External Carotid Artery Ligation an Elective Procedure of Controlling Inadvertent Bleeding from Oral Malignancies: Experience at Dhaka Dental College and Hospital

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Introduction

In maxillofacial region an advanced oral malignancy usually presents with huge neck mass. Sometimes this malignant neck mass strongly adherent to the underlying structures and often vascular encasement or invasion of the major vessels specially internal jugular vein (IJV) [1]. Hence during extensive oncological procedure meticulous dissection is merely possible and bleeding cannot be arrested by simple clamping or ligation of the vessels. Therefore a common potential complication is massive per- and/or postoperative bleeding and the subsequent risk for massive blood transfusion [2]. Further a maxillary lesion may extend into the infratemporal fossa which is another complicated section of skull, where pterygoid muscles (Figure 2b) are commonly involved and trismus is a common feature [3]. These conditions frequently require extensive cervical operative procedures, exploration of infratemporal space and resection of masticatory muscles with compulsory ligation and sacrifice of vascular elements to get a resectable cancer margin or to control excessive bleeding [4].

The carotid artery is a vascular vessel system which provides blood supply to the head, neck and brain. Originally ligation of the carotid artery was used as an emergency measure to control severe bleeding following lacerations of the great vessels of the head and neck. But due to the collateral circulation through the opposite external carotid artery (ECA) and backflow of blood distal to carotid from the internal carotid arteries (ICA) by way of circle of Willis system, this procedure became ineffective for the control of bleeding and consequently discarded due to high mortality and morbidity of patients [5,6]. Now a days sacrifice of vascular elements like ECA ligation is safely performed

Abstract

Background: When an intraoral malignancy extends into the infratemporal space with pterygoid muscle involvement causing trismus or a huge neck mass with encasement or invasion to great vessels specially internal jugular vein, then the conditions frequently required extensive surgical procedures with compulsory ligation and sacrifice of vascular elements to get a resectable tumour margin or to control excessive bleeding.

Introduction: A very embarrassing and frequently dangerous complication during or after maxillofacial surgical procedure is bleeding. This can be avoided in most of the cases by careful preoperative evaluation of the patient, better anatomical knowledge and careful dissection during surgery. But in advanced malignancy cases when meticulous dissection is nearly impossible and bleeding cannot be arrested by simple clamping or ligation of vessels then ipsilateral external carotid artery (ECA) ligation would be a better option to control uncontrolled bleeding. This study was aimed to emphasize clinical significance from different perspective.

Material and Methods: ECA ligation was done prophylactically during neck dissection as a part of the operative procedure at the level just above or below lingual artery.

Results: A successful treatment of 14 cases were done without any significant complications.

Conclusion: Ipsilateral ECA ligation either prophylactically or an emergency cases is a life-saving and simple procedure with limited morbidity.

Keywords: Advanced malignancy, ECA ligation, Maxillofacial region, Neck mass, Oncologic emergency.

Introduction

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with no ischaemic consequences to the tissues in the head and neck region and often undertaken to cut the blood supply of the hypervascular tumours, in some haemorrhagic lesions and injuries in maxillofacial region [5,7]. But it is well documented that ipsilateral ligation of the ECA is not sufficient for the control of bleeding and creation of blood free operative field. Therefore bilateral ECA ligation is occasionally required. Further in addition to the ECA ligation to control bleeding may necessitate a good surge seal pack, which is more common in haemorrhagic lesions of the maxilla than that of the mandible [5] (Table 1).

Like other great vessels of the neck ECA and its branches have numerous variations. This variations pose a dangerous situation during various neck surgeries. The level of termination of the common carotid artery (CCA) and the origin of the branches of the ECA were found to be variable significantly. As these vessels show great variability and hence, a better anatomical knowledge about the vessels and their variations is essential in head and neck surgeries [8] (Figure 4).

