Ultrasonography-guided Drainage Versus Surgical Drainage for Deep Neck Space Abscesses: A Systematic Review and Meta-analysis

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Declaration

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**Author contribution:**
Mohammad Alzaid was responsible for the study concept and design.
Mohammad Alzaid and Mohammed Ramadhan contributed to the data acquisition and literature search.
Mohammad Karam and Ahmad Abul were responsible for the analysis and interpretation.
Ahmad Abul and Abdulmalik Alsaif were responsible for the quality and bias assessment of the included studies.
Emma Stapleton contributed to the supervision of the study and critical review.
All the authors were responsible for drafting the manuscript.
All the authors read and approved the final manuscript.

**Data availability statement:** The datasets generated and analysed during the current study are available from the corresponding author on reasonable request.
What is already known about this topic?

- Deep neck space abscesses are relatively common otolaryngology-head and neck surgery emergencies and are traditionally treated with surgical incision and drainage (I&D).
- Patients undergoing I&D often require general anesthesia and may need airway stabilisation via tracheostomy. In addition, this modality is associated with a risk of neurovascular injury and can result in a cosmetically undesirable scar.
- Ultrasonography-guided drainage (USD) is a minimally invasive and inexpensive tool that could overcome the abovementioned drawbacks.

What does this study add?

- This paper showed that USD was associated with a shorter hospital stay and appeared to be more cost-effective with better cosmetic outcomes.
- There was no statistically significant difference in the recurrence rate between USD and I&D.
- Further, well-designed multi-centre prospective studies with standardised outcomes reporting are needed to increase confidence in the use of USD.
Abstract

Objective
To compare ultrasonography-guided drainage (USD) versus conventional surgical incision and drainage (I&D) in deep neck space abscesses.

Methods
The study was pre-registered on PROSPERO (CRD42023466809) and adhered to PRISMA guidelines. MEDLINE, EMBASE and CENTRAL databases were searched. Primary outcomes were length of hospital stay and recurrence. Heterogeneity and bias risk were assessed, and a fixed effects model was applied.

Results
Of 646 screened articles, seven studies enrolling 384 participants were included. USD was associated with a significantly shorter hospital stay (Mean Difference [MD] = -2.31, \( P < 0.00001 \)), but no statistically significant difference was noted in recurrence rate compared to I&D (odds ratio [OR] = 2.02, \( P = 0.21 \)). USD appears to be associated with cost savings and better cosmetic outcomes.

Conclusion
USD was associated with a shorter hospital stay, making it a viable and perhaps more cost-effective alternative. More randomised trials with adequate outcomes reporting are recommended to optimise the available evidence.

Keywords
Ultrasonography, Abscess, Retropharyngeal Abscess, Drainage, Length of Stay, Cost Savings
Introduction

The neck is a complex structure, with superficial and multilayered deep fascia forming several potential spaces among the fascial planes. Deep neck space abscesses (DNAs) can develop from infectious involvement of these spaces and planes, most commonly following dental and pharyngotonsillitis infections.\(^1\), \(^2\) Submandibular space is most implicated (around 42.3% of cases), followed by parapharyngeal and parotid spaces at 21.15% and 11.53%, respectively.\(^3\) The primary complaint varies depending on the involved space and can include fever, pain, swelling, trismus, dysphagia and odynophagia.\(^4\) Improper control of infection can result in significant complications such as descending necrotizing mediastinitis, pneumonia, jugular vein thrombosis, carotid artery erosion and septic shock with up to a 50% mortality rate.\(^5\)\(^-\)\(^7\) The incidence of DNAs had decreased with antibiotics and improved dental hygiene, yet this trend has been reversed over the past 10 years.\(^8\)

Traditionally, surgical incision and drainage (I&D) performed intraorally or extraorally, coupled with antibiotics coverage, has been the mainstay treatment for DNAs.\(^9\), \(^10\) Several drawbacks remained unaddressed despite the proven efficacy of I&D in the literature. Patients often undergo general anaesthesia and require an airway secured with tracheostomy or fibre-optic nasal intubation. In addition, the intraoral approach could be complicated by purulent discharge or persistent bleeding, worsening already limited visualisation and, on some occasions, leading to airway compromise. When performed extraorally, the surgeon often requires neck incision and exploration, which carries the inherent risk of neurovascular injury on top of the cosmetically undesirable scar. Rarely, tumour dissemination could occur following I&D in patients with deep neck space infection caused by malignancy.\(^11\), \(^12\)
More recently, several studies have advocated that ultrasonography-guided drainage (USD) is minimally invasive and an effective alternative to I&D, obviating the abovementioned drawbacks.\textsuperscript{10,11,13-16} With this readily available and inexpensive tool, surgeons can insert the puncture tube under real-time imaging guidance. This is particularly important as abscess development is dynamic, requiring accurate puncture timing and subsequent drainage monitoring.\textsuperscript{11}

