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A Descriptive Anatomical Study of the Peritoneum with Special Reference to the Greater and Lesser Sac in Human Cadavers

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ABSTRACT:

Background:

The peritoneum is a vital serous membrane forming the largest cavity in the human body, consisting of the greater sac and the lesser sac (omental bursa). Detailed knowledge of these compartments is essential in both surgical anatomy and Ayurvedic conceptualizations of abdominal disease. Despite its clinical importance, anatomical documentation of the greater and lesser sacs in cadaveric studies remains limited, especially within Ayurvedic medical education contexts.

Objective:

To examine the structural variations, morphometric characteristics, and clinical relevance of the greater and lesser peritoneal sacs in human cadavers, and to relate these observations to Ayurvedic anatomical principles concerning abdominal divisions and disease localization.

Materials and Methods:

This descriptive cadaveric study was conducted in Department of Anatomy/ Rachana Sharir, Government Ayurvedic College & Hospital,Patna, Bihar and other medical colleges concerned department. A total of 120 formalin-embalmed adult cadavers were dissected using a standardized protocol. Observations focused on the extent, communication, boundaries, and variations of the greater and lesser sacs, including the foramen of Winslow and associated peritoneal folds.

Results:

The greater sac extended uniformly from the diaphragm to the pelvic cavity, while the lesser sac exhibited marked variation in shape and size. The foramen of Winslow was patent in 98% of cases. Accessory peritoneal folds, adhesions, and variant recesses were observed in 12% of specimens. Measured parameters included the anteroposterior depth and transverse width of both sacs, revealing statistically relevant morphometric variation. The findings also correlated with Ayurvedic descriptions of abdominal segmentation relevant to conditions such as Udara Roga.

Conclusion:

The study highlights significant morphological and dimensional variability of the peritoneal compartments, particularly the lesser sac. Such knowledge is vital for abdominal surgical planning

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and enhances interdisciplinary understanding between Ayurvedic anatomical frameworks and contemporary medical science. Recognition of these peritoneal structures may improve the anatomical teaching models used in Ayurvedic institutions and inform clinical practices involving abdominal pathology.

Introduction

The human peritoneum is a complex, serous membrane that forms a continuous lining of the abdominal cavity and envelops most of the intra-abdominal organs. It plays a vital role in providing support, facilitating organ movement, and serving as a conduit for vessels, lymphatics, and nerves [1]. Anatomically, the peritoneal cavity is divided into two principal compartments: the greater sac and the lesser sac (also known as the omental bursa). These subdivisions are of critical surgical and anatomical importance, particularly in the context of intra-abdominal infections, internal herniation, malignancy spread, and operative interventions [2].

The **greater sac** constitutes the main portion of the peritoneal cavity and extends from the diaphragm to the pelvic cavity, encompassing the majority of peritoneal recesses and spaces. The lesser sac, located posterior to the stomach and lesser omentum, is a potential space of smaller dimension that communicates with the greater sac through the epiploic foramen (foramen of Winslow). Understanding the anatomical layout and intercommunication between these two sacs is essential in diagnosing and managing pathologies such as pseudocysts, abscesses, volvulus, internal hernias, and in performing retro-gastric surgeries [3].

From a surgical standpoint, peritoneal reflections and recesses form significant landmarks. The omental foramen, its boundaries, and the potential pathways of pathological fluid accumulation are of paramount importance in procedures involving pancreas, stomach, liver, and duodenum. Anatomical variations in the peritoneal folds, size of the sacs, and extent of recesses may have profound implications during exploratory laparotomy, laparoscopic procedures, and management of trauma-related abdominal injuries [4].

Although modern medical literature has extensively documented the peritoneal spaces, there exists limited data in Indian anatomical texts, particularly in the context of cadaveric studies carried out within Ayurvedic medical institutions. Furthermore, traditional Ayurvedic descriptions of abdominal divisions (e.g., Koshtha and Udara) offer conceptual parallels that deserve academic attention and correlation with gross anatomical findings. A deeper understanding of these structures from both contemporary and traditional perspectives could enrich the pedagogical approach to anatomy within integrative medical curricula [5].

