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Comprehensive Treatment Strategies for "Cardiac-Cerebral Comorbidities" in Cardiovascular Surgery

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Abstract:

The comorbidity of cardiovascular diseases and neurological disorders (referred to as "cardiac-cerebral comorbidities") is receiving increasing attention in the field of cardiovascular surgery. The "heart-brain synergy" strategy, as a comprehensive treatment concept, emphasizes the interaction and balance between the heart and brain, offering a novel perspective for the simultaneous treatment of "cardiac-cerebral comorbidities." This article focuses on common conditions in cardiovascular surgery and their perioperative neurological complications, elucidating the "heart-brain synergy" strategy to provide clinical practitioners with more scientific and effective treatment guidance.

Keywords:

Cardiovascular diseases
Neurological disorders
Comorbidity phenomenon
Cardiovascular surgery
Review

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1. Introduction

With the development of panvascular medicine, the treatment of comorbid cardiovascular and neurological diseases (hereafter referred to as "cardio-cerebral comorbidity") by cardiovascular surgery has drawn increasing attention. There is a significant comorbid relationship between cardiovascular diseases such as coronary artery disease, aortic dissection, hypertension, and atrial fibrillation, and cerebrovascular diseases such as ischemic and hemorrhagic strokes [1]. The comorbidity rate has been rising annually [2], particularly among the elderly population [3], adding complexity to cardiovascular surgical procedures and postoperative outcomes, while increasing the risk of disability and mortality. Against this backdrop, the "cardio-cerebral co-treatment" strategy has emerged as a crucial approach.

The "cardio-cerebral co-treatment" strategy is based on the interaction and balance between the heart and brain [4], emphasizing a comprehensive treatment concept. It advocates for the concurrent treatment of cardiovascular and neurological diseases and, in the field of cardiovascular surgery, focuses on preventing perioperative neurological complications, improving surgical success rates, and enhancing patient outcomes.

Although the application of the “cardio-cerebral co-treatment” strategy in cardiovascular surgery is still in its early stages, its potential and significance are increasingly recognized by clinicians and researchers [1].

This article discusses the “cardio-cerebral co-treatment” strategy for “cardio-cerebral comorbidity” in cardiovascular surgery, along with the principles for managing perioperative neurological complications, aiming to provide clinicians with more scientific and effective treatment guidance.

2. Coronary artery disease and carotid artery stenosis comorbidities

The comorbidity of coronary artery disease (CAD) and carotid artery stenosis is relatively common, with approximately 11.8% of CAD patients aged 60 and above also having carotid artery stenosis [5]. These two conditions are closely related in terms of pathophysiological mechanisms, clinical manifestations, and potential complications, presenting significant challenges in clinical treatment. Coronary artery bypass grafting (CABG) can improve myocardial blood supply and alleviate ischemic symptoms in CAD patients, while carotid endarterectomy (CEA) is an effective treatment for carotid artery stenosis, reducing the incidence of ischemic cerebrovascular events.

For CAD patients with severe carotid artery stenosis (70%–99% stenosis), undergoing standalone CEA may result in stress responses such as blood pressure fluctuations and heart rate changes, potentially worsening coronary artery stenosis and increasing the risk of perioperative myocardial infarction (7%–8%) [6]. Conversely, during standalone CABG, hemodynamic changes can affect cerebral blood flow, and the presence of carotid artery stenosis significantly increases the risk of perioperative cerebral hypoperfusion and stroke (7.4%–9.1%) [7-10].

Adopting a “cardio-cerebral co-treatment” strategy by performing simultaneous CABG and CEA offers distinct advantages: first, it significantly reduces the risk of perioperative neurological complications, particularly cerebrovascular events, thereby protecting both cardiovascular and cerebrovascular systems [11]; second, it shortens anesthesia and hospitalization durations, lowers medical costs, and improves hospital bed utilization rates [12]; finally, it optimizes cardiovascular and cerebrovascular hemodynamics, improving long-term outcomes and enhancing quality of life.

However, simultaneous surgery may increase the risk of postoperative cognitive dysfunction. Therefore, it is crucial to conduct a thorough preoperative evaluation of cerebrovascular conditions, especially carotid and intracranial artery stenosis [8], and to develop individualized treatment plans to minimize the risk of perioperative neurological complications and improve surgical success rates [9]. This will be an important direction for future research.

3. Managing aortic dissection with the heart-brain synergy strategy

Aortic dissection is a critical cardiovascular emergency that disrupts the structural integrity of the aorta and often involves the carotid arteries, leading to the formation of a false lumen. This can impair cerebral hemodynamics, causing ischemic brain events such as stroke, transient ischemic attacks (TIA), and cognitive dysfunction [13], resulting in permanent neurological deficits or even death [14,15]. Aortic dissection typically requires urgent open-chest surgical intervention to repair or replace the damaged aorta, a procedure associated with high risks, including neurological complications that severely impact patient outcomes and may lead to long-term cognitive and motor impairments.

