Iatrogenic Carotid Artery Dissection during Neurointerventional Procedures: a Case Report and Review of the Literature

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Authors: C. Cotea, J. Hocking, A. Coulthard; QLD/AU
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Learning objectives

In this article, we describe iatrogenic carotid artery dissections, review the literature on treatment options and present a case of iatrogenic carotid artery dissection.
Background

Cervical artery dissections are the result of blood entering the media through a tear in the intima of vertebral or carotid arteries, which can be either intracranial or extracranial. Extracranial internal carotid dissections are the most common occurring 2-3 cm above the bifurcation of the common carotid artery. The aetiology of cervical artery dissections can be separated into spontaneous, traumatic and iatrogenic.

Iatrogenic Carotid Artery Dissections

Neurointerventional procedures require the insertion of catheters and guidewires into cervical arteries, resulting in an inherent risk of arterial dissection. With the development of soft tip guide catheters and meticulous catheter manipulation, its occurrence is uncommon, with a per procedure incidence of 0.15-0.6%. Some factors suspected to cause intimal tear during catheter advancement include pre-existing vascular disease, tortuous vascular anatomy and higher catheter or guide wire manipulation.

An iatrogenic carotid artery dissection (CAD) is a longitudinal split of the inner and medial layers of the arterial wall leading to mural haemorrhage, which tends to occur in mobile segments of carotid arteries such as the pharyngeal portion. Patterns of dissection are classified based on flow limitation: a minimal intimal tear is most commonly non-flow limiting, while a separation of the intimal flap to variable length either longitudinally or circumferentially (double lumen) is most commonly flow limiting. Furthermore, pseudoaneurysms caused by a dissection between the media and adventitia have no flow limitation but act as distal emboli, while slow arterial filling and distal emboli can also present as arterial dissection.

Imaging Modalities

Cervical angiography performed for neurointerventional procedures typically consists of diagnostic cerebral angiogram combined with the use of large vascular sheaths, microcatheters or microwires.

Conventional catheter-based digital subtraction angiography (DSA) is the gold standard for CAD as it allows easy reconstruction of cervical arteries and detects pseudoaneurysms, intimal flaps, high grade stenosis and double lumen. The most common CAD finding on DSA is a string sign characterized by a long, narrow column of
contrast material or flame-shaped tapering of the lumen. Angiographic mimics of CAD such as atherosclerotic disease and fibromuscular dysplasia need to be differentiated from CAD using previous imaging and follow-up imaging.

While CT angiography is the most sensitive imaging modality used for follow-up of iatrogenic CAD, MR imaging, MR angiography and Duplex ultrasonography are also useful non-invasive techniques for follow-up. The sensitivity and specificity of each test varies based on the location and extent of the dissection.

**Literature review**

Although the optimal treatment and associated clinical outcomes of iatrogenic CAD are not clearly established, management can be guided by the three largest studies of iatrogenic dissections currently available, including an 18 patient series by Paramasivam et al, a 12 patient series by Cloft et al, and a 68 patient series by Groves et al.

Arterial dissections can cause ischemic symptoms due to flow limitation, which can be attributed to severe stenosis, occlusion or thromboembolism. There are three options for the management of iatrogenic dissections: (1) medical treatment with antiplatelet and/or anticoagulation therapy to reduce the risk of thromboembolism; (2) no treatment, mainly where antiplatelet/ anticoagulation therapy is contraindicated; and (3) endovascular stenting to restore flow.

Antiplatelet and anticoagulation therapy is used by most institutions to reduce the risk of thromboembolism. In non-iatrogenic dissections, the indication for antiplatelet therapy includes general contraindication to anticoagulation, large infarcts, and intradural extension of the dissections given the risk of subarachnoid haemorrhage. The indication for anticoagulation includes the presence of a fresh thrombus in the arterial lumen or multiple ischemic lesions in the same arterial territory. Several class IV studies, systematic reviews, and a recent class I study to date have not found any significant difference in efficacy between anticoagulation and antiplatelet therapy in patients with CAD.

Furthermore, compared to traditional anticoagulants for CAD, treatment with new oral anticoagulants (NOACs) is associated with similar rates of recurrent stroke, fewer haemorrhagic complications, but greater rates of radiographic worsening. These data suggest that NOACs may be a reasonable alternative in the management of CAD.
In non-flow limiting iatrogenic dissections, a short course of heparin has been proposed in the acute phase followed by antiplatelet therapy for several months.\(^3\)

**1. Indication for Stenting**

The literature suggests that given the difficulty of selecting patients who may benefit from endovascular therapy, the indications are highly variable and often institution specific.\(^6,17\) However, most iatrogenic dissections are non-flow limiting and can be safely managed with medical treatment.\(^2\) Given that with optimal antithrombotic therapy stenosis resolves in approximately 90% of CADs and occlusion recanalises in approximately 66% of cases, endovascular stent placement is a very rare procedure; it is often reserved for flow limiting iatrogenic dissections with a lack of contralateral cross putting patients at risk of impending stroke. Furthermore, when intraoperative complications develop during an elective procedure, the literature suggests re-attempting the procedure at a later stage if possible, after thoroughly considering all potential treatment options.\(^4\)

**2. Outcome**

Although non-iatrogenic dissections are an important cause of stroke in young patients, previous studies have shown that post-injury infarction is uncommon in both non-iatrogenic and iatrogenic dissections.\(^3,9\) Infarction related to CAD generally occurs in the first two weeks after the dissection\(^13,19\) and decreases considerably beyond that point, with the risk of infarction after two weeks being similar to symptomatic carotid stenosis.

