

Endovascular Treatment of Gunshot Cervical Injury

Resolución endovascular de lesiones por arma de fuego en la región cervical

SEBASTIÁN RIZZONE[†], SERGIO ZOLORSA, ÁLVARO BORDENAVE, DANIEL DI NANNO[†], MARINA BAGLIONI

ABSTRACT

Background: The best approach for the treatment of gunshot wounds involving the cervical region remains controversial. Endovascular therapy of this type of pathology has become relevant in the last years due to the development of new devices and, consequently, to the lower incidence of procedure complications.

Objective: The aim of this study was to define the role of endovascular treatment of gunshot cervical lesions.

Methods: Seventy-six patients suffering from gunshot lesions in the cervical region underwent angiography of the supra-aortic vessels to decide the therapeutic approach.

Results: Among the 76 patients included in the study, 47 (61.8%) presented a pathologic angiography and endovascular treatment of the lesion was decided in 26, with 1.1 stent implant per patient. Average in-hospital stay was 10.4 days. At 30 days of follow-up, 2 patients presented neurological sequels and one evolved with sepsis. In the long-term follow-up with an average of 4 years, one death was registered 117 days after the procedure.

Conclusions: Endovascular treatment has achieved a predominant role with the development of new devices to treat ever increasing complex pathologies and reduce the time of in-hospital stay, as well as procedure-related complications.

Key words: Endovascular Treatment - Carotid Artery Injury - Firearms

RESUMEN

Introducción: Las heridas producidas por armas de fuego que comprometen la región cervical son materia de controversia en cuanto a cuál es el mejor método para tratarlas. La resolución endovascular de este tipo de patología ha cobrado gran relevancia en los últimos años debido al desarrollo de nuevos dispositivos y, consecuentemente, a la menor incidencia de complicaciones inherentes al procedimiento.

Objetivo: Determinar el rol del tratamiento endovascular en la resolución de las lesiones cervicales por arma de fuego.

Material y métodos: Se incluyeron 76 pacientes que sufrieron lesiones cervicales por arma de fuego, a los cuales se les realizó angiografía de los vasos supraaórticos para decidir la conducta a seguir.

Resultados: Del total de 76 pacientes, 47 (61,8%) presentaron una angiografía patológica; de estos, en 26 se decidió la resolución endovascular de la lesión, implantándose 1,1 stents por paciente. La estadía intrahospitalaria fue en promedio de 10,4 días. A los 30 días de seguimiento, 2 pacientes presentaron secuela neurológica y uno evolucionó con sepsis. En el seguimiento alejado con un promedio de 4 años se registró una muerte a los 117 días de realizado el procedimiento.

Conclusiones: La intervención endovascular ha ganado mayor protagonismo con el desarrollo de nuevos dispositivos que permiten el tratamiento de patologías cada vez más complejas y reducir el tiempo de internación intrahospitalaria, como también las complicaciones relacionadas con el procedimiento.

Palabras clave: Tratamiento endovascular - Traumatismo de carótida - Lesiones por armas de fuego

INTRODUCTION

Although the frequency of cervicofacial penetrating injuries is relatively low, the anatomical complexity of this area makes its repair a challenge for the medical team (1). Historically, the treatment of these lesions was performed by surgical approach and the mecha-

nism of injury was secondary to high-velocity and large-caliber ammunition in the military context.

This has been modified over the years and is currently present in civil settings where the use of low caliber fire arms is common and therefore the approach may not always allow open surgery. (1) The treatment

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Address for reprints: Dr. Sebastián Rizzone - Uspallata 3400 - CABA, Argentina - Tel. 54 11 4912-5445, int. 4926 - e-mail: sebastianrizzone@yahoo.com.ar

[†] Hemodynamics Division, "Churrucá-Visca" Medical Complex of the Argentine Federal Police, Buenos Aires, Argentina.

[†] To apply as Full Member of the Argentine Society of Cardiology

of gunfire head and neck wounds remains a point of controversy within the trauma issue. (2) Anatomically, the neck can be subdivided into three regions: central, involving the cervical spine; posterior, involving soft tissue located behind the cervical spine and anterolateral, involving mostly vital structures of the respiratory, vascular, digestive and endocrine systems.

According to Saletta et al. (1) the anterior neck has been divided into three zones. Zone I is a horizontal area between the collarbone and the cricoid cartilage where the emergence of the thoracic vasculature lies, together with the vertebral and proximal carotid arteries, the lungs, the trachea, the oesophagus, the thoracic duct and the sympathetic nerve trunks.

