Review Article

Anatomy of the Liver in Relation to Surgical Procedures

Segmental Anatomy of the Liver: Explore the Segmental Anatomy of the Liver in Relation to Surgical Procedures, Like Liver Resections and Transplantations

Rahmat Ullah Jan[1], Nauman Khan[1], Motasim Billah[2], Amjad Ali Shah[3], Huma Shafiq[1] and Syeda Gulrukh Saba Shah[1]

ABSTRACT

Objective: To explore the segmental anatomy of the liver in relation to surgical procedures, like liver resections and Transplantations.
Study Design: A review study.
Methods: The following review is based on approximately 25 split and living related liver transplantations in adults of both genders that were completed over a four-year period from 5 Jan 2022 to 5 Jan 2023.
Conclusion: For segmental liver transplantation and liver resections to continue to produce great results, it is vital to have a solid understanding of and use hepatic surgical anatomy.
Key Words: Segmental Anatomy, surgical procedures,

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INTRODUCTION

This study was conducted in Khyber medical university Peshawar from 5 Jan 2022 to 5 Jan 2023 to explore the segmental anatomy of the liver in relation to surgical procedures, like liver resections and Transplantations.
Couinaud's 1954 article and 1957 book Le foie; 'etudes anatomiques et chirurgicales described the liver's architecture, which advanced surgical methods and diagnostic and interventional radiology. Since this anatomical model's inception, various changes have complicated liver architecture nomenclature.
The liver has a smooth, often black exterior.[1] An adult's liver weighs around 1800 g for men and 1400 g for women, or 2% of their total weight.[2] An essential component of the human system is the liver. There are two blood supply systems in it. The hepatic artery provides the liver with 20% of its blood supply in the form of oxygenated blood.

[1.] Department of Anatomy, MCM, Peshawar.
[2.] Department of Anatomy, Pak International Medical College Peshawar
[3.] Department of Surgery, Northwest Teaching Hospital, Peshawar

Correspondence: Motasim Billah, Assistant Professor of Anatomy, Pak International Medical College, Peshawar.
Contact No: 03339252784
Email: drmotasim05@gmail.com

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The blood from the pancreas, spleen, and digestive system, on the other hand, is deoxygenated and rich in nutrients and travels into the portal vein. This blood provides 75–80% of the blood flow to the liver, which is a significant portion. Blood from the intestines and spleen, among other digestive organs, is collected via the portal vein.[3] A significant blood channel in the body that transports blood rich in nutrients from the digestive organs to the liver is the portal vein. Usually, the splenic vein is not the immediate outlet of the inferior mesenteric vein. Rather, it often forms an indirect connection to the splenic vein via the intricate venous network known as the splenic-mesenteric confluence.[4] The celiac artery (Fig. 1) is the parent of the common hepatic artery as well as the left gastric and splenic arteries. Although the liver is divided into many lobes, the falciform ligament is not the main reason of this division. The liver is connected to the diaphragm and front abdominal wall via the falciform ligament. It does not create lobes inside the liver directly. The liver is split into several lobes based on its internal structure, blood supply, and functional needs. The right and left lobes are the two primary lobes. The left lobe is much smaller than the right lobe. The quadrate lobe and the caudate lobe are two more minor lobes found in the liver.[5] The remnant of the umbilical vein is preserved in the ligamentum teres, which is situated near its base. Figure 2.
The idea of liver segments was initially put out by Healy in 1953[6], and it was further refined by Couinaud in 1957. The Couinaud classification separates the liver into eight different functioning sections.[7] It is now the most widely used classification scheme for describing

the architecture of the functioning liver.[8] Compared to the more traditional morphological description based on the liver's external appearance, it splits the liver into eight distinct functional components, or segments, making it the favored technique of describing anatomical features. Together with the bile duct, hepatic arterial and portal branches, and hepatic vein, each segment has a distinct hepatic venous branch that acts as an outflow. When looking at the liver from the front, or anterior, the segments are, in fact, numbered in a clockwise manner. Many people refer to the liver segment numbering scheme as the "Couinaud classification," after the French surgeon Claude Couinaud, who developed it to depict the functional architecture of the liver. The words "topographic left lobe" and "left lateral segment of the liver" are also used to refer to segments II and III, which are also known as the anterior and posterior segments of the left lobe, respectively. Because the region of the liver that is located on the topography or surface of the left side is known as the "topographic" left lobe, it is so named.[9] Segment IV represents the left lobe's medial region. The Roman numerals I through VIII, which were once used to denote the hepatic segments, have been superseded with Arabic digits 1 through 8.

Because the liver is divided into several segments, each of which has a blood supply and drainage system, surgical resections and other medical procedures are possible.

Sections II, III, and IV make up the liver's left functional lobe. These sections make up the liver's left lobe and are in charge of many processes include bile generation, detoxification, and metabolic processing. Every one of these sections has a separate blood supply and drainage system.

The functional right lobe of the liver is comprised of segments VI and VII. These sections belong to the liver's right lobe.[10] The functional right lobe of the liver carries out comparable tasks to those of the left lobe, such as generation of bile, detoxification, and metabolic processes. They are situated behind the V and VIII anterior portions. These segments are located in the anterior (front) part of the liver. They are part of the right lobe and likely have specific functions related to their position in the liver's anatomical structure.

