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RESEARCH

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Utility of computed tomography in assessing caustic ingestion damage to the esogastric tract

Hamza Retal[1*], Soumya El Graini[1], Amine Naggar[1], Alia Yassine Kassab[1], Asaad El Bakkari[1], Laila Jroundi[1] and Fatima Zahrae Laamrani[1]

Abstract

Background Ingestion of corrosive substances represents a frequent and consequential medical scenario, significantly impacting both vital and functional prognoses through the emergence of acute complications or stenosis, which pose considerable therapeutic challenges. Currently, endoscopy remains the cornerstone modality for diagnostic assessment and management. Nevertheless, recent research highlights computed tomography (CT) as a promising alternative, avoiding the risks associated with endoscopy and reducing the unnecessary surgical interventions based on its findings.

Methods Our retrospective study, spanning three years, encompassed 28 patients who had ingested corrosive substances. Among them, 24 underwent both CT scanning and endoscopic evaluation using CT and endoscopic scores.

Results Employing Standardized CT scoring criteria alongside the Zargar's endoscopic classification, our findings revealed significant concordance between the two modalities, particularly in discerning trans-parietal necrosis within the esophagus and stomach. Notably, radiographic evidence of digestive tract injury was found to be predictive of complications in over 80% of cases, demonstrating high sensitivity and negative predictive value. Furthermore, CT scores indicating moderate to severe injury were significantly associated with stenosis, with slightly inferior performance compared to endoscopy. Of particular note, a CT score indicative of severe injury was found to be a good predictor of mortality, further underscoring the prognostic value of CT in these cases.

Conclusion While the utility of CT in this context is undeniable, its integration with endoscopic findings remains imperative. We advocate for a systematic approach incorporating CT scanning, with further prospective research warranted to explore the feasibility of CT as a standalone diagnostic tool, as suggested by some scholars.

Keywords Caustic ingestion, Upper digestive tract, CT scan, Endoscopy, Transmural necrosis

Background

Caustic burns of the digestive tract are a frequent emergency in adults. While often benign, their occurrence can be life-threatening and result in significant functional impairment, with both immediate and delayed mortality. This pathology necessitates immediate and multidisciplinary care. Esogastric fibroscopy has been an essential diagnostic tool, crucial for determining prognosis and guiding therapeutic management [1].

However, computed tomography (CT) had gained recognition as a valuable radiological method for assessing the severity of lesions, establishing a comprehensive lesion assessment, and guiding management strategies [2]. The objective of our study is to collect the experience of Ibn Sina Hospital, focusing on the contribution of CT in order to establish clear indications and reduce the reliance on endoscopic examinations in the acute phase.

Fiberoptic endoscopy is traditionally used in the management of caustic burns, providing a direct visualization

*Correspondence:
Hamza Retal
Retal.hamza95@gmail.com
[1] Emergency Radiology, Ibn-Sina University Hospital, Rabat, Morocco

of the extent and severity of esophageal burns. The Zargar's classification, developed from endoscopic findings, is pivotal in determining the prognosis and therapeutic approach for patients with caustic ingestion [1]. In the other hand, computed tomography offers a noninvasive alternative to endoscopy, providing detailed imaging that helps in the evaluation of high-grade esophageal necrosis through transmural thickness of esophageal and gastric wall. By accurately assessing the severity of caustic burns, CT can help avoid unnecessary surgical interventions, such as esophagectomy, thereby reducing patient risk and healthcare costs [2].

Given the potential life-threatening nature of caustic burns and the importance of timely intervention, incorporating CT into the diagnostic protocol can enhance the accuracy of severity assessment and guide appropriate management, potentially reducing the need for invasive endoscopic procedures in the acute phase [3].

Methods

Study design

This retrospective, descriptive, and analytical study was conducted on 28 adult patients who experienced caustic injuries, over a period from September 6, 2018, to November 20, 2021.

Study population

The study was carried out within the Emergency Radiology Department at Ibn Sina University Hospital in Rabat. It included 28 adult patients, among them, 24 underwent both endoscopic and computed tomographic (CT) examinations following caustic injuries (Table 1).

Adult patients over 18 years old who ingested caustic agents and were assessed by CT in the emergency room or later for control met the inclusion criteria. Pediatric patients and absence of scannographic or endoscopic examination were excluded unless contraindicated.

Confidentiality and medical secrecy were strictly maintained, with personal data encrypted by assigning a number to each patient. The hospital authorities approved the exploitation of the collected data.

Sample size

The sample size was determined based on a power analysis to ensure adequate statistical significance. This analysis accounted for the number of clinical groups, anticipated dropout rates, and the desired level of statistical power.

Endoscopic assessment

The endoscopic interpretation was based on Zargar's Score: Grade 0 normal, Grade 1 (erythema and edema), Grade 2 (mucous ulceration) divided into two subgrades, 2a (superficial ulcerations, false membranes, mucous hemorrhages) and 2b (digging and confluent ulcerations), Grade 3 (mucous necrosis) with two subgrades, 3a (focal non-circumferential necrosis) and 3b (diffuse circumferential necrosis).