Zone II extends from the cricoid cartilage to the angle of the mandible. It is the central, largest area, and also the zone of greatest trauma frequency, but carrying lower mortality than zones I and III. The internal jugular veins, the carotid and vertebral arteries, the trachea, the esophagus and the larynx lie in this area.

Zone III is the area between the angle of the mandible and the base of the skull. It contains the pharynx, salivary glands, internal jugular veins, vertebral arteries and the distal segment of the internal carotid artery.

Regarding the anatomy of each region, each institution should consider working protocols according to its resources. The use of endovascular treatment, both in its diagnostic and therapeutic role, has gained significant relevance with the development of new devices and techniques.

The aim of this study was to define the role of endovascular treatment in the therapeutic decision-making of open trauma to the head and neck by gunshot wounds, as well as to describe the in-hospital and long-term 4-year follow-up outcome of patients undergoing this procedure.

METHODS

A retrospective analysis was performed on the outcome of 76 patients with cervicofacial and thoracic gunshot injuries between January 2000 and March 2014, undergoing angiography of supra-aortic trunks and aortogram, as needed. The right femoral artery was the vascular access in all cases, using a 6 to 9 Fr introducer. Ioxalate contrast was used, at an average volume of 130 ml. Amnesia, physical examination and laboratory data were collected to calculate the APACHE II score. The therapeutic approach in each case and the value of the hemodynamic study were analyzed for decision-making, as well as the time of hospital stay and complications during hospitalization and at 4 years.

Endovascular treatment was performed in patients who were hemodynamically stable and had no airway or digestive tract involvement or uncontrollable bleeding, in which case they were referred to the Department of Surgery to resolve their condition. Likewise, patients with complex anatomy that could technically preclude endovascular repair were also referred to surgery.

Statistical analysis

Statistical analysis was performed using Epi Info software.

Quantitative variables were expressed as mean and standard deviation or median and interquartile range, according to the type of distribution. Qualitative variables were expressed as absolute values and percentages.

Ethical considerations

Informed consent was obtained from all the patients and procedures were performed following the Declaration of Helsinki guidelines. All the material used was approved by the National Administration of Drugs, Food and Medical Technology (ANMAT) and the United States Food and Drug Administration (FDA).

RESULTS

Treatment analysis according to the zone of the neck affected showed that zone II was the one most frequently involved with 67% of cases, zone I with 13% of cases and zone III with 20% of cases.

Figures 1 and 2 show how common carotid artery-injury by gunshot at the cervical level was successfully resolved with the implantation of a stent graft, without complications.

Seventy-six male patients were included in the series. Mean age was 38 ± 7 years and mean APACHE II score was 5.47 ± 1.20 . In 47 patients angiography showed pathological results. The compression of the vertebral artery by hematoma was the most common condition (55.3%), 13 patients (27.6%) required conventional surgery, and 26 patients underwent endovascular treatment (55.3%) with stent graft implantation decided at the moment of the intervention depending on the condition diagnosed by the angiography (ulcer, arteriovenous fistula, aneurysm). Only 8 patients (17%) were excluded from surgery: 4 due to gastrointestinal tract involvement, 2 due to airway involvement, 1 extrinsic compression of the vertebral artery (Figure 3), and 1 due to hemodynamic shock.

None of the 76 patients revealed atherosclerotic lesions in the carotid arteries that would increase the probability of procedure failure, nor the occurrence of related neurological complications.

Table 1 shows the vascular territories affected in the 47 patients with abnormal angiography.

An average of 1.1 stents was used in the group of 26 patients with endovascular treatment; in 3 patients 2 stents were used, and in one patient 3 stents. Stents had a diameter between 5 and 9 mm and 7 mm was the most frequently used diameter; most were stent grafts. Regarding the type of stent graft, Wall-graft was the most frequently used stent, followed by Fluency, Viabhan and Jostent stents.

All patients with endovascular treatment received antiplatelet therapy with aspirin and clopidogrel during the in-hospital phase and the long-term follow-up. No patient received clopidogrel loading dose in case of an eventual surgical repair of the vascular pathology and/or its associated lesions, although, after the endovascular treatment all received a 75 mg/day dose.

Regarding the post procedural phase, the length of

Table 1. Zones affected by cervicofacial gunshot lesions

Zones affected	n	Frequency (%)
Facial	7	14.9
Cervicofacial	8	17.0
Cervical	18	38.3
Cervicothoracic	6	12.8
Transcervical	8	17.0

in-hospital stay of patients with endovascular treatment was 13.3 days while the intensive care stay was 3.8 days (Table 2). During hospitalization and the first 30-day follow-up, there were no deaths or major complications. No patient had complications secondary to the placement of the introducer such as retroperitoneal hematoma, arteriovenous fistula, pseudo aneurysm, or hematoma at the puncture site of more than 6 cm in diameter and/or requiring transfusion with blood derivatives. There was no case of acute intrastent thrombosis or vascular complication of the treated vessel. Post-implant stent deployment was not necessary as the angiographic result was always optimal since these arteries were free of atherosclerotic disease.

