

# Penetrating Carotid Artery Injuries

Abdul Salam Y Taha

**ABSTRACT:****BACKGROUND:**

Penetrating carotid artery injuries (PCAI) in civil time are infrequent, yet they present significant diagnostic and therapeutic challenges and can be associated with significant morbidity and mortality. Proper resuscitation and urgent exploration is necessary for actively bleeding patients.

**OBJECTIVE:**

The aim of this paper is to present our humble experience in management of such injuries with literature review.

**PATIENTS AND METHODS:**

Herein, we present 5 cases of penetrating carotid artery injuries managed in Sulaimania and Basrah from January 1996 to 30<sup>th</sup> of November 2009.

**RESULTS:**

All patients were young males. Three injuries were located in zone III and 2 in zone II. Four patients presented hours to days after the injury while the fifth presented after few months. Angiography was done in 2 patients with a false aneurysm of internal carotid artery (ICA). All 3 patients with ICA injuries were managed by ligation due to profuse bleeding and poor access. The 2 patients with common carotid artery (CCA) injuries in zone II had an end to end repair. All 5 patients have survived without significant neurological deficits.

**CONCLUSION:**

Penetrating carotid artery injuries in zone II usually do not require preoperative angiography unlike those in zone I and III. Repair is always desired. It is a straightforward operation for zone II injuries but really challenging for zone III due to poor access. Certain zone III injuries may be just observed or treated by endovascular stenting when facilities permit. Ligation of ICA carries a high risk of stroke; however, young people with well developed circle of Willis may tolerate it well.

**KEY WORDS:** carotid artery, penetrating injury, neurological deficit.

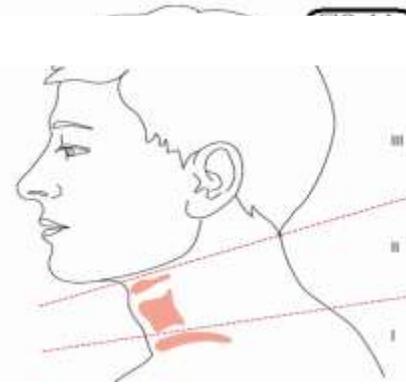
**INTRODUCTION:**

Penetrating carotid artery injuries in civil time are infrequent.<sup>(1)</sup> However; they present significant diagnostic and therapeutic challenges. They can be associated with significant morbidity and mortality<sup>(2,3)</sup>. The injuries are best studied in relation to the well known three anatomical zones of the neck (Fig 1 A)<sup>(3,4)</sup> Proper resuscitation and urgent exploration is necessary for actively bleeding patients. Zone II injuries usually do not require angiography prior to surgery unlike those encountered in zone I and III. Injuries in Zone III are challenging due to poor surgical access.

Though repair is always desired, some injuries are irreparable. Ligation may be life saving when bleeding is profuse and uncontrollable.<sup>(5)</sup> Ligation of ICA carries a high risk of stroke; however, young people with well developed circle of Willis may tolerate it well.<sup>(1-3)</sup> Herein, we present 5 cases of penetrating carotid artery injuries managed in Sulaimania and Basrah from July 1996 to 30<sup>th</sup> of November 2009. The aim of this paper is to present our humble experience in management of such injuries with literature review.

---

Department of Thoracic and Cardiovascular  
Surgery University of Sulaimania/ Faculty of  
Medical Sciences/ School of Medicine.



**Case 1:** An 18 years old male admitted to the Thoracic and Cardiovascular Surgical Department of Basrah Teaching Hospital in July 1996 with severe arterial bleeding from a stab wound to zone II of right neck. The patient was urgently explored via an oblique neck incision (Fig 1 B). Proximal and distal control of CCA was achieved. End to end repair was done. The patient had recovered without a central neurological deficit but he had mild hoarseness of voice mostly due to recurrent laryngeal nerve injury.

