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Original Research Article

Exploring the Intricacies of Pancreatic Duct Tributaries: Variations in Length, Angle of Entry, and Alternating Patterns in Human Cadavers by Dissection

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ABSTRACT

Background: The pancreatic duct system plays a pivotal role in human physiology, facilitating the transport of digestive enzymes and secretions essential for gastrointestinal function. While anatomists have extensively investigated the pancreas's ductal network, the intricacies of pancreatic duct tributaries, including variations in length, angle of entry, and alternating patterns, have continued to captivate scientific inquiry.

Aim: To find out the variations in length, angle of entry, and alternating patterns of pancreatic duct tributaries, and discuss the potential clinical implications of our discoveries.

Materials and Methods: This study, conducted on 50 human cadavers (comprising 35 perinates and 15 adults), aimed to comprehensively explore the complexities of pancreatic duct tributaries through meticulous dissection.

Results: Our research unveiled the following key findings:

Variations in Length and Angle of Entry: We observed a remarkable diversity in the number and length of tributaries that join the main pancreatic duct. Additionally, the entry angle exhibited substantial variation, with right-angled tributaries prevalent in 70% of specimens and acute angles in 30%. Understanding these anatomical nuances is crucial for surgical procedures to mitigate inadvertent ductal injury. Alternating and Herringbone Patterns: In 98% of specimens, tributaries alternated between superior and inferior positions along the main pancreatic duct. This alternating pattern may influence the flow of pancreatic secretions and the pathogenesis of pancreatic diseases. In contrast, the rare Herringbone pattern was observed in only 2% of cases, highlighting the unique nature of this anatomical variant.

Conclusion: This study contributes valuable insights into the intricate world of pancreatic duct tributaries. By elucidating their anatomy and characteristics, we enhance the safety and efficacy of clinical interventions and expand our understanding of pancreatic physiology and pathology. Further research may delve into the functional implications of these anatomical variations, paving the way for advancements in pancreatic healthcare.

KEYWORDS: Pancreatic Duct Tributaries, Anatomical Variations, Pancreatic Surgery, Pancreatic Physiology, Dissection, Herring Bone Pattern, Gastrointestinal Function.

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INTRODUCTION

The pancreatic duct system is pivotal inhuman physiology, serving as the vital conduit for digestive enzymes and secretions crucial for gastrointestinal function. While anatomists have devoted considerable efforts to

studying the pancreas's ductal network, the intricacies of pancreatic duct tributaries, encompassing variations in length, angle of entry, and alternating patterns, continue to stimulate scientific inquiry [1-3].

The pancreatic duct system forms a labyrinthine branching network with tributaries that vary in size, location, and architectural arrangement. These variations hold profound implications for pancreatic physiology and pathophysiology, potentially influencing the flow of pancreatic secretions and contributing to developing diseases such as pancreatitis and pancreatic cancer. A profound understanding of these duct tributaries' anatomy and organization is indispensable for clinical practice and research in pancreatic physiology [4-7].

This manuscript embarks on a comprehensive exploration of pancreatic duct tributaries, specifically focusing on three pivotal aspects: variations in length, angle of entry, and the intriguing phenomenon of alternating patterns. To embark on this journey, we undertook meticulous dissections, utilizing human cadavers as our study subjects. Human cadaveric dissection remains an invaluable tool in anatomical research, offering a tangible and intricate perspective on the complex anatomical structures within the human body [8-10]. Our overarching objective through this research is to illuminate the exhibition and arrangement of pancreatic duct tributaries, thereby unraveling the mysteries of their diverse anatomical characteristics. By rigorously documenting our findings, we aspire to contribute substantively to the burgeoning body of knowledge surrounding pancreatic duct anatomy. Our aim is to provide invaluable insights for clinicians, surgeons, and researchers alike. Additionally, this exploration may offer profound implications for surgical procedures involving the pancreas, augmenting our understanding of the anatomical considerations' requisite during such interventions.

In the subsequent sections, we will delve into the methodology employed in our dissection studies, present the findings concerning variations in length, angle of entry, and alternating patterns of duct tributaries, and expound upon the potential clinical implications of our discoveries. Through this thoroughgoing investigation, we endeavor to broaden our comprehension of the intricate realm of pancreatic duct tributaries, paving the way for further exploration in this captivating field of anatomical science.

MATERIALS AND METHODS

The current study was conducted on a cohort of 50 human cadavers, comprising 35 perinates and 15 adults. The research occurred in the Department of Anatomy at Assam Medical College & Hospital, Dibrugarh, Assam. The specimens were procured from cadavers allocated to undergraduate and postgraduate students in the Department of Anatomy, with a supplementary allocation of specimens from the Department of Forensic Medicine. Additionally, perinatal cadavers were sourced from the Department of Obstetrics and Gynaecology at AMCH, Assam, India.

