BLOOD PRESSURE AND FLOW CONTROL DURING ASPIRATION THROMBECTOMY INCREASES THE LIKELIHOOD OF CLOT RETRIEVAL SUCCESS

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Abstract

Aspiration thrombectomy is an established method of clot removal in acute ischemic stroke (1). Advancements in catheter technology have resulted in the advent of newer generation 8Fr, balloon guide catheters (BGCs) and superbore catheters (SBCs), that can be used to deliver 6Fr large bore catheters (LBCs) to perform clot retrieval. In comparison to conventional 8Fr guide catheters (CGCs), placed in the internal carotid artery (ICA), BGCs achieve proximal flow control via inflation of a balloon in the ICA (2). SBCs, designed for intracranial use, offer local flow and pressure control, as they can be navigated to distal vascular regions (1,2). Little research has been completed to-date comparing these systems, their impact on pressure and flow, and likelihood of clot retrieval success. Thus, the aim of this work was to assess these technologies in vitro. We hypothesize that control of blood pressure and flow during clot retrieval will increase the likelihood of retrieval success. This study will provide critical insights into the clinical use of these emerging technologies.
To evaluate the systems in clinically challenging environments two distinct in vitro anatomical models were used. Five aspiration devices were investigated. Devices were used as per manufacturer's instructions by two interventional neuroradiologists. Two groups of thrombus analogues: cohesive and friable, were prepared with ovine blood (4). Analogues were used to create an occlusion in the M1 Middle Cerebral Artery (MCA). To simulate the clinical use of the devices, tracking to the target location and clot retrieval performance were evaluated. Five replicates were completed per device. Physiological blood pressure and flow were simulated and monitored throughout the experiment at defined time points: prior to device introduction, following device placement and during and after device use. Aspiration was applied through the LBCs via a 60cc syringe.

The SBC system significantly reduced the flow through the MCA during device tracking in comparison to the CGC & BGC systems ($p < 0.001$). The influence of the BGC in anatomical models with varying arrangements of the Circle of Willis (CoW) was recorded. Inflation of the BGC was not significant in Model 1, due to its possession of a complete CoW, resulting in collateral flow supplying the MCA. The BGC and SBC systems had the highest rates of clot retrieval success, indicated by the higher values of flow restored through the MCA ($p < 0.001$).

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The presented results demonstrate the importance of pressure and flow control on clot retrieval success. The CGC system had limited flow control in the M1, and this translated to reduced flow restoration through the vessel. In comparison the BGC and SBC systems, which offer proximal and local control, had significantly higher rates of flow restoration. In one case the SBC, could not be tracked to the MCA to complete clot retrieval. This was attributed to a unique design feature of the device. The greatest challenge with the use of SBCs is their ability to track to distal vascular locations. This research suggests in cases where a SBC system is unable to track to the target location, proximal flow control with a BGC may provide equivalent results, however, the anatomical arrangement of the CoW should be considered. These results illustrate the importance of pressure and flow control during aspiration to maximize the likelihood of retrieval success. This research may influence device selection clinically and can be used to innovate the next generation of aspiration thrombectomy devices.

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(2) Patki *et al.* Cardiovasc Eng Tech 15:481–502, 2024.

(3) Nogueira, *et al.* JNIS 14:184-188, 2022.
(4) Johnson *et al.* JNIS 12(9):853-857, 2020.