To our knowledge, this is the first systematic review and meta-analysis to compare USD to I&D in adult patients with DNAs, focusing on the length of hospital stay and recurrences as primary outcomes; the reported complications, cosmetic appearance/scar formation and cost savings were also studied.
Materials and Methods

Registration

This systematic review and meta-analysis adhered to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 statement and Sataloff et al. instructions.\textsuperscript{17,18} The study protocol was registered a priori with the National Institute of Health Research Prospective Register of Systematic Reviews (PROSPERO), registration number CRD42023466809.

Data Sources and Literature Search

A comprehensive systematic search of MEDLINE, EMBASE and CENTRAL was performed in October 2023 without any language or geographical restrictions. A combination of free text, medical subject headings terms and Boolean logical operators were used to construct the search strategy after consultation with a literature search expert. The reference list of the included studies and ‘cited by’ articles were also screened for relevance. Key ENT journals were manually searched, including \textit{JAMA Otolaryngology–Head & Neck Surgery}, \textit{Rhinology}, \textit{European Archives of Oto-Rhino-Laryngology} and the \textit{Journal of Laryngology and Otology}. Specific databases (OpenMD, MedNar and BASE) specialising in grey literature were briefly searched. A search was conducted using the following keywords: (Deep Neck Space OR Deep neck abscess OR Deep neck abscesses OR Deep neck infections OR Deep neck infection OR Neck abscess OR Neck infections OR DNSIs OR Parapharyngeal OR Retropharyngeal OR Submandibular) and (Ultrasound OR Ultrasonography OR Ultrasound-guided OR Ultrasonography-guided) and (incision OR Surgical).

Eligibility Criteria

To identify the totality of relevant literature, all randomised control trials and observational studies on deep neck space abscesses comparing USD with I&D that reported at least one clinical outcome of interest were deemed eligible for inclusion. The interventional group of
interest was draining with ultrasound, and the comparator was surgical incision. Participants were adults (aged 16 and above) with a clinical diagnosis of deep neck space abscess. No gender, ethnicity or morbidity status restrictions were applied. Duplicates, case reports, case series, review articles, conference abstracts, opinion pieces, single-arm observational studies, and studies in non-English languages without translation were excluded. Paediatric patients under the age of 16 were excluded.

Outcomes

The primary outcomes were length of hospital stay and recurrence. The secondary outcomes included scar formation/cosmetic appearance, reported complications and cost savings.

Process of Screening and Data Extraction

Two reviewers (MA and MR) independently screened titles and abstracts. Once shortlisted, full texts of all potentially eligible papers were retrieved and assessed for our inclusion criteria. Discrepancies in study selection were resolved by consulting the senior author (ES), who provided an unbiased expert perspective for the final determination of the inclusion/exclusion of the article.

A standardised Excel spreadsheet was created in keeping with Cochrane’s data collection form for intervention reviews. A spreadsheet pilot test was performed, extracting data from random articles and adapting it where necessary. Two independent authors (MA and MR) conducted data extraction. An attempt was made to contact the corresponding authors of relevant studies to share study-level anonymised data regarding missing data, particularly the standard deviation for our outcomes of interest. However, weeks after the first attempt at contact, no replies had been received. The extracted data included first author, publication year, study design, participant demographics (gender, age and comorbidity where reported), length of follow-up and outcomes of interest as above.
Risk of Bias and Quality Assessment

Two independent authors (AA and AA) assessed the quality of the included studies, and any discrepancies were resolved by consulting ES. For the observational studies, the risk of bias was assessed using Risk Of Bias In Non-randomised Studies - of Interventions (ROBINS-I), endorsed by the Cochrane organisation.\(^{19}\) This tool covers seven domains with ‘signaling questions’ to facilitate judgements regarding the risk of bias, and the judgements of each domain are carried forward to calculate an overall bias risk score. The assessed domains include (1) bias due to confounding, (2) bias in the selection of participants into the study, (3) bias in the classification of interventions, (4) bias due to deviations from intended interventions, (5) bias due to missing data, (6) bias in the measurement of outcomes and (7) bias in the selection of the reported result. The quality of randomised controlled trials (RCTs) was evaluated using the Cochrane risk-of-bias tool version 2.0 for randomised trials (RoB2), which comprises five distinct domains from which risk of bias can be ascertained to produce an overall bias score.\(^{20}\) These domains include (1) bias arising from the randomisation process, (2) bias due to deviations from intended intervention, (3) bias due to missing outcome data, (4) bias in the measurement of the outcome and (5) bias in the selection of the reported result.

