Interscalene Brachial Plexus Block in Severe Obstructive Lung Disease

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Abstract

Brachial Plexus block above the clavicle in presence of severe chronic obstructive pulmonary disease (COPD) is considered risky due to the fear of inadvertent phrenic nerve paralysis leading to severe respiratory distress. We present a case report of open reduction and internal fixation of proximal humerus fracture done successfully without pulmonary complications under a low Interscalene Brachial Plexus Block (ISBPB) as the sole anaesthetic. Patient refusal for a general anaesthetic for fear of prolonged postoperative ventilation was indication for carrying out the procedure of open reduction and internal fixation of humerus solely under regional anaesthesia.

Key Words: Regional Anaesthesia, Interscalene Brachial Plexus Block [ISBPB], Severe Chronic Obstructive Pulmonary Disease [COPD], Complications, Phrenic Nerve Paresis.

Introduction

The interscalene approach is regional anesthetic technique of choice for the shoulder surgeries. However the interscalene block is associated with an inevitable consequence "the phrenic nerve block – leading to hemidiaphragmatic paresis" [2,5,6,31]. The resulting diaphragmatic dysfunction causes changes in the lung mechanics which is tolerated by majority of healthy patients but potentially deleterious in patients with limited respiratory reserve. A 25% reduction in pulmonary function is not tolerated by patients with pre-existing pulmonary pathology [6]. Ultrasound guided interscalene block allows precise placement of the needle and reduces the local anaesthetic volume. This has lowered the incidence of diaphragmatic paralysis [1,3,4,16,21,27].

Case Report:

A 68 year old female patient with fracture of right proximal humerus was posted for open reduction and internal fixation. The patient was hypertensive and obese with restricted mobility. She had history of severe progressive restrictive lung disease for almost 25 years for which she needed non-invasive ventilation and nasal oxygen at home. Her X-ray (Fig. 1) and CT scan (Fig. 2) chest revealed chronic interstitial lung disease. In the propped up position, desaturation was observed after oxygen was briefly discontinued for 2-3 mins (Fig. 3). Saturation was maintained at 100% with 8 liters of Oxygen administered via a face mask. She could not lie down in supine position and had to be kept in propped up position. In 2016, she had history of previous hospitalization for pneumonia and respiratory failure for which she was mechanically ventilated for ten days. This discouraged her and relatives to have a general anaesthetic administered to her for the present surgery. Her blood investigations were within normal limits except for mild anaemia with a haematocrit of 32%.

Pulmonary function tests (Fig. 6) revealed a severe restrictive disease with a FEV1 of 41% of predicted value with no reversibility with bronchodilators. The FVC was 36.5% of predicted value and MVV was 26% of predicted value indicating severe restrictive disease. The preoperative arterial blood gas revealed a PO2 of 67% and a PaCO2 of 43.7% on air. A 2D Echocardiography was normal with no evidence of pulmonary hypertension. She was admitted in the intensive care unit with continuous oxygenation, minimal hydration, antibiotics and nebulization with bronchilators (Fig 5).

A written informed high risk consent was obtained and the possibility of...
Postoperative mechanical ventilation was explained to her relatives along with a consultation with the pulmonologist. Non-invasive ventilator device was kept ready. Preoperatively the patient had tachycardia (HR 107) and tachypnoea (RR 32/min) with an O2 saturation of 82% on air which improved to 100% with O2 @ 8 L/min with a Hudson’s facemask. All the while she was placed in a semi reclined position.

Anesthetic Technique
The patient was in propped up position on the operating table (figure 9). The interscalene groove was identified and marked from C6 level to the clavicle. A low interscalene brachial plexus block was performed at two-thirds of this distance caudally from C6 (figure 8) under ultrasound guidance with an in-plane technique with the needle approaching from lateral to medial side.

Anesthetic Technique

Perioperative Course
The surgery was carried out in the same semi-reclined position after confirmation of a complete and successful sensorimotor block of the affected upper limb as assessed by inability to perceive tactile sensation and inability to move the upper limb. The procedure (figure 11) which lasted for 2 hours was uneventful. There was no evidence of cardiorespiratory distress as observed clinically with no changes in the respiratory pattern and Oxygen saturation values. The patient was monitored in the post-anaesthesia care unit for 2 hours after the surgery, where she was completely pain-free and comfortable with no evidence of respiratory discomfort. Thereafter she was shifted to High Dependence Unit for further monitoring and observation. The postoperative course remained uneventful and the patient was discharged from hospital on 5th postoperative day.