In general, resolution and healing of CADs is observed on follow-up imaging six months after diagnosis.\(^11,20\) Although complete recanalisation of the dissected vessel is usually observed, residual stenosis or occlusion may persist; however, the risk of stroke recurrence remains very low.\(^21\)

Follow-up non-invasive vascular imaging with MRA or CTA is recommended to document healing of the dissection before cessation of antithrombotic therapy.\(^20\)

**3. Location and Pattern of Dissection**
In the largest study, iatrogenic dissections were most common in the vertebral arteries, likely due to small vessel diameter, tortuous origin, and bony constraints of the transverse foramina. The most common pattern of dissection was minimal intimal tear.

4. Follow-up

The follow-up period ranged from one day to five years and the imaging modalities were variable, as all studies were retrospective. For example, Groves et al reported that follow-up imaging consisted of CT (12%), MRI (5.9%), angiography (49%), CT angiography (8.8%), and MR angiography (10%). Doppler ultrasonography was also used by Paramasivam et al.
Imaging findings OR Procedure details

A 53-year-old female was admitted for coiling of a 7mm left anterior communicating artery aneurysm. (Fig 1, Fig 2)

**Fig. 1:** 3D CT angiography showing a 7mm left anterior communicating artery aneurysm (arrow).

**References:** Royal Brisbane and Women’s Hospital - QLD/AU
Fig. 2: CT angiography showing a 7mm left anterior communicating artery aneurysm (arrow).

References: Royal Brisbane and Women's Hospital - QLD/AU

The procedure was performed under general anaesthetic. A right internal carotid artery (ICA) dissection was suspected when angiography showed a standing column of contrast within the right ICA and the micro guide wire and microcatheter could not be passed into the cavernous ICA. (Fig 3, Fig 4, Fig 5)
Fig. 3: Digital subtraction angiography (DSA) showing the micro guide wire and microcatheter at roughly the location in the cavernous ICA where the dissection occurred (arrow).

References: Royal Brisbane and Women's Hospital - QLD/AU
**Fig. 4:** DSA showing a standing column of contrast (flame sign) within the right internal carotid artery (ICA) (arrow). The micro guide wire and microcatheter could not be passed into the cavernous ICA.

**References:** Royal Brisbane and Women's Hospital - QLD/AU
Fig. 5: DSA showing a standing column of contrast within the right ICA (arrow).

References: Royal Brisbane and Women's Hospital - QLD/AU

The left ICA was cannulated to establish excellent crossflow into the right anterior and middle cerebral arteries with retrograde flow into distal right ICA. (Fig 6)
Fig. 6: DSA showing cannulation of the left ICA to establish excellent crossflow into the right anterior and middle cerebral arteries with retrograde flow into distal right ICA.

Red Arrow - ICA, Blue Arrow - PCOMM, Pink Arrow - Vertebral Artery

References: Royal Brisbane and Women's Hospital - QLD/AU

Left vertebral injection filled the right ICA retrogradely to the syphon via a prominent posterior communicating artery. It was felt that there was sufficient crossflow and collateral flow to compensate for the absence of flow within the right ICA, and it was considered that further attempts to re-establish flow in the right ICA could be counterproductive and unsafe. The procedure was therefore terminated. The patient was managed conservatively with anticoagulation (intravenous Heparin for 48 hours) and antiplatelet therapy (Plavix and Aspirin), in case of requirement for endovascular therapy.

The patient demonstrated early complete revascularisation of the right internal carotid artery with minimal residual irregularity. It would appear most likely still that it was a localised dissection that has recanalised, possibly complicated by spasm or thrombus in view of the surprising rapid, almost full recovery. (Fig 7)
Fig. 7: Axial MR angiography demonstrating early complete revascularisation of the right internal carotid artery with minimal residual irregularity (arrow).

References: Royal Brisbane and Women's Hospital - QLD/AU

The patient had no neurological deficits and was discharged home on Enoxaparin for one week and Aspirin.

MR angiography at three and six months confirmed complete revascularisation of the right internal carotid artery with minimal residual irregularity. (Fig 8, Fig 9)
**Fig. 8**: MR angiography at 3 months confirming complete revascularisation of the right internal carotid artery with minimal residual irregularity.

**References**: Royal Brisbane and Women's Hospital - QLD/AU
**Fig. 9:** MR angiography at 6 months confirming complete revascularisation of the right internal carotid artery with minimal residual irregularity.

**References:** Royal Brisbane and Women's Hospital - QLD/AU
Conclusion

Our case and literature review confirm that iatrogenic carotid artery dissections are uncommon and are primarily managed with conservative treatment. Endovascular treatment for carotid artery dissection is performed as a rescue treatment to prevent impending ischemic stroke despite optimal conservative treatment. A low rate of complications has been reported following a generally conservative approach to the management of CAD using either no treatment or antiplatelet/anticoagulation therapy. Angiography is the best modality for follow-up.

Given the relatively rare incidence of iatrogenic CAD, collaboration between neurointerventional centers worldwide should be considered to enroll patients in a randomised trial comparing the available treatment options discussed above. Given the excellent outcomes seen with early detection and aggressive management of CAD, it is important for radiologists to be aware of this complication and consider stenting as a feasible rescue treatment.
Personal information

Dr Cristina Cotea is a Junior House Officer at the Royal Brisbane and Women’s Hospital.

Dr Jeffrey Hocking is a Senior House Officer at the Royal Brisbane and Women's Hospital.

Professor Alan Coulthard is a Consultant Diagnostic and Interventional Neuroradiologist at the Royal Brisbane and Women's Hospital, Brisbane and Professor of Neuroradiology and Head of the Academic Discipline of Medical Imaging at the University of Queensland.
References


