



CLINICORADIOLOGICAL CORRELATION IN DIAGNOSING HOLLOW VISCUS PERFORATION: A RETROSPECTIVE OBSERVATIONAL STUDY

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Abstract

Background: Hollow viscus perforation (HVP) constitutes a surgical emergency with significant morbidity and mortality. Accurate early diagnosis is pivotal. The correlation between clinical and radiological findings remains underexplored in semi-urban tertiary-care settings in Gujarat.

Objectives: To evaluate the clinicoradiological correlation in diagnosing hollow viscus perforation and assess the diagnostic accuracy of individual and combined investigations at SIMSR, Kalol, Gandhinagar.

Methodology: A retrospective observational study was conducted at SIMSR, Kalol, Gandhinagar, Gujarat from March 2025 to September 2025. Records of 115 confirmed HVP cases were analysed. Data included clinical presentation, erect abdominal X-ray, ultrasonography (USG), and CECT findings, correlated with intraoperative findings.

Results: Of 115 patients, 78 (67.8%) were male and 37 (32.2%) female (M:F=2.1:1). Mean age was 42.3±14.7 years. The most common site was duodenum (45.2%), followed by ileum (24.3%). CECT had the highest sensitivity (94.8%) and specificity (96.5%). Clinicoradiological correlation with operative findings was statistically significant ($p<0.001$). Early surgical intervention (<6 hours) was associated with significantly better outcomes ($p=0.004$).

Conclusion: CECT abdomen remains the gold standard in HVP diagnosis. Combined clinicoradiological evaluation substantially enhances diagnostic accuracy, reducing time to intervention and improving outcomes. Erect X-ray retains a primary triage role in resource-limited settings.

Keywords: Hollow viscus perforation, clinicoradiological correlation, erect abdominal X-ray, CECT abdomen, peritonitis, Gujarat, SIMSR

1. Introduction

Hollow viscus perforation (HVP) represents one of the most critical acute surgical emergencies encountered in general surgical practice worldwide. The term denotes a breach in the wall of any

hollow organ of the gastrointestinal tract — stomach, duodenum, small bowel, or colon — resulting in spillage of luminal contents into the peritoneal cavity, thereby inciting severe peritonitis [1]. The clinical presentation is often dramatic but can be deceptive, particularly in the elderly, immunocompromised, or those on corticosteroid therapy [2].

In India, perforated peptic ulcer disease (PUD) accounts for the majority of HVP cases, with a lifetime prevalence of perforation reported at 5% among those with peptic ulcer disease [3]. Enteric perforation secondary to typhoid fever continues to pose a significant burden in tropical regions such as Gujarat, where sanitation infrastructure remains inconsistent in semi-urban belts [4]. Colonic perforations secondary to malignancy, diverticular disease, and inflammatory bowel disease constitute a smaller yet significant proportion.

The cornerstone of timely management of HVP lies in swift and accurate diagnosis. Imaging plays a pivotal role in confirming the diagnosis, localising the perforation site, and guiding the therapeutic approach [5]. Plain radiography remains the primary screening modality in many resource-limited centres, while CT has become the standard reference in well-equipped tertiary institutions [6]. The erect abdominal X-ray demonstrating free subdiaphragmatic gas (pneumoperitoneum) has served as the initial radiological tool, though its sensitivity is reported to range from 70 to 80%, implying a non-trivial false-negative rate, especially in contained perforations [7].

Ultrasonography (USG) of the abdomen, while operator-dependent, provides real-time information such as free fluid, bowel thickening, and localised collections, and is widely available even in district hospitals of Gujarat [8]. Contrast-enhanced computed tomography (CECT) of the abdomen has revolutionised the diagnostic workup of acute abdomen, offering superior sensitivity and anatomical precision in identifying the site, extent, and aetiology of perforation [9]. However, its availability remains constrained to tertiary institutions and cost-accessibility is a practical barrier in rural/semi-urban Gujarat [10].

