Ultrasound-guided bilateral parasternal block: A boon for managing pain after sternal fracture/dislocation

ABSTRACT
Sternal fractures are high velocity injuries which is associated with thoracic or lumbar vertebral fractures. Severe pain associated with sternal fractures can lead to impaired ventilation, low partial pressure of arterial oxygen, need of non-invasive or invasive ventilation with an endotracheal tube thereby leading to significant morbidity. In a series of three patients with manubrium sternal dislocation, we administered continuous bilateral parasternal blocks and initiated infusion of local anesthetics for different periods of time in all patients. The high pain scores drastically decreased followed by improved spontaneous ventilation. There was improvement in partial pressure of oxygen in arterial blood gas. None of the patient required a non-invasive or invasive ventilation. The spread of local anesthetic using injection of radio-opaque contrast through bilaterally placed parasternal catheters was followed by a computed tomography scan. This was done after obtaining informed consent from patient and waiver for scan. To the best of our knowledge, this is first report of successful pain management in patients who sustained manubrium – sternal dislocations using bilateral continuous catheters for a prolonged period.

Key words: Anaesthesia; fracture; pain; regional; sternum; ultrasound

Introduction
Manubriosternal fracture-dislocations are extremely painful and associated with respiratory insufficiency and sputum retention. Usually, such events are associated with multiple rib fractures (MRFs), underlying lung and cardiac contusion along with hydro, hemo, and pneumothorax.[1‑3] Adequate analgesia is essential on an individual on the basis to prevent respiratory complications.[4] We discuss pain management of three patients who sustained high-impact trauma with manubriosternal fracture/dislocations. A contrast study was performed to understand the spread of drugs via indwelling catheters in the interfascial plane.

Case Series
Three patients who sustained injuries following road traffic accident were shifted from the accident site in a state of severe desaturation on a face mask with oxygen at 10 L/min. Preliminary examination revealed that all patients were in a hypotensive state (arterial blood pressures varied from 76/60 to 84/58 mm Hg), a Glasgow Coma Scale of 15/15, and with severe sternal pain (visual analog scale [VAS] 8–10). Two of the three patients had pericardial effusion (troponin-T was positive). Focused assessment with ultrasonography (USG) revealed manubriosternal dislocation in all three patients [Figure 1a].

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Patients were shifted for computerized tomography (CT) scan for thoracic and abdominal imaging after they were administered intravenous (IV) paracetamol 1 gm, after hemodynamic stabilization and obtaining blood samples (hemogram, renal and liver function tests, cardiac markers and arterial blood gas [ABG]). On admission in ICU, the VAS was 8/10 to 10/10 and IV fentanyl infusion was initiated at 5 ml/hour (10 µg/ml). At 12 hours after admission with a persistent VAS of 6/10 to 8/10 and no significant improvement in ABG, it was decided to administer bilateral parasternal blocks.

**Technique**

Informed consent was obtained before performing the bilateral parasternal block. In the supine position, a 6–13 MHz linear transducer (Sonosite M-Turbo, Sonosite Inc.) was placed on the sternal bone and moved laterally to identify the lateral edge of the sternum. The internal mammary vessels (IMVs) were identified immediately lateral to the lateral edge of the sternum.

From inferior to superior the pleura (hyperechoic line with gliding movement during respiration) was visualized in each intercostal space. This was followed by the intercostal muscles sandwiched between the ribs and the pectoralis major muscle (PMm) forming the roof [Figure 1b].

In the parasagittal plane, 2 or 3 cm lateral and parallel to the sternum, the ribs were identified in the short axis (as a hyperechoic curved line) and with the corresponding acoustic shadow below. This point is lateral to the IMV. The needle entry was made lateral to IMVs after deploying color doppler US to help identify the internal thoracic artery and its branches that courses between the PMm and external intercostal muscle (EIM). The injection entry point was infiltrated with 5 ml 1% lidocaine on both sides. An 18G Tuohy needle was inserted in-plane with the US probe, in a caudal-to-cranial direction [Figure 1c]. The point of needle entry was lateral to the IMVs and was advanced until the tip was positioned in the interfascial plane between the PMm and EIM. A test dose of normal saline (2–3 mL) was injected in real-time to confirm that the tip has been placed correctly in the interfascial plane, shown by separation of the fascial layers [Figure 1d]. 20 ml ropivacaine 0.375% and 50 µg of clonidine were injected thereafter and an 18G epidural catheter was placed 5 cm in the parasternal space. The procedure was repeated on the other side [Figure 2a].

