MANAGEMENT OF BLUNT CEREBROVASCULAR INJURY - AN OVERVIEW

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ABSTRACT

Blunt cerebrovascular injury (BCVI) is one of the most common clinical manifestations in patients with skull base trauma and severe traumatic brain injury. It is also the cause of later stroke, including ischemia and hemorrhage. Screening high-risk patients by several grading scales will support the identification and management of the complications of BCVI. Computerized tomographic angiography (CTA) and digital subtraction angiography (DSA) play a crucial role in identifying the lesion of cerebrovascular injuries. Antithrombotic therapy is the essential treatment for minimizing the risk of BCVI-related. This chapter aims to review the updated management of BCVI.

Keyword: *Blunt cerebrovascular injury, antithrombotic, endovascular, Denver criteria, computerized tomographic angiography, digital subtraction angiography*

I. INTRODUCTION

Blunt cerebrovascular injury includes blunt macrovascular and penetrating cerebrovascular injuries, which occur in about 1% of all traumatic brain injuries, 9% in severe traumatic brain injuries, and 1-2% in the in-hospital trauma population. The imaging modality for diagnostic BCVI still focuses on CT angiography and DSA. The standard of reference is DSA, but CT angiography becomes popular and contributes many useful characteristics of BCVI. All patients with high-risk factors for BCVI should undergo DSA as the final test for BCVI.

While the application of screening protocols are accepted generously, the treatment remains a disscusion. Early identification and treatment BCVI help reduce the rate of mortality and morbidity. Antithrombotic therapy, either with anticoagulation or antiplatelet agents, has long been accepted as the first-line of BCVI patients. However, the medication choice and the duration of treatment are still controversial.

II. EPIDEMIOLOGY

The prevalence of BCVI as a variant depends on the different studies. A systematic review and meta-analysis from Franz et al (2012) [1], the incidence range of BCVI was between 0.18% and 2.7% among 122.176 blunt trauma patients. This result came from 20 studies published from 2004 to 2011. Another study by Esnault et al (2017) [2] found that BCVI accounts for 9.2% of all severe traumatic brain injury admissions. These included 71% with carotid artery injury, 24% with vertebral artery injury, and 5% with damage to both. The injury of carotid artery and vertebral artery in the study of Harper et al (2022) [3] were 47% and 58%, respectively. But the difference in incidence of stroke between internal carotid (8.8)% and vertebral injuries (3.6%) was not statistically significant.

III. MECHANISMS OF BCVI

High-energy injury mechanisms are confirmed as the cause of BCVI by many researchers [2, 4-6]. High-speech motor vehicle collisions is the most popular cause

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of BCVI, but chiropractic manipulation, direct blows to the neck, and any mechanism resulting in rapid deceleration or acceleration accompanied with or without rapid head turning was reported as the cause of BCVI

IV. BCVI SCREENING

Some guidelines are recommended for screening the patients who had high risk of BCVI, including Denver criteria and/or modified Denver criteria [7], Western Trauma Association (WTA) [5] screening recommendation, and Eastern Association for the Surgery of Trauma (EAST) [8]. The summary of screening recommendations for BCVI are shown in the table below.

Table 1. ***Signs, symptoms and risk factors of BCVI***

Signs/symptoms	Massive hemorrhage from the neck, nose, and mouth, Cervical hematomas develop. Cervical bruit in a patient below 50 years old Focal neurological deficit Appearance of the secondary stroke on CT or MRI
Risk factors for BCVI	Maxillofacial fractures from high-energy mechanism, including mandible fracture, Le Fort II or III fractures. Complex skull, basilar skull and/or occipital condyle fractures. Cervical spine fracture or subluxation, including vertebral body fracture, transverse foramen fracture, subluxation or ligamentous injury, any fracture at C1 through C3. Severe traumatic brain injury Traumatic brain injury with thoracic injuries

Screening for BCVI was recommended as level II by EAST in case of the unexplained neurologic symptoms or arterial epistaxis after the traumatic brain injury. This guideline also gives a recommendation with III level for the asymptomatic patients who suffered from traumatic brain injury with Glasgow Coma Scale less than or equal to 8, a diffuse axonal injury, petrous bone fracture, fracture at high cervical segments [8]. The advantage of applying a screening tool helps the detection of BCVI increase versus no screening protocol [9].

