Case in which coaxial drain proved effective for unexpected major bleeding

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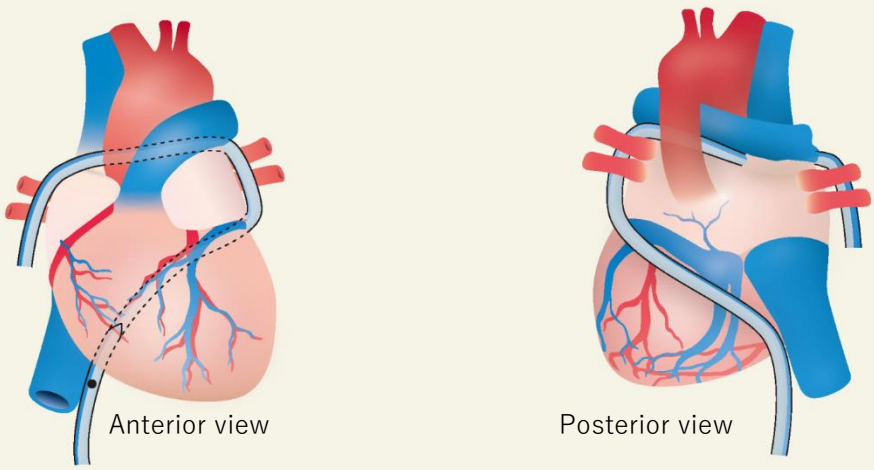
Introduction

Following coronary artery bypass graft (CABG), a situation occurred in which heparin could not be neutralized due to protamine shock, and bleeding could not be controlled.

Here, we report on a case we experienced in which unexpected major bleeding was treated by Circular Pericardial Drainage (CPD) of the pericardium using smart drainage with a coaxial drain in the anterior mediastinum [Fig 1.] and cardiac tamponade was avoided.



[Fig. 1] **CPD** (Circular Pericardial Drainage)

Case

The patient was a 64-year-old man (with no history of insulin usage for diabetes). He was admitted to hospital with unstable angina and a decision was taken to perform a triple coronary artery bypass graft (CABG). The operation went smoothly with minimal bleeding and we considered it appropriaate to detach the patient from the artificial heart-lung.

In this case, the initially administered dose of heparin was 20 ml (20,000 units) and we had prepared 20 ml (200 mg) of protamine to neutralise the heparin.

After completing the CABGand detaching the artificial lung, we administered 1/4 of the protamine. At our hospital, to protect against severe pulmonary artery (PA) spasm, the initial 1/2 dose is administered into systemic circulation (not pulmonary circulation) from the surgical field. The PA pressure rose slightly and systemic hypotension occurred, but as this is a pattern we see frequently with this procedure, vasopressors were administered and the administration of protamine was continued until the full dose had been delivered.

However, as work was being performed to remove the artificial lung machine and stop bleeding behind the sternum, systemic hypotension occurred again and PA pressure suddenly rose. At this point, the anaesthesiologist administered ephedrine and adrenaline. However, systemic pressure dropped to 26/. PA pressure as 49/22, and we started direct heart massage. As the left ventricular wall motion was normal and ST had not risen on the electrocardiogram, we determined that there was no problem with bypass procedure and no air embolism had occurred.

PA pressure rose further, reaching a maximum of 69/31. Diagnosing protamine shock, we gave an infusion of isosorbide dinitrate accompanied by a continuous infusion of nitroglycerin, but with no sign of improvement becoming evident, we decided to apply percutaneous cardiopulmonary support (PCPS).

