

# Internal to External Jugular Vein Bypass Allowing for Simultaneous Bilateral Radical Neck Dissection

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**Objectives/Hypothesis:** The goal of the study was to determine the role of internal jugular vein (IJV) to external jugular vein (EJV) bypass grafting in the setting of bilateral radical neck dissection with IJV sacrifice.

**Study Design:** The study group consisted of eight patients who underwent bilateral radical neck dissection with IJV sacrifice. Demographic and oncologic parameters were defined for each patient, including age, gender, and pathology. Patients were monitored and evaluated for potential effects of increased intracranial pressure (ICP). Doppler ultrasonic evaluation was performed to assess patency of the site of anastomoses.

**Results:** In all, six patients underwent unilateral bypass grafting, whereas two patients underwent bilateral bypass grafts. Average age at time of surgery was 68.2 (range 56–71). Postoperatively, no sequelae of increased ICP were noted. Follow-up ultrasonic evaluation revealed patent vessels in all patients.

**Conclusion:** We presently report on the use of EJV-to-IJV bypass grafting for all patients undergoing bilateral radical neck dissection for extensive neck disease.

**Key Words:** Neck dissection, jugular vein, neck disease, radical neck dissection, head and neck cancer.

**Level of Evidence:** 4.

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## INTRODUCTION

Radical neck dissection in the surgical treatment of cervical lymph node malignancy was first described by Crile in 1905.<sup>1</sup> The enbloc cervical lymphadenectomy described by Crile included resection of the spinal accessory nerve, sternocleidomastoid muscle, and the internal jugular vein (IJV). Consideration for bilateral sacrifice of the IJV and its potential morbidity and mortality was anticipated in the first half of the nineteenth century. Several authors recognized the occurrence of cyanosis; facial edema; and on occasion, death after second ligation of the IJV during bilateral neck procedures.<sup>2,3</sup> In 1932, Leclerc and Roy were the first to recommend staged ligation of the IJVs at a 20-day interval.<sup>4</sup>

Bilateral sacrifice of IJVs is thought to disrupt cerebral venous outflow, leading to increased intracranial pressure (ICP), with subsequent complications including blindness, ophthalmoplegia, inappropriate secretion of antidiuretic hormone, facial edema, stroke, and death.<sup>5–11</sup> Although some authors believe simultaneous sacrifice of IJVs to carry low risk for morbidity and mortality, most authors advocate for a staged procedure at a

1-month interval to allow for development of collateral venous outflow.<sup>9,10,12</sup> However, staging neck dissections may still lead to increases in ICP as well as optic nerve edema.<sup>11</sup> Furthermore, staging procedures may also lead to treatment delay of up to 1 month in anticipation of a second resection. Therefore, some authors perform simultaneous resections in a single-staged procedure. To mitigate the potential effects of increased ICP, several intraoperative reconstructive techniques have been proposed to facilitate a single-staged approach.<sup>13–18</sup>

Takeichi et al. first described an external jugular vein (EJV)-to-IJV anastomosis following failed reconstruction utilizing autologous and synthetic graft material.<sup>13</sup> In 2000, Katsuno et al. further characterized several reconstructive options for IJV reconstruction, including an EJV-to-IJV bypass graft (type A reconstruction).<sup>19</sup> We presently propose the largest series to evaluate clinical outcomes following type A reconstruction of the IJV, utilizing a proximal IJV-to-EJV anastomosis as a primary bypass modality.

## MATERIALS AND METHODS

Following approval by our institutional review board, we performed a single surgeon retrospective case series and chart review of all patients undergoing simultaneous bilateral radical neck dissection with IJV sacrifice, with subsequent proximal IJV-to-EJV anastomoses between 1997 and 2014. Demographic and oncologic parameters were defined for each patient, including age, gender, and pathology. Patients were monitored and evaluated for potential effects and complications of increased ICP. Complications were defined as any changes in visual acuity, ophthalmoplegia, facial edema, cerebral vascular accidents, postoperative neurological deficits, syndrome of inappropriate diuretic hormone secretion, or death. Syndrome of inappropriate