We recorded 22 cases with no evidence of neck vessel involvement; however, there was a case of vein injury and active bleeding which was referred to the Department of Surgery for repair.

Regarding the 4-year long-term follow-up, 2.6% mortality (1 case) was recorded but not associated with the diagnostic or therapeutic procedures. The patient died, after torpid evolution, at 117 days of hospitalization, with symptoms of sepsis secondary to nosocomial pneumonia during his stay in the general medical ward with kinetic rehabilitation for his neurological sequel. On the other hand, of the two patients presenting with neurological sequel only one died and the other patient recovered some degree of functionality, presenting mild paresis of the right upper limb; he continued with rehabilitation. The absence of progression of the motor sequel and the lack of development of new motor and/or sensory foci were also determined by clinical follow-up at the Department of Neurology. Doppler ultrasound of the neck vessels was also performed at 1 month, 6 months and then annually to assess restenosis, which as well as the need for reintervention was not evidenced at 4 years.

DISCUSSION

Certain relevant epidemiological data which allow assessing and determining the course of treatment in penetrating wounds to the neck show that over 50% of patients have no injuries in any structure requiring surgical repair, and that mainly vascular lesions occur: 12.3% arterial and 18.3% venous.

The wounds in zone I can affect the common carotid artery, the subclavian artery and vein and the verte-

Table 2. Days of hospital stay.

	Median	Interquartile range
Days of hospital stay	13.3	8.3-18.3
Days in ICU	3.8	1.8-5-8

ICU: Intensive Care Unit

bral vessels. To corroborate the existence of these lesions a four-vessel arteriography should be performed together with the complete venous phase of the study, evaluating also both subclavian vessels.

A study by Flint et al.(3) reported that, in the absence of direct or indirect clinical signs of bleeding (not including X-ray), the presence of major vascular lesions was established by angiography in 32% of cases.

Zone II injuries are the most common, and in turn, the most easily addressed surgically; therefore, the choice of treatment varies and depends on the experience of the surgical team and of the endovascular cardioangiology team of each center.

Rivers et al. (4) reveal that while zone III injuries rarely go clinically unnoticed, angiography allows the determination of possible injuries without hemodynamic repercussion, facilitating their treatment with a high success rate.

In a series by Hirschberg et al. (2), 83% of patients with transfixion of the neck injuries had cervical structure lesions and 29% were multiple lesions. This high incidence of injuries is transferred to a dramatic clinical presentation, with high mortality and prolonged hospital stay, indicating that transfixion of the neck injuries serve as an excellent severity predictor and constitute the most serious and challenging forms of neck penetrating injuries.

The clinical status of the patient will initially determine the management of vascular lesions. Thus, those who present with shock or uncontrollable bleeding will be promptly operated on, usually with vessel ligation. (6, 7) However, this procedure is associated with complications involving 9% of ischemic events, and technically the approach may be difficult when the lesion is near the base of the skull. Stable patients may be subjected to other diagnostic procedures to determine the length of the lesion and raise therapeutic options. Therefore, endovascular treatment has become the strategy of choice for patients with symptomatic dissection, since anticoagulation treatment is not possible in patients with gunfire wounds.

Pseudoaneurysm natural evolution is growth, entailing greater risk of rupture and cerebral embolism due to thrombus formation. This type of lesions as well as arteriovenous fistulas, have been successfully treated by endovascular therapy.

This shows that endovascular therapy can solve successfully and with minimal morbidity and mortality a variety of traumatic vascular lesions, constituting

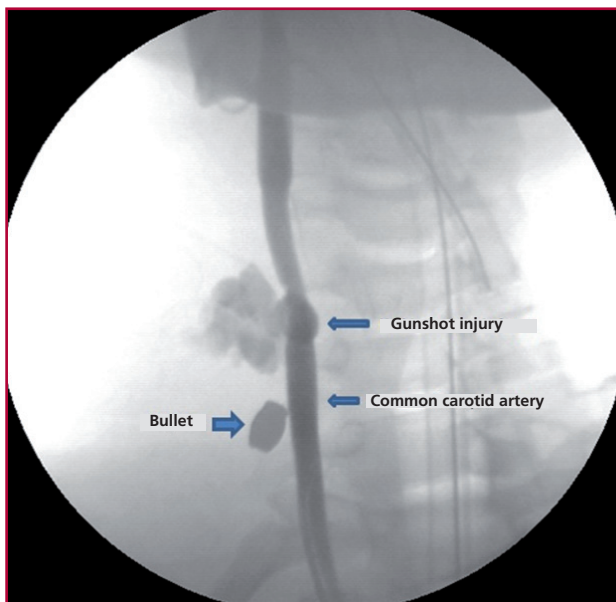


Fig. 1. Image showing gunshot injury in the common carotid artery.

