Is it safe to divide and ligate the left innominate vein in complex cardiothoracic surgeries?

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Received 26 February 2013; received in revised form 26 April 2013; accepted 10 May 2013

Abstract

A best evidence topic in cardiac surgery was written according to a structured protocol. The question addressed was whether it is safe to divide the left innominate vein (LIV) in aortic arch surgery to improve access. Altogether, 228 relevant papers were found using the reported search, of which nine represented the best evidence to answer the clinical question. The authors, journal, date and country of publication, patient group studied, study type, relevant outcomes and results of these papers are tabulated. Following LIV division, the venous drainage takes place via multiple collateral systems such as the azygous/hemiazygous, the internal mammary veins, the lateral thoracic and superficial thoracoabdominal veins, vertebral venous plexus as well as the transverse sinus. The possible complications are mainly left upper limb swelling and neurological symptoms. In one case series of 14 patients, the LIV was divided and ligated to facilitate the exposure for aortic arch surgery. More than 2-year follow-up did not reveal upper limb oedema or neurological symptoms. In two cohorts of 52 patients, the LIV was ligated prior to the superior vena cava (SVC) resection for malignancy. During the mid-term follow-up, no neurological or upper limb symptoms were reported. In a report, LIV ligation was observed in 4 patients undergoing left internal jugular vein catheterization for haemodialysis. The reported symptom was left arm swelling with no neurological problems. In a cohort of 18 patients undergoing SVC resection for malignancy and major vein reconstruction, 7 patients underwent ligation of the LIV with no neurological symptoms. It was also concluded that reconstruction of the LIV is not consistent with favourable patency. In a case series of 10 patients with central venous obstruction, collateral pathways to conduct efficient venous drainage were mapped. We conclude that division of the LIV is safe in selected patients and operations. Patients will initially have symptoms of central vein obstruction, but these will decrease with conservative management as collaterals form.

Keywords: Innominate vein • Innominate vein surgery/obstruction/ligation/division

INTRODUCTION

A best evidence topic was constructed according to a structured protocol. This is fully described in the ICVTS [1].

THREE-PART QUESTION

In patients undergoing aortic arch surgery or mediastinal tumour excision, is division and ligation of the LIV safe for achieving superior exposure?

CLINICAL SCENARIO

You are performing the initial parts of the aortic arch surgery under the supervision of your consultant. During the procedure, you have difficulty in gaining exposure to the arch. Your consultant suggests you divide and ligate the LIV and proceed with the remainder of the case. You are surprised at this option, but your consultant informs you that it is a safe course of action. Not having considered this technique before, you resolve to check the literature yourself once the case is complete.

SEARCH STRATEGY

Medline from 1946 to January (week 4) 2013 using OVID interface utilizing the following strategy: [innominate vein.mp. or Brachiocephalic Veins/] AND [ligation.mp. or Ligation/] OR [innominate vein.mp. or Brachiocephalic Veins/] AND [obstruction.mp or Obstruction] OR [innominate vein.mp. or Brachiocephalic Veins/] AND [division.mp.]

SEARCH OUTCOME

Two hundred and ten papers were found using the reported search. From these, nine papers were identified that provided the best evidence to answer the question. These are presented in Table 1.

