

Rapid Detecting Brachial Plexus Injury by Point-of-Care Ultrasonography

CME Credits

Cheng-Hsun Chuang, Chao-Yen Huang, Sai-Wai Ho, Chia-Ching Chen*

Department of Emergency Medicine, Chung Shan Medical University Hospital, Taichung, Taiwan

Abstract

Brachial plexus injury (BPI) is regarded as one of the most devastating injuries of the upper extremity. Brachial plexus neuropathy can have a high morbidity by seriously affecting the motor function and sensation of upper limbs with loss of activities of daily living. The use of computed tomography myelogram and/or magnetic resonance imaging (MRI) assessing brachial plexus offers valuable details including the location, morphology, and severity of preganglionic and postganglionic injuries during the preoperative period. High-field-strength MRI with specific coil and specialized MRI sequences might be not available in every emergency setting and is time-consuming. Point-of-care ultrasonography (POCUS) comes in handy and offers good image resolution of muscles and nerves that makes early detection of neuromuscular injury possible. Here, we present a case report of BPI that POCUS provides indirect evidence of cervical root injury and expedite time to MRI.

Keywords: Brachial plexus injury, cervical root, point-of-care ultrasonography, ultrasonography

INTRODUCTION

Brachial plexus injury (BPI) is a devastating injury that may result in limb immobility and handicap which impact largely on patient's quality of life.^[1,2] Clinical features of BPI included numbness, hypoesthesia, weakness, paralysis, and burning pain of the affected upper limb. The brachial plexus is formed by five cervical nerve roots: C5, C6, C7, C8, and T1. The brachial plexus injuries are classified based on the location with respect to the dorsal root ganglion. A preganglionic injury occurs proximal to the dorsal root ganglion, and a postganglionic injury occurs distal to the dorsal root ganglion.^[1] Torsion the head violently away from the shoulder can result in injury to the upper brachial plexus (C5, C6) roots and with varying degrees of injury to the lower roots (C7, C8, and T1).^[3-5] Violent overhead abduction and traction can result in lower BPI with varying degrees of upper root injury.^[3-5] Other mechanisms including falling, stabbing, penetrating, and ballistic trauma have also been reported.^[4,6,7] A detailed history of the trauma mechanism and neurologic examinations such as motor function and sensory nerve are mandatory to guide diagnosis and treatment planning which might be difficult due to pain.^[8]

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While recently 3.0T multiparameter magnetic resonance imaging (MRI) with specific coil and specialized MRI sequences (e.g., fast imaging employing steady-state acquisition or CUBE) provides detailed images of spine and nerve root for interpretation,^[2,9] current golden diagnostic modality of BPI remains CT myelogram.^[3,8]

Nerve conduction studies (NCSs) are useful in differentiating preganglionic or postganglionic lesions during preoperative evaluation and intraoperative management.^[3] Both MRI and ultrasound assessment of the nerves, surrounding tissues, and innervated muscles can provide localizing, diagnostic, and prognostic information that complements clinical and electrodiagnostic testing.^[10,11]

While surgical inspection provides the definitive pathological diagnosis of BPI,^[12] point-of-care ultrasonography (POCUS) plays an important adjunct to clinical and MRI with its nature of high positive predictive value and accessibility.^[3]

Address for correspondence: Dr. Chia-Ching Chen,
Department of Emergency Medicine, Chung Shan Medical University
Hospital, No. 110, Section 1, Jianguo N. Rd., South Dist., Taichung City
402, Taiwan.
E-mail: medlife.c11g@gmail.com

