



Vicissitude and Seven Patterns of Arterial Supply of the Human Liver, the Significance of the Accessory Hepatic Artery

*Corresponding Author(s): **Takayoshi MIYAKI**

Department of Anatomy, Aichi Medical University,
Nagakute, Aichi 480-1195, Japan.

Email: nagoyamiyaki@oregano.ocn.ne.jp

Abstract

The human liver usually receives blood supply from hepatic artery arising from the common hepatic artery (Figure 1). One or two aberrant hepatic arteries (S,D) appear in 30% of fetal livers and 28.6 % of adult livers (Table 1), [1,2,3]. The aberrant arteries (S or D) occupy an entire lobe of the liver in high frequency. The human liver receives any of three arterial supplies; triple (MSD), double (MS, MD, SD), or single (M,S,D; Figure1, Table 1). The arterial supply of the liver has been classified into seven patterns: MSD, MS, MD, SD, M, S, D (Table 1) [4,2,3]. The triple arterial supply (pattern MSD) shows a basic arterial supply of the liver. It is possible that this pattern changes to the other patterns in the embryological and fetal periods.

Received: Dec 14, 2020

Accepted: Feb 08, 2021

Published Online: Feb 11, 2021

Journal: Annals of Gastroenterology and the Digestive System
 Publisher: MedDocs Publishers LLC

Online edition: <http://meddocsonline.org/>

Copyright: © MIYAKI T (2021). *This Article is distributed under the terms of Creative Commons Attribution 4.0 International License*

Vicissitude of the arterial supply of the fetal liver (Figure 1), [1].

The liver receives any of three arterial supplies; triple (MSD), double (MS, MD, SD) or single (M,S,D). The arterial supply of the latter two will be derivable from the triple arterial supply of the liver according to the vicissitudes of the arteries.

The triple or double arterial supply persists during the fetal period in high frequency [1,2]. The double and single arterial supply will be derivable from the triple arterial supply of the liver according to the vicissitudes of the three arteries (M,S,D). The basic pattern remains the triple arterial supply of the liver, pattern MSD, and consists of three different arterial territories; left lobe, quadrate and caudate lobes, and right lobe (Figure 2). The triple arterial supply (pattern MSD) shows a basic arterial supply of the liver. It is possible that this pattern changes to the other patterns.

Frequency and intrahepatic territory of three different hepatic arteries in the fetal and adult livers (Figure 2), [1,2].

Three different hepatic arteries (Figure 2): The liver receives arterial supply from two aberrant hepatic arteries (S,D) and the usual hepatic artery. The right aberrant artery (D) arises from the superior mesenteric artery (Ams), the left one (S) arises from the left gastric artery (Ags), and middle or usual artery (M) arises from the common hepatic artery (Ahc). AI: Lienal artery or splenic artery, Tc: Celiac trunk.

The fetal liver: One or two aberrant hepatic arteries (S, D) has been found in 30% of 60 fetal livers. The middle hepatic artery (M) appears in 96.7 % of 60 fetal livers, the left hepatic artery (S) appears in 25 %, and the right hepatic artery (D) appears in 18.3 % (Table 2), [1].

Cite this article: Miyaki T. Vicissitude and Seven Patterns of Arterial Supply of the Human Liver, the Significant of the Accessory Hepatic Artery. *Ann Gastroenterol Dig Syst.* 2021; 4(1): 1030.



The artery S appears in 83.3% of 18 fetal livers, and the artery D appears in 61.1 % of 18 fetal livers. In three Patterns (MSD, MS, SD), the artery S occupies an entire left lobe in 33.3 % of 15 livers. In three Patterns (MSD, MD, SD), the artery D occupies an entire right lobe in 45.5 % of 11 livers [1,2,3].

Adult liver: The middle hepatic artery (M) appears in 97.6 % of 378 adult livers, but the usual artery does not appear in 2.4 %. The left hepatic artery (S) appears in 20.6 %, and the right hepatic artery (D) appears in 14.6 % (Table 1,2).

One or two aberrant hepatic arteries (S,D) has been found in 28.6 % of 378 adult livers (Table 1).The artery S appears in 72.2 % of 108cases, and the artery D appears in 50.1 % of 108 livers (Table 1). In two patterns (MSD, MS), the artery S occupies an entire left lobe in 46.7 % of 30 livers [2]. In two patterns (MSD, MD), the artery D occupies an entire right lobe in 59 % of 22 livers.