**Case 2:** A 20 years old man brought to the Emergency and Accident Department of

Sulaimania Teaching Hospital in September 2008 with severe arterial bleeding from a bullet wound in left side of the neck. He was in a state of shock. Local examination revealed an entrance of a bullet in Zone II of left neck with profuse bleeding. The bleeding was temporarily controlled by manual pressure. The patient was resuscitated and urgently taken to the operation theatre. An oblique incision was made along left sternocleidomastoid (SCM) muscle. Proximal and distal control of L CCA was achieved followed by an end to end repair (Fig 2-A and B). The bullet was extracted after exploring its tract. The patient had smoothly recovered but was lost for follow up later on.



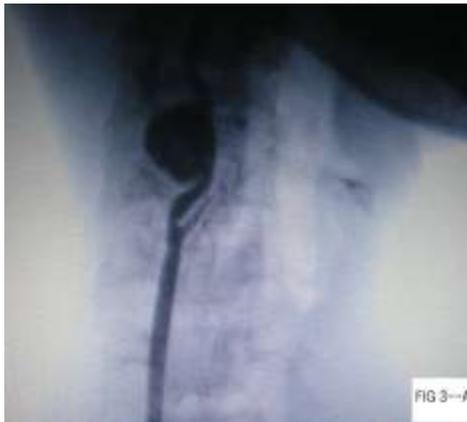
**Case 3:** A 21 years old male patient presented to ED of Sulaimania Teaching Hospital in January 2006 with multiple shell injuries to different parts of his body following a terrorist attack and an explosion. The neck examination revealed multiple tiny entrances of shells but no significant haematoma. Plain X-ray of the neck was normal. On repeat examination the next day, a faint bruit was heard over the right side of the neck. Doppler

ultrasonography was normal. The patient was managed conservatively as other body injuries were more severe and took the attention of treating physicians. Angiography could not be arranged immediately as it was not available in the city but done few months later elsewhere. It showed an aneurysm of R ICA just above the bifurcation (Fig 3-A). The patient was advised for surgery but he was hesitant. He was then lost for follow up till

April 2006 when he presented with a huge pulsating swelling in right neck with erosion of overlying skin indicating an impending rupture. He was admitted to our unit and prepared for emergency operation at night.

Under general anaesthesia (GA), a segment of right great saphenous vein was harvested from upper thigh to be used as a graft when necessary. Then the right neck was explored via an oblique incision parallel to anterior border of SCM muscle. Dense adhesions were encountered. The internal jugular vein was isolated and was intact. The CCA was isolated and encircled by a tape. The proximal

ICA was similarly isolated. Then the cavity of the aneurysm was entered. Clots were removed as well as pieces of wood which were surprisingly found there (Fig 3-B). A big tear was seen in ICA extending to the base of the skull with profuse back bleeding. We attempted to repair the tear first but we failed due to poor access and severe back bleeding. Therefore, we decided to ligate the distal ICA by transfixing silk suture. Haemostasis was secured. A closed drain was placed. The wound was closed in layers. The patient recovered smoothly from GA with no neurological deficit. The postoperative course was uneventful. We discharged him home 5 days after operation. He was again lost for follow up.



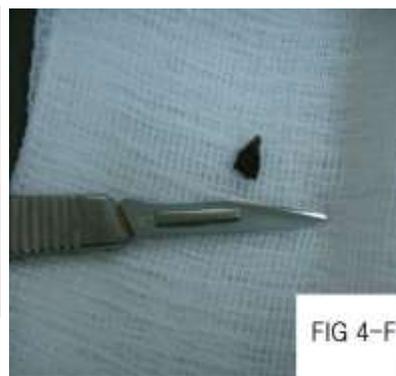
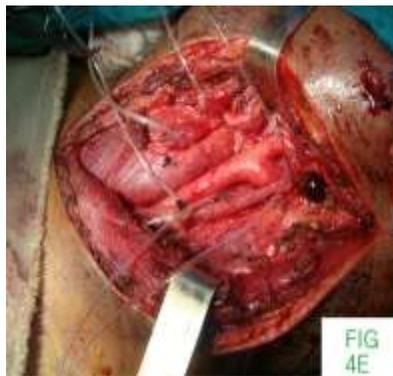
**Case 4:** A 30 years old policeman sustained a shell injury to his left neck following a bomb explosion in Kirkuk on 30<sup>th</sup> of November 2009. He arrived to our unit 24 hours after the injury. He had a pulsating hematoma of left parotid region with a small wound just above the angle of left mandible (Fig 4-A). There was no thrill or bruit. The left carotid pulse was normal. The tongue deviated to the left when he replied to our request to put his

