

CASE REPORT

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# A case of paradoxical cerebral infarction by spraying thrombus in the catheter for dialysis

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## Abstract

**Background:** The authors herein report a case of paradoxical cerebral infarction by spraying thrombus in the catheter for dialysis. The clinical manifestations of paradoxical cerebral infarction are nonspecific, and the diagnosis is sometimes difficult to establish. Patients with paradoxical cerebral infarction may present with neurologic abnormalities or features suggesting arterial embolism. And paradoxical cerebral infarction has been associated with foramen ovale (PFO).

**Case presentation:** A multi-lumen catheter for dialysis was inserted into the right internal jugular vein. After injecting heparin-added physiological saline solution to confirm the patency of the catheter, paradoxical cerebral infarction developed. Detailed examination revealed PFO. PFO patent is a common condition that affects one in four people.

**Conclusion:** The size of multi-lumen catheter for dialysis is relatively large. We learned from this case that the use of multi-lumen catheter poses a potential risk of paradoxical infarction. Clinicians should be aware that central venous catheter is a risk factor for paradoxical cerebral infarction.

**Keywords:** Paradoxical cerebral infarction, Catheter, Foramen ovale

## Background

Paradoxical cerebral infarction is a pathological condition caused by paradoxical embolism, in which clots or air travel from the venous side to the arterial side via the right-to-left shunt due to patent foramen ovale, anomaly of pulmonary artery, atrial septal defect, or ventricular septal defect, etc. [1]. In general, embolism does not occur even if there is a hole in the septal wall because blood pressure in the arterial side is higher than that in the venous side. A right-to-left shunt requires transient or permanent increase of the pressure in the right ventricle and atrium compared to the left side. The incidence of conditions such as anomaly of pulmonary artery and atrial septal defect is low, and their presence is usually recognized when patients receive medical treatment. Therefore,

sudden onset of paradoxical infarction is considered to be extremely rare.

On the other hand, patent foramen ovale affects approximately 25% of healthy adults [2]. It is not a rare condition. However, abnormalities including paradoxical infarction do not develop unless a right-to-left shunt is present, as described above. Therefore, most patients with patent foramen ovale are asymptomatic. We experienced a case of paradoxical cerebral infarction caused by a double-lumen catheter for dialysis. The size of multi-lumen catheter for dialysis is relatively large.

## Case presentation

The patient was a 40-year-old woman who had been treated for ulcerative colitis at our department of gastroenterological medicine. She was admitted to our hospital because of poor control of disease and was scheduled for granulocyte apheresis (GCAP). Since it was difficult to secure vascular access because the patient's blood vessels were thin, a double-lumen catheter (GamCath®

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HighFlow Double-Lumen Catheter Kit GDHK-1315) for dialysis was inserted into the right internal jugular vein for blood access. GCAP was performed twice a week, and there were no problems until after the completion of the second treatment.

Two days after the second GCAP, maintenance of catheter was performed in the ward. The maintenance consisted of confirmation of patency and injection of heparin into the catheter, which was a routine procedure for patients with long-term indwelling catheter for the prevention of catheter occlusion. A nurse extracted the contents of the catheter using an empty 5-mL syringe. Approximately 4 mL of fluid and a tiny amount of thrombi were aspirated. Then, 5 mL of a heparinized solution was injected into the catheter using a Heparin Na Lock 10-units/mL syringe (Otsuka Pharmaceutical). After confirming the patency, the catheter was enclosed. Immediately after this, the patient complained of respiratory discomfort, numbness in the left side of the body, and visual field abnormality. The patient was referred to a local neurosurgery clinic. Computed tomography (CT) and magnetic resonance imaging (MRI) of the brain showed no obvious abnormalities and her subjective symptoms improved, and the patient was followed up without surgery. The patient had no history of diseases, except for ulcerative colitis. In particular, she had no history of arteriosclerotic disease.

Seven days later, the catheter maintenance procedure was carried out again while the patient was in a sitting position because she was talking to her friend. Immediately after this, the patient complained of tightness in the chest, numbness in the left side of the body, and rigidity in the right upper extremity, and a sense of feeling bad. She was monitored on an electrocardiogram and suspected as having ST elevation. An emergent cardiac catheterization was performed and showed no evidence of coronary artery disease. Pulmonary computed tomography was performed, and the scan showed no abnormalities. After cardiac catheterization, the patient was referred to the Department of Neurosurgery for detailed neurological examination.

