

Ultrasound-Assisted Subarachnoid Block of a Patient with Severe Muscle Wasting for Urologic Surgery

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ABSTRACT

Muscle atrophy, also termed "muscle wasting," is defined as a reduction in muscle mass resulting from progressive muscle weakness and shrinkage. Potential causes include prolonged immobilization, inadequate nutritional intake, severe burn injuries, and a range of serious and often chronic conditions such as muscular dystrophies, renal failure, and immune-mediated disorders. We report the case of a female patient in her 60s with severe muscular wasting who presented with recurrent urinary tract infections and was scheduled for surgical intervention for cystolithiasis. The patient exhibited marked musculoskeletal deformities, including severe scoliosis, multiple joint contractures, and limited cervical mobility, and had been chronically bedridden since adolescence, for which the working impression was muscular dystrophy. In light of the elevated perioperative risk associated with the use of general anesthesia in patients with suspected neuromuscular disorders and severe restrictive pulmonary pathology, ultrasound-assisted neuraxial anesthesia was successfully performed.

Introduction

Muscular dystrophy and other neuromuscular disorders present unique anesthetic challenges due to their associated respiratory compromise, difficult airway anatomy, and increased susceptibility to perioperative complications. These challenges become even more pronounced in patients with severe musculoskeletal deformities, where both airway management and neuraxial access may be technically difficult. This case report describes the successful use of ultrasound-assisted subarachnoid block in a patient with severe muscle wasting and restrictive lung disease undergoing urologic surgery, highlighting the value of individualized anesthetic planning and the role of ultrasound in facilitating safe neuraxial anesthesia in patients with distorted spinal anatomy.

Case Report

The patient is a female in her 60s presenting with a two-year history of recurrent urinary tract infection and dysuria without associated febrile episodes. Workup revealed cystolithiasis necessitating surgical management. Notable features of the patient included atrophied muscles and severe contractures of both upper and lower extremities, pronounced scoliosis, and a difficult airway characterized by limited neck extension and restricted mouth opening.

The patient was reportedly ambulatory and independent in all activities of daily living, with a normal build and height, until the onset of symptoms during adolescence. With no specific trigger, there was progressive development of contractures of the bilateral upper and lower extremities, leading to her current state (Figure 1). On admission, the working diagnosis was muscular

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dystrophy with poliomyelitis. Unfortunately, no further investigation was done due to financial constraints. Ideally, additional tests such as a muscle biopsy or electromyogram should have been done to confirm the working diagnosis.

Preoperative diagnostics revealed mild leukocytosis ($11.2 \times 10^9/L$) and thrombocytosis ($520 \times 10^9/L$), likely reactive to infection. Calcium (2.07 mmol/L) and albumin (30 g/L) were low, while electrolytes and creatinine were within normal limits; estimated GFR was 97 mL/min. Baseline ECG was unremarkable. Echocardiography showed a normal-sized left ventricle with preserved systolic function (EF 64%), normal chamber dimensions and contractility, a non-dilated IVC, structurally normal valves, and a low probability of pulmonary hypertension. Chest radiograph showed severe thoracic dextroscoliosis (Figure 2). A pulmonary function test, which would have been beneficial to emphasize the severity of the restrictive lung disease, was not done due to financial constraints.



Figure 1- Severe muscle wasting in a 66-year-old female. Prominent features are a short neck with limited extension, severe contractures of the bilateral upper and lower extremities, a shortened torso, and severe scoliosis.



Figure 2- Patient's chest radiograph taken during admission showing the severe thoracic dextroscoliosis.

Severe contractures of all extremities left the patient bed-bound, dependent on all daily activities, and

preferring a moderate to high backrest position. On preoperative assessment, her vital signs were noted to be within normal limits, with a blood pressure of 110/70, heart rate of 99 beats per minute, respiratory rate of 20 cycles per minute, and oxygen saturation of 94% on room air.

She was oriented and conversant and had clear but decreased breath sounds on the right lung base. Her weight was approximately 25 kilograms. Airway assessment suggested a difficult airway due to limited mouth opening, a short neck, and a Mallampati score of IV with limited neck extension.

