Intrajugular balloon catheter reduces air embolism *in vitro* and *in vivo*

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Background

Neurosurgical procedures requiring a sitting position may put the patient at risk for a potentially life-threatening air embolism (1). Transiently manual jugular venous compression limits further air entry in this situation (2). This study presents an alternative technique aimed at reducing air embolism (3).

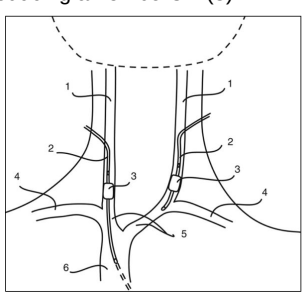

Figure from (3).

Fig. 1: (1) Vena jugularis interna, (2) intrajugular balloon catheter, (3) inflatable balloon cuff (here inflated), (4) venae subclaviae, (5) vena brachiocephalica, (6) vena cava superior.

Methods

In an in vitro model, an intrajugular balloon catheter was inserted to demonstrate that this device prevents air embolism. In an in vivo study, this device was bilaterally placed into jugular vessels in pigs. Using ultrasound technique, the blood flow was monitored and the jugular venous pressure was recorded before and during cuff inflation. Air was applied proximally to the inflated cuffs to test the hypothesis whether this novel device blocks air passage.

Results

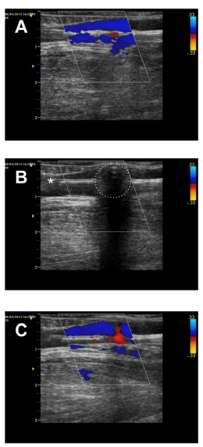

Fig. 2: (A) View on an intrajugular balloon catheter (whitish) within a jugular vein. Note the venous blood flow determined by Doppler (*blue*). (B) After inflation of the balloon (*dotted line*) the blood flow was completely obstructed. The catheter tip is marked by an asterisk (*white*). A typical air shadow of the inflated cuff is clearly visible. (C) Following deflation of the cuff venous blood flow returned.

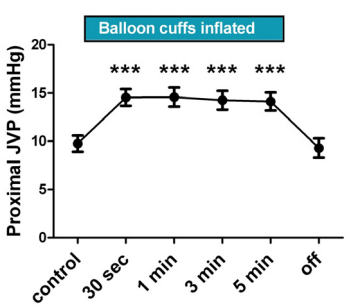

Fig. 3: Time course of the jugular venous pressure (JVP) before and after cuff inflation. Bilateral inflation of the cuff significantly increased the proximal JVP about 54.4±11.5% proving the obstruction (n=8, p<0.001). Deflation of the balloon (off) led to initial JVP values.

In vitro, the intrajugular balloon catheter reliably reduced further air entry in the conducted experiments (n=10). Additionally, accumulated air could be aspirated by an orifice of the catheter (n=10). In vivo, inflation of the catheter's balloon completely obstructed venous blood flow (n=8). Bilateral inflation of the cuff increased significantly the proximal jugular venous pressure from 9.8±2.4 mmHg to 14.5±2.5 mmHg (n=8, p<0.001). By mimicking an air embolism, air passage across the inflated cuffs could be prevented and 78±20% (n=6) of the air dose could be aspirated by the proximal orifice of the catheter.

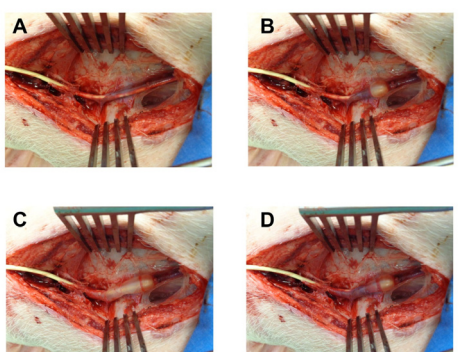

Fig. 4: (A) View on the intrajugular balloon catheter inserted in a jugular vessel. (B) Inflation of the balloon was clearly visible. (C) To mimic air embolism air was slowly injected after cuff inflation. (D) After an incubation time of 30 seconds, an attempt was performed to aspirate the remaining air through the proximal orifice of the catheter.

Conclusions

This study provides first evidence that an intrajugular balloon catheter reduces air embolism. These findings may serve as a starting point for the development of intrajugular balloon catheters to be used for patients undergoing neurosurgery in a sitting position.

References (1) Anesthesiology. 2007; 106, 164–177. (2) Anesthesiology.1992; 76, 156–157. (3) J Neurosurg Anesthesiol.2012; 24, 81–82.