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Effects of prolonged head-down tilt on internal jugular vein cross-sectional area

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Background. Head-down tilt is often used to assist cannulation of the internal jugular vein (IJV). However, the optimal duration of tilt before cannulation is not well defined.

Methods. Fifteen healthy volunteers were studied by B-mode duplex sonography to assess changes in cross-sectional area (CSA) of the right IJV during 10° head-down tilt.

Results. Median CSA in the supine position was 102 mm^2 [range 16–266, mean (SD) 113 (69)]. CSA increased to 139 mm^2 [23–388, 158 (93)] immediately after tilting ($P<0.0001$, repeated measures ANOVA). No significant further change was noted in the next 20 min. CSA returned to baseline level after return to the supine position.

Conclusion. The 10° head-down tilt manoeuvre in healthy volunteers causes an immediate, significant increase in CSA in the right IJV. A longer tilt did not cause further increase in jugular CSA.

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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,[2 4] hepatic compression[5 6] and positive intrathoracic pressure in ventilated patients[5 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 mm^2 [range 16–266, mean 113 (69)]. One minute after tilting the median area had increased to 139 mm^2 [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) mm^2 when supine increased to 213 (112) mm^2 with 10° tilt (relative increase +25%).[6] CSA increased by 37% (from 118 to 162 mm^2 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) mm^2 and follow-up values of 118 (39) and 116 (43) mm^2 after 1 and 10 min of tilt respectively.[1] We found that the venous CSA changes

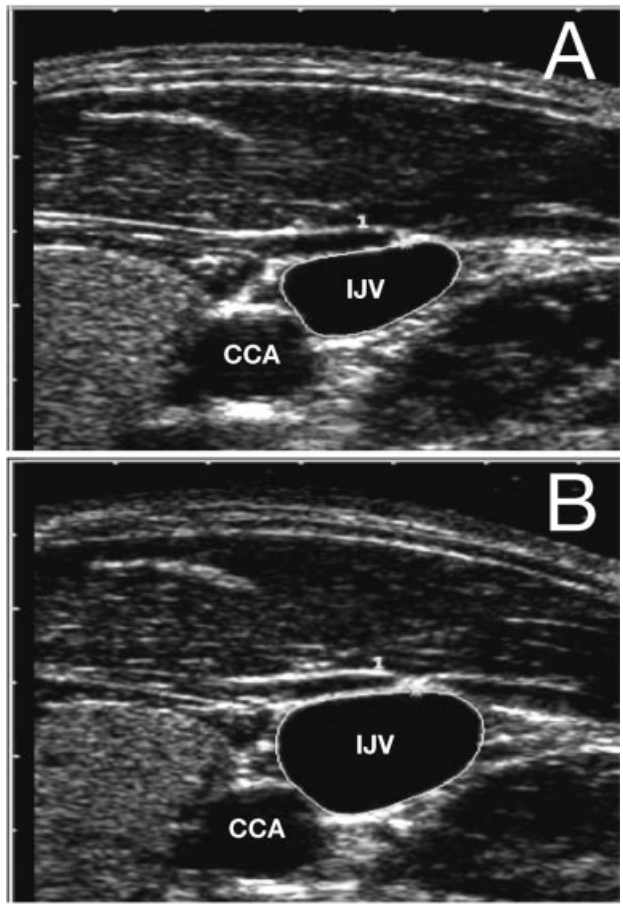

Fig. 1 Cross-sectional B-mode ultrasound scan. (A) Right IJV. CSA of a subject in the supine position; area 43.9 mm^2. (B) CSA in the same subject during 10° head-down tilt; area 73.2 mm^2. CCA = common carotid artery.

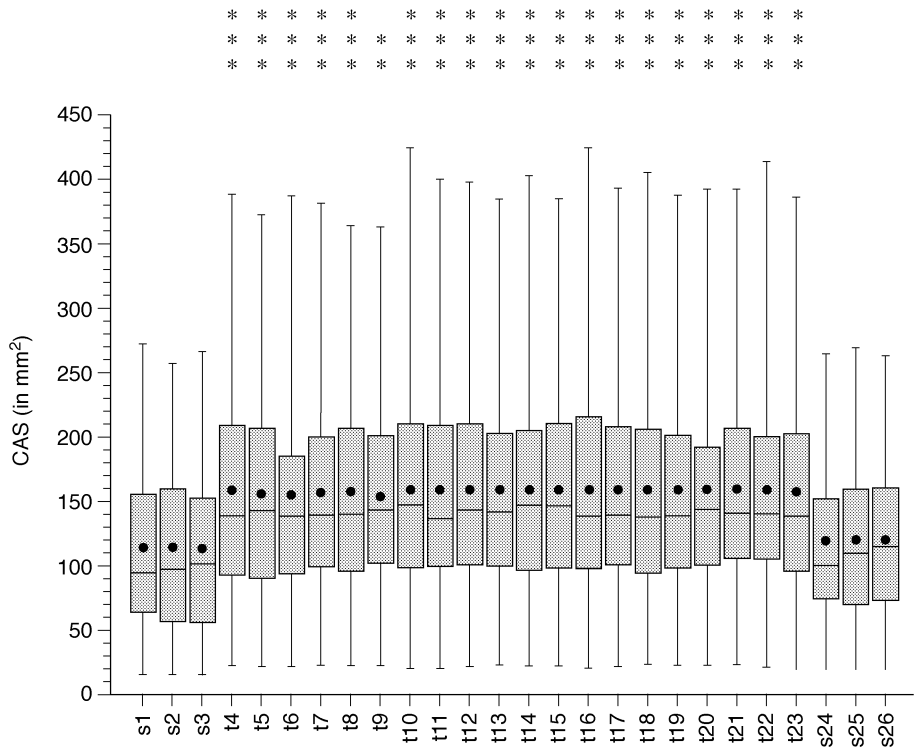

Fig 2 Box plot analysis of results including mean (dot), median (horizontal bar within box), 25th and 75th percentiles (box) and minimal/maximal values (whisker). Time course of jugular CSA changes at baseline (supine position, s1–s3), during 20 min of 10° head-down tilt (tilt position, t4–t23) and upon return to baseline position (s24–s26). Statistical comparison between groups (Dunn's test): s3 *vs* t4–t23: $^{**}P<0.01$, $^{***}P<0.001$.

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 mm^2 [range 0–37, mean 12 (10)] and 8 mm^2 [range 0–16, mean 8 (5)] respectively. The remaining real increase in mean area of 2 mm^2 during 20 min of head-down tilt compared with a 37 mm^2 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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