Feasibility of Arantius duct maneuver for tunneling between middle and left hepatic veins and their isolation for liver resection: A cadaveric study

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ABSTRACT

Introduction: Arantius duct is the remnant of ductus venosus arantii which, during the fetal development connects umbilical portion of portal vein to the inferior-venacava. It runs from the left branch of portal vein and its fibers insert into either the left hepatic vein or pass between left and middle hepatic vein. Arantius duct when retracted, helps in isolation of left hepatic vein from middle hepatic vein, this maneuver is Arantius duct maneuver. **Methods**: This cross-sectional observational study was carried out at College of Medical Sciences Teaching Hospital, Nepal. The study included 25 cadaveric livers. Meticulous dissection was done on the livers, data were collected in proforma and entered into IBM SPSS 16.0 and electronically analyzed. **Results:** The mean length of the Arantius duct was 54.76±3.74 mm (48mm to 63mm). The mean thickness of the duct was 5.64±0.56 mm (4.8mm-7mm). The duct terminated at the common trunk of MHV and LHV in 16(64%) cases and terminated at LHV in nine (36%) of specimens. In the presence of common trunk, the Arantius duct maneuver for tunneling between the left and middle hepatic vein was successful in 14(87.5%) of the specimens in this study. The maneuver was 100% successful in isolating left hepatic vein when it had a separate origin. **Conclusions:** Arantius duct maneuver is a safe approach to tunnel between the middle and the left hepatic veins and their isolation for liver resection. It allows better vascular control with less post-operative morbidity associated to increased blood loss and reduces the risks of hepatic congestion post-surgery due to possible vascular compromise.

Keywords: Arantius duct maneuver, left lateral hepatectomy, ligamentum venosum.

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INTRODUCTION

Arantius duct, also commonly known as ligamentum venosum is the remnant of Ductus Venosus Arantii which during fetal development connects the umbilical portion of the portal vein to the inferior venacava (IVC). It is established during fetal development, allowing the oxygenated blood from the placenta to bypass the liver and travel to the right atrium via umbilical veins. The duct obliterates later to a fibrous cord known as "Arantius duct".[1,2] The Arantius duct runs from the left branch of the portal vein and its fibers insert into either the left hepatic vein (LHV) or the axilla between the left and middle hepatic vein (MHV).[3] Therefore, the Arantius duct is a very important structure which serves as a landmark for isolation and control of the left hepatic vein from the middle hepatic vein during left-sided hepatectomies.[4] Hepatectomy followed by reconstruction of its vascularity takes a lot of time and effort during surgery and typically follows extensive blood loss, which increases morbidity and has an associated risk of mortality.[5,6] With the rise in living donor liver transplantation (LDLT) and in-situ liver procurements, a left lateral hepatectomy is preferably performed without vascular exclusion on either side of the liver.[7,8]

Dividing the Arantius duct in its midway and lateral retraction provides access to the axilla between the LHV and MHV, which helps in selective control of LHV without injuring MHV during left lateral sectionectomy.[9] The narrow angle between MHV and LHV further adds to the importance of this plane of transection.[10] The maneuver is very useful in encircling the common trunk and its bifurcation, preparing harvest for split liver transplantation, or isolation of left hepatic vein during left lateral sectionectomy.[11]

During laparoscopic approach to left hepatectomy, Arantius duct maneuver offers traction of left lobe and isolation of the left and middle hepatic veins. This technique safeguards the MHV, which if injured, can cause congestion of segment-IV and hinders the regeneration of the remnant liver.[4,12]

This study aimed to clarify the location and variations of Arantius duct, identify external landmarks during left lateral sectionectomy, and assess the feasibility of the Arantius maneuver for cannulation between LHV and MHV.

METHODS

A cross-sectional observational study was carried out at Ethical approval from the Institutional Review Committee of the College of Medical Sciences Teaching Hospital (Ref. No. COMSTH-IRC/2023-60). The study included 25 cadaveric livers from the Department of anatomy of College of Medical Sciences Teaching Hospital. The study was conducted in the cadaveric lab of the department of anatomy and included cadavers preserved in formalin, which were previously utilized for gross anatomical teaching to medical students. Cadaveric livers with no abnormalities and evidence of prior liver surgery with an intact hilum were reutilized for the study.