Radiologic assessment

CT scan was performed for initial lesion assessment or for follow-up and complications with a 16-slice Optima General Electric CT machine. Patients were in a strict dorsal decubitus position. Acquisition area included cervico-thoraco-abdominal region or thoraco-abdominal field. A first spontaneous contrast acquisition was assessed for calcifications, hemorrhage, and evaluation of contrast enhancement, followed by an injection of 2 ml/kg of iodinated contrast medium (ULTRAVIST 300 mg/ml) at a speed of 3 cc/second using an automatic injector. Two contrast acquisitions were performed a first arterial phase at 45 s for arterial analysis and pancreatic exploration then a portal phase at 75 s for evaluating the enhancement of the digestive wall and adjacent organs (mediastinum, liver, spleen, pancreas, and mesentery). Digestive opacification with water-soluble iodinated contrast (Gastrografin®: 100–150 cc) was performed in some follow-up examinations to assess stenosis or perforation.

Interpretation of scannographic images was based on the classification of Bruzzi and Mircea Chirica, which we modified (Fig. 1). Images were reviewed by two expert radiologists specializing in emergency and gastrointestinal radiology. Both radiologists have extensive experience in interpreting CT scans related to gastrointestinal emergencies, including caustic ingestion injuries.

Grade 1 normal. Grade 2 (submucosal parietal edema) is divided into two subgroups, IIa (submucous edema limited by mucous enhancement and of the outer layer "target appearance", without peridigestive fat stranding, and IIb (Submucosal edema associated to enhancement of the outer layer and absence of enhancement of the mucosa 'Mucous necrosis' with fat standing). Grade 3 (transmural necrosis) Defined by the absence of the digestive wall enhancement after contrast injection, with fat stranding. Grade 4 (perforation/eso-tracheal fistula) with signs of peritonitis (pneumoperitoneum, peritoneal effusion, digestive continuity solution or peritoneal collection) or mediastinitis (pneumo-mediastinum, mediastinal or pneumopericardium effusion, esophageal wall continuity solution or mediastinal collection.

Histopathology

Our study lacked histological evidence due to the rarity of surgical indications within our series, with only one patient undergoing surgery. In this case,

Table 1 Characteristics of included patients with caustic substance ingestion

	AGE/ GENDER	INTENT	CAUSTIC	QUANTITY (MI)	CT SCORE	ESOPHAGUS CT SCORE	GASTRIC CT SCORE	ENDOSCOPIC SCORE	ESOPHAGUS ENDOSCOPIC SCORE	GASTRIC ENDOSCOPIC SCORE	ICU	JEJUNOSTOMY	SURGERY	STENOSIS	DEATH
1	41/M	A	Strong acid	225	IIb	IIb	IIa	3a	2b	3a	N	N	N	N	N
2	35/F	S	Strong Acid	150	IIa	I	IIa	3a	2a	3a	N	N	N	N	N
3	23/F	S	Strong Acid	450	IIa	I	IIa	3a	3a	2a	Y	Y	N	Y	Y
4	71/F	S	Strong Acid	150	IIb	IIb	IIb	3a	2b	3a	N	N	N	Y	N
5	23/M	S	Strong Acid	150	IIb	IIb	IIa	2b	2b	2b	N	Y	N	Y	N
6	27/F	S	-	150	III	III	IIa	2b	2b	2a	N	Y	N	Y	N
7	22/M	S	Strong Acid	150	IIb	IIa	IIb	3b	2a	3b	N	Y	N	Y	N
8	40/M	A	Strong Acid	40	I	I	I	2b	2b	2a	N	N	N	N	N
9	22/F	S	Weak Alkali	150	I	I	I	2a	2a	1	N	N	N	N	N
10	19/F	A	Oxydant	150	I	I	I	2a	2a	2a	N	N	N	N	N
11	56/F	S	Strong Acid	150	IIa	I	IIa	2b	2a	2b	N	N	N	N	N
12	18/M	-	Strong Acid	150	IIb	IIa	IIb	2b	2a	2b	N	N	N	N	N
13	27/M	S	Strong Acid	450	III	III	III	3a	3a	3a	Y	Y	N	N	N
14	41/M	S	Strong Acid	150	IIa	IIa	IIa	2b	2b	2a	N	N	N	Y	N
15	26/M	S	Strong Acid	150	III	III	III	3b	3b	3b	N	N	N	Y	N
16	39/F	S	Strong Acid	75	IIb	IIb	IIb	3b	2b	3b	Y	N	N	N	Y
17	42/M	S	Strong Acid	150	III	III	III	2b	2b	-	N	N	N	Y	N
18	60/M	-	Strong Acid	300	III	IIb	III	3b	2b	3b	N	N	N	Y	Y
19	21/F	S	Strong Acid	300	IIa	IIa	IIa	3a	2b	3a	N	N	N	Y	N
20	53/M	S	Strong Acid	300	IV	IV	IIb	-	-	-	N	N	N	-	Y
21	26/M	S	-	150	I	I	I	2b	2a	2b	N	N	N	N	N

