Ken Takasaki

Glissonean Pedicle Transection Method for Hepatic Resection
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With 238 Illustrations, Including 59 in Color

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Foreword

The first time I met Professor Takasaki was in 1986, at the CICD meeting in Jerusalem, when he presented his personal technique for liver resection. I was very enthusiastic about the originality and simplicity of his method and suggested that he report his experience. I told him that if he wrote a book, I would write the foreword for it. Here I keep my word.

Professor Takasaki’s technique for liver resection derives from an original concept of anatomical division of the liver into three segments based on the distribution of the portal branches. This might seem strange when we have been used to the Couinaud anatomy for the past 20 years. In fact, however, there is a close correlation between the two anatomies if we consider that the right portal branch is short or even nonexistent. We can say that portal blood is distributed to three portions of the liver: the right segment, the middle segment, and the left segment for Takasaki; and the right posterior sector, the right anterior sector, and the left liver for Couinaud.¹ Thus the liver is divided into three in both classifications.

The second original contribution by Professor Takasaki is the approach to the portal pedicles inside the liver parenchyma. Initially, I was opening the Glisson capsule to clamp and ligate the vascular elements independently but changed many years ago to the Takasaki technique, which is easier, quicker, and safer. Apart from the Pringle maneuver for the whole liver, this technique is the best way to control a part of the liver for liver resection in a real anatomical manner. The video material that accompanies this volume shows the most common liver resections carried out using this technique and provides the best illustration of its quality.

¹The similarity is even greater if we consider, as I said in 1982 in “Anatomical surgery and surgical anatomy of the liver” (World J Surg 6:3–9), that segments 4 and 3 of Couinaud are indeed artificially separated by the exteriorization of the left portal vein by the round ligament: segments 4 and 3 are one segment and, with segment 2, represent one sector. The left liver is indeed one sector. Therefore, the liver is three segments for Takasaki and three sectors (each divided into two segments) for me.
Professor Takasaki is to be complimented for the pioneering advances he has made in the history of liver surgery.

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Foreword

In the field of liver surgery, metastatic liver tumors and primary liver cancer are the two major diseases to be treated. Among the latter, hepatocellular carcinoma is the most prominent and frequent disease encountered in Asia. Surgical treatment for hepatocellular carcinoma is more challenging than for metastatic tumors because of the underlying fibrosis and cirrhosis due to viral hepatitis. Pursuit of the optimal balance between the radical step of removal of the cancer and preservation of the noncancerous liver parenchyma becomes a matter of significance.

The surgical technique for hepatocellular carcinoma (HCC) is demanding. For example, due to liver cirrhosis, hemostasis after liver transection is much more difficult than that for metastatic tumors. Many new techniques have been developed in Asian countries, where hepatocellular carcinoma is prevalent and many hepatic surgeons have been fighting this dismal disease: Tien-Yu Lin from Taiwan, GB Ong from Hong Kong, M Balasegaram from Malaysia, Ton-That Tung and Trinh Van Minh from Vietnam, Ichio Honjo and others from Japan.

Professor Takasaki was with Tokyo Women's Medical University, School of Medicine, for 36 years. During his long career, he devised many new techniques and methodologies that are now considered essential to liver surgery. Among his major contributions are the remaining liver function test, the portal pedicle dissection method from the hilum, and the “anterior approach” in hemi-liver resection.

The remaining liver function test was developed to predict the postoperative hepatic failure from the retention rate of indocyanine green at 15 minutes (ICG 15′) and the remnant liver volume. When the postoperative ICG 15′ value exceeds 40%, the patient is likely to suffer from liver dysfunction. The “anterior approach” for extended right hemihepatectomy is a technique in which the liver parenchyma is transected from the anterior surface of segment 4 to the inferior vena cava. The technique can be found first in a figure in T. Starzl’s paper, published in 1980 in *Surgery, Gynecology & Obstetrics*. The title of the paper was, however, “Right Trisegmentectomy for Hepatic Neoplasms,” and the details of the technique were not well described. The technique was described in detail as the “anterior approach” for the first time by Edward C.S. Lai from Hong Kong in 1996, in the journal *World Journal of Surgery*. However, Professor Takasaki introduced a detailed, precise description of the technique at an international meeting held in Padua in 1992, 4 years earlier than the Hong Kong group’s report. Unfortunately, his work failed to gain international recognition, because the publication of the
technique was limited to a Japanese-language surgical journal at the time. Similarly, Professor Bernard Launois from France is often incorrectly thought to have been the first to introduce the method of portal pedicle dissection from the hepatic hilum in the literature. Professor Launois described it as the “posterior” intrahepatic approach in 1992.1 One must realize, however, that Professor Takasaki had described the innovative and elegant technique in 1986, that is, 6 years earlier, long before the publication by Professor Launois. The portal pedicle dissection from the hepatic hilum, or the “Glissonean pedicle transaction method” for hepatic resection, is Professor Takasaki’s invention.

