On the Road to Understanding and Internal Carotid

Improvements in neurovascular imaging have led to an increased recognition of cranio-cervical dissections and have provided considerable data regarding causation.

By Carlos A Feliciano, MD and Réza Behrouz, DO

A relatively rare entity overall, internal carotid arterial dissection (ICAD) is a common cause of ischemic stroke in persons younger than 45 years of age.[1] The incidence of detected carotid artery dissection is estimated to be 2.5 to three per 100,000.[1-3] There is no overall sex-based predilection, however, women are on average younger than men.[1]

Improvements in neurovascular imaging have led to an increased recognition of cranio-cervical dissections and have provided considerable data regarding causation. Despite these advances and numerous published case series, no evidence-based guideline exists to steer medical or surgical management. To date, no controlled study has yet been undertaken, and most published studies advocating one therapeutic scheme over another are based on uncontrolled and retrospective data.[1] This is perhaps due to the rarity of ICAD and the fact that a large and uncertain number of patients are needed to conduct these studies. Moreover, ICAD does not always translate into a clinical syndrome and many affected individuals remain asymptomatic. In this review, the authors will describe causes, risk factors, and diagnostic and therapeutic modalities of ICAD.

Pathogenesis

Although the exact pathogenesis of ICAD is unclear, an underlying arteriopathy leading to a "weakness" of the vessel has been postulated.[4-7] Other studies have suggested the presence of vessel wall abnormality, which could impair vasomotion and subsequently predispose an artery to dissection.[6]

ICAD occurs when blood penetrates through a subintimal tear into the arterial wall leading to creation of a false lumen (Figure 1). Blood accumulation can occur in the false lumen, leading to stenosis or occlusion of the artery (Figure 2). Distal embolization from this site and/or hypoperfusion can result in cerebral ischemia.[8,9]

ICAD often occurs in otherwise healthy individuals without known risk factors for stroke and frequently develops spontaneously without relevant trauma. Occasionally, mild mechanical stress such as a sudden head movement, infection, coughing, or sport activities before dissection has been report.[10]

Some of the risk factors for ICAD are genetic or inborn disorders with a familial association, such as fibromuscular dysplasia and connective tissue diseases (Marfan, Ehler-Danlos), migraine, and homocysteinemia.[10] Direct or indirect trauma to the neck may cause ICAD, but the cause of most spontaneous dissections is not known; the role of trivial trauma is uncertain because most reported activities had been performed previously without incident.[4]

Identifying Artery Dissection

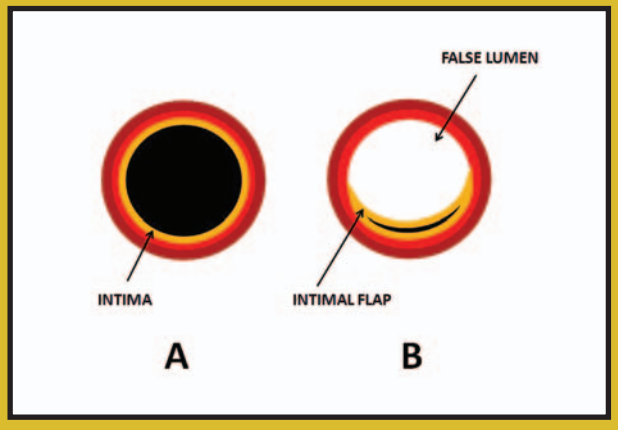

Fig. 1
Cross sectional view of the internal carotid artery (ICA): A.) Normal vessel. B.) Intimal tear and subsequent folding of the flap resulting in formation of a "false lumen" within the artery.

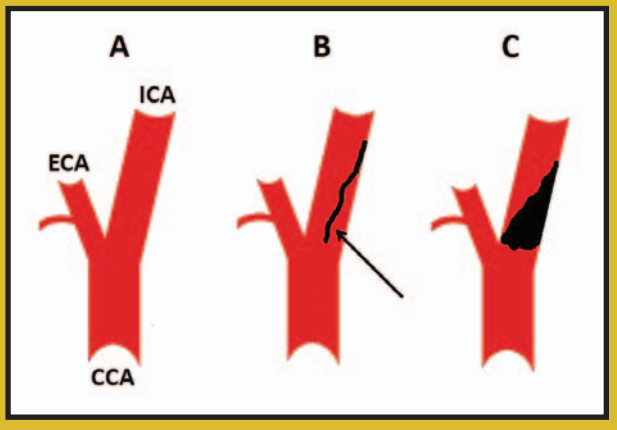

Fig. 2
A.) Normal vessel. B.) Intimal tear (arrow). C.) Accumulation of blood within the "false lumen," creating an intramural thrombus.

