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Clinical Study

Vertebral artery pseudoaneurysms secondary to blunt trauma: Endovascular management by means of neurostents and flow diverters

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ABSTRACT

Extracranial vertebral pseudoaneurysms that develop following blunt trauma to the cervical area may have a benign course; however, embolic or ischemic stroke and progressive pseudoaneurysm enlargement may occur. We review the presentation and endovascular management of pseudoaneurysms of the cervical vertebral artery (VA) due to blunt trauma in nine patients (eight male, mean age 27 years). Pseudoaneurysms occurred in dominant vessels in seven patients and coexisted with segmental narrowing in six. We favored endovascular intervention during the acute phase only in cases with significant narrowing of a dominant VA, especially when anticoagulation was contraindicated. Four patients were treated during the acute stage (contraindication to anticoagulation, mass effect, severely injured dominant VA/impending stroke); five during the chronic phase (pseudoaneurysm growth, ischemic stroke on aspirin prophylaxis, patient preference). Reconstructive techniques were favored over deliberate endovascular occlusion when dominant vessels were involved. Arterial reconstruction was performed in eight of nine patients using a flow-diverter implant (5 patients), stent-assisted coiling (1), overlapping stent implant (1), or implantation of a balloon-expandable stent (1). Deliberate VA occlusion with coils was performed in one of nine patients due to suboptimal expansion of the stented artery after flow-diverter implant. No neurological complications occurred during follow-up. All cases treated by reconstructive techniques showed complete, persistent pseudoaneurysm occlusion and full arterial patency. Endovascular therapy of traumatic VA pseudoaneurysms using neurostents and flow-diverters resulted in occlusion of the pseudoaneurysms, preservation of the parent vessel, and no periprocedural or delayed clinical complications, supporting the feasibility and safety of the approach.

1. Introduction

Cervical pseudoaneurysms of the vertebral artery (VA) have been reported only rarely and have received little attention in the literature. As occurs with their carotid counterparts, they can be classified based on etiology, clinical presentation, location, size, compromise of neighboring structures, degree of compromise of the involved vessel, and status of the collateral supply. Adequate characterization of the pseudoaneurysm guides appropriate therapeutic considerations.

Extracranial vertebral pseudoaneurysms are caused primarily by penetrating injuries to the neck, most commonly gunshot or stab wounds, while blunt trauma is considered less likely to provoke them [1]. Iatrogenic VA pseudoaneurysms have been described after a variety of interventions such as chiropractic manipulation, spinal surgery, subclavian vein catheterization, cervico-thoracic sympathectomy and cardiac pacemaker placement [2–5]. VA pseudoaneurysms frequently have an asymptomatic, indolent, and benign clinical course, and may even heal spontaneously [6]. However, embolic stroke and progressive pseudoaneurysm enlargement leading to local or irradiated pain, compression syndromes, arteriovenous fistula, or even compromise to the Parent artery lumen, with consequent risks of ischemic stroke, have all been described [7–10].

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The aim of our work is to present the clinical presentation, complications, and management of cervical pseudoaneurysms of the cervical VA secondary to blunt trauma.

2. Material and methods

We retrospectively reviewed clinical and imaging files to identify patients with pseudoaneurysms of the cervical VA who were treated in our Department from January 2008–January 2015. Cases of pseudoaneurysm that were diagnosed following blunt trauma were included in the current study; cases of vertebral dissection without pseudoaneurysm and those of pseudoaneurysm caused by penetrating injury or medical procedures (iatrogenic) were excluded. The Institutional Review Board waived the requirement for informed consent.

2.1. Imaging work-up

In general, patients admitted to the Emergency Department for head, neck, or multiple traumatic injuries are primarily evaluated with noncontrast head and neck CT scan, based on our institutional protocols and in accordance with accepted screening guidelines. CT angiography (CTA) is routinely performed in patients with suspected neurovascular injury, including all patients with cervical spine injuries. Catheter-based contrast angiography of the cervical and cerebral vessels is performed in cases of penetrating neck injuries; when neurovascular injury is suspected or proven on CTA; when there are acute focal neurological signs that are in apparent contradiction to the presentation on post-trauma head and neck CT scan, including cases of normal CTA; and in patients presenting with lower cranial nerve neuropathy or Horner's syndrome. In general, when there was no contraindication, anticoagulation is administered to all patients with traumatic supra-aortic trunk dissections.