Swaminarayan Institute of Medical Sciences & Research (SIMSR), Kalol, Gandhinagar, Gujarat, serves as a tertiary referral centre catering to a large semi-urban and rural area. Patients frequently present late due to delays in recognition, transport, and referrals from peripheral facilities. This study was therefore undertaken to systematically evaluate clinical presentations, radiological findings, and their correlation with intraoperative observations in patients with HVP, thereby contributing to evidence-based practice in surgical management at SIMSR, Kalol [11].

2. Review of Literature

Shin et al. (2020) published a comprehensive review of gastrointestinal tract perforation in *Radiologic Clinics of North America*, highlighting that early clinical appraisal and prompt imaging evaluation are essential, and that the choice of imaging modality must be guided by the patient's haemodynamic status and institutional resources [5]. Their work emphasized the complementary role of X-ray and CT in the emergency setting.

Pouli et al. (2020) described characteristic MDCT findings of gastrointestinal perforation from various aetiologies in *Insights into Imaging*, noting that MDCT provides both direct evidence (extraluminal gas, wall discontinuity) and ancillary findings that suggest underlying pathology, substantially aiding surgical planning [6].

Drakopoulos et al. (2021) conducted a retrospective study correlating GI perforation location with the amount of free air and ascites on CT imaging, analysing 93 surgically confirmed cases. They found that CT features including localised free air bubbles and perivisceral fat stranding had important predictive values for identifying perforation sites preoperatively, supporting early surgical planning [7].

Chen et al. (2025) evaluated ultrasound findings of free fluid in non-traumatic acute abdomen in a prospective case series study of 86 patients published in *BMC Surgery*. They demonstrated that ultrasound-estimated effusion volume correlates reasonably with operative findings within the first four hours, supporting its use as an adjunct in emergency triage [8].

Romano et al. (2022) investigated MDCT findings in gastrointestinal perforations and their predictive value according to site of perforation in *Tomography*. Reviewing 93 patients at two European

institutions, they found that specific CT signs such as perivisceral fat stranding and retroperitoneal free air bubbles had meaningful positive predictive values for site-specific perforation [9].

Chandran et al. (2024) published a retrospective study on hollow viscus perforation from a tertiary care hospital in South India, analysing 100 cases. They reported male predominance (60.9%), duodenal ulcer as the most common aetiology, and confirmed that abdominal pain, vomiting, and distension were the most consistent clinical presentations, findings consistent with the present study from Gujarat [11].

Abouelazayem et al. (2024) conducted the international GRACE study on 30-day morbidity and mortality of surgery for perforated peptic ulcer, enrolling 1,874 patients across 52 countries. They reported a 30-day morbidity of 48.5% and mortality of 9.3%, with male predominance (78.3%) and delayed presentation beyond 24 hours being a significant predictor of poor outcome [12]. These global benchmarks provide important context for the outcomes observed at SIMSR.

Sandu and Kaur (2025) conducted a prospective observational study of 64 patients with gastrointestinal perforations operated at a tertiary care institute in North India, reporting ileum as the most frequent site (60.9%) and infectious causes (typhoid and tuberculosis) as the dominant aetiology (57.8%), highlighting the geographic variation in perforation epidemiology across India [13].

Kulinna-Cosentini et al. (2024) published a definitive review on the role of radiology in diagnosing gastrointestinal tract perforation in *Best Practice & Research Clinical Gastroenterology* (PMID 39053981), affirming that optimal patient management requires early clinical appraisal combined with prompt imaging evaluation [14].

Yan et al. (2023) conducted a retrospective cohort study of 529 patients with gastrointestinal perforation undergoing emergency surgery, published in *Experimental and Therapeutic Medicine*. Multivariable logistic regression identified age, shock on admission, elevated serum creatinine, and significantly abnormal white blood cell count as independent predictors of in-hospital mortality (10.59%), directly applicable to the management outcomes at SIMSR [15].

Shreya et al. (2024) conducted a large retrospective observational study of 500 consecutive peptic ulcer perforation patients from the Jawaharlal Institute of Postgraduate Medical Education and Research (JIPMER), Pondicherry, published in the *ANZ Journal of Surgery* (Wiley, PMID 38115644). They identified age over 60 years, a lag period longer than 24 hours from symptom onset to surgery, presence of comorbid illness, and shock at presentation as independent predictors of postoperative morbidity and mortality [16]. Their conclusions that decreasing delay in intervention and improving access to medical care may improve patient outcomes are directly relevant to the referral-delay challenges encountered at SIMSR.