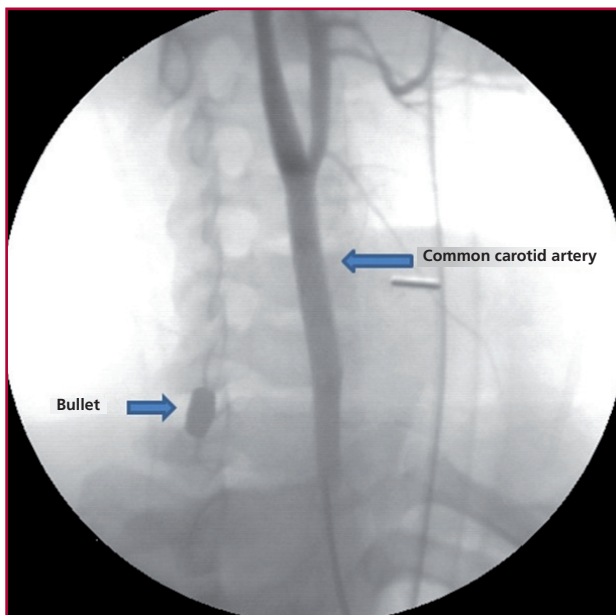


Fig. 2. Endovascular repair of the gunshot injury shown in Figure 1.

a promising alternative to the conventional technique.

Consequently, we emphasize that angiography remains a valuable diagnostic tool, mainly for zone I or zone III wounds, and as it allows immediate treatment, it is highly advisable to perform it when Zone II is involved, provided there is no hemodynamic decompensation requiring immediate surgical exploration.

Arteriography in this particular type of pathology significantly influenced treatment decision-making, allowing in some cases immediate endovascular repair, thus avoiding high-risk surgical procedures. In

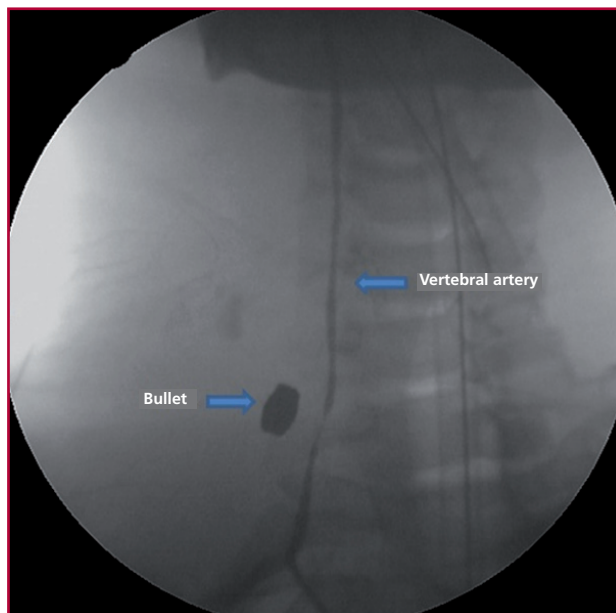


Fig. 3. Image showing compression of the right vertebral artery by cervical hematoma, secondary to gunshot injury.

other cases it guided the exploration to find the lesion.

A database analysis revealed that the endovascular repair of this pathology has significantly increased in recent years, associated with the development of new low profile, safer, and easier to implant stents.

This advance in technology also allows the use of smaller diameter introducers which reduces complications associated with the procedure.

In this experience, endovascular repair of lesions had no mortality, probably due to the increased clinical and hemodynamic stability of patients who did not undergo urgent surgery. Similarly, reoperation rate at 4 years of the procedure was also 0%.

Limitations

One of the study limitations is that it was not planned as a randomized comparison between endovascular and surgical treatment, so the results should be interpreted with caution and making a careful selection of the optimal intervention for each patient.

CONCLUSIONS

Endovascular treatment appears to be a safe therapeutic option, with low incidence of complications in patients likely to be treated by this method. In addition, it may also shorten hospital stay, with the concomitant reduction of costs and possible comorbidities secondary to a long stay in a closed and/or general ward, resulting in a marked economic benefit.

Conflicts of interest

None declared. (See author's conflicts of interest forms in the web / Supplementary Material)

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