Based on the classification of the American Society of Anesthesiology, she was categorized as ASA 3 due to muscular dystrophy and severe restrictive lung disease. She was classified as having intermediate risk (13.3%) of in-hospital postoperative pulmonary complications (30 points in the Assess Respiratory Risk in Surgical Patients in Catalonia [ARISCAT] Risk Index). The revised cardiac risk assessment showed a low risk of developing perioperative cardiovascular complications for an intermediate-risk non-cardiac surgery (0.4%).

Intraoperatively, the patient was attached to standard monitors and was administered oxygen supplementation via a Hudson face mask at 6 liters per minute. Prior to positioning for neuraxial anesthesia, she was mildly sedated with midazolam (0.02 mg/kg) and fentanyl (0.5 mcg/kg). The patient was assisted to assume a right lateral decubitus position, and surgical asepsis was done on the planned puncture site (L4-L5 interspace). Following the technique described by NYSORA [10], the transducer was positioned 1–2 cm lateral to the spinous process in the lower back, with its orientation marker facing cranially.

A slight medial angulation of the probe allowed imaging of the spine in the paramedian sagittal oblique (PMSO) plane. The sacrum was identified, which appeared as a flat, hyperechoic structure producing a prominent acoustic shadow anteriorly (Figure 3). Moving the transducer upward, a gap between the sacrum and the L5 lamina corresponds to the L5–S1 interlaminar space, also known as the L5–S1 gap (Figure 3). The interlaminar spaces at L4–L5 and L3–L4 were identified by sequentially counting in the cranial direction (Figure 4). The intrathecal space is presented as an anechoic region between the posterior dura and the anterior complex [1].

The posterior surface of the sacrum is identified as a flat hyperechoic structure with a large acoustic shadow anteriorly. The gap between the sacrum and the L5 lamina is the L5–S1 intervertebral space. AC, anterior complex; CE, cauda equina; ES, epidural space; ESM, erector spinae muscle; ITS, intrathecal space; LF, ligamentum flavum; PD, posterior dura. Images lifted from NYSORA. The epidural space appears as a narrow hypoechoic band situated between the bright echogenic lines of the ligamentum flavum and the posterior dura.

The intrathecal space is the anechoic area between the posterior dura and the anterior complex. Within the thecal sac, the cauda equina nerve roots are visualized as bright, elongated structures. Echogenic reflections in front of the anterior complex are the intervertebral discs (IVDs). AC, anterior complex; CE, cauda equina; ES, epidural space; ESM, erector spinae muscle; ILS, interlaminar space; ITS, intrathecal space; IVD, intervertebral disc; L3, lamina of L3 vertebra; L4, lamina of L4 vertebra; L5, lamina of L5 vertebra; LF, ligamentum flavum; PD, posterior dura. Images lifted from NYSORA.

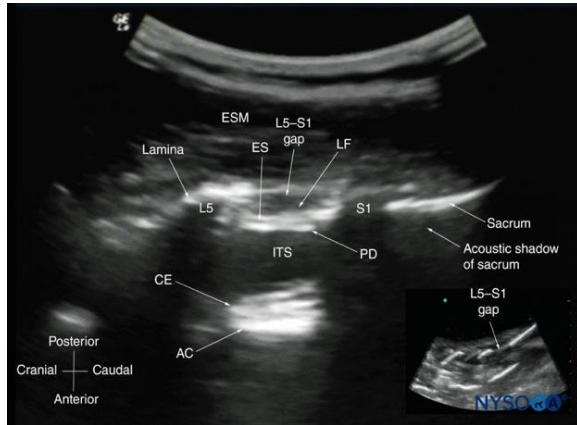


Figure 3- Paramedian sagittal ultrasound image of the lumbosacral junction.