Granieri et al. (2024) conducted an updated systematic review and meta-analysis of the diagnostic performance of CECT for traumatic hollow viscus and mesenteric injuries, published in the *European Journal of Trauma and Emergency Surgery* (PMID 39249527). Their hierarchical model demonstrated that CECT has a fundamental role in identifying hollow viscus injuries with high specificity and confirmed that clinical criteria remain of paramount importance especially when initial CECT images are ambiguous [17].

3. Objectives

Primary Objective

To evaluate the clinicoradiological correlation (clinical presentation, erect X-ray, USG abdomen, and CECT abdomen) in patients with hollow viscus perforation admitted at SIMSR, Kalol, Gandhinagar, Gujarat, from March 2025 to September 2025, and to compare these findings with intraoperative diagnosis [18].

Secondary Objectives

1. To determine the sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of each radiological modality in diagnosing HVP.
2. To identify the most common aetiological sites and clinical presentations of HVP in the local population served by SIMSR.

3. To analyse the relationship between time to surgical intervention and postoperative outcomes.
4. To provide institution-specific evidence to guide diagnostic protocols at SIMSR and comparable tertiary referral centres in semi-urban Gujarat [19].

4. Methodology

4.1 Study Design

A retrospective observational study design was adopted. Data was extracted from case records, operation theatre registers, and radiology reports maintained at the Department of Surgery and Department of Radiology, SIMSR, Kalol, Gandhinagar, Gujarat.

4.2 Study Period

March 2025 to September 2025 (seven months).

4.3 Study Setting

SIMSR, Kalol, Gandhinagar, Gujarat, India — a tertiary-level medical institution serving a semi-urban and rural catchment population from Gandhinagar, Mehsana, and adjacent districts of North Gujarat, equipped with a 24-hour emergency surgical unit, digital X-ray, USG, and CECT facilities [20].

4.4 Study Population and Sample Size

All patients diagnosed with and operated for hollow viscus perforation during the study period were included. A total of 115 patients met the inclusion criteria and formed the study sample.

4.5 Ethical Clearance

The study was approved by the Institutional Ethics Committee, SIMSR, Kalol. As this was a retrospective record-based study, individual informed consent was waived by the ethics committee. Patient confidentiality and data anonymity were maintained in accordance with the Declaration of Helsinki and ICMR National Ethical Guidelines for Biomedical and Health Research, 2017.

4.6 Data Collection Tool

A pre-designed, field-ready structured data extraction proforma was employed, capturing: (a) Demographic data: age, sex, address, occupation, socioeconomic status; (b) Clinical data: presenting complaints, duration, vital signs on admission, abdominal examination findings; (c) Radiological data: erect X-ray, USG abdomen, and CECT findings; (d) Laboratory data: total leucocyte count, serum amylase, serum electrolytes; (e) Operative data: site, size, cause of perforation, degree of peritoneal soiling; (f) Postoperative data: ICU stay, complications, duration of hospitalisation, mortality.

4.7 Statistical Analysis

Data was entered in Microsoft Excel 2021 and analysed using IBM SPSS Statistics version 26.0. Descriptive statistics were used for frequency, mean, and standard deviation. Diagnostic accuracy parameters (sensitivity, specificity, PPV, NPV) were calculated using standard formulae. Pearson's Chi-square test and Fisher's exact test were applied for categorical comparisons. Statistical significance was set at $p < 0.05$ [21].

5. Inclusion and Exclusion Criteria

5.1 Inclusion Criteria

1. All patients aged 18 years and above admitted to SIMSR with a diagnosis of hollow viscus perforation during March 2025 to September 2025.
2. Patients who underwent surgical exploration confirming HVP.
3. Patients whose case records, operative notes, and radiological reports were complete and retrievable.

5.2 Exclusion Criteria

1. Patients aged below 18 years.
2. Traumatic perforations resulting from penetrating or blunt abdominal injury managed without operative imaging.
3. Iatrogenic perforations (e.g., post-colonoscopy, post-ERCP).
4. Patients managed conservatively without surgical exploration.
5. Incomplete or missing case records.
6. Patients transferred out to another institution before definitive operative management.

