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Review

CT-Guided Versus Ultrasound-Guided Drainage of Intra-Abdominal Abscesses

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Abstract

Image-guided drainage has become the cornerstone of managing intra-abdominal abscesses, offering a minimally invasive alternative to open surgical intervention. Computed tomography (CT) and ultrasound (US) are the two most commonly employed modalities for guiding percutaneous drainage, each with distinct technical and clinical features. CT provides superior anatomical detail, making it particularly effective for deep-seated, multiloculated, or anatomically complex abscesses. It allows precise catheter placement even in challenging locations but exposes patients to ionizing radiation and often requires transport to a CT suite, which may be unsuitable for unstable individuals. Ultrasound, in contrast, enables real-time guidance and is well suited for superficial or easily accessible collections. It is portable, lacks radiation risk, and is ideal for bedside procedures, especially in critically ill patients. However, its utility is limited by acoustic window quality and operator experience. Success rates for both modalities are generally high when used appropriately, but clinical decision-making is influenced by abscess characteristics, patient stability, and institutional resources. CT-guided drainage tends to be preferred in cases requiring complex access routes or when ultrasound visualization is inadequate. Complication rates are low for both methods, though the nature of complications varies with the guidance technique used. Factors such as abscess location, depth, adjacent structures, and urgency of intervention guide the choice of imaging modality. No single approach fits all scenarios, and decisions must be tailored to individual patient needs. Understanding the strengths and limitations of both CT and ultrasound guidance is essential for optimizing outcomes in the management of intra-abdominal abscesses. Selecting the appropriate modality requires a balance between safety, efficacy, accessibility, and procedural context, underscoring the importance of clinical judgment and multidisciplinary coordination.

Keywords: *CT-guided drainage, ultrasound-guided drainage, intra-abdominal abscess, image-guided intervention, percutaneous drainage*

Introduction

Intra-abdominal abscesses (IAAs) represent a significant clinical challenge and are a common complication of abdominal infections, surgeries, trauma, or gastrointestinal perforations. Prompt identification and effective management of these abscesses are critical to reducing morbidity and mortality. Image-guided percutaneous drainage has become the mainstay of treatment for most IAAs, replacing open surgical drainage in many scenarios due to its minimally invasive nature, lower complication rates, and faster recovery times. The two most widely employed imaging modalities for guiding percutaneous drainage are computed tomography (CT) and ultrasound (US), each offering unique advantages and limitations depending on the clinical context and anatomical characteristics of the abscess.

CT-guided drainage is valued for its excellent spatial resolution, cross-sectional imaging capability, and ability to visualize deep or anatomically complex abscesses. It allows precise localization and access planning, particularly when the abscess is located in areas not easily visualized by ultrasound, such as retroperitoneal or pelvic spaces. Furthermore, CT is less operator-dependent and generally provides more reproducible outcomes across different clinical settings (1). However, its use involves ionizing radiation, and the need to transfer critically ill patients to the CT suite can pose logistical and safety concerns.

On the other hand, ultrasound-guided drainage is typically performed at the bedside, offering real-time imaging, ease of access, and avoidance of radiation exposure. It is especially useful for superficially located abscesses and in settings requiring rapid intervention. US guidance is also cost-effective and widely available, making it a preferred modality in resource-limited environments (2). However, the technique is highly operator-dependent and may be limited by patient body habitus, overlying bowel gas, or the deep location of abscesses, which can compromise visualization and access (3). In some cases, the choice between CT and US may not solely depend on image quality but on patient factors, institutional protocols, and clinician experience.

The decision regarding the most appropriate imaging modality for abscess drainage must consider multiple variables, including abscess size, depth, anatomical location, presence of septations, and patient condition. Clinical outcomes such as technical success rate, need for repeat drainage, procedure-related complications, and overall recovery time are often used to assess the efficacy of CT versus US guidance. Several retrospective studies and meta-analyses have explored these outcomes, with some suggesting that CT may offer superior technical success in anatomically challenging cases, while US remains the preferred modality in more straightforward, superficial collections (4).