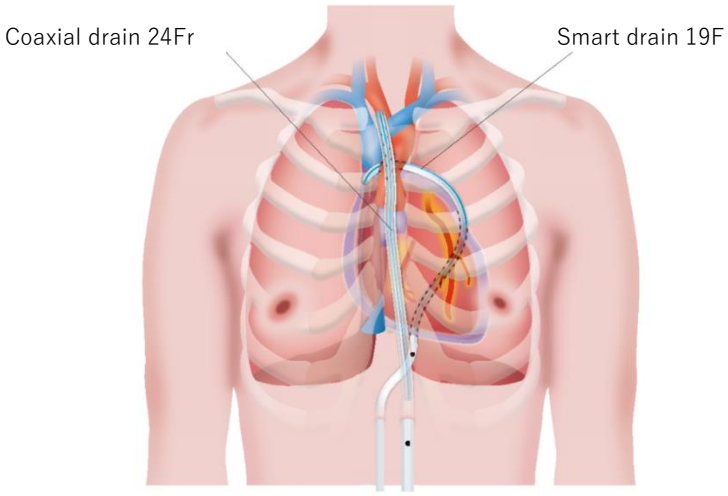
Assuming that the situation was likely to be prolonged, the PCPS approach was from the femoral artery the femoral vein. Following installation, circulation rapidly improve and systemic blood pressure rose to 170/. From the heart massage, it took 25 minutes to introduce PCPS.

Heparin is required to prevent clotting in the PCPS circuit, with the dose being such set that that activated clotting time (ACT) is at least 200 seconds. In this case, ACT had returned to 99 seconds and so a dose of 10 mL of heparin, which amounts to half the initial dose, was given. However, ACT unexpectedly jumped to 418 seconds. Thereafter, pulmonary hypertension improved and intraoperative withdrawal of PCPS was achieved.

As protamine could no longer be used, there was no option but to wait for the effects of the heparin to disappear. Perhaps due to the elevation in systemic pressure, bleeding started from sutured wound. The source of this slow bleeding from the substernal detached surfaces was not clear. The blood did not clot with the application of pressure. Additional packed red blood cells and frozen plasma were ordered and delivered from the blood centre, but there were no platelets (even of different blood types) in stock in Akita Prefecture, and we were informed that delivery from the blood centre in another prefecture (Sendai) 250 km away would taken until 3:00 the next morning.

As the operating time had exceeded 8 hours, we decided to close the chest in spite of the large amount of bleeding (and aware that cardiac tamponade could occur).

In the pericardium, we placed a smart drain 19Fr using normal Circular Pericardial Drainage (CPD). In the anterior mediastinum, we placed a coaxial drain 24F. We then closed the chest leaving the pericardium open [Fig. 2].



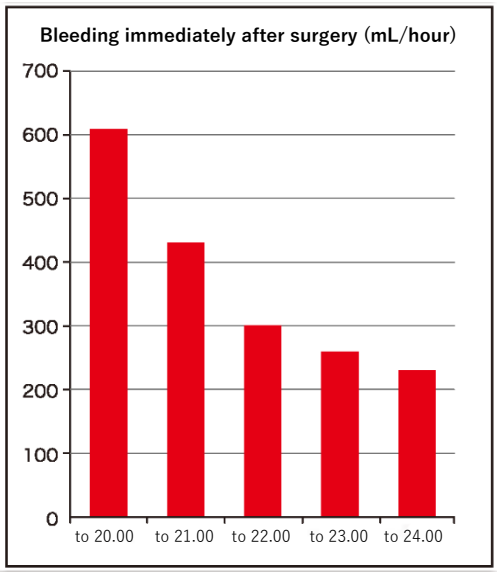
[Fig. 2]

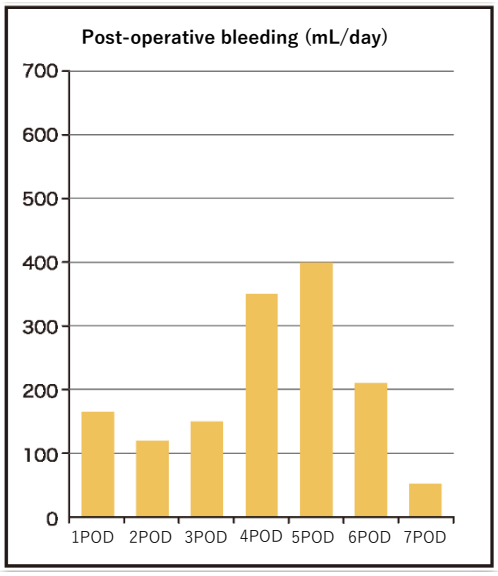
Immediately after chest closure, bleeding was 100 mL/10 mins(600mL/h). In the ICU, 80 mL of blood was being drained every 10 minutes (480 mL/h) mainly from the anterior mediastinum [Table 1]. However, the coaxial drain placed in the anterior mediastinum did not clog and so cardiac tamponade did not occur.