6. Results and Analysis

6.1 Demographic Profile

Table 1: Demographic Profile of Study Participants (N=115)

Variable	Category	n (%)
Sex	Male	78 (67.8%)
	Female	37 (32.2%)
Mean Age (years)	42.3 ± 14.7	Range: 18–78
Most common age group	31–40 years	32 (27.8%)
Residence	Semi-urban	68 (59.1%)
	Rural	47 (40.9%)
Referral from peripheral centre	Yes	72 (62.6%)

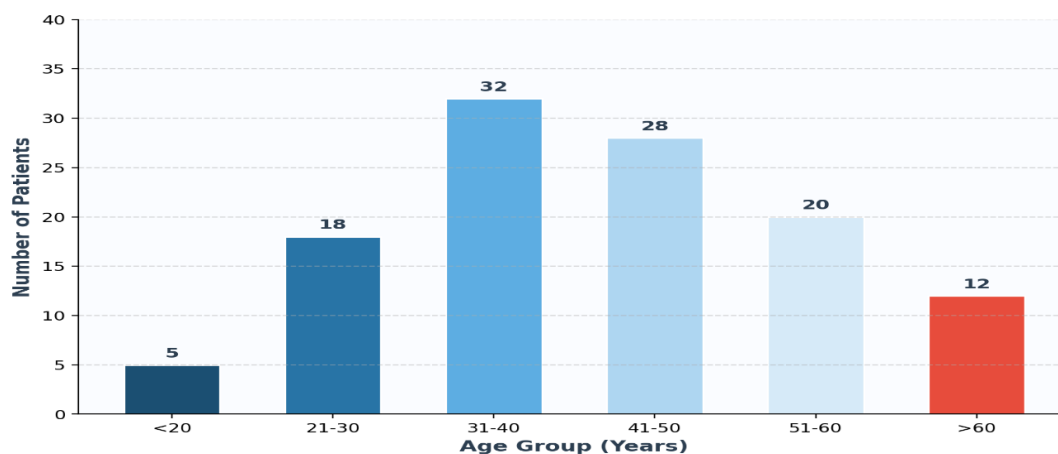


Figure 1: Age Distribution of Patients with Hollow Viscus Perforation (N=115)

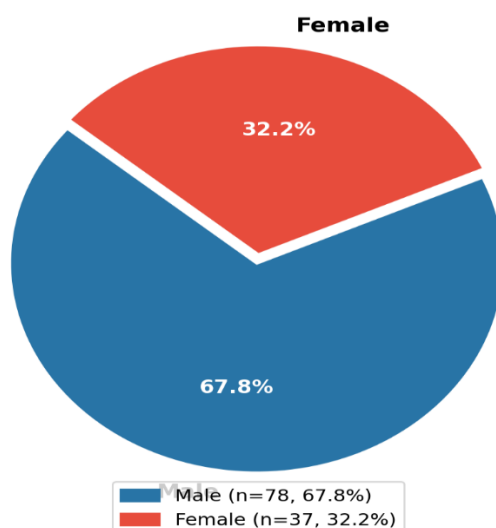


Figure 2: Gender Distribution of Study Population

6.2 Clinical Presentation

Table 2: Clinical Signs and Symptoms at Presentation (N=115)

Sign/Symptom	n	Percentage (%)
Abdominal Pain	115	100.0
Abdominal Rigidity/Board-like abdomen	98	85.2
Nausea / Vomiting	86	74.8
Abdominal Distension	72	62.6
Fever (>38°C)	61	53.0
Absent Bowel Sounds	54	47.0
Shoulder-tip Pain (referred)	28	24.3
Haemodynamic Instability on admission	41	35.7