Pattern of the Arterial Supply of the Liver (Figure 3,6), (Table 1), [2].

One or two aberrant hepatic arteries (S,D) has been found in 28.6 % of 378 adult livers (Table 1).

The artery S appears in 72.2 % of 108cases, and the artery D appears in 50.1 % of 108 livers. In two patterns (MSD, MS), the artery S occupies an entire left lobe in 46.7 % of 30 livers. In two patterns (MSD, MD), the artery D occupies an entire right lobe in 59 % of 22 cases.

In the Pattern MSD, the artery S occupies an entire left lobe and the artery D supplies an entire right lobe in 50 % of 8 cases [2]. The artery D supplies an entire right lobe in 75 % of 8 cases. In the Pattern SD, the entire area of the liver receives a double supply from the two aberrant arteries in 0.8 % of adult livers.

In the Pattern MS, the artery S occupies an entire left lobe in 45.5 % of 22 cases [2]. In the Pattern MD, the artery D supplies an entire right lobe in 64 % of 14 cases. In the Pattern D, the hepatic artery (D) occupies an entire liver in 1.1 % of 378 livers, and in the Pattern S, the hepatic artery (S) occupies an entire liver in 0.5 % of 378 livers.

The gastrosplenic and common hepatic arteries of two independent branches of the aorta (Figure 4), [2].

The celiac trunk usually is formed by the gastrosplenic and common hepatic arteries. Rarely the left gastric and splenic arteries remain two independent branches of the aorta, and the celiac trunk is not formed in 0.3% of 378 human livers (Figure 4), [2]. Moreover, the celiac trunk and the superior mesenteric artery form one trunk (celiacomesenteric or gastrohepatosplenomesenteric) in 1.1 % of 378 human livers.

Three segmental arteries supplying the embryonic liver (Figure 5), [5,6].

Three different hepatic arteries arise from the three segmental arteries of the embryo. The embryonic liver receives the triple arterial supply from each hepatic artery derived from three segmental arteries [5,6].The three segmental arteries correspond to the gastrosplenic (left gastric and splenic), the common hepatic, and the one artery of superior mesenteric artery (Figure 2).

Patterns of arterial supply of the liver of anthropoids

In the chimpanzee, three patterns (MSD, MS, MD) appear in 67 % of 6 livers [7,8]. The left hepatic artery (S) appears in two livers and the right hepatic artery (D) appears in three livers. In the gorilla, the Pattern MS of liver appears in one case. In the white-handed gibbon, the middle hepatic artery (M) supplies all areas of the liver in all of 8 cases.

The aberrant artery has an important significance for the arterial supply of the liver.

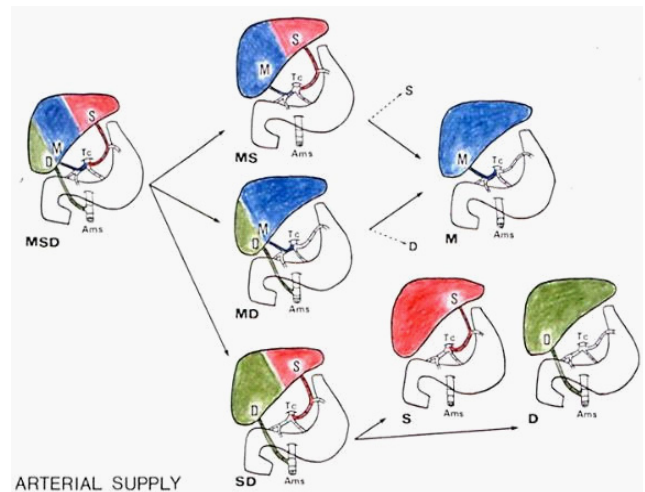


Figure 1: Vicissitude (arrows) and seven patterns of the arterial supply of the fetal liver; anterior view [1].

The liver receives any of three arterial supplies; triple (MSD), double (MS, MD, SD) or single (M,S,D). The arterial supply of the latter two will be derivable from the triple arterial supply of the liver according to the vicissitudes of the arteries.