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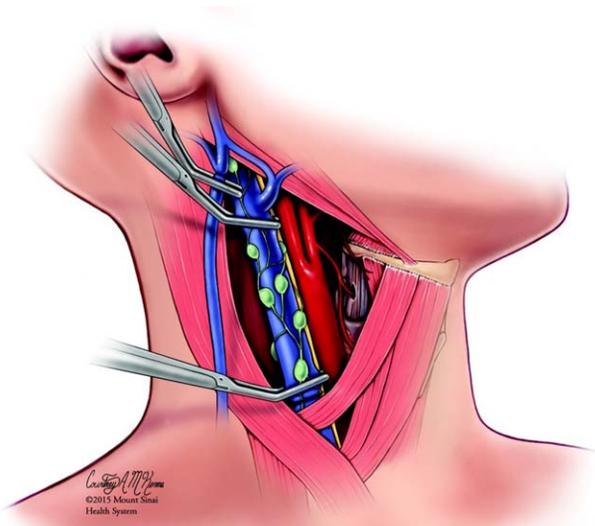


Fig. 1. Schematic demonstrating proximal ligation and preservation of the external jugular vein. Proximal and distal ligation of the internal jugular vein is demonstrated as part of the radical neck dissection specimen.

diuretic hormone was defined as hyponatremia beyond the immediate postoperative period, requiring strict intake and output monitoring as well as fluid restriction and endocrinology consultation. Furthermore, ophthalmologic consultation and evaluation was performed on all patients to evaluate for optic nerve changes. Patients were monitored as part of their routine postoperative care while inpatients. Patients were then followed up at 1 to 2 weeks postdischarge for further evaluation. Follow-up Doppler ultrasonic evaluation was performed at 1 to 2 months to assess patency of the bypass conduit.

### Surgical Methods (Figs. 1–3)

In each case, intraoperative evaluation of both IJVs was performed. In all cases, overt malignant involvement of bilateral IJV was noted, requiring sacrifice. During radical neck dissection, care was taken to identify and preserve the EJV. Following sacrifice of the IJV, the ipsilateral EJV was skeletonized along its entire course, from the posterior border of the sternocleidomastoid to the level of the mandible (Fig. 1). Once the EJV was mobilized, it subsequently could be advanced within 1 to 2 cm of the skull base to the site of IJV proximal ligation (Fig. 2). Under microscopic visualization, the EJV was anastomosed utilizing 9.0 nylon suture (Fig. 3). Postoperatively, anticoagulation did not exceed that of DVT prophylaxis, including sequential compression dressings and subcutaneous heparin.

### RESULTS

Between 1997 and 2014, a total of 2,040 neck dissections were performed. In all, eight patients were identified who underwent bilateral radical neck dissection with IJV sacrifice for advanced neck disease, with proximal IJV-to-EJV bypass grafting (Table I). Seven patients were identified to be male, with one female. All patients had squamous cell carcinoma with overt bilateral IJV

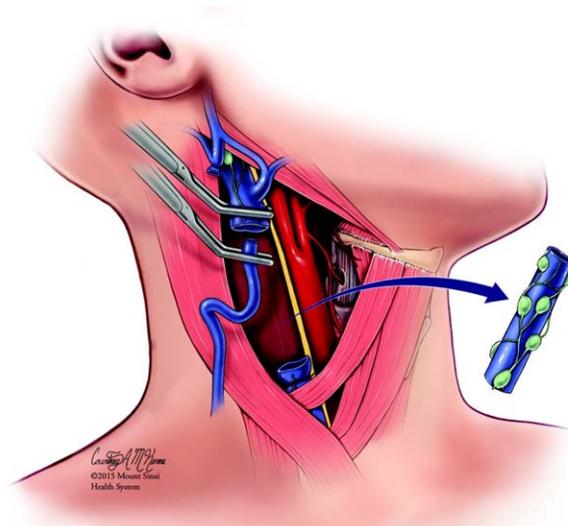


Fig. 2. Schematic demonstrating mobilization of external jugular vein toward the proximal internal jugular vein.