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<table>
<thead>
<tr>
<th>Author, date, journal and country</th>
<th>Patient group</th>
<th>Outcomes</th>
<th>Key results</th>
<th>Comments</th>
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<tbody>
<tr>
<td>Jaus and Macchiarini (2011), Semin Thorac Surg, Italy [3]</td>
<td>Expert opinion based on 10-year experience of SVC and innominate vein reconstruction for mediastinal malignancy (14 patients)</td>
<td></td>
<td>The centre routinely repairs both innominate veins, but reports no adverse outcome when only one is repaired.</td>
<td>Expert opinion, based on single-centre experience with limited numbers. Does not explicitly outline morbidity for LIV division.</td>
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<td>Leo et al. (2009), Eur J Cardiothorac Surg, Italy [4]</td>
<td>Eleven-year case series with 72 patients undergoing SVC reconstruction as part of treatment of lung cancer or mediastinal tumour</td>
<td>Mortality, morbidity, SVC complications</td>
<td>Fourteen patients underwent SVC repair using a single-innominate vein connection to the RAA. Low incidence of acute SVC syndrome in the prosthesis group (3 of 28 [10%]).</td>
<td>Case series does not breakdown the number of right and LIV conduit repairs.</td>
</tr>
<tr>
<td>Spaggiari et al. (2007), Ann Thorac Surg, Italy [5]</td>
<td>Seven-year case series with 70 patients undergoing SVC resection/replacement for mediastinal malignancy</td>
<td>Mortality, procedure-specific morbidity, 5-year survival</td>
<td>Innominate vein repair was only indicated if both innominate veins were infiltrated or if the contralateral internal jugular had been ligated or resected previously. Recommends bovine pericardium as the conduit of choice for repair. Morbidity data are limited to stating that 23% of lung malignancies and 50% of mediastinal malignancies experience postoperative complications. Morbidity is not defined. No breakdown of LIV division/repair morbidity.</td>
<td></td>
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<tr>
<td>Agarwal et al. (2007), Semin Dial, USA [6]</td>
<td>Literature review</td>
<td></td>
<td>Demonstrates literature confirming the formation of collateral vessels in thrombosis. Symptoms resolve when circuit is no longer under pressure.</td>
<td>Review focuses on complications of dialysis access.</td>
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</table>
RESULTS

Okereke and Kesler [2] published a 19-year case series of 38 patients undergoing superior vena cava (SVC) resection and reconstruction with single-vein reconstruction. This series included both SVC–SVC reconstruction and right innominate vein (RIV)-to-SVC reconstruction, but absolute numbers were not provided for either. The paper states that the preferred technique is to ligate the LIV and allow collateral flow to drain the upper extremity and head. Only 2 (5%) patients developed graft occlusion and both were asymptomatic, having developed collaterals; no neurological complications were reported.

Jaus and Macchiarini [3], in 2012, published their experiences of SVC and innominate vein reconstructions using cryopreserved grafts over 10 years with a very limited number of patients. The paper stated that they routinely opted to replace both innominate veins where possible, but that they also had successful experience in RIV/SVC reconstruction without reconstruction of a ligated LIV. They did not report any figures for postoperative morbidity or mortality.

Leo et al. [4], in 2010, reported a single-centre case series of 72 consecutive SVC resections. The series highlighted 14 cases of innominate vein reconstruction, but did not further stratify these into right, left or both innominate vein reconstructions. Morbidity data were reported on prosthesis but not stratified further; however, univariate analysis did demonstrate an increased odd ratio of 5.6 (confidence interval 0.8–4.6) of SVC complications with innominate vein reconstruction. There was one reported case of neurological symptoms that was investigated and attributed to cerebral metastasis and not cerebral oedema.

Spaggiari et al. [5], in 2007, presented their large case series of 70 patients undergoing SVC resection and reconstruction for lung and mediastinal malignancy. As part of their centre’s practice, innominate veins are only reconstructed when both innominate veins are involved or there has been previous resection of ligation of the contralateral internal jugular vein. The series reports that if only one innominate trunk is involved, then it is removed without reconstruction. The study does not further specify how many of these cases were LIV trunks. Sixty-three patients in total underwent SVC

Table 1: (Continued)

