Section: Radiodiagnosis

Original Research Article

A STUDY TO EVALUATE THE ROLE OF ULTRASOUND-GUIDED PERCUTANEOUS DRAINAGE IN THE MANAGEMENT OF POSTOPERATIVE INTRA-ABDOMINAL COLLECTIONS

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ABSTRACT

Background: Postoperative intra-abdominal collections pose a significant risk for morbidity in patients following routine surgery. Traditionally managed by re-exploration or open surgical drainage, these collections can now be effectively addressed using minimally invasive techniques. Ultrasound-guided percutaneous drainage (USG-PD) offers a real-time, cost-effective approach that not only minimizes patient discomfort but also reduces hospital stay and overall complication rates. The present study evaluates the safety, efficacy, and utility of USG-PD in a cohort of postoperative patients in a teaching hospital of West Bengal. **Materials and Methods:** We conducted a prospective study over a period of two years at a teaching hospital of West Bengal. All patients enrolled had undergone routine surgery and subsequently developed intra-abdominal collections confirmed on imaging. Under ultrasound guidance, percutaneous drainage was performed using standard protocols. Data collected included patient demographics, surgical details, collection characteristics (size, locularity and content), catheter size, duration of drainage, and clinical outcomes. Statistical analyses were performed using SPSS version 25. Continuous variables were expressed as mean ± standard deviation and categorical variables as percentages. Chi-square test and logistic regression analysis were used to identify factors associated with drainage failure, considering a p-value of <0.05 as significant. **Result:** A total of 150 patients (56.7% males and 43.3% females; mean age 45 ± 12 years) underwent USG-PD. The mean collection size was 6.2 ± 2.1 cm. A technical success rate of 100% was achieved, while the clinical success rate after a single drainage attempt was 90%. A minority of patients (6%) required a second drainage intervention, and 2% eventually necessitated conversion to open surgical drainage. Statistical analysis revealed that collections larger than 7 cm ($p = 0.012$) and the presence of septations ($p = 0.019$) were significantly associated with a higher risk of clinical failure. The overall complication rate was 15%, with minor complications—including catheter dislodgement and transient discomfort—being most common. **Conclusion:** USG-guided percutaneous drainage is a safe, efficient, and minimally invasive method for managing postoperative intra-abdominal collections in patients who have undergone routine surgery. With high technical and clinical success rates, the procedure significantly reduces the need for reoperation, shortens hospital stay, and minimizes patient morbidity. Our findings support its routine incorporation into postoperative care protocols, especially in resource-constrained settings such as India.

INTRODUCTION

Postoperative complications, particularly intra-abdominal collections, remain a serious concern in surgical practice. These collections are associated with an increased risk of infection, sepsis, and prolonged hospitalization. Traditionally, the remediation strategies involved open surgical intervention, which although effective, often add to the patient's morbidity through longer recovery

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intervals and higher complication risks. In recent years, the evolution of imaging techniques has facilitated the adoption of minimally invasive procedures. Among these, ultrasound-guided percutaneous drainage (USG-PD) has emerged as a favorable alternative.[1,2]

USG-PD offers numerous advantages. It provides a real-time assessment of the target fluid collection, allows precise catheter placement, and significantly lowers the incidence of complications compared to open surgical drainage.[3,4] Furthermore, its cost-effectiveness improves accessibility, an important consideration in resource-limited settings such as many regions in India. The current study aims to systematically evaluate the safety, technical success, clinical outcomes, and potential limitations of USG-PD in a tertiary care teaching hospital in West Bengal. Our hypothesis posits that USG-PD can be integrated into routine postoperative protocols with favorable outcomes, thereby reducing the need for reoperations and minimizing patient morbidity.

MATERIALS AND METHODS

Study Design and Setting: This prospective observational study was conducted over a period of two years (from January 2023 to December 2024) at a teaching hospital in West Bengal, India. The procedures were explained to the patients and informed consent was obtained from all participants.

Patient Selection: Patients were eligible if they had undergone routine surgical procedures and subsequently developed intra-abdominal collections confirmed via ultrasound imaging. Exclusion criteria included patients with known bleeding disorders, coagulopathy or contraindications to percutaneous procedures. A total of 150 patients met the inclusion criteria.