Table 1 (continued)

	AGE/ GENDER	INTENT	CAUSTIC	QUANTITY (MI)	CT SCORE	ESOPHAGUS CT SCORE	GASTRIC CT SCORE	ENDOSCOPIC SCORE	ESOPHAGUS ENDOSCOPIC SCORE	GASTRIC ENDOSCOPIC SCORE	ICU	JEJUNOSTOMY	SURGERY	STENOSIS	DEATH
22	31/M	S	Strong Acid	300	I	I	I	3a	2b	3a	N	N	N	Y	N
23	65/M	-	Strong Acid	300	-	-	-	3b	3b	3b	Y	Y	Y	Y	N
24	44/M	S	Strong Acid	300	IIb	IIa	IIb	3b	2b	3b	Y	N	Y	Y	Y
25	53/M	S	Strong Acid	450	IV	IV	III	-	-	-	Y	Y	Y	-	Y
26	77/F	S	Strong Acid	450	IV	III	IV	-	-	-	Y	N	Y	-	Y
27	18/F	-	Strong Acid	-	IV	III	IV	-	-	-	Y	N	Y	-	Y
28	18/M	S	Strong Acid	150	IIb	IIb	IIa	3a	3a	3a	N	N	N	Y	N

M: Male. F: Female. S: Suicidal intent. A: Accidental. Y: Yes. N: No. ICU: Intensive care unit