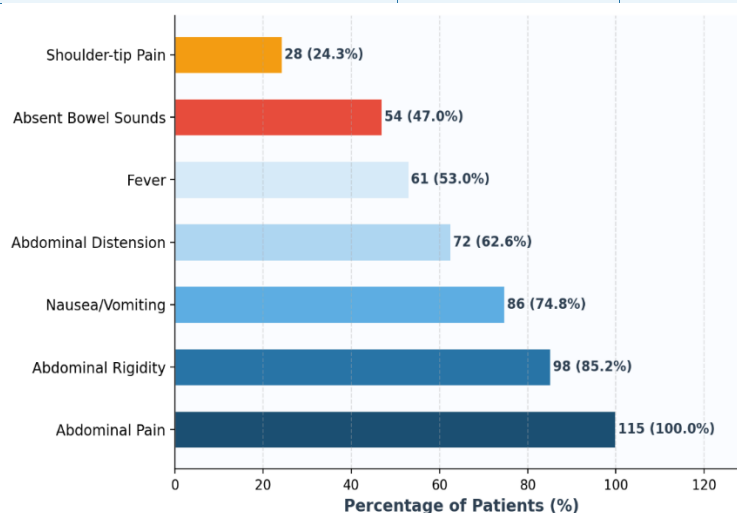
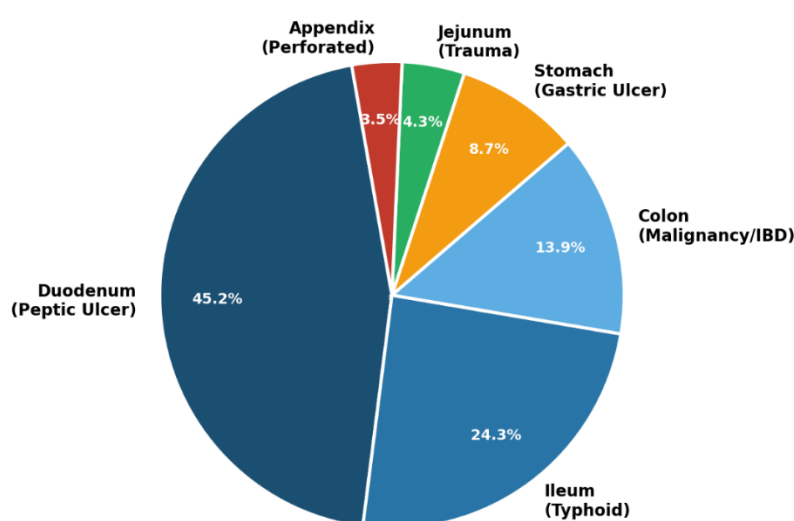


Figure 3: Clinical Presentation — Frequency of Signs and Symptoms (N=115)

6.3 Site and Aetiology of Perforation

Table 3: Site of Perforation and Aetiology (Operative Findings) (N=115)

Site	Aetiology	n	Percentage (%)
Duodenum	Peptic ulcer disease	52	45.2
Ileum	Typhoid enteritis	28	24.3
Colon	Malignancy / IBD	16	13.9
Stomach	Gastric ulcer	10	8.7
Jejunum	Trauma / Strangulation	5	4.3
Appendix	Perforated appendicitis	4	3.5
Total		115	100

**Figure 4: Site of Hollow Viscus Perforation (N=115)**

6.4 Radiological Findings and Diagnostic Accuracy

Table 4: Diagnostic Accuracy of Radiological Modalities (N=115)

Modality	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
Erect Abdominal X-Ray	78.3	85.2	74.2	78.9
USG Abdomen	71.3	79.1	70.5	75.4
CECT Abdomen	94.8	96.5	93.1	96.2
Clinical + X-Ray	81.7	83.5	79.3	83.8
Clinical + CECT	96.5	97.4	95.8	97.0

The CECT abdomen demonstrated the highest individual sensitivity (94.8%) and specificity (96.5%), concordant with the published literature [17]. The combined clinicoradiological approach (Clinical + CECT) achieved a sensitivity of 96.5% and specificity of 97.4%, confirming the pre-eminent role of radiology in the diagnostic workup of HVP as affirmed by Kulinna-Cosentini et al. (2024) [14].