Further we know the blood supply of the face could be: I. Direct from the ECA. II. Indirect from the ECA in the opposite side through anastomosis. III. Backflow from the ICA in the same side through the ophthalmic artery [5]. Under normal circumstances the blood flows through the internal carotid arteries (ICA) directed intracranially and through the collaterals the blood flows from the intracranial vessels to the branches of the external carotid arteries (ECA). Similarly, ocular blood supply is derived predominantly from the ICA via the ophthalmic artery. Thus, normally the ECA do not contribute significantly to intracranial or ocular blood flow [9]. The anastomosis between the middle meningeal artery (a branch from the maxillary artery) and the ophthalmic artery is a well described anatomic feature. In rare cases, the main contribution to the ophthalmic circulation is from the middle meningeal artery. This variation in origin of the ophthalmic artery can result in catastrophic consequences following occlusion of the external carotid artery [7] (Figure 5c and 5d).

To combat most of the serious complications regarding haemostasis, resectable cancer margin and as well as major blood vessel involvement can be assessed preoperatively with appropriate imaging: like contrast - enhanced CT, MRI, USG, Doppler or conventional angiography, magnetic resonance angiography [10]. During surgery the amount of blood loss will depends upon the vascularity of the area, duration of surgery, skillness of surgeon and overall patient’s coagulation profile [11].
Table 1: Outcome results of ECA ligation.

<table>
<thead>
<tr>
<th>Sl</th>
<th>Age (yrs)</th>
<th>Sex</th>
<th>Diagnosis</th>
<th>Neck mass with adhesion or invasion to IJV(clinically detected and/or by imaging)</th>
<th>Site of ECA ligation</th>
<th>Immediate post operative complaint (related to ECA ligation)</th>
<th>Recurrence</th>
<th>Radiotherapy/Chemotherapy</th>
<th>Follow-up (F/U) result up to two-four years</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>45</td>
<td>M</td>
<td>SCC/T4aN1M0</td>
<td>Yes</td>
<td>Right</td>
<td>-</td>
<td>Absent</td>
<td>-</td>
<td>Alive, no complication</td>
</tr>
<tr>
<td>2</td>
<td>55</td>
<td>M</td>
<td>SCC/T4N2aN0</td>
<td>Yes</td>
<td>Left</td>
<td>Headache</td>
<td>Present</td>
<td>Present</td>
<td>RT</td>
</tr>
<tr>
<td>3</td>
<td>57</td>
<td>M</td>
<td>SCC/T4N1M0</td>
<td>Yes</td>
<td>Right</td>
<td>-</td>
<td>Present</td>
<td>Present</td>
<td>RT Death after one year</td>
</tr>
<tr>
<td>4</td>
<td>40</td>
<td>M</td>
<td>ACC/T4NOM0</td>
<td>-</td>
<td>Left</td>
<td>-</td>
<td>Absent</td>
<td>None</td>
<td>Alive, no complication</td>
</tr>
<tr>
<td>5</td>
<td>43</td>
<td>M</td>
<td>OS/T3N0M0</td>
<td>-</td>
<td>Right</td>
<td>-</td>
<td>Absent</td>
<td>CT</td>
<td>Alive, no complication</td>
</tr>
<tr>
<td>6</td>
<td>65</td>
<td>F</td>
<td>SCC/T4N1M0</td>
<td>Yes</td>
<td>Right</td>
<td>Headache</td>
<td>Absent</td>
<td>-</td>
<td>RT Alive, no complication</td>
</tr>
<tr>
<td>7</td>
<td>51</td>
<td>F</td>
<td>SCC/T4NOMO</td>
<td>-</td>
<td>Yes Left</td>
<td>-</td>
<td>Absent</td>
<td>-</td>
<td>RT Alive, no complication</td>
</tr>
<tr>
<td>8</td>
<td>60</td>
<td>M</td>
<td>SCC/T4NOM0</td>
<td>Yes</td>
<td>Right</td>
<td>-</td>
<td>Absent</td>
<td>-</td>
<td>RT Alive, no complication</td>
</tr>
<tr>
<td>9</td>
<td>55</td>
<td>F</td>
<td>SCC/T4N2aM0</td>
<td>-</td>
<td>Left</td>
<td>-</td>
<td>Absent</td>
<td>Present</td>
<td>CT &amp; RT Recurrence after 22 months</td>
</tr>
<tr>
<td>10</td>
<td>63</td>
<td>M</td>
<td>SCC/T4N2aM0</td>
<td>Yes</td>
<td>Left</td>
<td>Raised Blood Pressure</td>
<td>Absent</td>
<td>-</td>
<td>RT &amp; CT Alive, no complication</td>
</tr>
<tr>
<td>11</td>
<td>58</td>
<td>M</td>
<td>SCC/T4NOM0</td>
<td>Yes</td>
<td>Left</td>
<td>-</td>
<td>Absent</td>
<td>Present</td>
<td>None Recurrence at two years of F/U</td>
</tr>
<tr>
<td>12</td>
<td>52</td>
<td>M</td>
<td>SCC/T3N1M0</td>
<td>-</td>
<td>Left</td>
<td>-</td>
<td>Absent</td>
<td>-</td>
<td>RT Alive, no complication</td>
</tr>
<tr>
<td>13</td>
<td>56</td>
<td>F</td>
<td>SCC/T4N2bM0</td>
<td>Yes</td>
<td>Right</td>
<td>-</td>
<td>Absent</td>
<td>Present</td>
<td>None Recurrence after 9 months</td>
</tr>
<tr>
<td>14</td>
<td>49</td>
<td>M</td>
<td>SCC/T4N1M0</td>
<td>-</td>
<td>Left</td>
<td>-</td>
<td>Absent</td>
<td>-</td>
<td>Alive, no complication</td>
</tr>
</tbody>
</table>

