INTRODUCTION

Liver transplantation has had a profound impact on the care of patients with end-stage liver disease and is the most effective treatment for many patients with acute or chronic liver failure resulting from a variety of causes ***(Belle et al., ١٩٩٧).***

Biliary continuity after liver transplantation is done via duct to duct choledochocholedochostomy (cd-cd) or via Roux-en-y choledocho-jejunostomy (cd-j) depending on anatomic factors, duct size discrepancy, underlying native liver pathology and surgeon performance ***(George et al., ١٩٩٩).***

Biliary complications occur in ١٠–٣٠٪ of recipients after liver transplantation ***(Wise et al., ٢٠٠١)***. And most of them occur within the first ٣ months with most leaks occurring in the first month after transplantation and stricture developing later ***(George et al., ١٩٩٩).***

Prevention of biliary complications has focused on efforts to diminish tissue ischemia ***(Wise et al., ٢٠٠١).***The diagnosis of biliary complications was based on clinical symptoms, laboratory tests, and imaging studies including transabdominal US, CT, diisopropyl iminodiacetic acid (DISIDA) scan, ERCP, and/or percutaneous transhepatic cholangiography (PTC). Median follow-up from transplant-tation to last follow-up was ٢٠ months (range, ٤-٥٣ months) ***(Sherman et al., ١٩٩٥).***

Over the past ٢ decades, there has been a transition in the primary management of biliary complication to primarily endoscopic management ***(Sharma et al., ٢٠٠٨).***

A transpapillary or percutaneous transhepatic approach was selected for treatment of a biliary complication depending on accessibility of the lesion and the type of biliary reconstruction ***(Catalano et al., ١٩٩٥).***

As a general rule, transpapillary intervention was chosen for lesions located distal to the left and right main hepatic ducts, whereas the percutaneous approach was selected for lesions proximal to these ducts ***(Hintze et al., ١٩٩٧).***

Also, the former approach was used in patients with Choledocho- choledochostomy reconstruction and the latter for those with a Roux-en-y choledocho-jejunostomy. However, the percutaneous approach was used in patients with a choledochocholedochostomy when an initial approach by means of ERCP was unsuccessful or the general condition of the patient precluded ERCP ***(Wolfsen et al., ١٩٩٢).***

Surgical revision is now reserved for patients who have failed the endoscopic and transhepatic measures, and retrans-plantation is the final option when all else fails ***(Graziadei et al., ٢٠٠٦).***

Anyhow, Endoscopic treatment has become the first-line management for the biliary complication of LDLT because it is less invasive and more convenient for the patient ***(Ryu et al., ٢٠٠٨).***

Endoscopic retrograde cholangiography (ERC) has a role not only as the first treatment option but also as the second treatment option for the patients who underwent percutaneous transhepatic biliary drainage (PTBD) successfully after the endoscopic treatment had failed. To date, several reports have shown the usefulness of endoscopic treatment in LDLT with DD biliary anastomosis ***(Lee et al., ٢٠٠٩).***

It is also necessary to accept endoscopic or percutaneous long-term management as a successful outcome because resources for performing repeat transplantation are markedly limited, surgery may be too hazardous, and portal vein or hepatic artery thrombosis may make retransplantation impossible ***(Kulaksiz et al., ٢٠٠٨).***

Successful treatment of the biliary complication was defined as follows: ***(Rizk et al., ١٩٩٨).***

(١) Complete resolutions of clinical symptoms, laboratory test abnormalities, and abnormal imaging findings (e.g., US or CT).

(٢) Direct cholangiographic demonstration of resolution of the complication at completion of treatment.

(٣) No recurrence of clinical symptoms and/or signs of the complication after treatment (e.g., after removal of a stent or tube placed for the treatment).

(٤) Absence of evidence of the biliary complication on follow-up cholangiography.

AIM OF THE WORK

Aim of the work is to demonstrate different techniques of biliary repair in post living donor liver transplantation.

ANATOMY OF THE LIVER AND BILIARY TRACT

"A good knowledge of the anatomy is a prerequisite for modern surgery of the liver". Throughout the history of knowledge of the human body the liver has been regarded as a central vital organ. From ancient times till the end of the ١٨th century the main object of interest was its macroanatomy ***(Bismuth et al.,*** ١٩٩٤***)***.