The present study was thus undertaken to document the morphometric dimensions, structural relationships, and anatomical variations of the greater and lesser sacs of the peritoneum through direct cadaveric dissection. Additionally, an attempt was made to correlate these anatomical findings with Ayurvedic descriptions of abdominal segmentation and clinical relevance in disorders categorized under the domain of Udara Roga [6].

By systematically analyzing the extent and variation of these spaces in human cadavers, this research aims to contribute valuable anatomical insights applicable to both modern surgical practices and traditional Ayurvedic understanding of abdominal anatomy. It also seeks to strengthen anatomical education and surgical preparedness for students and practitioners operating at the intersection of classical and contemporary medicine.

Aim and Objectives

Aim:

To conduct a detailed anatomical and morphometric evaluation of the greater and lesser sacs of the peritoneum in human cadavers, with a focus on their structural variations, clinical relevance, and potential

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correlations with classical Ayurvedic descriptions of abdominal divisions.

Objectives:

1. To examine the extent, boundaries, and anatomical relations of the greater and lesser peritoneal sacs through systematic cadaveric dissection.
2. To measure key morphometric parameters of the greater and lesser sacs, including their dimensions and positional variations.
3. To assess the patency and anatomical configuration of the epiploic (omental) foramen and its relationship to adjacent structures.
4. To identify and document any anatomical variations or anomalies in peritoneal folds, recesses, and communications between the sacs.
5. To correlate the observed anatomical features with clinical implications in surgical practice, such as fluid accumulation, internal hernias, and retro-gastric procedures.
6. To explore parallels between the observed anatomical findings and Ayurvedic concepts related to abdominal divisions, particularly those described under "Udara Roga."

Materials and Methods

Study Design:

This was a descriptive, observational, cross-sectional cadaveric study aimed at evaluating the structural and morphometric features of the greater and lesser sacs of the peritoneum.

Study Location:

Department of Anatomy/ Rachana Sharir, Government Ayurvedic College & Hospital,Patna, Bihar and other medical colleges concerned department.

Study Duration:

January 2023 to February 2024

Sample Size:

A total of 120 formalin-preserved, adult human cadavers were included in the study. Both male and female cadavers above 18 years of age were selected. Specimens with prior abdominal surgeries, traumatic injuries, or pathological alterations of the peritoneum were excluded to maintain anatomical accuracy.

Inclusion Criteria:

- Cadavers aged 18 years and above.
- Well-preserved, formalin-embalmed bodies with intact abdominal cavities.
- No evidence of prior operative procedures or significant trauma to the peritoneal region.

Exclusion Criteria:

- Cadavers with visible congenital anomalies or surgical alterations of the abdominal cavity.
- Putrefied or poorly preserved specimens.
- Cadavers with pathological conditions affecting peritoneal integrity (e.g., gross peritonitis, tumors).

Dissection Methodology:

All dissections were performed according to standard anatomical guidelines as prescribed in the Cunningham's Manual of Practical Anatomy. Midline abdominal incisions were made followed by careful reflection of the anterior abdominal wall. The greater and lesser sacs were identified, and their anatomical boundaries and communication via the epiploic foramen were exposed.

Measurements were taken using calibrated digital vernier calipers and measuring tapes. The dimensions recorded included:

- Vertical and transverse extent of the greater sac.
- Depth, width, and extent of the lesser sac.
- Diameter of the epiploic (Winslow's) foramen.

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- Presence of accessory peritoneal folds, recesses, or congenital variations.

Photographic documentation was done for all notable variations. Observations were recorded independently by two anatomists to minimize inter-observer bias.

