Anesthesia for Pediatric Liver Transplantation

Essay

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Anesthesiology

By

Soliman Amin Mohamed Ali

(M.B., B.Ch.)

Under Supervision of

Prof. Dr. Azza Youssef Ibrahim

Professor of Anesthesiology & Intensive Care
Faculty of Medicine - Ain Shams University

Dr. Ahmed Mohamed Khamis

Lecturer of Anesthesiology & Intensive Care
Faculty of Medicine - Ain Shams University

Dr. Mohamed Ahmed Sobhy Rabie

Lecturer of Anesthesiology & Intensive Care
Faculty of Medicine - Ain Shams University

Faculty of Medicine
Ain Shams University
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بسم الله الرحمن الرحيم
قَالُوا سُبْحَانَكَ لاَ عِلْمَ لَنَا
إِلاَّ مَا عَلَّمْتَنَا إِنَّكَ أَنتَ
الْعَلِيمُ الْحَكِيمُ
صدق الله العظيم
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List of Abbreviations

abbreviation	Meaning
AAG	Alpha-1-acid glycoprotein
A1ATD	Alpha-1-antitrypsin deficiency
ABG	Arterial blood gases
ALT	Alanine aminotransferase
APPT	Activated partial thromboplastin time
AS	Argininosuccinic aciduria
AST	Aspartate aminotransferase
AT-III	Antithrombin III
ATN	Acute tubular necrosis
ATP	Adenosine triphosphate
A-V	Arteriovenous
BA	Biliary atresia
BUN	Blood urea nitrogen
CBD	Common bile duct
CCHMC	Cincinnati children's hospital and medical center
CF	Cystic fibrosis
CFTR	Cystic fibrosis transmembrane conductance regulator
CMV	Cytomegalovirus
CNI	Calcineurin inhibitors
CNS	Central nervous system
C.O	Cardiac output
Co A	Coenzyme A
CT	Computed tomography
CTP	ChiId-Turcotte-Pugh
CVP	Central venous pressure
CYP	Cytochrome P450
EBV	Epstein barr virus
ECG	Electrocardiography
EDTA	Ethylenediaminetetraacetic acid
EEG	Electroencephalograph

abbreviation	*Meaning*
EET	Endo-tracheal tube
ER	Endoplasmic reticulum
ESLD	End-stage liver diseases
FFP	Fresh frozen plasma
FHF	Fulminant hepatic failure
FRC	Functional residual capacity
GABA	Gamma aminobutric acid
GGT	Gamma glutamyl transferase
Hb	Hemoglobin
HBV	Hepatitis B virus
HCC	Hepatocellular carcinoma
HCV	Hepatitis C virus
HDLs	High-density lipoproteins
HIV	Human immunodeficiency virus
HLA	Human leukocytic antigen
HLH	Hemophagocytic lymphohistiocytosis
HPS	Hepatopulmonary syndrome
HRS	Hepatorenal syndrome
ICP	Intracranial Pressure
ICU	Intensive care unit
IgA	Immunoglobulin A
IL-2	Interleukin-2
INR	International normalized ratio
IVC	Inferior vena cava
LDLs	Low density lipoproteins
LDLT	Living donor liver transplantation
LLS	Left lateral segment
LRD	Living related donor
LT	Liver transplantation
MDR3	Multidrug resistance P-glycoprotein 3
ME	Microemulsion.
MELD	Model for End stage liver disease
MMF	Mycophenolate mofetil