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CASE REPORT

An 18-year-old male presents to our emergency department (ED) with 1-h history of right shoulder painful swelling after motor vehicle collision. He hit right shoulder to the ground with right neck muscle sprain. He complained of severe pain over his right arm and incapability of raising up his right arm. On physical examination, right neck, shoulder, and right upper chest wall contusions were found. The right arm was warm, and capillary refilling time was within 1 s. Passive range of motion of the right shoulder, elbow, and wrist was all unremarkable. Computed tomography scan revealed middle cervical subcutaneous tissue edema without vascular injury, fracture, dislocation, or intracranial hemorrhage. POCUS was arranged due to right neck and shoulder worsening painful swelling refractory to painkiller. Disrupted muscle fiber continuity coursing through middle scalene muscle and diffuse infiltration of hemerosous fluid over anterior scalene muscle filled in were identified, compatible with Grade II muscular injury^[13] [Figure 1]. Hyperechoic and edematous change of C6 anterior ramus edema was appreciated suggesting C6 root injury [Figure 2]. Right pupil miosis [Figure 3] with right eyelid ptosis [Figure 4] developed during ED observation suggesting superior cervical ganglion injury due to increased pressure in a restricted fascial space between longus colli muscle and anterior scalene after muscular edema.^[14] Emergent MRI was arranged at 2nd h of ED stay and revealed complete tear of right C7 nerve root [Figure 5] with spinal subarachnoid hemorrhage at the level of C5 and C6 [Figure 6]. NCSs revealed no response of F-wave in the right median and ulnar nerves, which were also compatible with MRI findings. Although surgical decompression was suggested, the patient asked for conservative treatment and loss follow-up.

DISCUSSION

The brachial plexus is an intricate anatomic structure with an important function, composed of four cervical nerve roots (C5-C8) and the first thoracic nerve root (T1). Injury may result in impaired sensory or motor function of the involving arm. Torsion of the head violently away from the shoulder can result in traction injury to the upper brachial plexus roots.^[4] Overhead abduction and traction of shoulder from the body can result in lower brachial plexus roots.^[4]

Physician should raise alert to BPI in patient with blunt and penetrating neck injury. For neck trauma patients, we suggest routinely use of ultrasound to detect any possibility of deep neck structure injuries such as carotid artery, jugular vein, and nerve root injury. This can include abduction and external rotation of the shoulder as well as other passive and active movements to assess for compression of the neurovascular structures.^[3] In acute stage, various ultrasonographic features of BPI can be detected by POCUS including thickening and edema of perineurium and endoneurium, perineural hematoma,

and nerve transection.^[11,15] Sonographic manifestation of late-stage nerve injury included neuroma, nerve thickening, and perineural scarring.^[6] A recent systematic review of the use of ultrasonography in diagnosing adult traumatic brachial plexus injuries identified an overall sensitivity of 87%, with higher accuracy in the higher root levels (C5-C7).^[16] With ultrasonography, we could rapidly detect emergent diseases such as brachial artery dissection, carotid artery dissection,

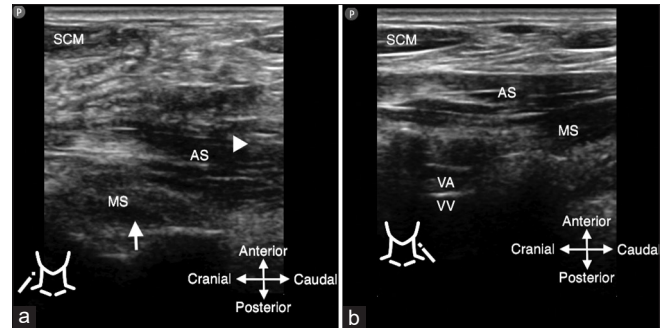


Figure 1: Long-axis (a) US views of anterior and middle muscle partial tear. long-axis (b) US views of the contralateral asymptomatic side. The lesion was compatible with a Grade II injury according to the Peetrons classification. White arrow: Hemerosous fluid accumulation, White arrowhead: Diffuse infiltration of hemerosous fluid, AS: Anterior scalene muscle, SCM: Sternocleidomastoid muscle, MS: Middle scalene muscle, VA: Vertebral artery, VV: Vertebral vein