As the effects of heparin wore off, the amount of bleeding gradually reduced and the patient survived overnight.

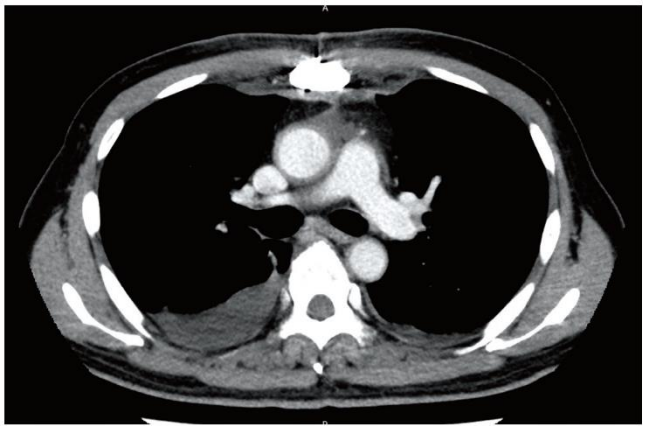
[Table 1]

Time	Bleeding (mL)
to 20.00	610
to 21.00	430
to 22.00	300
to 23.00	260
to 24.00	230
1POD	165
2POD	120
3POD	150
4POD	350
5POD	400
6POD	210
7POD	52
total	3277

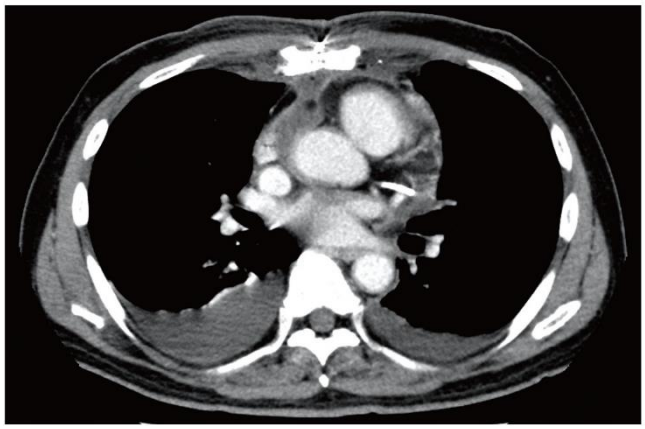




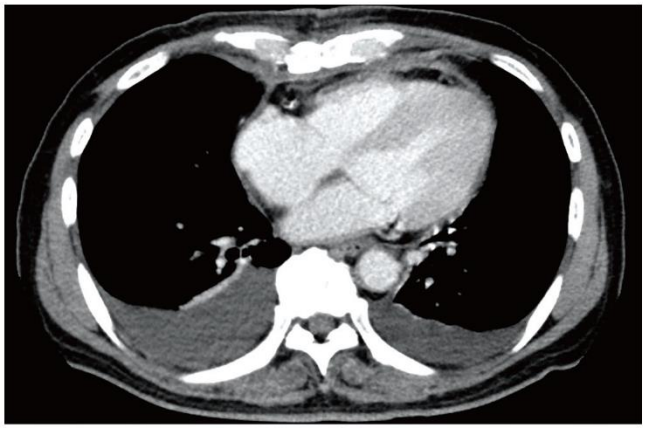
The transfusion consisted of around 20 units of red blood cells, 22 units of frozen plasma, and 20 units of plasma and was not accompanied encephalopathy or any other major complications. On day 7 after the operation, the anterior mediastinal drain was removed. There was no clogging in the removed coaxial drain. Postoperative CT imaging (day 13) showed a small amount of haematoma in the anterior mediastinum but no haematoma was apparent in the pericardium [Fig. 3]. The patient was able to leave hospital independently on day 18.



