

CASE REPORT

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Veno-arterial extracorporeal membrane oxygenation under dual antiplatelet therapy, immediately after craniotomy

Hiroshi Shimizu, Yu Fukunaga, Yumi Komatsu, Tatsuya Yamashita, Tomonori Imamura, Masayuki Kanai

ABSTRACT

Introduction: Extracorporeal membrane oxygenation (ECMO) is often considered a relative contraindication for traumatic brain injury and cerebral hemorrhage because fatal intracranial hemorrhage can occur. Moreover, dual antiplatelet therapy (DAPT)-related cerebral hemorrhage is associated with a high mortality rate. Herein, we report a case in which the patient was placed on ECMO under DAPT and managed without anticoagulation immediately after craniotomy.

Case Report: A 51-year-old man was hospitalized for surgery for Moyamoya disease. The surgery was performed as scheduled; however, the patient experienced cardiac arrest while awakening from anesthesia. After return of spontaneous circulation, during the emergency percutaneous coronary intervention (PCI), he was placed on ECMO for cardiac arrest which caused an electrical storm. Because computed tomography (CT) after PCI revealed a new cerebral hemorrhage, ECMO was managed with DAPT without anticoagulation. Subsequently, the CT showed no increase in hematoma; however, a thrombus was observed in the membrane of the ECMO, and ECMO was withdrawn on the 4th intensive care unit day.

Conclusion: Anticoagulation therapy with or without DAPT should not be used because of the risk of bleeding associated with veno-arterial ECMO immediately after craniotomy. Additionally, the risk of thrombosis may be high; therefore, additional care must be taken, and it is necessary to manage the ECMO circuit to consider the possibility of early replacement it too.

Keywords: Craniotomy, DAPT, ECMO, Intracranial hemorrhage

How to cite this article

Shimizu H, Fukunaga Y, Komatsu Y, Yamashita T, Imamura T, Kanai M. Veno-arterial extracorporeal membrane oxygenation under dual antiplatelet therapy, immediately after craniotomy. Int J Case Rep Images 2024;15(2):121–125.

Article ID: 101483Z01HS2024

doi: 10.5348/101483Z01HS2024CR

INTRODUCTION

Extracorporeal membrane oxygenation (ECMO) is used in the critical care of patients with cardiac arrest. During ECMO, oxygenator thrombosis can occur in approximately 10–16% of patients, depending on the circuit type and the patient's age [1, 2]. Therefore, anticoagulation therapy is recommended to prevent thrombosis [3]. On the other hand, bleeding is known to be a complication during ECMO, and is reported to occur in 30–50% cases [4, 5]. The rate of cerebral hemorrhage is low (2–6%) [5, 6]. However, the mortality rate of patients with central nervous system disorders is high, especially cerebral hemorrhage, which accounts for approximately 80% [7]. Therefore, ECMO is often considered a relative contraindication for traumatic brain injury and cerebral hemorrhage.

On the other hand, DAPT is typically continued after percutaneous coronary intervention (PCI) to prevent stent thrombosis. However, DAPT-related cerebral hemorrhage is associated with a high mortality rate [8]. Furthermore, the addition of anticoagulation therapy to DAPT has been reported to increase the risk of intracranial hemorrhage [9].

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Received: 25 August 2024

Accepted: 18 October 2024

Published: 24 October 2024

We report a case in which the patient was placed on ECMO under DAPT and managed without anticoagulation, immediately after craniotomy.

