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Editor,—Thank you for the opportunity to reply to Dr Khuenl-Brady.

The authors endorsing the use of a particular technique overlooked some of the data from our study as we compared accelerography with microphone acoustics and mechanomyography (see results). Our results are in accordance with previous data, demonstrating that acceleromyography has wide limits of agreement (–62 to +12%) and exhibits a bias of –25% relative to mechanomyography.<sup>1</sup> Another well controlled study concluded that acceleromyographic and mechanomyographic recordings of neuromuscular transmission cannot be used interchangeably because of different recovery courses.<sup>2</sup> Unlike the opinion expressed by Dr Khuenl-Brady, other authors have recommended that information from accelerography and mechanomyography should not be used interchangeably because of major differences between the methods.<sup>3</sup> Accordingly, it was shown that accelerography had wide and unacceptable limits of agreement and was more susceptible to drift than mechanomyography.<sup>4</sup> We would conclude that observed differences between mechanomyography and accelerography are far from being negligible in clinical use and that accelerography cannot be substituted for mechanical measurements, the present 'golden standard'.

We believe that acoustic myography is a method for daily clinical use by the anaesthetist, correlating closely with mechanical measurements, and which has the potential advantage of monitoring central muscles of respiration. We conclude that it is an easy to apply and *accurate* method of quantifying neuromuscular block when clinical monitoring is needed.

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## Bradycardia after administration of remifentanyl

Editor,—Remifentanyl is a recently introduced opioid with the desirable characteristics of a rapid onset and short duration of action.<sup>1</sup> Its use has been recommended for controlling the cardiovascular and intraocular pressure responses to tracheal intubation.<sup>2,3</sup> We report a case where its administration led to severe bradycardia.

An 82-yr-old woman, weighing about 70 kg, was scheduled for repair of a perforating eye injury after a fall. The only past medical history of note was hypertension. Medications included atenolol 50 mg, bendrofluazide 2.5 mg and aspirin 75 mg daily. The patient had received an uneventful general anaesthetic in 1998 for a bladder repair. Preoperative investigations were normal except that the ECG showed a sinus bradycardia of 45 beat min<sup>–1</sup>. She arrived in the operating room in the afternoon having taken all her medications in the morning before her fall.

After placement of non-invasive monitors (arterial pressure cuff, ECG and pulse oximeter), and sitting of an i.v. infusion of Hartmann's solution, the patient was given 100% oxygen. Anaesthesia was induced using a target-controlled infusion of propofol to a target of 2 µg ml<sup>–1</sup>. A bolus dose of remifentanyl 50 µg was administered over 1 min and the patient's lungs were ventilated with 100% oxygen. Heart rate decreased to 35 beat min<sup>–1</sup> within 30 s of administration of remifentanyl. Atropine 0.6 mg was administered i.v. The patient was given rocuronium 40 mg and the trachea intubated 60 s later. The patient's heart rate remained at 35 beat min<sup>–1</sup> and another dose of atropine 0.6 mg was given i.v. An infusion of remifentanyl which was intended to be commenced after the bolus was not started. Heart rate decreased further to 31 beat min<sup>–1</sup> and arterial pressure could not be recorded using the cuff. At this point, epinephrine, 0.5 ml (1:10 000) was given, resulting in a broad complex tachycardia, which was treated with lidocaine 100 mg i.v. The rhythm reverted to sinus bradycardia at a rate of 44 beat min<sup>–1</sup> with an arterial pressure of 70/30 mm Hg. An arterial line was inserted and an infusion of epinephrine was started to maintain the patient's heart rate and arterial pressure.

A decision was made to defer surgery and transfer the patient to the ICU to be monitored, and to be reviewed by a cardiologist. The infusion of epinephrine was continued overnight. In view of a persistent bradycardia, the patient had a temporary pacing wire inserted before surgery the following day when she was anaesthetized uneventfully using propofol, rocuronium and sevoflurane. The patient was transferred to the care of the cardiologists, and was discharged after insertion of a permanent pacemaker.

The recommended bolus of remifentanyl, according to the package insert, is 1.0 µg kg<sup>–1</sup> administered over 30–60 s, with a dose reduction in the elderly; our patient perhaps received a slightly large dose for her age. Laryngoscopy and intubation failed to increase heart rate. Others have also reported severe bradycardia in patients receiving beta-adrenergic receptor blocking agents and given remifentanyl.<sup>4,5</sup> In the case reported by DeSouza, Lewis and TerRiet, the patient was receiving metoprolol and nitrates, had

been premedicated heavily and had received remifentanyl  $1 \mu\text{g kg}^{-1}$  followed by an infusion of  $0.1 \mu\text{g kg}^{-1} \text{min}^{-1}$  for 2–3 min.<sup>5</sup> Concomitant administration of a neuromuscular blocking agent such as vecuronium with an opioid can lead to bradycardia. However, bradycardia occurred in our patient before administration of the blocker, and in any case rocuronium has a slight vagolytic action.

