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PII: S1522-2942(18)30084-9
DOI: 10.1053/j.optechstcvs.2018.06.005
Reference: YOTCT 448

To appear in: The End-to-end Journal

Received date: 15 August 2017
Accepted date: 20 June 2018

Please cite this article as: Dong-Seok Lee MD, Raja M. Flores MD, INVITED MANUSCRIPT: Operative Techniques in Thoracic and Cardiovascular Surgery, Management of NSCLC invading the superior vena cava, The End-to-end Journal (2018), doi: 10.1053/j.optechstcvs.2018.06.005

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INVITED MANUSCRIPT: Operative Techniques in Thoracic and Cardiovascular Surgery

Management of NSCLC invading the superior vena cava

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Conflicts of Interest: The author has no conflicts of interest to disclose.
ABSTRACT

Due to improvements in preoperative diagnosis and perioperative care, superior vena cava involvement in lung cancer is no longer considered an absolute contraindication to surgical resection. However, it continues to remain a challenge and requires a multidisciplinary approach. Preoperative work-up is essential to assess the true extent of disease. With careful patient selection and management at specialized centers, patients can achieve encouraging long-term outcomes.

KEY WORDS: Non-small cell lung cancer, Superior vena cava, Caval resection
INTRODUCTION

Surgical resection is the standard therapy for early stage non-small cell lung cancer (NSCLC) and it remains a vital component in the multidisciplinary treatment of locally advanced cancer. T4 lesions, those that invade mediastinal structures, remain a therapeutic challenge. Superior vena caval (SVC) involvement has historically been considered a contraindication to surgical resection with 5-year survival less than 10%. (1) However, advances in perioperative care have made surgery a viable tool in the treatment of patients with SVC involvement and more recent studies have exhibited improved long-term outcomes. (5,8,16)

When managing non-small cell lung cancers with SVC invasion, it is important to keep in mind that SVC involvement can be the result of direct tumor invasion or invasion of metastatic lymph nodes. Comprehensive preoperative evaluation is of vital importance. Assessment for surgical resection requires a concerted effort to rule out N2 or distant disease. This may require mediastinal evaluation. Pulmonary function testing is essential since resection may necessitate a pneumonectomy. Involvement of the left phrenic nerve is a contraindication to resection as the right phrenic nerve is often sacrificed with complete SVC resection. There is no role for urgent SVC resection in the setting of acute SVC syndrome.

Once surgical resection has been deemed acceptable, there are a few intraoperative issues to consider. Patients with chronic SVC syndrome have few hemodynamic sequelae from cross-
clamping due to collateralization of flow. These hemodynamic effects are further minimized with fluid expansion and vasoconstrictive agents. (3) Therefore, it is imperative to have large-bore intravenous access in the lower extremity during surgery in order to maintain volume during SVC clamping. Cerebral venous pressure monitoring is not required as SVC clamping for 45-60 minutes is usually well tolerated. Systemic heparinization does not need to be routinely administered and cardiopulmonary bypass is usually not necessary.
CLOSING, POSTOPERATIVE CARE

Postoperative morbidity and mortality have been reported as high as 40% and 14%, respectively. The most common complications are respiratory. Graft infection can occur as high as 7% but is exclusively due to pulmonary infectious complications such as empyema, pulmonary abscess, and bronchopleural fistula. Induction therapy imparts a statistically significant increased risk of postoperative morbidity. Pneumonectomy patients exhibit a trend towards increased risk of mortality over lobectomy patients but this does not reach statistical significance. (4)

Early graft thrombosis occurs within 1 month and can be as high as 11%. Late graft thrombosis has been reported as high as 30%. The risk of thrombosis may be the result of anatomical/technical issues, such as SVC stenosis in primary repairs or graft caliber, or functional issues, such as competitive flow from extensive collaterals or other grafts. Therefore, postoperative anticoagulation is usually given for 3 to 6 months after repair.

Median survival ranges from 8.5 months to 40.0 months and 5-year survival can reach up to 36.7%. Long-term outcomes improve with lesser extent of disease – one series reported 46.6% 5-year survival for N0/N1 disease versus 21.9% 5-year survival for N2/N3 disease. (16) Long-term outcomes also improve with a lesser extent of resection (lobectomy versus
pneumonectomy versus carinal pneumonectomy). (5) Induction therapy, although associated with increased perioperative morbidity, tends to increase disease-free survival. Improved survival was also noted in patients with primary tumor invasion versus metastatic mediastinal node invasion. (7) Resection in patients with SVC invasion from N2 disease, although associated with poorer long-term outcomes than those with direct tumor invasion, can be considered after induction therapy is given in carefully selected patients.

CONCLUSION

Due to improvements in preoperative diagnosis and perioperative care, SVC involvement in lung cancer is no longer considered an absolute contraindication to surgical resection. However, it continues to remain a challenge and requires a multidisciplinary approach. Preoperative work-up is particularly essential in order to assess the true extent of disease. With careful patient selection and management at specialized centers, patients can achieve encouraging long-term outcomes.
REFERENCES


Fig. 1. Hemi-clamshell thoracotomy, cervicosternotomy. Superior vena caval resections are often performed via a standard posterolateral thoracotomy through the fifth intercostal space. However, depending on the anatomy and surgeon comfort, other approaches are feasible alternatives. These include median sternotomy, hemi-clamshell thoracotomy, cervicosternotomy, or combined cervicotomy and thoracotomy.
Fig. 2. Tumor partially involving SVC. Extent of SVC involvement determines extent of resection and reconstruction. Those partially involving the SVC can be resected via tangential resection.
**Fig. 3. Partial cross-clamp.** When only a small portion of SVC is involved, the SVC can be partially occluded with a Satinsky cross clamp around the lesion for vascular control with subsequent en-bloc resection.
**Fig. 4. Primary suture repair.** Once en-bloc resection has been completed, primary repair with non-absorbable suture is performed with the cross-clamp in place. The decision to perform primary suture repair versus patch placement is made upon intraoperative evaluation. Primary repair is usually performed after tangential resection with minimal invasion such that the native cava is not significantly distorted. Patch is placed in more involved resections.
Fig. 5. Patch repair. If a more substantial portion of the SVC is involved such that primary repair would result in stenosis, patch repair with either autologous pericardium or prosthesis can be performed. The pericardium does not need to be treated prior to use as a patch. However, placement of the intrapericardial side intravascularly is essential. Prior to performing reconstruction, vascular control should be obtained by snaring or clamping the SVC proximal and distal to the tumor. The azygos may need to be clamped as well.
Fig. 6. Tumor largely involving SVC. If the tumor involves a significant portion of the SVC such that over 50% of the diameter requires resection, graft replacement with total SVC clamping for vascular control becomes necessary. Clamping the SVC above the azygos vein is preferred in order to preserve some blood flow to limit brain anoxia. However, if this is not possible, the SVC can be clamped for up to 60 minutes based on experimental animal models.
Fig. 7. **SVC graft replacement.** Complete SVC reconstruction can be performed with an in-situ interposition graft using a ringed polytetrafluoroethylene graft or tubularized pericardium with or without a caval shunt after resection.
Fig. 8. SVC bypass graft. For tumors involving the proximal SVC or right innominate vein, the SVC may be reconstructed by placing the graft between the left innominate vein and the right atrium. Only one innominate vein needs to be preserved.