CASE REPORT

A 51-year-old man was hospitalized for surgery for Moyamoya disease. He had been hospitalized for bilateral frontal lobe cerebral infarction due to Moyamoya disease one year previously and had undergone a left superficial temporal artery to middle cerebral artery (STA-MCA) bypass for Moyamoya disease six months previously. Surgery was scheduled for a right STA-MCA bypass. There were no particular abnormalities in the previous surgery, and no abnormalities were noted on the preoperative electrocardiogram or echocardiogram. On admission, his height and weight were 175 cm and 99 kg, respectively, and body mass index (BMI) was 32.3. The laboratory test results revealed no abnormalities. The surgery was performed as scheduled; however, while awakening from anesthesia, ST-segment depression was observed on induction. Subsequently, the blood pressure decreased and the patient entered a state of pulseless electrical activity. Cardiopulmonary resuscitation was immediately performed, and the return of spontaneous circulation took 25 min. Emergency coronary angiography showed 75% stenosis in the left main coronary trunk (LMT) and 90% stenosis in #2 of right coronary artery (RCA); overall vasospastic changes were observed. Myocardial ischemia is thought to be caused by a combination of severe coronary stenosis and vasospasm. Subsequently, he was placed on ECMO for cardiac arrest, which caused an electrical storm. Subsequently, aspirin 100 mg and prasugrel 20 mg were administered orally, and PCI was performed for the LMT. After PCI, defibrillation was performed to restore the sinus rhythm. A total of 5000 units of heparin were injected during PCI with a final activated clotting time of 256 s, and laboratory tests showed a fibrinogen level of 177 mg/dL. The computed tomography (CT) after the PCI revealed a new cerebral hemorrhage (Figure 1). After consulting with neurosurgeons and cardiology departments, ECMO was managed with aspirin 10 mg and clopidogrel 75 mg without heparin, and cerebral hemorrhage was followed up with CT imaging. After admission to the intensive care unit (ICU), 6 units of fresh frozen plasma (FFP) were transfused, and 12 h later, a follow-up CT showed an increase in hematoma and midline shift; therefore, an emergency decompressive craniotomy was performed (Figure 2). In addition, 12 units of FFP were transfused both intraoperatively and postoperatively. Follow-up CT showed no increase in the hematoma (Figure 3); however, a thrombus was observed in the membrane of the ECMO, and as the hemodynamics became stable, ECMO was thus withdrawn on the 4th ICU day.

As his consciousness was impaired, a tracheostomy was performed on the 10th ICU day. The ventilator was

weaned off on the 12th ICU day, and he was transferred to the general ward on the 14th ICU day. He currently has a Cerebral Performance Category score of 3 and is undergoing rehabilitation in a general ward.

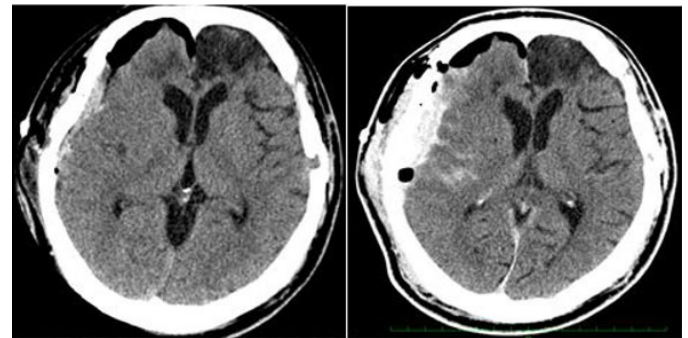


Figure 1: Before (left image) and after (right image) percutaneous coronary intervention.

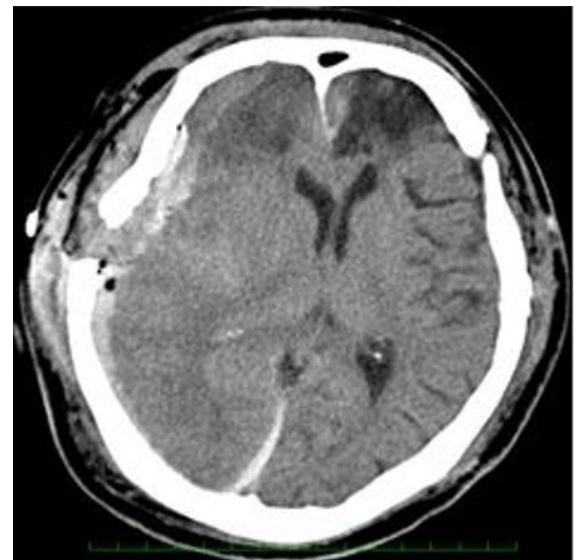


Figure 2: Computed tomography shows an increase in hematoma and midline shift.