Statistical Analysis

Statistical analysis was conducted using Review Manager version 5.4 and Microsoft Excel. Means difference (MD) was measured, and the dichotomous outcomes were assessed with an odds ratio (OR) for continuous variables such as the length of hospital stay. Heterogeneity was assessed using Cochrane ‘s Q test ($\chi^2$), and inconsistency was quantified by calculating $I^2$. The heterogeneity was interpreted as 0%–25% (low heterogeneity), 25%–75% (moderate heterogeneity) and 75%–100% (high heterogeneity). Due to the low heterogeneity in this study, a fixed effect model was used. Reported outcomes were represented in the forest plot at 95% confidence intervals (CIs). A value of $P < 0.05$ was considered statistically significant.
**Results and Analysis**

**Literature Search Results**

The last search was conducted on 13 November 2023. The search strategy retrieved 864 studies, and hand search/snowballing of references and articles ‘cited by’ identified three additional papers. After thoroughly screening the retrieved articles, the authors identified seven studies that met the eligibility criteria (Fig. 1).
Fig. 1: Prisma flow diagram. The PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) diagram details the search and selection processes applied during the overview.
Description of Studies

Table 1 summarises the included studies' baseline characteristics with a total sample size of 384 participants. The studies were standardised in population and design, comparing USD with I&D for DNAs.\textsuperscript{21-27}
Table 1. Baseline characteristics of the included studies.

<table>
<thead>
<tr>
<th>Study (year)</th>
<th>Journal, Country</th>
<th>Study Design</th>
<th>Age (USD : I&amp;D)</th>
<th>Sex M : F</th>
<th>Sample (USD : I&amp;D)</th>
<th>Mean Abscess Volume mL (USD : I&amp;D)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biron et al., 2013</td>
<td><em>Journal of Otolaryngology – Head and Neck Surgery</em>, Canada</td>
<td>RCT – sealed envelopes. Not blinded.</td>
<td>31.2 : 44.3</td>
<td>≈ 1 : 1 ratio</td>
<td>8 : 9 (17)</td>
<td>21 : 14.7 (P = 0.25)</td>
</tr>
<tr>
<td>Fan et al., 2021</td>
<td><em>Gland Surgery</em>, China</td>
<td>Observational study</td>
<td>55.8 [28–76]; 52.3 [27–75]</td>
<td>11 : 37</td>
<td>43 : 17 (60)</td>
<td>8.7 : 8.8 (P = 0.97)</td>
</tr>
<tr>
<td>Dabirmoghaddam et al., 2017</td>
<td><em>The Journal of Laryngology &amp; Otology</em>, Iran</td>
<td>Comparative case-control study with sealed envelope randomisation</td>
<td>34.97 : 35.73</td>
<td>25 : 33</td>
<td>30 : 30 (60)</td>
<td>USD = 13.03 I&amp;D NA</td>
</tr>
<tr>
<td>Author(s) et al., 2022</td>
<td>Journal</td>
<td>Study Type</td>
<td>Overall:</td>
<td>77:51</td>
<td>64:64 (128)</td>
<td>NA</td>
</tr>
<tr>
<td>------------------------</td>
<td>---------</td>
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</tr>
<tr>
<td>Limardo et al., 2022</td>
<td>Acta otorrinolaringológica española, Argentina</td>
<td>RCT</td>
<td>27.3 (range 15–62)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Strassen et al., 2022</td>
<td>Journal of Clinical Medicine, Munich, Germany</td>
<td>Retrospective observational study</td>
<td>51.78 (17–81): 58.68 (22–90)</td>
<td>25:33</td>
<td>18 : 39 (57)</td>
<td>5.7 : 10.1 (P = 0.244)</td>
</tr>
<tr>
<td>Mallick et al., 2023</td>
<td>Journal of Cardiovascular Disease Research, India</td>
<td>Retrospective observational study</td>
<td>49.58 (24–66): 58.55 (46–70)</td>
<td>11 : 19</td>
<td>12 : 18 (30)</td>
<td>NA</td>
</tr>
</tbody>
</table>
Table 1—Continued. Baseline characteristics of the included studies