abbreviation	*Meaning*
MPA	Mycophenolic acid
MRI	Magnetic resonance imaging
NEC	Necrotizing enterocolitis
NHBD	Non-heart beating donor
NK	Natural killer
NO	Nitric oxide
OLT	Orthotopic liver transplantation
OPTN	Organ procurement and transplantation network
PaO_2	Arterial partial pressure of oxygen
PAP	Pulmonary artery pressure
PBC	Primary biliary cirrhosis
PEEP	Positive end expiratory pressure
PELD	Pediatric end stage liver disease
PFIC	Progressive familial intrahepatic cholestasis
PRA	Panel reactive antibody
PSC	Primary sclerosing cholangitis
PT	Prothrombin time
PTT	Partial thromboplastin time
SFHF	Subfulminant hepatic failure
SGOT	Serum glutamic oxaloacetic transaminase
SGPT	Serum glutamic pyruvic transaminase
SVR	Systemic vascular resistance
T_4	Thyroxin
TEE	Transesophogeal echocardiography
TEG	Thromboelastography
TNFR	Tumor necrosis factor receptor
TPN	Total parenteral nutrition
UNOS	United network for organ sharing
VLDLs	Very low density lipoproteins
V/Q	Ventilation/perfusion

INTRODUCTION

Liver transplantation has been very successful in treating children with end-stage liver disease, and offers the opportunity for a long healthy life. Organ scarcity, which is the main limitation to the full exploitation of transplantation, is being overcome thanks to innovative surgical techniques, and all children in need, even the youngest, today have the chance of being transplanted, with almost no waiting list mortality. Split-liver and living-donor transplantation have contributed to reversing a situation in which, during the 1980s and 90s, children had greater waiting list mortality compared to that of adult patients ***(Spada et al., 2009).***

Several years ago, the main focus of care of children with end-stage liver disease was to find a liver transplant, but today, the main interest is in long-term follow-up, with prevention of immunosuppression-related complications and promotion of as normal growth as possible. The history of pediatric liver transplantation has clearly shown that success is dependent on strict and integrated collaboration between referring pediatricians, pediatric transplant hepatologists, transplant surgeons, nurses, transplant coordinators, psychologists and social workers. Everybody involved has the task of bringing a cure to a population of pediatric patients who present some of the most challenging clinical problems in modern medicine ***(Hammer and Krane, 2001).***

The numbers of patients grafted gradually increased and survival rates improved. There is no one reason for this improvement, but better selection, improved anesthetic and surgical techniques, the use of powerful and specific anti-microbials and immunosuppressive agents all made significant contributions ***(Lucey, 2003).***

Anatomy of the liver in pediatric

The liver is the largest gland in the body. In the healthy neonate, it represents up to about 5% of the body's weight; during adolescence, this decreases to the final adult proportion of 2% of body weight, or a weight of 1400 g in the female and 1800 g in the male ***(Baumann et al., 2008).***

Surface Anatomy:

The liver occupies most of the right upper quadrant of the abdomen. Physical examination demarcates the borders of a normal liver in the midclavicular line, from the fifth intercostal space to just below the costal margin. In infants, a liver palpable below the right costal margin is normal. A normal liver span on percussion and palpation can be estimated as:

- < 1 year: 4–5 cm
- 1–5 years: 6–7 cm
- 5–12 years: 8–9 cm

A prominent left lobe that is palpable in the epigastrium may be normal in infants, but in older children is suggestive of pathology ***(Baumann et al., 2008).***

Surfaces of the liver:

The liver has two surfaces a diaphragmatic surface in the anterior and superior directions and a visceral surface in the postero-inferior direction ***(Sherlock and Dooley, 2002).***

The diaphragmatic surface is smooth and dome shaped where it is related to the concavity of the inferior surface of the diaphragm. Subphrenic recesses exist

between diaphragm and anterior and superior aspects of diaphragmatic surface of the liver. The hepatorenal recess is a posterosuperior extension of the subhepatic space that is a gravity-dependant part of the peritoneal cavity in the supine position ***(Moore and Dalley, 2006).***

The visceral surface is covered with peritoneum except at the fossa for gallbladder and the portahepatis. The visceral surface bears multiple fissures and impressions from contact with other organs ***(Moore and Dalley, 2006).***

Ligaments of the liver:

The falciform ligament, which attach the liver to the anterior abdominal wall and anterior portion of the diaphragm.