Figure 3: Computed tomography shows no increase in hematoma on the fourth day in the intensive care unit.

DISCUSSION

In this study, two important clinical issues were encountered. One refers to the use of ECMO in situations where there is a risk of cerebral hemorrhage after craniotomy, and the other is ECMO management performed under DAPT without heparin.

First, there are few reports of a patient being placed on ECMO immediately after or during craniotomy. However, there have been several reports on the use of ECMO for multiple injuries complicated by traumatic brain injury, including intracranial hemorrhage. In one report, 13 patients with traumatic brain injury were placed on ECMO; however, none showed exacerbation of intracranial hemorrhage on CT [10]. In another report, three patients with traumatic brain injury complicated by acute respiratory distress syndrome were placed on ECMO; however, there were no bleeding complications [11]. Thus, ECMO may not increase the risk of bleeding even in the presence of brain injury, including intracranial hemorrhage. A previous study reported that 61.9% of patients with traumatic brain injury who were treated with ECMO were discharged alive [12]. The risk of bleeding may not be high even after craniotomy, because ECMO for intracranial hemorrhage does not increase the risk of bleeding. However, many of these ECMO procedures involve veno-venous (VV)-ECMO for trauma-associated respiratory failure. There is a difference in the bleeding risk between VV-ECMO and veno-arterial (VA)-ECMO, and the risk of bleeding and serious bleeding has been reported to be higher with VA-ECMO than with VV-ECMO [6, 13, 14]. This patient also showed an increase in hematoma after being placed on ECMO, and craniotomy was performed to remove the hematoma. Therefore, there remains a concern about the bleeding risk associated with VA-ECMO immediately after craniotomy.

Second, there are several reports on the bleeding risk associated with DAPT and anticoagulation therapy with VA-ECMO. The rate of bleeding during ECMO with anticoagulation is reported to be 30–50% [4, 5] and that without anticoagulation is reported to be 32.8%. Thus, there is little difference in the rate of bleeding [15]. In addition to anticoagulation, the high bleeding risk under ECMO can be attributed to multiple treatment-related factors associated with ECMO, including the ECMO circuit and pump itself, impairing multiple innate primary and secondary hemostatic mechanisms. However, the rate of cerebral hemorrhage alone was 0.5%, which is lower than that reported previously [15]. Therefore, anticoagulation therapy is not preferred if there is a risk of cerebral hemorrhage. Regarding the bleeding risk of DAPT, DAPT and anticoagulation were reported to be more likely to cause bleeding than anticoagulation alone; however, the difference was not statistically significant [16]. Additionally, DAPT should be continued because anticoagulation therapy alone is ineffective in preventing stent thrombosis. Based on these concerns, it is desirable to avoid anticoagulation, at least judging that there is a

risk of bleeding when placed on ECMO in combination with DAPT after craniotomy, as reported in this case.

However, the risk of thrombosis may increase without anticoagulation therapy during ECMO. In this case, the thrombosis formed early in the ECMO circuit. However, the rate of thrombosis during ECMO even without anticoagulation was 13.4%, which is within the range reported by previous studies that used systemic anticoagulation due to the coating of the ECMO circuit and the improvement of the oxygenator [15]. In this case, the cerebral hemorrhage tended to increase and the fibrinogen level was low; therefore, a large amount of FFP was transfused during ECMO. Therefore, it is thought that the thrombosis formed early in the ECMO circuit.

We administered ECMO under extraordinary circumstances. Although it is difficult to generalize the management in such situations, it will serve as a guide for similar situations in the future. In addition, it can also be useful as a reference when an intracranial hematoma is detected during VA-ECMO and a craniotomy is performed.