Procedure: Ligamentum Teres, falciform ligament, left triangular, and coronary ligaments were divided to mobilize the left lateral liver lobe. The left hemiliver was thus lifted up and pulled to the right leading to a clear exposure of Arantius duct. The lesser omentum was cut up to the diaphragm, the Arantius duct was identified, and anthropometric measurements were carried out by digital vernier calipers. The Arantius duct was divided along its course, and the cephalad stump of the duct was grasped with forceps and dissected upwards towards the IVC. Retraction of the cephalad duct to the left puts the walls of the left hepatic vein into tension and showed an avascular plane between the LHV and the Caudate lobe of the liver. Also, counter traction of the caudate facilitated further exposure of axilla between LHV and MHV. This maneuver is Arantius duct maneuver. (Figure 1 and 2)

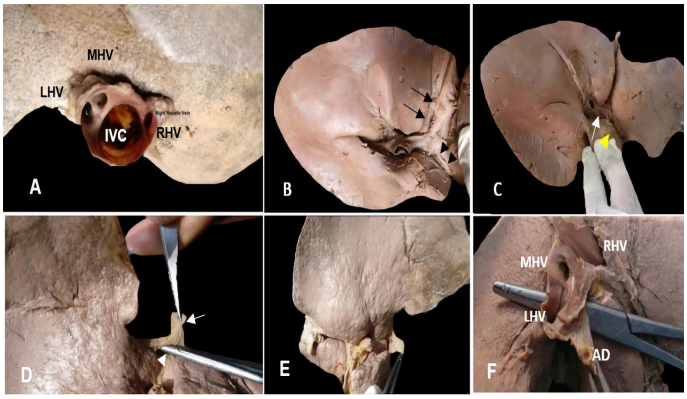

Figure 1: Step wise procedure of Arantius duct maneuver. 1A shows the RHV, LHV and MHV draining into IVC. 1B displays the umbilical plate (arrow) and the Arantius duct (arrowhead). 1C shows caudate lobe (arrow head) retracted to visualize caudate vessels (arrow). 1D demonstrates the mid-way incision and retraction of the Arantius duct (arrow) revealing the gap between LHV and MHV (arrowhead). This maneuver is known as the Arantius duct maneuver. 1E exhibits further retraction of the Arantius duct and finally, 1F demonstrates successful cannulation between the MHV and LHV using the Arantius duct maneuver. AD: Arantius duct, LHV: Left hepatic vein, MHV: Middle hepatic vein, RHV: Right hepatic vein

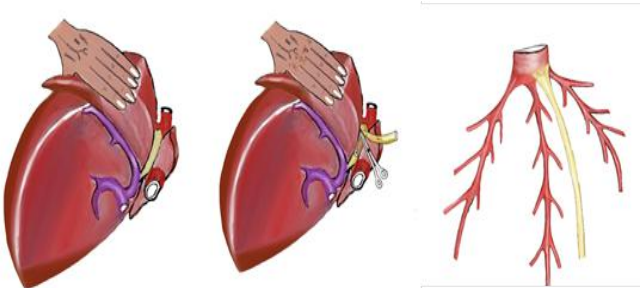

Figure 2: Displays illustrations demonstrating the topography of Arantius duct. In 2A, the left lobe is reflected towards the right side, revealing the Arantius duct. 2B showcases the incision of the Arantius duct, its retraction and the insertion of a forceps at the point where the Arantius duct inserts. 2C, shows the Arantius duct inserting between the spaces of the LHV and MHV

Measurements of the length of the Arantius duct, its thickness, and the termination were noted in the proforma. Collected data were entered into the IBM Statistical Package for the Social Sciences (SPSS) version 16.0 and electronically analyzed. Descriptive variables were described using frequency and percentage while continuous variables were described using mean and standard deviation.

RESULTS

The Arantius duct originated from a point between the transverse and umbilical portion of the left portal vein (Tri-um point) in all the specimens. It runs as a cord-like structure at the junction between the left liver and the caudate lobe.

In our study, 16(64%) livers had a common trunk of MHV and LHV. In these instances, the Arantius duct traversed through the axilla between the MHV and LHV. Meanwhile, nine (36%) of the specimens had separate insertions of LHV and MHV. In these cases, the Arantius duct terminated into LHV. The anthropometric profile of the Arantius duct is presented in table 1.