The brain magnetic resonance imaging scan showed a punctuated and patchy high signal intensity, suggesting cerebral infarction in the territories of both anterior cerebral arteries, both posterior cerebral arteries, and the right posterior central gyrus cortex (Fig. 1). The patient was suspected to have an underlying problem because she had previously had a similar episode. Transcranial Doppler ultrasound was performed. When Valsalva strain was released, microbubbles appeared. Echocardiography was performed twice and showed no abnormalities. Therefore,

abnormalities such as patent foramen ovale were suspected. Contrast transesophageal echocardiography was performed. Immediately after a Valsalva strain, echocardiography showed appearance of microbubbles in a same manner (Fig. 2). Subsequently, the presence of patent foramen ovale was confirmed (Fig. 3). Based on these findings, the patient was diagnosed with paradoxical cerebral infarction due to patent foramen ovale. However, the tissue plasminogen activator was not administered because more than 4 h had passed since the onset of cerebral infarction. After anticoagulant therapy, the patient underwent rehabilitation. Her subjective symptoms improved after treatment of cerebral infarction.

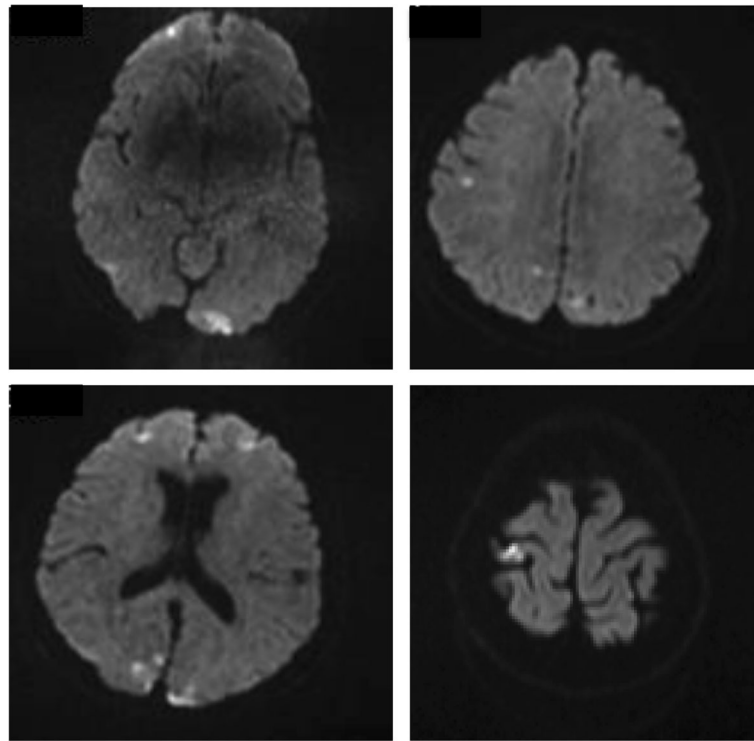
## Discussion

Paradoxical cerebral infarction is a condition caused by paradoxical embolism, in which obturators travel from the venous system to the arterial system via the right-to-left shunt. The requirements for this condition are twofold: “communication between the venous and arterial systems” and “increased pressure in the venous system.” Paradoxical cerebral infarction does not occur if one of the requirements is lacking.

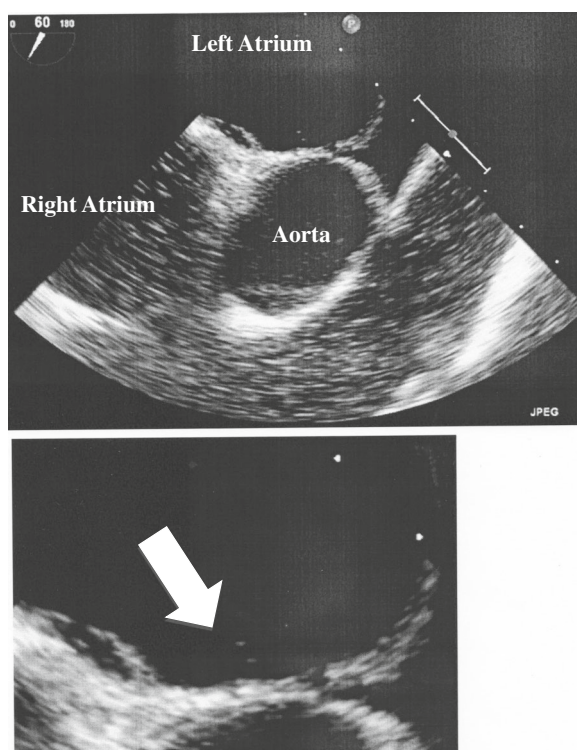
Patent foramen ovale is a common condition that affects one in four people [3], and it is difficult to detect with conventional echocardiography. In most cases, transesophageal echocardiography is required for the diagnosis [4, 5]. It is well known that patent foramen ovale is a risk factor for cerebral infarction; the resulting conditions are referred to as cryptogenic strokes or strokes of unclear origin. Treatments for patent foramen ovale, such as closure surgery, are under discussion [6]. More importantly, many cases of foramen ovale are asymptomatic, as was the present case, and the condition is therefore underdiagnosed.

