Rev Colomb Cir. 2021;36:421-6
https://doi.org/10.30944/20117582.832

ORIGINAL ARTICLE

The new age: Endovascular approach for carotid artery trauma

La nueva realidad: Manejo endovascular del trauma de carótida

Carlos Andrés Serna-Arbeláez[1], Luis Saldarriaga[1], Edgar Folleco[2], Alberto L. Rosero[2], Yaset Caicedo[3], Sofia Daniela Timaran[4], Jose Julián Serna[5,6], Alberto García[5,6], Fernando Rodríguez-Holguín[6], Carlos A. Ordoñez[5,6]

1 MD, specialist in General Surgery; fellow, Cirugía de Trauma y Emergencias, Universidad del Valle. Cali, Colombia.
2 MD, specialist in Radiology, Service of Neuroradiology, Departament of Radiology, Fundación Valle del Lili, Cali, Colombia.
3 MD, Clinical Research Center, Fundación Valle del Lili, Cali, Colombia.
4 Medical Student, Facultad Ciencias de la Salud, Universidad ICESI, Cali, Colombia.
5 MD, specialist in General Surgery and Trauma and Emergencies Surgery. Departament of Surgery, Hospital Universitario del Valle Evaristo García, Universidad del Valle, Cali, Colombia.
6 Division of Trauma and Emergencies Surgery, Departament Surgery, Fundación Valle del Lili, Cali, Colombia.

Abstract

Introduction. At our institution most cervical carotid injuries are managed via an or through an endovascular approach. The objective of this study was to describe the outcomes of patients with cervical carotid injuries who underwent endovascular management at a I Level Trauma Center in Cali, Colombia.

Methods. Retrospective, descriptive case series of patients with both penetrating and blunt carotid trauma who were admitted to a I Level Trauma Center between January 2018 and January 2020.

Results. Twenty patients with carotid injuries were evaluated, of which 90% had penetrating trauma, mostly from gunshot wounds. The most frequently affected portion or segment was the internal carotid (65%) and 40% of the patients had neurological symptoms upon admission. Endovascular management was performed in 13 patients, with a 75% success rate in endovascular management. Overall mortality was 20%, and mostly related to injuries in other organs; 69% of the patients were discharged without neurological sequelae and 25% with minimal sequelae.

Discussion. We describe a case series of patients with cervical carotid injury, who were carefully selected based on poor prognosis variables, and underwent endovascular management, resulting in successful outcomes.

Keywords: carotid artery injuries; wounds and injuries; multiple trauma; angiography; endovascular procedures; therapeutic embolization.

Received: 09/15/2020 - Accepted: 11/15/2020 - On line: 04/06/2021
Corresponding author: Carlos A. Ordoñez, MD, FACS. Carrera 98 #18-49, Fundación Valle del Lili, Cali, Colombia. Phone number: 300 631 9118. Email: ordonezcarlosa@gmail.com
Cite as: Serna-Arbeláez CA, Saldarriaga L, Folleco E, Rosero AL, Caicedo Y, Timaran SD, Serna JJ, García A, Rodríguez-Holguín F, Ordoñez CA. The new age: Endovascular approach for carotid artery trauma. Rev Colomb Cir. 2021;36:421-6.

Resumen

Introducción. La mayoría de las lesiones de carótida de cervical en nuestra institución se manejan por vía endovascular. El objetivo de este estudio fue describir los desenlaces del manejo de las lesiones de carótida cervical en un hospital de cuarto nivel en la ciudad de Cali, Colombia.

Métodos. Estudio de series de casos, retrospectivo, descriptivo, en pacientes con trauma de carótida (penetrante y cerrado), admitidos en un centro de alta complejidad de la ciudad de Cali, en el periodo comprendido desde enero de 2018 hasta enero de 2020.

Resultados. Se evaluaron 20 pacientes con lesión de carótida, de los cuales 90 % tenía trauma penetrante, en su mayoría por proyectil de arma de fuego. La zona más frecuentemente afectada fue la carótida interna (65 %) y el 40 % de los pacientes presentaban síntomas neurológicos al ingreso. Se realizó manejo endovascular en 13 pacientes, con un 75 % de éxito en el manejo endovascular al ingreso. La mortalidad general fue del 20 %, que en su mayoría estuvo relacionada con traumatismo en otros órganos. El 69 % de los pacientes quedaron sin secuelas neurológicas al alta y el 25 % con secuelas mínimas.

Discusión. Se muestra una serie de casos con lesión de carótida donde, teniendo en cuenta las variables de mal pronóstico para hacer una selección adecuada de los pacientes candidatos a este tipo de terapia, el resultado del manejo endovascular fue exitoso.

Palabras clave: traumatismos de las arterias carótidas; heridas y traumatismos; traumatismo múltiple; angiografía; procedimientos endovasculares; embolización terapéutica.

