I.V. access was obtained and ECG, pulse oximetry, and continuous invasive arterial pressure monitoring were established. The patient was placed in the right lateral position and commenced on NIV. The insertion of the intrathecal catheter was technically difficult, and the epidural space was located with a 16 G Tuohy and the use of the image intensifier and contrast. A dural tap was achieved at 7 cm and an intrathecal catheter inserted to 11 cm. After incremental titration with 5 ml of levobupivacaine 0.25%, a block to T12 provided conditions suitable for surgery, which was completed without incident.

After operation, NIV was continued. An infusion of bupivacaine 0.1% was commenced intrathecally at 1–1.5 ml h⁻¹, providing excellent analgesia and was continued for the following 4 days. The infusion was titrated to block height of T10–11 which provided good analgesia with no respiratory problems or motor block. The catheter was removed on day 5, following which the patient’s analgesia requirement were met with paracetamol and nefopam. The patient was discharged home on day 11.

The heterogeneity of ventilator-dependent patients and small number of studies of perioperative care makes the prediction of risk difficult. Patients now focus on psychosocial factors, rather than survival, leading to the concept of prolonged survival and acceptable exposure to risk. In this patient cohort, preoperative assessment and risk stratification is complex. Symptoms such as dyspnoea and orthopnoea are often late findings and physical evaluation is essential to detect accessory muscle recruitment, supine abdominal paradox, and encumbrance of upper or lower airways.¹ A substantial loss of respiratory muscle strength is typically accompanied by little or no change in spirometry or arterial blood gases.² Lung function tests can reveal a characteristically low vital capacity, reduced total lung capacity, and preserved residual volume. Transfer factor is normal when adjusted for lung volume.

Evaluation of respiratory muscle strength is extremely useful, and has been shown to be sensitive and prognostic.³ Peak expiratory flow during cough gives an overall evaluation of cough efficiency, values below 160–270 litre min⁻¹ suggesting poor airway clearance. Evaluation of respiratory muscle strength is achieved by measuring maximal inspiratory pressure (PImax) and sniff nasal inspiratory pressure. A maximal expiratory pressure (PEmax) below 45 cm H₂O may indicate compromised cough efficiency.

There are few reports of the use of Bipap in the operating theatre.⁴–⁷ Our case highlights that using intraoperative NIV can be useful, and avoid the need for general anaesthesia and invasive ventilation.

**Declaration of interest**

None declared.

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**Fig 1** CT reconstruction of the lumbar spine, demonstrating relatively preserved anatomy at L3/L4.

**Ultrasound description of a superior laryngeal nerve space as an anatomical basis for echoguided regional anaesthesia**

Editor—The superior laryngeal nerve (SLN) bifurcates near the pharynx into the external and internal sensory (SLN<sub>internal</sub>) branches.¹ ² The bilateral SLN<sub>internal</sub> block can be used to obtain airway anaesthesia, using a percutaneous
approach based on anatomic landmarks [greater cornu of the hyoid bone (HB) and the thyroid cartilage (TC)]]3–6. These landmarks may be difficult to locate in some patients, and we aimed to develop echoguided SLN block by describing the ultrasound anatomy of the structures surrounding the SLN internal in its extralaryngeal course.

A preliminary anatomical dissection on an embalmed human cadaver confirmed the presence of a space (named SLN space), containing the SLN internal, located between the HB (cephalad) and the TC (caudal), and delimited between the thyrohyoid muscle (THM), anteriorly, and the thyro-hyoid membrane (TH-Mb) and the pre-epiglottis space, posteriorly (Fig. 1A and B).

After informed consent, ultrasound imaging of the SLN space was performed in both neck sides in 100 patients (mean age 49 (sd 19) yr, BMI 24.0 (4.9) kg m⁻², and cervical circumference 37.4 (4.2) cm) using a Vivid GE 12 MHz 8L-RS, 4 cm width linear probe (General Electric Company, USA). Exclusion criteria were previous cervical disease or surgery. TC and HB (hyperechoic cortical and subsequent shadow cone) were identified first, with a probe in a parasagittal plane (Fig. 1C). The probe was then moved laterally to visualize from the skin to the larynx: (i) THM (large hypoechoic band, inserted on the HB and passing over the TC); (ii) TH-Mb (hyperechoic layer, marking the interface with the hypoechoic pre-epiglottis space); and (iii) the interface between the luminal surface and the superficial mucosae of the larynx (hyperechoic layer) (Fig. 1D). The quality of ultrasound image was rated optimal when all the following were seen: THM, pre-epiglottis space, HB, TC, and TH-Mb; suboptimal when all structures other than TH-Mb were seen; and poor in all other cases.