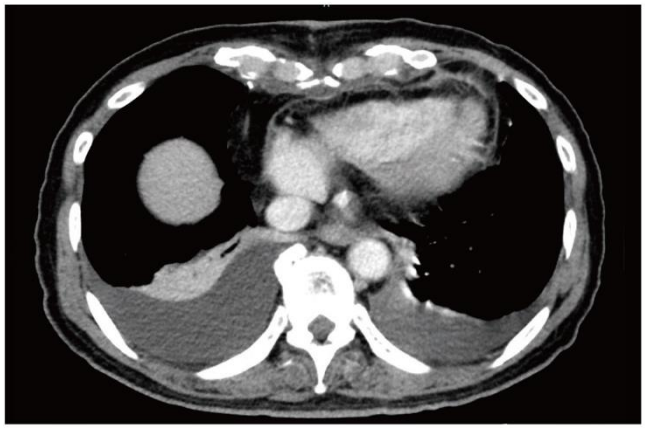
CT1



CT2



CT3



CT4

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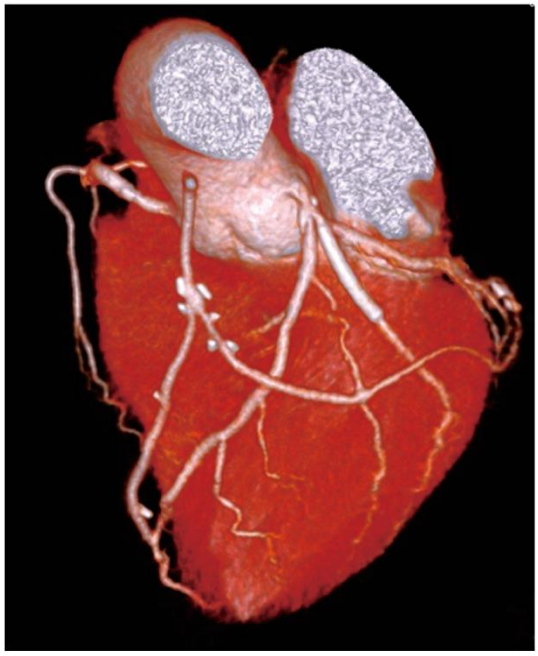
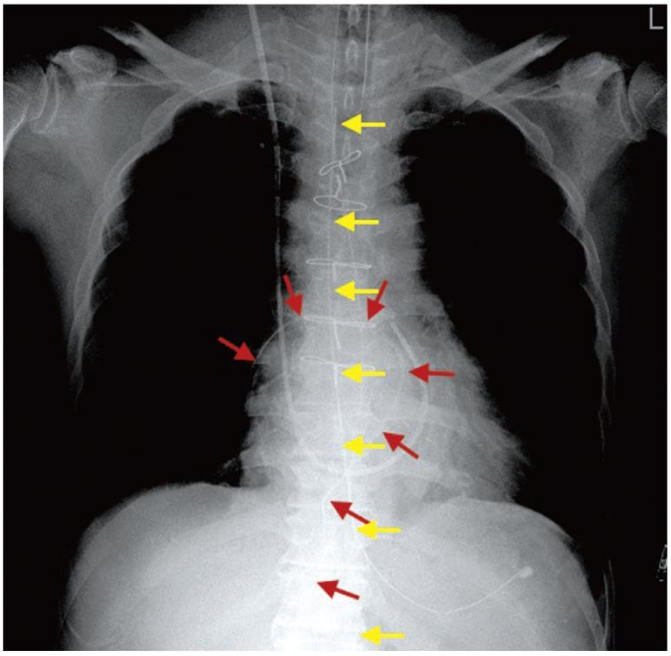


CTA
[Fig. 3]



X-P (Yellow: Anterior mediastinal drain: coaxial drain 24Fr
(Red: Pericardial drain Smart drain 19F)

Discussion

Protamine shock is thought to be caused by one or more of three things, namely 1) hypotension due to the vasodilator action of protamine itself under rapid administration, 2) anaphylactic reaction, 3) pulmonary hypertension due to severe pulmonary vasospasm①. The case in which pulmonary vasospasm occurs (3) is particularly severe, as right ventricular failure results in a loss of blood supply to the left ventricle, causing a sudden drop in systemic blood pressure. This phenomenon is said to be caused by substances such as thromboxane produced by the protamine and heparin complex. The protamine shock in the case we experienced was not anaphylactic shock but rather right ventricular failure due to pulmonary vasospasm. In such cases, steroids and adrenalin are ineffective and the first line treatment is vasodilators. In addition assisted circulation is required to overcome the shock state. Any physician who has experienced the pulmonary hypertension crisis seen in congenital heart disease should be aware of the severity of the severity of the situation.