Discussion:
Interstitial Lung Disease (ILD) is characterized by histologic abnormalities and involves the pulmonary interstitium. The interstitium supports the delicate relationship between the alveoli and the capillaries allowing for efficient gas exchange. If there is any injury in the form of specific exposure (asbestos, hay) or any autoimmune connective tissue disorder, the lung responds to that injury and repairs itself. However if the injury persists or the repair is imperfect, the lung may be permanently damaged with increased interstitial tissue replacing the normal capillaries, alveoli and healthy interstitium. These pathologic abnormalities lead to profound impairment of lung physiology owing to V/Q mismatching, shunt and decreased diffusion across abnormal interstitium. Work of breathing is markedly increased because of decreased lung compliance. This leads to a restrictive pattern of respiration.
The brachial plexus arises from the spinal nerves C5-C8 and T1. These five roots emerge from their respective intervertebral foramina to lie between the anterior and middle scalene muscles in the neck and unite to form the three trunks which further subdivide into divisions, cords and finally the terminal nerves which provide sensory and motor innervation of the upper limb.

The phrenic nerve (Fig. 12) is derived from spinal nerves C3,4,5 and normally courses anterior to the anterior scalene muscle where it is in close proximity to the brachial plexus\[14,17\]. This proximity of the phrenic nerve to the brachial plexus renders it susceptible to the effects of the local anaesthetic deposited in the interscalene groove (figure 12). The local anaesthetic deposited in the interscalene groove often spreads cephalad to the nerve roots C5, C4 and even upto C3, thus leading to a phrenic nerve block\[17\]. This could be related to the volume of local anaesthetic used for interscalene block. Lower volume may lower the chances of phrenic nerve blockade\[1,3,4,16\].

The author presents an obese non-ambulatory patient with long standing interstitial lung disease requiring intermittent home based non-invasive ventilation and continuous oxygenation suffering from fracture of proximal humerus. She was administered a successful interscalene brachial plexus block as the sole anaesthetic. The risk of hemidiaphragmatic paralysis and its consequences were taken into account.

Patients with pre-existing restrictive lung disease are associated with adverse respiratory events, but the literature still presents controversial results. General Anaesthesia with mechanical ventilation may increase the risk of exacerbating the inflammatory process of parenchymal fibrotic diseases and promote adult respiratory distress syndrome (ARDS)\[28\]. Hence after adequate counselling of the patient and her relatives and weighing the risk benefit ratio, a low Interscalene Brachial plexus block was performed.

Interscalene brachial blocks are performed either by the neurostimulation or ultrasound guidance. Interscalene blocks cause 100% diaphragmatic paresis \[9\]. Renes et al presented a study of 30 patients with a low interscalene block at the C7 level. They divided the patients randomly into two groups, ultrasound and neurostimulation. Each group received 10 ml of 0.75% ropivacaine. They concluded that incidence of hemidiaphragmatic paresis was significantly lower in ultrasound group (13%) as compared to neurostimulation group (93%)\[1,21\].

Transient ipsilateral phrenic nerve paralysis after interscalene brachial plexus block leading to immediate acute respiratory failure has been reported in several case reports \[2,5,6,7,9,17,20\]. After interscalene

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**Figure 8**: The point of needle entry for low level ultrasound guided interscalene block

**Figure 9**: Ultrasound guided interscalene block in propped up position

**Figure 10**: The In plane Ultrasound guided Interscalene Block

**Figure 11a**: Preoperative Xray of fracture humerus

**Figure 11b**: Immediate postoperative IITV image

**Figure 12**: Left Brachial Plexus cadaveric dissection depicting the phrenic nerve close to the proximal interscalene trunks. Orange arrows — Phrenic nerve ; Yellow arrows — Cervical roots ; light green — superior trunk

Cadaveric Dissection : Dr Purshottam Manvikar, HOD Anatomy, D Y Patil Pune
block there is a systematic transient diaphragmatic hemiparesis due to constant diffusion of local anaesthetic into the cervical plexus [4]. The paralysis reaches its maximum at 15 minutes after the block and persists for 3-5 hours and is accompanied by a 25 % reduction in vital capacity [5]. The loss of diaphragmatic motor function decreases respiratory function. The forced vital capacity and the forced expiratory volume are decreased by 25% independent of the presence of pre-existing pulmonary disease. The peak expiratory flow rate is also reduced [15,17,22]. In reality, most healthy patients tolerate unilateral phrenic nerve paralysis without any symptoms. The accessory musculature compensates the restriction imposed by the paralysis and expansion of the contralateral lung is able to produce a good enough negative pressure to guarantee good ventilation. Cangiani et al. did a study of 30 patients without pulmonary dysfunction and observed that 50% developed complete hemidiaphragmatic paralysis (i.e. >75% reduction of the diaphragmatic movement); 17% had partial paralysis (i.e. 25-75% reduction of diaphragmatic movement) but the reduction in pulmonary function was not significant. Thus they concluded that phrenic nerve blockade was an important adverse reaction which is well tolerated by patients with normal pulmonary function [20]. Ultrasound guidance for interscalene brachial plexus block helps in minimizing the incidence of a phrenic nerve block during an interscalene block. There are two methods for the ultrasound-guided approach:

