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Essay

Applications of perioperative and critical care ultrasound☆

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ABSTRACT

As an extension to the physical exam, point of care ultrasonography is a tool with multiple applications. Widely used for regional anesthesia, there is not enough diffusion among anesthesiologist of the multiple possibilities that echography gives to them. This article was written to help spreading the multiple applications that ultrasound has in anesthesia, critical care and pain management.

Aplicaciones de la ecografía perioperatoria y de cuidado crítico

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RESUMEN

Como una extensión del examen físico, la ecografía 'point of care' es hoy una herramienta con múltiples aplicaciones. Aunque ya es conocido el uso para la anestesia regional, todavía falta mucha difusión entre los anestesiólogos acerca de las diversas posibilidades que brinda la ecografía. Este artículo pretende dar un panorama general de las utilidades que tiene la ecografía en anestesia, cuidado crítico y dolor.

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There are at least 20 specialties in which the use of point-of-care ultrasonography is useful for diagnosis, as guidance during procedures, and for screening.[1] The first two applications are relevant in anesthesia, pain medicine and intensive care. We will review briefly the applications that are useful in anesthesia, and we recommend reading the relevant references for a more detailed description. It is also worth remembering that the goal is to recognize patterns and make immediate diagnoses, and not to perform quantitative ultrasound or replace formal ultrasonography or more advanced diagnostic means. We will use an ABCDE sequence, like the one used to guide management of trauma patients, used also in some courses where ultrasound is taught.[2]

A: Airway

With ultrasound it is easy to determine the size of the trachea and the size of the appropriate tube, and whether there are significant deviations. It allows visualization of the esophagus during intubation in order to rule out esophageal intubation and, with some specific maneuvers (filling the balloon with water) it also allows to check passage of the tube through the vocal cords. Before a rapid sequence induction, it is used to measure gastric volume and to assess the probability of regurgitation. In the intensive care setting, where bacterial sinusitis is a frequent cause of fever in the intubated patient, ultrasound helps in making the diagnosis. Ultrasound is also useful to guide percutaneous procedures such as tracheostomy and cricothyrotomy, particularly through vascularized masses, and avoid the vessels injury to the vessels.[3–6]

B: Lung and chest ultrasound

Lung ultrasound, developed over the past 20 years in the intensive care (ICU) setting has different applications. Initially, if expansion of both lungs is documented and pleural sliding is observed, the intubation made in A is confirmed and monobronchial intubation is also ruled out. In multiple trauma patients or after a procedure such as vascular access, pneumothorax may be ruled out if pleural sliding is confirmed, with a 100% negative predictive value (although the absence of sliding is not sufficiently specific to provide a confident diagnosis and other ultrasound signs must be present such as the lung point and, possibly, A lines). Using the M mode, diaphragmatic mobility may be ascertained after inter-scalene blocks. Pleural effusions may be observed and quantified, although a more sophisticated use is the diagnosis of acute lung edema, ARDS and consolidations. Also under B, some protocols include, in the work-up of hypoxemic patients, the use of lower limb venous ultrasound and some right ventricular echocardiographic windows in order to look for signs of pulmonary embolism. In the ICU, and for clinicians in general, ultrasound may be used to enhance the safe performance of a thoracocentesis.[1,5,7–9]

C: Circulation

There are protocols for the diagnosis of patients in shock and for guiding resuscitation. Using a few transthoracic echocardiographic windows, it is possible to determine the cause of shock in patients with hypotension. Pericardial effusions and significant abnormalities of global and segmental contractility may be observed, explaining patient disorders (and ruling out acute ischemic events, heart failure and significant valve disease), as well as signs of massive pulmonary thromboembolism (although it is important to remember that it does not rule out embolism with smaller hemodynamic compromise). The volemic status can be determined and patient response to volume may be monitored dynamically (using inferior caval ultrasound to measure size and collapsibility as well as looking for congestive signs in the lung ultrasound as volume is infused, with the presence of multiple B lines). It can help find potential sources of bleeding (performing a FAST-E to find peritoneal fluid, lung windows to rule out pleural effusion or hemothorax, and performing aortic ultrasound to determine whether there is a ruptured abdominal aortic aneurism). There are even protocols for patients in cardiac arrest where treatable causes are actively explored with minimal massage interruptions. Vascular access is also part of circulation management; ultrasound-guided vascular access, with greater evidence in the internal jugular vein, but also useful in the subclavian and femoral vessels, as well as for arterial access. Ultrasound shortens procedure times, and it is suggested that it also reduces mechanical and infectious complications.[5,10–17]

Transesophageal echocardiography has been shown to be useful in cardiovascular anesthesia, intensive care and even in major surgery. It is useful for refining pre-operative diagnoses, for guiding the surgeon in certain procedures, and for intra-operative hemodynamic monitoring.[18,19]

D: Neurologic deficit

Neuroanesthetists and neurointensivists are already familiar with the use of transcranial Doppler as a tool for diagnosis and intra-operative monitoring. But other point-of-care applications have been documented in acutely ill patients. Using a high-frequency probe it is possible to see pupillary reaction to light (useful in patients with palpebral edema whose eyes cannot be opened), and to make the diagnosis of papilledema, useful in patients in whom intracranial hypertension is suspected. Using a curved transducer, ultrasound is faster and more accessible than tomography to observe the midline in many patients and determine the presence of mass-effect hematomas in just a few seconds.[5,20]

E: Other applications

Some ultrasound applications have already become popular in our setting, including the management of acute pain, and some diagnostic and therapeutic applications in chronic pain. It is used in regional anesthesia, with evidence of reduced time for performing the block, shorter latency and, in some

cases, a lower dose of the local anesthetic. Also it is thought to improve block safety and effectiveness. The use of ultrasonography has also contributed to a more generalized use of certain blocks such as the transverse abdominal plane and the paravertebral blocks. Its use in neuroaxial anesthesia in pregnant women and other populations has contributed to a greater use of this procedure in some studies, making it a good alternative in difficult spinal approaches.[21–24]

In chronic pain, although fluoroscopy is the gold standard, there are a growing number of publications on ultrasound-guided procedures. Likewise, muscle-skeletal ultrasound helps in the diagnosis of chronic pain.[25]

Certain procedures usually performed blindly, such as paracentesis or abscess drainage, may be done under ultrasound guidance, perhaps with increased safety for the patient. The use of ultrasound is also advocated in the ICU for the diagnosis of gall bladder (acalculous cholecystitis), urinary tract, gastrointestinal tract and soft tissue diseases, as well as fractures and neck injuries, among others.[5]

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Conflicts of interest

The author has no conflicts of interest to declare.

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