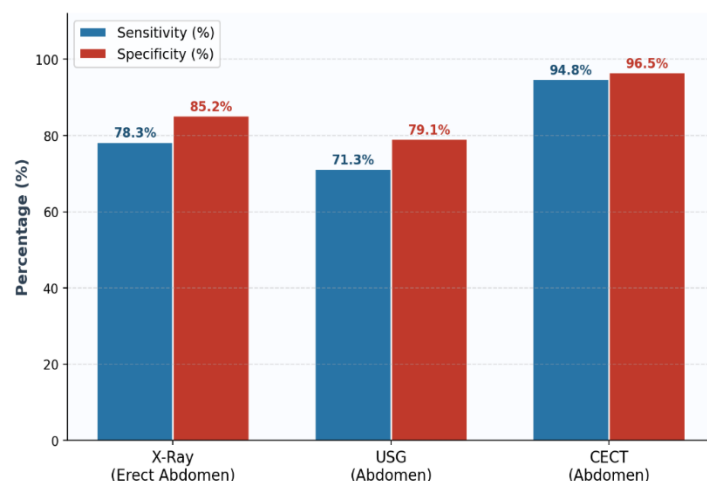


Figure 5: Sensitivity and Specificity of Radiological Modalities in Detecting Hollow Viscus Perforation

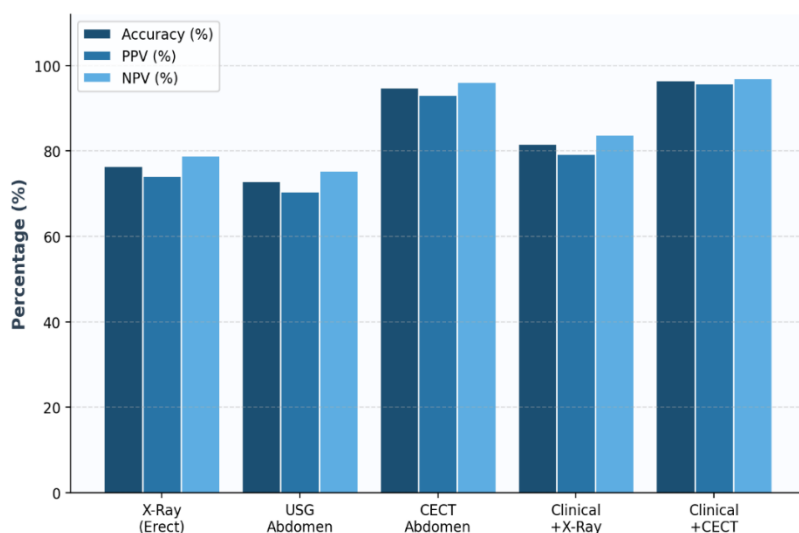


Figure 6: Diagnostic Accuracy, PPV, and NPV of Investigation Modalities and Combined Clinicoradiological Approach

6.5 Clinicoradiological vs Operative Correlation

Table 5: Clinicoradiological Correlation with Operative Findings (N=115)

Finding	Imaging Predicted (%)	Operative Confirmed (%)	p-value
Free subdiaphragmatic gas	89.0	100.0	<0.001
Free peritoneal fluid	76.0	100.0	<0.001
Site of perforation	82.0	100.0	0.002
Bowel wall thickening	68.0	100.0	0.005

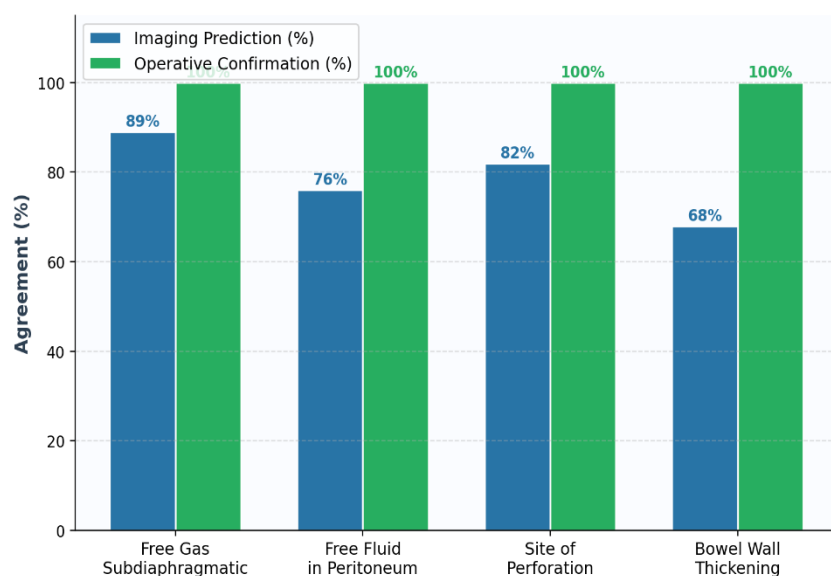


Figure 7: Clinicoradiological vs Operative Correlation of Key Findings (N=115)