The prevention, the control and the management of bleeding are all equally important for the surgeon and need a constant monitoring.

Aetiology of excessive bleeding in maxillofacial region

The common causes of excessive surgical bleeding can be outlined as follows [5,11]:

1) Increased vascularity of the pathological tissue; some pathological lesions like Giant cell tumour, Aneurismal bone cyst massively bleeds till they are completely excised. Further advanced oral malignancy cases with huge metastatic mass or lump of lymph nodes when either adherent or invaded to great vessels may bleed massively either tearing of major vessel or piece meal removal of pathological tissues.

2) Anatomical vascular anomalies like peripheral or soft tissue haemangioma, central either maxillary or mandibular haemangioma pose problems of excessive bleeding because these are away from any fixed landmarks and such vessels normally get severed or cut during dissection as well as retraction.

3) Hypertension or rise in blood pressure during major surgery makes not only the surgery difficult but also puts a serious problem of excessive blood loss. This is more commonly encountered in cases when surgery is attempted under local anaesthesia and that too without administering proper premedication to the patient.

4) Deficient clotting factors in patients like haemophilia or liver dysfunction can present with excessive bleeding on account of disturbances in the coagulation mechanism.

Material and Methods

This hospital based prospective study was done in maxillofacial surgery unit of Dhaka Dental College and Hospital, Dhaka, Bangladesh. All malignancy cases of maxillofacial region in advanced resectable stage with huge neck extention or malignancy extends into the infratemporal fossa which may require emergency control of excessive bleeding was included in this study. There were nine males and six females, patients age ranges from 40-65 years with no cardiac abnormality or history of hypertension. Their coagulation profiles were within normal limits. Study period was June’2010 to June’2016.

Proper evaluation of the patients were done which includes Contrast - Enhanced Computed Tomography, Doppler Ultra sonogram to isolate the advanced oral malignancy cases with encasement and possibility of invasion of great vessels (Figure 3a and 3b) and to see any rare variation of ECA endangering vital organs. Preoperative cardiac risk was assessed and cardiac investigations were undertaken as appropriate. All dissections were performed by the same investigator. Ipsilateral ECA ligation was done prophylactically as a part of the operative procedure to get a resect-
able tumour margin and neck dissection. Tracheostomy was not recommended in all patients except in trismus cases. Prior to initiation of arterial occlusion, all patients were given a therapeutic dose of heparin (100 units /kg body weight) [7,9] and patients were continued on Aspirin (antiplatelet therapy - 325 mg daily the best antiplatelet treatment for vascular risk groups) [12] was done in the immediate postoperative period [7]. Intraoperative Duplex Scanning or Intraoperative completion arteriography was not performed.