The caudate lobe is situated behind the other segments of the liver and is part of segment I. It's a smaller lobe with its own blood supply and drainage. Like the rest of the liver, it plays a role in various metabolic and detoxification processes. The liver's complex segmentation is important for understanding its function and for medical procedures like liver resections, where specific segments can be removed while preserving the functionality of the remaining liver tissue.

The liver does have hepatic veins, but they are responsible for draining deoxygenated blood from the liver tissue itself. The blood that has been processed by the liver flows into these veins and then into the inferior vena cava, which carries it back to the heart. Liver consists of right and left lobes. The right hepatic vein does indeed separate the right lobe of the liver, but it doesn't separate the anterior and posterior halves of the lobe. The liver is anatomically complex and has a more intricate division into lobes and segments.

The middle hepatic vein drains blood from the middle portion of the liver and usually drains into the inferior vena cava.[11] It's important to note that the middle hepatic vein is not responsible for dividing the liver into lobes; rather, the portal vein and its branches play that role. The left hepatic vein does drain blood from the left lateral section of the liver, but it doesn't divide the left liver into medial and lateral sections. The portal vein is a major blood vessel that carries blood from various abdominal organs, including the stomach, intestines, pancreas, and spleen, to the liver. It doesn't actually divide the liver into upper and lower sections. The liver is divided into functional units called lobes, with the left and right lobes being the primary divisions.[12] The portal vein supplies blood rich in nutrients and other substances absorbed from the digestive system to the liver, where it is processed, detoxified, and nutrients are stored or released into the bloodstream. Understanding segmental liver anatomy is crucial for both radiologists and surgeons when dealing with liver-related conditions and surgeries.[13]

METHODS

The research comprises about 25 split and living related liver grafts in adults over a period of four years from 5 Jan 2022 to 5 Jan 2023 sponsored by Khyber Medical University According to the Review. The study saw detailed surgical procedures for liver resections and transplantations, including how to handle the segmental anatomy of liver. Data collecting subsequently, a comprehensive search of medical and relevant papers, books for professors articles spread over an industry (university textbooks every year) was implemented to collect information on the Couinaud classification system, liver anatomy, surgical techniques, and outcome and complications for liver resections and transplantations. All of this data were analyzed in order to affirm how far the segmental anatomy of liver affected surgical procedures. Based on literature evidence at that time, the results from these materials were synthesized into a coherent explanation about what segmental anatomy played (if anything) in reaching better post-surgical outcomes by those performing operations. Finally, we gathered these findings in order to come to an understanding of segmental liver anatomy.

RESULTS

The review pointed out that without a clear conception about liver's segmental anatomy, liver resections and transplantations are doomed to be a failure altogether. Surgical operations such as segmentectomies and trisectionectomies depend on accurate division of liver segments into parts.

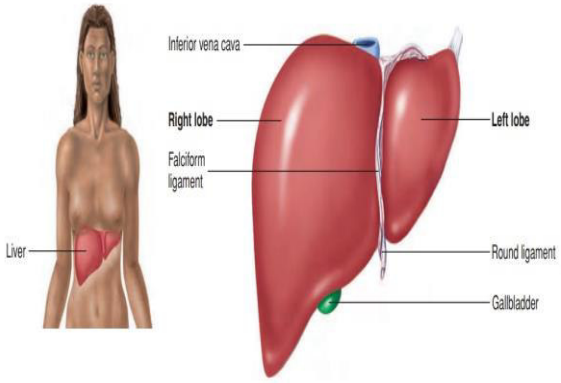

Figure No.1: Morphological anatomy of the liver.

Segmental anatomy determines in liver transplantation what kind of liver piece can be excised and surgical methodology for it. It is crucial that every detail of planning should be based on segmental anatomy in order to avoid destroying liver functionality and bringing about postoperative complications. In addition to improved blood supply and fewer physical demands, an understanding of the liver's extended segmental nature guarantees that enough healthy tissue remains after a resection to enable regeneration. Because of this, segmental liver anatomy contributes crucially to surgical outcomes and patient survival in all kinds of liver surgeries.

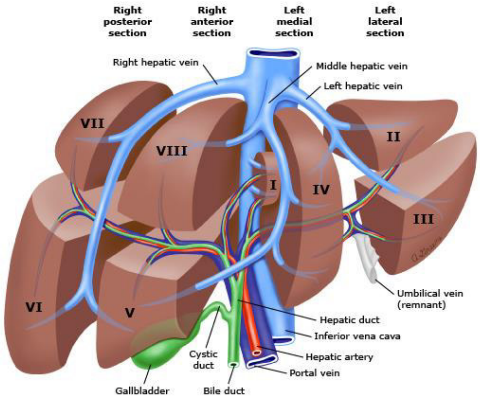

Figure No. 2: Segmental anatomy of the liver

Table No.1: Study Outcomes Related to Segmental Anatomy of the Liver and Surgical Procedures

