



History and Pitfall of Nomenclature for Liver Segmentation

Hee Chul Yu

Chonbuk National University, Korea

Unified terminology of hepatic anatomy and resection among surgeons and other physicians are important not only in clinical settings but also international communications. But, there is a highly varied nomenclature of the liver anatomy such as hemilivers, lobes, areas, sectors, segments, and subsegments. Concepts of Couinaud's 8 segments of the liver have gained worldwide acceptance. But, terminology of liver resections is still confused. Therefore, I will introduce how historical developments in liver anatomy have affected and accepted as a nomenclature of liver segmentation and resections.

Liver can be described using two different aspects which are morphological and functional anatomy. In the classical description, the external appearance of the liver is used to describe the anatomy. At the ancient times, right and left lobes were defined by the umbilical fissure and falciform ligament. In 1897, Cantlie described invisible liver surface line which lies in a plane runs from the middle of the gallbladder fossa anteriorly to the left side of the confluence of right HV with the inferior vena cava posteriorly, so called "Cantlie's line" to divide two parts of the liver defined by right and left lobes. The medial part of the left lobe is separated from the lateral part by the falciform ligament, morphologically. But, the classical liver anatomy does not demonstrate internal structures of vessels and biliary duct(BD)s, which are very important for hepatic resection. Early 20th century, Couinaud and Healey & Schroy used corrosion cast to define intrahepatic vasculatures and to establish the division of the liver. They divided the liver differently, because Healy & Schroy used hepatic artery (HA) and BD branches and Couinaud used portal vein (PV) branches and as the base of segmentation. Healey & Schroy termed lobes, segments, and areas. The liver divided into four segments designated as the lateral, medial, anterior, and posterior segments and the caudate lobe. Couinaud termed livers or hemilivers (as in right and left livers), sectors, and segments. The liver divided into four sectors designated as the left lateral, left paramedian, right paramedian, and right lateral sectors and caudate lobe. The right liver was anatomically identical to the right lobe, the right anterior and posterior sectors were identical to the right anterior and posterior segments, and the numbered Couinaud segments (S5~8) corresponded to four areas of Healey. However, left side liver division was apparently different by the sectors and the segments. Couinaud described the left PV to divide into an umbilical branch and a branch to S2. This divided the left liver into two sectors, consisting of a lateral sector



(S2) and a medial (or paramedian) sector (S3 and S4). Healey described the left HA and BD to divide into medial branch which supplied left medial segment, right side of the umbilical fissure, (S4) and lateral branch which supplied left lateral segment, left of the umbilical fissure, (S2 and S3).

The functional liver anatomy, hidden anatomy inside the parenchyma, explained by Couinaud and Bismuth classifications. Both are similar, although there are small differences. Couinaud classification, more popular in Asia and Europe, suggested dividing the liver based on PV and hepatic vein (HV) watershed as scissuras. The liver divided into a functional left and right liver by main portal scissura, so called Cantlie's line. It contains middle HV. Right liver divided into anterior (right paramedian) and posterior sectors by the right portal scissura which corresponds to right HV. Each sector consists of two segments; right lateral- S6 and S7, right paramedian- S5 and S8. Left liver divided into left paramedian and left lateral sectors by the left portal scissura or umbilical scissura which corresponds to left HV. Left paramedian sector consists of S3 and S4 and left lateral sector consist only S2. Caudate lobe, S1, considered an independent segment due to direct HV drainage into IVC.

Bismuth classification, more popular in America, suggests dividing the liver into four sectors by vertical planes contain three HVs and transverse plane by portal pedicles, further divided into 8 segments. Right liver divided into anterior and posterior sectors by right portal scissura. The anterior sector is subdivided into S5 (inferior) and S8 (superior) and the posterior sector is subdivided into S6 (inferior) and S7 (superior). Left portal scissura divides the left liver into two sectors: anterior and posterior. Left anterior sector consists of two segments: S4, which is the quadrate lobe and S3, which is anterior part of anatomical left lobe. S4 is divided into a superior part 4a and an inferior one 4b. These two segments are separated by the left hepatic fissure or umbilical fissure. Left posterior sector consists of only one S2. It is the posterior part of left lobe. Also, caudate lobe described as a separate S1.

Anatomical study of the liver has been great advanced but terminology has not been so. There were confused terminologies to affect name of liver resection based on surface anatomy and vascular watersheds so called "*Babel of*

Table. The Brisbane 2000 terminology of liver anatomy.

Sectors/ Sections	2 nd -order division (Segments)	
	Based on PV (Couinaud)	Based on BD and HA (Healy & Schroy)
Left lateral, or Left posterior	S2	S2, S3
Left medial, or Lt. paramedian	S3, S4	S4
Right anterior, or Right paramedian	S5, S8	
Right posterior, or Right lateral	S6, S7	

nomenclature for liver segmentation” which means surgeons and physicians unable to understand each other. So, the Brisbane 2000 terminology of hepatic anatomy and liver resections based on the Couinaud’s description but changes terminology were generally accepted by the International Hepato-Pancreato-Biliary Association (IHPBA) as the official terminology. IHPBA suggests calling the section based on BD and HA, and the sector based on PV. The term sector is replaced by the term section aimed to define the liver resections (Table). However, it does not find consensus among liver surgeons yet, especially for anatomical description of the lateral part of the left liver.

In conclusions, liver segmentation and resections with different terminology raises confusion to communicate each other. Functional liver division and segmentation by Couinaud’s and Bismuth’s classification seems conclusively established and the Brisbane 2000 terminology by IHPBA. It seems to have worldwide acceptance, but there is a controversy between real anatomical and functional divisions.