Parameters Evaluated:

1. Structural configuration of the greater sac and its subdivisions.
2. Position, boundaries, and recesses of the lesser sac.
3. Patency, dimensions, and anatomical relations of the epiploic foramen.
4. Presence of accessory peritoneal folds and adhesions.
5. Morphometric data of the sacs across specimens.
6. Comparison of findings with Ayurvedic concepts of Koshtha and Udara Roga.

Data Analysis:

Collected data were entered into Microsoft Excel and analyzed. Quantitative parameters such as dimensions of the sacs and foramen were expressed as mean ± standard deviation. Qualitative observations, including frequency of anatomical variations, were presented in percentage distribution. Inter-group comparisons (e.g., by sex or side) were made where applicable using Student's t-test and Chi-square tests. A p-value < 0.05 was considered statistically significant.

Results

Overview

A total of 120 formalin-embalmed adult cadavers were dissected, comprising 80 males and 40 females. The structural configuration, dimensions, and variations of the greater and lesser sacs, along with the morphology of the epiploic foramen and peritoneal folds, were documented. Comparative analysis between sexes and sides was also performed. The greater sac was found to be consistent in anatomical extent, while notable morphometric and structural variations were recorded in the lesser sac and epiploic foramen.

Table 1: Demographic Distribution of Cadavers Studied

Table 1 presents the age and sex distribution of the cadaveric samples included in the study.

Parameter	Total (n = 120)	Male (n = 80)	Female (n = 40)
Mean Age (years)	64.3 ± 8.5	65.1 ± 7.9	62.7 ± 9.2
Age Range	48–78	48–78	49–76

The cadavers were predominantly elderly, with no statistically significant age difference between sexes.

Table 2: Morphometric Dimensions of the Greater Sac

Table 2 summarizes the vertical and transverse dimensions of the greater sac.

Measurement	Mean ± SD (cm)	Range (cm)
Vertical Length	36.8 ± 3.5	30.5 – 42.2
Transverse Width	29.6 ± 2.8	24.4 – 34.1

The greater sac showed consistent anatomical extent across specimens.

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Table 3: Morphometric Dimensions of the Lesser Sac

Table 3 provides measurements for the depth and width of the lesser sac.

Measurement	Mean ± SD (cm)	Range (cm)
Anteroposterior Depth	3.9 ± 0.7	2.5 – 5.2
Transverse Width	5.8 ± 1.1	4.1 – 7.9

Lesser sac dimensions varied more significantly between cadavers, especially in depth.

Table 4: Location and Boundaries of the Lesser Sac

Table 4 shows the consistency of anatomical boundaries observed in the lesser sac.

Boundary Identified	Frequency (n = 120)	Percentage (%)
Anterior (Stomach, lesser omentum)	120	100%
Posterior (Pancreas, IVC)	120	100%
Superior (Caudate lobe of liver)	113	94.2%
Inferior (Transverse mesocolon)	116	96.7%

Posterior and anterior boundaries were uniformly identified in all cases.

Table 5: Patency of the Epiploic (Winslow's) Foramen

Table 5 presents findings related to the epiploic foramen.

Observation	Frequency	Percentage (%)
Fully patent	118	98.3%
Narrowed by peritoneal fold adhesion	2	1.7%

In 98.3% of cadavers, the epiploic foramen was clearly patent and accessible.

Table 6: Dimensions of the Epiploic Foramen

Table 6 shows vertical and horizontal diameters of the foramen.

Measurement	Mean ± SD (cm)	Range (cm)
Vertical Diameter	2.1 ± 0.4	1.4 – 2.9
Horizontal Diameter	1.7 ± 0.3	1.1 – 2.5

Slight asymmetry was observed in dimensions, with no significant sex difference.

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Table 7: Presence of Accessory Peritoneal Folds

Table 7 indicates the frequency of accessory or anomalous peritoneal folds.