involvement, necessitating bilateral sacrifice. All but two patients had N3 nodal disease, with two patients having N2c disease. Average age at time of surgery was 68.2 years old (range 56–71). Uncertain of the potential complications of bilateral IJV sacrifice, the first two patients were treated with bilateral bypass grafting (Table II). However, follow-up postoperative ultrasonic evaluation revealed graft patency, and the transition was made to only single-sided bypass grafting. Subsequently, the remaining six patients underwent single-sided bypass

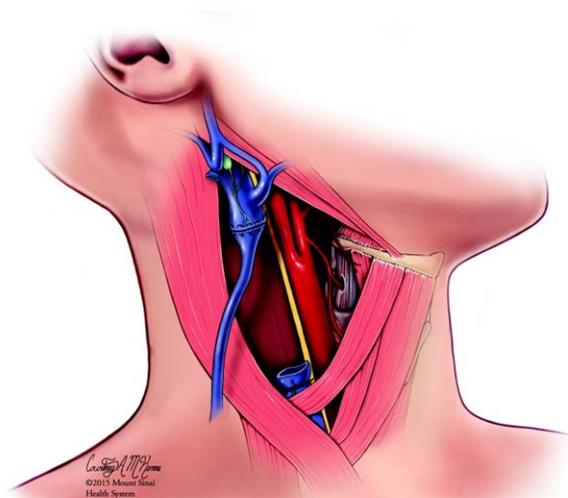


Fig. 3. Schematic demonstrating final anastomosis at the proximal internal jugular vein ligation site, with continuity of cerebral outflow.

TABLE I.  
Descriptive Table Demonstrating Patient Cohort Demographics and Oncological Parameters.

Patient	Age	Gender	Subsite	Nodal Stage	Final Stage	Previous Treatment
1	68	Male	Supraglottis	N3	IV	Chemo/EBRT
2	77	Male	Base of tongue	N2c	IV	EBRT
3	58	Female	Hypopharynx	N3	IV	Chemo/EBRT
4	81	Male	Oral tongue	N2c	IV	None
5	44	Male	Floor of mouth	N3	IV	None
6	63	Male	Nasal vestibule	N3	IV	None
7	72	Male	Larynx	N3	IV	None
8	69	Male	Oral tongue	N3	IV	EBRT

Chemo = chemotherapy; EBRT = external beam radiation therapy.

grafting. Postoperative ultrasound evaluation of the surgical anastomoses sites revealed patency in all patients at all sites (Fig. 4).

Postoperatively, no sequelae of increased ICP were noted, with normal ophthalmologic evaluation and absent evidence of optic nerve edema. No patients developed stroke, facial edema, visual complaints, or ophthalmoplegia. One patient died 8 months postoperatively due to distant metastases. A second patient died of an unrelated myocardial infarction 2 years postoperatively. All remaining patients are alive and free of disease at the most recent follow-up (range 18–84 months).

## DISCUSSION

Bilateral resection of IJVs, either in a single- or two-stage approach, disrupts cerebral outflow, increasing ICP.<sup>18,20,21</sup> Increase in ICP can consequently result in physiological changes that lead to systemic hypertension, facial edema, laryngeal edema with respiratory distress, ophthalmoplegia, blindness, and stroke.<sup>5–11</sup> These complications may arise during staged or simultaneous bilateral neck dissections.<sup>9,22–24</sup> The physiological consequences of bilateral IJV sacrifice are related to the venous drainage pathway of cerebral, facial, pharyngeal, and laryngeal venous outflow. The IJVs are the predominant cerebral outflow tracts, with 80% of the population having a right-sided dominant IJV.<sup>11,20,25</sup> Other outflow

tracts include pterygoid plexus, orbital plexus, and external vertebral plexus.<sup>11,25</sup> Following sacrifice of bilateral IJV, the predominant outflow is mediated through the external vertebral plexus.<sup>12</sup>