Paradoxical cerebral infarction is a well-known disease among experienced neurosurgeons. As expected, many reported cases of paradoxical cerebral infarction were caused by a patent foramen oval because of its high incidence. There are also several reported cases of cerebral infarction as a catheter-related complication. An air embolism is frequently found to be the cause. In particular, there are many reported cases of air migration at the time of catheter removal. Previous reports on paradoxical cerebral infarction due to catheter placement are shown in Table 1. There have been various cases of air embolism, and they are typically associated with multi-syringe catheters placed into the internal jugular veins.

In the present patient, the presence of a patent foramen oval was confirmed. We considered that the cerebral infarction was caused by catheter placement



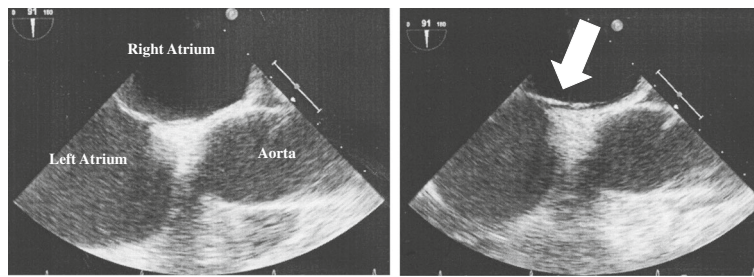
**Fig. 1** Brain magnetic resonance imaging: diffusion-weighted magnetic resonance imaging



**Fig. 2** Contrast transesophageal echocardiography after a valsalva strain. Numerous microbubbles are present in the *right* atrium. *Bottom A* magnified view of the upper image. The *arrow* indicates two microbubbles that traveled to the *left* atrium

because the patient showed similar symptoms after the catheter maintenance procedures. The patient discussed herein had no history of diseases, such as atrial fibrillation, that can cause arterial thrombosis. She also had no history of deep vein thrombosis or predisposing factors to venous thrombosis. To our knowledge, this is the first case of a patient with paradoxical cerebral infarction that was clearly caused by a flash of thrombi in the catheter.

In general, small thrombus formation does not lead to cerebral infarction of the systemic arterial system. Catheters are usually placed in the veins. Even if a patent foramen ovale is present, blood clots do not travel to the arterial system unless a right-to-left shunt is present, which occur only when venous pressure exceeds arterial pressure. It is therefore important to keep the blood pressure in the right atrium and ventricle well controlled during catheter procedures to prevent cerebral infarction. In general, blood pressure in the right atrium and ventricle is elevated by straining, lifting heavy baggage, defecating, sexual intercourse, changing position from lying to sitting, coughing, and sneezing. Therefore, it is important to avoid such conditions during catheter procedures. In the present case, the second catheter maintenance procedure was carried out while the patient was



**Fig. 3** Contrast transesophageal echocardiography. Left PFO closed. Right PFO is open (arrow)

sitting, which might have been a cause of cerebral infarction. As shown in Table 1, a higher percentage of patients underwent the procedure while sitting or standing, which is a risk of thrombosis, as confirmed by a study that examined the effects of body position during operation. Therefore, we conclude that catheter management should not be performed with patients in a sitting or standing position.