The catheters were secured with Tegaderm biofilm (3M™ Tegaderm™). Bacterial filters were attached to the catheters and infusion of 0.1% ropivacaine at 8 ml/hour was initiated through elastomeric infusion pumps (Baxter Corporation, Ontario, Canada) in the parasternal plane. All three patients received a serratus anterior plane block (SAPB) for associated fracture ribs. 0.1% ropivacaine infusion was initiated: 6 ml/hour for each parasternal catheter and 6 ml/hour for SAPB catheter. The patients received IV paracetamol 1 g every 8 hours. IV fentanyl infusion was tapered at 48 hours after the initiation of parasternal infusions and stopped eventually.

**Post-block period**

The parasternal region was infused with 0.1% ropivacaine for 8, 10, and 5 days in cases 1, 2, and 3, respectively. Total ropivacaine infused was 4680 mg, 5760 mg, and 2780 mg in patients 1, 2, and 3 for a duration of 8, 10, and 5 days, respectively. The fentanyl infusion was stopped 3 hours after the block. 30 µg fentanyl was ordered for a VAS score of 4 and more. Patients received fentanyl bolus for breakthrough pain on 4, 3, 4 occasions respectively in

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**Figure 1:** (a) Ultrasonography (USG) image showing manubriosternal dislocation. (b) USG image showing the relationship of IMA, pleura, rib, and pericardium (IMA-internal mammary artery, TTM-transversus thoracis muscle). (c) Image showing the desired plane between the pectoralis major and external intercostal muscle (EIM). (d) Image showing needle entry in the interfascial plane.

**Figure 2:** (a) Image showing the direction of needle entry (caudo-cranial) and probe placement. (b) The axial view after injecting contrast showing the spread of the contrast below and around the pectoralis major and above the EIM on the right side and on the left the contrast spreads deeper below the EIM. (c) The sagittal view after contrast injection depicts the catheter coursing below the sternum and contrast spread below the manubrium and sternum. (d) The coronal view after contrast shows spread in the retrosternal area and as far as the parasternal to intercostal area.
the first 24 hours. The oxygen saturation improved with the same 6 L/min with a FiO2 of 60% [Table 1]. The VAS decreased to 1/10 to 2/10, from a persistent 6–8/10. Fentanyl infusion was eventually stopped. Noninvasive ventilation and intubation were avoided in all three patients. All the catheters were removed once the SpO2 (oxygen saturation on pulse oximetry) stabilized for 24 hours.

**Contrast study**

A contrast CT study with a fee waiver was done for one patient who provided informed consent. Contrast injection was done in bilateral parasternal planes. 5 ml Omnipaque (300 mg iodine/ml) was injected with 15 ml 0.9% normal saline (total volume of 20 ml). Images obtained were analyzed with the help of a radiologist.

The axial view depicted the spread of the contrast below and around the PMm and above the EIM. [Figure 2b]. The sagittal view depicted the catheter coursing below the sternum and contrast spread below the manubrium and sternum [Figure 2c]. The coronal view showed the contrast in the retrosternal area and as far as the parasternal to the intercostal area [Figure 2d].

**Discussion**

Sternal fractures are often associated with thoracic vertebral fractures.[3] The overall mortality of patients with sternal fractures is 1.25% which increases to 15% in the presence of other associated injuries.[4] USG is a better guide to diagnose sternal fractures and manubriumsternal dislocations that are often missed on chest radiographs.[5] The manubriumsternal dislocations were easily diagnosed in our case series. Thoracic epidual and thoracic paravertebral analgesia have been the gold standard in the management of MRFs and thoracic trauma.[6,9] These patients with multiple injuries and sternal fractures are difficult to position in either sitting or lateral for interventional procedures.

The sternum is bilaterally innervated by the anterior divisions of the intercostal nerves. After their emergence from the spinal nerve, the intercostal nerve courses between pleura and endothoracic fascia first, thereafter between the innermost and internal intercostal muscle (IICM), and last, between the transversus thoracis and IICM. There are the anterior intercostal nerves that lie anterior to the internal mammary artery (IMA). The cutaneous nerve emerges at the anteromedial edge piercing the IICM, external intercostal aponeurosis (EICA) and PMm and innervates the anterior chest. The sympathetic plexus around the IMVs innervate the sternum.[10] The parasternal blocks are performed at the emergence of the anterior cutaneous nerves in the interfascial plane below the pectorals major lateral to the sternum.

In these three cases, bilateral parasternal catheters were placed below PMm lateral to IMVs. We strongly recommend this technique for pain relief in all patients with manubriumsternal dislocations.

**Conclusion**

USG guided parasternal catheters with continuous infusions improve pain scores and respiratory parameters without the need for noninvasive ventilation. USG can detect manubriumsternal dislocations. This case series propels the implementation of parasternal blocks in fracture-dislocations of the sternum.

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**Conflicts of interest**

There are no conflicts of interest.

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