tongue out (Fig 4-B). Plain X-ray of the neck revealed multiple small shells at C1-C2 intervertebral disc with enlargement of retropharyngeal space (Fig 4 C). He had no active bleeding and was haemodynamically stable. He was in pain but without respiratory compromise. Selective left carotid angiography revealed a small false aneurysm of left ICA just below the skull base (Fig 4 D). The patient was prepared for exploration and repair of ICA.



**Operative intervention:**

1. Anaesthesia: Endotracheal tube general.
2. Position: hyperextension of neck and tilting of head to left.
3. Naso-gastric tube in.
4. Left thigh was prepped and draped; a segment of great saphenous vein was harvested.
5. Left neck exploration via an oblique incision parallel to SCM muscle extending behind the ear.
6. Dissection and isolation of CCA, ECA and ICA.
7. Extra-exposure is obtained by division of digastric muscle.
8. Findings: a haematoma in left parotid region, lateral tear and false aneurysm of distal ICA with nearby retained shell (Fig 4 E).
9. Procedure: the haematoma was evacuated. The shell was extracted (Fig 4 F).



Profuse bleeding ensued from distal ICA. The field was inaccessible and the distal stump was short. The proximal ICA was ligated just above bifurcation with 00 silk and over-sewn with 5 0 prolene. The back flow was very difficult to control. Ultimately, it was possible to suture the distal stump with 6 0 prolene in 2 layers.

Haemostasis was secured. Negative pressure drain was placed. The wound was closed in layers.

**Postoperative course:**

The patient had a full neurologic recovery in the theatre apart from hypoglossal and mild facial palsies which were evident preoperatively. He was fully conscious and moved all extremities with full muscle power.

On third postoperative day, the patient developed mild left sided weakness (mild stroke most likely due to ICA insufficiency). Moreover, he was noticed to have lower cranial nerve palsies: Horner’s syndrome, difficulty in swallowing and hoarseness of voice.

He was re-evaluated by a neurologist. CT scan of brain was normal. In 1 month period of rehabilitation and physiotherapy, he had a full neurological recovery.

**Case 5:** A 30 yrs old man was admitted to E and A Department of Sulaimania Teaching Hospital at June 2007 with profuse bleeding from a stab wound in left neck. The patient was resuscitated and then taken to operation theatre. Standard exploration of left carotid arteries via an oblique incision was done. There was a tear in distal left ICA which was controlled by ligation due to poor access for repair. The patient had a smooth and full neurological recovery apart from hypoglossal nerve palsy. He is seen regularly at follow up and is doing very well.

**Table-1** summarizes the details of patients. All patients were males 18 to 30 yrs old with a mean age of 23.8 yr. Two of them (third and forth) were victims of terrorism while the remaining three had their injuries due to violence. Three injuries were located in zone III and 2 in zone II. Four patients presented hours to days after the injury while the fifth presented after few months. Angiography was done in 2 patients with a false aneurysm of internal carotid artery (ICA). All 3 patients with ICA injuries were managed by ligation. The 2 patients with common carotid artery (CCA) injuries in zone II had an end to end repair. All 5 patients have survived with no significant neurological deficits.