Optimal (Fig. 1D), suboptimal, or poor quality ultrasound images were obtained in 81%, 19%, and 0% of the cases, respectively. Older age, BMI >30 kg m⁻², and cervical circumference >40 cm were significantly associated with the suboptimal ultrasound image, where only the hypoechoic layer between the inner face of the THM and the laryngeal structures could be seen (P<0.05, univariate analysis, SAS 9.2, SAS Institute, Cary, NC, USA). This is probably related to a lower ultrasonic differentiation of tissue interfaces described in obese patients.

SLN internal was not visualized in any patient, and the superior laryngeal artery was seen in only one patient. Although we cannot exclude the nerve not being present in the space we described, as anatomical variations at this level have not been reported, this is most likely due to the small size of this nerve (1 mm), which is below the spatial resolution of our 12 MHz ultrasound probe. A higher resolution ultrasound probe may be more appropriate, but would the lack of depth of field in some obese patients, in whom the TH-Mb could be >3 cm under the skin.

Fig 1. Anatomic dissection of the perilaryngeal structures [lateral section (a) and oblique parasagittal section (b)], ultrasound imaging of the subhyoid region (c), and position of the scanhead (d). (1) TC; (2) HB; (3) TH-Mb; (4) THM (retracted in Fig. 1a); (5) insertion of the THM; (6) internal branch of the SLN; (7) cricoid cartilage; (8) superior laryngeal artery; (9) superior thyroid artery; (10) external carotid artery; (11) submandibular gland; (12) parotid gland.
A submandibular gland (hyperechoic echotexture, containing linear hyperechoic stripe) overlapped totally or partially the THM above the SLN space in 3% and 27% of the cases, respectively.

In conclusion, the structures of the SLN space can be indentified using a 12 MHz probe. Whether this space could be a target for ultrasound-guided SLN block deserves further investigation.

**Declaration of interest**

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**Possible explanation for failures during infraclavicular block: an anatomical observation on Thiel’s embalmed cadavers**

Editor—Ultrasound-guided infraclavicular block (US-ICB) yields a higher success rate and improved safety for analgesia of the upper limb compared with nerve-stimulation-guided injection. However, even with adequate US-ICB injection, block failure can occur, and no mechanism explaining such failures has yet been proposed.

We investigated the possible causes of block failure after posterior (6 o'clock) injection relative to the axillary artery during bilateral US-ICB in 20 cadavers preserved according to Thiel’s embalming method. Before US-ICB was performed, the infraclavicular region was scanned with the probe. The probe was oriented with a 30°–40° angle relative to the clavicle to obtain a transverse view of the axillary vessels. The needle was then inserted cranially relative to the probe, and advanced to reach the region immediately posterior to the axillary artery (6 o'clock point). Then, 0.5 ml kg⁻¹ of a local anaesthetic solution (LAS) composed of lidocaine 0.5% with methylene blue (MB) 0.02% (MB 1%, 2 ml per 100 ml of lidocaine) was injected into this site for each block with a 20 ml syringe, under ultrasound guidance, to achieve a U-shaped spread. A professional anatomist performed fine dissection of each brachial plexus injected and recorded which nerve structures of the brachial plexus were coloured by the MB solution.

The primary endpoint was the failure of US-ICB. A procedure was considered successful if sufficient nerve structures were coloured by the MB solution to indicate that the target structures had actually been reached by the LAS.

A total of 40 US-ICB were performed, and in 33, all nerves and cords of the brachial plexus were circumferentially coloured by MB, giving an ‘anatomical’ success rate of 82.5%.

**Fig 1** Axial view of the axillary region. The black arrow shows the thoracocapular region between the subscapularis (SSM) and the serratus anterior (SAM) muscles, where the LAS was found in four cases of block failure. LC, lateral cord; PC, posterior cord; MC, medial cord; IM, infraspinatus muscle; DM, deltoïd muscle; LHoB, long head of the biceps brachii muscle; CBM, coracobrachialis muscle; SHoB, short head of the biceps brachii muscle; PMM, pectoralis major muscle; CPF, clavicular fascia; SSM, subscapularis muscle; SAM, serratus anterior muscle; SA, subclavian artery; SV, subclavian vein; DAF, deep axillary fascia; PMM, pectoralis minor muscle; 1, normal space of LAS diffusion during infraclavicular block.