EE040
Blunt Cerebrovascular Injury: Indications for Screening and Imaging Criteria and Review of Current Guidelines

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Blunt Cerebrovascular Injuries (BCVI)

- Incidence of cerebrovascular injury in blunt trauma patients: 0.1%
- The majority of these injuries diagnosed after the development of symptoms
- Morbidity of up to 80% and mortality of up to 40%.
  - Screening of asymptomatic patients increases the incidence to 1%.
  - As high as 2.7% in patients with an Injury Severity Score 16.
- Most recent guidelines for screening, diagnosis and treatment are provided by the Eastern Association for the Surgery of Trauma Organization Practice Management Guidelines Committee, updating Denver Criteria
Evidence Based Recommendations

Committee of 10 trauma surgeons reviewed data to establish Evidence Based Guidelines:

Level I: unifying class I data, or strong class II evidence, especially if the issue does not lend itself to testing in a randomized format.

No level I guidelines were supported by the literature.

Level II: usually supported by class II data or a preponderance of class III evidence.

Seven level II guidelines

Level III: Supported by available data, but adequate scientific evidence is lacking. This recommendation is generally supported by class III data. This type of recommendation is useful for educational purposes and in guiding future clinical research.

Nine level III guidelines
Results: Indications for Screening and Imaging for BCVI

**Level II:**
1. Patients with unexplained neurologic sign/symptom
2. Blunt trauma patients with epistaxis from a suspected arterial source

**Level III:**
Asymptomatic patients with significant blunt head trauma as defined here are at higher risk for BCVI and screening should be considered:
1. Glasgow Coma Scale score <8
2. Petrous bone fracture
3. Diffuse axonal injury
4. Cervical spine fracture particularly those with (i) fracture of C1 to C3 and (ii) fracture through the foramen transversarium
5. Cervical spine fracture with subluxation or rotational component;
6. Le fort II or III facial fractures
ICA Dissection: Background

Delamination of ICA wall by tear or rupture of intima allowing blood to gain access to subintima and media

Demographics
- Age range: 30-55 years
- Average age: 40 years
- Annual incidence: 2.5-3 per 100,000
- Extracranial CAD > > intracranial CAD or common carotid artery dissection
- 20% of ICADs are bilateral or involve vertebral arteries

Prognosis
- 90% of stenoses resolve
- 66% of occlusions are recanalized
- 33% of aneurysms decrease in size
- Risk of recurrent dissection = 2% (1st month), then 1% per year (usually in another vessel)
- ↑ risk of stroke due to thromboembolic disease; related to severity of initial ischemic insult, not to degree of stenosis
- Death from CAD < 5%
ICA Dissection Imaging

- Imaging
  - Pathognomonic findings of dissection: **Intimal flap or double lumen** (seen in < 10% of cases)
  - Aneurysmal dilatation seen in 30% of cases
    - Commonly in distal cervical segment of ICA
    - Focal pseudoaneurysm unusual
  - Flame-shaped ICA occlusion (acute phase)
  - ICA dissection most commonly originates in ICA 2-3 cm distal to carotid bulb and variably involves distal ICA
    - Stops before petrous ICA
  - MR T1 with fat suppression best sequence for hyperintense mural hematomas
ICA Dissection Imaging

- **Best imaging tool**
  - Angiography may be gold standard for CAD, but few cases undergo angiography
  - CTA and MRA emerge as superior technologies to image intramural and extraluminal dissection components
  - Frequently, 1st step in imaging evaluation

- **MRI Protocol**
  - Best sequence for hyperintense mural hematomas:
    - MR T1 with fat suppression
ICA Dissection Classification

Biffle / Denver Grading Scale

Grade I:
- Intimal irregularity with < 25% narrowing

Grade II:
- Dissection with > 25% narrowing

Grade III:
- Arterial pseudoaneurysm

Grade IV:
- Arterial occlusion

Grade V:
- Transection with extravasation
ICA Dissection Differential Diagnosis

- **Carotid Fibromuscular Dysplasia**
  - "String of beads" and long-segment stenosis
  - May have associated CAD

- **Carotid Artery Fenestration**
  - Normal variant, short segment fenestration often at C1-C2

- **Atheromatous Plaque**
  - Irregular excavation of vessel, narrowing of vessel due to fibrofatty plaque ± calcified plaque in vessel wall

- **Glomus Vagale Paraganglioma**
  - Nasopharyngeal carotid space mass with "salt and pepper" flow phenomena on MR and avid enhancement on CECT and T1 C+ MR
Treatment Guidelines

**Level II:**

- Barring contraindications, grades I and II injuries should be treated with antithrombotic agents such as aspirin or heparin.

**Level III:**

1. Either heparin or antiplatelet therapy can be used with equivalent results.

2. Grade III injuries (pseudoaneurysm) invasive therapy (surgery or IR) should be considered.

3. In patients with an early neurologic deficit and an accessible carotid lesion operative or interventional repair should be considered to restore flow.
Imaging Pearl: ICA dissection may present as:

Luminal occlusion  Stenosis  Pseudoaneurysm

A) DSA in a patient with traumatic injuries shows right ICA dissection. ICA smoothly tapers to occlusion just above the bifurcation.