Data Collection: Patient data were meticulously recorded. Key variables included:

- Demographic data: Age, gender, and underlying comorbidities.
- Surgical details: Type of surgery performed, operative duration and any intraoperative complications.
- Collection characteristics: Size (in cm), locularity (uniloculated vs. multiloculated with septations), and content (serous, purulent, or hemorrhagic).
- Procedure-specific details: Type and size of catheter used, duration of drainage and the use of adjunct antibiotics.
- Outcome measures:
    - Technical success: Defined as successful catheter placement in the targeted collection despite subsequent clinical outcomes.
    - Clinical success: Resolution of the collection and improvement of symptoms following a single drainage attempt.
    - Failure: Defined as the need for additional drainage attempts or conversion to open surgical drainage.

USG-PD Procedure: Under aseptic conditions, each patient was prepared and draped following routine protocols. Local anesthesia was administered, and the procedure was performed under real-time ultrasound guidance. Catheters of variable sizes (ranging from 8 Fr to 12 Fr) were strategically positioned for effective drainage. The complete procedure was monitored to ensure appropriate catheter placement and immediate assessment of complications. Catheters were retained until imaging confirmed significant reduction or complete resolution of the collection.

Statistical Analysis: The statistical analyses were performed using SPSS version 25. Continuous variables were expressed as mean ± standard deviation, while categorical variables were expressed as percentages. A chi-square test was used to evaluate associations between categorical variables and success rates of the procedure. Logistic regression analysis was employed to determine the factors independently associated with clinical failure. A p-value of less than 0.05 was considered indicative of statistical significance.

RESULTS

Demographic and Clinical Profile: Out of the 150 patients enrolled, 85 (56.7%) were male and 65 (43.3%) were female. The study population had a mean age of 45 ± 12 years. Comorbid conditions, including diabetes and hypertension were present in approximately 35% of the patients.

Procedural Outcomes: The USG-PD procedure achieved a 100% technical success rate, with all catheters successfully positioned in the targeted collections on the first attempt. Clinical success after a single drainage attempt was observed in 135 patients (90%). Nine patients (6%) who had persistent collections underwent a second drainage attempt. In three patients (2%), failure of percutaneous management necessitated conversion to open surgical drainage.

Statistical Associations: Chi-square analysis pointed out that collections with a diameter greater than 7 cm were significantly associated with clinical failure ($p = 0.012$). In addition, the presence of septations within the collections significantly increased the risk of drainage failure ($p = 0.019$). A logistic regression model confirmed that both collection size >7 cm and septation were independent predictors of clinical failure, with odds ratios of 2.3 (95% CI: 1.1–4.8) and 2.0 (95% CI: 1.02–3.9), respectively.

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Table 1: Patient Demographics and Collection Characteristics

Parameter	Value/Range
Number of Patients	150
Mean Age (years)	45 ± 12
Gender	56.7% Male, 43.3% Female
Comorbid conditions	35%
Mean Collection Size (cm)	6.2 ± 2.1
Collection Locularity	75% uniloculated, 25% septated
Types of Collection	70% purulent, 20% serous, 10% hemorrhagic

[Table 1] Patient Demographics and Collection Characteristics. This table summarizes the baseline characteristics of the study population including age distribution, gender ratio and specifics about the collections (mean size, locularity and content).

Table 2: Outcome Measures and Complications.

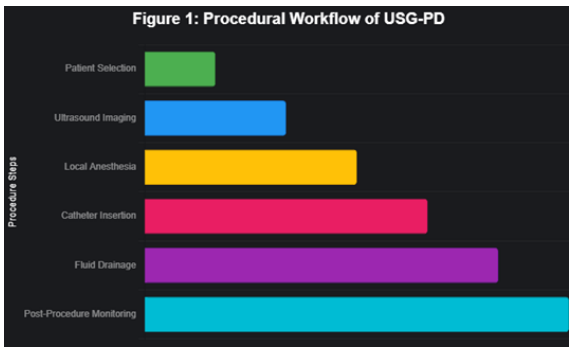
Outcome Parameter	Value
Technical Success	100%
Clinical Success (Single Attempt)	90%
Second Attempt Required	6%
Conversion to Open Drainage	2%
Overall Complication Rate	15%
Common Complications	Catheter dislodgement, transient discomfort

[Table 2] Outcome Measures and Complications. This table depicts the technical and clinical success rates, the number of additional interventions required and the details of observed complications.