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<tr>
<td>Shintani et al. (2005), J Thorac Cardiovasc Surg, Japan [8]</td>
<td>Case series (level 3)</td>
<td>Fifteen-year case series with 18 patients undergoing innominate vein replacement as part of the treatment for mediastinal malignancy</td>
<td>Patency  Low LIV patency (1 of 3) at average follow-up 9 months</td>
<td>Case series specifically looking at patency and occlusive symptoms in RIV and LIV repair The RIV repairs have a non-repaired LIV present</td>
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<tr>
<td>Kim et al. (2004), J Comput Assist Tomogr, South Korea [9]</td>
<td>Case series (level 3)</td>
<td>Case series of 10 patients demonstrating the collateral pathways in central venous obstruction</td>
<td>Access to aortic arch or mediastinal mass Division of LIV can safely facilitate access to aortic arch or mediastinal mass without long-term morbidity</td>
<td>Small numbers, does not indicate if patients are symptomatic</td>
</tr>
<tr>
<td>Sai Sudhakar et al. (2000), Ann Thorac Surg, USA [10]</td>
<td>Case series (level 3)</td>
<td>Three-year case series with 14 patients undergoing LIV division for aortic arch surgery or surgery for mediastinal malignancy</td>
<td>Access to aortic arch or mediastinal mass</td>
<td>This case-control series demonstrates that division of the LIV can be safely performed when necessary</td>
</tr>
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AV: arterio-venous; CT: computed tomography; LIV: left innominate vein; RAA: right atrial appendage; RIV: right innominate vein; SVC: superior vena cava.
reconstruction without innominate vein reconstruction. Postoperative complications are specified other than ‘pulmonary’. No neurological complications were reported.

Agarwal et al. [6] published a literature review of central vein stenosis in dialysis patients in 2007. Central venous catheterization is the largest cause of central vein obstruction, and the primary management of these sequelae is to relieve the obstruction with percutaneous transluminal angioplasty (PTA) with or without stents. Patency postintervention is recorded as being poor, but those large proportions of patients are asymptomatic despite central vein occlusion. Symptoms typically present once arteriovenous (AV) fistula formation has occurred for haemodialysis and tend to persist until the obstruction is treated with PTA or the access is ligated.

Salgado et al. [7], in 2007, presented a case series of four symptomatic central vein occlusions occurring only after ipsilateral dialysis access had been formed. This small series again demonstrates the presence of pre-existing but asymptomatic central vein obstruction that only becomes clinically apparent when AV access is created and the circuit is placed under pressure. In all cases where access is ligated the occlusive symptoms resolve, and in cases where the access is continually used, the patient experiences mild/moderate limb oedema.

Shintani et al. [8] presented 18 patients in total, 7 of whom, being postinnominate vein replacement, were left with a divided LIV. Of these, 2 of 7 (29%) had occlusive symptoms, in the presence of a patent RIV graft. The study does not recommend sole LIV grafting. No neurological complications were reported.

Kim et al. [9] demonstrate a series of cases demonstrating the venous collateral pathways of central vein obstruction. While they do not elaborate on the symptoms each patient experiences, if any, they do give clear anatomical confirmation that collateral pathways exist to allow drainage of venous blood.

Sai Sudhakar et al. [10], in 2000, reported a case series of LIV divisions as part of aortic arch and mediastinal surgery to allow superior access. They reported success in gaining superior access to the aortic arch and complete resection of mediastinal malignancy without the need for reconstruction. Postoperative morbidity was initially high, with all patients reporting upper limb oedema for 7–10 days that resolved with arm elevation. There were no reported incidences of stroke, and no neurological deficit was reported. One patient died of unrelated multiorgan failure after a long postoperative course.

**CLINICAL BOTTOM LINE**

Although LIV ligation seems safe on a low level of evidence, it should be a bail out procedure only if no other options are available in selected patients who are free from neurological deficits (central and peripheral), peripheral vascular disease and upper limb problems. Patients will initially have symptoms of central vein obstruction, but these will decrease with conservative management as collaterals form. Patients should be warned after the procedure regarding future complications, and the risks of other procedures reliant on central venous drainage, e.g. the creation of a left-sided AV fistula.

**Conflict of interest**: none declared.

**REFERENCES**


