

ORIGINAL ARTICLE

Biliary architecture of livers exhibiting right-sided ligamentum teres: an indication for preoperative cholangiography prior to major hepatectomy

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Abstract

Objective: To obtain information about the basic biliary anatomy of livers with right-sided ligamentum teres (RSLT).

Summary of background data: RSLT is a relatively rare anomaly with a reported incidence of 0.2–1.2%. Although the portal/hepatic venous and arterial anatomy of livers with RSLT has already been established, the biliary architecture of such livers remains unclear.

Methods: RSLT was detected in 48 patients during 12,071 consecutive image readings (0.4%). Of these patients, the cholangiograms of 46 patients were analyzed, and their intrahepatic biliary tree confluence patterns were classified.

Results: The following four unique biliary confluence patterns were identified in livers with RSLT: the symmetrical type (23/46), independent right lateral type (13/46), total left type (6/46), and total right type (1/46). Analyses of the portal and arterial branching patterns of these livers showed that there were no correlations between their biliary confluence patterns and their portal or arterial ramification patterns.

Conclusion: The basic biliary architecture of livers with RSLT was clarified. As the RSLT patients' anomalous biliary confluences differed from those seen in normal livers and were difficult to predict, preoperative cholangiography should be performed prior to complex hepatobiliary surgery involving livers with RSLT to ensure patient safety.

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Introduction

Right-sided ligamentum teres (RSLT) is a relatively rare congenital anomaly in which the fetal umbilical vein is connected to the right paramedian trunk of the portal vein; however, it can have clinically important implications for hepatobiliary surgery.^{1,2} RSLT is sometimes encountered during cholecystectomy

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or hepatobiliary surgery and has a reported prevalence of 0.2%–1.2% in the adult population.^{3,4} As this anomaly results in a right-sided dominant distribution of the portal veins, the segmental anatomy of adult livers with RSLT exhibits “extreme right-side dominance”, even though the external appearance of the liver is similar to that of a normal liver, except for the reversed positions and a small gap between the gallbladder and the ligamentum teres.¹ (Fig. 1a).

Shindoh *et al.* previously reported that the symmetrical configuration of the portal/hepatic venous systems and the segmental anatomy seen in the early stages of hepatic

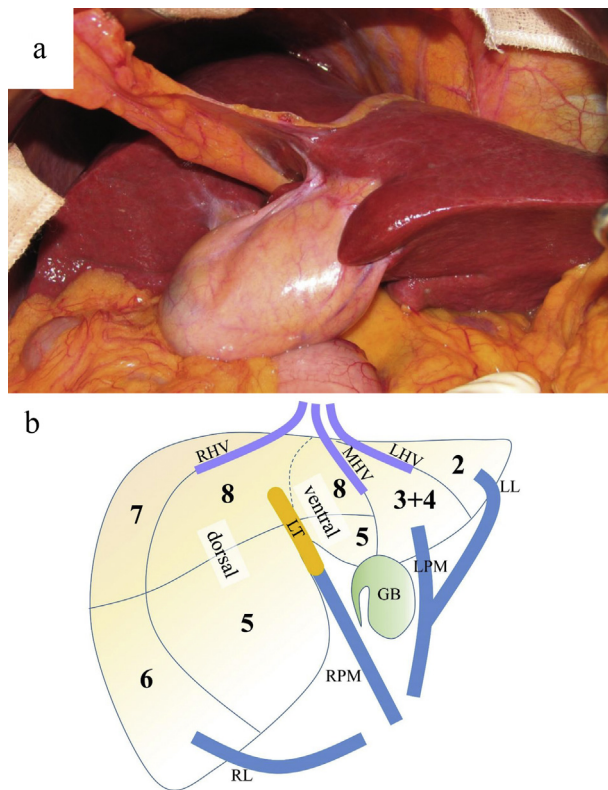


Figure 1 a) The appearance of a liver with right-sided ligamentum teres. Please note the reversed anatomy and the small gap between the ligamentum teres and gallbladder. b) A scheme of the relationships between hepatic segments and anatomical landmarks. RHV: right hepatic vein, MHV: middle hepatic vein, LHV: left hepatic vein, GB: gallbladder, LT: ligamentum teres, RL: right lateral portal vein, RPM: right para-median portal vein, LPM: left para-median portal vein, LL: left lateral portal vein