Case No.	Age (yr) & Sex	Type of Injury	Side & Zone	Time after Injury	Injured Artery	Type of Lesion	Procedure	Angiography	Preoperative nerve deficit	Postop N deficit
Case 1	18, M	Stab wound	R, II	Few hours	CCA	Lateral tear	End to End Repair	No	No	Hoarseness
Case 2	20, M	Bullet	L, II	Few hours	CCA	Near total transaction+ retained bullet	End to End Repair	No	No	Mild facial palsy
Case 3	21, M	Shrapnel	R, III	Few months	ICA	Big lateral tear+ false aneurysm+ retained	Ligation of ICA+ aneurysmectomy+ extraction of foreign bodies.	Selective carotid & vertebral	No	No

## CAROTID ARTERY INJURIES

						pieces of wood				
Case 4	30, M	Shrapnel	L, III	Few days	ICA	Lateral tear+ false aneurysm+ retained shrapnel+ facial art injury with haematoma	Ligation of ICA+ aneurysmectomy+ extraction of shrapnel+ transfixation of facial art	Selective carotid & vertebral	Hypoglossal n palsy	Mild L hemiparesis; resolved in 1 month Horner,s syndrome Glossopharyngeal n impairment
Case 5	30, M	Stab wound	L, III	Few hours	ICA	Lateral tear	Ligation of ICA	NO	NO	Hypoglossal n palsy

**Table 1: Details of Patients.**

### DISCUSSION:

It is noteworthy that all patients in this study were males. This finding is similar to Musaed Albadri's study in which males constituted 96.15% of his patients. <sup>(6)</sup> As men spend more time outdoors than women; they are more likely targeted by terrorist attacks and violence. Three patients (1<sup>st</sup>, 2<sup>nd</sup> and 5<sup>th</sup>) were actively bleeding and thus were urgently explored with no attempt to perform preoperative angiography. The first and second patients had zone II injuries which usually do not need angiography preoperatively as this test would not alter the surgical approach. <sup>(7,8)</sup> On the other hand, the third and fourth patients were haemodynamically stable and had zone III injuries which require angiography prior to exploration; <sup>(9)</sup> thus it was arranged and was helpful indeed as it nicely showed the false aneurysm of ICA in both patients.

Aneurysms of the carotid artery are rare (1% of all extracranial aneurysms). According to reports in the English medical literature, false aneurysms are even rarer. Ligation of the carotid artery (the first definitive surgical procedure for carotid aneurysms

initially performed by Astley Cooper in 1808) has a mortality of 50% <sup>(10)</sup> and a stroke rate of approximately 30%. This incidence is decreased considerably if there is normal patency of the contralateral ICA, vertebral arteries and circle of Willis. Definitive management involves surgical excision of the aneurysm with arterial reconstruction. Occasionally an extra-anatomical bypass may be required for high ICA lesions, and in these situations an extra-cranial to intra-cranial bypass can be performed using the superficial temporal artery. <sup>(10)</sup>

The surgical approach used in all cases was the standard oblique neck incision parallel the anterior border of SCM muscle, however, extra-exposure

proved to be necessary and was achieved in the fourth patient by dividing the digastric muscle.

Distal ICA lesions may in addition require anterior subluxation of the jaw and mandibular osteotomy. <sup>(4)</sup>

The surgical treatment of CCA in zone II seems to be a straightforward operation as we did in the first and second patients, but it is really challenging for

zone III injuries like the third, fourth and fifth patients due to poor access to the distal injured segment <sup>4</sup>. This is the reason why such injuries are currently dealt with by endovascular techniques in centers with such a facility. <sup>(3,11,12)</sup> In our opinion, the third and fourth patients were not good candidates for such treatment even if it was available because they had an impending rupture of the false aneurysm in case 3 and expanding haematoma in case 4 and retained foreign bodies in both cases which required removal for optimum result. Repair could not be achieved in case 3, 4, and 5 because of poor access and profuse bleeding. Thus ligation or transfixation of the distal arterial segment was a life saving measure. It proved to be safe or at least tolerable in our young patients most probably because of good blood flow through circle of Willis.