2.2. Preprocedure clinical assessment

Routine trauma evaluation, full appraisal to rule out or identify hemorrhagic injuries, and assessment of the cervical spine are mandatory. Traumatic VA dissections occur most frequently at the V2 and V3 segments [11], but they may occur in other locations, extend to more than one segment, or occur in a dominant or hypoplastic artery, in patients with or without a complete circle of Willis, and in patients with or without rich collaterals. Evaluation of the vascular status and potential collateral supply, and thus the vascular reserve guides therapeutic options and defines procedural risks.

Clinical suspicion based on a CTA diagnosis of VA dissection followed by the detection of a corresponding ischemic lesion on advanced brain imaging (diffusion MRI) is the diagnostic basis for therapy. Available therapeutic strategies include anticoagulation, revascularization techniques (stent-assisted arterial reconstruction), and endovascular permanent arterial occlusion. When an endovascular approach is indicated, revascularization techniques are preferred, especially when dealing with dominant arteries or patients with limited collateral supply. Permanent arterial occlusion is considered only in the case of severely injured hypoplastic vessels where injuries did not involve the posterior inferior cerebral artery (PICA) origin and in patients with an absolute contraindication for antiaggregation therapy.

2.3. Indications for endovascular intervention in VA dissections

The clinical and radiographic questions used to determine when and whether VA dissections/pseudoaneurysms could be managed with endovascular techniques include:

(A) Is there a major contraindication for anticoagulation, usually due to the presence of traumatic intracranial hemorrhagic lesions, a large brain infarction, multiple systemic hemorrhagic injuries, or the need for other surgical or invasive procedures?

(B) Is there impending risk of stroke based on analysis of dissection severity, type, and location, as well as evaluation of both VAs and assessment of the presence and collateral blood flow via the posterior communicating arteries (PComAs)? At the high end of the risk continuum would be a patient presenting with hemodynamically significant dissection, string sign, or acute occlusion in a dominant or sole VA, without PComAs, especially in the presence of fluctuating neurological status. Patients at high risk of stroke should be considered for urgent endovascular reconstruction.

(C) Is there an ischemic stroke secondary to VA dissection with indication for emergent intracranial revascularization? Patients who are candidates for emergent intracranial revascularization procedures are considered for combined intra- and extracranial revascularization.

(D) Has there been clinical failure of anticoagulation? Patients who continue to suffer from repetitive transient ischemic attack, neurological instability, and/or neurological deterioration despite anticoagulation are regarded as nonresponders who are at high risk for stroke.

(E) Is the pseudoaneurysm enlarging or leading to local or distant symptoms, despite medication?

2.4. Endovascular procedure and technical considerations

Every patient with a suspected diagnosis of VA dissection based on findings at CTA is taken to the endovascular suite for diagnostic cervical and cerebral angiography, with eventual endovascular treatment when warranted.

Thrombocyte inhibition levels are confirmed by P12Y12 assay (VerifyNow, Accumetrics, San Diego, CA, USA) and a standard thrombocyte aggregation test. Patients are treated only if the thrombocyte inhibition level is above 30%; if the response is lower and without resistance, additional loading doses or increased daily doses (clopidogrel 150 mg daily) are administered. If clopidogrel resistance is detected, clopidogrel is discontinued and prasugrel or ticagrelor is given instead. Anesthesia is selected based on the patient's clinical status and level of cooperation, and ranged between local anesthesia, conscious sedation, and general anesthesia.

A 4F introducer sheath is placed in the right femoral artery and a selective bilateral subclavian-VA artery, common carotid artery, internal carotid artery, and external carotid artery angiographic study, including the extracranial and intracranial circulation is performed. Every lesion is analyzed in multiple angiographic positions and graded based on the aforementioned criteria. Potential working positions are identified in the preliminary diagnostic study.

If a VA endovascular procedure is planned, the 4F femoral introducer sheath is exchanged for a 6F introducer sheath. Following our protocol, the diagnostic angiogram is performed under a low dose of heparin (bolus of 1000 units intravenous). In cases where the need for endovascular revascularization is confirmed, the patient receives additional heparin to maintain moderate levels of anticoagulation (activated clotting time 250–270 seconds) and a loading dose of 300 mg aspirin and 300 mg clopidogrel orally or per nasogastric tube. A 6F guiding catheter is placed at the proximal VA dissection, selective angiography is performed and the injured arterial segment is characterized. Normal arterial diameters, lesion extension, severity of stenosis, and associated lesions are measured with the guiding catheter used as a reference diameter, and an appropriate stent for implantation is selected if stenting is indicated. Unsubtracted images are often very useful at this