<table>
<thead>
<tr>
<th>Author</th>
<th>Location of lesion (USD/I&amp;D)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mallick et al., 2023</td>
<td>Submandibular/parapharyngeal space</td>
</tr>
<tr>
<td>Biron et al., 2013</td>
<td>Submandibular/parapharyngeal space</td>
</tr>
<tr>
<td>Hassan et al., 2021</td>
<td>NA</td>
</tr>
<tr>
<td>Fan et al., 2021</td>
<td>Neck level, mandibular, masticatory space (temporal, interpterygoid, submaseterine, . . .)</td>
</tr>
<tr>
<td>Dahmehroohdel et al., 2017</td>
<td>12:18, 1(15)</td>
</tr>
<tr>
<td>Strassen et al., 2022</td>
<td>13:13 (26)</td>
</tr>
<tr>
<td>Limardo et al., 2022</td>
<td>0:0 (0)</td>
</tr>
<tr>
<td>Dabirmoghaddam et al., 2017</td>
<td>Bilateral, left submandibular-right parotid space</td>
</tr>
<tr>
<td>Strassen et al., 2022</td>
<td>7:21 Right parotid</td>
</tr>
<tr>
<td>Mallick et al., 2023</td>
<td>11:17 Left parotid</td>
</tr>
<tr>
<td>Fan et al., 2021</td>
<td>Bilateral, left parotid</td>
</tr>
<tr>
<td>Dahmehroohdel et al., 2017</td>
<td>Bilateral, right parotid</td>
</tr>
<tr>
<td>Strassen et al., 2022</td>
<td>Bilateral, left submandibular-right parotid space</td>
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<tr>
<td>Limardo et al., 2022</td>
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<tr>
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<tr>
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</tr>
<tr>
<td>Limardo et al., 2022</td>
<td>Not enough information. Instead, the authors only reported the most common site overall: 'the left submandibular space (40%), followed by the right submandibular (25%).'</td>
</tr>
<tr>
<td>Dabirmoghaddam et al., 2017</td>
<td>Not enough information. Instead, the authors only reported the most common site overall: 'the left submandibular space (40%), followed by the right submandibular (25%).'</td>
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<tr>
<td>Strassen et al., 2022</td>
<td>Not enough information. Instead, the authors only reported the most common site overall: 'the left submandibular space (40%), followed by the right submandibular (25%).'</td>
</tr>
</tbody>
</table>
Primary Outcomes

Recurrence

Fig. 2 presents the meta-analysis’ findings for recurrence rate based on data from six studies involving 297 participants. No statistically significant difference was observed in the odds ratio for the recurrence rate between the two groups (OR = 2.02, CI = 0.67 to 6.08, \( P = 0.21 \)). A low level of heterogeneity was demonstrated among the studies (\( I^2 = 0\% \), \( P = 0.16 \)).

Fig. 2: Forest plot for the odds ratio of ultrasound-guided drainage versus surgical drainage for deep neck space abscesses – recurrence. There was no statistically significant difference in the odds of recurrence between both groups.

Length of hospital stay

The length of hospital stays in two studies involving 160 participants is quantitatively depicted in a forest plot, as shown in Fig. 3. A statistically significant difference in the mean length of hospital stay in days was observed, favouring the USD group over the I&D group (MD = -2.31, CI = -3.03 to -1.58, \( P < 0.00001 \)). A low level of heterogeneity was demonstrated among the studies (\( I^2 = 0\% \), \( P = 0.74 \)). Five additional studies, as reported by Biron et al. (2013),\(^{21}\) Dabirmoghaddam et al. (2017),\(^{22}\) Fan et al. (2021),\(^{24}\) Strassen et al., (2022)\(^{26}\) and Mallick et al.
(2023) also demonstrated mean shorter length of hospital stay in days for the USD group (3.1 vs. 5.2, \( P = 0.042 \); 5.47 vs. 9.70, \( P < 0.001 \); 8 vs. 10.8, \( P = 0.00028 \); 5.88 vs. 7.33, \( P = 0.30 \); 5.416 vs. 7.77, \( P = 0.03 \), respectively).

Fig. 3: Forest plot for the mean difference in ultrasound-guided drainage versus surgical drainage for deep neck space abscesses – length of hospital stay (in days). The results indicate a statistically significant reduction in hospital stay duration in the USD group.

