BRIEF REPORT

Hand-held portable sonography for the on-mountain exclusion of a pneumothorax

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Introduction

Pneumothoraces are the most common serious intrathoracic injury following blunt trauma¹ and are a common cause of preventable morbidity and mortality. Medical personnel responding to an injured patient in a hostile environment must quickly assess the victim and attempt to exclude potentially life-threatening injuries without the benefit of standard imaging modalities, such as radiography. The recent availability of lightweight portable ultrasound units that can easily be carried by emergency medical personnel adds this adjunct to prehospital care. An exciting aspect of sonography is the recent appreciation of the potential of sonography to exclude pneumothoraces. We report the on-mountain use of a portable, hand-held, ultrasound device carried by the responding mountain physician at a commercial alpine ski resort, to exclude the presence of a traumatic pneumothorax in an injured snowboarder presenting with hemoptysis.

Case report

A previously healthy 18-year-old male lost control after jumping over a mogul and fell forward onto his chest. The incident occurred at an elevation of approximately 4000 feet above sea level, approximately 1700 feet above the base of the Blackcomb Mountain. The patient did not lose consciousness and was able to stand unassisted after sitting for several minutes. He soon began coughing and had bright red hemoptysis. He presented

to a nearby ski-patroller, who summoned the volunteer "Mountain Doctor" physician by radio. When assessed by the Mountain Doctor, the patient was hemodynamically stable, oriented, and able to move all limbs. He was able to speak normally and was not dyspneic. He produced frank hemoptysis with deep coughing. Auscultation of the chest revealed equal breath sounds. Examination of each lung field with a SonoSite 180 hand-held 2.4-kg ultrasound machine, using a 10- to 5-MHz broadband linear transducer, showed normal lung sliding and the presence of identifiable "comet-tail" artifacts in both lung fields, as shown in the Figure. The physician thought the patient able to be transported by toboggan to the medical clinic near the Mountain Base. He remained hemodynamically stable in transport. Further examination at the clinic revealed no serious thoracic injuries, and the patient was discharged in good condition.

Discussion

Pneumothoraces after blunt trauma are commonly associated with rib fractures that lacerate the surface of the lung.^{2,3} Indications of lung injury may include dyspnea, tachypnea, labored respirations, and hemoptysis. If the diagnosis is missed or not suspected, a tension pneumothorax can develop, which can quickly lead to cardiorespiratory collapse.¹ Reviews of trauma deaths have identified hemo/pneumothoraces as preventable causes of death,^{4,5} which is tragic, as these injuries are usually quite effectively and simply treated through pleural decompression. Thoracotomies are required in no more than 10% to 15% of patients with severe thoracic trauma.⁶ The key to reducing morbidity and mortality is early diagnosis and timely treatment with pleural decompression prior to decompensation.

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Still longitudinal sonographic image obtained with a 10- to 5-MHz high-frequency linear transducer of the right chest of the patient. Double arrow indicates parietal-vascular pleural symphysis where “sliding” movement is detected in real time. Single arrow indicates a “comet-tail artifact” that enhances the sensitivity for excluding pneumothorax.

When practicing medicine in challenging environmental conditions, pneumothoraces are a further concern when the patient cannot be fully assessed or monitored during transportation. Noise, physical restraints on both the patient and caregivers, and the need for timely evacuation by toboggan, helicopter, or snowmobile make clinical diagnosis challenging on a mountain.

Although sonography has been used clinically for many years, its value in excluding pneumothorax has not been widely appreciated. In some respects, the technique might appear almost paradoxical, as only artifacts are seen deep to the normal lung-chest wall interface, due to the high acoustic reflectance of air-containing structures.⁷ Using a high-frequency linear transducer, the sonographer can, however, detect the pleural interface by identifying the presence of a “to and fro” movement of the pleural surfaces that corresponds to normal respiration.^{7–14} The diagnosis of a pneumothorax is inferred by the absence of visualization of normal “sliding” or

“gliding” movement of the pleural surfaces.^{10,15} The diagnosis of a pneumothorax is further supported by the inability to visualize comet-tail artifacts, pleural-based densities that provide a reverberation artifact deep to the pleural interface.^{8,12,16} (An instructional website demonstrating digital video recordings of normal and abnormal thoracic sonograms may be accessed at <http://www.vghtraumaresearch.com>.)

In the present case, the sonographic examination of both hemithoraces revealed normal pleural sliding and the presence of comet-tail artifacts, corroborating the clinical impression that there was no pneumothorax, as shown in the Figure. In addition to reassuring both the patient and medical personnel, this finding increased the confidence level, allowing for transport by toboggan rather than helicopter. With further validation and experience, the ultimate use would be to prevent the unnecessary institution of an invasive thoracic procedure such as needle decompression or a tube thoracostomy.

tomy in a dyspneic patient who had some other responsible condition.

The examination was carried out with a commercially available lightweight portable ultrasound device (2.4 kg). The device was carried by one of the mountain physicians without difficulty throughout entire 8-hour shifts as Mountain Doctor in all weather and hill conditions. Effectiveness of this device has been demonstrated in the diagnosis of abdominal trauma in tertiary trauma centers.^{17,18} Evaluations of this device for the prehospital screening of abdominal trauma are also ongoing.^{19,20} To our knowledge, the use of this device for the exclusion of pneumothoraces or for on-mountain use has not been reported. Technical limitations of the present equipment include the inability to easily record dynamic rather than static images. In the future, technical developments may provide the ability to rapidly teletransmit real-time sonographic pleural images to off-site medical directors. We believe this technology offers a powerful diagnostic tool for use in remote and hostile settings where portable radiography is not available or practical.

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