JORNAL VASCULAR BRASILEIRO
Cirurgia Vascular, Endovascular e Angiologia

Pseudoaneurysm of the brachiocephalic trunk and bullet embolism in the axillary artery in thoracic trauma

(Portuguese PDF version)

Leopoldo Mariné, Renato Mertens, Francisco Valdés, Albrecht Krämer[1]

1. Vascular and Endovascular Surgery, Department of Cardiovascular Diseases, Hospital Clínico y Facultad de Medicina, Pontificia Universidad Católica de Chile.

Correspondence:
Leopoldo Mariné
Department of Vascular Surgery
Barnes Hospital/WU
St. Louis, Missouri, USA
E-mail: marinel@msnotes.wustl.edu

ABSTRACT

Pseudoaneurysm of supraaortic trunks and arterial bullet embolism are uncommon traumatic injuries with high associated morbidity-mortality. The diagnosis of such injuries require a high index of clinical suspicion, since they can often go unnoticed in the initial assessment, presenting complications or sequels of a complex solution. The study of images is fundamental for planning the best therapeutic strategy. Multi-slice helical computed tomography offers information at a minimum risk for hemodynamically stable patients. We present a clinical case of thoracic bullet injury that determined a pseudoaneurysm of the brachiocephalic trunk and embolism into the right axillary artery. The literature on such diseases is reviewed.

Key-words: bullet injury, arterial embolism, supraaortic pseudoaneurysm.

J Vasc Br 2005;4(1):93-8

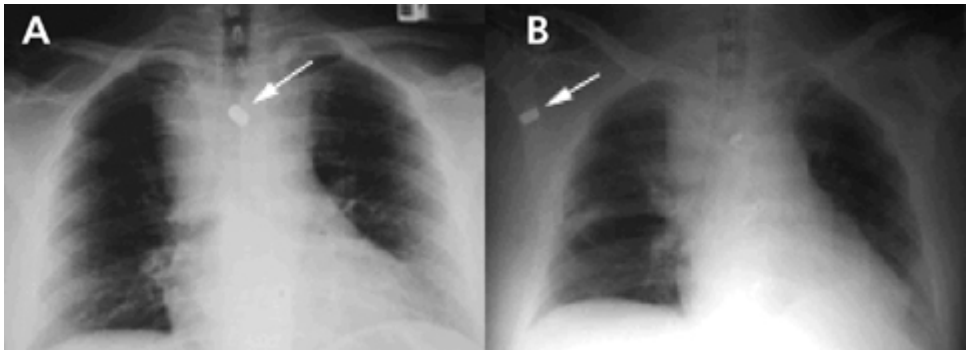
Thoracic injuries caused by gunshot are more and more frequent and associated to high morbidity-mortality, which can be reduced by early and proper diagnosis and treatment. We report a case of thoracic trauma caused by a bullet, in which two uncommon arterial injuries presenting a difficult clinical diagnosis were associated: pseudoaneurysm of the brachiocephalic trunk and further embolization of the bullet towards the right axillary artery.

CLINICAL CASE

A 27-year-old man suffered a .32 caliber bullet injury entering the left second intercostal space, mid-clavicular line, without bullet exit.

When he arrived at the Emergency Room of another hospital center, he was normotensive and tachycardic. General physical examination was normal. Chest roentgenogram (Figure 1A) shows mediastinal widening and the bullet located in the superior mediastinum, mid-sternal line in the third intercostal space.

Figure 1 - A) Thoracic radiography at admittance: it shows mediastinal widening; the arrow indicates the bullet location at the superior mediastinum, mid-sternal line (third intercostal space). B) Early postoperative thoracic radiography: the arrow indicates bullet migration to the right axillary region.