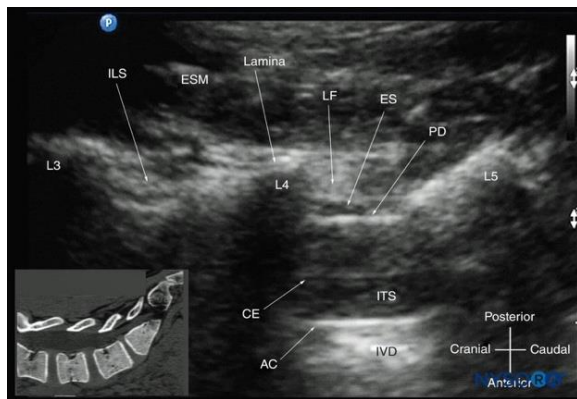


Figure 4- A paramedian sagittal oblique ultrasound image of the lumbar spine at the laminar level displays the L3-4 and L4-5 interlaminar spaces.

After two failed attempts of lumbar puncture using a Quincke needle gauge 25, the subarachnoid space was successfully reached, and backflow of cerebrospinal fluid was visualized (Figure 5). With adequate barbotage, hyperbaric bupivacaine 10 mg with fentanyl 10 mcg was administered intrathecally (Figure 6). Since the volume given was proportionally large for the patient, the risk of high spinal was anticipated. To mitigate the risk, the local anesthetic was given very slowly, and the Trendelenburg position was avoided.



Figure 5- Anesthesiologists doing ultrasound-assisted identification of the intervertebral spaces for neuraxial (spinal) anesthesia.



Figure 6- Administration of hyperbaric bupivacaine 10 mg with fentanyl 10 mcg intrathecally via paramedian approach.

Adequacy of the block was confirmed by assessing loss of sensation to temperature, pinprick, and motor block. Post-induction, the level of the block was assessed to be at T4. Oxygen support was provided via face mask, with spontaneous respiration and adequate oxygenation maintained. Cystolithotomy and open suprapubic tube cystostomy were done successfully, with an estimated blood loss of 50 ml. The surgery lasted for two hours, and the patient was transferred to the recovery room for close monitoring.

Results

Postoperatively, the patient was transferred to the post-anesthesia care unit for close monitoring. Her course at the post-anesthesia care unit was uneventful, with a noted full recovery from the block after two hours, and she was then cleared to return to her room. Pain was well controlled, registering a numerical pain scale score of 0. With an unremarkable postoperative course, she was discharged in stable condition after five days.

Discussion

Skeletal muscle atrophy or wasting is defined by structural and molecular changes, including myofiber shrinkage, shifts in muscle fiber composition or myosin isoform expression, and an overall reduction in cytoplasmic volume, organelles, and total protein content. Among these features, a reduction in myofiber diameter represents the most prominent histopathological hallmark of skeletal muscle atrophy. It can be classified as primary or secondary. Primary skeletal muscle atrophy is caused directly by various inherited muscle disorders, such as congenital and genetic myopathies. Inherited myopathies can be further categorized as muscular dystrophies, congenital myopathies, mitochondrial myopathies, and metabolic myopathies. Secondary skeletal muscle atrophy, on the other hand, includes acquired causes such as age-related sarcopenia, cachexia from cancer, diabetes, chronic kidney disease, malnutrition, and prolonged immobilization [2].

Muscular dystrophy encompasses a heterogeneous group of inherited genetic disorders characterized by a deficiency of sarcolemmal glycoproteins essential for muscle cell stability. It affects 1 in 5,000 individuals globally and can manifest at any stage of life but is commonly diagnosed in childhood. The pathophysiology involves mutations in genes responsible for the structural integrity and function of muscle fibers, resulting in their progressive degeneration and loss. Both skeletal and cardiac muscles are commonly involved, and while disease progression varies based on the specific subtype and severity, it typically follows a trajectory of increasing muscle weakness, loss of mobility, and potential complications affecting respiratory and cardiac function [3].

Patients with muscular dystrophy pose anesthetic challenges; hence, a comprehensive preoperative assessment and planning are essential. According to a study by Echeverry-Marín et al., it is recommended that a thorough assessment of the patient's functional status be conducted, paying particular attention to respiratory and cardiac function. Screening for difficult airway features is also vital [4].