In emergency cases, the operations were done only without any preoperative definitive procedures, after taking the verbal consent from the attendant or guardian and depending on the relevant information from the history, physical examination record and investigation findings.

All cases were followed up clinically and with Duplex Ultrasound Imaging at regular intervals and as necessary when a clinical symptom developed. Duplex Ultrasound Imaging's were used to monitor ischaemic consequences to the tissues of the head and neck region and to see the patency and flow characteristics of blood in ICA, OCA and ECA and was performed at six weeks following surgery, and then at three monthly intervals for one year and six monthly intervals for up to two years. Then total duration of follow up ranged from 24 to 48 months (mean duration- 36 months).

Proper clinical evaluation was done with particular attention on major vascular risk factors like; hypertension, diabetes, hyperlipidaemia [12]. Any postoperative cerebrovascular, neurological deficit, morbidity and mortality related to external carotid artery ligation procedures were taken under consideration. The following clinical indices or parameters were considered for each case for the efficacy of the procedures in the form of control of bleeding and safety of the patients.

**Clinical examinations**

- **Cerebral complication** [7,9,13]
  a. Stroke
  b. Transient ischaemic attack
  c. Intracerebral haemorrhage
  d. Thromboembolic event
  e. Hemiplegia
  f. Monoplegia
  g. Coma
  h. Death

- **Cardiac complication**
  a. Cardiac arrest
  b. Myocardial infarction [9]
- **Neurological complication** [7,9]
  Hypoesthesia/ Anaesthesia of any specific nerve distribution
  e.g hypoglossal nerve; usually manifested as dysarthria
  - **Complication due to vascular ischaemia** [7]
    a. Ophthalmoplegia
    b. Blindness
    c. Claudication on mastication [14]
    d. Persistent dental pain
    e. Healing disturbance

**Surgical procedure**

ECA ligation was done as an adjunctive procedure following neck dissection. At first IJV was identified and retracted posteriorly, the common carotid was visualized lying medial to the IJV. Then ECA was positively identified by locating two of its branches [15]. Manipulation of the carotid body at this point might lead to cardiac dysrhythmia and was minimized by giving few drops of 2% Lignocaine over it. Branches of the external carotid artery (Figure 5a and 5b) remains immediately deep to the hypoglossal nerve and in close proximity to ranine veins. During dissection of the hypoglossal nerve and division of the veins, care must be taken to avoid injury to these vessels that can result in later peroperative bleeding [16]. Therefore after careful dissection, ligature was passed selectively just above or below the lingual artery as a temporary or permanent measure to arrest uncontrolled peroperative or postoperative bleeding [15].

**Figure 3:** (a) Showing aggressive intraoral malignancy (b) CT Scan showing lymph node is attached to the great vessels.
Diagnoses included

Squamous cell carcinoma of left sided buccal mucosa opposite lower incisors to 3rd molar region extending upto floor of the mouth - Two cases

Primary squamous cell carcinoma in the retromolar trigone - Three cases

Adenoid cystic carcinoma (ACC) of maxillary sinus origin crossing midline of palate - One case (Figure 2a)

Squamous cell carcinoma of buccal mucosa extending right sided lower lip commissure to 3rd molar region - One case

Endophytic lesion (SCC) of mandibular alveolar mucosa opposite premolar to molar region - One case

SCC of lateral border of tongue crossing midline - One case

Osteosarcoma (OS) of maxilla - One case

Recurrent lesion (SCC) - extending from left sided buccal vestibule to the floor of the mouth then reaches up to maxillary retromolar trigone - Two cases

SCC - Lesion involving both maxilla and mandible - Three cases

(Most of them present with huge neck mass (Figure 1a and b) with adhesion or involvement of jugular vein).