### Secondary Outcomes

#### Complications

Fan et al. reported one case of post-operative pneumonia in the surgery group, whereas the USD had no complications in their cohort.\(^{24}\) However, Limardo et al. reported two cases of persistent fever and increased oedema, one in each group. Both cases required re-operation with cervicotomy and wide drainage.\(^{25}\)

Strassen et al. reported one complication of post-operative bleeding in the I&D cohort. In contrast, there was no incidence of bleeding in the USD cohort despite repeated needle aspirations over multiple days.\(^{26}\) An incident of no pus punctured was seen in the USD cohort. Four cases of abscess recurrences were reported in the I&D cohort and only three in the USD.
Two patients, one from each cohort, underwent surgical parotidectomy due to several recurrences.

In Mallick and colleagues’ study, one patient from the I&D group had a bleeding problem, whereas in the USD group no bleeding was reported despite repeated needle aspirations. Moreover, the authors observed a higher frequency of pain, swelling, localised heat and redness in the I&D cohort.

**Cosmetic appearance/scar formation**

According to Hassan et al., USD resulted in significantly less scar formation than those who underwent surgery \( P = <0.001 \). Limardo et al. used a patient-scored scar assessment scale, which concluded that 98% satisfaction was achieved with USD compared with 62% satisfaction reported after I&D.

**Cost savings**

According to Biron et al., USD was associated with 41% cost reductions compared with I&D; this resulted in an estimated $8,505.00 reduction in hospital bed costs per patient.

**Methodological Quality and Risk of Bias Assessment**

Four RCTs were assessed using the ROB2 assessment tool, as seen in Table 2. The results generally show that the studies had some bias concerns; Limardo et al.’s 2022 study indicated a high risk of bias. Three observational studies were assessed using the ROBINS-I tool, as seen in Table 3.
Table 2: Visualisation tool showing assessment of the risk of bias using the Cochrane Collaboration Tool (ROB2) for randomised controlled trials.

<table>
<thead>
<tr>
<th>Study</th>
<th>D1</th>
<th>D2</th>
<th>D3</th>
<th>D4</th>
<th>D5</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biron et al 2013</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>x</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Limardo et al 2022</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Dabirmoghaddam et al 2017</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>x</td>
<td>+</td>
<td>-</td>
</tr>
</tbody>
</table>

Domains:
- D1: Bias arising from the randomization process.
- D2: Bias due to deviations from intended intervention.
- D3: Bias due to missing outcome data.
- D4: Bias in measurement of the outcome.
- D5: Bias in selection of the reported result.

Judgement:
- Red: High
- Yellow: Some concerns
- Green: Low
- Blue: No information
**Table 3:** Visualisation tool showing the risk of bias assessment using the Cochrane Collaboration Tool (ROBINS-I) for observational studies.

<table>
<thead>
<tr>
<th>Study</th>
<th>D1</th>
<th>D2</th>
<th>D3</th>
<th>D4</th>
<th>D5</th>
<th>D6</th>
<th>D7</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fan et al 2021</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Strassen et al 2022</td>
<td>X</td>
<td>X</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>X</td>
</tr>
<tr>
<td>Mallick et al 2023</td>
<td>X</td>
<td>X</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>X</td>
</tr>
</tbody>
</table>

Domains:
- D1: Bias due to confounding.
- D2: Bias due to selection of participants.
- D3: Bias in classification of interventions.
- D4: Bias due to deviations from intended interventions.
- D5: Bias due to missing data.
- D6: Bias in measurement of outcomes.
- D7: Bias in selection of the reported result.

Judgement:
- Serious
- Moderate
- Low
Discussion

This meta-analysis demonstrates that both USD and I&D can be used effectively in treating deep neck space abscesses, with no significant difference in the recurrence rate ($P = 0.16$). However, statistically significant shorter lengths of hospital stay were associated with USD compared to I&D ($P < 0.00001$). All studies exhibited low heterogeneity ($I^2 = 0\%$) and therefore, they were analysed using a fixed effects model. Secondary outcome measures revealed that USD was associated with fewer surgical scars, post-operative bleeding events and appeared to be more cost-effective.

