

Effects of bubble size differences on the bubble-trapping performance of arterial line filters

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Abstract

Microbubbles inside a cardiopulmonary bypass circuit are captured by a venous reservoir or by the artificial lung, and ultimately, an arterial line (ALF) prevents gaseous micro-emboli (GME) from getting injected into the patient's body. In our study using ALFs with pore sizes of 40 μ m (PS40) and 20 μ m (PS20), bubbles with a mean bubble diameter of 50 μ m, 100 μ m, and 180 μ m were injected into the ALF. Arterial line filter GME removal was examined using different bubble sizes.

In the bubble group with various bubble sizes, the number of bubbles and the rate of bubble removal were determined for 50 μ m bubbles (PS40=44.5 $\pm$ 0.7%, PS20=56.1 $\pm$ 0.4%, $P > 0.001$), 100 μ m bubbles (PS40=13.7 $\pm$ 1.9%, PS20=9.9 $\pm$ 3.8%, $P = 0.205$), and 180 μ m bubbles (PS40= - 7.0 $\pm$ 1.5%, PS20= - 29.3 $\pm$ 1.8%, $P < 0.001$). Air shrinkage and bubble removal rates were significantly higher with PS20.

The bubble's internal pressure becomes lower as the bubble size is larger, which suggests that air bubbles can easily change shape and disrupt. This suggests that GME removal capability increases when all microbubbles that flow into the ALF are maintained at a diameter of 40-50 μ m or less.

Key words

gaseous microemboli (GME), microbubbles, bubble trap performance, arterial line filter

Postoperative cognitive dysfunction following cardiac surgery

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Abstract

[Background] Various causes of postoperative cognitive dysfunction (POCD) following cardiac surgery have been speculated, including a previous report that found use of a heart-lung machine to be a causative factor.

[Methods] We investigated 160 consecutive patients who underwent a heart valve operation with a cardiopulmonary bypass, and received 4 different types of pre- and postoperative recognition function tests. Those who showed a greater than 20% reduction in postoperative test values or experienced difficulty with the assessments following surgery were judged to be POCD. Factors related to POCD occurrence were then evaluated using multivariate analysis.

[Results] POCD occurred in 49 cases (30.6%). Comparisons between the onset and non-onset groups revealed that patients with onset were significantly older, while many of those had a medical history of cognitive impairment and blood symptoms, as well as higher HbA1c values. The onset group also had a significantly shorter rewarming time during cardiopulmonary bypass, and significantly lower perfusion index (PI), hemoglobin, and oxygen delivery (DO_{2i}) values during rewarming. During the postoperative course, the onset group had a significantly higher creatinine value, greater rate of increase in postoperative serum creatinine, longer intubation time, and longer length of ICU or hospital stay. Multivariate analysis showed age (cut-off value 72 years, AUC 0.71, OR 6.09, CI 2.40-15.5; $P=0.0021$) and DO_{2i} during rewarming at 35°C (cut-off value 276ml/min/m², AUC 0.79, OR 9.28, CI 4.22-20.4; $P<0.0001$) as independent risk factors for POCD occurrence.

[Discussion] POCD following cardiac surgery results not only in a decline of cognitive capacity, but also has a negative influence on the postoperative course. Notably, for effective cardiopulmonary bypass management in elderly patients, maintaining an adequate DO_{2i} value during rewarming is important.

[Conclusion] Both age and DO_{2i} during the rewarming period following a cardiopulmonary bypass were found to be factors related to POCD occurrence in cardiac surgery patients.

Key words

postoperative cognitive dysfunction (POCD), age, recognition function test, DO_{2i}

A survey of the methods for efficiently training patients and their caregivers on how to handle implantable ventricular assist devices

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Abstract

This survey targeted 128 patients with approved implantable ventricular assist devices (iVADs) in Japan implanted from April 2011 to September 2017, and 330 caregivers that were trained on the handling of iVADs. We looked into the outcomes of tests for handling their wearing iVADs.

We then studied the relationship between the results of device handling tests and the trail making test-B (TMT-B) performed for patients; 3 and/or 6 months after implanting iVADs. The data was analyzed by Fisher's exact test, with $p < 0.05$ considered statistically significant. The number (rate) of patients who required re-testing for competency more than 3 times was for EVAHEART®, DuraHeart®, HeartMate II®, Jarvik2000®; 0, 0, 4, 3 (0, 0, 8.7, 10.0%), respectively. Also, the rate of caregivers who required re-testing for competency more than 3 time was 0, 0, 5.8, 11.3%, respectively. The relationship between the results of the device handling test and the trail making test-B (TMT-B) was considered statistically significant ($p=0.002$), the sensitivity and specificity were 29.1, 95.5%, respectively. These results may suggest the possibility that training on the handling of iVADs can be efficiently conducted in reference to the outcome of TMT-B. However, the frequency of the device test required tends to depend on the types of iVADs that the patient receives. Our previous study showed that there was an association between the types of devices and the incidence rate of mistakes. Therefore, we strongly feel the importance of adapting fool proof and/or fault tolerant in designing the devices, thereby improving the usability for efficient training on the handling of iVADs.

Key words

ventricular assist devices, handling training, trail making Test-B, usability

Study for the quantification of the roller pump occlusion on the cardio-pulmonary bypass

—Definition factors of the roller pump occlusion on stable the roller pump operation —

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Abstract

In our country, a centrifugal pump is chosen by the open-heart surgery that have gave top priority to safety and bio-compatibility. However, in the foreign countries, the open-heart surgery using the roller pump increases in consideration of operability and economy. The roller pump occlusion paid attention to the long-time operation causing axis displacement; Our study carried out that perfusion temperature executed the technology as a rule factor of the occlusion.

To evaluate the manifestation of the circumference of the occlusion, we used three kinds of different rollers diameter and measured perfusion temperature(Pt)and the electrical resistivity (Rz: resistance sigma), a pressure degree of the occlusion. Based on JIS-T1603, we observed the changed to kinds of the three pumps with degree of the occlusion which we were setting in the same condition as change of the occlusion by the progress at time. Pt and Rz repeated up-down motion in three pumps every 30-60 minutes. In addition, the occlusion extended the interval in progress at time. The pressure level of the sensor rose every 30 minutes and became unmeasurable afterwards.

This phenomenon affects is that perfusion temperature changes influence the blood viscosity and, we suppose that it influenced a rise in para-blood temperature and it appeared in pressure change and Rz of the occlusion. Therefore, control of the Pt leads to the appropriate control of the roller pump and thinks with an indispensable element though we carry out physiological extracorporeal.

Key words

occlusion, perfusion temperature, electrical resistivity (resistance sigma)