Increased rates of morbidity and mortality are observed in simultaneous procedures when compared to staged procedures.<sup>9,18</sup> The most common complication of bilateral sacrifice of IJV is facial edema, which is seen twice as often in single-staged procedures.<sup>9,18</sup> Razack et al. compared single-staged and two-staged approaches and found that two-stage complications occurred at rates of 3% to 30% as opposed to 5% to 63% in single-staged approaches.<sup>9</sup>

Several authors have reported on several reconstructive options of the IJV to ameliorate complications caused by an increase in ICP. Takeichi et al. utilized autogenous graft material and synthetic vascular prosthesis to reconstruct the IJV.<sup>13</sup> The reconstructed IJV, however, thrombosed, with subsequent salvage by EJv to proximal IJV anastomosis. In addition, several authors have also reported on spiral saphenous vein grafting in IJV reconstruction.<sup>14–16</sup> Leafstedt et al. reported on a series of three patients who underwent spiral saphenous vein grafting, without any complications of elevation in ICP or resultant facial edema.<sup>14</sup> They reported pregrafting pressures of 24 to 28 mmHg, followed by a decrease by half, following grafting. Comerota et al. reported on a series of 11 patients who underwent bilateral IJV sacrifice, either

TABLE II.  
Table Demonstrating the Resection and Reconstruction Details, Elevated Intracranial Pressure Complications, and Follow-up Imaging Results.

Patient	No. Bypass	Anastomosis	Reconstructive Flap	Recipient Vessels	ICP Complications	Doppler Ultrasound
1	Bilateral	End-to-end	PM	NA	None	Patent Bilaterally
2	Bilateral	End-to-end	Rectus	TCA/TCV	None	Patent Bilaterally
3	Unilateral	End-to-end	RFFF	TCA/TCV	None	Patent
4	Unilateral	End-to-end	Rectus	TCA/CVT	None	Patent
5	Unilateral	End-to-end	Fibula/PM	TCA/CVT	None	Patent
6	Unilateral	End-to-end	SCM	NA	None	Patent
7	Unilateral	End-to-end	SCM	NA	None	Patent
8	Unilateral	End-to-end	PM	NA	None	Patent

CVT = cephalic vein transposition; ICP = intracranial pressure; PM = pectoralis major; RFFF = radial forearm free flap; SCM = sternocleidomastoid muscle; TCA = transverse cervical artery; TCV = transverse cervical vein.

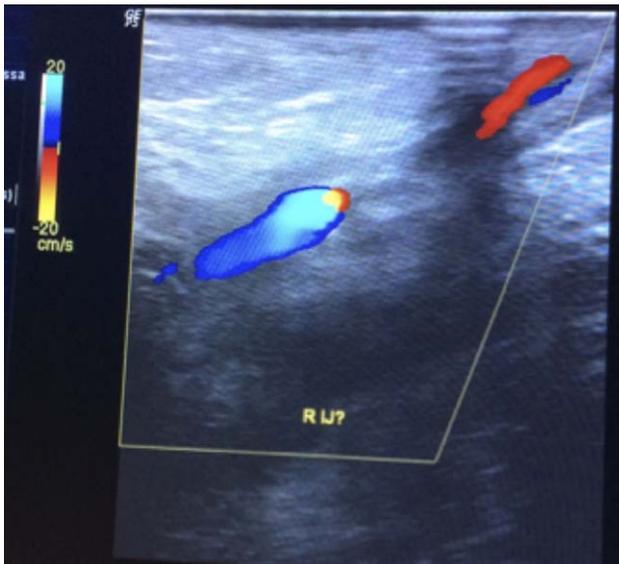


Fig. 4. Doppler ultrasonic evaluation of right internal jugular vein to right external jugular vein anastomoses, demonstrating venous flow and effective patency.

staged or simultaneously.<sup>14</sup> Only two patients underwent simultaneous bilateral neck dissection resection, both undergoing spiral saphenous vein reconstruction. One patient died on postoperative day 5 of myocardial infarction, and the second patient exhibited no complications of ICP increase, with maintained patency at 14 months postoperatively.<sup>15</sup> Citrin et al. further demonstrated the use of spiral saphenous vein reconstruction in six patients, with only mild facial edema reported as a postoperative complication.<sup>16</sup>

