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Imaging of Omental Pathologies with Histopathological Correlation

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Abstract: ***Background: The omentum, a dynamic peritoneal fold, is frequently affected by infective, inflammatory, and neoplastic conditions. Its nonspecific clinical presentation makes imaging and histopathological correlation essential for accurate diagnosis. Aim: To evaluate the imaging features of omental pathologies and correlate them with histopathological findings for diagnostic accuracy. Methods: This prospective observational study was conducted at Silchar Medical College & Hospital, Assam, over 12 months (September 2023–August 2024). A total of 49 patients with clinically suspected omental disease underwent imaging (USG, CT, and MRI). Ultrasound-guided FNAC or biopsy was performed, and findings were correlated with histopathology. Data were analyzed using descriptive statistics and diagnostic metrics, with ethical approval obtained prior to study initiation. Results: Infective pathologies were most common (46.9%), followed by neoplastic (34.7%) and non-neoplastic (14.3%) causes. Tubercular peritonitis accounted for 52.2% of infective cases. Most patients were aged 21–60 years (77%), with a slight female predominance. USG revealed ascites, peritoneal thickening, omental caking, and mesenteric thickening in TB peritonitis, while CT was superior in detecting peritoneal deposits, matted bowel loops, and irregular thickening in neoplastic disease. Peritoneal carcinomatosis was the leading secondary omental tumor (83.3%). Conclusion: Imaging modalities, especially CT and USG, provide valuable diagnostic clues in omental diseases. However, histopathological confirmation remains the gold standard, ensuring precise diagnosis and guiding optimal clinical management.***

Keywords: Omentum, Tubercular peritonitis, Omental caking, Peritoneal carcinomatosis, Histopathological correlation.

1. Introduction

The omentum, often referred to as the "policeman of the abdomen," is a significant peritoneal fold composed of fat, blood vessels, lymphatics, and connective tissue. It plays a vital role in abdominal immunity, fat storage, and limiting the spread of infections or malignancies. Because of its diverse structure and function, the omentum is involved in various benign and malignant diseases. Timely and accurate diagnosis of omental pathologies is critical, especially given their nonspecific clinical presentation. Radiological imaging combined with histopathological analysis serves as a reliable approach to delineating and confirming these conditions.

Radiological imaging modalities such as computed tomography (CT), ultrasonography (US), magnetic resonance imaging (MRI), and contrast-enhanced ultrasound (CEUS) have transformed the diagnostic landscape of abdominal pathology. In particular, imaging of the omentum has gained importance due to its involvement in both primary and secondary disease processes. Common omental conditions include omental infarction, torsion, encapsulated fat necrosis, peritoneal carcinomatosis, tuberculosis, and metastatic nodules. CT and MRI remain the most valuable techniques for identifying these pathologies, especially when radiological patterns like omental nodularity, caking, or thickening are present [1].

Despite the sophistication of imaging techniques, many omental lesions cannot be definitively diagnosed without histopathological evaluation. For example, omental infarction, though rare in children, may clinically mimic acute appendicitis or cholecystitis. In such cases, CT imaging can suggest the diagnosis, but histological analysis is required to identify underlying causes like vasculitis, as observed in pediatric case series [2].

Histopathology remains the gold standard in confirming the nature of omental lesions. However, the process of correlating radiological findings with pathology is intricate and requires precise alignment of imaging, specimen sectioning, and registration. Studies have outlined the stepwise methodology for achieving accurate radiologic-pathologic correlation, including resection protocols, tissue sectioning, staining, and image registration. While essential, this process remains resource-intensive and technically complex [3].

Ultrasound and CT-guided percutaneous biopsies have become indispensable in diagnosing omental and mesenteric lesions. They allow tissue sampling with high diagnostic accuracy and minimal invasiveness. In one large series, image-guided biopsies achieved near-perfect technical success and very high diagnostic yields, regardless of lesion size or depth [4]. Contrast-enhanced ultrasound also improves biopsy accuracy by helping to target viable tissue areas, although imaging alone cannot reliably distinguish between benign and malignant causes of omental thickening [5].