B) T1WI FS MR of right ICA dissection shows high signal intensity in a subacute mural hematoma of the right ICA (white solid arrow) with low signal in the residual narrowed lumen, and diameter of ICA compared to that of the normal left.

C) DSA in a patient involved in head-on collision shows focal wall irregularity of the upper cervical right ICA, representing dissection. A focal pseudoaneurysm is present.

Source: StatDx
Vertebral artery dissection

Irregularity of vertebral artery from intimal tear or subadventitial hematoma:

- Two distinct forms of VA dissection
  1. **Steno-occlusive dissection**
     - Dissection to subintimal plane with vessel luminal narrowing or occlusion
  2. **Dissecting aneurysm**
     - Dissection into subadventitial plane with dilatation of outer wall

- Intramural hematoma is pathognomonic,
  - Best seen as bright crescent on T1 FS MR
Case 1: Vertebral and ICA Dissections

The patient was involved in an ATV accident and met the following criteria for screening and imaging for suspected BCVI (highlighted):

1. **Glasgow Coma Scale score <8**
2. Petrous bone fracture
3. Diffuse axonal injury
4. **Cervical spine fracture particularly those with (i) fracture of C1 to C3 and (ii) fracture through the foramen transversarium**
5. Cervical spine fracture with subluxation or rotational component;
6. Le fort II or III facial fractures
Case 1. A) The patient in an ATV accident had a Jefferson’s fracture.

B) Right vertebral artery dissection and thrombus at its expected location.

C) Left distal ICA dissection and D) pseudoaneurysm (Arrows).
Case 1.

Coronal reconstructions in the same patient demonstrate distal left cervical ICA shows a dissection causing moderate to severe narrowing with a pseudoaneurysm measuring 5 x 8 mm. Focal pseudoaneurysm is an uncommon imaging finding in carotid dissection.
Case 1: Outcome

- This patient was high risk based on the provided criteria and underwent CT Angiography of head and neck revealing bilateral cerebrovascular injuries:
  - Right vertebral artery dissection
  - Left distal ICA dissection and pseudoaneurysm
  - The patient was treated with long-term heparin given the absence of contraindications.
  - Follow up CT Angiography demonstrated reduced calibre of dissections.
Case 2: Bilateral ICA Dissections

The patient was involved in an MVC, and was asymptomatic. She orthopedic fractures and did not meet any of the following proposed following criteria. She underwent imaging after development of neurological symptoms.

1. Glasgow Coma Scale score <8
2. Petrous bone fracture
3. Diffuse axonal injury
4. Cervical spine fracture particularly those with (i) fracture of C1 to C3 and (ii) fracture through the foramen transversarium
5. Cervical spine fracture with subluxation or rotational component;
6. Le fort II or III facial fractures
Case 2: Bilateral ICA Dissections

CTA demonstrates the presence of (A) left and B) right ICA dissections with apparent intimal flaps.

C) Coronal reconstructions show bilateral distal internal carotid artery irregularity and thrombus.
Case 2: Bilateral ICA Dissections

- This patient did not meet any of the proposed screening criteria and underwent delayed imaging after becoming symptomatic.
- This case illustrates the limitations of the proposed criteria for screening and imaging of patients involved in blunt trauma.
- Further studies are required to increase the sensitivity of screening criteria.
- However, the cost-benefit analysis of more inclusive criteria is unclear.
The patient was involved in an ATV accident and suffered multiple injuries. He met the following criteria for BCVI screening and imaging (highlighted):

1. **Glasgow Coma Scale score <8**
2. Diffuse axonal injury
3. Cervical spine fracture particularly those with (i) fracture of C1 to C3 and (ii) fracture through the foramen transversarium
4. Cervical spine fracture with subluxation or rotational component;
5. Le fort II or III facial fractures
6. Petrous bone fracture
Case 3: Bilateral ICA Dissections

A) Bilateral ICA dissections in a patient involved in ATV accident.

B) Bilateral ICA dissections extending to the cranioservical junction. The patient was not an optimal candidate for heparin infusion, due to concomitant liver lacerations, and was treated with Aspirin 81mg daily.
Case 3

- The patient had contraindications (Liver lacerations) to heparin infusion therapy and was treated with ASA 81 mg daily.

- This case illustrates that despite inclusive criteria for detection of BCVI in trauma patients, contraindications limit institution of antithrombotic therapy in some cases of trauma.

- Further studies are required to determine the incidence of contraindications.
Summary

- ICA dissections can present with imaging findings of:
  - Luminal occlusion, stenosis, pseudoaneurysm

- Vertebral Artery dissections can present as two forms:
  - Steno-occlusive or dissecting aneurysm

- Screening criteria for imaging of blunt trauma patients for BCVI include:

  1. **Glasgow Coma Scale score <8**
  2. Diffuse axonal injury
  3. Cervical spine fracture particularly those with (i) fracture of C1 to C3 and (ii) fracture through the foramen transversarium
  4. Cervical spine fracture with subluxation or rotational component;
  5. Le fort II or III facial fractures
  6. Petrous bone fracture