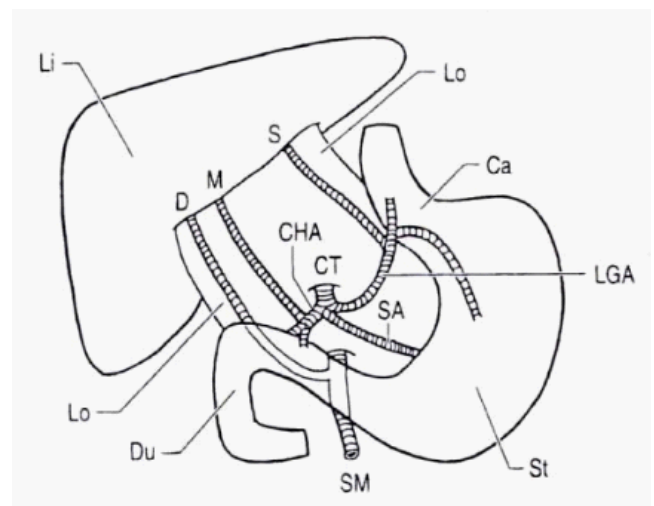


Figure 2: Three hepatic arteries (M, S, D) in 60 fetuses and 387 adults; anterior view [1].

The right aberrant artery (D) arises from the superior mesenteric artery, the left one (S) arises from the left gastric artery, and middle or usual artery (M) arises from the common hepatic artery.

Ca: Cardia; CHA: Common Hepatic Artery; CT: Celiac Trunk; Du: Duodenum; LGA: Left Gastric Artery; Li: Liver; Lo: Lesser Omentum; SA: Splenic or Lial Artery; SM: Superior Mesenteric Artery; St: Stomach.

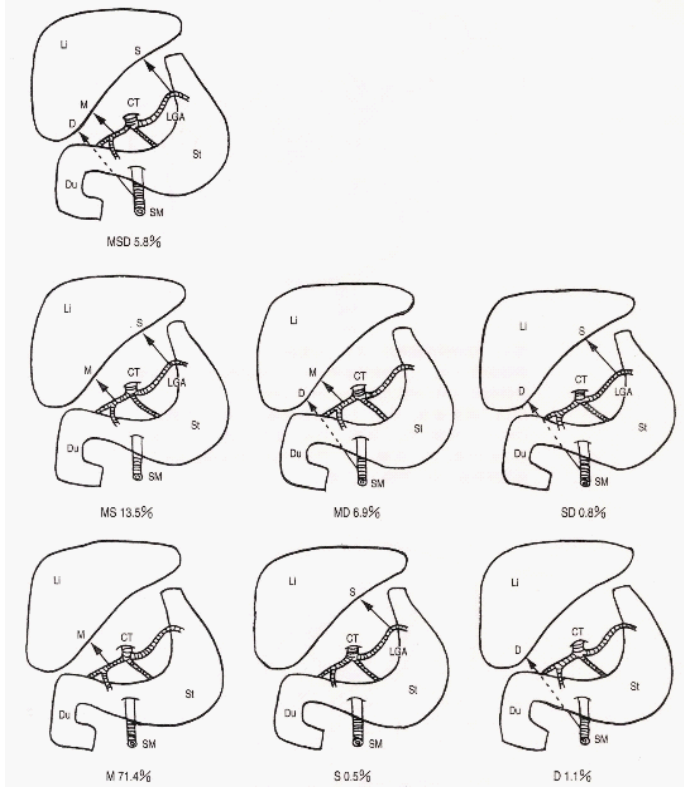


Figure 3: Frequency of seven patterns of the arterial supply of the adult liver (378 cases); visceral view [2].
 CT: Celiac Artery, Du: Duodenum; LGA: Left Gastric Artery; Li: Liver; SM: Superior Mesenteric Artery; St: Stomach