Table 1: The anthropometric profile of the Arantius duct

Arantius Duct	Range	Mean ±SD
Length (mm)	48-63	54.76 ±3.74
Thickness (mm)	4.8-7	5.64 ±0.56

A gap between MHV and LHV is referred to as Arantius gap. Arantius duct maneuver is considered successful when we can safely cannulate between MHV and LHV. In this study Arantius duct maneuver was successful in all cases when MHV and LHV had separate insertion. However, in instances where they shared a common trunk, the maneuver was successful in 14(87.5%) of the specimens. In 2(12.5%) of livers with common trunk, vein avulsion occurred while tunneling between MHV and LHV possibly due to very small Arantius gap.

DISCUSSION

Carvalho et al.[11] illustrated the insertion of the ligamentum venosum or the Arantius ligament into LHV and into the IVC. They explained the course of the ligament and the wide fanning of its ligamentous fibers into the adventitia of larger vessels. Further studies by Silva et al.[13] and Manjo et al.[11] confirmed the insertion of the ligamentum venosum either to the LHV or at the junction between the LHV and MHV.

Ligamentum venosum terminates between the supra-hepatic and infra-hepatic parts, the termination could be traced at the boundary of the left lobe and caudate lobe and passes through the axilla of LHV and MHV.[9]

Dhamane et al.[4] in their study reported that the length and thickness of Arantius ligament were 60±8mm (range 52-70mm) and 6±2 mm (range 5-8mm) respectively. Similar results were obtained in this study as length being 54.76±3.74 mm (range 48-63mm) and thickness being 5.64± 0.56 mm (range 4.8-7mm) which are in contrast to the study by Hur et al.[9] which reported a length of 35.8 ± 9.2 mm (range 5.9–53.2 mm). Length of the Arantius ligament is subject to the size of the liver which is affected by the age, sex and the body size of individuals. This can explain the possible variations found in different studies carried out on different subjects at different place and time.

Dhamane et al.[4] noted a 4% occurrence of patent ductus venosus. In this study, due to aging cadavers causing tissue deterioration and fixative artifacts Arantius duct patency couldn't be assessed. Patent ductus venosus is rare and can stem from developmental or hepatic failure issues.[14,15] Given the potential for the duct to remain patent, it is always wise to incise the duct in between the ties.[16]

A thorough understanding of the layout of left hepatic vein, middle hepatic vein, and ligamentum venosum is crucial before planning a left hepatic resection. Minimizing blood loss during this procedure is critical for better postoperative outcomes and lower risks of morbidity and mortality.[17,18] The ligamentum venosum can be utilized as the landmark which discloses the posterior surface of the left portal sheath and facilitates the posterior intrahepatic approach to the left portal pedicle.[19] Dividing the Arantius duct close to its insertion to LHV and lateral retraction of the structures provides access to the axilla between the LHV and MHV which aids to dissect and secure control of LHV required for segmental resection of the left lateral liver.[9] Prolongation of the extrahepatic parts of LHV and the common trunk of MHV and LHV can be achieved by the dissection of lesser omentum at the parenchyma, carried along the hepato-venous junction with the traction of the ligmentum venosum. Dissection of the lesser omentum along with the Arantius duct and its lateral traction together with the exposure of the anterior part of the hepato-caval junction facilitates extra-hepatic taping or clamping of the left hepatic veins or the common trunk of the MHV and LHV.[4] In this study, we could successfully cannulate between MHV and LHV in 87.5% of cases utilizing the Arantius duct maneuver when there was a common trunk of MHV and LHV. Hence, this maneuver is a very useful and safe approach while carrying out left lateral sectionectomy.

Further, it is important for one to access the patency of the duct prior to the transection of the Arantius duct to prevent bleeding from the patent Arantius duct. A vigorous and overzealous traction of the duct while performing this maneuver could avulse MHV, LHV or both.

CONCLUSIONS

Arantius duct maneuver is a feasible and safe approach for tunneling between the left and the middle hepatic

veins and their isolation during left liver resection. It's always wise to incise the Arantius duct in between ties, considering the possibility of a patent Arantius duct.

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AUTHORS' CONTRIBUTION

SK did concept designing, the definition of intellectual content, literature search, data acquisition, cadaveric dissection, and manuscript review. SK is the guarantor of this study. All authors had helped in the literature search, preparing manuscript and data analysis.

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