Section: Anatomy

Original Research Article

THE STUDY OF SEGMENTAL BRANCHES OF PORTAL VEIN TO CAUDATE LOBE OF LIVER AND ITS CLINICAL IMPORTANCE IN PARTIAL LIVER RESECTION AND ORTHOTOPIC LIVER TRANSPLANTATION

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Abstract

Background: The caudate lobe is anatomically complex owing to its proximity to vital structures. The knowledge of their variations is of paramount importance in tumour resection involving the Caudate Lobe of the liver, partial liver resections, and orthotopic liver transplantation. This study is aimed to investigate the anatomical and functional characteristics of the segmental branches of the portal vein supplying the caudate lobe of the liver. **Materials and Methods:** 25 liver specimens were examined at the Department of Anatomy, Thiruvarur Medical College. Parameters including origin of segmental branches to the caudate lobe, number of segmental branches, and number of segmental branches from the portal vein to the caudate lobe. **Result:** The segmental branch to the caudate lobe originated from the left portal vein in all 25 specimens (100%). Additional branches originated from the right portal vein in 21 (84%), the right posterior sectorial branch in 2 (8%), and the main portal vein bifurcation in 4 (16%) specimens. The caudate lobe received 2 branches in 16 (64%) specimens, 3 branches in 7 (28%), and 4 or 5 branches in 1 specimen each (4%). **Conclusion:** Segmental branches to the caudate lobe arose from the left portal vein in all cases and from the right branch of the portal vein in the majority of cases. A detailed study of the anatomy of portal vein branches to the caudate lobe can make surgery at this site less challenging.

INTRODUCTION

The caudate lobe was first described in detail by Spieghel, and hence designated Spieghel's lobe by Glisson.[1] While it has been designated as an independent hepatic segment viz. Couinaud segment 1,[2] A lot of confusion exists in the literature because of its proximity to the portal vein, portal confluence, main hepatic arteries, and confluence of hepatic veins with the vena cava.[3] As such, advanced hepatobiliary surgery is routinely performed globally, and it is vital to understand the anatomy of the caudate lobe in detail. Although small in volume, the caudate lobe is involved in both primary and secondary tumours of the liver, including hepatocellular carcinoma and hilar cholangio-carcinoma. In such cases, combined resections are performed.[4] It has been demonstrated that simply adding the caudate lobe to a left liver graft can raise the graft volume by 9% and can help avoid a mismatch between donor and graft in adult liver transplant.[5] In both hepatic resection and liver transplantation, it is vital to disconnect all the feeding vessels of the caudate lobe, and hence a detailed knowledge of anatomy is crucial.

Aim:

This study is aimed to investigate the anatomical characteristics of the segmental branches of the portal vein supplying the caudate lobe of the liver.

MATERIALS AND METHODS

25 liver specimens were examined at the Department of Anatomy, Government Thiruvarur Medical College. Parameters including origin of segmental branches to the caudate lobe,number of segmental branches from the branches of portal vein to the caudate lobe, total no of segmental branches to caudate lobe were observed.

RESULTS

The segmental branch to the caudate lobe arising from the left portal vein was present in all 25 (100)

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liver specimens. One or more segmental branches arose from the right branch of the portal vein in 21 (84%) liver specimens. In one liver specimen, two segmental branches arose from the bifurcation, apart from one segmental branch from the right portal vein. For the other three liver specimens, the segmental branch to the caudate lobe arose from the bifurcation of the main portal vein and not from the right portal venous branch. The segmental branches to the caudate lobe arose from the right posterior sectorial branch instead of the right portal vein in two (8%) of the liver specimens. The segmental branches to the caudate lobe arose from the bifurcation of the main portal vein in four (16%) of the liver specimens. The caudate lobe received two segmental branches in 16 (64%) liver specimens, three segmental branches in seven (28%) liver specimens, four segmental branches in one (4%) specimen, and five segmental branches in one (4%) liver specimen [Table 1].

