NMB, or recurrent upper airway obstruction in the postoperative period.

The stress response during airway management is potentially dangerous in obese patients with increased cardiovascular risk. The mean arterial pressure and plasma norepinephrine levels increase significantly after tracheal intubation and extubation in obese patients. Magnesium has been used to attenuate the cardiovascular response during airway management. This effect is probably secondary to a reduction in the release of catecholamines from the adrenal medulla and adrenergic nerve terminals after sympathetic stimulation. Sympatholysis, vasodilatation, improved contractility, limitation of infarct size, reduced frequency of arrhythmias, and coagulation modification are all effects that may be involved in the potential cardioprotection of magnesium. Sympatholysis and antagonism of N-methyl-D-aspartate receptors in the central nervous system may be also responsible for the intraoperative analgesic effect of magnesium.

The administration of magnesium sulphate also results in potentiation of the effects of neuromuscular blocking agents, mainly through inhibition of acetylcholine release at motor nerve terminals. Even if sugammadex did not bind magnesium by encapsulation in microcalorimetric experiments, more sugammadex is suggested to overcome the new level of NMB. In fact, after raising the magnesium concentration of the buffer from 3.5 to 4.07 mmol litre$^{-1}$ (resulting in a decrease in twitch height to 65% of baseline value), much higher concentrations of sugammadex were required to reverse the block in the experimental setting. Moreover, increasing the dose of sugammadex may also reduce the risk of recurrence of NMB if magnesium sulphate is given after operation. It was found that magnesium caused only a small decrease in twitch height (to 72% of baseline twitch height) in the presence of sugammadex concentrations ranging from 5.6 to 19 mmol litre$^{-1}$, which represents the effect of magnesium alone.

In conclusion, sugammadex should be administered according to the level of NMB observed at accelerographic monitoring in the setting of magnesium sulphate administration in order to have a quick, safe, and effective reversal of rocuronium-induced NMB in morbidly obese patients.

Declaration of interest

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Prolonged diaphragm dysfunction after interscalene brachial plexus block and shoulder surgery: a prospective observational pilot study

Editor—Interscalene blocks (ISB) result in a decrease in forced vital capacity (FVC) of 20–25%, secondary to ipsilateral hemidiaphragmatic paralysis (DP) which is known to occur in up to 100% of patients. This is known to resolve upon resolution of the anaesthetic block. However, several cases of prolonged diaphragmatic dysfunction (PDD) have been reported post-ISB, some asymptomatic. Consequently, we sought to study the incidence of PDD after ISB by performing pulmonary function testing on patients before and after operation. The aim was to observe the incidence of prolonged phrenic nerve dysfunction manifested by a decrease in FVC of more than 20% from the preoperative value.

After IRB approval, 98 patients undergoing ISB for shoulder arthroscopy were enrolled (31 paraesthesia technique, 57 nerve stimulator, and 10 via ultrasound). FVC and negative inspiratory force were recorded and measured in the sitting position before surgery, in the recovery room, and at post-surgical follow-up (7–14 days). Each measurement was repeated for confirmation.

Two patients had PDD at the time of post-surgical follow up as per our definition (a decrease in FVC by 20%). One was asymptomatic (paraesthesia technique) and refused further work-up. The other (nerve stimulator technique) had shortness of breath with persistent symptoms at 5 weeks after operation with elevated hemidiaphragm ipsilateral to the surgical site on chest radiograph. Diaphragmatic stimulation was noted during needle insertion. Of the 57 patients with nerve stimulator technique, 17% had diaphragmatic stimulation as well, but without sequelae. This may be indicative of the proximity of the phrenic nerve to the path travelled by the needle.

The incidence of definite PDD post-ISB and shoulder surgery in this prospective observational study was 1% (95% confidence interval 0.05–5.03). The exact mechanism is unclear, and may be attributed to different causes. The incidence

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appears to be high. The number of patients enrolled in the study is small, and may limit the interpretation of such findings, although this is the only study which has looked at this prospectively. Other retrospective studies have reported lower incidence, with the history of prior cervical radiculopathy as a risk factor.¹ The patient with PDD confirmed on chest radiograph was subsequently found to have cervical stenosis. Other possible factors which may lead to prolonged diaphragmatic paresis include direct nerve injury, neurotoxicity from use of local anaesthetic, intraneural injection, nerve compression from haematoma, and surgical malpositioning.⁵ ⁷ Nerve injury from shoulder surgery has also been reported under general anaesthesia.⁸ Recovery from prolonged diaphragmatic paresis, however, is thought to be quite good. In studies looking at the effect of unilateral phrenic nerve section on lung function, patients recover by 6–12 months with normalization of vital capacity.⁹ ¹⁰

The study was initially designed to only use the paraesthesia technique for the ISB. With time, participating anaesthesiologists felt more comfortable using a nerve stimulator since diaphragmatic twitches would be detected if the needle was close to the nerve. However, it did not protect against PDD. This concern over safety resulted in the small number of patients for each anaesthesia technique. This study shows the evolution of ISB to the most current way of performing it, via ultrasound. This method, however, does not seem to prevent PDD as we are aware of one case at our institution using this technique. We have also seen PDD in two patients who had shoulder surgery utilizing supraclavicular blocks performed with ultrasound. The aetiology of prolonged diaphragmatic paralysis is multifactorial, but regardless of anaesthesia type, the possibility of PDD should be considered in the setting of shoulder surgery.

Declaration of interest

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Proposal for a surrogate surgical invasiveness score to obtain a ‘post hoc’ quantification of surgical stress and tissue trauma in the context of postoperative outcome assessments

Editor—When dealing with post-anaesthesia outcome, it is natural to take into consideration the type, length, and choice of the antecedent anaesthesia and the amount of drugs given. These items have an immediate influence on the course of postoperative recovery. However, surgery has at least a similar, if not an even stronger and longer lasting impact on the postoperative outcome, in particular by its duration and amount of concomitant tissue trauma. This aspect has not yet been involved in anaesthesiological reports related to postoperative outcome. However, there have been efforts to quantify surgical stress and tissue trauma as in the case of the ‘spine surgery invasiveness index’,¹⁻² but this is not suited for a very specific surgical intervention only. Another resembling term is the ‘surgical stress index’ which is a surrogate parameter resulting from objective measurements of the vegetative balance between nociception and anti-nociception during general anaesthesia.³⁻⁵ This one-dimensional value reflects the intraoperative level of stimulation in real time, but rapidly fades away as soon as surgery has been concluded. Therefore, it seems not to be suitable to quantify the amount of surgical invasiveness and tissue trauma with its longer lasting repercussions.

A comprehensive method to quantify surgical invasiveness would be certainly useful in order to permit and facilitate the comparisons among various surgical cases. The aim of such a variable is in the first instance to obtain a universally applicable assessment tool to quantify the postoperative ‘impact’ of surgery independently of the type and scope of the surgical intervention or the involved operative specialty. Under the term ‘impact’, one has to understand the sum of various concomitant postoperative effects of surgery such as pain, stress, and tissue factors released from the operated organs. If such