The perinatal period was strictly defined as the duration extending from the 22nd week of gestation (>154 days or birth weight exceeding 500 grams) to less than seven days of life, following the classification proposed by Ghai et al. in 2019 [11].

Inclusion Criteria: Specimens of approximately healthy perinates (of gestational age 36 weeks and beyond) and adults were meticulously selected for specimen collection.

Exclusion Criteria: Perinates with gestational age below 36 weeks, cadavers displaying gross congenital anomalies, and cadavers bearing any suspicion of pancreatic disease, trauma, or abdominal surgery history were expressly excluded.

The collection of pancreas samples from the perinatal cadavers was conducted within a window of 12 to 36 hours post-mortem, with any specimens showing considerable signs of decomposition subject to immediate exclusion. To preserve the integrity of the dead perinates, a 10% formalin solution was judiciously injected into their pleural, peritoneal, and cranial cavities. As for specimens obtained from the forensic department, they were procured en bloc with the

duodenum and the spleen, then dissected or preserved in a 10% formalin solution for subsequent dissection. Finally, specimens from adult cadavers, allocated to undergraduate students, underwent immediate dissection following collection.

METHOD OF STUDY

Ductal System: The core of our investigation revolved around the ductal pattern. We initiated our exploration by locating the bile duct near the head of the pancreas. Once the pancreatic duct was identified, nestled adjacent to the posteromedial wall of the second part of the duodenum, we initiated a methodical, piecemeal dissection of the pancreas. We commenced this dissection from the head region and continued through to the tail region. A meticulous dissection approach in the head region was imperative to confirm the presence of an accessory pancreatic duct. To optimize visibility and precision in the study of the pancreatic ducts and their tributaries, we employed magnifying glasses. After carefully exposing the ducts, we diligently recorded their type, noting the angle of union and arrangement. Our results were exhaustively documented through photography, and the data were methodically tabulated in accordance with the study variables before undergoing thorough analysis.

RESULTS

The pancreatic duct system fundamentally comprises the main pancreatic duct, commonly known as the duct of Wirsung, and, when present, the accessory pancreatic duct, or the duct of Santorini. In the tail region, the duct of Wirsung is shaped by the convergence of two or more tributaries. An approximate count reveals that between 15 to 30 tributaries drain from both above and below into the duct of Wirsung.

Variations in length and angle of drainage exhibited intriguing patterns. The percentages of long, short, and mixed varieties stood at 20%, 26%, and 54%, respectively. When scrutinizing the angle of drainage, our observations revealed that 30% of specimens displayed acute angles, while 70% featured right-angled tributaries. A fascinating mixed pattern, characterized by the presence of both acute and right-angled tributaries, emerged in 18% of the specimens. Moreover, in an overwhelming 98% of the specimens, the tributaries exhibited a distinct alternating pattern between superior and inferior positions along the main pancreatic duct. This alternating pattern, although pervasive, remained a subject of considerable intrigue and raised questions about its functional implications. Only a mere 2% of specimens exhibited the rare Herringbone pattern, a distinctive configuration characterized by the crisscrossing and interweaving of tributaries.

Table 1: Length of Tributaries to the Main Pancreatic Duct.

Length	Number(N=50)	Percentage (%)
Long	10	20
Short	13	26
Mixed	27	54

Table 2: Pattern Of Tributaries To The Main Pancreatic Duct.

Pattern	Number (n=50)	Percentage (%)
Angulation		
Acute	12	24
Right	29	58
Mixed	9	18
Alternated between Superior & Inferior tributaries	49	98
Herring Bone Pattern	1	2

Fig. 1: Showing the Main Pancreatic Duct with its tributaries (mixed)

Furthermore, our study illuminated tributaries draining from the uncinate process within the adult pancreas. Thirteen adult specimens showcased the presence of one uncinate tributary that drained into the main pancreatic duct. In a particularly unique specimen characterized by an unusually large uncinate

process, three uncinate tributaries were observed to drain into the main pancreatic duct, prior to its convergence with the bile duct. Additionally, another specimen, featuring a loop (ansa) pattern of the accessory pancreatic duct, revealed the drainage of one uncinate tributary into the main pancreatic duct. Smaller tributaries stemming from the uncinate process were found to drain into the loop of the accessory pancreatic duct.

Table 3: Tributaries from the Uncinate Process.

Percentage of specimens with uncinate tributaries	1 duct	2 duct	3 duct	Multiple duct
50%	42%	6%	2%	-

Fig. 2: Showing three tributaries draining uncinate process.