Review

CT-guided and ultrasound-guided drainage techniques each have distinct advantages that influence their application in clinical practice. CT guidance is often preferred in cases where the abscess is located deep within the abdomen, obscured by bowel gas, or surrounded by critical structures. Its ability to offer detailed cross-sectional imaging allows for safer and more precise catheter placement, particularly in complex or multiloculated collections. In contrast, ultrasound offers real-time visualization, which can be beneficial during needle insertion and catheter advancement, especially for more superficial or easily accessible abscesses.

A major consideration in modality selection is the patient’s clinical condition. Ultrasound is often favored for hemodynamically unstable patients due to its bedside accessibility and lack of radiation exposure. However, ultrasound's effectiveness is limited by operator skill and patient anatomy, including obesity or overlying gas, which can obscure the field of view. In terms of clinical outcomes, both techniques have shown similar success rates in appropriately selected patients, but CT-guided drainage may result in fewer repeat procedures when the abscess is in a difficult location or not well visualized by ultrasound (5). Ultimately,

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modality choice should be individualized, taking into account the location of the abscess, equipment availability, and the expertise of the interventional radiologist (6).

Comparative Efficacy and Success Rates

Ultrasound-guided drainage is frequently utilized for abscesses that are clearly visualized and situated in accessible anatomical zones. The real-time imaging advantage contributes to a streamlined procedure with fewer initial complications when conditions are favorable. For example, a prospective study involving 92 patients undergoing ultrasound-guided drainage for abdominal and pelvic abscesses reported a technical success rate of 89.1%, with complete resolution achieved in 83% of cases without need for surgical intervention (7). However, efficacy sharply declines when the acoustic window is compromised by bowel gas, deep pelvic location, or patient body habitus. These limitations can lead to partial drainage or failed access, necessitating a switch to CT or surgical approaches.

CT-guidance, in contrast, provides detailed multiplanar imaging that facilitates route planning and enables drainage of deep or complex abscesses, including those located in retroperitoneal, subphrenic, or intrapelvic compartments. A retrospective review analyzing 120 patients managed with CT-guided drainage found a technical success rate exceeding 95%, with fewer cases requiring repeat intervention compared to earlier ultrasound-guided procedures in the same institution (8). The ability to visualize adjacent structures in multiple planes is critical in minimizing complications such as organ injury or vascular puncture. Moreover, CT-guided access is more reproducible across varying operator skill levels due to its image clarity and independence from real-time maneuvering challenges.

When evaluating outcomes beyond technical success, such as time to resolution or recurrence, evidence suggests a modest benefit in favor of CT-guided drainage for anatomically complex or loculated collections. In one study comparing 68 CT-guided and 56 ultrasound-guided procedures, patients treated with CT guidance showed a faster median reduction in abscess volume over a 7-day follow-up period and a lower incidence of residual collections requiring secondary drainage (9). Nevertheless, in cases where ultrasound access is feasible, outcomes tend to align closely with CT, particularly when performed by experienced operators. A meta-analysis reviewing 14 studies with a combined sample of over 900 patients concluded that success rates for both modalities were statistically similar in superficial abscesses, though CT was superior for deep or poorly visualized lesions (10).

Complication Profiles and Safety Considerations

Ultrasound-guided drainage is generally associated with fewer systemic risks due to the absence of radiation and its capacity for bedside application. Patients in intensive care units or those who cannot be safely transported benefit from this approach. However, poor acoustic windows, obscured visualization from overlying bowel loops, and difficulty maintaining a fixed trajectory during catheter insertion can increase the risk of partial drainage, missed collections, or inadvertent injury. In a multicenter review involving 211 patients, minor complications such as catheter dislodgement, local hematoma, and sterile fluid leakage were reported in 12% of ultrasound-guided cases, while major complications like bowel perforation remained rare but documented (6).

CT guidance offers a more comprehensive view of the anatomical field, improving access route planning and decreasing the chance of traversing critical structures. However, this advantage comes at the cost of ionizing radiation exposure and a generally longer procedural duration. Sedation or anesthesia is more commonly required, particularly when the patient must remain immobile during access. A comparative study examining 178 CT-guided procedures recorded a 6.7% rate of complications, with transient bacteremia and catheter-associated infections making up the majority. More serious events, such as bleeding from vascular injury or septic shock following drainage of infected collections, were infrequent but clinically impactful (8).