The “cardio-cerebral co-treatment” strategy encompasses meticulous surgical techniques, comprehensive bedside monitoring (e.g., vital signs, neurophysiological monitoring, bedside ultrasound), and intraoperative cardiac and cerebral protective measures. This approach simultaneously addresses the aortic dissection and its potential neurological complications.

In 2022, the cardiovascular surgery team at Xiangya Second Hospital of Central South University proposed an innovative treatment strategy known as the “Brain-Heart Priority.” During cardiopulmonary bypass in aortic dissection surgery, this strategy redefined the surgical workflow, cardiac perfusion, and cerebral protection methods. Unlike the conventional deep hypothermia (20–25°C) surgical environment, this approach utilizes mild hypothermia (≥ 30°C) to reduce cooling and rewarming times effectively.

The surgical sequence is altered by first repairing and reconstructing the proximal ascending aorta and/or aortic root, followed by anastomosis of the left common carotid artery. Intraoperatively, cardiac and left common carotid artery perfusion is restored and maintained, significantly shortening the ischemic duration for both the heart and brain. Cardiopulmonary bypass management is optimized by adjusting cerebral perfusion flow to 1.00–1.23 L/(m²·min), aligning more closely with physiological needs without increasing the risk of stroke [16].

This strategy has yielded satisfactory outcomes, providing protection for both the cardiovascular and cerebrovascular systems, reducing the risk of perioperative stroke and other neurological complications, and improving the quality of life and long-term prognosis for patients. Additionally, it shortens intensive care unit stays and overall hospitalization durations, alleviating the economic burden on healthcare systems [16].

4. Patent foramen ovale and neurological comorbidities

Patent foramen ovale (PFO) is a congenital heart defect that allows thrombi or air emboli to pass from the right atrium to the left atrium through the unclosed foramen ovale, potentially causing ischemic stroke [17,18] or other neurological disorders such as transient ischemic attack and migraines [19,20]. For patients with PFO comorbid with neurological diseases, performing either PFO closure alone or intracranial arterial stenting alone has certain limitations.

While PFO closure can effectively prevent cardioembolic emboli from entering the cerebral vasculature via the unclosed foramen ovale, performing this procedure alone may miss the critical window for treating cerebral vascular stenosis. Conversely, intracranial arterial stenting alone cannot prevent cardioembolic emboli originating from the unclosed PFO, increasing the risk of stroke. Furthermore, long-term anticoagulation therapy required after intracranial arterial stenting increases the risk of intracranial hemorrhage in patients with comorbid PFO.

Simultaneously performing PFO closure combined with intracranial arterial stenting offers a more comprehensive treatment approach. This combined strategy not only addresses the limitations mentioned above but also reduces the risks associated with multiple surgeries for the patient.

5. Cardiac myxoma and neurological complications

Atrial myxoma is a rare cardiac tumor that, during its development, may shed emboli consisting of tumor fragments or surface-adhered thrombi. These emboli can travel through the bloodstream to the cerebral vasculature, causing cerebral ischemia [21]. A 2022 case report described a patient with biatrial myxoma who experienced pulmonary embolism and ischemic stroke during the perioperative period [22].

For patients with atrial myxoma comorbid with ischemic stroke, surgical treatment is more complex, with a heightened risk of postoperative cognitive dysfunction. The key to successful surgical treatment lies in comprehensive preoperative evaluation and a multidisciplinary team (MDT) approach. This strategy helps to clarify tumor characteristics (size, location, nature, and presence of thrombi), embolic risk (whether the tumor surface has easily dislodged thrombi), and tumor activity.

6. Conclusion

Intraoperatively, precise surgical techniques and stable hemodynamic management are critical, along with real-time neuroelectrophysiological monitoring to prevent emboli from entering the cerebral vasculature. Perioperative pharmacological treatment, particularly the appropriate use of anticoagulants and antiplatelet agents, is essential to reduce thrombus formation, while coagulation function should be closely monitored (international normalized ratio [INR] 2.00–2.50) to balance bleeding risk.

Implementing this “heart-brain synergy” strategy can effectively reduce the risk of perioperative neurological complications, enhance surgical safety and success rates, and improve patient outcomes.

In summary, the implementation of the "heart-brain synergy" strategy in cardiovascular surgery indicates significant potential for pan-vascular medicine in improving surgical success rates, reducing perioperative complications, and alleviating the economic burden on healthcare systems. The future development of the "heart-brain synergy" strategy should focus on precise identification of indications, requiring comprehensive evaluation of "cardiac-cerebral comorbidities" and multidisciplinary collaboration involving experts from cardiovascular and neurosurgery fields.

Simultaneous surgeries should prioritize not only surgical success rates but also long-term outcomes and quality of life. Additionally, prospective multicenter clinical studies should be conducted to provide high-level evidence-based support for refining the "heart-brain synergy" strategy.

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Disclosure statement

The author declares no conflict of interest.

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