EVALUATING OFF-THE-SHELF BALLOONS FOR PARTIAL REBOA

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Introduction

Partial resuscitative endovascular balloon occlusion of the aorta (pREBOA) is a technique for establishing haemostasis in patients with non-compressible torso haemorrhage [1]. Partial inflation of the balloon within the descending aorta leads to incomplete occlusion and subsequent trans-balloon flow, with the aim of striking a balance between haemorrhage and distal ischemia [2]. The preeminent device for pREBOA is the pREBOA-PRO®. However, in emergency situations, pREBOA may be performed with the off-label use of balloons not approved for pREBOA. Traditional compliant balloons easily deform when deflated, resulting in sudden increases in distal flow and potential exsanguination [3,4]. We hypothesize that balloons which share the semi-compliant nature of the pREBOA-PRO® may allow for finer flow titration. This study aimed to compare the capacity of clinically available compliant and semi-compliant balloon (CB and SCB) catheters to titrate flow in a pREBOA setting.

Methods

We present a new measure to assess a balloon's pREBOA ability; optimal working range (OWR). The OWR is the balloon volume range that corresponds to ideal trans-balloon flows (0.3-0.7 L/min). Flows outside this range lead to significantly greater ischemia and rebleeding [4]. This in-vitro study used a continuous flow loop filled with an aqueous glycerol solution. Tubing with a compliance of 0.067 ml/mmHg and inner diameter of 19 mm was used as an aortic model. Initial (uninflated balloon) loop flows ranged from 1.5-3.1 L/min. A 27 mm CB and a 25 mm SCB were compared, with titratability assessed through incremental deflation from full occlusion, using a programmed syringe pump. Data, including intra-balloon pressure and volume, trans-balloon flow rate, and loop pressures, were recorded for analysis.

Results

For all initial flow rates, the OWR was significantly higher for the SCB compared to the CB (mean 1.13 vs. 0.34 ml; p<0.001). Linear regression analysis revealed that the slope of the SCB's titration curve was significantly lower than the CB's (0.39 vs. 1.39; p<0.0001), indicating superior titratability (Figure 1). Varying initial flow rate had a negligible effect on OWR.



Figure 1: Titration curves of the compliant and semicompliant balloon (CB and SCB) catheters for an initial flow rate of 2.3 L/min. Horizontal lines at 0.3 and 0.7 L/min represent ideal flow range during pREBOA, optimal working range for each balloon visualized.

Discussion

The OWR of the SCB far exceeded that of the CB across all initial flow rates, indicating that SCBs should be considered when performing pREBOA using off-theshelf equipment. Additionally, we showed that OWR is a measure that can be used for pREBOA evaluation. When considering clinical implementation of pREBOA, the benefits of wider OWRs become apparent. Using a fine adjustment syringe [2] to incrementally titrate practical aliquots of 0.1-0.2 ml [5,4] the OWR of the SCB translates to a minimum of 6-11 "safe" steps, compared to a maximum of 2-4 for the CB. The larger OWR of the SCB enables finer flow control, potentially increasing the likelihood of users achieving ideal transballoon flows during balloon titration, which could translate to improved patient outcomes.

References

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