Ligamentum teres hepatis (The round ligament), which lies in the free edge of the falciform ligament, extending from the umbilicus to the notch between the two lobes. It is the obliterated remnant of the left umbilical vein.

The ligamentum venosum, which is the fibrous remnant of the fetal ductus venosus. Additional folds of peritoneum connect the liver to the stomach (hepatogastric ligament), the duodenum (hepatoduodenal ligament), and the diaphragm (right and left triangular ligaments, anterior and posterior coronary ligaments) ***(Skandalakis et al., 2004).***

Relations of the liver:

The liver fills the right hypochondrium and epigastric region, extending into the left hypochondrium, just below the diaphragm. It is related by its domed upper surface to the diaphragm, which separates it from pleura, lungs, pericardium and heart. Its postero-inferior (visceral) surface is related to the abdominal oesophagus, the

stomach, duodenum, hepatic flexure of the colon and the right kidney and suprarenal, and the gall-bladder ***(Figures 1&2)*** ***(Ellis, 2006).***

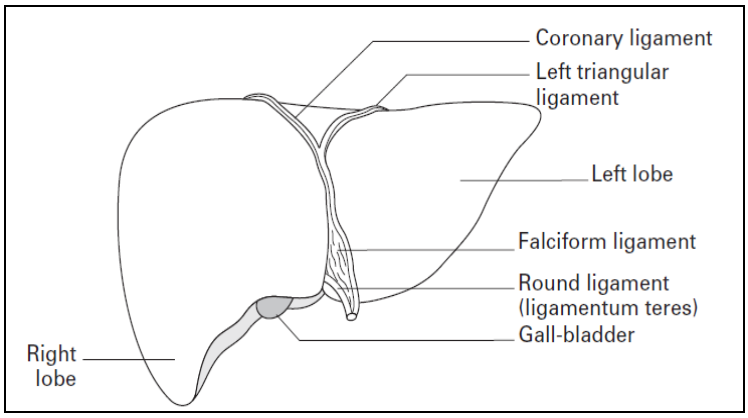

Figure (1): Anterior of the liver.
From ***(Ellis, 2006).***

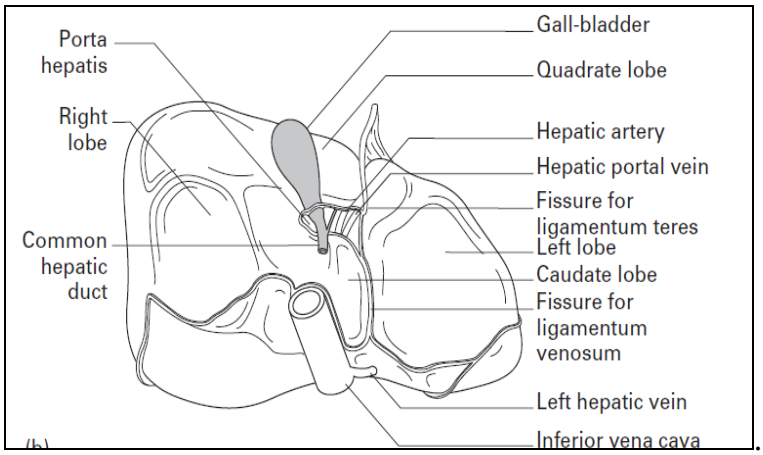

Figure (2): Visceral surface of the liver.
From ***(Ellis, 2006).***

The biliary duct and gallbladder:

The excretory apparatus of the liver consists of:

1- The common hepatic duct
2- The gallbladder
3- The cystic duct
4- The common bile duct ***(Drake et al., 2006).***

The common hepatic duct:-

The hepatocytes secrete bile into the bile canaliculi. The canaliculi drain into the small interlobular biliary ducts and then into large collecting bile ducts of the intrahepatic portal triad which merge to form right and left hepatic ducts. The right and left hepatic ducts drain the right and the left liver, respectively. Shortly after leaving the porta hepatis, the right and the left ducts unite to form the common hepatic duct, which is joined on the right side by the cystic duct to form the bile duct ***(Moore and Dalley, 2006).***