As a drainage after open heart surgery, we like to perform circular pericardial drainage (CPD) with a smart drain. CPD has been reported to provide efficient pericardial drainage and to no leave haematoma in the pericardial space after surgery③. Smart drains are considered to be comparatively resistant to clogging but have also been identified as being problematic where there is bleeding in mediastinum. Specifically, while the suction force is delivered directly locations in proximity to the site of insertion, it tends to weaken with increasing distance from the site of insertion. And, in the event of clogging of a proximal portion, it not longer functions effectively as a drain.

The coaxial drain was developed to ameliorate this issue. The design combines the standard hole-type drain and slit-type drain so as to deliver the suction force to more distal portions of the device. [Fig. 4].

Though we did not expect to experience major bleeding in the course of heart surgery, when the unexpected occurred, it was an opportunity to make use of the coaxial drain we had prepared just in case, and we can only take our hats off to way it performed. When postoperative CT showed almost no haematoma in the pericardium or anterior mediastinum, we could not help but feel that the CPD + anterior mediastinal coaxial drain combination was very good one.

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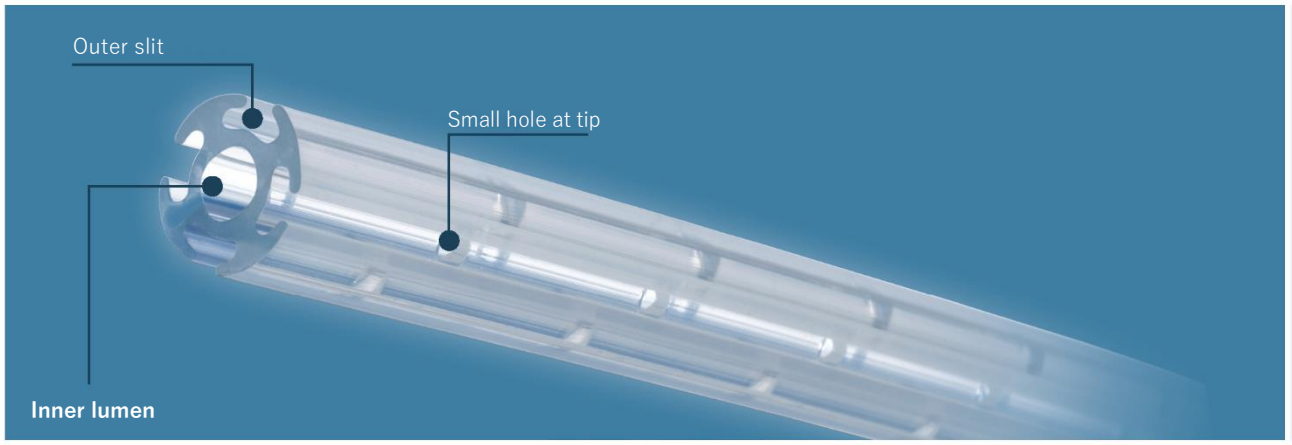

