Use of ultrasound-guided intercostal nerve block as a sole anaesthetic technique in a high-risk patient with Duchenne muscular dystrophy

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Abstract: Duchenne muscular dystrophy is a progressive neuromuscular disease. Mortality is typically related to combined respiratory failure and dilated cardiomyopathy. Surgery under general anesthesia or deep sedation presents increased risks for pulmonary complications or ventilator dependency postoperatively. We describe the utility of ultrasound guided intercostal nerve blocks for surgery on the chest wall in a patient with Duchenne muscular dystrophy and severe respiratory compromise.

Key words: Intercostal nerve blocks; muscular dystrophy; ultrasound.

Duchenne muscular dystrophy (DMD) is a progressive neuromuscular disease transmitted by X-linked inheritance with an incidence of approximately 1 in 3,500 live male births (1). Scoliosis and lumbar lordosis are almost always present due to progressive muscle weakness. As the disease progresses, most patients lose their ability to walk by age 9 y, and many develop respiratory insufficiency by age 15 y. Respiratory failure, cardiomyopathy or their combination are the most common risk factors for postoperative complications. Preoperative assessment of cardiopulmonary function and astute anesthetic management are of key importance for patients with DMD (1).

Several publications have reported analgesic efficacy of intercostal nerve blocks (INB) in patients with acute pain, such as rib fractures (2), herpetic neuralgia, postoperative pain control for cholecystectomy (3), thoracic surgery (4, 5, 6), mastectomy (7) etc. However, very few reports have been published on the use of INB for surgical anesthesia on the chest wall (7, 8, 9). One of the reasons for its infrequent use as a surgical anesthesia modality may be a perceived risk for complications, such as pneumothorax or hemothorax (10, 11, 12), which could be devastating in patients with already compromised respiratory function, such was the case in our patient with DMD. We describe the utility of INB for surgery on the chest wall in a patient with DMD and severe respiratory impairment that obviated the need for general anesthesia (GA) and mechanical ventilation (MV).

Case Description

After written informed consent from the patient was obtained for publication of this report, a 27-year-old, male patient (41 kg, 170 cm) with DMD was scheduled for evacuation of a thoracic wall hematoma resulting from a pathologic fracture (Fig. 1). The patient was diagnosed with DMD at age 5 y based on clinical presentation, serum enzyme levels (CPK > 7000) and a muscle biopsy. By age 11 y, the patient became wheelchair bound due to progressive kypho-scoliosis and collapse of several thoracic and lumbar vertebrae. At age 17 y, a spinal arthrodasis was performed (between level T3-S1). Over the next several years, the patient developed progressive muscle wasting and deterioration of the respiratory function, requiring chronic use of non-invasive positive pressure ventilation (NPPV). Two years prior to the current surgery, he developed pleural effusion that resulted in subtotal atelectasis and hepatization of the right lung.

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The patient’s pulmonary evaluation revealed a forced vital capacity (FVC) of 346 ml, maximum inspiratory pressure (MIP) of 15 cmH$_2$O, maximum expiratory pressure (MEP) of 8 cmH$_2$O, peak cough flow (PCF) of 63 l.min$^{-1}$, and SpO$_2$ in room air of 98%. A preoperative echocardiography revealed no significant structural or functional abnormalities. The patient presented with a large swelling on the lateral aspect of his right chest wall, developed over a period of 3 weeks. A computerized tomography scan demonstrated a pathologic fracture and a large hematoma (diameter 7 cm) spanning three intercostal levels (Fig. 2). A previously diagnosed right pulmonary heparisation and a pathologic fracture of the right 10$^{th}$ rib, a probable cause of the hemorrhage, were also present.

According to the American College of Chest Physicians (ACCP) Consensus Statement on Respiratory and Related Management of Patients with DMD Undergoing Anesthesia or Sedation (FVC < 30%, PCF < 270 l.min$^{-1}$, MEP < 60 cmH$_2$O) [1], this patient was considered to be at high risk for postoperative respiratory failure, complications and ventilator dependency. He had severe muscle weakness and substantially impaired chest wall kinetics. In addition, due to extreme head flexion, airway management was expected to be difficult. After discussion with the surgical team, a decision was made to perform multiple INB under US guidance for surgical anesthesia in order to decrease risk for respiratory complications associated with tracheal intuba-

![Fig. 1. — The patient with Duchenne Muscular Dystrophy (DMD) and a large swelling on the lateral aspect of his right chest wall (a thoracic wall hematoma) resulting from a pathologic fracture. The apparatus on the patient’s head is a non-invasive positive pressure ventilation mask, that the patient chronically uses at home.](image1)

![Fig. 2. — A computerized tomography scan demonstrated a pathologic fracture and a large hematoma (diameter 7 cm) spanning three intercostal level spaces.](image2)
InterCostal nerve blocks in a high risk patient

Effects of GA and procedural sedation (1). In addition to their cardiac and respiratory insufficiency, patients with DMD are also at risk for cardiac arrest due to acute hyperkalemia, hyperthermia and postoperative rhabdomyolysis. These risks have led an ACCP multidisciplinary panel to publish a consensus statement on perioperative management of patients with DMD that outlines multiple challenges and risks associated with administering anesthesia in these patients (1). The panel suggested that the use of a total intravenous anesthesia (TIVA) technique to induce and maintain GA (e.g., propofol and short-acting opioids) and advised against the use of depolarizing muscle relaxants. The panel also suggested that adequate postoperative pain control should not be compromised because of concerns over suppressing respiratory drive with opioids. This is because adequate ventilation can be achieved with continuous NPPV or by delaying endotracheal extubation for 24 to 48 h. While the panel acknowledged a potential benefit of the neuraxial techniques and local analgesia to decrease the risk for respiratory complications of GA, the utility of peripheral nerve blocks in patients with DMD has not been reported (48, Panel).

In conclusion, INB can be used as an alternative to accomplish complete anesthesia and effective postoperative analgesia in patients with DMD who present for chest wall surgery. US guidance gave us greater confidence to use this technique in a patient scenario where respiratory complications due to

vary from that in a patient with normal anatomy. Color Doppler flow was used to identify and avoid the intercostal vessels. After negative aspiration for blood and air, 4 ml of ropivacaine 0.75% was injected at each level (T7-12). The patient tolerated the anesthetic procedure well. The distribution of sensory block achieved was consistent with the expected multi-level INB. No sedation or additional analgesia was used during surgery; the patient breathed spontaneously using his own NPPV. Surgery was uneventful and consisted of a 10 cm incision, evacuation of 500 ml of blood, and extensive wound exploration followed by the rib biopsy. Postoperative analgesia consisted of intravenous paracetamol 500 mg/6h which resulted in adequate pain control, with VAS score < 3 throughout the 72 hours postoperatively.

Discussion

The mechanisms of anesthesia and analgesia accomplished with INB are well described in publications and often taught at regional anesthesia workshops (13). However, examples of clinical utility of the INB to guide clinical decision-making are much less commonly reported. In our report we describe the clinical utility of US guided INB in a patient with severe respiratory compromise having thoracic wall surgery. Patients with DMD are uniquely vulnerable to the adverse physiologic effects of GA and procedural sedation (1).
either INB or GA would have been deleterious. While unilateral paravertebral blocks and/or thoracic epidural anesthesia are also viable options in patients without spine and chest wall deformity, this may not always be feasible in patients with DMD due to the anatomical challenges and often present history of previous spine surgery and instrumentation. Unfortunately, our patient deceased six months after the surgery due to respiratory complications after an upper respiratory tract infection.

References