The gallbladder:-

The gallbladder is a pear-shaped sac. It is situated on the inferior surface of segment V of the right liver. It is customarily divided into the fundus, the body and the neck or the infundibulum which leads to the cystic duct ***(Cuschiere et al., 2002).***

The cystic duct:-

The cystic duct connects the neck of the gallbladder to the common hepatic duct to form the bile duct. The mucous membrane of the cystic duct is raised to form a spiral fold that is continuous with a similar fold in the neck of the gallbladder. The fold is commonly known as “spiral valve”. The function of the spiral valve is to keep the lumen open. The cystic duct drains the gallbladder, which lies in the median plane between the two functioning halves of the liver on its anterior undersurface ***(Snell, 2004).***

The common bile duct (CBD):-

The CBD forms in the free edge of the lesser omentum by the union of the cystic duct and the common hepatic duct. On the left side of the descending part of the duodenum, the CBD comes into contact with the main

pancreatic duct. These ducts run obliquely through the wall of this part of the duodenum, where they unite to form the hepatopancreatic ampulla, the dilation within the major duodenal papilla. The circular muscle around the distal end of the CBD is thickened to form the sphincter of the bile duct ***(Moore and Dalley, 2006).***

Functional anatomy (Segmental anatomy) of the liver:

The functional anatomy of the liver is composed of eight segments, each of which is supplied by a single portal triad (also called a pedicle) composed of a portal vein, hepatic artery, and bile duct. These segments are further organized into four sectors that are separated by scissurae containing the three main hepatic veins. The four sectors are even further organized into the right and left liver. This system was originally described in 1957 by Woodsmith and Goldburne as well as Couinaud and defines hepatic anatomy as it is most relevant to surgery of the liver ***(Fig. 3)*** ***(Baumann et al., 2008).***

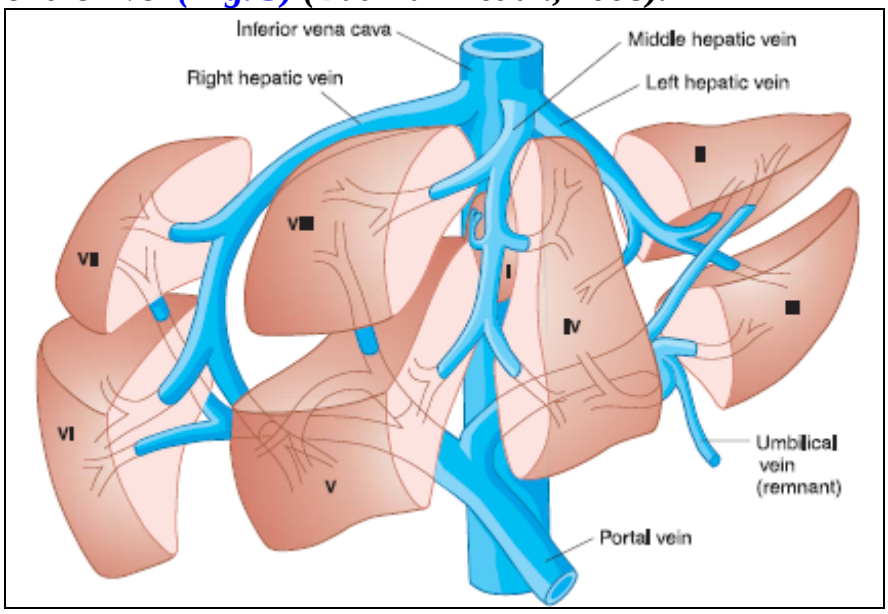

Figure (3): Functional division of the liver.
From ***(Sandberg and Raines 2008).***