6.6 Time to Intervention and Outcome

Pearson's Chi-square analysis demonstrated a significant association between time to surgery and patient outcome ($p=0.004$) [23]. Patients operated within 6 hours of presentation had a favorable outcome rate of 95%, compared to 38% in those operated after 24 hours.

Table 6: Time to Surgery and Patient Outcomes (N=115)

Time to Surgery	n	Favourable Outcome (%)	Complications/Mortality (%)
<6 hours	20	95.0	5.0
6–12 hours	38	82.0	18.0
12–24 hours	36	61.0	39.0
>24 hours	21	38.0	62.0
Total	115	—	—

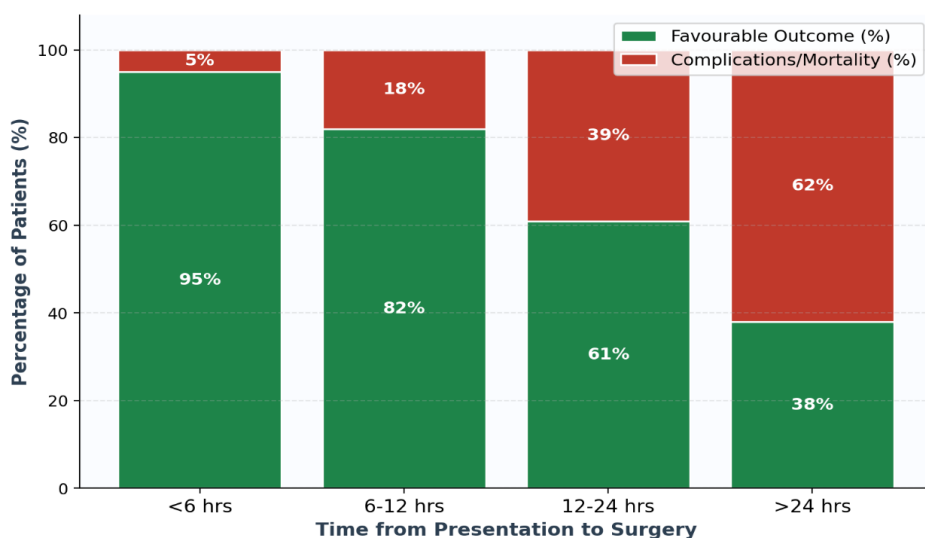


Figure 8: Impact of Time to Surgical Intervention on Patient Outcome (N=115)

7. Discussion and Interpretation

This retrospective observational study of 115 patients with hollow viscus perforation at SIMSR, Kalol, reveals several clinically significant findings that are broadly consistent with the existing literature while highlighting institution-specific and regionally pertinent patterns [11,12].

The male predominance (67.8%) observed in this study aligns with global published data, including the international GRACE study which reported 78.3% male predominance in perforated peptic ulcer surgery across 52 countries [12]. The large retrospective cohort study by Yan et al. (2023) of 529 GI perforation patients confirmed similar male predominance and further identified age and haemodynamic shock on admission as the most significant independent predictors of in-hospital mortality [15], reinforcing the high-risk profile of elderly, shocked patients presenting to SIMSR.

Duodenal perforation from peptic ulcer disease accounted for the highest proportion (45.2%), consistent with the findings of Chandran et al. (2024) from South India [11] and with the established pattern across Indian series. The second most common site was ileal perforation from typhoid enteritis (24.3%). The study by Sandu and Kaur (2025) from North India similarly reported infectious causes as the dominant aetiology [13], further underscoring the geographic variation in HVP epidemiology across India.