CT imaging has proven particularly effective in characterizing omental infarction. Primary omental infarctions usually appear larger and more ill-defined than secondary ones. With time, the infarcted area evolves to display a well-demarcated fat-density lesion with a hyperdense rim. These radiological changes are crucial in distinguishing omental infarction from other pathologies [6].

In cirrhotic patients, omental biopsy is both safe and diagnostically effective. A comparative study between cirrhotic and non-cirrhotic groups found no significant differences in biopsy outcomes. Interestingly, cirrhotics often exhibited nonspecific inflammation and smudged imaging appearances, yet biopsy performance remained consistent [7].

Histopathological correlation further increases diagnostic accuracy. For instance, in a retrospective study of 181 omental biopsies, diagnostic agreement with surgical pathology was 99%, far superior to paracentesis cytology. Furthermore, the risk of malignancy increased progressively across imaging appearances from omental thickening to caking highlighting the prognostic value of imaging patterns when verified by pathology [8].

Emerging technologies, such as artificial intelligence and self-supervised learning models, are beginning to support radiological-pathological interpretation. Domain-specific interpolation techniques have enhanced model accuracy in detecting subtle histological patterns, suggesting the future potential of deep learning in correlating omental imaging with histopathology [9].

Finally, rare but life-threatening conditions such as omental pregnancy illustrate the critical role of advanced imaging modalities like MRI in identifying ectopic gestations. These diagnoses are ultimately confirmed by histopathology following surgical intervention. Such cases underscore the essential partnership between imaging and tissue diagnosis in managing omental diseases [10].

Imaging plays a vital role in detecting and characterizing omental pathologies, but histopathological correlation remains essential for definitive diagnosis. Together, these tools provide a comprehensive approach to accurately identifying and managing a wide spectrum of omental diseases.

2. Methodology

1) **Study Design:** This was a prospective observational study conducted to evaluate the imaging features of various omental pathologies and correlate them with histopathological findings. Patients were followed from presentation to diagnosis using standardized imaging protocols and pathological assessment. No interventions were applied beyond routine diagnostic procedures.
2) **Study Setting:** The study was carried out in the Department of Radiology, Silchar Medical College & Hospital, Assam a tertiary care referral center. Imaging procedures were supported by the Radiology Department, while histopathological analyses were performed by the Pathology Department. Multidisciplinary collaboration ensured comprehensive data collection.
3) **Study Duration:** The study was conducted over 12 months, from September 2023 to August 2024. Patient recruitment, imaging evaluations, biopsies, and pathological correlation were done continuously during this period. Ethical approval was obtained before starting the study.
4) **Participants – Inclusion & Exclusion Criteria:** Patients clinically suspected of omental pathology referred for imaging were included. Exclusion criteria were: known allergy to contrast media, children under 12 years, pregnant women, and those with abdominal trauma. Informed consent was obtained from all eligible participants.
5) **Study Sampling:** Purposive sampling was used, selecting patients with clinical suspicion of omental disease referred from various departments. This non-random approach ensured inclusion of diverse pathologies for meaningful imaging-pathological correlation.
6) **Study Sample Size:** Sample size was calculated using Daniel's formula, considering 95% confidence and 5% precision. Based on expected prevalence, a total of 49 patients were included for comprehensive imaging and histopathological evaluation.
7) **Study Groups:** No formal groups were pre-assigned. However, based on histopathological diagnosis, cases were later categorized into inflammatory, non-neoplastic, and neoplastic types to assess imaging features across different pathological classes.
8) **Study Parameters:** Parameters studied included lesion type (nodules, caking, thickening), enhancement patterns, ascites, and organ involvement on USG, CT, and MRI. These were compared against histopathological diagnoses for accuracy and correlation.
9) **Study Procedure:** After clinical evaluation, patients underwent USG, CT, and MRI as needed. Ultrasound-guided FNAC or biopsy was done under aseptic precautions. Imaging findings were later correlated with histological and cytological reports.
10) **Study Data Collection:** Data were recorded using structured proformas covering clinical history, imaging findings, and pathology results. All data were anonymized and stored digitally for analysis, with strict confidentiality maintained throughout the study.
11) **Data Analysis:** Data were analyzed using descriptive statistics and diagnostic metrics like sensitivity, specificity, PPV, and NPV. Associations between imaging and pathology findings were tested using chi-square and relevant statistical tests.
12) **Ethical Considerations:** Ethical clearance was obtained from the Institutional Ethics Committee. Written informed consent was taken from all participants. Patient data were anonymized, and privacy was strictly maintained. Participation was voluntary.

