Ischemic stroke

After subarachnoid hemorrhage delayed onset vasospasm can result in devastating ischemic stroke.

Ischemia results if blood flow to the brain is below 18 to 20 ml per 100 g per minute, and tissue death occurs if flow dips below 8 to 10 ml per 100 g per minute.

Epidemiology

Ischemic stroke epidemiology.

Classification

Acute ischemic stroke.

Anterior circulation stroke.

Cardioembolic ischemic stroke

Chronic ischemic stroke.

Delayed cerebral ischemia.

Cryptogenic stroke

Large vessel ischemic stroke.

Non-cardioembolic ischemic stroke.

Perinatal arterial ischemic stroke.

Chronic Cerebral Ischemia

Pathogenesis

Cerebral Ischemia Pathogenesis.

There are four categories of cerebral hypoxia; they are, in order of severity:

Diffuse cerebral hypoxia (DCH),

Focal cerebral ischemia, cerebral infarction, and global cerebral ischemia. Prolonged hypoxia induces neuronal cell death via apoptosis, resulting in a hypoxic brain injury.

Etiology

Pneumothorax,MI,CHF…

The cranial cavity is a closed compartment and any breach to this confined space secondary to neurosurgery or trauma causes an imbalance between atmospheric pressure and intracranial pressure. As the altitude increases, the atmospheric pressure decreases, and hypoxia with hypercarbia is a well-known fact. In children, there is an argument to suggest that hypoxia can contribute to a mild increase in intracranial pressure during commercial flights [1)].

Many competitive breath-hold divers use dry apnoea routines to improve their tolerance to hypoxia and hypercapnia, varying the amount of prior hyperventilation and lung volume. When hyperventilating and exhaling to residual volume prior to starting a breath-hold, hypoxia is reached quickly and without too much discomfort from the respiratory drive. Cerebral hypoxia with loss of consciousness (LOC) can easily result.

Valdivia-Valdivia et al. from the Neurosurgery Department, St. Joseph's Hospital, Tampa report on a case where an unsupervised diver used a nose clip that is thought to have interfered with his resumption of breathing after LOC. Consequently, he suffered an extended period of severe hypoxia, with poor ventilation and recovery. He also held his breath on empty lungs; thus, trying to inhale created an intrathoracic sub-atmospheric pressure. Upon imaging at the hospital, severe intralobular pulmonary edema was noted, with similarities to images presented in divers suffering from pulmonary barotrauma of descent (squeeze, immersion pulmonary edema). Describing the physiological phenomena observed in this case highlights the risks associated with unsupervised exhalatory breath-holding after hyperventilation as a training practice in competitive freediving [2)].

Risk factors

Ischemic stroke risk factors.

Pathophysiology

In brain tissue, a biochemical cascade known as the ischemic cascade is triggered when the tissue becomes ischemic, potentially resulting in damage to and death of brain cells.

Clinical features

see Acute Ischemic stroke clinical features.

Diagnosis

see Acute Ischemic stroke diagnosis.

Treatment

see Ischemic stroke treatment.

Prevention

Choice of oral anticoagulant: compared to vitamin K antagonists (VKAs) (e.g. warfarin), the novel oral anticoagulants (NOACs) dabigatran, rivaroxaban & edoxaban are at least as effective in preventing ischemic stroke and systemic embolization in patient with atrial fibrillation.

Complications

see Ischemic stroke complications.

Outcome

Ischemic stroke is a major cause of death and long-term disability worldwide.

Case series

A cohort study involved a retrospective analysis using data for 4888 US hospitals from the 2016-2020 National Inpatient Sample database. Participants included adults (age ≥18 years) with ischemic stroke (per codes from the International Statistical Classification of Diseases, Tenth Revision, Clinical Modification), who were organized into study groups of hospitalized patients with cardiac interventions vs without. Individuals were excluded from the study if they had either procedure before admission, Endovascular thrombectomy (EVT) before cardiac intervention, EVT more than 3 days after admission or cardiac intervention, or endocarditis. Data were analyzed from April 2023 to October 2023.

Exposures: Cardiac intervention during admission.

Main outcomes and measures: The odds of undergoing EVT by cardiac intervention status were calculated using multivariable logistic regression. Adjustments were made for stroke severity in the subgroup of patients who had a National Institutes of Health Stroke Scale (NIHSS) score documented. As a secondary outcome, the odds of discharge home by EVT status after cardiac intervention were modeled.

Results: Among 634 407 hospitalizations, the mean (SD) age of the patients was 69.8 (14.1) years,

318 363 patients (50.2%) were male, and 316 044 (49.8%) were female. A total of 12 093 had a cardiac intervention. An NIHSS score was reported in 218 576 admissions, 216 035 (34.7%) without cardiac intervention and 2541 (21.0%) with cardiac intervention (P < .001). EVT was performed in 23 660 patients (3.8%) without cardiac intervention vs 194 (1.6%) of those with cardiac intervention (P < .001). After adjustment for potential confounders, EVT was less likely to be performed in stroke patients with cardiac intervention vs those without (adjusted odds ratio [aOR], 0.27; 95% CI, 0.23-0.31), which remained consistent after adjusting for NIHSS score (aOR, 0.28; 95% CI, 0.22-0.35). Among individuals with a cardiac intervention, receiving EVT was associated with a 2-fold higher chance of discharge home (aOR, 2.21; 95% CI, 1.14-4.29).