Introduction

Injuries to the carotid arteries are present in 6% of all neck trauma and represent the 22% of vascular injuries [1–5]. Eighty percent of patients with penetrating carotid trauma are admitted in hemorrhagic shock, 60% with active bleeding, 33% with hematoma, and 20% with neurological deficit [2]. In addition to a high mortality rate, patients are also at high risk of developing neurological sequelae, with a stroke rate of up to 70% [6].

Currently, the management of carotid trauma is a clinical challenge [7,8]. Classically, an emergency surgical approach had been proposed for the treatment of this type of injury, with unsatisfactory outcomes. For this reason, the use of angiography, that allows vascular interventionism, is the new management proposal resulting in favorable outcomes, in both blunt and penetrating trauma [4-6]. A case series from Hospital San Vicente de Paul, in Medellín, Colombia, reported that 97% of carotid injuries were successfully managed with an endovascular approach.

The potential candidates for endovascular management has been described as hemodynamically stable patients, whose clinical status allows the study by angiotomography to define the best intervention [8,9]. Type and location of the injury determine the risk in this type of injury [10].

The objective of this study was to describe our experience on the management of carotid trauma, at a level 4 medical center, with special emphasis on patients undergoing endovascular management.

Methods

Retrospective study of a series of patients treated at the Fundación Valle del Lili. A highly complex center of reference for the management of trauma patients, in Cali, Colombia.

We included patients with a minimum age of 18 years and carotid trauma diagnosed by imaging or by surgical exploration, from January 2018 to January 2020. All patients under 18 years of age, with severe head trauma (AIS> 3) and those who

died upon admission to the emergency service were excluded.

The patients were identified from the with the ICD-10 code. Institution's information system the selection criteria was reviewed in the clinical history and, a second imaging analysis was performed by an independent radiologist in those with confirmed carotid trauma. As a result, the severity of trauma was reclassified and the relevant data for the study was recorded in a Microsoft Excel database.

The variables included demographic data, age, mechanism of trauma, type of injury, location of the injury, trauma severity index, shock index, management and blood transfusions. The clinical evolution was followed during the first 30 days of admission and the neurological outcome and mortality (due to any cause during the hospital stay) were also assessed.

For the descriptive analysis, categorical variables were reported as relative and absolute frequencies, and continuous variables as median and interquartile range (IQR). Statistical analysis was performed using Language R version 3.6.3 [11].

Results

Twenty-eight patients were identified in the institution's database, and, after an exhaustive review of the medical records and diagnostic images 20 patients met the study selection criteria and were included in the analysis. The baseline characteristics of the patients are summarized in table 1.

Ninety percent of the patients were male and the most frequent mechanism of injury was penetrating trauma (90%), mostly from gunshot wounds (80%). Ninety-five percent of the patients had some degree of head trauma and the median Glasgow Coma Scale was 14 (IQR: 9-15). Forty percent 40% of the patients were admitted with limb paresis, 65% with active bleeding, 40% with an expansive hematoma, 55% with an stable hematoma, and 50% required transfusion of blood products.

The injuries anatomic distribution was: 25% in the common carotid 10% in the external carotid, and 65% in the internal carotid. The type

Table 1. Experience of carotid trauma management.

Carotid trauma patients (n=20)	
Gender	
Male	18 (90%)
Type of trauma	
Penetrating	18 (90%)
Stab wounds	2 (10%)
Gunshot wounds	16 (80%)
Blunt	2 (10%)
Vital signs on admission	
Heart rate	97 (70-117)
Glasgow Coma Scale	14 (9-15)
Systolic blood pressure, mmHg	117 (80-125)
Paresia clinical signs on admission	8 (40%)
Bleeding	13 (65%)
Expansive hematoma	8 (40%)
Stable hematoma	11 (55%)
Transfussion	10 (50%)
Head trauma	19 (95%)
Surgical approach	
Raffia	1 (5%)
Saphenous graft	1 (5%)
Ligature	1 (5%)
Arteriography	
Diagnostic	6 (40%)
Therapeutic	9 (60%)
Endovascular management	
Arteriography (diagnostic)	6 (40%)
Embolization	2 (13%)
Stent	7 (47%)
Carotid portion injured	
Common	5 (25%)
External	2 (10%)
Internal	13 (65%)
Type of injury	
Dissection less than 30%	2 (10%)
Dissection greater than 30%	1 (5%)
Pseudoaneurysm	7 (35%)
Rupture	3 (15%)
Amputation	7 (35%)
Antiplatelet therapy / Anticoagulation	
No	5 (25%)
Platelet antiaggregation	7 (35%)
Anticoagulation	1 (5%)
Combined	7 (35%)
Neurological impairment at discharge (alive n=16)	
None	11 (69%)
Minor	4 (25%)
Major	1 (6%)
Clinical outcomes	
Hospital stay, days	5 (5-14)
Cardiac arrest	5 (25%)
Mortality	4 (20%)

of injuries were dissection of the intima (15%), pseudoaneurysm (35%), rupture with active bleeding (15%), and amputation of the vessel (35%).