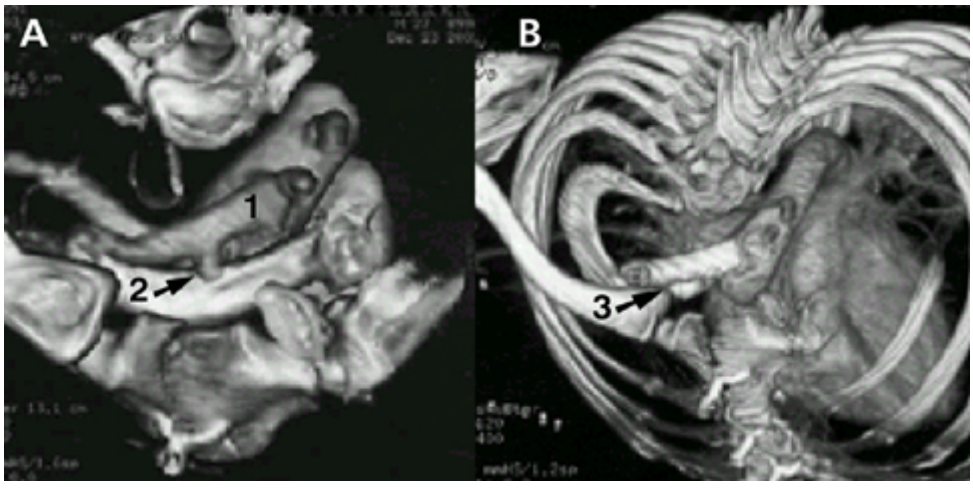


Due to the suspicion of persistent arterial bleeding with mediastinal widening, he was submitted to exploratory median sternotomy. An active hemorrhage of the left internal mammary artery was found, and corrected by ligation. The bullet or other apparent bleeding sites were not detected. In the postoperative period he remained with stable hemodynamic parameters, requiring mechanical ventilation. At physical examination there was clear asymmetry of blood pressure between both arms and pulse of the right arm was absent. Early postoperative chest roentgenogram (Figure 1B) showed migration of the bullet towards the right axillary region. This finding prompted his transfer to our institution for further evaluation and management.

When admitted the patient was on mechanical ventilation, mild or moderate fever, normal blood pressure, and with a central venous pressure of 18-19 mmHg. At physical examination an absent pulse of the right upper limb was detected and hematocrit had fallen from 49% to 39%. The non-invasive arterial study (pulse volume recording) showed hypoperfusion of the right upper limb, with a 35-mmHg pressure gradient related to the left arm.

Arterial phase contrast-enhanced thoracic helical computed tomography was performed (Figure 2A), which showed a 2 cm diameter pseudoaneurysm of the brachiocephalic trunk and upper mediastinal hematoma associated to the fracture of the manubrium sterni. To further pinpoint the anatomy, the study was complemented with an arteriography of the aortic arch, which confirmed the pseudoaneurysm, with its origin in the brachiocephalic trunk and occlusion of the proximal right axillary artery caused by the bullet, with thrombi adjacent to the bullet and distal reconstitution of the humeral artery by collaterals.

Figure 2 - A) Initial helical computed tomography of the thorax (tridimensional reconstruction, apical view): 1. Brachiocephalic arterial trunk 2. Pseudoaneurysm of the brachiocephalic trunk. B) Helical computed tomography of the thorax, post-procedure (tridimensional reconstruction, apical view): 3. Wallgraft endoprosthesis in the brachiocephalic trunk with exclusion of the pseudoaneurysm.



These findings demanded a new intervention. The right common carotid artery was exposed by cutdown under general anesthesia. After systemic heparinization, endovascular devices in a retrograde manner were advanced towards the brachiocephalic trunk lesion, in order to deploy a 70 mm selfexpandible covered endoprosthesis (Wallgraft®, Boston Scientific, USA) with a diameter of 12 mm by 70 mm of length. The endoprosthesis covered from the origin of the brachiocephalic trunk to the origin of the right common carotid artery, obstructing the ostium of the right subclavian artery and the false aneurysm. The axillary artery was simultaneously exposed through infraclavicular approach to extract the bullet and the thrombus directly through a transverse arteriotomy.

The patient awoke with no neurological deficit and with good perfusion of the right upper limb, as confirmed by the control plethysmography. The post-endovascular procedure tomography showed thrombosis of the pseudoaneurysm and appropriate spread of the endoprosthesis, with size reduction of the mediastinal hematoma (Figure 2B).