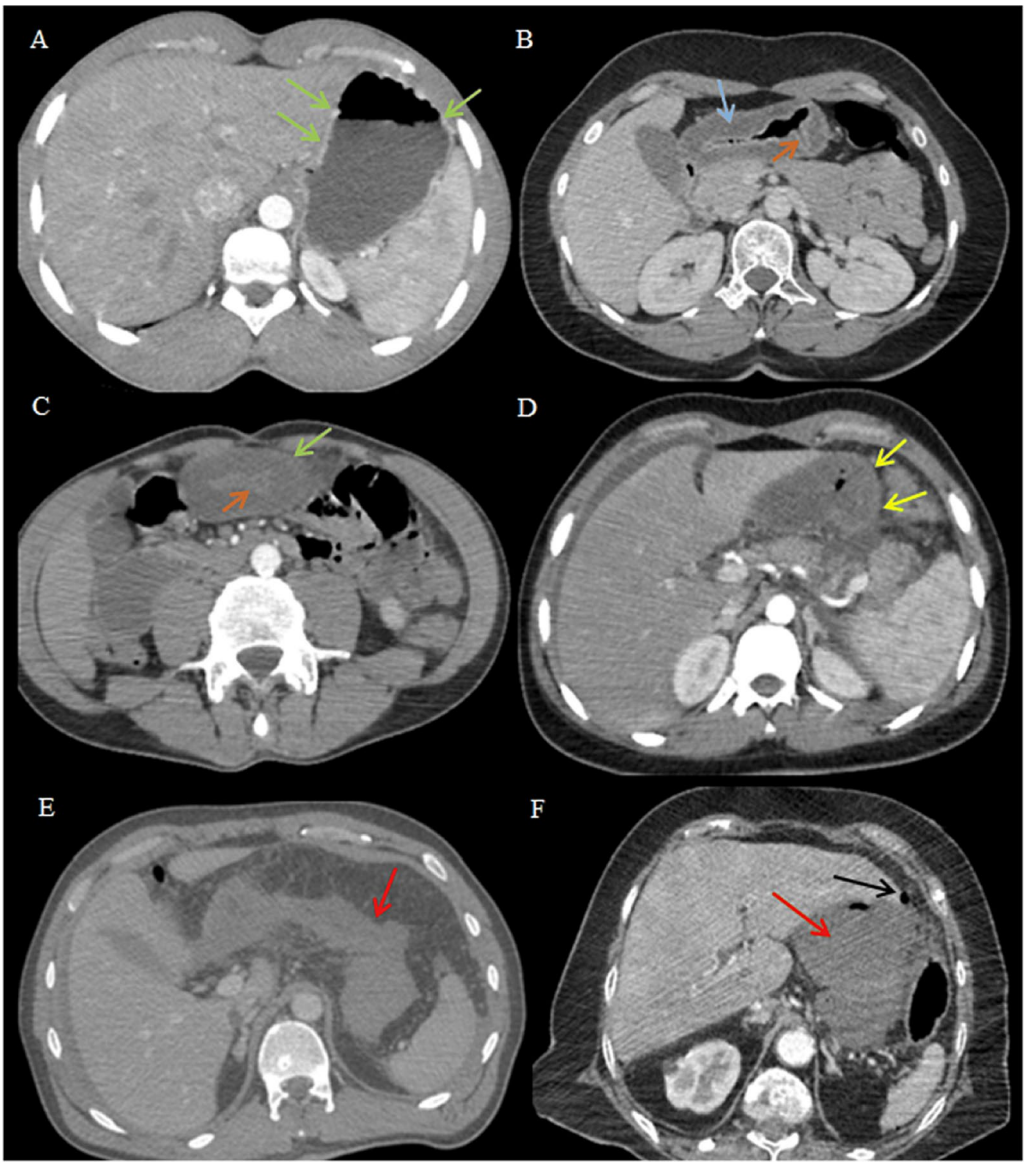

Fig. 1 Features of computed tomography classification. **A** Grade 1: normal enhancement of gastric wall (green arrow). **B** Grade 2a: gastric submucosal edema (blue arrow) with normal mucosa enhancement (orange arrow). **C** Grade 2a: pyloric submucosal edema with mucosal (orange arrow) and extern wall enhancement (green arrow) target sign. **D** Grade 2b: non-enhancing mucosal necrosis with a normal enhancement of the extern layer of the digestive wall (yellow arrow). **E** Grade 3: non-enhancing gastric wall suggesting trans-parietal necrosis (red arrow). **F** Grade 4: gastric trans-parietal necrosis (red arrow) with peritoneal air bubble (black arrow) suggesting perforation

macroscopic necrosis of the digestive tract was confirmed post-esophagogastrectomy.

Statistical analysis

The statistical evaluations were performed using the Jamovi project 'Jamovi (version 2.2.5) [Computer Software] Retrieved from https://www.jamovi.org' The Chi-square test for qualitative variables was performed using cross-tabulations, with a p-value < 0.05 considered significant to compare radiological and endoscopic assessment of trans parietal necrosis od the upper digestive tract following caustic ingestion. Qualitative Variables expressed in numbers and percentages. Quantitative Variables expressed in mean standard deviation for Gaussian distribution or in median quartiles for skewed distribution.

Results

Study population

During the 3-year study period, from September 6, 2018, to November 20, 2021, the average annual incidence of

caustic ingestion was 15 patients. Approximately 65 patients were admitted to the emergency department of Ibn-Sina Hospital for caustic ingestion during this period, but only 28 patients met our inclusion criteria.

A male predominance was noted, with 17 (60.7%) men and 11(39.3%) women. The most affected age group was 18 to 30 years, constituting 13(46.4%) patients of the study population, with a median age of 33 years. Hydrochloric acid was the most commonly ingested substance, accounting 24 (85.7%) patient, with 21 instances of intentional ingestion (suicide attempts) and 3 accidental ingestions. Assessing the psychiatric profile of the patients was crucial for prognosis and evaluating the severity of the situation.

Emergency assessment

Endoscopy was the first-line investigation, performed within 24 h of admission. In 4 cases, endoscopy could not be performed due to suspicion of gastrointestinal perforation. In 2 patients, the procedure was incomplete due to impassable strictures. CT scans were performed on 27 out of 28 patients. One patient only received a delayed CT scan in postoperative esophageal stripping.

Acute complications

Several acute phase complications were encountered.

Peritonitis was diagnosed in 3 (10.7%) patients, caused by gastric perforation in 2 of them, and by necrotic pancreatitis in the other patient following corrosive ingestion.

Mediastinitis resulted in 2 (7.1%) patients from esophageal perforation, classified as grade IV on the radiological score, where endoscopy was not performed.

Pneumonitis occurred in 9 (32.1%) patients due to caustic inhalation or during hospitalization, primarily as ventilator-associated pneumonia (VAP). One of these patients was diagnosed with viral pneumonitis due to COVID-19, initially suspected on CT and confirmed by polymerase chain reaction (PCR).

Necrotic pancreatitis of caustic origin was encountered in 2 (7.1%) patients. Diagnosis was based on hypodensity and lack of enhancement of the pancreatic head and tail on CT, confirmed by elevated lipase levels. Both patients had radiological digestive lesions classified as IIb.

Active hemorrhage bleeding was visualized on CT in 2 (7.1%) patients presenting with hematemesis and hemodynamic instability.

Delayed complications

During the delayed phase, the major complications were intestinal occlusion, esophageal stenosis and less common iatrogenic perforation. Occlusion occurred in one patient following esophageal stripping and jejunostomy, diagnosed by CT scan. Stenosis observed in 14 (50%) patients. The timeframe for the appearance of stenosis is difficult to specify in our study due to a lack of clinical data. It is estimated to be approximately 1 month after ingestion, corresponding to the date of the follow-up endoscopic examination in some patients. Esophageal iatrogenic perforation following endoscopic dilation occurred in one patient, necessitating esophagoplasty due to the complication.

Mortality

Death occurred in 7 (25%) patients. This included one death due to stenosis a year after ingestion, 4 deaths in the acute phase due to gastrointestinal perforation (2 esophageal with mediastinitis and 2 gastric with peritonitis), one death from peritonitis due to necrotic pancreatitis, and one from nosocomial pneumonitis after mechanical ventilation.

Endoscopy versus computed tomography for emergency evaluation of caustic injuries

Prediction of transmural necrosis

We analyzed concordant and discordant results between endoscopy and CT separately in the stomach and esophagus for predicting transmural necrosis, defined as radiological score III and endoscopic score 3b or higher. This analysis included 23 out of 28 patients who had both assessments, excluding 4 patients contraindicated for primary endoscopy and one patient without an acute phase CT scan.