In ١٦٥٤, F. Glisson (١٥٩٧–١٦٧٧) studied the liver .He discussed topography of the intrahepatic vessels and surrounding connective tissue. Even today this is referred to as Glisson's capsule and the triad (portal vein, biliary duct and hepatic artery) is called portal pedicle or Glisson's pedicle ***(Bismuth et al.,*** ١٩٩٤***)***.

Clinical anatomy of the liver

Liver anatomy can be described using two different aspects: morphological anatomy and functional anatomy and, now, the real anatomy, when ultrasound allows a precise intraoperative display in individual cases ***(Bismuth et al.,*** ١٩٩٤***).***

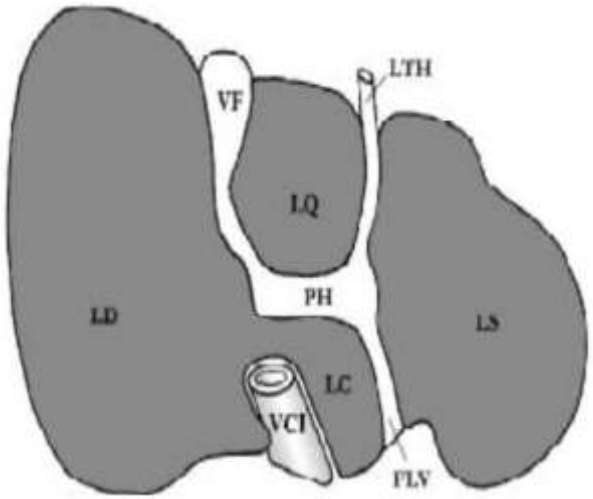

Figure (١): Visceral surface of the liver ***(Skandalakis et al., ٢٠٠٤).***

Traditionally, based on external appearance, four lobes are distinguished: right, left, quadrate, and caudate ***(Skandalakis et al., ٢٠٠٤)*** **(Fig.١).**

On the diaphragmatic surface, *ligamentum falciforme* divides the liver into the right and left anatomic lobes. On the visceral surface the *ligamentum venosum* and round ligament fissures provide a demarcation. The quadrate lobe is demarcated on the visceral surface by the gallbladder fossa, *porta hepatis*, and *ligamentum teres* ***(Abdalla et al., ٢٠٠٢).***

Besides, this classical description of liver anatomy, a second more recent description, involves the functional anatomy. This description, initiated by J. Cantlie in ١٨٩٨, was followed by works of J. Healey and P. Schroy, N.

Goldsmith and R. Woodburne, C. Couinaud, and H. Bismuth ***(Abdalla et al., ٢٠٠٢).***

Classification of Healey and Schroy

John E. Healey and Paul C. Schroy (١٩٥٣), were the first to divide the liver into functional parts. They suggested a classification based on biliary ducts and hepatic artery branching **(Fig. ٢ A, B).** They divided the liver into left and right livers and five segments: medial, lateral, posterior, anterior and caudate. They divided the liver by principle plane or Cantlie's line ***(Healy et al., ١٩٥٣).*** **(Table ١).**