In the annual postoperative control, the patient had recovered his working activity without neurological restrictions or intermittent claudication of his right upper limb, keeping an antiaggregating therapy with aspirin. Plethysmography and segmental pressures were normalized.

DISCUSSION

The high mortality of thoracic vascular traumas is mainly due to exsanguinate aortic lesions, determining that only 20% of these patients are admitted alive to the hospital.[1] Supraaortic trunk injuries have, on its turn, high morbidity mortality that can be reduced through proper diagnosis and therapy.[2]

The mechanism by which these two arterial injuries (pseudoaneurysm of the brachiocephalic trunk and bullet embolism in the axillary artery) occurred simultaneously is explained by the bullet trajectory. It first went through the skin in the left hemithorax, followed an extrathoracic trajectory until the impact on the left side of the manubrium sterni, fracturing it and losing part of its kinetic energy, to finally enter the thorax and injure the left internal mammary artery. The bullet then injured the brachiocephalic trunk (first thoracic radiography, Figure 1A), leaving a solution of continuity in its wall with the consequent pseudoaneurysm. Probably related to the surgical exploration, the bullet migrated led by the blood flow following the direction of the subclavian artery flow, to finally impact on the right axillary artery with simultaneous absence of the right upper limb pulse (postoperative radiography, Figure 1B).

The specific diagnosis of the type of thoracic arterial injury is difficult. There are clinical and radiological elements in injuries of the brachiocephalic trunk that allow their detection[2] (Table 1). However, up to one third of patients can initially be asymptomatic,[3] and 18% can have a normal initial thoracic radiography.[4] The described case did not present any suggested specific clinical procedures, but with the mediastinal widening in the initial radiography we could establish some intrathoracic vascular injuries.

Table 1 - Clinical and radiological elements that allow to detect an injury of the arterial brachiocephalic trunk[2]

Clinical elements
Antecedent profuse hemorrhage on the affected site
Hemodynamic instability during transportation
Refractory hypotension in the emergency unit care
Asymmetry of blood pressure between upper limbs
Loss of pulse of the right upper limb and/or appearance of supraclavicular bruit
Right supraclavicular hematoma (expansive)
Major right hemothorax
Associated neurological deficit
Thoracic radiography
Upper mediastinal widening (> 8 cm in the second intercostal space and/or deviation of the trachea to the left)
Right pleural involvement (massive hemothorax)
Confusing bullet trajectory (mark entrance and exit site with radiopaque elements in the x-ray)
Bullet near great vessels or out of reach considering other elements observed

Bullet embolism presents a more difficult diagnosis, being asymptomatic in 80% of cases, depending on the affected vessel. It is clinically manifested by peripheral ischemia in two thirds of symptomatic patients[5] (Table 2). There must be a suspicion when the clinical findings do not topographically correlate to what is expected from the possible bullet trajectories. The diagnosis was made by radiology in 39% of cases, clinically in 33%,

and by autopsy in 22%.[6] In the presented patient, the loss of peripheral pulse and the change in the bullet position in successive radiographic controls allowed this diagnosis.

Table 2 - Clinical and thoracic radiography elements that detect bullet arterial embolism[5]

Early signs
Penetrating thoracic gun shot wound with hemodynamic instability
Loss of peripheral pulse and unexpected ischemia in sites far from the bullet route
Absence of bullet exit site
Thoracic radiography
Position change of the bullet in successive x-ray controls
Bullet out of reach that appears within the cardiac silhouette or inside the central portion of the lung
Absence of the bullet from the expected route in the chest film
Appearance of the bullet in an unexpected site of the chest film
Symptoms and/or late signs
Intermittent claudication
Ischemic pain
Gangrene
Pericardial effusion
Cardiac arrhythmia
Sepsis
Formation of pseudoaneurysm

The fact that most patients with thoracic vascular trauma are admitted with an active hemorrhage and hemodynamic instability demands an urgent surgery with high morbidity mortality associated and with no proper imaging support. There is another smaller group of patients with moderate vascular injuries and hemodynamic instability, to which the presented case belongs, in which it is possible to make image studies that offer a more precise anatomical diagnosis and thus choose the best therapeutic alternative.[2] Conventional arteriography has been the exam with best results, but it presents unavailability inconveniences and associated morbidity mortality, with greater significance in traumatized patients. Less invasive methods have been developed, such as the helical CT angiography, which is possible to be performed before an arteriography or, in some cases, as a substitute to it.[7] Although clinical findings have allowed the detection of this type of injuries in the presented patient, it was the helical CT angiography that first established the pseudoaneurysm diagnosis, and after the arteriography confirmed this diagnosis and added more information concerning the bullet embolism.