Outcome Measure	Findings
Surgical Procedures	Liver resections and transplantations rely on understanding segmental anatomy - Various surgical techniques (e.g., segmentectomies, trisectionectomies) based on segmental anatomy
Liver Transplantation	Segmental anatomy crucial for graft selection and surgical planning - Donor grafts selected based on segmental anatomy to minimize complications
Complications	Meticulous planning and execution needed to avoid postoperative complications - Accurate localization and planning crucial for minimizing complications in liver resections
Preservation of Liver Function	Preservation of healthy tissue while removing diseased areas essential for maintaining liver function - Segmental anatomy guides surgical decisions to preserve liver function and minimize postoperative risks
Liver Regeneration	Liver capable of profound growth and regeneration post-resection with knowledge of segmental anatomy - Understanding segmental anatomy aids in leaving enough healthy tissue behind to support normal regeneration

DISCUSSION

To understand segmental anatomy of liver is very important for surgical procedures, like liver resections and Transplantations. A study of the present work is the segmental anatomy of the liver and its relationship to surgical techniques such as liver resections, transplants etc. Segmental anatomy of the liver is important in planning and executing hepatectomies because it provides a framework to help clarify the distribution of blood supply, baillary drainage and functionally independent units in the liver. The liver is made up of eight functional segments, each of which has its own blood supply and bile ducts. This segmental division is based on the distribution of the hepatic veins and portal veins, which supply and drain different parts of the liver. Understanding the segmental anatomy enables surgeons to assess the extent of disease in the liver and

to plan resections accordingly. They can determine which segments are affected by cancers or other ailments as well as by how many of the hepatocytes are to be excised in order that clear resection margins be still observed while preserving as much normal hepatocytes as possible. Resecting a liver segment rather than more of the liver postoperatively improves liver function and reduces complications. Knowing the segmental anatomy enables surgeons to accurately define the borders of individual segments during operation, so that blood flow, bile drainage, and functional liver tissue will not be compromised. The liver is capable of a profound amount of growth after resection.[14-16] Knowledge of segmental anatomy enables the surgeon to leave enough healthy tissue behind to support normal liver regeneration. The remaining segments can compensate for the loss of a single segment by multiplying. The significance of liver segmentation lies in that a segmental resection can save patients from the trouble of undergoing further, larger surgery by upgrading liver function after resection. Wisdom segmental anatomy specialist physicians to clear the border of each segment, retaining its blood supply and bile drainage system an working liver tissue. This means that by targeting segments as the object for resection, a given individual patient will not suffer serious loss of total function of the entire liver. It is especially important in patients who have the liver background as their routine employment(background)? Segmental anatomy serves as a guide for liver operations that direct surgeons in planning surgery to cause minimal destruction of working liver and avoids risks for patients having these surgeries. Liver transplantation depends on segmental anatomy: it provides the donor with detailed information about the recipient's liver's veins and bile ducts. This knowledge is vital for liver transplant surgery, including graft procurement, planning and smoothness at each phase of operation to decrease complications borne by patients. A suitable liver segment for transplantation can be identified by segmental anatomy, making sure that the graft is appropriate for the receiver. Segmental anatomy helps us to locate the best spot for graft implantation and to devise a strategy for connecting blood vessels and bile ducts during surgery. A detailed knowledge and understanding of the segmental anatomy helps avoid complications such as venous blood thrombosis (later blood flows in the right direction), biliary leakage and too much biliary environmental change to standards which can occur during or after liver transplant operation. There can be problems following transplantation. One is hepatic artery thrombosis, another is biliary leakage[17]. Prolonged ischemic time produces liver graft dysfunction. This regulatory network of communication can make vascular reconstruction and bile duct anastomosis respectable expedients within safe limits as is the need to reduce operation time to a passable minimum. let me tell you how segmental anatomy aids this process: it indicates the best location of the recipient's vasculature in relation to connection sites on the donor's liver and distal third of it That's important in pottery (so varied) 20 Segmental anatomy helps healthcare professionals, researchers, and anatomists better comprehend the intricate structures of the body and how they interact with each other. It's an essential approach for medical education, diagnosis, and treatment planning.[18]

CONCLUSION

Indeed, it was concluded that the above review accurately highlights the critical importance of a comprehensive grasp and precise application of surgical liver anatomy for successful outcomes in segmental liver transplantation and liver resections. The liver's intricate structure, consisting of multiple segments, lobes, and blood vessels, demands meticulous surgical planning and execution to avoid complications and ensure optimal results. In both segmental liver transplantation and liver resections, a profound understanding of the liver's vascular supply, biliary drainage, and segmental distribution is vital. Surgical decisions must be guided by this understanding to preserve healthy tissue, minimize ischemia-reperfusion injury, and prevent postoperative functional impairment.

Author's Contribution:

Concept & Design of Study:	Rahmat Ullah Jan
Drafting:	Nauman Khan, Motasim Billah
Data Analysis:	Amjad Ali Shah, Huma Shafiq, Syeda Gulrukh Saba Shah
Revisiting Critically:	Rahmat Ullah Jan, Nauman Khan
Final Approval of version:	Rahmat Ullah Jan

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