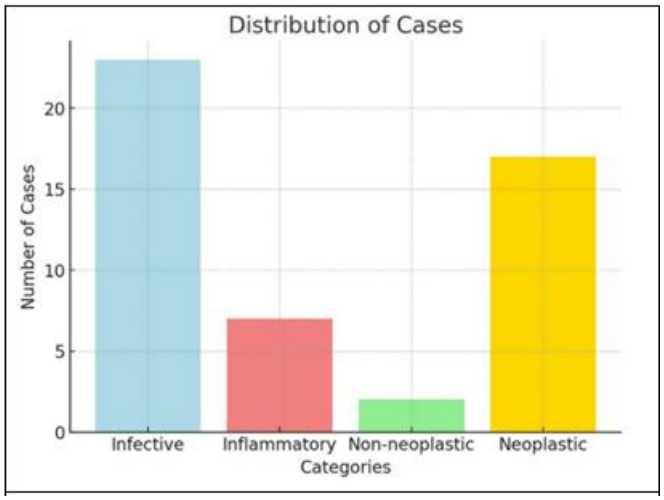
3. Results

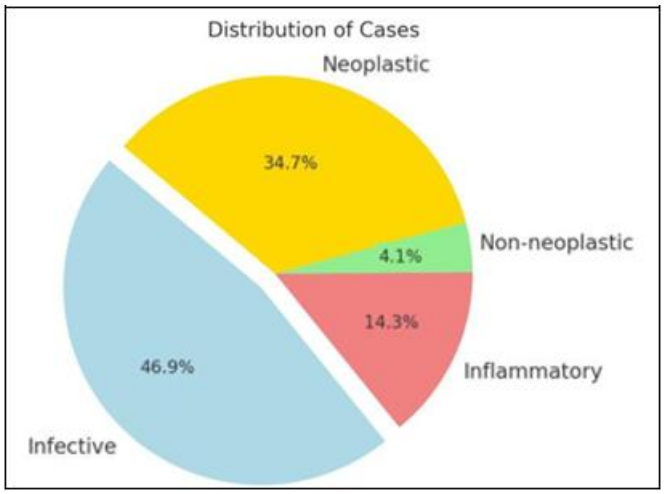
1) Distribution of Omental Pathologies

Infective pathologies were the most common, comprising 46.9% of all cases. Neoplastic and non-neoplastic causes accounted for 34.7% and 14.3% respectively (Table 1).

Table 1: Distribution of Omental Pathologies

Category	No. of Cases	Percentage
Infective	23	46.94%
Non-neoplastic	7	14.29%
Neoplastic	17	34.69%
Total	49	100%