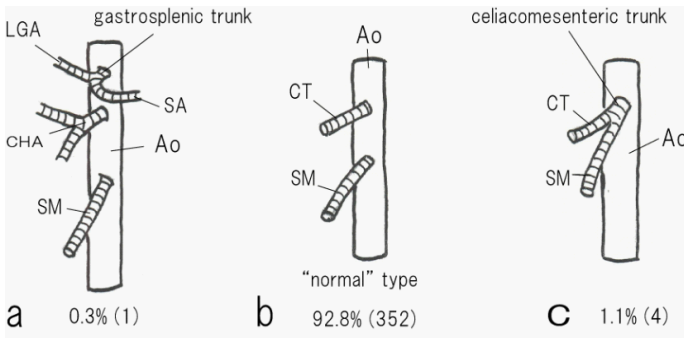


Figure 4: Variations of celiac trunk (adult 378 livers, [2]).
 a) Gastrosplenic trunk and Common Hepatic Artery (CHA) are the independent branch of the aorta (Ao) in 0.3% (1 case).
 b) "Normal type" as seen in textbook, the Celiac Trunk (CT) is formed by the left gastric, splenic, and common hepatic artery 92.8% (352 cases).
 c) The celiacomesenteric trunk is formed by the Celiac Trunk (CT) and the superior mesenteric artery (SM) 1.1 % (4 cases).

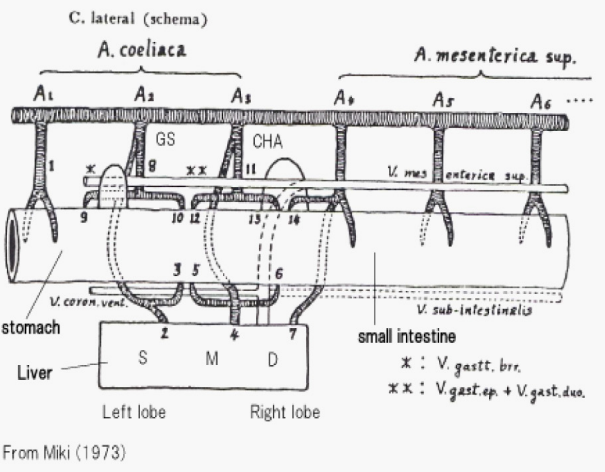


Figure 5: Genesis of arterial supply of the liver [5].
 The artery of liver is derived from the three ventral segmental arteries arising from dorsal aorta. They are gastrosplenic artery (2 of GS), common hepatic artery (4 of CHA), and a branch (7 of A4) of superior mesenteric artery.