When a small unit of the liver is resected, it should be strictly anatomical in patients with HCC. Identification of the relevant area of the liver is essential for this purpose. We performed dye injection into the portal venous branch while Professor Takasaki dissected and clamped the portal pedicles from the hepatic hilum for this purpose.

I am devoted to Professor Takasaki because he is a true liver surgeon, a man of few words, with a sharp mind and excellent hands. He has fought furiously against a deadly disease, and has never ceased his criticism of others, or of himself, to achieve true improvement in the field. He has performed almost 4000 hepatectomies at Tokyo Women’s Medical University, School of Medicine.

This volume contains the essence of his ideas and clinical experiences in liver surgery. Its publication is definitely a milestone, and offers a great wealth of experience to both new and experienced surgeons alike who genuinely wish to become masters of liver surgery. The book is filled with original concepts in liver surgery for hepatocellular carcinoma, concepts that are essential for today’s HPB surgeons.

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Preface

In liver surgical procedures, the blood flow supplying the area to be resected must first be stopped to minimize blood loss. It is commonly recognized that hepatocellular carcinoma metastasizes through the portal vein, spreading into the liver and causing intrahepatic metastasis in the area of the liver nourished by the cancer-bearing portal branch. Therefore, the area nourished by the cancer-bearing portal branch should be totally resected in a systematic manner. In order to prevent intrahepatic dissemination of carcinoma during surgery, it is important that, prior to manipulation of the liver, the cancer-bearing branch be ligated.

Since 1950, the standard procedure for hepatic surgery in the West has been the so-called controlled method. That is, the hepatic artery, portal vein, and bile duct are separately ligated and cut at the hepatic hilum for right or left hepatic resection. In the West, hepatic resection has been done mostly for metastatic liver cancer, and the term simply refers to lobectomy.

Applying the techniques of lung surgery to hepatic surgery, Dr. T.Y. Lin devised and reported in 1958 a new procedure named the "finger fracture method" in which the parenchyma of the liver is fractured bluntly with the fingers and the strands not "fractured" are ligated and cut.

In the history of hepatic surgery, these two procedures have been compared and discussed. However, the basic principle of each is different, so it is not necessary to choose between the two. In a systematically precise liver resection, even if a small area is resected, the portal triad should be treated (or manipulated) as proximally as possible. For this purpose, neither of the two methods is indicated; therefore, a new technique needed to be devised.

When I began to study liver surgery, I learned a great deal in the liver cancer treatment study group that was conducted by Dr. Hiroshi Hasegawa, Dr. Susumu Yamazaki, Dr. Masatoshi Makuuchi, and others. Dr. Makuuchi (now a professor at Tokyo University) established the systematic resection of the liver by making full use of sonography. After that, I developed the same kind of systematic liver resection by another approach.

It is possible that at the hepatic hilum, each artery, portal vein, and bile duct of the primary and secondary branches of the portal triad can be ligated and cut separately. However, in the more peripheral area, inside the liver parenchyma, the artery, portal vein, and bile ducts exist as one bundle covered by connective tissues, i.e., Glisson's sheath. Therefore, so far I have been compelled to manipulate the portal triad as one bundle.

For that reason, I devised a new method in which I treated vessels of the portal triad, always taking the Glissonean pedicle into consideration.
Whether it is a segmentectomy or a lobectomy or even a small resection of the liver, the portal triad can be cut either in the intrahepatic portion or the hepatic hilum, followed by dissection of the parenchyma. I originated this procedure in 1984, and since then I have performed more than 2000 hepatic resections for hepatocellular carcinoma with it. The figure below shows the number of hepatic resections performed for hepatocellular carcinoma. All of these resections have been completed without problems.

The clinical experiences reported in this volume were completed with the support of many leaders in the field, among whom I would name Prof. Komei Nakayama (our major leader), Prof. Seiichiro Kobayashi, Prof. Fujio Hanyu, Prof. Mitsuo Endo, Prof. Yukio Mikoshiba, Prof. Michio Iwatuka, and Prof. Kyoichi Hamano, in addition to many other colleagues.

I thank Mr. Leon Sakuma, my favorite artist, for his illustrations. Photography and editing of the attached DVD were done by Mr. Akira Miyama, Mr. Kazuhiro Muraoka, Mr. Yutaka Suzuki, and the staff of the Imaging Information Research Center, Photography Division, of Tokyo Women’s Medical University.

I am also grateful to my friends Dr. Akira Fujimoto, Dr. Kuranosuke Miyauchi, and Prof. David Baldwin for their encouragement and support.

When I started writing this book, my aim was to create a textbook of hepatic resection; but now, after completing the editing of the contents, I believe that it has become a history of hepatic surgery. I look forward to further developments by young surgeons in the field.