In one patient, endoscopic examination was incomplete due to an impassable esogastric junction stenosis, allowing only esophageal exploration.

Confirmation of trans-parietal necrosis was not possible without histological evidence, except in one patient. This patient underwent surgery after a CT scan revealed trans-parietal gastroduodenal necrosis and perforation (Fig. 2A). The surgery confirmed macroscopic necrosis of the upper digestive tract necessitating an esogastrectomy (Fig. 2B).

In the stomach, endoscopic and radiological findings were concordant in 16 patients, indicating the absence of trans-parietal necrosis, and in 2 patients, confirming its presence. Discrepancies were noted in 4 cases, 3 of which required intensive care and jejunostomy. These cases had a Zargar's score indicative of trans-parietal necrosis (3b) and a CT score suggestive of mucosal necrosis (IIb). Significant peridigestive fat stranding and necrotic pancreatitis were observed in two of these patients, both of whom subsequently died (Fig. 3).

In the esophagus CT and endoscopic scores concurred on the absence of trans-parietal necrosis in 19 cases and its presence in one. Discrepancies were noted in 3 cases,

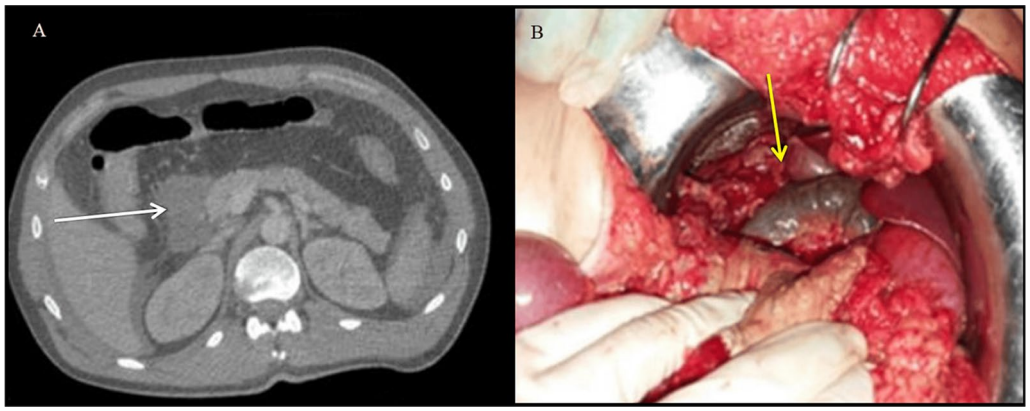

Fig. 2 Extensive gastric and duodenal necrosis following caustic product ingestion in a patient who underwent surgery. **A** contrast CT Axial slice of the abdomen, showing a non-enhancing duodenal wall with fat stranding CT score III (white arrow). **B** Peroperative picture matching with an extensive gastroduodenal necrosis (Yellow arrow)

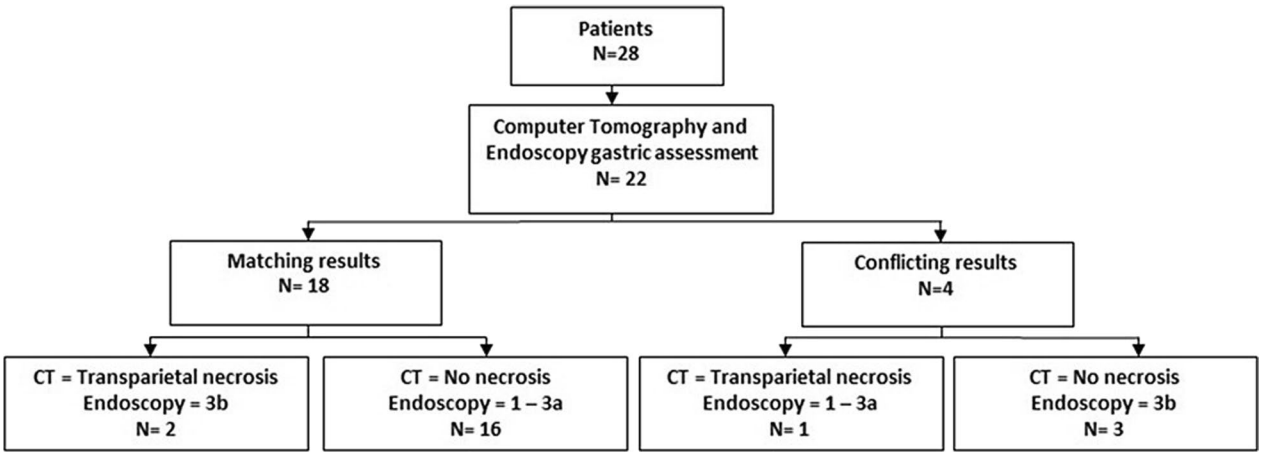

Fig. 3 Flowchart of parietal necrosis analysis by computed tomography versus endoscopy in stomach. CT: Computed tomography. N: Number of patients

with CT indicating trans-parietal necrosis while endoscopy found only focal mucosal necrosis or deep confluent ulcers, these patients required intensive care management with jejunostomy and intubation in of them (Fig. 4).