Five patients did not undergo arteriography, of which two died in the emergency room before any intervention and three underwent immediate surgery. All of those who underwent surgery, had common carotid artery injuries, and were treated via a primary suture repair (n=1), inverted saphenous graft (n=1), and emergent vascular ligation in one patient with complex trauma who dyed later.

Fifteen patients underwent carotid arteriography of which 60% were therapeutic and the rest were diagnostic, with no further interventions requirement. Two of the therapeutic arteriograms resulted in the embolization of the internal carotid artery, one because it was completely occluded and the other because it had a patent polygon of Willis with active bleeding in the petrous portion. The remaining seven patients required the placement of a covered stent, two in the common carotid and five in the cervical portion of the internal carotid (Table 2).

None of the patients who underwent surgery or died received antiplatelet or anticoagulation therapy, while all patients who underwent endovascular management received either of these therapies after the procedure.

Four patients died two from multiple trauma during emergency care, one from massive bleeding at different sites (in whom the common carotid was ligated) and the other from stroke prior to admission (in whom the internal carotid was embolized because the neurological damage was already established). Overall mortality was 20% and cardiac arrest occurred in five patients, of which one survived.

Of the 16 patients who survived, one (6%) was discharged with major neurological sequelae (hypoxic-ischemic encephalopathy), four (25%) with minor neurological sequelae (paresis or praxia), and 11 (69%) without neurological sequelae. The average hospital stay was 5 days (IQR: 5-14).

Discussion

Our literature review of carotid trauma mostly found case series publications, since it is difficult to perform studies with comparative interventions and good epidemiological quality, in this rare type of injury with devastating consequences.

In the last 80 years the approach to this type of trauma has evolved. Moreover, diagnostic and therapeutic methods proposed by the different associations have been refined in the last 20 years. However, there in no consensus on this issue and will be difficult to achieve, since there are many variables to control, and each of these variables can strongly influence the neurological outcomes of the patient [12].

Table 2. Patients with internal carotid trauma managed with a stent.

Case	1	2	3	4	5
Age, years	42	29	42	25	42
Type of wound	Gunshot wound	Gunshot wound	Gunshot wound	Gunshot wound	Gunshot wound
Glasgow scale score at admission	15	15	13	15	15
Active bleeding	Yes	Yes	Yes	No	Yes
Type of injury	Pseudoaneurysm	Pseudoaneurysm	Rupture	Pseudoaneurysm	Pseudoaneurysm
Neurological compromise at discharge	None	Mild	None	Mild	None
Hospital stay, days	6	5	8	12	5

Until 3 decades ago, every patient with suspected neck vascular injury had an indication for emergent surgical intervention. Although this premise still holds, endovascular management has been considered in specific cases [4].

When evaluating a patient with carotid artery injury, it is important to take into account the anatomical location, severity (or classification) and time of evolution of the injury, mechanism of trauma, Glasgow Coma Scale, presence of neurological symptoms, hemodynamic stability other life-threatening injuries, availability of hybrid operating room, and intensive care unit (ICU). Taking into account all these variables, the sugeon must decide whether to repair the veseel or not, hoping neurological improvement due to reperfusion of ischemic areas, but considering the risk of conversion to hemorrhagic stroke, cerebral edema and death due to reperfusion [12,13].

In our study, most of carotid injuries followed penetrating trauma, due to gunshot wounds. The most frequently affected portion was the internal carotid, which confers a poor neurological prognosis. In spite of this, endovascular management was successful in most cases, with minimal neurological compromise at discharge, making this intervention a very good management option for patients with carotid artery injury who are hemodynamically stable.

In addition, the mortality in our study was not related to the vascular intervention per se, but to associated injuries in other organs. However, endovascular management is not free from complications, therefore, it is important to evaluate the context of the patient and his or her prognostic variables (such as time of injury or neurological symptoms) before deciding whether or not to revascularize the brain [4].

This study has multiple limitations, due to it´s descriptive and retrospective nature, this study has a limited statistical weight. Furthermore, due to the characteristics of the trauma center where the study was conducted, the patients with more serious injuries were more likely transferred there. This explains the disproportion of patients with penetrating trauma versus blunt trauma, and the frequent involvement of the internal carotid artery.

Conclusions

This study shows a series of cases where endovascular management was successful, always taking into account the variables of poor prognosis to make an adequate selection of candidates for this therapy. This work can serve as a starting point for future studies with greater statistical power, which will help us make good decisions regarding the management of cervical carotid artery trauma, since currently the literature is limited.