Opioid-induced bradycardia is generally accepted to be vagally mediated.<sup>6</sup> This effect seems to be exacerbated in the presence of beta-receptor blocking agents, and in this patient it appears that we may have unmasked a tendency to a bradyarrhythmia. This may have been the cause of the fall, which led to the initial injury to the eye.

We suggest that even a slow bolus of remifentanyl may result in severe bradycardia in elderly patients receiving beta-receptor blocking drugs or with pre-existing bradycardia. A slow infusion may be preferable and result in less haemodynamic disturbances.

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## Pulmonary haemorrhage after percutaneous paravertebral block

Editor,—With reference to the case report by Thomas, Sanders and Berrisford,<sup>1</sup> which described pulmonary haemorrhage as a complication of percutaneous paravertebral block when a 16-gauge Tuohy needle was inserted to a depth of 6 cm in the mid-thoracic region, I would like to make the following comments.

The Tuohy needle was inserted inappropriately deep for a mid-thoracic paravertebral block; identification of the paravertebral space with the loss of resistance technique may give a false negative result; and a 22-gauge Tuohy needle is the needle of choice for single-shot percutaneous paravertebral blocks.

A full understanding of the anatomy is essential for safe use of any regional technique. When performing a paravertebral block, it is imperative to locate the transverse process of the vertebra, before advancing the needle into the paravertebral space. In the thoracic region, the spinous process of a vertebra lies in the same horizontal level as the transverse process of the vertebra below, because of the extreme angulation of the spinous processes. In adults, the transverse processes are located 2.5 cm lateral to the midpoint of the spinous processes. The skin to transverse process

distance varies from 2–3 cm in the T5–6 region to 5 cm in the T1–2 region. However, there may be a small variation depending on the size of the patient. The paravertebral space lies anterior to the transverse processes and superior to the costotransverse ligaments, at a depth of 1 cm from the posterior surface of the transverse processes.

Loss of resistance with saline or air can be used to locate the space as the needle passes through the superior costotransverse ligament but may result in false negatives. Scar tissue in the paravertebral space, or a previous thoracotomy, may interfere with the loss of resistance technique.

A 22-gauge Tuohy needle (B. Braun Medical Inc, Product code E2230T) is the needle of choice for single-shot percutaneous paravertebral blocks. It has the advantage of a small diameter, 1-cm markings to a depth of 8 cm so that the precise depth of the tip of the needle is always known and a blunt tip so that a 'pop' may be experienced as it passes through the costotransverse ligament. Unfortunately, this needle is not available in the UK, but can be imported by special arrangement by B. Braun Medical Inc.

At Duke University Medical Center, all breast surgery is performed using percutaneous paravertebral blocks with sedation. We have performed more than 1000 percutaneous blocks with no pneumothoraces and only two epidural spreads. We would like to describe our technique. First, choose which dermatomes will be involved in the operative field. For mastectomy with axillary dissection, we routinely block T1–T6. The patient is placed in the sitting position with their neck flexed, back arched and shoulders dropped forward. The spinous process of each level is identified and a mark is placed at its most superior aspect. From the midpoint of these marks a needle entry site is marked 2.5 cm lateral to each spinous process ipsilateral to the incision. These marks should overlie the transverse process of the immediately caudal vertebra. Using an aseptic technique, a 22-gauge 8-cm Tuohy needle attached via extension tubing to a syringe is inserted through the skin and advanced anteriorly in the parasagittal plane until it contacts the transverse process, which is 2–5 cm depending on the habitus of the patient. In the T6 region, the expected depth of the transverse process is 2–3 cm. Inserting the needle 1 cm past this predicted depth is allowed. If the transverse process is not identified at the appropriate depth, it is assumed that the needle tip lies between adjacent transverse processes, and the needle should not be advanced any deeper. If bone is contacted at a point that seems too deep, this is probably a rib lying anterior to the transverse process. In both these cases, return the needle to the skin point, and search in a cephalad and then a caudal direction until the transverse process is successfully contacted. This depth is noted as the estimated distance to subsequent transverse processes. The needle is then withdrawn to the subcutaneous tissue and angled to walk onto the caudad edge of the transverse process by 1 cm. At thoracic level, it is common to appreciate a loss of resistance or a subtle 'pop' as the needle passes through the superior costotransverse ligament. After aspiration, 3–5 ml of local anaesthetic (0.5% bupivacaine or 0.5% ropivacaine with epinephrine 1:400 000) are injected at each level.

Percutaneous paravertebral blocks can be safe and effective when performed in good hands. The complications of the block are minimized by a full understanding of the anatomy of the paravertebral space and identification of a safe pre-end-point (i.e. the transverse process).

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