Complications prediction

The presence of scannographic digestive lesions had a positive predictive value of 81.8% and a negative predictive value of 80% for predicting short- or long-term complications, with a sensitivity of 94.7% and a specificity of 50%. A score > IIb predicted complications with a PPV of 88.2%. Endoscopy scores ≥ 2b had better positive and negative predictive values of 88.2% and 85.7%, respectively, with a sensitivity of 93.8% and a specificity of 75%, but the latter endoscopic results were not statistically significant due to a high p-value (Table 2).

Five patients were excluded due to incomplete CT study follow-up data, and four were excluded for missing endoscopic follow-up data. CT scans predicted the occurrence of esophageal stenosis with a positive predictive value (PPV) of 73.3% for scores between IIa and III and a negative predictive value (NPV) of 75%. Endoscopic examination demonstrated a higher predictive value with a PPV of 76.5% for scores of 2b or greater and an NPV of 85.7%. However, these results were not statistically significant (Table 3).

Discussion

The contribution of CT as a predictive assessment of complications is a new approach that is still debated, as few studies have been able to reach the subject so far. Its interest lies essentially in the diagnosis of transparietal necrosis, but some papers have been able to

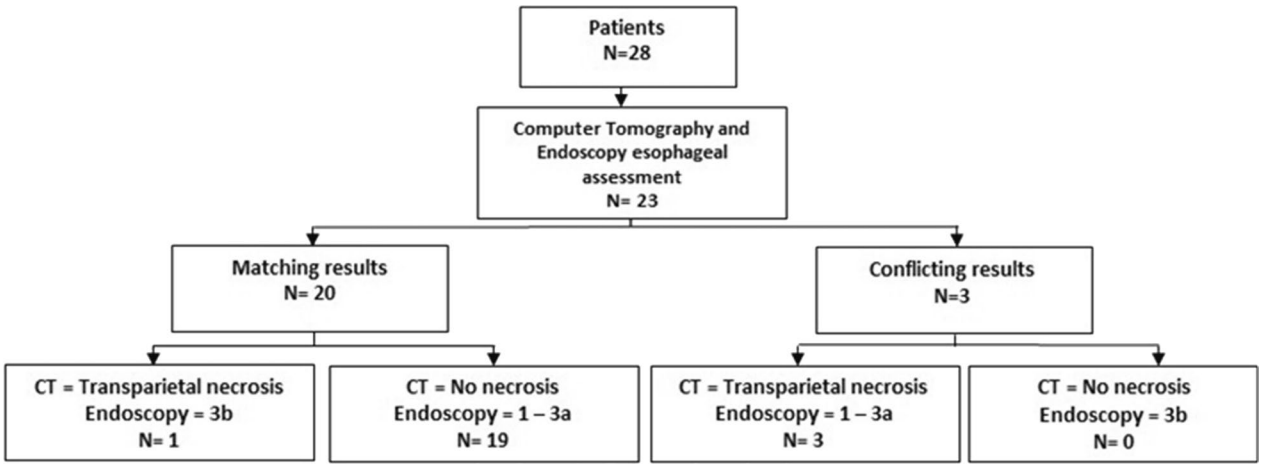

Fig. 4 Flowchart of parietal necrosis analysis by computed tomography versus endoscopy in esophagus. CT: Computed tomography. N: Number of patients

Table 2 Occurrence of complications in correlation to CT scan and endoscopic scores

		General morbidity					
		Specificity (%)	**Sensitivity (%)**	**PPV (%)**	**NPP (%)**	***P* value**	**Chi-square Value**
CT scan	Grade ≥ IIa	50	94,7	81,8	80	0.0062	7.4799
	Grade ≥ IIb	75	78,9	88,2	60	0.0368	4.3594
Endoscopy	Grade ≥ 2b	75	93,8	88,2	85,7	0.0679	3.3333

Chi-square test, with a *p*-value < 0.05 considered significant. PPV: Positive predictive value. NPP: Negative predictive value

Table 3 Occurrence of stenosis in correlation to CT scan and endoscopic scores

		Stenosis					
		Specificity (%)	**Sensitivity (%)**	**PPV (%)**	**NPP (%)**	***P* value**	**Chi-square value**
CT scan	Grade IIa and III	60	84,6	73,3	75	0.7787	0.0786
Endoscopy	Grade ≥ 2b	60	92,9	76,5	85,7	0.3685	0.8086

Chi-square test, with a *p*-value < 0.05 considered significant. PPV: Positive predictive value. NPP: Negative predictive value

demonstrate its capacity to predict stenosis, morbidity and mortality of patients. However, the results remain conflicting [4, 5].

In a study conducted by Y. Lurie, CT evaluation was found to underestimate lesions, resulting in poor sensitivity and specificity compared to endoscopy in predicting the prognosis of lesions in the acute phase. This necessitates comparing radiological and endoscopic examination results to guide surgical management, thus underscoring the importance of endoscopy upon admission. However, the study's limitations include a small sample size (23 cases) and its retrospective nature, which restricts certain parameters, such as the absence of histological data [6].

