Crit Ultrasound J (2011) 3:47–49
DOI 10.1007/s13089-011-0058-3

CASE REPORT

Transcranial color coded duplex sonography in the intensive care unit

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Received: 19 October 2010 / Accepted: 3 February 2011 / Published online: 2 March 2011

Abstract
Case report A case of a 43-year-old male with severe pancreatitis complicated with neurological deterioration is presented.
Methods and result Different neurosonological examinations using transcranial color coded duplex sonography (TCCS) were combined to obtain a certain diagnosis.
Conclusion This case illustrates some of the applications of TCCS at bedside in ICU patients. These sonographic explorations are useful in the monitoring of ICU patients, and may avoid hazardous transfers to the radiology department for the patient.

Keywords Transcranial color coded duplex sonography · Critically ill patients · Intensive care unit

Introduction

Transcranial color coded duplex sonography (TCCS) constitutes an established tool in the management of neurological patients. However, its use in the intensive care unit (ICU) is less common, although it can be used bedside and avoiding complicated transportation of the patients [1].

TCCS has been shown to be useful in monitoring different disorders in the ICU [1]: cerebral hemodynamics, midline shift, vascular stenoses, cerebrovascular disease, intracranial hematomas, vascular malformations and aneurysms, posttraumatic carotid-cavernous fistulas, cerebral vasospasm, and cerebral circulatory arrest. In addition, the use of ultrasound contrast agents (UCAs) allows the increase in the quality and the number of conclusive studies in cases of poor acoustic window [2] and the minimally invasive study of cerebral perfusion [3, 4].

We would like to present an interesting case which illustrates some of the potential applications of TCCS in the ICU.

Case report

A male patient of 43 years was admitted in the ICU with the diagnosis of severe pancreatitis which rapidly worsened and developed multiorgan failure. He was treated with sedatives, muscle relaxation, high dose of norepinephrine, mechanical ventilation with FiO2 100%, and continuous renal replacement therapy. On day 3 after ICU admission, left fixed mydriasis was detected, and TCCS was solicited. TCCS was performed using a Vivid 7 (GE Medical Systems) equipped with a 2- to 4-MHz phased array transducer for cerebral studies and 7.5–10 MHz linear array for carotid duplex ultrasound studies.

In the initial examination, we detected a 9 mm shift evaluated in the third ventricle, suggesting a marked mass effect from the left hemisphere over the right one. The technique used in this evaluation has been previously described [5]. In the vascular examination through the left temporal approach, and even after injecting an UCA (Sonovue®, Bracco Altana, Amsterdam, The Netherlands) in a bolus form of 2.5 ml injected followed by a 10 ml saline through a central catheter with the distal tip placed at the superior cava vena, we observed a complete absence

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of flow in the left intracranial carotid, middle cerebral and anterior cerebral arteries (Fig. 1a).

With the presumptive diagnosis of left extracranial carotid artery thrombosis, we performed a carotid duplex ultrasound study which confirmed the existence of an occlusive thrombi in the left common carotid artery (Fig. 1b). Finally, the study was completed by performing a perfusion study following the technique described by Eyding et al. [6]. This exploration showed an absence of progression in the time-intensity curves (TIC) in the left hemisphere (flat curves), compared with a normal pattern in the right circulation (Fig. 1c), suggesting an absence of tissue perfusion. Subsequent cranial computed tomography confirmed the sonographic diagnosis (Fig. 1d). Limitation of the therapeutic effort was instituted and the patient died.

Discussion

TCCS constitutes a diagnostic tool commonly used in the neurological patients. However, its use in the neurocritically ill patients within the ICU is less common although it represents clear advantages over transcranial Doppler (TCD) [1].

TCCS allows the non-invasive morphological study of the brain parenchyma using the B-mode. It is especially useful in the study of midline shift in patients with brain injury [5] and cerebrovascular disease [7], as evidenced in our patient. Measurement was performed as described earlier [5, 7] by placing the transducer in the temporal window and the axial plane, locating the mesencephalon with its classic butterfly-wing structure. Later, the transducer was moved 10° cephalad, locating the third ventricle (diencephalic plane), which is identified by a double hyperecogenic image in the center of the sonogram. The measurement was taken from the center of the third ventricle to the source of the ultrasound wave, which corresponds to the external side of the skull (distance A). The identical maneuver was repeated on the contralateral side (distance B). The following mathematical formula was then applied: Midline shift $= (A - B)/2$. Other commonly used applications using the B-mode are the evaluation of the ventricular system size [8] and the study of intraparenchymal hematomas [9].