Choice of Anesthetic Technique

The choice of anesthetic technique was tailored based on the high index of suspicion of muscular dystrophy in this patient. There is no definite protocol dictating the use of general or regional anesthesia in this patient population. In the past, patients with muscular dystrophies were believed to be susceptible to developing malignant hyperthermia (MH). According to Gurnaney et al., however, there was no significant increase in MH susceptibility in these patients [5]. Nevertheless, the use of volatile anesthetics can still present significant potential for life-threatening rhabdomyolysis, leading to

kidney injury, hyperkalemia, hyperphosphatemia, and lethal arrhythmias [5]. To circumvent these risks, general anesthesia using total intravenous anesthesia (TIVA) may be an option. Propofol remains the most frequently utilized hypnotic agent for both the induction and maintenance of anesthesia in individuals with Duchenne muscular dystrophy [3]. For those with co-existing cardiac pathologies, alternative agents such as etomidate and thiopental have been successfully administered, particularly in patients with myotonic dystrophies [3].

The decision to utilize spinal anesthesia was further supported by the need to mitigate risks associated with anticipated difficult airway management and the presence of severe restrictive pulmonary disease. General anesthesia can exacerbate ventilatory impairment, increase the risk of hypoventilation, and reduce pulmonary compliance, potentially leading to postoperative respiratory failure [6]. Although not evident in this case, general anesthesia is also not recommended in those with suspected cardiomyopathy, as volatile agents can depress myocardial contractility, precipitate arrhythmias, and impair hemodynamic stability, thereby significantly increasing perioperative morbidity and mortality [7]. In contrast, a well-controlled and executed neuraxial block allows for the maintenance of spontaneous ventilation while providing sufficient sensory coverage for the surgical site, making it a safer and more appropriate choice in this clinical context.

Peripheral nerve blocks, specifically quadratus lumborum (QL) and transversus abdominis plane (TAP) blocks, may be acceptable alternatives in high-risk patients, as they similarly minimize the complications associated with general anesthesia, particularly in those with compromised cardiopulmonary function. They can likewise provide effective somatic and visceral analgesia while minimizing airway manipulation and cardiovascular stress. In a study by Tripta et al., a bilateral TAP was done in an 80-year-old patient for emergency open cystolithotomy using a 0.5% bupivacaine and 2% lignocaine mixture, 15 ml on each side, using anatomical landmarks supplemented with intravenous sedation [8]. However, considering the patient's low body weight (25 kg), administering a full surgical dose of local anesthetic posed a substantial risk of exceeding the calculated maximum safe dose of isobaric bupivacaine (75 mg), thereby increasing the potential for local anesthetic systemic toxicity (LAST).

Spinal anesthesia offers a clear advantage over general anesthesia in mitigating potential complications, but its effectiveness relies critically on the successful execution of the technically difficult lumbar puncture. The patient's atypical anatomical features significantly complicated the identification of neuraxial landmarks. Moreover, there have been reports of myotonic contractures, described as muscle contractions with delayed relaxation, which could be attributed to incomplete neuraxial

blockade or to the shivering associated with neuraxial anesthesia [9]. Additional challenges include the unpredictable spread of the neuraxial block and the absence of established protocols or guidelines for determining the appropriate dose of the local anesthetic.

The application of ultrasound in performing spinal anesthesia enhances safety by more accurately visualizing the spinal canal, improving needle placement accuracy, lowering the risk of accidental vascular injury with consequent hematoma formation, and enabling more precise delivery of local anesthetic, thereby reducing the required dosage [10]. An alternative imaging modality that could also be utilized in the operating room is C-arm fluoroscopy [11]. The value of new, readily available imaging technologies in aiding clinicians with the management of patients presenting with comparable clinical features cannot be overemphasized.

Conclusion

This is the first local documentation of ultrasound-guided spinal anesthesia in an adult patient with muscular dystrophy undergoing a urologic surgery. This case highlights the importance of individualized anesthetic planning in patients with neuromuscular disorders and significant musculoskeletal deformities. In the presence of severe restrictive lung disease and high perioperative risks associated with general anesthesia, ultrasound-guided neuraxial anesthesia can offer a safe and effective alternative. The successful management of this complex case underscores the value of imaging in facilitating neuraxial blockade, especially in patients with altered anatomy.

Ethics approval and consent to participate

Informed consent was obtained for the writing and possible publication of this case report.

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