Prevention of serious air embolism during cryoballoon ablation, risk assessment of air intrusion into the sheath by catheter selection, and change in intrathoracic pressure: an \textit{in vivo} study

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**Introduction**: One of the causes of cerebral infarctions during cryoballoon ablation is the entry of a large amount of air into a steerable sheath due to the use of inappropriate catheters. It is known that the left atrial pressure of patients with obstructive sleep apnea syndrome can be negative. However, the impact of catheter selection and negative pressure changes in the sheath on air intrusion are not yet well understood. The aim of this study was to quantitatively evaluate how catheter selection and the negative pressure changes in the sheath affect air intrusion.

**Methods**: This experiment used the siphon principle to create negative pressure in the sheath. nonCryo-catheters (non-dedicated to a steerable sheath for cryoballoon ablation) and Cryo-catheters (dedicated to the sheath) were investigated. Catheters were inserted into the sheath and then pulled out. Thereafter, the amount of air in the sheath was measured. For catheters related with significantly larger amounts of air intrusion, the catheters were inserted via a long sheath in the steerable sheath (sheath-in-sheath technique) and the same procedures were carried out.

**Result**: The amount of air intrusion during the use of nonCryo-catheters was almost significantly higher than Cryo-catheters. It was observed that increase in the magnitude of negative pressure in the sheath resulted in a proportional increase of air intrusion. It was observed that the sheath-in-sheath technique significantly reduced air intrusion.

**Conclusion**: The amount of air intrusion depends on catheter type and the magnitude of the negative pressure. The sheath-in-sheath technique may be an effective countermeasure.