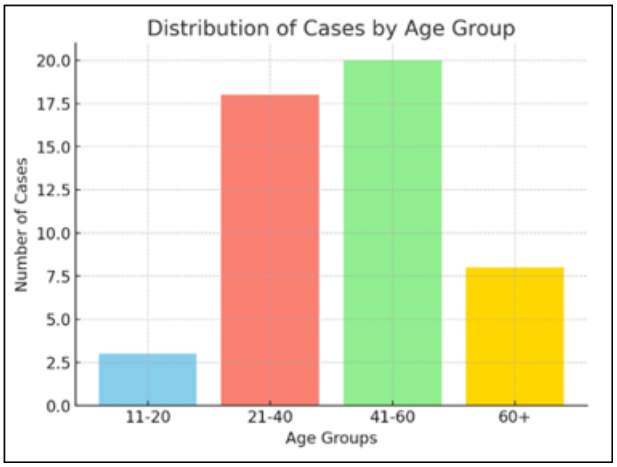


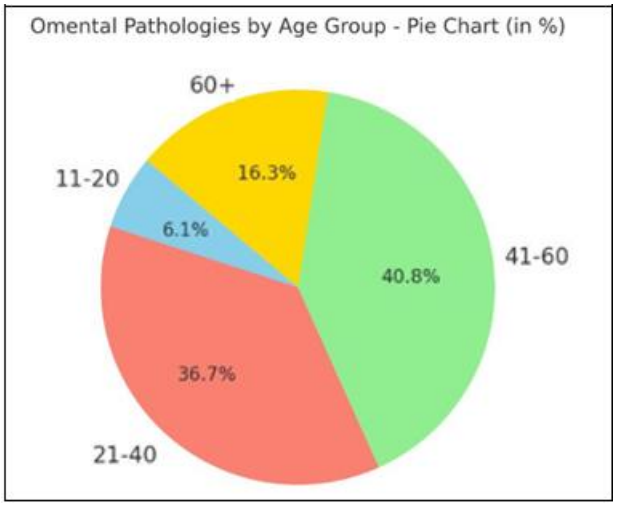
2) Age-wise Distribution of Omental Pathologies

Most cases occurred in the 21–60 age group, accounting for over 77% of total patients. This shows that omental diseases are most common in middle age (Table 2).

Table 2: Age-wise Distribution of Omental Pathologies

Age Group (Years)	No. of Cases	Percentage
11–20	3	6.12%
21–40	18	36.73%
41–60	20	40.82%
>60	8	16.33%
Total	49	100%



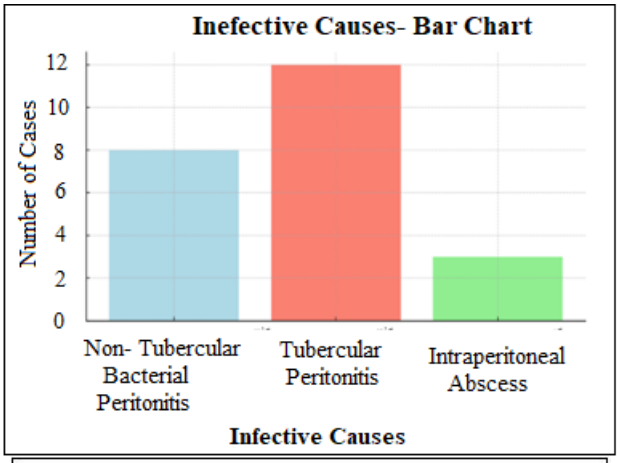


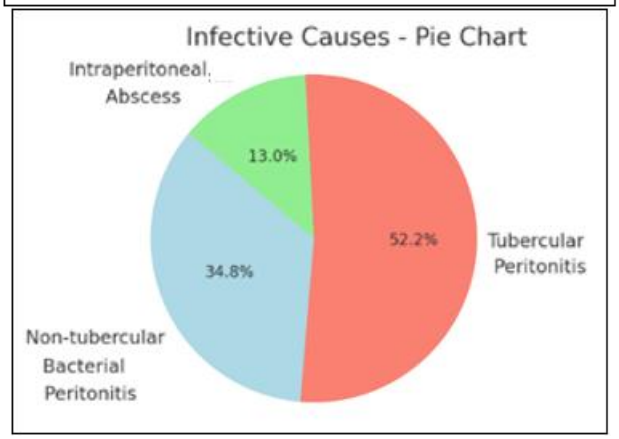
3) Infective Causes of Omental Pathology

Tubercular peritonitis was the most common infectious cause, seen in 52.2% of cases. Bacterial peritonitis followed at 34.8% (Table 3).

Table 3: Infective Causes of Omental Pathology

Cause	No. of Cases	Percentage
Tubercular peritonitis	12	52.2%
Bacterial peritonitis (non-TB)	8	34.8%
Intraperitoneal abscess	3	13.0%
Total	23	**100%**





4) USG Features of Tubercular Peritonitis

USG commonly showed ascites, peritoneal thickening, omental caking, and lymphadenopathy, aiding in early suspicion of TB peritonitis (Table 4).