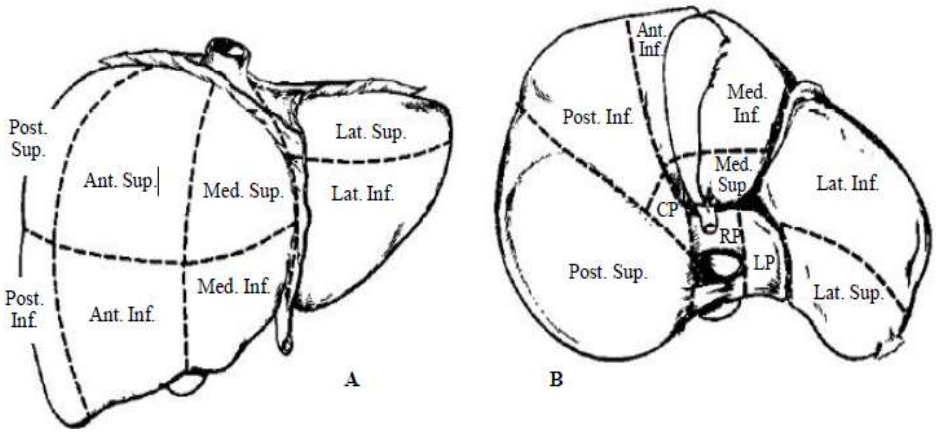

Figure (٢): Terminology of J.E. Healey and P.C. Schroy (١٩٥٣). A: Diaphgramatic surface; B- Visceral surface. Ant. Inf. – anterior inferior subsegment, Ant. Sup. **–** anterior superior subsegment; Lat. Inf. – Lateral inferior subsegment; Lat. Sup. – lateral superior subsegment, Med. Inf. – medial inferior subsegment; Med. Sup. – medial superior subsegment; Post. Inf. – posterior inferior subsegment; Post. Sup. – posterior superior subsegment; CP – caudate process; LP – left subsegment, RP – right subsegment ***(Healy et al., ١٩٥٣).***

Classification of Goldsmith and Woodburne

Goldsmith and Woodburne (١٩٥٧), unlike ***Healey and Schroy (١٩٥٣),*** performed studies *in vivo* and suggested a classification based on portal and hepatic veins. They described right and left lobes and four segments: lateral, medial, anterior and posterior **(Fig. ٣)**. Each segment consists of two subsegments: superior and inferior ***(Goldsmith et al., ١٩٥٧)***.

The right and left lobes are divided by a vertical plane, passing from the gallbladder fossa inferiorly to the middle hepatic vein superiorly. The right lobe consists of anterior and posterior segments and the left lobe – of medial and lateral segments ***(Goldsmith et al., ١٩٥٧)***.

The anterior and posterior segments of right lobe are divided by a vertical plane through the hepatic vein. The medial and lateral segments of left lobe are divided by another vertical plane through a fissure from the round ligament inferiorly and left hepatic vein superiorly ***(Goldsmith et al., ١٩٥٧)***.

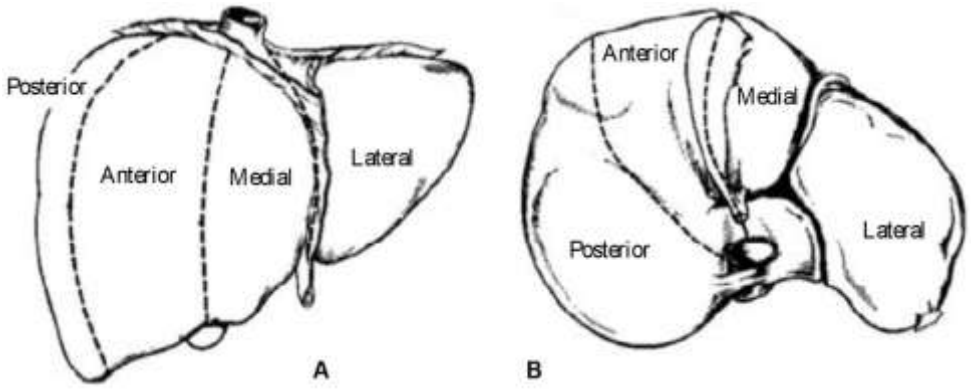

Figure (٣): Classification of N. Goldsmith and R. Woodburne. A – diaphragmatic surface; B – visceral surface. Posterior – posterior segment; anterior – anterior segment; medial – medial segment; lateral – lateral segment; CL – caudate lobe ***(Goldsmith et al., ١٩٥٧)***.

Couinaud's classification

Couinaud (١٩٥٧), similarly to N. Goldsmith and R. Woodburne, suggested dividing the liver based on portal and hepatic veins. However, his nomenclature differed – he proposed a division into eight segments by the third order branch of portal vein **(Fig. ٤, ٥)**. From a personal collection of vasculobiliary casts and analysis of anatomical data the authors argue that portal and hepatic vein segmentation is preferred over arteriobiliary segmentation (classification of Healey and Schroy) ***(Couinaud et al., ١٩٩٩).***