Using color-mode, the main advantage over conventional TCD is based on the identification of the basal arteries of the Circle of Willis. This identification allows the examiner to perform angle-corrected and sample volume-adjusted determinations, resulting in an increase in the number [10] and quality of the vessels studied [11].

In cases with a poor acoustic window or in incomplete studies with the color-mode, some authors support the use of UCA. Based on their biochemical properties [4], the UCA generates an increase of the acoustic signal which results in quantitative and qualitative improvements in TCCS examinations [2]. In addition, the use of UCAs permits the minimally invasive study of the cerebral

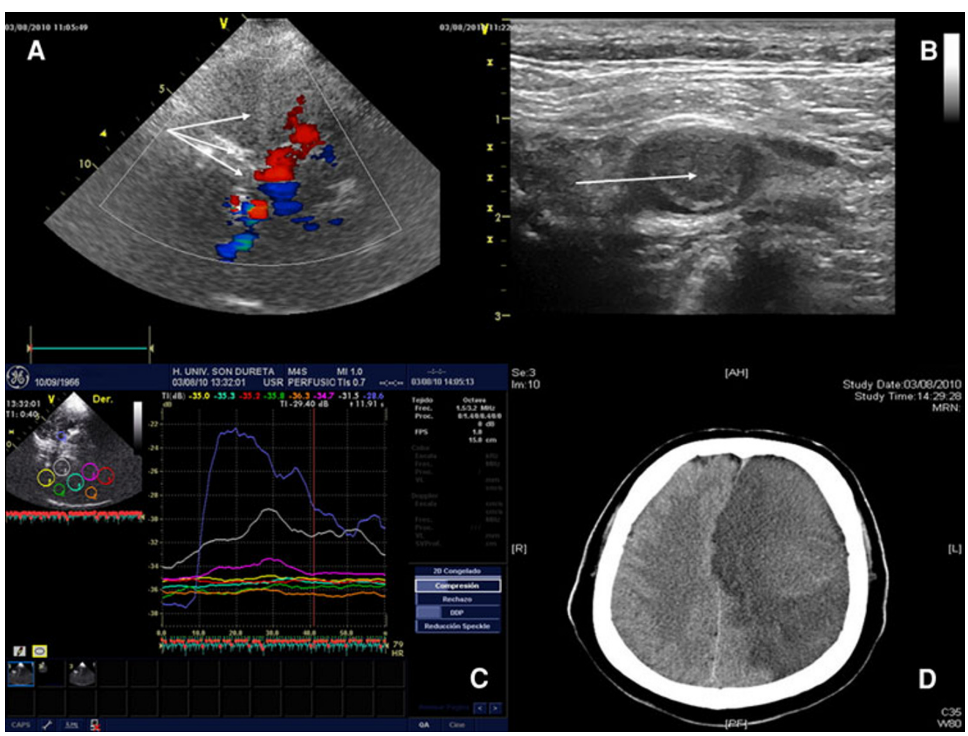

Fig. 1 Absence of filling in the left internal carotid, middle cerebral and anterior cerebral arteries (*arrows*) through the temporal window (**a**). Tranversal image of the left common carotid artery shows an occlusive thrombi of the lumen (*arrow*) (**b**). Perfusion study through the right temporal window. Time-intensity curves in the left hemisphere are flat compared with normal time-intensity curves in the right areas (**c**). Computed tomography showed a complete infarction of the anterior circulation of the left hemisphere (**d**)

perfusion using ultrasound perfusion imaging techniques in patients with neurological disorders, especially those with ischemic cerebrovascular disease [12]. In our patient, we used the bolus kinetic approach, evaluating different regions of interest (ROIs) in which we studied the TICs. Different derived parameters after infusion of UCAs have been studied [12]. The peak intensity, peak width, and time to peak intensity have been correlated with cerebral perfusion. A delay in the time to peak intensity has been suggested to constitute the most accurate parameter for studying cerebral perfusion in cerebrovascular disease because its value shows low intraindividual variability and is not influenced by the depth of the insonation plane [6, 12]. A delay of close to 4 s compared with the unaffected hemisphere may identify hypoperfused areas [6]. In our patient, we obtained a flat TIC in the left hemisphere, suggesting an absence of perfusion in this hemisphere.

In conclusion, this case illustrates some of the applications of TCCS at bedside in ICU patients. These sonographic explorations are useful in the monitoring of ICU patients, and may avoid hazardous transfers to the radiology department for the patient.

Conflict of interest None.

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