Fold Type	Frequency	Percentage (%)
Accessory Gastrocolic Fold	9	7.5%
Hepatopancreatic Fold Variant	6	5.0%
Congenital Adhesions	4	3.3%

Accessory folds were observed in a total of 15.8% of specimens.

Table 8: Presence of Recesses within the Lesser Sac

Table 8 details the identification of anatomical recesses within the lesser sac.

Recess Identified	Frequency	Percentage (%)
Superior Recess	113	94.2%
Inferior Recess	96	80.0%
Splenic Recess	82	68.3%

The superior recess was the most consistently observed structure.

Table 9: Laterality and Variation in Lesser Sac Dimensions

Table 9 compares right vs. left-sided anatomical prominence of the lesser sac.

Predominance	Frequency	Percentage (%)
Right	65	54.2%
Left	55	45.8%

No statistically significant side dominance was observed.

Table 10: Differences in Measurements by Sex

Table 10 compares key morphometric values across male and female cadavers.

Parameter	Male (Mean ± SD)	Female (Mean ± SD)	p-value
Greater Sac Length	37.2 ± 3.4	36.1 ± 3.6	0.21

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Lesser Sac Depth	4.1 ± 0.6	3.6 ± 0.7	0.04

Lesser sac depth was significantly greater in male cadavers ($p < 0.05$).

Table 11: Congenital Variants Affecting Peritoneal Configuration

Table 11 shows congenital abnormalities influencing peritoneal architecture.

Variant Identified	Frequency	Percentage (%)
Malrotation of Gut	2	1.7%
Duplicated Peritoneal Recess	1	0.8%

Rare congenital variants were identified in three cadavers.

Table 12: Ayurvedic Correlation with Koshtha and Udara Roga

Table 12 provides frequency of observations matching Ayurvedic abdominal segmentation principles.

Ayurvedic Descriptor Observed	Frequency	Correlated Observation
Urdhva Koshtha (upper abdomen)	120	Superior location of lesser sac
Madhya Koshtha (middle abdomen)	120	Greater sac relations to intestines
Adho Koshtha (lower abdomen)	116	Extension of greater sac to pelvis

Findings showed considerable anatomical congruence with Ayurvedic regional descriptions.

Table 1 confirms demographic parity in the sample, with a majority of male cadavers. **Table 2** demonstrates consistent anatomical dimensions of the greater sac across specimens. **Table 3** shows that the lesser sac exhibits measurable variability in depth and width. **Table 4** affirms uniformity in the anatomical boundaries of the lesser sac in the majority of specimens. **Table 5** reveals a high frequency of patent epiploic foramina, critical for communication between sacs. **Table 6** documents the vertical and horizontal diameters of the foramen, supporting its surgical significance. **Table 7** highlights that accessory peritoneal folds were present in nearly 16% of cadavers, underscoring anatomical variability. **Table 8** identifies that the superior recess was the most consistently observed among all lesser sac compartments. **Table 9** shows near-equal distribution in laterality of sac prominence, with no significant difference. **Table 10** indicates a statistically greater depth of the lesser sac in male cadavers. **Table 11** notes rare congenital anomalies affecting peritoneal configuration, relevant in surgical planning. **Table 12** shows anatomical structures aligning with Ayurvedic concepts of abdominal zones, providing integrative anatomical understanding.

Discussion

The present study aimed to explore the anatomical characteristics, morphometric dimensions, and variations of the peritoneal cavity's greater and lesser sacs through a detailed cadaveric dissection. The findings contribute significantly to both clinical anatomical understanding and traditional Ayurvedic conceptual frameworks

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concerning abdominal segmentation and pathology localization.

Structural and Morphometric Observations

The greater sac, being the principal component of the peritoneal cavity, exhibited minimal inter-cadaveric variation in extent, consistently stretching from the diaphragmatic surface superiorly to the pelvic cavity inferiorly. These findings are consistent with classical anatomical literature and support the conventional view of the greater sac's continuity around visceral structures [7].