Table 3: Subgroup Analysis – Clinical Success Rate by Collection Characteristics and Demographics

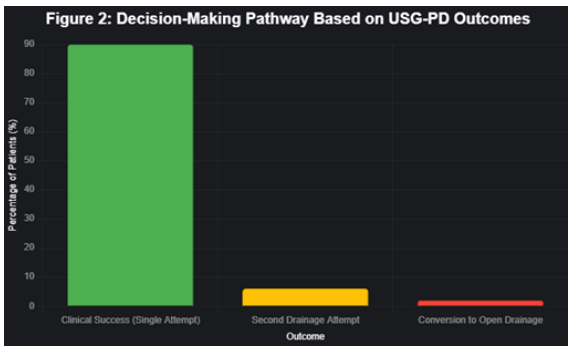
Parameter	Subgroup	Number of Patients	Clinical Success Rate (%)
Collection Size	≤ 7 cm	95	95%
	> 7 cm	55	80%
Collection Locularity	Uniloculated	113	94%
	Septated	37	78%
Type of Collection	Purulent	105	91%
	Serous	30	87%
	Hemorrhagic	15	80%
Age Group	≤ 50 years	100	92%
	> 50 years	50	86%
Gender	Male	85	89%
	Female	65	91%

[Table 3] Subgroup Analysis. This table details subgroup analyses comparing outcomes based on collection characteristics and patient demographics.



[Figure 1] illustrates the procedural workflow of USG-PD from patient selection and imaging to catheter insertion and fluid drainage.

Explanation: This horizontal bar chart lists the key steps of the USG-PD procedure as described in the "USG-PD Procedure" section (patient selection, imaging, anesthesia, catheter insertion, drainage, and monitoring). The data values (1 to 6) are arbitrary to sequence the steps, and the chart uses distinct colors for clarity. The y-axis labels represent the steps, and the x-axis is hidden since it's not relevant for a workflow.



[Figure 2] outlines the decision-making pathway and the subsequent management based on drainage outcomes.

Explanation: This bar chart visualizes the outcomes of USG-PD as percentages, as mentioned under "Procedural Outcomes" section (90% clinical success, 6% second attempt, 2% conversion). The colors are chosen to differentiate outcomes clearly, with green for success, yellow for second attempts, and red for conversion to open drainage.

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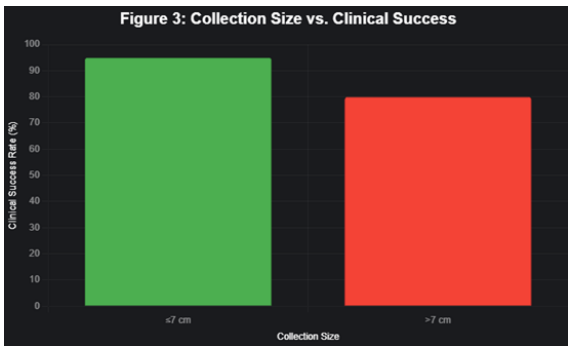
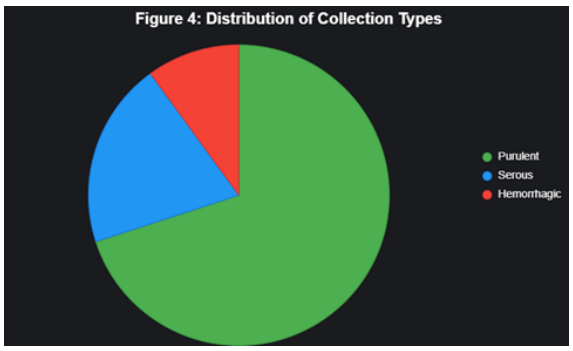


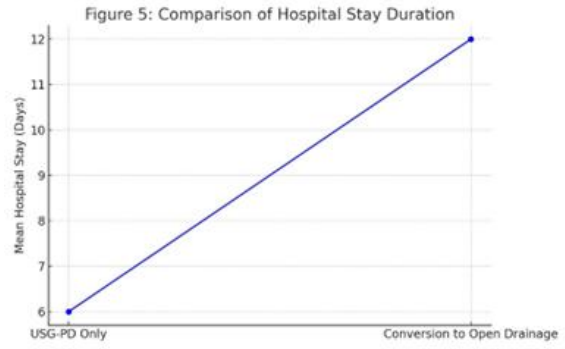
[Figure 3] shows a bar graph that was generated to illustrate the relationship between collection size and clinical outcome. The graph shows a clear trend with a drop in clinical success rates for collections larger than 7 cm.