Table 4: USG Features of Tubercular Peritonitis

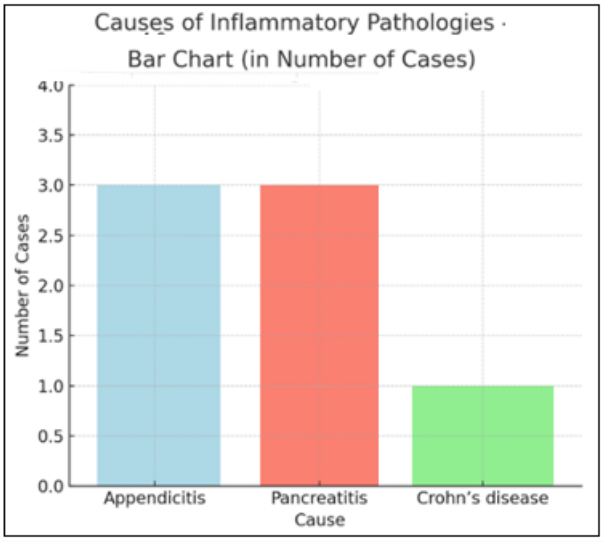
USG Feature	No. of Cases (n=12)
Ascites (Free / Loculated)	9 / 3
Septation (Mobile / Fixed)	7 / 3
Debris in fluid	9
Peritoneal thickening	Smooth – 9; Nodular – 2
Omental caking	7
Lymphadenopathy	8
Mesenteric thickening	10

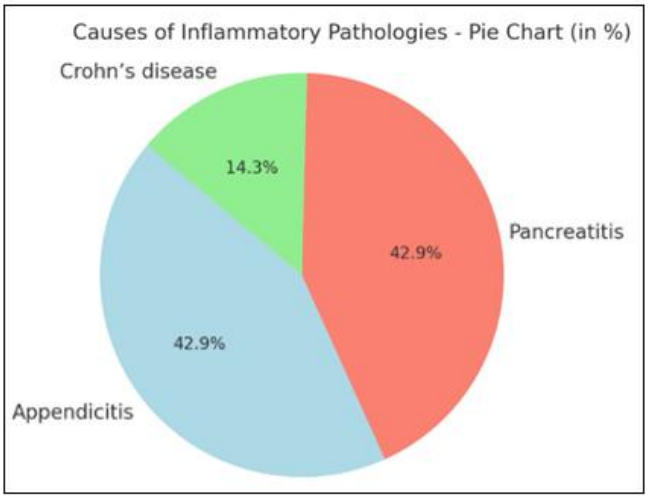
5) Causes of Omental Inflammatory Pathologies

Pancreatitis and appendicitis were equally common causes (42.9%) of secondary mesenteric inflammation, followed by Crohn's disease (Table 5).

Table 5: Causes of Omental Inflammatory Pathologies

Cause	No. of Cases	Percentage
Appendicitis	3	42.9%
Pancreatitis	3	42.9%
Crohn's Disease	1	14.3%
Total	7	100%



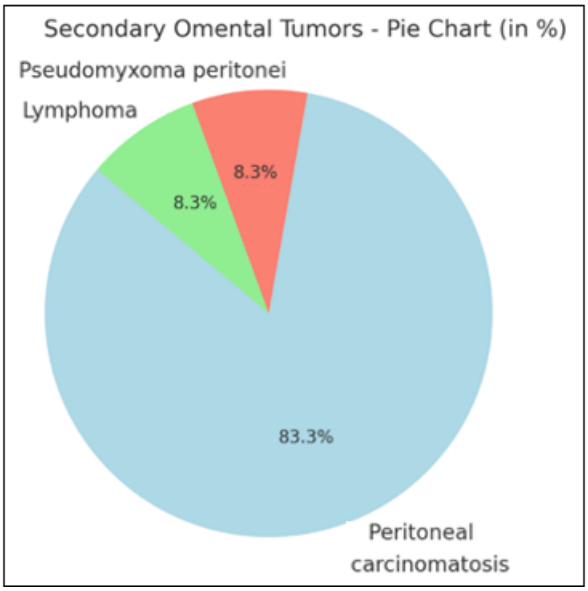


6) Secondary Omental Tumors

Peritoneal carcinomatosis was the leading secondary omental tumor (83.3%), followed by one case each of pseudomyxoma peritonei and lymphoma (Table 6).

