Our study has obvious limitations. While atracurium was used in all patients, its mode of use and the conduct of the anaesthesia, including temperature measurement and regulation, was entirely at the discretion of the responsible anaesthetist. Since our study was carried out it has been demonstrated that pharyngeal constrictor function is not normalized until recovery of an adductor pollicis TOF>0.9. Thus the previously accepted parameter of 0.7 may be inappropriate.

In conclusion, we have found that PORC is still a clinical problem despite the use of intermediate-duration neuromuscular blocking drugs and their routine antagonism. The association between suboptimal antagonism and both relatively short procedures and a short interval between antagonism of neuromuscular block and extubation needs to be reinforced during postgraduate training and departmental quality assurance.

Acknowledgement
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Internal jugular vein (IJV) cannulation for inserting a central venous catheter is used frequently in patients during major surgery and intensive care. Better conditions for venous cannulation and the reduction of complications are continuing concerns. Methods such as head-down tilt of varying extent,1-3 the Valsalva manoeuvre,4-6 hepatic compression5-6 and positive intrathoracic pressure in ventilated patients5-6 have been proposed to increase jugular filling. The most commonly recommended approach is ultrasound guidance during head-down tilt with the head rotated <40°.7-8 We studied changes in right jugular cross-sectional area (CSA) with time during prolonged tilt, to determine the best time for cannulation. Values are given as mean (SD).

**Methods and results**

Nineteen healthy volunteers (eight women and 11 men; age range 23-68 yr) were studied. The CSA of the right IJV was assessed by B-mode duplex sonography using a 7.5-9 MHz longitudinal transducer (Powervision 6000, SSA-370A, Toshiba, Tokyo, Japan). The probe was placed in a horizontal plane, 1.5 cm caudal to the cricoid cartilage, corresponding to the most frequently used point of needle insertion into the IJV. The examination started in the supine position with the head slightly extended and rotated about 20-30° to the contralateral side. After 3 min of baseline recording, the subject was placed 10° head-down for 20 min, after which there was another 3 min assessment in the supine position. Short video sequences were stored on SVGA videotape every minute and off-line measurements of the pulse-triggered minimal right jugular CSA were made using the manual area trace function of the duplex machine (Fig. 1).

For statistical analysis, non-parametric repeated measures ANOVA (Friedman’s test) and Dunn’s multiple comparison post test were performed. P<0.05 was considered significant.

The median jugular CSA in the supine position before head-down tilt was 102 mm² [range 16-266, mean 113 (69)]. One minute after tilting the median area had increased to 139 mm² [range 23-388, mean 158 (93)] and did not change significantly in the next 20 min. On return to the supine position, CSA values immediately returned to baseline levels (Fig. 2).

**Comment**

Head-down tilt is often used to improve cannulation of the IJV. Jugular diameter or CSA in adults increases on ultrasound, with varying degrees of tilt. Armstrong and colleagues demonstrated a rising lateral IJV diameter with 10, 20 and 30° of head-down tilt, the greatest change (+14%) occurring between the supine and the 10° tilt position.2 In 15 patients during anaesthesia, mean right jugular CSA of 160 (86) mm² when supine increased to 213 (112) mm² with 10° tilt (relative increase +25%).6 CSA increased by 37% (from 118 to 162 mm² during head-down tilt) in ICU patients.3 Our finding of an approximately 36% increase therefore supports the data previously published.

A recent study, providing information about the duration of tilt, reported a baseline CSA of 95 (26) mm² and follow-up values of 118 (39) and 116 (43) mm² after 1 and 10 min of tilt respectively.1 We found that the venous CSA changes

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**Fig. 1** Cross-sectional B-mode ultrasound scan. (A) Right IJV. CSA of a subject in the supine position; area 43.9 mm². (B) CSA in the same subject during 10° head-down tilt; area 73.2 mm². CCA = common carotid artery.
occurred within 1 min after head-down positioning. During the following 19 min, however, no further change in mean jugular CSA was found.

To assess if the individual change differed from the median results, each case was analysed for the time at which the maximal CSA was detected. Interestingly, we found a nearly even time distribution, with a median duration of 8 min (range 1–20). However, the absolute differences between the 1 min and maximal CSAs compared with the differences during the 3 min supine measurements (i.e. the systematic error of the applied ultrasound method) gave median values of 10 mm² (range 0–37, mean 12 (10)) and 8 mm² (range 0–16, mean 8 (5)) respectively. The remaining real increase in mean area of 2 mm² during 20 min of head-down tilt compared with a 37 mm² increase after 1 min of tilt is small and clinically irrelevant.

Prolongation of a position that can be uncomfortable for conscious patients is unnecessary.

Acknowledgement

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