Explanation: The bar chart compares clinical success rates for collections ≤7 cm and >7 cm. It demonstrates 95% success for collections ≤7 cm (marked in green) and 80% for collections >7 cm (marked in red).



[Figure 4] presents a pie chart delineating the distribution of collection types (i.e., purulent, serous, hemorrhagic) among the study participants.

Explanation: This pie chart directly uses the data from [Table 1] (70% purulent, 20% serous, 10% hemorrhagic). This chart clearly shows the proportion of each collection type among the study participants.



[Figure 5] shows a line graph comparing the length of hospital stay between patients managed exclusively with USG-PD and those requiring conversion to open surgical drainage.

DISCUSSION

Postoperative intra-abdominal collections continue to challenge clinical management due to their potential to deteriorate patient outcomes significantly if not managed promptly and effectively.[5] In our study, USG-PD demonstrated a very high technical success rate (100%), underscoring the reliability of ultrasound guidance in achieving appropriate catheter placement. Clinical success, defined as resolution of the collection and improvement in clinical parameters, was achieved in 90% of the patients following a single drainage attempt. These results are reflective of the current trend favouring minimally invasive interventions in postoperative care.

Advantages of USG-PD: The procedure's efficacy and safety are contingent upon the ability to precisely localize the collection and guide the catheter under real-time imaging.[6] The reduced incidence of complications compared with open re-exploration is attributable to the minimally invasive nature of the procedure: the smaller incisions and targeted approach result in reduced trauma and decrease the risk of secondary infections. Moreover, procedure-associated costs are typically lower—the economic factors carry additional significance in resource-constrained healthcare settings such as those frequently encountered in parts of India.[7,8]

Factors Impacting Clinical Failure: Our analysis revealed that larger collections (those exceeding 7 cm) and septated collections are independently associated with an increased risk of clinical failure. The complexity inherent in septated collections likely complicates full drainage, necessitating either catheter repositioning or multiple drainage sessions. This has been supported by similar findings in other studies, which also underline size and complexity as critical factors for procedural success.[9,10] In our logistic regression analysis, these factors presented with odds ratios that call for increased vigilance during patient selection and procedure planning.

Comparison with Traditional Techniques: Historically, open surgical drainage was the mainstay of treatment for intra-abdominal collections. However, the morbidity associated with re-exploration—extended hospital stay, increased pain, and risk of wound complications—makes USG-PD a preferable first-line option in many cases. Even when open drainage becomes necessary, the use of USG-PD as an initial intervention may limit the severity of the infection and reduce the extent of surgical intervention required.[11,12]

Limitations and Challenges: While the study's findings are robust, some limitations merit discussion. First, the study was conducted in a single tertiary care teaching hospital; hence, the results may not be generalizable to all settings. Second, as with any operator-dependent procedure, the success of USG-PD heavily relies on the expertise of the interventional radiologist. Future multicentric studies

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could help in validating these findings across different healthcare settings. Finally, long-term follow-up was not extensively documented in this study and further research might address potential recurrence rates and long-term outcomes.

Implications for Clinical Practice: Given the demonstrated benefits in our cohort, it is reasonable to consider USG-PD as a standard of care in the postoperative management of intra-abdominal collections. Regular training in ultrasound-guided techniques coupled with a structured protocol for patient evaluation and follow-up could enhance overall patient outcomes. Future research might also explore the adjunctive use of prophylactic antibiotics and strategies for managing complex collections.[13-15]

CONCLUSION

The study unequivocally demonstrates that ultrasound-guided percutaneous drainage is a safe and effective method for managing postoperative intra-abdominal collections. With a technical success rate of 100% and a clinical success rate of 90%, USG-PD minimizes patient morbidity, decreases hospital stay and reduces the need for extensive surgical re-intervention. Its advantages become particularly pronounced in resource-constrained settings where cost-effectiveness and rapid recovery are key priorities. While challenges remain—particularly in cases of larger and septated collections—the overall benefits support its routine inclusion in postoperative management protocols.

Future studies should aim to validate these findings in multicentre trials and potentially refine technique protocols to further enhance success rates. Continued education and training in interventional radiology can play a pivotal role in ensuring that the benefits of minimally invasive approaches are realized universally across varied clinical environments.

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