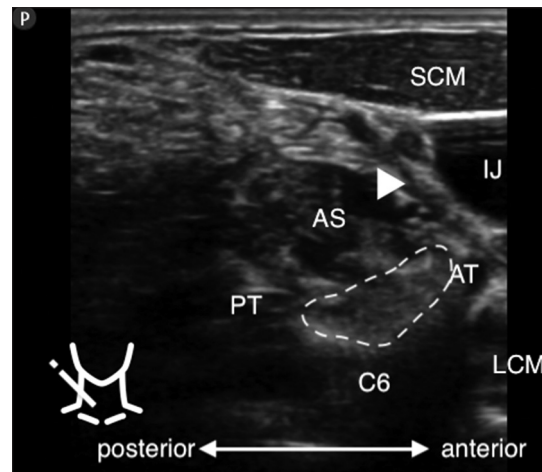


Figure 2: Transverse US image of the right neck revealed hyperechoic and edematous change of C6 anterior ramus edema (dotted line) between intertubercular groove suggesting C6 root injury. Hemerosous fluid accumulation within anterior scalene (white arrowhead) was compatible with a Grade II injury. AS: Anterior scalene, SCM: Sternocleidomastoid muscle, LCM: Longus colli muscle, AT: Anterior tubercle, PT: Posterior tubercle, IJ: Internal jugular vein

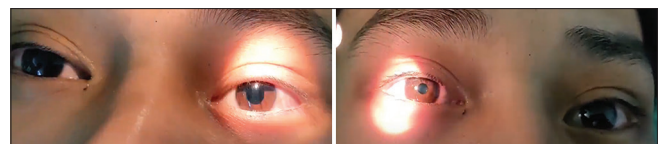


Figure 3: Right eye miosis



Figure 4: Right eye ptosis

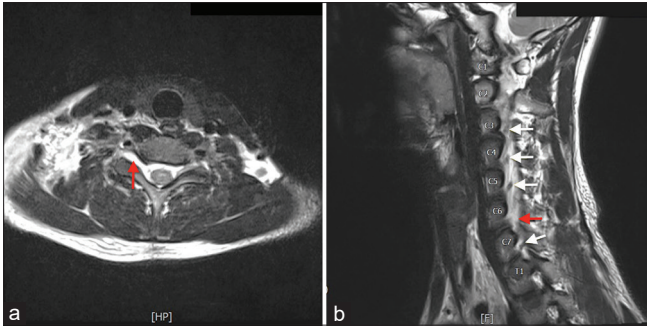


Figure 5: T2 axial (a) and sagittal (b) cervical spinal cord magnetic resonance imaging revealed nonvisualization of neural element in right C6/7 neural foramen (red arrow) suggesting right C7 nerve root avulsion injury with complete tear. White arrow, normal neural elements

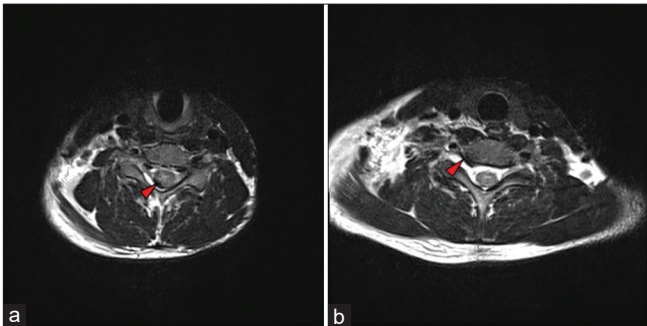


Figure 6: (a) Small crescent dark T2-blood artifact around the right-posterior aspect of spinal cord at the level of C5-C6 (red arrowhead) suggesting spinal subarachnoid hemorrhage. (b) linear dark T2-blood artifact around the intertubercular groove at the level of C6 (red arrowhead)

brachial artery embolism, muscle tear, tendon rupture, and BPI as early as possible.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given her consent for his images and other clinical information to be reported in the journal. The patient understands that his name

and initials will not be published, and due efforts will be made to conceal his identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

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