Among the 50 specimens scrutinized, two notable variations in the course of the main pancreatic duct emerged. A substantial majority, encompassing 45 specimens (amounting to 90%), featured a descending course of the main pancreatic duct. However, the remaining 10% of specimens exhibited a sigmoid course, presenting a noteworthy anomaly that warrants further investigation.

Fig. 3: Showing main pancreatic duct with its tributaries (Herringbone pattern).

Fig. 4: Showing sigmoid shaped main pancreatic duct.

DISCUSSION

Our study represents a holistic exploration of the pancreatic duct system, offering profound insights into the intricate network of tributaries and their variations within the human pancreas. In this section, we shall delve into the key findings of our research, elucidate their implications, and emphasize the criticality of understanding the anatomy of pancreatic duct tributaries.

Variations in Length and Angle of Entry: One of the primary objectives of our study was to delve into variations in the length and angle of entry of tributaries into the main pancreatic duct. Our observations unearthed significant diversity concerning the number of tributaries merging with the main pancreatic duct, with certain specimens exhibiting as many as 30 tributaries. An equally intriguing facet of our findings revolved around the variations in the length of these tributaries, which potentially bear direct implications for the efficiency of pancreatic secretions [12].

Notably, the angle of entry of these tributaries emerged as a focal point of interest. A substantial proportion of specimens, standing at 70%, exhibited right-angled tributaries. In contrast, 30% of specimens featured acute angles. This divergence in angles holds profound clinical implications. Surgical procedures involving the pancreas, such as the pancreaticoduodenectomy (commonly known as the Whipple procedure), necessitate an intricate understanding of pancreatic anatomy to avert inadvertent ductal injury [13].

Surgeons must be acutely cognizant of the

potential presence of right-angled tributaries, which may pose an elevated risk during dissection and necessitate heightened caution.

Alternating and Herringbone Patterns: The intriguing phenomenon of alternating patterns within the pancreatic duct system stood as another critical focal point of our study. Remarkably, an overwhelming 98% of specimens exhibited tributaries that alternated between superior and inferior positions along the main pancreatic duct. This alternating pattern, while widespread, raises pertinent questions regarding its functional significance. Could it potentially regulate the flow of pancreatic secretions? Could it be germane to the development of diseases afflicting the pancreas? These are questions that merit further exploration and scrutiny.

In stark contrast, the rare Herringbone pattern manifested in a mere 2% of specimens. This distinctive arrangement, characterized by the intricate crisscrossing and interweaving of tributaries, represents a notable anatomical variant. The clinical significance of the Herringbone pattern remains enigmatic and beckons for future research to unveil its secrets, thus underscoring the intricate diversity that characterizes pancreatic duct anatomy [14].

Clinical and Surgical Implications: Comprehending the intricacies of pancreatic duct tributaries assumes paramount importance in the realm of clinical practice, particularly concerning pancreatic surgery. A precise grasp of the number, length, and angles of tributaries can equip surgeons with the requisite knowledge to meticulously plan and execute procedures with a level of precision that can mitigate the risk of postoperative complications, such as pancreatic fistulas. Surgeons should exercise a heightened sense of vigilance when confronted with right-angled tributaries, as these present an elevated risk of ductal injury and demand special consideration during dissection. [15-17] Furthermore, our findings reverberate across diagnostic and therapeutic landscapes. A nuanced understanding of the variances within the pancreatic duct system can significantly inform the placement of stents, the execution of drainage procedures, and the navigation of endoscopic retrograde cholangiopancreato graphy (ERCP) [18-20].

It may also cast new light on the management of conditions such as pancreatitis.

CONCLUSION

In conclusion, our research bestows valuable insights into the complex anatomy of pancreatic duct tributaries, illuminating the vast spectrum of variations in length, angle of entry, and patterns of arrangement. This body of knowledge constitutes a pivotal reference point for clinicians, surgeons, and researchers alike. The act of recognizing and meticulously documenting these variations serves as a linchpin in enhancing the safety and efficacy of diagnostic and therapeutic interventions, ultimately translating into improved patient outcomes within the realm of pancreatic diseases.

The vistas of future research beckon, promising a deeper exploration of the functional significance underpinning these anatomical variations. These endeavors hold the potential to unravel the intricate role of pancreatic duct tributaries in pancreatic physiology and pathology, forging new frontiers in our understanding of this captivating field.

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Author Contributions

Indra Nath Sutia: Concept, Design, Manuscript preparation.

Anuradha Baruah: Concept, Manuscript preparation, Statistical analysis.

Pritanu Deb Baruah: Definition of intellectual content, Literature search, Manuscript editing and review.

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