Table 6: Secondary Omental Tumors

Type	No. of Cases	Percentage
Peritoneal carcinomatosis	10	83.34%
Pseudomyxoma peritonei	1	8.33%
Lymphoma	1	8.33%
Total	12	100%



7) CT Features of Peritoneal Carcinomatosis

CT revealed high incidence of ascites, irregular peritoneal thickening, omental caking, and lymphadenopathy, aiding in diagnosis of advanced peritoneal disease (Table 7).

Table 7: CT Features of Peritoneal Carcinomatosis

HPE diagnosis	10
Imaging diagnosis	8
Omental involvement	8 (Caking = 5)
Peritoneal deposit / nodule	6
Peritoneal thickening	8 (Smooth = 2, Irregular = 6)
Ascites	9
Peritoneal enhancement	8
Lymphadenopathy	5
Matted bowel loops	6
Mesenteric involvement	4

4. Discussion

This study evaluated the imaging features of various omental pathologies and their correlation with histopathological findings over a one-year period at a tertiary care center in northeast India. The most common category of omental disease in our cohort was infective pathology, accounting for 46.9% of all cases. This finding is consistent with other Indian studies, such as by Kamat et al. (2016) and Singh et al. (2006), which reported high prevalence of tubercular peritonitis in endemic regions [11, 6]. Our finding that tubercular peritonitis constituted 52.2% of all infective cases underlines tuberculosis as a significant public health concern in this region.

In terms of age distribution, most patients were between 21–60 years, with a mean age of 41.6 years. This aligns with studies by Vadvala et al. (2017) and Patidar et al. (2020), which reported peak incidence of omental and peritoneal diseases in the 3rd to 6th decades [4, 7]. Similarly, our data

showed female predominance in both infective and neoplastic groups, which was also noted by Trenker et al. (2019) in a European cohort [5].

Ultrasound findings in tubercular peritonitis in our study included free and loculated ascites, peritoneal thickening, omental caking, and mesenteric thickening. These results are in line with those of Lee et al. (2005), who reported similar USG features of omental involvement in pediatric TB cases [2]. CT imaging in our study confirmed peritoneal enhancement, nodular thickening, and omental caking, consistent with findings from Sen et al. (2021) [3].

Secondary omental tumors accounted for 83.3% of neoplastic cases, with peritoneal carcinomatosis being the most frequent. Ovarian and gastrointestinal primaries were the leading sources, paralleling reports by Hill et al. (2017), who found similar imaging features and origin patterns in peritoneal spread [8]. CT was superior to USG in detecting nodular peritoneal deposits and matted bowel loops, although USG showed reasonable sensitivity (70%) for ascites and thickening.

Interestingly, inflammatory pathologies secondary to pancreatitis and appendicitis were also frequent, mirroring trends seen in the Western literature. Our findings reaffirm the diagnostic importance of imaging, especially USG and CT, in guiding clinical management of omental diseases, particularly in tuberculosis-endemic areas like northeast India.

5. Conclusion

This prospective observational study highlights the importance of imaging in diagnosing omental pathologies while underscoring the indispensable role of histopathology for definitive confirmation. Infective causes, particularly tubercular peritonitis, were predominant, consistent with regional endemicity. CT and USG proved vital in detecting features like ascites, omental caking, and peritoneal deposits, with CT offering superior sensitivity for neoplastic conditions. The strong imaging–pathology correlation demonstrates the value of multidisciplinary collaboration, enabling accurate diagnosis, timely intervention, and improved patient outcomes in varied omental diseases.

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