development are well preserved in adult livers with RSLT, as they are in normal livers.^{1,5} (Fig. 1b) Thus, in RSLT livers the basic vascular architecture of the portal vein, hepatic vein, and hepatic artery are established according to the developmental anatomy of the liver.¹ However, the anatomical characteristics of the biliary system in RSLT livers are not yet fully understood because of the difficulty of evaluating the confluence patterns of the biliary tree on computed tomography (CT) images. It is important to understand the anatomy of the intrahepatic biliary tree because several clinically critical variations in biliary anatomy have been reported in patients with RSLT, which could cause serious biliary injuries or complications during major hepatectomy.^{6–10} Given the increasing requirements for precise understanding of the anatomical variations of the liver in the era of aggressive surgical approaches, this study sought to clarify the biliary anatomy of livers with RSLT to improve the safety of complex hepatobiliary surgery.

Methods

Screening and study population

Radiological screening for RSLT was basically performed using axial CT images. RSLT was suspected when one of the following findings was encountered during the initial CT screening: a strong deviation of the umbilical portion towards the right, a lack of liver parenchyma between the gallbladder and the umbilical portion, or a deeply fissured groove for the ligamentum venosum near the level of the portal bifurcation.¹ Then, the three-dimensional (3D) portal-hepatic venous relationship was examined using CT, 3D-CT, and magnetic resonance imaging (MRI) to obtain a definitive diagnosis of RSLT, as described previously.^{1,11} First, the right lateral portal pedicle (Sg. 6 + 7) was identified. Then, the right hepatic vein (RHV) was identified by searching for a prominent vein that ran along the intersectoral plane of the right posterior sector. The right paramedian portal pedicle (Sg. 5 + 8), which is another significant branch, was then found next to the border of the drainage area of the RHV. The middle hepatic vein (MHV) was located on the left surface of the right anterior sector, and the midplane of the liver was finally identified. The ligamentum teres was then sought as a cord-like fatty structure with an occluded umbilical vein at its center that connected to the portal vein in a cleft of liver parenchyma. RLST was diagnosed when the connection of the ligamentum teres to the portal vein (the umbilical portion) was located on the right side of the midplane of the liver.

The study population was derived from two sets of clinical general radiology databases (rather than from hepatobiliary pancreatic directed radiology databases). Based on the 8050 consecutive image readings performed by M.A. at the University of Tokyo Hospital between May 2002 and January 2009, 35 patients were diagnosed with RSLT (0.4%), and their images were used for vascular analysis in a previous study.¹ Of these, the appropriate intrahepatic biliary tree radiological information was available for 33 patients. Based on the consecutive screenings performed by R.N. and T.Y. of 4021 patients who underwent magnetic resonance cholangiopancreatography (MRCP) at Kyoto Katsura Hospital between January 2006 and August 2015, 13 patients (0.3%) were diagnosed with RSLT. The diagnoses of the 46 patients were re-confirmed by R.N., J.S., T.Y. and M.A., and the biliary anatomy of the 46 patients was studied in detail using CT and MRCP.

Terminology and anatomical classification

Couinaud's conventional terms "sector" and "segment",¹² as defined in the addendum in *The Brisbane 2000 Terminology of Liver Anatomy and Resections*,¹³ were used to describe the basic structure of the liver. (http://www.ihpba.org/myHPBA/92_Liver-Resection-Guidelines.html). The segmental anatomy and portal/hepatic venous anatomy of the livers with RSLT were defined according to Shindoh's classification.¹

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