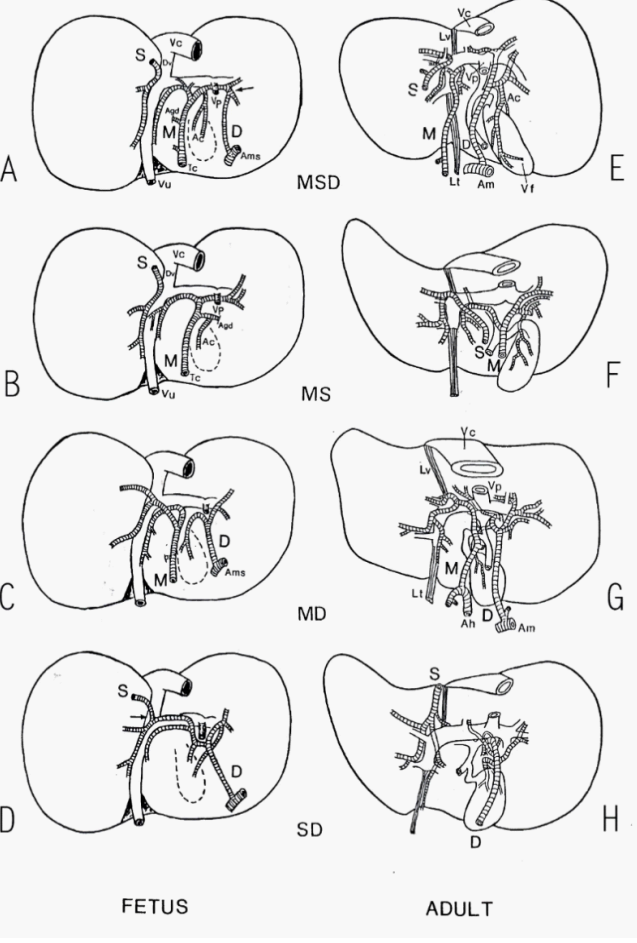


Figure 6: Arborization and intrahepatic branches of the aberrant hepatic arteries (S,D); visceral view [2]. A~D: Fetus; F~H: Adult.
 M: Middle Artery; S: Left Artery; D: Right Artery; Ac: Cystic Artery; Agd: Right Gastric Artery; Ah: Common Hepatic Artery, Am Or Ams: Superior Mesenteric Artery; Dv: Ductus Venosus; Lt: Ligamentum Teres Hepatis; Lv: Ligamentum Venosum; Tc: Celiac Artery; Vc: Vena Cava Inferior; Vf: Vesica Fellea; Vp: Portal Vein; Vu: Umbilical Vein; Arrows: Connecting Portion.

Table 1: Frequency of seven patterns of arterial supply of the liver [1,2].

Pattern	Adult (378 cases)	Fetus (60 cases)
Triple MSD	22 (5.8 %)a)	6 (10.0 %)
Double MS	51 (13.5 %)	7 (11.7 %)
MD	26 (6.9 %) a)	3 (5.0 %)
SD	(0.8 %)	2 (3.3 %)
Single M	270 (71.4 %)	42 (70.0 %)
S	2 (0.5 %)	0 (0 %)
D	4 (1.1 %)	0 (0 %)

a): Contains one cases of hepatic artery arising from celiac artery.

Table 2: Frequency of each of hepatic arteries (M, S, D) based on table 1.

Hepatic artery	Adult (378 cases)	Fetus (60 cases)
M (middle hepatic rtery)	369 (97.6 %)	58 (96.7 %)
S (left hepatic artery)	78 (20.6%)	15 (25.0 %)
D (right hepatic artery)	55 (14.6 %) a)	11 (18.3 %)

a): Contains two cases of hepatic artery arising from celiac artery.

References

- Miyaki T. Patterns of arterial supply of the human fetal liver. *Acta Anat. (Basel)*. 1989; 136: 107-111.
- Sato T, Akita K. *Anatomic variations in Japanese*. Univ. of Tokyo Press, Tokyo. 2000.
- Miyaki T. The basic pattern of the arterial supply of the liver and the vicissitude, Comparison to Adult and fetal livers. *Keitai-kagaku*. 2015; 18: 21-27.
- Miyaki T, Sakagami S, Ito H. Intrahepatic territory of the accessory hepatic artery in the human. *Acta Anat (Basel)*. 1989; 136: 34-37.
- Miki S. The genesis of blood vessels to the ventriculus. *Jap. J. Gastroent.Surg*. 1973; 6: 2-4.
- Miki S. Genesis of the splenic vein 195-201; in Bevan, et al. *Vascular neuro-effector mechanisms*, 4th International Symposium. Raven Press, New York. 1983.
- Miyaki T. The comparative anatomy of the hepatic artery, based on seven patterns of the human liver. *Keitai-kagaku*. 2016; 19: 13-22.
- Miyaki T, et al. The arterial supply of the liver in chimpanzee, gorilla, and white-handed gibbon., *Keitai-kagaku*. 2007; 10: 83-89.
- Adachi, B. *Das Arteriensystem der Japaner*. Bd. 2 (Kaiserlich-Japanische. Universitat zu Kyoto, Kyoto. 1928.
- Miyaki T with a prologue by Sato T. *Method of Human Anatomy*. Tetsugakudo Publishing, Saitama. 2014.
- Corning HK. *Lehrbuch der Entwicklungsgeschichte des Menschen*. Bermann, Munchen. 1925.
- Elias H, Sherrick JC. *Morphology of the liver* (Academic Press, New York). 1969.
- Lippert H, Pabst R. *Arterial variations in man. classification and frequency*. Bergmann, Munchen. 1985.
- Popper H, Schaffner F. *Liver. structure and function* (McGraw-Hil, New York. 1957.
- Miyaki T, Sakai T. Frequency and intrahepatic territories of right and left hepatic arteries. *Japanese Research Society of Clinical Anatomy*. 2001; 1: 30-31.
- Miyaki T. Significance of the accessory hepatic artery in the arterial supply of the liver from the viewpoint of comparative anatomy. *Japanese Research Society of Clinical Anatomy*. 2013; 13: 52-53.