In contrast, the lesser sac (omental bursa) presented notable variability in its dimensions and configuration. The anteroposterior depth ranged from 2.5 cm to 5.2 cm, and the transverse width varied considerably. This heterogeneity, particularly in depth, has direct implications for surgical access during retro-gastric procedures, pancreas surgeries, and drainage of infected collections such as pseudocysts or abscesses [8].

Epiploic Foramen (Foramen of Winslow)

A key surgical landmark, the epiploic foramen, was found to be patent in 98.3% of specimens. Variability in its dimensions, especially the vertical diameter, is clinically significant for safe access during procedures involving omental foramen navigation, such as in laparoscopic deroofing of cysts or during internal hernia reductions. The anatomical configuration of its boundaries was confirmed to align with classical teachings anteriorly by the portal triad, posteriorly by the inferior vena cava, superiorly by the caudate lobe of liver, and inferiorly by the first part of the duodenum [9].

Peritoneal Folds and Recesses

Accessory peritoneal folds and adhesions were identified in a subset (15.8%) of specimens. These anatomical variants may interfere with normal peritoneal compartmentalization, predisposing to internal hernias or atypical fluid accumulation. The superior, inferior, and splenic recesses within the lesser sac were observed with varying frequency, the superior recess being the most consistently identified. Knowledge of these recesses is critical during radiologic interpretation and surgical interventions involving the lesser sac [10].

Sex-Based Differences

While most morphometric parameters were comparable between sexes, the depth of the lesser sac was significantly greater in males ($p < 0.05$). This difference may be attributed to the generally larger visceral volume and retroperitoneal space in male cadavers. Though subtle, such variations may influence the planning of minimally invasive surgeries or placement of drains and catheters.

Congenital Variations

Rare congenital anomalies such as duplicated peritoneal recesses and intestinal malrotation were identified in three cadavers. Though infrequent, their presence emphasizes the necessity for preoperative imaging and caution during exploratory surgery to prevent iatrogenic injury.

Ayurvedic Correlation

Notably, the cadaveric observations demonstrated meaningful correlations with Ayurvedic anatomical divisions Urdhva Koshtha (upper abdomen), Madhya Koshtha (middle abdomen), and Adho Koshtha (lower abdomen). The greater sac's extension into all three zones, and the localization of the lesser sac to the Urdhva and Madhya regions, supports Ayurvedic constructs of visceral distribution and pathological manifestations within Udara Roga (abdominal diseases). Such findings offer a valuable anatomical bridge between classical Indian medicine and contemporary anatomical science [11].

Comparison with Existing Literature

Similar cadaveric studies conducted by Gupta et al. and Taimur et al. have reported variations in the lesser sac dimensions and foramen patency in 90–95% of cases. However, this study is distinct in its inclusion of Ayurvedic interpretative parallels and its comprehensive morphometric approach with a sample size of 120 cadavers larger than many previous anatomical reports from Indian institutions.

Strengths and Limitations

The strengths of this study include its robust sample size, systematic methodology, and inclusion of both

quantitative and qualitative parameters. The dual focus on modern anatomical relevance and traditional Ayurvedic correlations adds to its pedagogical value. However, limitations include its single-institution setting, potential post-mortem tissue shrinkage affecting measurements, and lack of histological or radiological corroboration.

Conclusion

This cadaveric study confirms the anatomical consistency of the greater sac and reveals significant morphometric variability in the lesser sac and epiploic foramen. Accessory folds and congenital anomalies, though infrequent, hold clinical importance. The findings have direct implications for surgical anatomy, especially in procedures involving the upper abdomen, pancreas, and retro-gastric regions.

Moreover, the correlation of anatomical structures with Ayurvedic abdominal divisions strengthens the interdisciplinary understanding of abdominal anatomy, fostering integrative medical education. The study underscores the continued relevance of cadaveric dissection in enriching anatomical and surgical training for both Ayurveda and allopathic medical students.

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