The definite treatment of the traumatic pseudoaneurysm of the brachiocephalic trunk is indicated due to risk of complications, such as rupture with exsanguinations and death. Among the therapeutic alternatives is the conventional surgical treatment that demands, like the injuries of the subclavian and axillary vessels, extensive surgical approaches, arterial repair technically demanding and death risk due to uncontrollable hemorrhage.[8] Due to the high magnitude of the open conventional surgery that has to be performed in such cases, the endovascular surgery, being less invasive, is a good alternative, considering the risk-benefit ratio.[9] The implant of an autoexpansible covered endoprosthesis was considered the best alternative for this patient, thus avoiding a thoracic reintervention. We decided to sacrifice the subclavian artery covering its origin in order to obtain proper stability of the device, a situation we have faced in other opportunities without major ischemic complications.

On the other side, arterial bullet embolisms have an associated morbidity incidence of 11% and it can lead to amputation[10,11] or death.[12,13] We suggest the removal of the bullet and the following thrombi, as well as the

correction of the defect caused on the entrance site, which, in this case, was performed simultaneously with the pseudoaneurysm repair.

Finally, we would like to emphasize that only a proper diagnosis allows the patient with thoracic vascular trauma to survive its injuries and eventual sequels. The most efficient diagnostic studies and the choice of the best possible therapeutic alternative for each case in particular are major factors in the recovery of these high-risk patients.

REFERENCES

1. Snow N, Johnson P. Traumatic fistula between the descending thoracic aorta and the left main pulmonary artery. J Trauma 1985;25:263-5.

2. Wall MJ, Hirshberg A, Le Maire SA, Holcomb J, Mattox K. Thoracic aortic and thoracic vascular injuries. Surg Clin North Am 2001;81:1375-93.

3. Flint LM, Snyder WH, Perry MO, Shires GT. Management of major vascular injuries in the base of the neck. An 11-year experience with 146 cases. Arch Surg 1973;106:407-13.

4. Calhoon JH, Grover FL, Trinkle JT. Chest trauma: approach and management. Clin Chest Med 1992;13:55-67.

5. Michelassi F, Pietrabissa A, Ferrari M, et al. Bullet emboli to the systemic and venous circulation. Surgery 1990;107:239-45.

6. Shen P, Mirzayan R, Jain T, Mcpherson J, Cornwell EE. Gunshot wound to the thoracic aorta with peripheral arterial bullet embolization: case report and literature review. J Trauma 1998;44:394-7.

7. Trerotola SO. Can helical CT replace aortography in thoracic trauma? Radiology 1995;197:13-5.

8. Demetriades D, Asensio J. Subclavian and axillary vascular injuries. Surg Clin North Am 2001;81:1357-73.

9. Mertens R, Valdés F, Krämer A, Mariné L. Pseudoaneurisma traumático de troncos supraórticos: tratamiento endovascular. Rev Med Chil 2002;130:1027-32.

10. Adegboyega PA, Sustento-Reodica N, Adesokan A. Arterial bullet embolism resulting in delayed vascular insufficiency: a rationale for mandatory extraction. J Trauma 1996;41:539-41.

11. Trimble C. Arterial bullet embolism following thoracic gunshot wounds. Ann Surg 1968;168:911-6.

12. Mattox KL, Beall AC Jr, Ennix CL, Debakey ME. Intravascular migratory bullets. Am J Surg 1979;137:192-5.

13. Mattox KL. Red river anthology. J Trauma 1997;42:353-8.