Mircea Chirica and his team conducted comprehensive studies aimed at elucidating the role of CT in evaluating esophageal necrosis across two phases-retrospective and prospective-encompassing a sample of 197 patients who underwent systematic CT scanning. In the prospective phase, surgical indications were based on these CT findings.

The team compared the histological data of postoperative specimens with CT results in patients classified as endoscopic Grade 3b, which helped to clarify the role of CT in detecting transmural necrosis. This approach significantly reduced the number of surgical interventions compared to the group managed solely by endoscopy, where 124 patients underwent potentially avoidable

surgeries. Consequently, given the limitations of fibroscopy in determining trans-parietal involvement, relying on CT scans helped to prevent unnecessary esophagectomies and avoid excessive surgical procedures [7].

No deaths were reported among patients who benefited from a conservative approach. Consequently, mortality decreased from 16 to 7%, and morbidity decreased from 66 to 53% with the integration of computed tomography into the therapeutic decision-making process. This outcome prompted the gastroenterology team at the same center to primarily rely on this assessment [2].

A similar prospective study was conducted by V. Gault, comparing preoperative CT data of 14 patients with endoscopic grade 3b with histological findings. The study concluded that CT exhibited good specificity and sensitivity in predicting trans-parietal necrosis. However, the study's limitations include its small sample size [8].

In our study, the concordance of results between computed tomography (CT) and endoscopy regarding diagnosis of transmural necrosis was satisfactory. The CT scan provided the additional advantage of enabling direct evaluation of the digestive wall and analysis of the surrounding visceral environment without the need for an invasive procedure, which carries inherent risks during the acute phase. Despite the limitations in the sample size of our study, the findings demonstrated the efficacy of CT in the acute phase and non inferiority to endoscopy to detect transmural necrosis, suggesting its potential to replace endoscopy in this context going along with existing literature.

Esophageal strictures represent a prevalent late complication of caustic ingestion, primarily affecting the esophagus, the most proximal gastrointestinal organ. Strictures or stenosis develop in up to 70% of patients with Zargar grade 2b lesions and in over 90% of those with Zargar grade 3 lesions. These esophageal lesions typically manifest after the third week post-ingestion, with some cases emerging as late as the eighth week [9]. Gastric stricture is less seen and ranks as the second most common complication following caustic ingestion [10].

Matthieu Bruzzi and M. Chirica tracked in another study the evolution of 152 patients who underwent conservative management, with the aim of establishing a correlation between the scannographic classification and the prediction of esophageal strictures compared to endoscopy. The results indicated that the CT score outperforms endoscopy in predicting stenosis formation at 120 days of ingestion. Interestingly, the combination of both examinations did not yield significant differences compared to CT alone at this stage. Furthermore, at the one-year mark post-ingestion, CT alone proved superior to endoscopy in predicting the need for esophageal reconstruction [3].

In another study conducted in South Korea and published in 2009, HH. Ryu compared the utility of CT versus endoscopy in predicting caustic stenosis in 49 patients. The findings revealed that CT exhibited superior sensitivity and specificity [11].

In our study, scannographic scores ranging from IIa to III demonstrated relatively good positive and negative predictive values for occurence of complications in the acute phase. Endoscopy scores for positive and negative prediction values of complications were slightly superior, but the stastical impact was not relevant in our sample in opposit to CT scan results. In another hand, results for Prediction of occurence of stenosis in endoscopy were superior to CT scan, but with no significant p values.

In our study, scannographic scores ranging from IIa to III demonstrated relatively good positive and negative predictive values for the occurence of complications in the acute phase. Endoscopy scores had slightly superior positive and negative prediction values for complications, but the statistical significance was not relevant in our sample, unlike for the CT scan findings. Conversely, endoscopy showed better predictive values for the occurrence of stenosis compared to CT scans, although these results were not statistically significant.

Our study was constrained by several limitations, including its retrospective nature, a small sample size, and the absence of histological data due to the limited number of surgical indications.

Upper gastrointestinal endoscopy is essential after caustic ingestion to assess injury severity and guide treatment. While endoscopic Grade 1 injuries heal spontaneously, Grade 2 injuries may require monitoring through repeat endoscopy to decide on intervention. For endoscopic Grade 3 injuries, some authors advocate for surgical intervention due to the high risk of perforation. However, conservative management is feasible if clinical and biological signs of severity are absent, which can reduce the need for esogastrectomy and maintain a low mortality rate [12, 13].

As a result of this study, we advocate for the integration of computed tomography (CT) into the patient management algorithm in the acute phase. We also encourage further prospective and multicentric studies to validate these findings. This integration aims to reduce the reliance on endoscopic examinations during this phase of caustic injuries, which can pose risks and potentially lead to unnecessary surgeries. Therefore, we suggest reserving endoscopy for patients with a CT score of IIb or III and follow-up, while surgical intervention should be considered mandatory for those with a CT score of IV (Fig. 5).