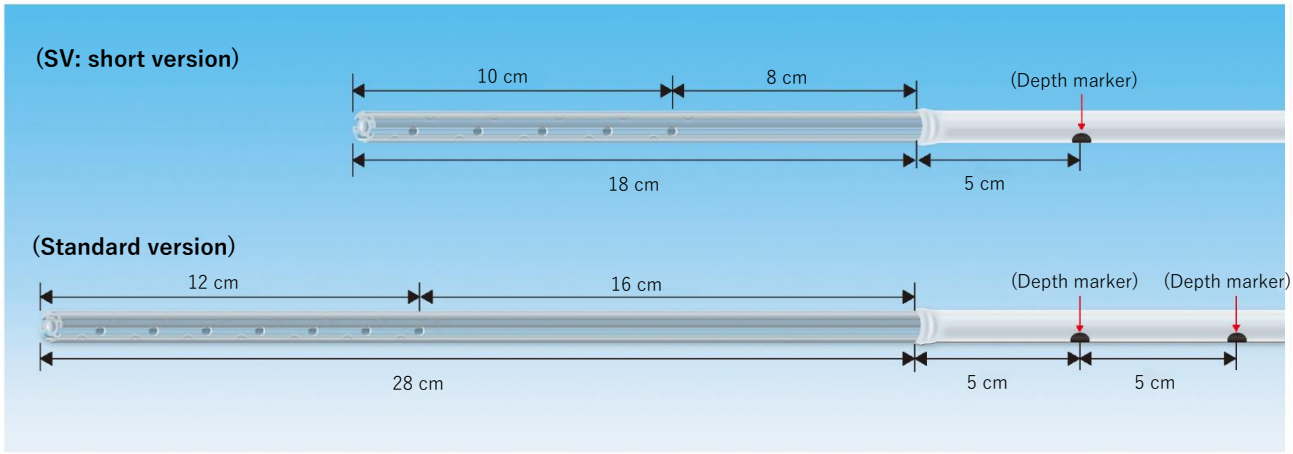

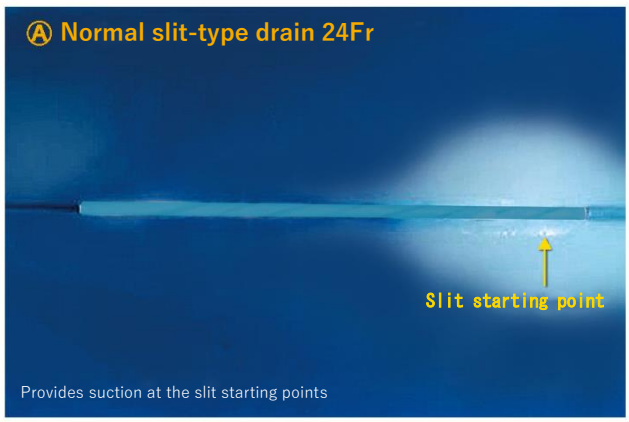

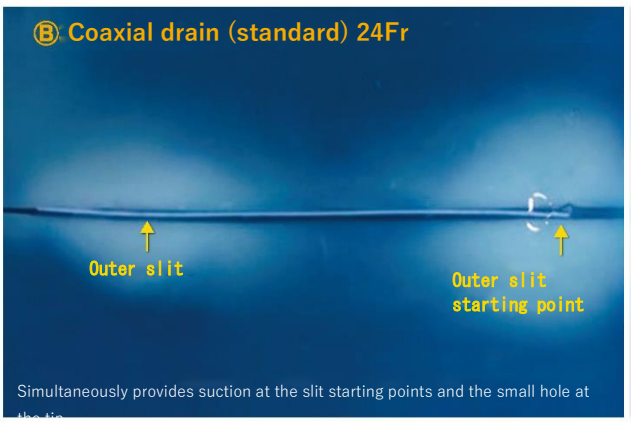

[Fig. 4] Suction state visibility test: Locations where suction is present turn white

Conclusion

We experienced a case of unexpected major bleeding that was overcover using CPD and a coaxial drain. The coaxial drain offers efficient drainage and appears to be effective in cases where major bleeding is present.

Reference

① Japanese Society of Anesthesiologists; Protamine Sulfate, Guidelines for the use of Anesthetics and Anesthetic-Related Drugs;
Third edition, Third revision: 665-667, 2012

② Shingo OUCHI et al; Basic techniques for drainage after open heart surgery and a new pericardial drainage method:
An experience of a CPD method using the REDAX Silicone Drainage System; Clinical Interview 7: 1-8., 2016

③ Shingo OUCHI et al; Usefulness of a new pericardial drainage method after open heart surgery; Vol. 63 No. 11 (2010-10)

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●Reimbursement classification: 029 Suction indwelling catheter (1) Active suction type ④ Storage use A: Soft type

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