Optimum Timing for Postoperative Tracheal Extubation after Liver Transplantation

An Essay

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In General Intensive Care

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Mohamed Shaban Ahmed

Contents

List of Abbreviations

AASLD	:	American Association for the Study of Liver Diseases
ALD	:	Alcoholic liver disease
ALF	:	Acute liver failure
AMA	:	Anti-mitochondrial antibodies
ARDS	:	Acute respiratory distress syndrome
AST	:	Aspartate aminotransferase
AZA	:	Azathioprine
BEE	:	Basal energy expenditure
CLD	:	Chronic liver disease
CNS	:	Central nervous system
CRRT	:	Continuous renal replacement therapy
CsA	:	Cyclosporine
CTP	:	Child-Turcotte-Pugh
ELTR	:	European liver transplant registry
ERC	:	Endoscopic retrograde cholangiography
ERCP	:	Endoscopic-retrograde cholangio-pancreatography
ESLD	:	End stage liver disease
HAART	:	Highly active antiretroviral therapy
HAT	:	Hepatic artery thrombosis
HCC	:	Hepatocellular carcinoma
HPS	:	Hepato-pulmonary syndrome
IL-2	:	Interleukin-2
IL-2Ra	:	Interleukin-2 receptor antagonist
IVC	:	Inferior vena cava
LT	:	Liver transplantation
MELD	:	Model for End-Stage Liver Disease
MMF	:	Mycophenolate mofetil
MRC	:	Magnetic resonance cholangiography
NIV	:	Non-invasive ventilation
PAC	:	Pulmonary artery catheterization

List of Abbreviations (Cont.)

PAP	:	Pulmonary arterial pressure
PBC	:	Primary biliary cirrhosis
PEEP	:	Positive end expiratory pressure
PFIC	:	Progressive familial intrahepatic cholestasis
PPV	:	Pulse pressure variation
PS	:	Pressure support
PSC	:	Primary scalerosing cholangitis
PT	:	Prothrombin time
PTC	:	Percutaneous transhepatic cholangiography
PVT	:	Portal vein thrombosis
RES	:	Reticulo-endothelial system
SBP	:	Subacute bacterial peritonitis
SORELT	:	Safe Operating Room Extubation after Liver transplantation
SSC	:	Secondary sclerosing cholangitis
SVV	:	Stroke volume variation
TAC	:	Tacrolimus
TACE	:	Trans-arterial chemo-embolization
TOR	:	Target of rapamycin
TPN	:	Total parenteral nutrition
TPN	:	Total parenteral nutrition
TRALI	:	Transfusion-related acute lung injury
U.S	:	United States
UKELD	:	United Kingdom model for end-stage liver disease
UNOS	:	United Network for Organ Sharing

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Introduction

The first human liver transplantation was performed in 1963 by a surgical team led by Dr. Thomas Starzi in United States. Dr. Starzi performed several additional transplantation operations over next few years before the first short-term success was achieved in 1967. In 1980 liver transplantation was considered as a standard clinical treatment for patient with end stage liver disease (ESLD). Now liver transplantation is performed in many centers with improvement of the outcome of the operation ***(Munoz et al., 2000).***

Patients should be considered for liver transplantation if they have evidence of fulminant hepatic failure; a life threatening systemic complication of liver disease, a liver based metabolic defect or more commonly cirrhosis with complications such as hepatic encephalopathy, ascites, hepatocellular carcinoma, hepatorenal syndrome or bleeding caused by portal hypertension ***(Wiesnor et al., 2003).***

The early post-operative period is a crucial time when strict monitoring and sustainment of cardiorespiratory function, frequent assessment of allograft performance, timely recognition of unexpected complications and prompt treatment of extra hepatic organ system dysfunction are mandatory. Intensive care management of liver transplanted patients mainly centers on rapid hemodynamic stabilization, correction of coagulopathy, early weaning from mechanical ventilation, proper fluid administration, kidney function preservation, graft rejection prevention, and infection prophylaxis ***(Feltracco et al., 2011).***