We consider it important to remove small thrombi in the catheter during catheter use and maintenance. Thrombi should be aspirated as completely as possible, and flushing them should be avoided as much as possible. There is no established consensus on regular catheter maintenance procedures, such as heparin injection, for the prevention of catheter occlusion. The National Kidney Foundation Kidney Disease Outcomes Quality Initiative (NKF KDOQI) guidelines, the European Renal Best Practice guidelines, and the Canadian Society of

Nephrology guidelines do not stipulate whether such management is needed. On the other hand, the Japanese Society for Dialysis Therapy Guidelines for Vascular Access Construction and Repair for Chronic hemodialysis (2005) state that “Anticoagulant therapy such as heparin lock should be performed only on the day of hemodialysis because infection rate is lower in this manner compared with daily administration. However, this is not a strict rule because some patients require anticoagulant therapy such as heparin lock also on the day without hemodialysis for the prevention of thrombus formation in the catheter.” [7]. From the viewpoint of prevention of catheter infection, the Centers for Disease Control and Prevention (CDC) guidelines stipulate as follows [8]: “Do not routinely use anticoagulant therapy to reduce the risk of catheter-related infection in general patient populations” (Category II). They recommended that anticoagulant therapy should not be performed for the prevention of

**Table 1** Previous reports on paradoxical cerebral infarction due to catheter placement

CN	Author	Emboli	Operation	Catheter type	Catheter position	Position at treatment
[9]	Kariya S	Air	Removal	Single	Right internal jugular vein	Supine position
[10]	Eichhorn V	Air	Removal	Triple lumen (7 Fr)	Right internal jugular vein	Sitting in an upright position
[11]	Copetti R	Air	Insert	NC	Right internal jugular vein	Supine position
[12]	Khan H	Air	Removal	Triple lumen	Right internal jugular vein	Sitting in an upright position
[13]	Petrea RE	Coagulus	NC	PICC	Superior vena cava prolapsing into the right atrium	NC
[14]	Bowles PF	Air	Removal	Pulmonary artery (PA) catheter	Right internal jugular vein	Supine position
[15]	Wu YC	Air	Removal	NC	NC	NC
[16]	Levy SD	Air	Removal	14 Fr catheter	NC	Trendelenburg position
[17]	Yu AS	Air	After HD	Double lumen	The right subclavian vein	NC
[18]	Zuha R	Air	Removal	NC	NC	NC
[19]	Batsis JA	Coagulus	NC	Single	Right internal jugular vein	Supine position
[20]	De Jong A	Air	Removal	NC	NC	NC
[21]	Cardim N	Coagulus	NC	Permanent CVC	Superior vena cava	NC
[22]	Han SS	Air	Insert	NC	Right internal jugular vein	NC
[23]	Suzuki S	Coagulus and air	Removal	Double lumen	Right internal jugular vein	Supine position
[24]	Biller J	Coagulus	NC	Swan-Ganz catheter	NC	NC

CN citation number, NC not clear, PICC peripherally inserted central catheter, HD hemodialysis, CVC central venous catheter



infection. Given that the effectiveness of anticoagulant therapy for the prevention of catheter occlusion has not been established, it may be appropriate not to perform anticoagulant therapy, except for special cases, in order to reduce the risk of infection and paradoxical cerebral infarction. In addition, it is important to consider the possibility of paradoxical cerebral infarction when a patient shows symptoms of cerebral infarction or coronary artery infarction after catheter maintenance procedure, etc.

## Conclusion

We learned from this case that the use of multi-lumen catheter poses a potential risk of paradoxical infarction. Specialists in dialysis and cardiovascular disease and neurosurgeons should be aware of the risk of paradoxical cerebral infarction. Clinicians should be aware the risk of paradoxical cerebral infarction in patients with indwelling central venous catheter.

## Abbreviations

CN: Citation number; CT: Computed tomography; CVC: Central venous catheter; GCAP: Granulocyte apheresis; HD: Hemodialysis; MRI: Magnetic resonance imaging; NC: Not clear; PFO: Foramen ovale; PICC: Peripherally inserted central catheter

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## Availability of data and materials

The data and materials were all included in the manuscript.

## Ethics approval and consent to participate

Written informed consent was obtained from the patient after a detailed explanation of the objectives of the study. The patient requested strongly that the report be published to aid in the prevention of paradoxical cerebral infarction in patients with indwelling catheter.

## Authors' contributions

SH is responsible for the manuscript. HS, HM, and TK are staff of the Medical Safety Management Office and conducted a cause investigation. TH was in charge of actual diagnosis and treatment. All authors read and approved the final manuscript.

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## Consent for publication

Written informed consent was obtained from the patient for publication of this case report and the accompanying images.

## Competing interests

The authors declare that they have no competing interests.

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