The current study findings agreed with the previously published literature. Baatenburg de Jong and colleagues published one of the earliest case series supporting the use of USD as a cheap and effective alternative after successfully treating five patients with a parapharyngeal and/or retropharyngeal abscess without any complications or recurrences during 18-27 months of follow-up.\(^2\)\(^8\) Notably, the length of hospitalisation ranged between two to three weeks, but that could have been related to the poor health of the recruited patients and the little experience with the procedure; the drain was left \textit{in situ} for several days after discharge had stopped. Yeow et al. demonstrated the successful drainage of a deep retropharyngeal abscess and uniloculated parotid abscesses under ultrasound guidance; no incisions or only a small (5 mm or smaller) incision was needed to drain the pus, leading to better cosmetic outcomes and reducing pus contamination of the surrounding neck visceral spaces.\(^2\)\(^9\),\(^3\)\(^0\) The same researchers reported their experience in a trial that included 15 patients with uniloculated DNAs, achieving an 87% (13/15) success rate without complications or recurrences during the six months of follow-up.\(^3\)\(^1\) Two patients required I&D due to the
abscess progression and a diffuse spreading inflammatory process. Interestingly, the authors noted a shorter mean length of hospital stay (nine days) associated with the use of a catheter despite draining larger abscesses compared with using a needle (12 d); this suggested that small-calibre (7–8-F) pigtail catheters may be effective in treating uniloculated abscesses with liquefied pus content. In a different case series, Al-Belasy demonstrated the resolution of masseteric space abscesses in eight of the eleven patients (73%). The failure in these cases was associated with higher average abscess volume (8.5 mL vs 17.5 mL). However, Brion and colleagues successfully drained a higher mean abscess volume (21 mL) in 8 patients using USD without recurrences. More recently, Wang and colleagues successfully drained a huge retropharyngeal abscess of 350 mL of tawny viscous pus using USD under local anesthetic in a patient with pneumonia and suspected (COVID-19). In this case, USD had added benefits of avoiding general anaesthesia risk for pneumonia patients and minimising infection spread via respiratory secretions and aerosols. Finally, Gudi and colleagues successfully treated 10 patients with submasseteric space abscesses using USD, and only one patient underwent I&D due to infection spread.

When thick pus or a narrowed puncture port and lumen create poor drainage, USD might be difficult to accomplish. However, abscess development is a dynamic process, and its viscosity depends on the timing of the drainage; it is easier to drain when abscess formation is completed and more difficult if the pus is viscous due to incompletely liquefied tissue. Nevertheless, a study by Lin et al. demonstrated successful drainage of thick pus in 14 patients with head and neck abscesses after implementing a contra-drainage method using a multi-catheter and ultrasound guidance. Otolaryngologists might find it more challenging to drain multiloculated DNAs as it is hard to open all septations effectively. Despite that, a
poster of RCT including 32 patients concluded that USD is safe and effective alternative to I&D for “uni- or multiocular deep neck abscesses”.23

That being said, the reported outcomes should be viewed considering this meta-analysis’ limitations. First, the number of studies included in the analysis was relatively small, with only seven studies comprising 384 patients. This may not be sufficient to compare the two techniques accurately. Only one study reported a breakdown of costs associated with USD vs. I&D, and different healthcare systems account for different variables; therefore, it is hard to come to a firm conclusion about cost savings. Two included studies were non-randomised, which introduces selection bias and affects the reliability of the results, raising the chances of type II error. Moreover, some of the included studies had moderate to high risks of bias; this lowers the quality of the meta-analysed data. A quantitative meta-analysis of secondary outcomes was not possible due to the limited data available on these outcomes. In addition, we excluded five relevant studies from the meta-analysis (Fig. 3) because of inadequate data reporting, despite efforts to contact the corresponding authors via email. As the results of these studies favoured USD, they would have been unlikely to divert the direction of our results, yet more precise effect estimates and corresponding CIs would have been gained. Future studies should aim to standardise outcome reporting and ensure all data is included to strengthen the available evidence within the literature.

**Conclusion**

This is the first systematic review and meta-analysis with robust methodology to compare USD with I&D in adult patients with DNAs. It is crucial for head and neck surgeons to consider using USD as a safe and effective alternative to I&D, especially when DNAs are uninoculated and well-defined and when general anesthesia is undesirable. There may be cost
saving associated with the reduction in hospital stay and better cosmetic outcomes, however these are not the primary outcomes of this study. The authors suggest further randomised controlled trials that adhere to Consolidated Standards of Reporting Trials guidelines to increase the confidence in the use of USD and provide a stronger evidence base to support its usage. There is a clear heterogenous outcomes reporting amongst the published studies, therefore developing core outcomes sets (COS) using consensus methods is implicated to reduce risk of bias and foster methodological research in DNAs.

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