Complications in this period can be broadly divided into surgical and non-surgical complications. Surgical complications are mostly operation-related and can be further subdivided into post-operative hemorrhage, portal vein

obstruction, hepatic vein thrombosis and biliary complications. Non-surgical complications include pulmonary, renal, cardiovascular, coagulopathy, neurological and infection in the form of wound infection, pneumonia, opportunistic infections & recurrence of hepatitis B virus ***(Bucaloiu et al., 2010).***

Improvements in preoperative workups, surgical techniques, and perioperative and postoperative care have made early extubation following liver transplantation (LT) a feasible and safe procedure for a significant proportion of patients. Optimum timing of extubation has physiological advantages over prolonged mechanical ventilation, including increased venous return to the heart, increased cardiac output, and increased hepatic blood flow. All of these factors contribute to increasing patient and graft survival, shortening hospital stay, and reducing treatment cost ***(Elnour et al., 2015).***

Aim of the Essay

The Aim of this essay is to overview the ICU management of liver transplanted patients & highlight the optimum timing for postoperative tracheal extubation after liver transplantation operation.

Chapter 1

Anatomical Aspects of the Liver

Segmental anatomy of the liver:

The liver is one of the largest organs in the body, representing 2% of the total body weight. In classic descriptions, the liver was characterized as having four lobes: right, left, caudate, and quadrate; however, this is an overly simplistic view that fails to consider the much more complex segmental anatomy ***(Gerard and Doherty, 2015).***

The liver is divided into eight segments based on the branching of the portal triads and hepatic veins. The structures of the portal triad (hepatic artery, portal vein, and biliary duct) are separate extrahepatically but enter the hepatic hilum ensheathed within a thickened layer of the Glisson capsule ***(Sleisenger and Fordtran, 2010).***

The three main hepatic veins divide the liver into four sectors, each of which is supplied by a portal pedicle. The caudate lobe is an exception because its venous drainage is directly into the vena cava and therefore independent of the major hepatic veins. The four sectors delimited by the hepatic veins are called the portal sectors and these portions of the parenchyma are supplied by independent portal pedicles arising from the right or left main pedicles ***(Gerard and Doherty, 2015).***

The divisions separating the sectors are called portal scissurae, within each of which runs a hepatic vein. Further branching of the pedicles subdivides the sectors into segments. The liver is thus subdivided into eight segments, with the caudate lobe designated as segment I. Segments I-IV comprise

the left liver lobe, and segments V-VIII, the right liver lobe. Each segment is supplied by an independent portal pedicle, which forms the basis of sub-lobar segmental resections Fig. (1) ***(Sleisenger and Fordtran, 2010).***

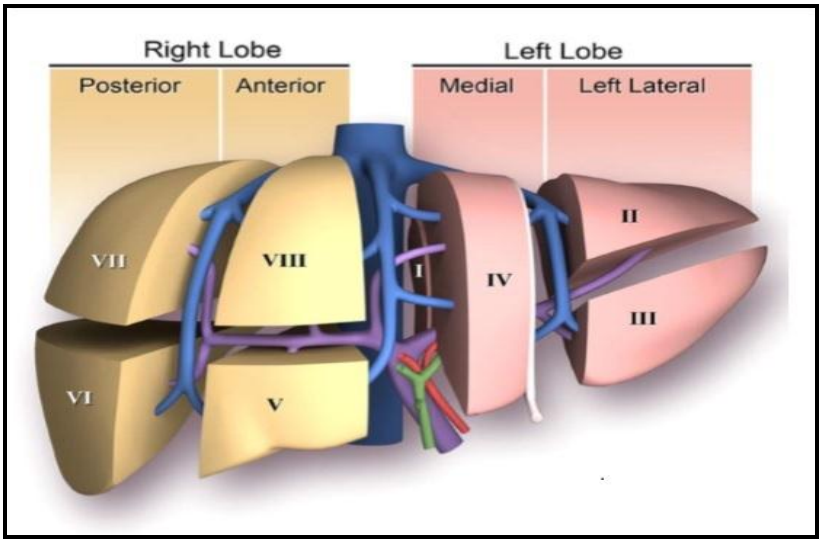

Fig. (1): Segmental anatomy of the liver ***(Sibulesky, 2013).***

The anatomical right and left hemi-livers are separated by an imaginary line running from the medial aspect of the gallbladder fossa to the inferior vena cava, running parallel with the fissure of the round ligament. This division is known as the Cantlie line or the principal plane and marks the course of the middle hepatic vein ***(Gerard and Doherty, 2015).***

