Reduced dysfunction of hemodialysis catheters via a blood flow control system ～an *ex vivo* evaluation～

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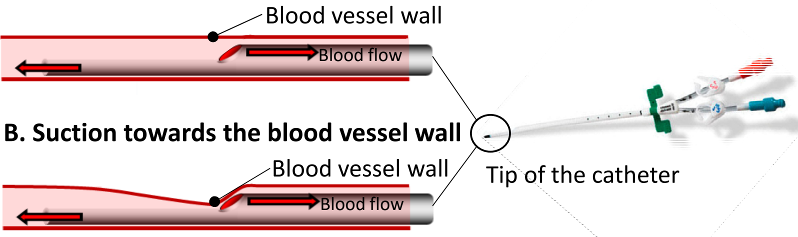
Aim

To assess the potential improvement in hemodialysis catheter dysfunction by implementation blood pump control based on pressure changes in the blood circuit.

Conclusion

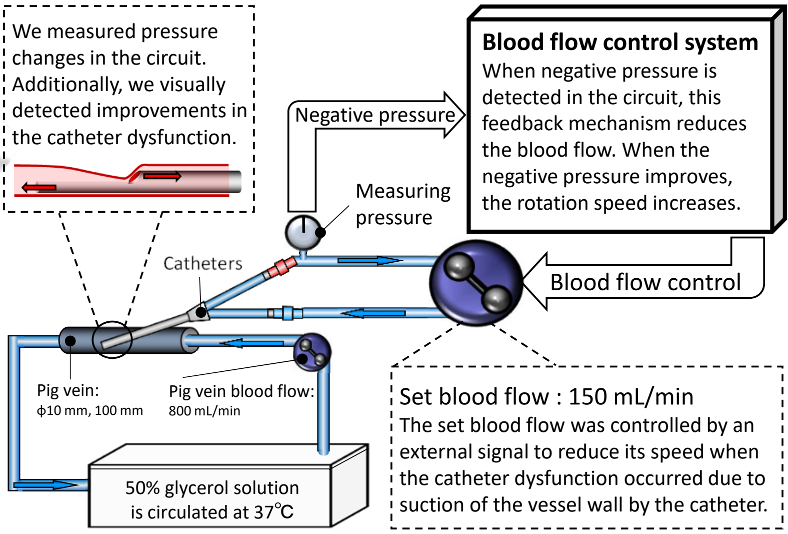
Controlling the blood pump prior to the occurrence of excessive negative internal pressure in the blood circuit could effectively reduce the frequency of blood pump stoppages. In future research, further improvements can be made by repeatedly verifying the measurement conditions to identify more optimal control settings.

BACKGROUND

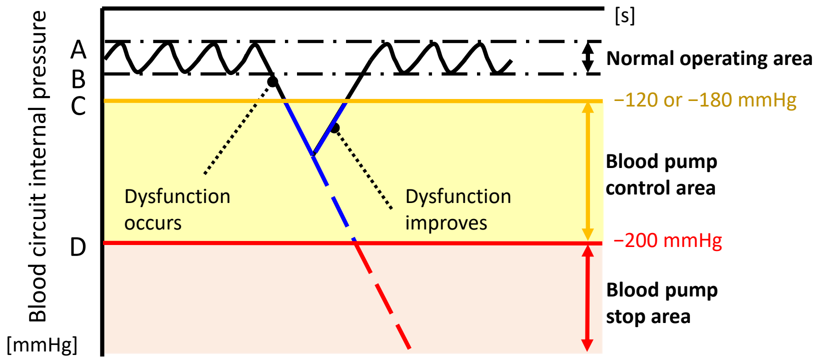


Sudden dysfunction of vascular access hemodialysis catheters can cause serious complications during continuous renal replacement therapy (CRRT)[1] . Suctioning of the arterial pores of catheters toward the blood vessel wall is one of the main catheter-related problems during CRRT. Unfortunately, this complication is not readily observable during CRRT. Therefore, we aimed to assess the pathophysiological mechanisms associated with vessel wall suctioning using an *ex vivo* evaluation.

Developed blood flow control system[2]

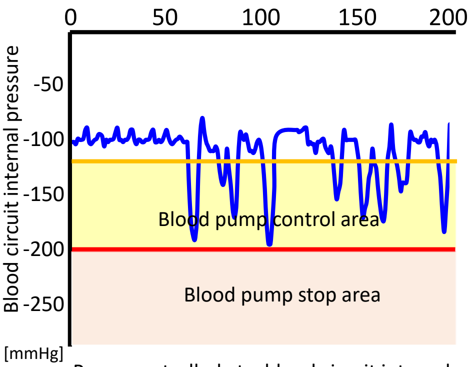


Blood pump control based on pressure changes on the blood removal side

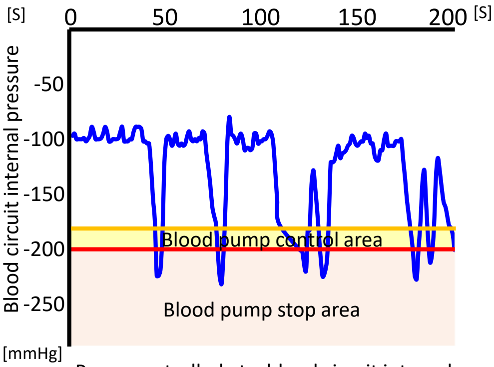


- ✓ When dysfunction occurs and decreases the internal pressure of the blood circuit to point C, the pump speed decreases accordingly.
- ✓ The control conditions involved decreasing the blood flow to 50 mL/min/s when the internal pressure of the blood circuit before the roller pump reached -120 mmHg or -180 mmHg.
- ✓ The roller pump was stopped when the internal pressure reached −200 mmHg.
- ✓ If the internal pressure of the blood circuit continues to decrease, it reaches point D and the pump stops.
- ✓ When the internal pressure improves within the range between points C and D, the pump speed increases, and normal operation resumes.
- ✓ The effect of this system is evaluated when the threshold values for initiating pump control at point C are set to −120 or −180 mmHg.

RESULTS



Pump controlled at a blood circuit internal pressure of −120 mmHg



Pump controlled at a blood circuit internal pressure of −180 mmHg

By controlling the pump speed before the pressure in the circuit reaches excessively negative levels, we could prevent the blood pump from stopping.

DISCUSSION

When the blood pump was controlled and the circuit pressure dropped to −120 mmHg, the pump did not stop. This is likely because controlling the blood pump speed at −120 mmHg allowed for easier separation of the catheter from the blood vessel wall without generating excessive negative pressure.

However, when the blood pump control was initiated after the pressure in the circuit dropped to −180 mmHg, the pressure tended to decrease further , resulting in frequent blood pump stoppages. Even when attempting to control the blood pump at −180 mmHg, the control response was extremely slow, leading to a stronger suction force of the catheter against the vascular wall, and no improvement in the situation.

REFERENCES

1) *Van Canneyt K, et al. Int J Artif Organs.36, 17-27, 2013.*
2) *Yoshimitsu T,er al.Renal Replacement Therapy. 4:20,2018.*