Injuries of the distal extracranial internal carotid artery present difficulties because distal cross-clamping may not be possible. Insertion of a Fogarty balloon catheter produces rapid control of bleeding. The catheter itself is narrow and does not interfere with repair of the laceration. <sup>(4)</sup>

Fortunately all patients in this study have survived, though the mortality in the literature approaches 20% <sup>(1)</sup> which is close to 17.3% reported by a local study from Iraq <sup>(6)</sup>. The chance of survival is very

slim for patients in haemorrhagic shock and/or coma with active arterial haemorrhage from penetrating carotid artery injury. Yoshie Hara et al studied 30 patients with penetrating carotid artery injury presenting with shock or coma, 3 or 4 patients with shock died, despite surgical repair of the injured vessel, and 19 of 26 patients with coma died. <sup>(13)</sup>

### CONCLUSION:

Penetrating carotid artery injuries in zone II usually do not require preoperative angiography unlike those in zone I and III. Repair is always desired. It is a straightforward operation for zone II injuries but really challenging for zone III due to poor access. Certain zone III injuries may be just observed or treated by endovascular stenting when facilities permit. Ligation of ICA carries a high risk of stroke; however, young people with well developed circle of Willis may tolerate it well.

### REFERENCES:

1. Zachary T. Levine, Donald C. Wright, Sean O' Malley, Wayne J. Olan and Laligman N. Sekharet. Management of zone III Missile Injuries involving the carotid artery and cranial nerves. Skull base surgery. 2000;10.
2. Salim Satar, Ahmet Sebe, H. Hak Poyrazoglu and M. Kemal Avşar. An Unusual Presentation of penetrating Neck Trauma in Zone III. Internet Journal of Thoracic & Cardiovascular Surgery, 2007.
3. David V. Feliciano. Management of penetrating injuries to carotid arteries. World J. Surgery. 2001;25:1028-35.
4. P C Clifford and E J Immelman. Management of penetrating injuries of the internal carotid artery. Annals of the Royal College of Surgeons of England 1985; 67.
5. Col Arthur Cohen, Donald Brief and Carleton Mathewson. Carotid Artery Injuries: An analysis of 85 cases. The American Journal of Surgery. August 1970;120:210-15.
6. Musaed L. H. Albadri et al. Penetrating Injuries of the Neck. The Iraqi Postgraduate Medical Journal. 2009;8:196- 203,
7. Eric Wahlberg, Pär Olofsson and Jerry Goldstone. Vascular Injuries to the Neck in Emergency Vascular Surgery A Practical Guide. Springer-Verlag Berlin Heidelberg 2007.
8. Haydar Yasa, Ahmet Ozelci, Ufuk Yetkin, Tefik Gunes, Orhan Gokalp, Levent Yilic, Cengiz Ozbek and Ali Gurbuz. Our Experience in the Management of Carotid Artery Injuries. The Internet Journal of Thoracic and Cardiovascular Surgery™ ISSN: 1524-0274
9. Yair Edden, Anat Globerman, Amir Elami, Jean-Yevis Sichel, Chen Rubinstein, Charles Weissman, Yoram G. Weiss and Yakov Berlatzky. Is definitive vascular reconstruction of carotid arteries justified during a mass casualty event? Injury Extra 2007;38:182- 86.
10. D G Hargreaves and P A Baskerville. False aneurysm of the carotid artery. Journal of the Royal Society of Medicine. January 1995;88 :50- 51.
11. Richard M Karlin and Charles Marks. Extracranial Carotid Artery Injuries. Current Surgical Management. The American Journal of Surgery. Vol 146, August 1983:225-28.
12. Capt Jeffrey D. Mcneil, Maj Andy C Chiou, Maj Michael G. Gunlock, Capt David E Grayson, Maj Gregory Soares, and Maj Ryan T Hagino. Successful endovascular therapy of a penetrating zone III internal carotid injury. J Vasc Surg 2002;36:187-90.
13. Yoshie Hara, Haruo Yamashita, Kohei Ohta, Syuichi Kozawa and Masahiko Nakamura. Emergent surgical repair for penetrating injury of the cervical carotid artery associated with shock-case report. Neurol Med Chir (Tokyo) 1990; 49:300-2.