Compliance with ethical standards

Informed consent: This is a descriptive, retrospective chart review study, and as such, there is no need for informed consent. Approval was obtained by the Ethics Committee of the institution to carry out the research.

Conflict of interest: None declared by the authors.

Funding source: The financing resources of the project were entirely provided by the authors.

Authors' contributions:

- Conception and design of the study: Carlos Serna, Edgar Folleco, Alberto Rosero, Yaset Caicedo, Jose Serna, Alberto García, Carlos Ordoñez.
- Data acquisition: Carlos Serna, Luis Saldarriaga, Edgar Folleco, Alberto Rosero, Yaset Caicedo, Sofia Timaran, Jose Serna.
- Data analysis and interpretation: Yaset Caicedo, Carlos Serna, Jose Serna, Alberto García, Fernando Rodríguez, Carlos Ordoñez.
- Drafting the manuscript: Carlos Serna, Yaset Caicedo, Jose Serna, Luis Saldarriaga, Sofia Timaran.
- Critical review: Carlos Serna, Yaset Caicedo, Jose Serna, Edgar Folleco, Alberto Rosero, Alberto García, Fernando Rodríguez, Carlos Ordoñez

References

1 Navsaria P, Omoshoro-Jones J, Nicol A. An analysis of 32 surgically managed penetrating carotid artery injuries. Eur J Vasc Endovasc Surg 2002;24:349–55. https://doi.org/10.1053/ejvs.2002.1736.

2 Demetriades D, Asensio JA, Velmahos G, Thal E. Complex problems in penetrating neck trauma. Surg Clin North Am 1996;76:661–83. https://doi.org/10.1016/S0039-6109(05)70475-8.

3 Lee TS, Ducic Y, Gordin E, Stroman D. Management of Carotid Artery Trauma. Craniomaxillofac Trauma Reconstr 2014;7:175–89. https://doi.org/10.1055/s-0034-1372521.

4 Biagioni RB, Burihan MC, Nasser F, Biagioni LC, Ingrund JC. Endovascular treatment of penetrating arterial trauma with stent grafts. Vasa - Eur J Vasc Med 2018;47:125–30. https://doi.org/10.1024/0301-1526/a000672.

5 Foreman PM, Harrigan MR. Blunt Traumatic Extracranial Cerebrovascular Injury and Ischemic Stroke. Cerebrovasc Dis Extra 2017;7:72–83. https://doi.org/10.1159/000455391.

6 Kraus RR, Bergstein JM, Debord JR. Diagnosis, treatment, and outcome of blunt carotid arterial injuries. Am J Surg 1999;178:190–3. https://doi.org/10.1016/S0002-9610(99)00157-9.

7 Jiménez HC, Romero E, Medina R, Botache W, Sanjuán J, Martínez C, et al. Caracterización de trauma arterial periférico en un hospital de tercer nivel. Rev Colomb Cir 2018;33:272–9. https://doi.org/10.30944/20117582.72.

8 Pacheco MA, Aldana GE, Granados ÁE, Martínez LE, Santacoloma J, Baquero RL, et al. Manejo del trauma penetrante de cuello en dos hospitales de Bogotá, Colombia. Rev Colomb Cir 2018;33:34–43. https://doi.org/10.30944/20117582.45.

9 Herrera DA, Vargas SA, Dublin AB. Endovascular treatment of penetrating traumatic injuries of the extracranial carotid artery. J Vasc Interv Radiol 2011;22:28–33. https://doi.org/10.1016/j.jvir.2010.09.022.

10 Hundersmarck D, Reinders Folmer E, de Borst GJ, Leenen LPH, Vriens PWHE, Hietbrink F. Penetrating Neck Injury in Two Dutch Level 1 Trauma Centres: the Non-Existent Problem. Eur J Vasc Endovasc Surg 2019;58:455–62. https://doi.org/10.1016/j.ejvs.2019.04.020.

11 R Core Team. R: A language and environment for statistical computing. 2019.

12 Blitzer DN, Ottochian M, O'Connor J, Feliciano D V., Morrison JJ, DuBose JJ, et al. Penetrating Injury to the Carotid Artery: Characterizing Presentation and Outcomes from the National Trauma Data Bank. Ann Vasc Surg 2020:1–8. https://doi.org/10.1016/j.avsg.2020.03.013.

13 Martin MJ, Mullenix PS, Steele SR, Asensio JA, Andersen CA, Demetriades D, et al. Functional outcome after blunt and penetrating carotid artery injuries: Analysis of the National Trauma Data Bank. J Trauma 2005;59:860–4. https://doi.org/10.1097/01.ta.0000187964.47703.e9.