A ) It can be performed on the superior trunk ( the C5 and C6 combine to form the superior trunk ).
B ) The injection can be performed on the caudal aspect of the C6 nerve root [24,25]. Although different studies define and name the procedures slightly differently (low approach, lower interscalene approach, or superior trunk approach), these procedures are identical in terms of using an approach through the lower regions of the C6 level compared to the existing ISB.

The phrenic nerve is located within 2 mm of the brachial plexus at the cricoid cartilage (Fig. 10). As it moves caudally over the anterior scalene muscle it moves more medially. Thus, it can be predicted that the incidence of phrenic nerve palsy-induced hemidiaphragmatic paralysis can be reduced if a low ISB is performed caudal to the C6 level or on the superior trunk [24,25,26]. Fredrickson et al found that the incidence of hemidiaphragmatic paresis was significantly lower in the low volume group (45%) as compared to the standard volume group (100%) [4]. The post operative SpO2 levels were higher in the low volume group and no differences were found in the pain scores, sleep quality and the total morphine consumption [4]. A study of 40 patients, by Riazi et al, randomised to receive an ultrasound guided single injection interscalene block using either 5 or 20 ml of 0.5% ropivacaine concluded that the incidence of hemidiaphragmatic paralysis was lower in the low volume group [3]. However Sinha et al. presented a study of 30 patients who received Ultrasound guided interscalene brachial plexus block at the level of cricoid cartilage (C5-6 roots) with 10-20 ml of 0.5% ropivacaine and concluded that reduction in volume of local anaesthetic does not reduce the incidence of hemidiaphragmatic paresis (93% patients in their study)[11]. Hortense, Perez, et al. conducted a study of 30 patients undergoing elective upper limb surgery under ISBPB and evaluated the effects of 0.5% bupivacaine with epinephrine(1:200,000) and 0.5% ropivacaine on pulmonary function. They found a mean decrease of 25% in FVC in 17 patients with hemidiaphragmatic paresis and the changes were more pronounced in the ropivacaine group. They concluded that these changes were maintained for at least 6 hours and they were not associated with relevant clinical repercussions [33].

This author choose an ultrasound guided low interscalene approach and combined with a low volume 12ml 0.5% bupivacaine. A successful block was achieved with adequate analgesia throughout the 2 hours surgical procedures.

Alternative approaches for anaesthesia for shoulder surgeries includes the selective nerve blocks of the shoulder. These have been termed the phrenic nerve sparing blocks, but are less commonly utilised for a surgical procedure [35,37]. The suprascapular and the axillary blocks combined with a superficial cervical plexus block is described. Singelyn et al did a comparable study to assess the outcomes in 120 patients with interscalene block as against suprascapular nerve block and intra-articular local anaesthetic injection. The pain scores were much lower in interscalene block and suprascapular nerve block as compared to intra articular injection[30].

In yet another technique a suprascapular nerve block was combined with an infracavicular brachial plexus block to avoid the risk of phrenic nerve paralysis [34].

Conclusion:
The aetiology of prolonged diaphragmatic paralysis is multifactorial but regardless of the anaesthesia type, the possibility of prolonged diaphragmatic dysfunction should be considered in the setting of shoulder surgery. The author presents here a case report of a patient with severe restrictive lung disease( continuous oxygen dependant) posted for open reduction and internal fixation of fracture of proximal humerus. This was performed with an ultrasound guided low approach and low volume interscalene brachial plexus block. The use of ultrasound facilitates precise localization of target nerves and also aids in achieving adequate block with low volume of local anaesthetic. There was no blockade of the phrenic nerve to cause significant respiratory distress. Hence it can be concluded that a low interscalene block with a low volume of local anaesthetic and use of ultrasound and neurostimulation for precise localization of the brachial plexus may help to avoid the respiratory complication of phrenic nerve paralysis which may otherwise be deleterious in patients with severe interstitial lung disease. Thus the judicious use of ultrasound guided interscalene brachial plexus block can be successfully employed in high risk patients with restrictive respiratory disease.

References


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How to Cite this Article


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