Artwork by Réza Behrouz, DO

Clinical Presentation

In most cases, ICAD causes permanent or transient ischemia of the brain or retina. These are often preceded by local signs and symptoms on the side of dissection. Local signs and symptoms include headache, neck pain, Horner syndrome, pulsatile tinnitus and palsy of the cranial nerves. Less frequently, ICAD causes no cerebral or retinal ischemia but shows local signs and symptoms only or remains clinically asymptomatic. Asymptomatic ICAD may be incidentally detected during a routine diagnostic work-up.[5,11]

Pain is often noted to be the most common presenting feature, reported in 60 to 94 percent of patients.[2] In adults, pain often serves as an important "warning symptom," facilitating early diagnosis of cerebral arterial dissection. Headache is frequently the earliest symptom of carotid artery dissection and is reportedly present in 60 to 75 percent of patients.[2] The frequent occurrence of fronto-temporal headaches and orbital, facial, and ear pain in patients with ICAD is consistent with the observation that stimulation of the carotid artery bifurcation can produce pain referred to these areas.[2,7,11]

Physicians still have to decide whether an individual with ICAD should receive immediate anticoagulation or antiplatelet agents.

Another frequent finding in patients with ICAD is partial oculosympathetic palsy (Horner's Syndrome) characterized by ptosis and miosis, but less commonly anhydrosis. This is because sympathetic fibers innervating the facial sweat glands track along the external rather than internal carotid artery. The combination of Horner's syndrome and unilateral headache (hemicrania), especially in the anterior head region, is strongly suggestive of ICAD.[2]

Signs of cerebral ischemia at presentation are noted in 49 to 79 percent of patients.[2] Other associated neurologic manifestations: include dysgeusia, amaurosis fugax, and cranial nerve (CN) palsies.[2,5,12]

Carotid Dissection and Stroke

Cervical artery dissections account for up to 20 percent of ischemic strokes in young adults.[13] ICAD causing severe stenosis or occlusion are more likely to lead to cerebral or retinal ischemia than those without luminal narrowing. Stroke due to ICAD is a consequence either of embolism originating from the injured intima or of hemodynamic compromise. Several arguments support an embolic mechanism. These include observation of

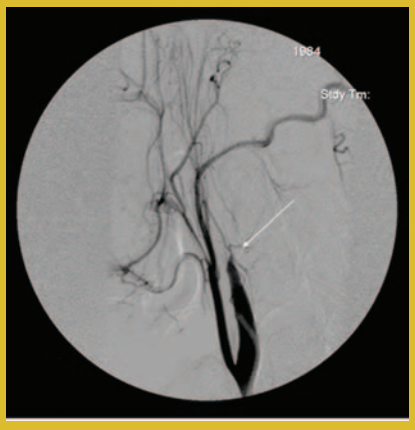

Fig. 3
Digital subtraction (catheter) angiography of the ICA demonstrating a "flame-shaped" stump suggesting dissection of the artery.

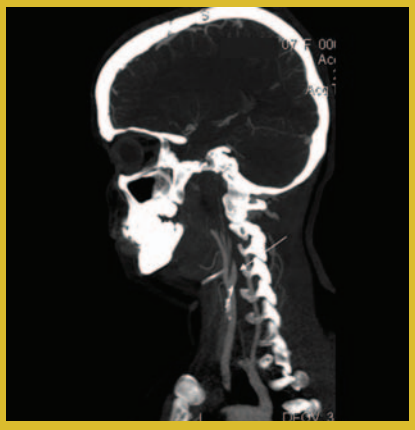

Fig. 4
CT angiography (CTA) of ICA demonstrating a "flame-shaped" stump suggesting dissection of the artery.

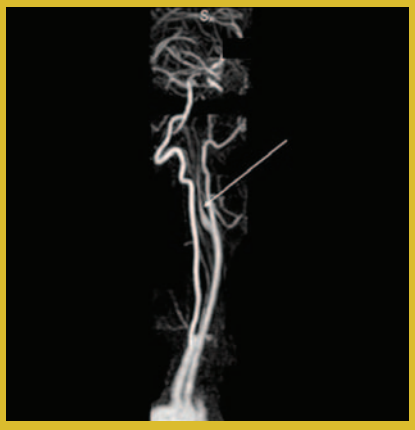

Fig. 5
MR angiography (MRA) of ICA showing narrow flow through the lumen in a "string" pattern.

microemboli on transcranial Doppler ultrasound, the occurrence of distal branch occlusions, and the infarct lesion pattern on brain scans.[1,5,8,10,13,14,15] Studies looking at infarct lesion pattern on CT or MRI in stroke patients with ICAD have revealed that the vast majority had cortical, large subcortical or mixed cortical-subcortical lesions.[8] Diffusion-weighted imaging (DWI) analyses have revealed that 71 percent of ICAD patients have multiple abnormalities, suggesting that in most patients, artery-to-artery embolism rather than hemodynamic compromise is the main underlying mechanism in stroke attributable to ICAD.[15]