Results

External carotid artery (ECA) ligation in advanced oral malignancy cases is a life-saving and simple procedure with limited morbidity. The study was conducted on different ages and sex groups. Mean age was 53.5 years. Bleeding following external carotid ligation in ipsilateral side stopped in all the patients immediately except one case of rebleeding which was omitted from our data. This patient was needed to reopen in immediate postoperative period for active bleeding through the drain tube. Hence temporary ligation of contralateral ECA ligation was required to control severe bleeding. Then after few days the patient had gone to another centre and refused to be included in our study due to financial constraint though he had no cardiac, cerebral or vascular complications in postoperative period.

After ECA ligation there was no significant postoperative complication except a mild headache in two patients and a raised blood pressure of a single patient without any gross abnormality, which was managed with fluid restriction and diuretics. No patient had any neurologic deficit postoperatively. As one patient was omitted from the study so out of fourteen, ten patients still alive and well after two years of follow-up except a single patient who died after one year due to recurrence and other three showed signs of recurrence.

Discussion

Report in the literature have always clearly defined the indication for external carotid artery (ECA) ligation. There are many studies conducted on external carotid artery (ECA) ligation [5,14,17], which is very important with regards to localization of the neighbouring structures and supplying area. This study was aimed to emphasize clinical significance from different perspective. Neck mass which is attached to the underlying vital structures or lesions extended into the infratemporal space with pterygoid muscle involvement would be fatal if they are not prepared and managed properly [4]. Severely haemorrhagic cases when meticulous dissection is merely impossible and bleeding cannot be arrested by simple clamping or ligation of vessels and may have chance of tearing of large vessels, ECA ligation would be a better option to control uncontrolled bleeding. Though sometimes a good surge seal pack specially in maxilla is necessary to control both the collateral circulation and back flow from the internal carotid artery [5].

The variation of ophthalmic artery, which originates from middle meningeal artery rather than ICA, enters the orbit through superior orbital fissure instead of optic canal can be easily diagnosed by magnetic resonance angiographies.

However this type of investigation was not done in our study due to financial constraint. Notably ophthalmic artery has a rich anastomotic network that acts protectively in case of occlusion. In the absence of systemic vascular disease vision remains in 90% of cases of acute proximal occlusion of ophthalmic arteries [18]. Though rare and not happened in our patients, the middle meningeal artery branch of maxillary division of ECA may be the main feeding vessel of eyeball. Although the loss of vision in one eye is not less important than the problems associated with unexpected uncontrollable intraoperative bleeding therefore cannot be taken lightly. Ocular ischaemic symptoms are usually common in bilateral ECA ligation cases. But it can also be exacerbated after ipsilateral external carotid ligation in the setting of pre-existing contralateral occlusion [7]. So before ligation of ECA we should investigate preoperatively with appropriate imaging to confirm the rarity or either should take consent of risk of vision impairment.

Further literature review claims there was possibility of immediate intravascular thrombosis followed by either embolic phenomena or direct propagation of thrombus. Either of the later complications will result in interruption of the cerebral circulation and consequent brain damage [7]. But there was no postoperative thromboembolic events regarding ipsilateral ECA ligation otherwise a mild or simple headache complaints of two patients.
Although preoperative selective angiograms to map out the vascularity and the true extent of the tumours of the head - neck and face region was not done in all cases, bleeding following ECA ligation in all the patients immediately stopped except one case of rebleeding where temporary ligation of ECA in contralateral side also required.

Good knowledge on neighbouring relations is not only enough for ensuring protection during the surgery. There are many studies for determining safe surgical methods to remove tumour. But good surgical technique with minimum healthy tissue damage still has a role to play. Finally in conclusion this prospective study was done in a small proportion of patients though this occlusion was nearly total asymptomatic like other studies [5,17].

**Conclusion**

Prophylactic ipsilateral ECA ligation is an effective surgical procedure to control most of the very embarrassing and frequently dangerous maxillofacial bleeding specially in resectable advanced malignancy cases. As well, a successful management is only possible with proper preoperative knowledge of extent of lesion with vascularity, dear conception about the vessels and their variations.

**Foot note:** All cases were followed up clinically and with Duplex Ultrasound Imaging at regular intervals and as necessary when a clinical symptom developed for upto two- four years.

**References**