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Contents

Foreword ................................................................. V
Preface ................................................................. IX

Chapter 1. Glissonean Pedicle Tree ....................... 1

Chapter 2. New Concept of Liver Segmentation on the
Basis of the Glissonean Pedicle (Takasaki’s
Segmentation) ..................................................... 7

Chapter 3. Ramification of the Tertiary Branches
from the Secondary Branches of
the Glissonean Pedicle ........................................ 17

Chapter 4. Concept of the Cone Unit ...................... 25

Chapter 5. Procedures for Hepatic Resection .......... 27
Anterior Approach Technique ............................... 76

Chapter 6. Resection of the Caudate Area (i.e., Spiegel Area
and Caudate Process) ........................................... 83

Chapter 7. Hepatic Cone Unit Resection (Anatomical
Subsegmentectomy) ............................................ 93

Appendix A History of Challenges Faced in
Hepatic Surgery (2000 Cases of Hepatic
Resection for HCC) .......................................... 145

References .............................................................. 161
1 Glissonean Pedicle Tree

Components of the Glissonean Pedicle

The Glissonean pedicle consists of three kinds of vessels: portal vein, portal artery, and bile duct. Glisson’s capsule (Fig. 1.1), on the surface of the liver, extends into the liver and covers the portal triads, where it is called Glisson’s sheath. Glisson’s capsule, shown by the dotted lines.
capsule also covers the Glissonian pedicles inside the liver. Therefore, the term “Glisson's sheath” is generally used only to refer to the portion of the Glissonian pedicle inside the liver. Figure 1.2a,b shows the components of the Glissonian pedicle.

In the extrahepatic portion of the Glissonian pedicle, the portal triads in the hepatoduodenal ligament are also enclosed by connective tissue and peritoneum up to the hepatic hilum. The intrahepatic and extrahepatic portions of the portal triads have the same structure anatomically. In other words, the extrahepatic and intrahepatic portal triads can be considered as parts of the same Glissonian pedicle tree.

**Fig. 1.2a.** The Glissonian pedicle tree, intraoperative photograph. After removing the surrounding liver tissue, care is taken not to damage the vessels, using a Cavitron ultrasonic aspirator (CUSA) on the resected specimen of the right lobectomy. Not visible are arteries, veins, and the bile duct; seen here is the fibroid bundle called the Glissonian pedicle. It consists of two main trunks and several branches of almost the same length, which are bifurcated from the main trunk. The structure is connected to the outside of the liver and hepatoduodenal ligament. This fibroid bundle system is called the Glissonian pedicle tree.
Fig. 1.2b. Components of the Glissonean pedicle
Branching Pattern of the Glissonean Pedicle Tree

Figure 1.3 shows the Glissonean pedicle tree. The hepatoduodenal ligament forms the main trunk of the Glissonean pedicle tree, which expands into two branches, the right and left primary branches, at the hepatic hilum. The right branch subdivides into two secondary branches. The left branch proceeds to a transverse portion and then continues to the umbilical portion (i.e., the secondary branch; Fig. 1.3). Blood is supplied to the liver by the three secondary branches of the Glissonean pedicle tree. Both of the primary branches are located outside the liver, while the secondary and more peripheral branches run inside the liver.
Advance of the Secondary Glissonean Pedicle Tree Branches into the Liver

Figure 1.4 shows the entry of the branches of the Glissonean pedicles into the liver at the hepatic hilum. Three secondary branches—that is, those contributing to the right, middle, and left segments—enter the liver through separate openings, while some small branches go to the caudate area, entering the liver through smaller openings. All of these openings begin at the hepatic hilum and lead to the liver parenchyma.

Fig. 1.4. Entry of the Glissonean pedicles into the liver at the hepatic hilum
2 New Concept of Liver Segmentation on the Basis of the Glissonean Pedicle (Takasaki’s Segmentation)

Three Segments and One Caudate Area (Fig. 2.1)

The blood supply of the liver is derived from the three secondary branches of the Glissonean pedicle, and each secondary branch feeds one segment. Consequently, the liver can be separated into three segments: right, middle, and left. There is one additional area, called the caudate area, which is nourished directly from the primary branch. The three segments are almost the same size, each accounting for about 30% of the total liver volume, with the remaining 10% occupied by the caudate area.

![Fig. 2.1. Takasaki’s segmentation](image)
Relationship Between the Hepatic Veins and the Three Segments (Fig. 2.2)

Generally speaking, the hepatic vein is comprised of three veins: right, middle, and left. The right hepatic vein runs between the right segment and the middle segment, that is to say, the intersegmental plane. The middle hepatic vein runs between the middle segment and the left segment.

In many individuals, the middle and left hepatic veins meet each other and form a common channel, draining into the inferior vena cava (IVC). Therefore, the left hepatic vein is regarded as a branch of the middle hepatic vein. The left hepatic vein drains only the left segment. Thus, it is a general rule that the two main hepatic veins, right and middle, run along the intersegmental plane. Also, several short hepatic veins come from the caudate area that surrounds the inferior vena cava (IVC) and flow directly into the IVC.

Fig. 2.2. Relationship between the hepatic veins and the three segments. *IVC*, inferior vena cava; *RHV*, right hepatic vein; *MHV*, middle hepatic vein.