The right hepatic vein further subdivides the right liver into anterior (segments V and VIII) and posterior (segments VI and VII) sectors, while the umbilical fissure subdivides the left liver into the medial sector (segment IV) and left lateral segment (segments II and III) ***(Sleisenger and Fordtran, 2010).***

Vascular Anatomy of the Liver

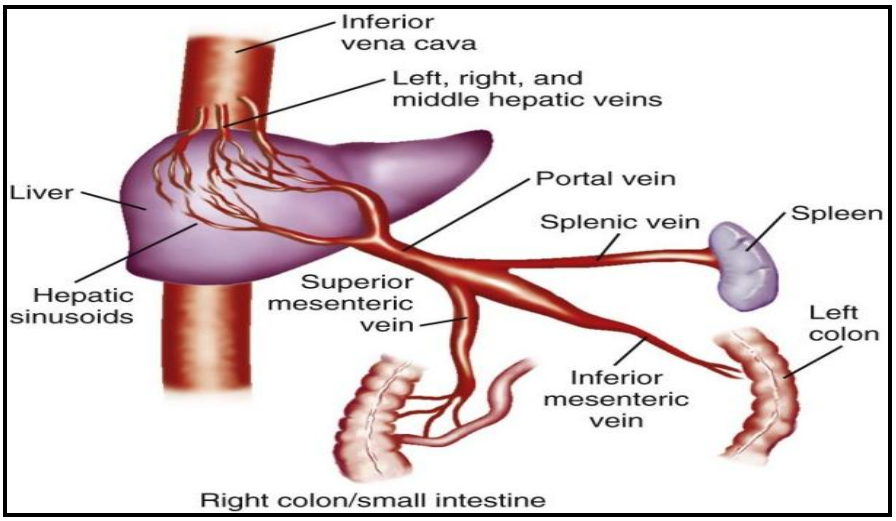

Fig. (2): Vascular anatomy of the liver ***(Gerard and Doherty, 2015).***

The liver receives approximately 70% of its blood supply and 40% of its oxygen from the portal vein and 30% of its blood supply and 60% of its oxygen from the hepatic artery Fig. (2) ***(Sleisenger and Fordtran, 2010).***

I. Hepatic Artery

The liver has a dual blood supply consisting of the hepatic artery and the portal vein. The hepatic artery delivers approximately 30% of the blood supply, and the portal vein approximately 70%. The common hepatic artery arises from the celiac axis (trunk), as well as the left gastric and splenic artery. The common hepatic artery then divides into the gastro-duodenal artery and the hepatic artery proper. The right gastric artery typically originates of the hepatic artery proper, but this is variable. The hepatic artery proper divides into the right and left hepatic arteries ***(Charles et al., 2016).***

This "classic" or standard arterial anatomy is present in approximately 75% of cases, with the remaining 25% having variable anatomy. It is critical to understand the arterial (and biliary) anatomic variants to avoid surgical complications when operating on the liver, gall bladder, pancreas or adjacent organs ***(Charles et al., 2016).***

Portal Vein

The portal vein is formed by the confluence of the splenic vein and the superior mesenteric vein. The inferior mesenteric vein usually drains into the splenic vein upstream from the confluence. The main portal vein traverses the porta hepatis before dividing into the left and right portal vein branches. Closer to the liver, the main portal vein typically gives off a short branch (posterior lateral) to the caudate process on the right side Fig. (3) ***(Sleisenger and Fordtran, 2010).***

The left portal vein typically branches from the main portal vein outside of the liver with a sharp bend to the left and consists of the transverse portion followed by a 90-degree turn at the base of the umbilical fissure to become the umbilical portion before entering the liver parenchyma ***(Charles et al., 2016).***

The left portal vein then divides to give off branches to the segment III and II (the left lateral segment), as well as the segment IV feedback branches that supply the left medial segment. The left portal vein also provides the dominant inflow branch to the caudate lobe (although branches can arise from the main and right portal veins also); usually close to the bend between the transverse and umbilical portions. The division of the right portal vein is usually higher in the hilum and may be close to (or inside) the liver parenchyma at the hilar plate ***(Sleisenger and Fordtran, 2010).***