V. IMAGING

5.1. Digital Subtraction Angiography (DSA)

DSA plays a key role and standard imaging modality for the diagnosis of BCVI, but it still has some limitations. This method is an invasive, cost-effective tool, has a complication rate of 1%-3% which includes vascular dissection and thromboembolism, and not provide by all trauma centers as a full-time, 24/7 service. According to EAST guidelines [8], DSA was given a level II recommendation in screening BCVI. The two lastest systematic review and meta-analysis study of CTA versus DSA in BCVI diagosis suggests that CTA has reasonable specificity but low sensitivity [10],[11]. The pooled sensitivity and specificity of CTA was 64% (95%CI, 53-74%) and 95% (95%CI, 87-99%), respectively when compared to DSA. This guideline showed the estimated positive likelihood ratio, a negative likelihood ratio, and a diagnostic odds ratio was 11.8 (95%, 5.6-24.9), 0.38 (95%, 0.30-0.49), and 31 (95%, 17-56), respectively [11]. To determine accuracy of CTA versus DSA in evaluate the lesions between BCVI carotid and BCVI vertebral, the result showed the similar in sensitivity and specificity.

5.2. CT Angiography

Most of patients who had BCVI got the polytrauma presentation. The BCVI

candidates always have indication for screening whole-body for prevention the missing-lesions such as thoracic, abdomen, and spine. Hundersmarck et al (2021) [12] indicated an augmentation of the dose of intravenous contrast administration flow for total body CT scanning from 3 to 6ml/s to advance the diagnostic yield for cervical vascular lesions. Because of this remodeling, an increase in explorer incidence from 0.3% to 0.8%, from 0.9% to 2.4%, from 1.2% to 1.9%, from 4.6% to 8.5% in the whole blunt trauma group, in the polytrauma subgroup, in patients with a basilar skull fracture and in the cervical spine trauma subgroup, respectively, have been shown. These authors believe that in the setting of not scanning the total body, the patients may benefit from the modification for confirming the grade of cervical artery injuries. CTA can be used to classify and follow-up BCVIs. It can provide important decisions in management and planning the treatment of lesions.

CTA is a useful modality for the purpose of follow-up the BCVI patients. Wu et al (2020) suggests that CTA has the highest diagnostic yield in identifying the changing of lesions within the first 30 days after the trauma. These authors also confirm the best effect on treatment of BCVI when CTA was performed within 30 days of injury. However, CTA has intermediate effects between 30 and 90 days, and no transformation when performed beyond 90 days, particularly in high-grade injuries.

VI. TREATMENT

To date, guidelines from the Western Trauma Associations [5] and EAST [8] recommend antithrombotic therapy, endovascular therapy, or surgical treatment based on the location and grade of injuries.

The choice of antiplatelet therapy or anticoagulation depends on grade of BCVI, concomitant injuries, neurological symptoms, and the volume of infarcted territory at risk for hemorrhagic transformation. Recommendation from Brommeland et al (2018) [6] suggests that a low-molecular weight heparin in antithrombotic doses within 24-48h of the diagonis followed by oral aspirin 75mg daily. They also made a strong recommendation for timing of antithrombotic therapy. Early usage as soon as possible is recommended even in the setting of severe traumatic brain injury or other solid organ injury. The practice management guideline from Eastern Association for the Surgery of Trauma (2020) [9] suggested the benefit from the usage of antithrombotic versus no antithrombotic can decrease risk of stroke (OR=0.20 – 95%CI, 0.06-0.65 – $p < 0.0001$) and mortality (OR=0.17 – 95%CI, 0.08-0.34 – $p < 0.0001$). And the guideline can not show any significant difference in the risk of stroke among patients with grade II or III injuries who underwent stenting as a adjunt to antithrombotic versus antithrombotic alone (OR=1.63 – 95%CI, 0.2-12.14 – $p = 0.63$).But the Western Trauma Association can not indicate any antithrombotic drugs for initial management. Aspirin may be available, but dual antiplatelet therapy (aspirin combined with clopidogrel) can be a safety an efficacy in a number of clinical situations [5].

The benefits of endovascular for patients with BCVI remains controversial because of its complication, stent predominance, and the rate of stroke. The indication of endovascular therapy includes: patients with a contraindication to antithrombotic agents, lesions that worsen or become symptomatic despite antithrombotic therapy, and lesions not amenable to surgical therapy. The grade II and III injuries should be treated by endovascular to decrease the risk for embolism and rupture by developing flow

into the pseudoaneurms. Endovascular can be performed for the grade V patients that are not surgically accessible. Patients with vessel occlusion also is the candidate of endovascular therapy to keep away from recanalization and embolic.

Surgical therapy has a limitation in treatment BCVI. No data, to date, can confirm the advantages of surgical performance. Carotid ligation, revascularization with direct, patch repair or bypass of the injuried segment were recommended. In particular, the perioperative risk of hemorrhage may make surgical the prefferred over endovascular stent, which requires antiplatelet treatment.

VII. CONCLUSION

BCVI is preventable cerebrovascular disorder by the application of screening recommendations, imaging modalities, and chosing a suitable repair therapy. CTA or DSA can be helpful to detect the morphology and location of the injuries. Early treatment of antithrombotic has been suggested to be both effective and safe, particulary in patient with minor and moderate injuries. The role of endovascular and surgical therapy remains controversial due to the lack of data.

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