[18]
Consistency and Discrepancies Across Primary Studies: Across the three included studies, there was marked consistency in the diagnostic performance of ultrasonography compared with MRI for the detection of odontogenic fascial space infections. All studies reported identical sensitivity (100%) and specificity (50%), with no false-negative results observed [7,9,12]. USG has high sensitivity but does not produce a clinically meaningful reduction in post-test probability. (Tables 4 and 5) [7,9,12].

Table 4. Diagnostic Accuracy Metrics of USG Compared to MRI in Included Studies

S. No.	Author, year of study	Index test	Reference standard	True positive (TP)	False positive (FP)	False negative (FN)	True negative (TN)	Sens-itivity (%)	Spec-ificity (%)
1	Bassioni et al., 2009 [1]	USG	MRI	32	10	0	10	100	50
2	Kapoor et al., 2019 [2]	USG	MRI	30	22	0	22	100	50
3	Ghali et al., 2021 [3]	USG	MRI	42	08	0	08	100	50

Table 5. showing descriptive diagnostic accuracy values for USG

Study	Sensitivity	Specificity	PPV	NPV	Accuracy
Bassiony et al., 2009	100%	50%	76.2%	100%	80.8%
Kapoor et al., 2019	100%	50%	57.7%	100%	70.3%
Ghali et al., 2021	100%	50%	84.0%	100%	86.2%

In contrast, positive predictive value (PPV) varied substantially across studies, ranging from 57.7% in Kapoor et al. to

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84.0% in Ghali et al. (Table 5) [7,9,12]. This variation is most plausibly explained by differences in disease prevalence and case mix across study populations, with lower infection prevalence in Kapoor et al. and higher prevalence in Ghali et al. As expected, these differences directly influenced PPV despite identical sensitivity and specificity. The uniformly low specificity across studies indicates a consistent tendency toward false-positive findings, reinforcing that positive ultrasonography results should be interpreted in conjunction with clinical assessment and, where available, confirmatory MRI. These findings support the role of ultrasonography as a screening and triage tool for detecting fascial space infection, while MRI remains necessary for definitive confirmation and anatomical delineation [4,5,7,9,12].

Clinical Applicability: Although USG has limited specificity[7,9,12], its strengths lie in accessibility, portability, absence of ionizing radiation, and real-time assessment.(6,8) These characteristics make USG particularly useful in emergency departments, outpatient clinics, and resource-limited environments where MRI is not readily available.(6) USG's high negative predictive value suggests that a negative USG scan can reassure clinicians that a significant collection is unlikely.[7,9,12]

It may, therefore, play a useful role in triage, particularly in differentiating cases requiring urgent imaging or surgical intervention from those suitable for conservative management.[18] However, its diagnostic utility decreases in deeper fascial spaces due to reduced penetration and operator dependency, despite improvements when using lower-frequency probes.[8] For definitive assessment particularly involving retropharyngeal, parapharyngeal, or multiple interconnected fascial spaces MRI while highly accurate, is not a perfect gold standard; lack of surgical or microbiological confirmation may introduce reference standard bias.[4,5]

Impact of Bias and Study Design: An important limitation of the included evidence is the high risk of bias in patient selection, particularly the use of case control designs and restrictive eligibility criteria in two studies. Such pre selected populations, enriched with patients already known or strongly suspected to have infection, are likely to overestimate sensitivity and, to a lesser degree, other measures of test performance. Consequently, the observed 100% sensitivity of USG should be interpreted cautiously, as it may not generalize to unselected clinical populations where the spectrum of disease and non disease is broader.

Comparison with Previous Systematic Reviews: The findings of this review are consistent with broader literature analyzing diagnostic tools for deep neck infections.[2,13] Previous systematic reviews have likewise reported variability in USG performance, emphasizing high sensitivity but limited specificity and operator dependence.[2,23]

In contrast, MRI consistently demonstrates high diagnostic accuracy in delineating fascial boundaries, and assessing deep or multi-space involvement.[4,5]

These observations reinforce that USG should be viewed as complementary rather than competitive to MRI.[28] Notably, other reviews have included larger samples and broader infection categories such as phlegmon, and lymphadenitis, but the conclusions remain similar: USG performs best in superficial infections and as an adjunct for guiding aspiration, whereas MRI is superior for comprehensive diagnostic mapping.[2,13,23]

Future Research Directions: Current evidence is limited by small sample sizes, heterogeneous methodology, and inconsistent reporting of diagnostic parameters.[16,20,29] Future research should focus on multicenter prospective trials with standardized imaging protocols, clear reporting of TP, FP, TN, and FN values to support robust diagnostic accuracy assessment, and standardization of ultrasonography training including probe selection and scanning technique.[11,36]

It should also explore the use of combined imaging pathways to assess how USG and MRI complement each other in clinical workflows [28], integration of artificial intelligence to reduce operator dependency and improve interpretation consistency(33,34), and cost-effectiveness analyses comparing USG-first versus MRI-first diagnostic pathways.[35] Such research would better clarify the appropriate clinical role of USG and inform evidence-based diagnostic algorithms.[20]

LIMITATIONS

This review is limited by the small number of eligible studies and the modest sample sizes available for analysis.[20,29] The included studies demonstrated methodological variability, particularly in patient selection, USG technique, and operator experience.[11,14] Variations in MRI protocols and degree of blinding may also have influenced diagnostic performance.[11]

Because only three studies were available, formal statistical pooling using hierarchical ROC or bivariate meta-analysis models was not possible.[20,36] The resulting descriptive synthesis should therefore be interpreted with caution.[20] Additionally, likelihood ratios and diagnostic odds ratios showed wide confidence intervals, reflecting substantial imprecision.[16,18] These factors limit the generalizability of the findings and highlight the need for higher-quality research to some extent.[13]

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CONCLUSION

This systematic review demonstrates that USG, while highly sensitive, lacks the specificity and comprehensive diagnostic accuracy of MRI in evaluating odontogenic deep fascial space infections.[7,9,12,20] USG serves as an excellent point-of-care and triaging modality, particularly in emergency and resource-limited settings.[6,8,18] However, MRI remains essential for definitive diagnosis and surgical planning in deep or complex infection.[4,5] Future multicenter studies with standardised protocols are required to refine diagnostic pathways.[11,36]

Registration: PROSPERO CRD42025642764

DECLARATIONS

Protocol and Registration: The review followed the PRISMA-DTA checklist and was registered in PROSPERO (CRD42025642764),[19] an international registry maintained by National Institute for Health Research supports the University of York's Centre for Reviews and Dissemination in order to avoid duplicate systematic reviews.[37,38]

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