Managing Hyperperfusion Syndrome Post Carotid Endarterectomy or Stent

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Disclosures

• I have no conflicts of interest
Hyperperfusion Syndrome

- Cerebral hyperperfusion syndrome is a rare, serious complication of carotid revascularization either after carotid endarterectomy or carotid stent placement.
- Impaired cerebral autoregulation and post-revascularization changes in cerebral hemodynamics are the main mechanisms involved in the development of the syndrome.
- In severe cases it can lead to intractable seizures and fatal intracranial hemorrhage.
Hyperperfusion Syndrome

• Cerebral Hyperperfusion Syndrome
  • Spetzler first described the phenomenon of hyperperfusion in 1978 following resection of an AVM, and attributed it to impaired cerebral autoregulation
  • First described following CEA by Thor Sundt in 1981
  • Described a combination of increased arterial blood pressure with the clinical triad of ipsi-lateral migraine-like headache, seizure, and transient focal neurologic deficits in the absence of cerebral ischemia following a successful CEA
Hyperperfusion Syndrome

• Risk Factors
  • Underlying sub-clinical chronic ischemia
    • High grade internal carotid artery stenosis
      • Can be unilateral or bilateral
  • Intra-operative ischemia during CEA or CAS
  • Hypertension
Hyperperfusion Syndrome
Hyperperfusion Syndrome

• Hyperperfusion is defined as the increase in CBF compared to pre-operative or baseline values.

• Hyperperfusion syndrome is usually associated with more than 100% increase in baseline values

• Hyperperfusion following CEA or CAS occurs in < 1% of patients

• The presence of symptoms is essential in the definition of the syndrome
Hyperperfusion Syndrome

• Hyperperfusion Syndrome could also be called “reperfusion syndrome”

• The main autoregulatory mechanism is the cerebrovascular reactivity, the ability of the arterioles to constrict or dilate in response to the alterations of blood flow or to other stimuli

• Patients with extracranial carotid stenosis often present exhausted cerebrovascular reactivity. This situation represents a status of maximal vasodilatation of cerebral arterioles, in order to maintain sufficient cerebral blood supply, counterbalancing the reduced perfusion caused by a hemodynamically significant carotid lesion
Hyperperfusion Syndrome

- The most catastrophic event that can occur secondary to hyperperfusion is intracerebral hemorrhage (ICH).
- Intracerebral hemorrhage occurs in 0% to 1% of patients in large series of carotid endarterectomy (CEA) and in 0.3 to 4.5% following CAS.
- Since intracerebral hemorrhage is associated with CHS, manifestations of increased intracerebral pressure (eg, vomiting or altered sensorium) can be present.
- Hyperacute intracranial hemorrhage is a variant that has been reported occurring within hours following CAS and involves rupture of perforating arteries acutely exposed to normalized perfusion pressure.
Hyperperfusion Syndrome

- The severity of microvascular autoregulation impairment may be dependent on the duration and intensity of cerebral hypoperfusion;
- This is associated with the severity of the ipsilateral carotid stenosis, the presence of contralateral carotid occlusion, and poor collateral flow;
- Increased nitric oxide levels during clamping of the ICA and increased oxygen-derived free radicals produced during the restoration of the perfusion pressure are involved in endothelial dysfunction and the deterioration of autoregulatory mechanisms after CEA;
- Increased CBF, which can not be controlled by autoregulatory mechanisms, leads to transudation of fluid into the pericapillary astrocytes and interstitium. This results in vasogenic white matter edema.
Cerebral Edema in Hyperperfusion
Hyperperfusion Syndrome

• Clinical Presentation
  • Headache in the early post-operative period following carotid revascularization
  • Periodic lateralizing epileptiform discharges on EEG
    • PLEDS
  • Seizures
  • Cerebral edema may be seen on MRI
  • Intracranial hemorrhage
  • Herniation
Hyperperfusion Syndrome

• PLEDs Features
  • Lateralized or focal
  • Periodic (or near periodic)
  • Usually electronegative bi-, tri- and polyphasic spikes and sharp waves
  • Present for most of the recording
  • Usually maximal on side of structural lesion
  • Ipsilateral background slowing on side of PLEDS
  • Ipsilateral reduction of background activity
Hyperperfusion Syndrome

• PLEDs
  • Repetitive, rhythmic lateralized or focal spike, spike-wave, or sharp wave complexes recurring at regular or nearly regular intervals throughout most of all of the EEG recording, with return to background activity between discharges, and without clear evolution in frequency or location
Hyperperfusion Syndrome

PLEDS
Hyperperfusion Syndrome

• PLEDS
Hyperperfusion Syndrome

• Management
  • Oral medication to relieve tension and migraine headaches caused by dilated intracranial blood vessels for mild cases
    • Midrin
      • Isomethptene for mild vasoconstriction
      • Dichloralphenazone for calming effect
      • Actetaminophen for pain
  • Control of hypertension is critical
    • IV infusions for blood pressure control
  • Control of seizure activity
  • May require intubation and deep sedation until EEG normalizes
Hyperperfusion Syndrome

Hyperperfusion Syndrome: A condition characterized by increased cerebral blood flow leading to cerebral edema, increased intracranial pressure, and potential cerebral infarction.

Symptoms may include headache, neurological deficit, or seizures.

Diagnosis and Treatment:
- **CEA or CAS**:
  - Headache
  - If severe: TCD
    - Perfusion increase >100%
- **Brain CT scan**:
  - Cerebral edema
  - ICH
    - Negative: Ischemic infarct
    - Negative: Normal
    - DW-MRI
    - Duplex scan
      - Technical defect or thrombus
      - Normal
      - Consider re-intervention
- **Conservative treatment**:
  1. Strict control of BP
  2. Consider mannitol, cortisone, diuretics, anti-epileptic
  3. Consider discontinuation of anticoagulants, antiplatelets
- **Consider neurosurgical management**
- **Consider embolectomy, thrombolysis or aspiration**
Hyperperfusion Syndrome

• Summary
  • Hyperperfusion syndrome is not truly predictable
  • However, be vigilant in patients who have very high-grade stenosis, particularly when bilateral and long-standing
  • Post-operative hypertension should be vigorously managed
  • If post-operative headache is noted, obtain EEG to look for PLEDS
  • If PLEDS identified, transfer to observation unit and aggressively treat hypertension and any seizure activity
  • Consider use of mannitol, steroids, diuretics, anti-epileptics
  • Consider discontinuation of anticoagulants and antiplatelets
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Thank you!
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