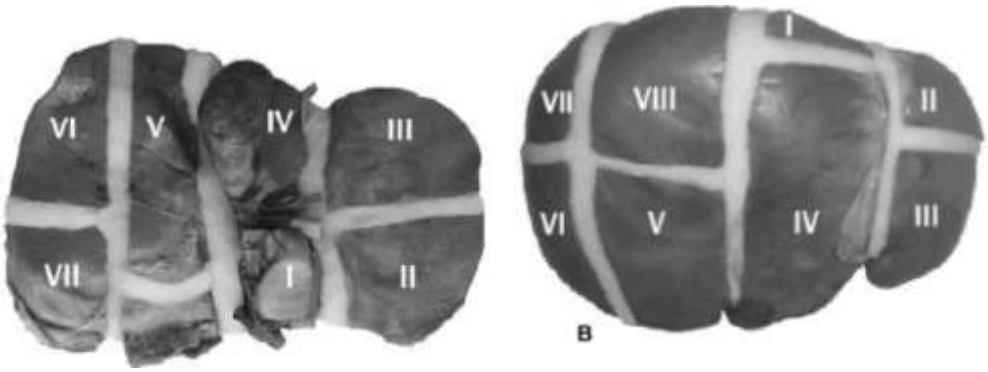

Figure (٤): Couinaud's classification. A – Visceral surface; B – diaphragmatic surface. Segment I – caudate lobe; segment II corresponds to the left lateral sector; segments III and IV – to the left paramedian sector; segments V and VIII – to the right Paramedian; segments VI and VII – to the right lateral sector ***(Couinaud et al., ١٩٩٩).***

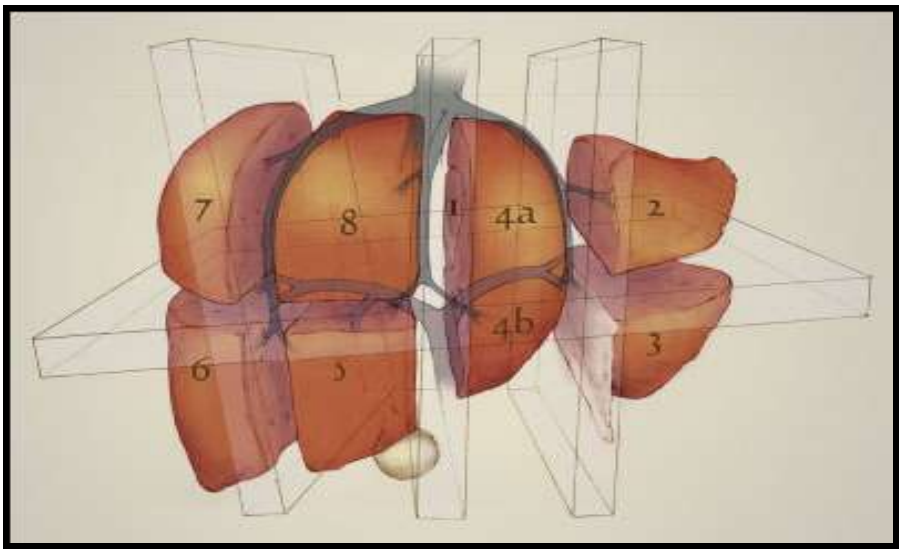

Figure (٥): Segmental anatomy of the liver as originally described by Couinaud ***(Couinaud et al., ١٩٩٩).***

Couinaud divided the liver into functional parts: left and right liver by a main portal scissurae containing the middle hepatic vein and which is known as Cantlie's line.

Each right and left liver is subdivided by the left and right hepatic veins, lying in the left and right portal scissurae, respectively. The right portal scissura is also poorly defined by surface features but passes at an angle of ٤٠° with the horizontal from a point at the right gallbladder fossa border back to the confluence of right hepatic vein with the inferior vena cava posteriorly, forming a ٧٥° angle with the horizontal **(*Couinaud et al., ١٩٩٩*).**

The right liver is hence divided into two sectors: right lateral sector lying posterolateral and another right paramedian sector lying anteromedial. Each sector consists of two segments: the right lateral sector consists of segments VI and VII and right paramedian sector of segments V and VIII. The left portal scissura or umbilical scissura lies posterior to the ligamentum teres within the liver parenchyma and corresponds to a plane passing from the confluence of the left hepatic vein with the inferior vena cava towards the most lateral left lobe tip, dividing it into left paramedian and left lateral sectors. The left paramedian sector consists of segments III and IV. The left lateral sector is comprised of only one segment II, which is the posterior part of the left lobe ***(Couinaud et al., ١٩٩٩).***