Table 1: Distribution of segmental branches to the caudate lobe based on origin and number

		Frequency (%)
Origin of segment branch to the caudate lobe	Left portal vein (LPV)	25 (100%)
	Right portal vein (RPV)	21 (84%)
	Right posterior sectorial branch	2 (8%)
	Bifurcation of main portal vein	4 (16%)
Number of segmental branches to the caudate lobe	2	16 (64%)
	3	7 (28%)
	4	1 (4%)
	5	1 (4%)

DISCUSSION

Using corrosion liver casts, Kumon studied portal venous branches to the caudate lobe. To standardize the study, the caudate lobe was divided into three portions: Spiegel, paracaval, and caudate. They observed important branches arising from the ventral aspect of the hepatic vena cava. Ramifications of the portal venous branches most commonly arose from the left portal vein (transverse portion) in 14 livers (60.9%). In six livers, ramifications were noted from both the transverse portion and the main portal trunk (26.1%), from both the transverse portion and the right portal vein in two livers (8.7%), and from the transverse portion, the main portal trunk, and the right portal vein in one liver (4.3%). In comparison, the paracaval branches were noted to have roots from the left portal vein (transverse portion) in 14 livers (73.7%) and from the right portal vein in five livers. The portal venous branches of the caudate process arose from the main portal trunk in five livers, from the right portal vein in 11 livers, and from the right posterior portal vein in three cases, which were designated as the independent right posterior branch type.[6]

Kumon et al. developed liver corrosion models by injecting coloured Mercox, epoxy resin, silicone rubber, and other materials into the portal vein, hepatic artery, bile duct, and hepatic vein of autopsied livers. They were able to use portal branching as a means to define the boundaries and extent of the caudate lobe.[7] Kumon et al. also specifically described a paracaval branch of the portal vein that branches off the right portal vein on the Rex-Cantlie's line.[8] Benko et al. studied virtual three-dimensional study of liver in over 140 potential liver donors and noted that the caudate lobe has a greater intrahepatic than extrahepatic portal inflow volume (mean 55 ± 26 vs. 45 ± 26%: $p = 0.0763$).[9]

Makki et al. noted in a prospective study that the caudate lobe is increasingly being accepted in human transplants, especially in paediatric cases and adult cases where graft volume is a concern.[10] Dubey et al. demonstrated independent vascular supply of the caudate lobe by piecemeal dissection, as it receives blood supply mainly from the left branch, whereas the caudate process is from the right branch of the portal vein and drains independently into the venecava through hepatic veins.[11] Ibuki et al. described a living donor liver transplant in which they performed a left trisection graft with the addition of the caudate lobe to meet the desired volume in both the graft and donor. They handled both the hepatic veins draining the Spiegel's lobe with a single cuff.[12]

The caudate lobe poses a unique challenge in dissection, as the segment of the liver demonstrates a shared inflow with both the left and right arterial and portal venous systems and directly drains into the vena cava. The vein to the IVC, hepatic veins and hepatic pedicle encircle the caudate lobe to form a vascular ring, essentially trapping it and making surgical access extremely challenging.[13] While traditionally performed by open surgery, recent reviews have suggested that minimal access techniques, including laparoscopic and robotic surgery, have the added advantage of allowing visualization of the structures from the caudal view while producing similar results to open surgery.[14]

Recently, it has been noted that isolated caudate lobectomies are being performed, either for HCC or for metastases. This allows the remaining hepatic parenchyma to be preserved, as noted by Fernandes et al.[15] However, it remains a complex surgery, even for the most experienced surgeons, because of the difficult location and ambiguity of vascular structures in that area, which makes manipulation difficult.[16] Hence, a clear understanding of the anatomy of this area can pave the way for better surgical outcomes.

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CONCLUSION

Segmental branches to the caudate lobe arose from the left portal vein in all cases and from the right branch of the portal vein in the majority of cases. A detailed study of the anatomy of portal vein branches to the caudate lobe can make surgery at this site less challenging.

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