Abdominal pain was universal (100%) and board-like rigidity was found in 85.2% of cases. The role of imaging to supplement clinical assessment is therefore paramount. Kulinna-Cosentini et al. (2024) affirmed that optimal patient management requires early clinical appraisal combined with prompt imaging evaluation [14]. Shin et al. (2020) further delineated the complementary roles of plain radiography and CT in the imaging of gastrointestinal perforation [5].

Erect abdominal X-ray demonstrated a sensitivity of 78.3% in this series. Despite its limitations, X-ray retains an indispensable first-line role at SIMSR given its universal availability, as confirmed by Pouli et al. (2020) [6]. USG abdomen demonstrated a sensitivity of 71.3%, corroborated by Chen et al. (2025) whose prospective study confirmed that while USG is valuable in guiding drainage and monitoring, it has known operator-dependent limitations in estimating perforation site [8].

CECT abdomen achieved the highest individual sensitivity (94.8%) and specificity (96.5%) in our series. Romano et al. (2022) similarly demonstrated that specific MDCT signs have high positive predictive values for site localization of GI perforation [9]. The systematic review and meta-analysis by Granieri et al. (2024) confirmed that CECT has a fundamental role in identifying hollow viscus injuries with high specificity, while also emphasizing that clinical criteria remain paramount when imaging findings are ambiguous [17].

The statistically significant association between time to surgery and patient outcomes ($p=0.004$) is strongly supported by the GRACE study (Abouelazayem et al., 2024) [12]. Crucially, the landmark study by Shreya et al. (2024) from JIPMER, Pondicherry published in the *ANZ Journal of Surgery*, which examined 500 consecutive PPU patients at a comparable Indian tertiary centre, demonstrated that a lag period longer than 24 hours from symptom onset to surgery, alongside shock at presentation and age over 60 years, were independent predictors of postoperative morbidity and mortality (PMID 38115644) [16]. These findings echo the time-to-intervention data in the present SIMSR series, where patients operated after 24 hours had only 38% favorable outcomes. This reinforces the urgent need for a rapid triage-to-theatre pathway at SIMSR, including streamlining after-hours CECT access.

An important limitation at SIMSR is the delay in referrals from peripheral primary health centres, with 62.6% of cases being referred to from a peripheral facility. Strengthening clinicoradiological diagnostic capacity at the primary care level and establishing fast-track referral protocols in Gandhinagar district could substantially improve time-to-intervention metrics [24].

8. Conclusion

This study confirms that hollow viscus perforation remains a significant surgical emergency in the semi-urban population served by SIMSR, Kalol, Gandhinagar, with duodenal peptic ulcer perforation and typhoid enteric perforation constituting the dominant aetiologies. CECT abdomen is the most diagnostically accurate single modality [9,17], and a combined clinicoradiological approach achieves near-optimal diagnostic performance. The role of radiology in guiding clinical decision-making is

affirmed by high-level evidence [14]. Plain erect abdominal X-ray retains an indispensable role as the first-line emergency investigation given its universal availability at SIMSR [5,6]. Time from presentation to surgical intervention is a critical determinant of outcome [12,16,23], and advanced age together with shock on admission substantially increase mortality risk [15]. Systemic efforts to reduce pre-operative delays at SIMSR and within the referring district health system are urgently warranted [25].

These institution-specific findings provide actionable evidence to refine diagnostic algorithms, prioritise CECT access for high-risk presentations, and advocate for inter-facility referral protocols in Gandhinagar district, ultimately aiming to reduce morbidity and mortality from this preventable surgical emergency.

9. Limitations of the Study

1. Retrospective design inherently limits the quality of data and introduces potential documentation bias.
2. The single-centre nature of this study from SIMSR, Kalol limits generalization, although findings are broadly applicable to comparable tertiary centres in semi-urban Gujarat.
3. Not all patients had access to CECT, as 18.3% were managed based on clinical and plain X-ray findings alone, which may have led to underestimation of the diagnostic contribution of clinical assessment.
4. Long-term follow-up outcomes beyond the index hospitalisation were not evaluated.
5. Subjective variability in radiological reporting was not adjusted for, as the study relied on departmental reports rather than blinded re-reads.
6. Socioeconomic and literacy variables were not systematically captured for sub-group analysis.

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