Intracranial artery dissections (IADs) arerarer than extracranial artery dissections. IAD has two major clinical presentations: subarachnoid hemorrhage (SAH) andbrain ischemia. The mechanism involved in SAH is related to the absence of an external elastic membrane and the presence of thin muscular and adventitial layers. This characteristic makesthese arteries prone to subadventitial dissection and rupture, with subsequent SAH.[12,15] IAD is associated with subarachnoid hemorrhage in 20 percent of patients.[15] Interestingly, adults with intracranial dissections have a younger age at onset than those with extracranial dissections. In addition, a slight male predominance has been noted in adults with intracranial CAD.[11]

Diagnosis

Historically, diagnosis of arterial dissections has depended upon digital subtraction catheter angiography (DSA) (Figure 3). Magnetic resonance and computed tomographic angiography (MRA and CTA, respectively) are considered to proximate the sensitivity of DSA (Figures 4 and 5). The affected artery may appear completely occluded with a "flame-shaped" stump or demonstrate narrow flow through the true lumen, a picture that is often called "string sign."

Ultrasonographic techniques may be useful in the initial assessment of patients with a suspected ICAD. A combination of Doppler color-flow imaging and transcranial ultrasonography provides the most useful information in the detection and follow-up of carotid-artery dissection.[18,19] One study suggest that ultrasound allows the reliable exclusion of an underlying CAD in patients with carotid territory ischemia and reduces the diagnostic workup and associated costs. However, the false-positive findings indicate that the diagnosis of ICAD should be confirmed by cervical MRI and MRA.[18] Others suggest that ultrasound is not a reliable method to diagnose ICAD in patients with local signs and symptoms.[19]

Management

Although anticoagulation is the widely-advocated treatment for ICAD, it is still debated whether this approach is superior to antiplatelet agents. Unfortunately, evidence from randomized trials on the efficacy of either therapeutic approach is lacking. One has to obviously balance the risks and bene-

fits of therapy. The risk of intracranial hemorrhages as a treatment complication seems to be low.[5,8,16] It must be emphasized that intracranial extension of ICAD seems a feature arguing against anticoagulation.[17]

In spite of the controversy, physicians still have to decide whether an individual with ICAD should receive immediate anticoagulation or antiplatelet agents in order to prevent cerebral infarction. As a limitation, this assumption is based upon uncontrolled dataA large randomized controlled trial-comparing anticoagulants and antiplatelets is desirableand ethically justified.[8]

Approximately 75 percent of ICADs recanalize in three to six months.[13] Patients may be treated via anticoagulation for this period and then switched to an antiplatelet agent. Some practitioners repeat a CTA or MRA at three months to determine if the artery has recanalized. If flow has been reconstituted and the interior wall of the artery does not demonstrate irregularities, then the patient is taken off anticoagulants and placed on antiplatelets. Otherwise, he or she is anticoagulated for an additional three months and then switched to aspirin or other antiplatelet agents.[5,6]

Although over 85 percent of medically-treated patients with ICAD improve clinically and angiographically, there are circumstances which may insinuate that medical management is inadequate.[3] When medical therapy is inadequate, surgical repair can be used. ICAD can be safely and effectively treated with stenting. This may be treatment of choice for patients with persistently symptomatic steno-occlusion in spite of medical therapy. Because the natural history of most cases of CAD is generally favorable, most patients with ICAD do not require endovascular therapy.[3,20]

Prognosis

The reported mortality from ICAD is less than five percent and about three fourths of patients who have had a stroke make a good functional recovery.[5,21,22] As previously mentioned, most severe stenoses and some occlusions will recanalize within weeks or months, but may persist in 15 to 25 percent of cases.[13] The annual rates for ischemic stroke in the territory of the dissected carotid artery and for any stroke were similarly low in patients with permanent (0.7and 1.4 percent) and transient (0.3 and 0.6 percent) severe stenosis or occlusion of the ICA.[13]

The incidence of ICAD recurrence is difficult to ascertain since some recurrences are asymptomatic, especially within the first few weeks. Nonetheless, the risk of recurrent carotid dissection identified by angiography is estimated at approximately two percent in the first month and one percent annually.[1]

One study estimated the rate of symptomatic CAD recurrence at 0.3 percent per year).[22] This is slightly lower than that reported in previous studies in which patients with connective tissue disease or a familial history of ICAD accounted for the vast majority of recurrences.[22] **PN**

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