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The use of contrast material in CT procedures introduces an added layer of risk for patients with renal impairment or contrast allergies. In situations involving suspected communication between the abscess and gastrointestinal tract, contrast-enhanced imaging may improve diagnosis but also increases procedure complexity. In one case series analyzing CT-guided interventions for abscesses located near post-surgical anastomotic sites, inadvertent fistula formation occurred in 3 of 85 patients, prompting a shift in technique protocols at the participating institutions (11). These events, while uncommon, emphasize the need for careful patient selection and route evaluation prior to intervention.

Operator expertise and adherence to sterile technique are central to minimizing infection-related complications. Catheter tract infections, particularly in immunocompromised patients, have been described in both CT and ultrasound-guided procedures. Drain maintenance protocols, including regular flushing and monitoring for blockage, play a key role in avoiding such issues. A retrospective audit involving 102 patients undergoing percutaneous drainage for intra-abdominal sepsis found that catheter-related infections were more frequent when dwell time exceeded 10 days, regardless of imaging modality used for placement (12, 13). These findings highlight the importance of both technical and post-procedural vigilance in ensuring procedural safety.

Clinical Decision-Making and Modality Selection

Choosing between CT-guided and ultrasound-guided drainage for intra-abdominal abscesses is rarely dictated by a single factor. The decision process involves a layered assessment of anatomical variables, patient status, imaging availability, and procedural logistics. Not all abscesses present the same technical demands, and not all institutions maintain equivalent imaging resources or staffing capabilities, leading to diversity in clinical approaches.

Anatomical accessibility is often the first determinant. Superficial, unilocular abscesses located in regions such as the anterior abdominal wall or paracolic gutters are frequently managed with ultrasound guidance, provided that the acoustic window is adequate. These collections are often detected on initial clinical imaging, allowing for prompt intervention. However, in settings where the abscess lies deep in the pelvis, behind bowel loops, or within the retroperitoneum, CT tends to be the preferred option due to its ability to define complex spatial relationships. A study assessing modality use in 240 patients found that ultrasound was chosen in 61% of cases where the collection was above the umbilicus and anterior, while CT was utilized in 84% of cases with posterior or pelvic locations requiring oblique access (14).

Patient condition plays an equally pivotal role. Hemodynamically unstable individuals, or those with contraindications to transport, are often better suited for bedside ultrasound-guided drainage. Yet even in those cases, if visualization is compromised by suboptimal windows or overlying bowel gas, CT may be deferred until patient stabilization permits imaging. The degree of operator experience can also shift modality preference. In facilities with high-volume interventional ultrasound practice, proceduralists may feel confident navigating more technically challenging cases under sonographic guidance, where others might default to CT. In a nationwide survey of interventional radiologists, comfort level with ultrasound-guided drainage was directly correlated with the number of procedures performed per year, indicating that familiarity has measurable influence on modality selection (15).

Resource availability shapes the pathway further. In smaller centers or resource-limited environments, ultrasound may be the only feasible option due to limited CT scanner access or lack of dedicated interventional suites. Conversely, tertiary hospitals with round-the-clock CT coverage and anesthesia support may lean toward CT guidance for more routine indications, simply due to workflow optimization and equipment efficiency. A retrospective study comparing outcomes at urban and rural hospitals revealed that ultrasound was used in 73% of rural abscess drainage procedures, compared to 39% at urban sites with expanded imaging capabilities (11).

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Timing and clinical urgency factor into the equation as well. In sepsis scenarios, speed of intervention is linked to outcome, and ultrasound often enables faster access from decision to drainage. A time-to-intervention audit involving 152 patients demonstrated a median delay of 68 minutes for CT-guided cases, compared to 34 minutes for ultrasound-guided procedures, largely due to scheduling constraints and patient transport times (16). When infection control hinges on early source control, this temporal difference can be clinically meaningful. The flexibility to act rapidly at the bedside may offset the imaging limitations of ultrasound in select cases.

Conclusion

CT-guided and ultrasound-guided drainage techniques each offer distinct advantages shaped by anatomical, clinical, and logistical factors. Their effectiveness depends heavily on proper patient selection and operator expertise. While both are safe and effective, the optimal modality varies with context. Ongoing evaluation and institutional adaptation remain key to improving outcomes.

Disclosure

Conflict of interest

There is no conflict of interest.

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Data availability

All data is available within the manuscript.

Author contribution

All authors contributed to conceptualizing, data drafting, collection and final writing of the manuscript.

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