Conclusions and Relevance: In this study, patients hospitalized with ischemic stroke and cardiac intervention may be less than half as likely to receive EVT as those without cardiac intervention. Given the known benefit of EVT, there is a need to better understand the reasons for lower rates of EVT in this patient population [3].

A total of 781 patients (median [IQR] age, 67 [57-76] years; 414 men [53%]) constituted the derivation cohort, and 3260 patients (median [IQR] age, 72 [61-80] years; 1684 men [52%]) composed the validation cohort. Nine variables were included in the model: age, baseline National Institutes of Health Stroke Scale (NIHSS) score, pre-stroke mRS score, history of diabetes, occlusion location, collateral score, reperfusion grade, NIHSS score at 24 hours, and symptomatic intracranial hemorrhage 24 hours after EVT. External validation in the MR CLEAN Registry showed excellent discriminative ability for functional independence (C statistic, 0.91; 95% CI, 0.90-0.92) and survival (0.89; 95% CI, 0.88-0.90). The proportion of functional independence in the MR CLEAN Registry was systematically higher than predicted by the model (41% vs 34%), whereas observed and predicted survival was similar (72% vs 75%). The model was updated and implemented for clinical use.

The prognostic tool MR PREDICTS@24H can be applied 1 day after EVT to accurately predict functional outcomes for individual patients at 90 days and to provide reliable outcome expectations and personalize follow-up and rehabilitation plans. It will need further validation and updating for contemporary patients [4].

Case reports

A 7-year-old boy with Down syndrome and atlanto-axial subluxation. The patient presented with an ischemic stroke in the left hemisphere and cervical cord compression with increased cord edema. Diagnostic digital subtraction angiography revealed unique patterns of vascular involvement, with retrograde flow through the anterior spinal artery, ascending cervical artery, occipital artery, and multiple leptomeningeal arteries compensating for bilateral vertebral artery occlusion. This case underscores the underreported phenomenon of upward retrograde flow through the anterior spinal artery in bilateral vertebral artery occlusion. They address the rare manifestation of posterior circulation involvement in moyamoya syndrome, highlighting the importance of considering atlantoaxial instability as a contributing factor, as the absence of atlantoaxial stability is a risk factor for vertebral artery dissection. This study contributes valuable insights into the intricate relationship of moyamoya syndrome, Down syndrome, and atlantoaxial instability, urging clinicians to consider multifaceted approaches in diagnosis and treatment. It also emphasizes the potential significance of the anterior spinal artery as a compensatory pathway in complex vascular scenarios [5]

Books

Ischemic Stroke (Emergency Management in Neurology) By Giuseppe D'Aliberti, Marco Longoni, Valentina Oppo, Valentina Perini, Luca Valvassori, Simone Vidale, Cristina Motto

1)
Lo Presti A, Weil AG, Ragheb J. Flying with a shunt. J Neurosurg Pediatr. 2015;15(2):223-224.
2)
Valdivia-Valdivia JM, Räisänen-Sokolowski A, Lindholm P. Prolonged syncope with multifactorial pulmonary oedema related to dry apnoea training: Safety concerns in unsupervised dry static apnoea. Diving Hyperb Med. 2021 Jun 30;51(2):210-215. doi: 10.28920/dhm51.2.210-215. PMID: 34157738.
3)
de Havenon A, Zhou LW, Koo AB, Matouk C, Falcone GJ, Sharma R, Ney J, Shu L, Yaghi S, Kamel H, Sheth KN. Endovascular Treatment of Acute Ischemic Stroke After Cardiac Interventions in the United States. JAMA Neurol. 2024 Jan 29. doi: 10.1001/jamaneurol.2023.5416. Epub ahead of print. PMID: 38285452.
4)
Chalos V, Venema E, Mulder MJHL, Roozenbeek B, Steyerberg EW, Wermer MJH, Lycklama À Nijeholt GJ, van der Worp HB, Goyal M, Campbell BCV, Muir KW, Guillemin F, Bracard S, White P, Dávalos A, Jovin TG, Hill MD, Mitchell PJ, Demchuk AM, Saver JL, van der Lugt A, Brown S, Dippel DWJ, Lingsma HF; HERMES CollaboratorsMR CLEAN Registry Investigators. Development and Validation of a Postprocedural Model to Predict Outcome After Endovascular Treatment for Ischemic Stroke. JAMA Neurol. 2023 Jul 31. doi: 10.1001/jamaneurol.2023.2392. Epub ahead of print. PMID: 37523199.
5)
Abramyan A, Fu AY, Patel K, Sun H, Roychowdhury S, Gupta G. Neurovascular considerations in patients with Down syndrome and moyamoya syndrome. Childs Nerv Syst. 2024 Jan 25. doi: 10.1007/s00381-024-06293-z. Epub ahead of print. PMID: 38273142.