In 2000, Katsuno et al. characterized three techniques utilized in the reconstruction of the IJV following bilateral sacrifice (type A, B, and C), along with a proposed treatment algorithm.<sup>19</sup> Type A reconstruction involved IJV to EJV anastomosis if EJV length was sufficient to reach the upper IJV stump. Type B reconstruction involved use of the greater saphenous vein as an interposition graft between the two IJV stumps. Finally, type C reconstruction involved use of the greater saphenous vein as an interposition graft between the upper IJV stump, and a lower EJV stump to be used during the presence of inferior jugular node metastases. Katsuno et al. performed the three different reconstructions in four patients but did not make mention of clinical outcomes.<sup>19</sup> Kamizono et al. documented the use of type A reconstruction in a patient who received staged bilateral neck dissections, with reconstruction performed at the initial surgery with no complicating sequelae.<sup>26</sup> They further characterized a novel type K reconstruction utilizing an end-to-end anastomosis between the IJV and the anterior jugular vein.

Within our study, we report the largest clinical series assessing the clinical outcomes involved in type A IJV reconstructions. Although the study is limited in its low sample size, it was evident that no complications of ICP or its sequela were observed. Furthermore, no

postoperative facial edema, airway obstruction related to laryngeal edema, visual changes, optic nerve changes, or stroke developed.

Limitations exist that may impair type A reconstructions when performing bilateral radical neck dissections. The EJV may be congenitally absent or missing due to previous surgeries, precluding type A reconstructions. In such circumstances, a type B reconstruction with a greater saphenous vein interposition graft may be performed. Furthermore, the presence of significant superior level II disease may necessitate extensive superior resection of the IJV, limiting the size of the superior IJV stump. This may preclude the EJV from reaching the superior stump. In such circumstances, a type B reconstruction would be recommended. Furthermore, division of the digastric and stylohyoid musculature may allow for exposure of the IJV to the level skull base, better improving exposure and facilitating different reconstructive options.<sup>27</sup>

Other limitations that should be accounted for are EJV and IJV size mismatch, making anastomosis challenging. If significant size mismatch occurs, an end-to-side anastomosis may be performed. However, within our study we found that all reconstructions could be performed with an end-to-end anastomosis (Table II).

The most common complication of bilateral IJV sacrifice is facial and laryngeal edema as opposed to complications related to cranial outflow obstruction and increases in ICP.<sup>9,18</sup> Therefore, some authors recommend preferential preservation of facial and laryngeal venous outflow by preservation of the EJV, precluding it from our proposed method of reconstruction.<sup>28</sup> Da Rocha et al. documented two cases for whom preservation of the external jugular venous drainage pathways resulted in diminished postoperative complications associated with bilateral IJV sacrifice, predominantly facial and laryngeal edema.<sup>28</sup> However, in their first case, bilateral resections was performed in a staged fashion 3 months apart, allowing for collateral circulation to develop. In their second case, they preserved the thyrolingualfacial trunk to the superior IJV stump during bilateral resections, preserving intracranial venous outflow. In both cases, no conclusions can be made with regard to the utility of the preservation of the EJV as a primary option in ameliorating the effects of bilateral IJV resection. Furthermore, the IJV receives venous outflow from the basilar plexus, pterygoid plexus, and pharyngeal plexus, as well as the occipital plexus.<sup>20</sup> Therefore, preservation of the IJV drainage pathway facilitates outflow from facial and pharyngeal sites in addition to cranial sites, contributing to diminished complications of facial and laryngeal edema.

## CONCLUSION

Bilateral radical neck dissection is often performed in the setting of advanced head and neck cancer. Several authors have reported on the reconstruction of at least one IJV. We describe a bypass technique, utilizing the EJV as a recipient vessel to the proximal IJV stump (type A reconstruction). This technique is an option

during simultaneous bilateral neck dissection to ameliorate the effects of venous outflow obstruction.

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