From a functional point of view, the caudate lobe (or segment I) must be considered an autonomous segment, for its vascularization independent of the portal division and three main hepatic veins. It receives vessels both from the

left and right branches of the portal vein and hepatic artery: its hepatic veins are independent and drain directly into the inferior vena cava ***(Bismuth et al., ١٩٨٢).***

However, in more recent studies Couinaud suggested that the caudate lobe could be divided into a left part or Spiegel's lobe or segment I and the right part or segment IX or paracaval portion ***(Abdalla et al., ٢٠٠٢).***

Couinaud described eight segments: one for the caudate lobe (segment I), three on the left (segments II, III and IV) and four on the right (segments V, VI, VII and VIII). All segments are numbered clockwise on the diaphragmatic surface and counterclockwise on a visceral view **(Fig. ٤)** ***(Couinaud et al., ١٩٩٩)***.

Bismuth's classification

Bismuth brought together the Couinaud's cadaveric system *in situ* and the system of Goldsmith and Woodburn *in vivo*. His classification became more popular among surgeons in Europe and America. He distinguished three planes (scissurae), hosting the hepatic veins and a transverse plane passing through the right and left portal branches **(Fig. ٦)** ***(Soyer et al., ١٩٩٣).***

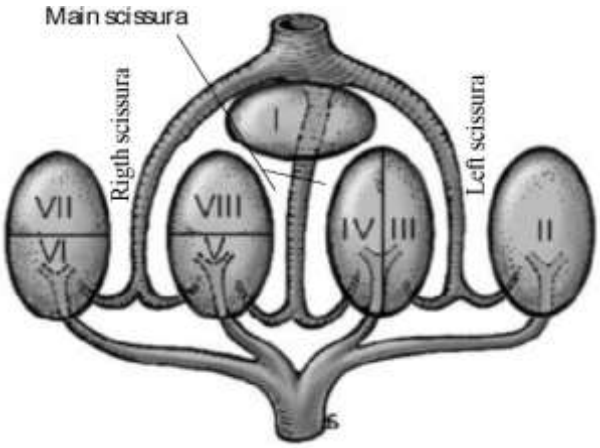

Figure (٦): Bismuth's functional classification of the liver. The liver is divided in to four sectors by three portal scissurae. Each sector is supplied by a portal pedicle. The hepatic veins and portal pedicels are intertwined, as are the fingers of two hands ***(Soyer et al., ١٩٩٣).***

Additionally, H. Bismuth described the caudate lobe as a separate segment I. Three hepatic veins divided the liver into four sectors. The sectors are termed portal sectors as each is supplied by a portal pedicle. The separation line between sectors (which contain a hepatic vein) is called a portal scissura and scissurae containing the portal pedicles are called hepatic scissurae. H. Bismuth suggests dividing the liver into left and right livers (hemilivers). A right portal scissura divides the right liver into two sectors. Each sector has two segments: right anteromedial sector – segment V anteriorly and segment VIII posteriorly; right posterolateral sector – segment VI anteriorly and VII posteriorly. The left portal scissura divides the left liver into two sectors: anterior and posterior. Left anterior sector consists of two segments: segment IV, which is the anterior part of quadrate lobe and segment III, which is anterior part of anatomical left lobe.

These two segments are separated by the left hepatic fissure or umbilical fissure. Left posterior sector consists of only one segment II. It is the posterior part of left lobe. This is an exception to this nomenclature ***(Bismuth et al., ١٩٩٤).***

FCAT liver terminology

Federative Committee on Anatomical Terminology FCAT's aim was to unify terminology and make it an internationally accepted living language of anatomy ***(Whitmore et al., ١٩٩٩).***

FCAT describes the liver lobes, parts, sectors or divisions and segments ***(Terminologia Anatomica., ١٩٩٨).***

These are developmental, functional and surgically separable units of the liver and are based on distributions of the portal vein, hepatic arteries and biliary ducts. Segment I corresponds to a proper caudate lobe or posterior part of the liver. The remainder segments II–VIII are numbered clockwise from the left, beginning with the left lateral posterior segment (segment II). The left lateral sector (II – left lateral posterior segment and III – left lateral anterior segment) is separated from the left medial sector (IV – left medial segment) and from the posterior part of the liver (segment I) by the umbilical fissure. The liver is divided into left and right parts by the main portal fissure or Cantlie's line running anteriorly from a line between the long axis of the gallbladder fossa and middle of the inferior vena cava as it