CONCLUSION

In conclusion, we report a case in which the patient was placed on ECMO under DAPT and managed without anticoagulation immediately after craniotomy. As there remains a concern about the bleeding risk of VA-ECMO immediately after craniotomy, it is advisable to not use anticoagulation with or without DAPT. In addition, the risk of thrombosis may be high, especially when receiving blood transfusions; therefore, care must be taken, and it is necessary to manage the ECMO circuit to consider the possibility of early replacement it too.

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Acknowledgments

We would like to thank Editage for English language editing.

Author Contributions

Hiroshi Shimizu – Conception of the work, Design of the work, Acquisition of data, Drafting the work, Final approval of the version to be published, Agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved

Yu Fukunaga – Acquisition of data, Revising the work critically for important intellectual content, Final approval of the version to be published, Agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved

Yumi Komatsu – Acquisition of data, Revising the work critically for important intellectual content, Final approval of the version to be published, Agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved

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Guarantor of Submission

The corresponding author is the guarantor of submission.

Source of Support

None.

Consent Statement

Written informed consent was obtained from the patient for publication of this article.

Conflict of Interest

Authors declare no conflict of interest.

Data Availability

All relevant data are within the paper and its Supporting Information files.

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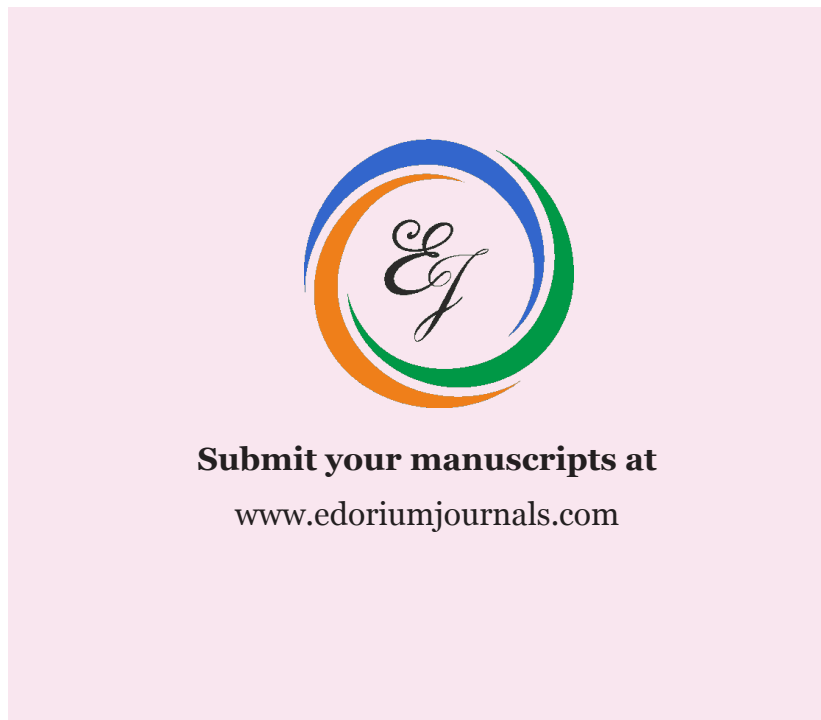
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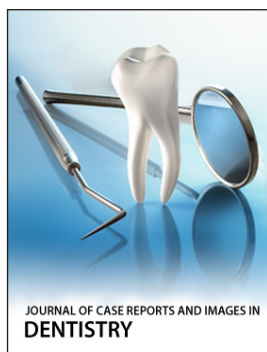
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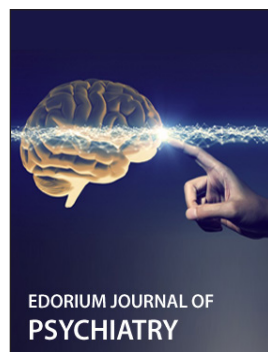
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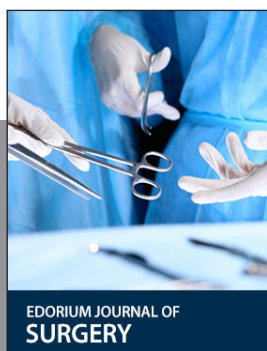
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