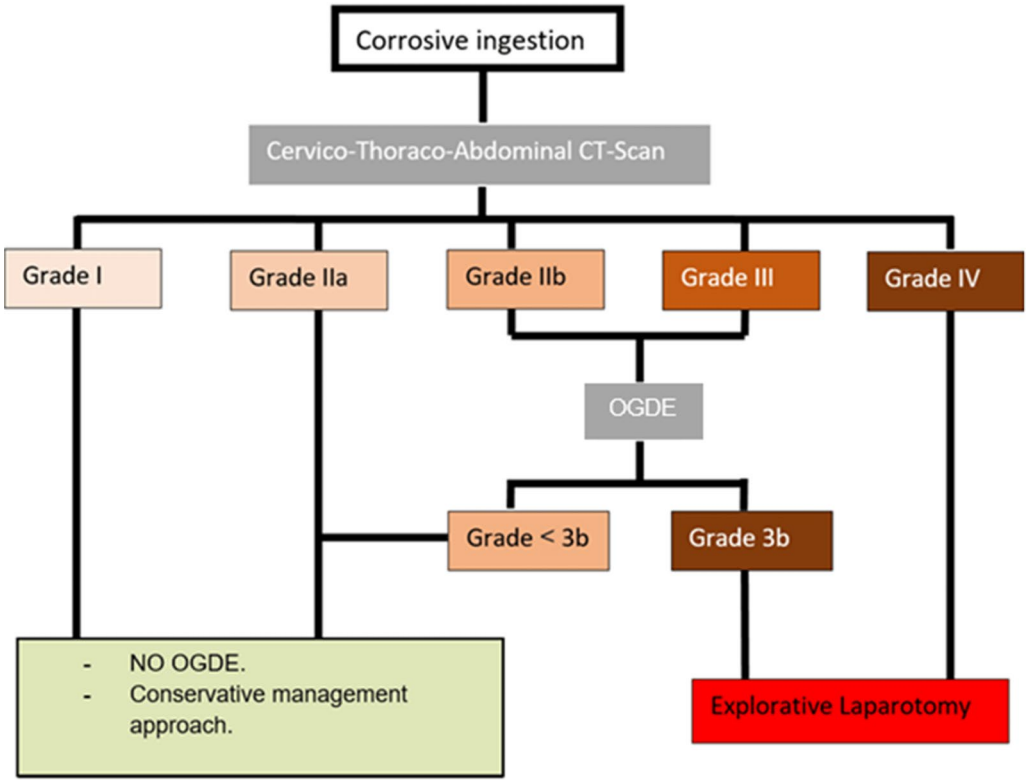

Fig. 5 Algorithm of the approach of caustic ingestion management study's recommendations. Grade I: normal; Grade IIa: Submucosal edema 'target sign'; Grade IIb: Submucosal edema with decreased mucosal enhancement and fat blurring; Grade III: transmural necrosis; Grade IV: perforation or fistula. Grade 3b: Endoscopic score = Diffuse circumferential mucosal necrosis; OGDE: Esogastroduodénal endoscopy. Image Credit: Authors

Conclusions

In conclusion, our findings align with existing literature, suggesting that while CT scans provide valuable diagnostic information, endoscopy remains crucial for comprehensive evaluation, particularly in predicting transmural necrosis and guiding surgical management. Therefore, the study has led to the development of an algorithmic approach for managing caustic ingestion patients, based on existing literature, with CT scans as the first-line assessment tool. This approach promotes a more conservative management strategy; reserving endoscopy for patients with higher CT scores (IIb and III). We recommend incorporating computed tomography into the patient management algorithm for caustic injuries to minimize the need for endoscopic examinations in the acute phase, which can be hazardous and lead to excessive surgeries. This study's limitations include its retrospective nature, small sample size, and lack of histological data. Further prospective and multicentric studies are encouraged to validate these findings and optimize patient management strategies.

Abbreviations

CT	Computed tomography
VAP	Ventilator-associated pneumonia
PCR	Polymerase chain reaction
PPV	Positive predictive value
NPV	Negative predictive value

Author contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work. Hamza Retal, Soumya El Graini, Amine Naggar, Alia Yassine Kassab, Fatima Zahrae Laamrani, Laila Jroundi contributed to concept and design. Hamza Retal, Soumya El Graini, Amine Naggar, Alia Yassine Kassab, Fatima Zahrae Laamrani contributed to acquisition, analysis, or interpretation of data. Hamza Retal drafted the manuscript. Hamza Retal, Soumya El Graini, Amine Naggar, Alia Yassine Kassab, Fatima Zahrae Laamrani, Laila Jroundi critically reviewed the manuscript for important intellectual content. Fatima Zahrae Laamrani and Laila Jroundi supervised the study.

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Availability of data and materials

All data generated or analyzed during this study are included in this published article.

Declarations

Ethics approval and consent to participate
We confirm that any aspect of the study involving human patients has been conducted with the ethical approval of our institutions.

Consent for publication
Consent for publication obtained from patient or third party in charge with anonymization of personal Data.

Competing interests
No conflict of interest to disclose.

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