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Near-infrared spectroscopy during cesarean section with common iliac artery balloon occlusion for total placenta previa: a case report

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Summary

Purpose of investigation: The aim of this study was to evaluate lower limb circulation during vascular occlusion in patients undergoing cesarean section with total placenta previa. *Materials and Methods:* Two pregnant women with total placenta previa underwent regional oxygen saturation (rSO_2) monitoring in the lower limb, using near-infrared spectroscopy (NIRS) during cesarean section with common iliac artery balloon occlusion(CIABO). *Results:* There was no decrease in rSO_2 during balloon inflation and after balloon inflation in the two patients. *Conclusion:* The authors found that it is possible to evaluate limb ischemia by balloon occlusion in real-time using NIRS to measure regional oxygen saturation.

Key words: Regional oxygen saturation; Near-infrared spectroscopy; Common iliac artery balloon occlusion; Total placenta previa; Placenta accreta.

Introduction

Recently, intravascular occlusion has been used for cesarean section for placenta accreta where a high risk of considerable bleeding is present [1]. Types of intravascular occlusion include intra-aortic balloon occlusion (IABO), common iliac artery balloon occlusion (CIABO), and internal iliac artery balloon occlusion. The type used varies according to institution.

Lower limb ischemia is a rare, but a serious complication of balloon occlusion. In IABO, the occlusion time to prevent lower limb ischemia has been reported to be approximately 20–45 minutes [2]. However, In CIABO, the appropriate occlusion time remains unknown.

In the present institution, the balloon inflation time for CIABO is within 60 minutes. However, it is unknown whether this balloon inflation time is appropriate.

Recently, measurement of regional oxygen saturation (rSO_2) using near-infrared spectroscopy (NIRS) has been investigated for evaluation of tissue ischemia. rSO_2 is an index used to assess the perfusion and metabolic state of mixed blood immediately beneath a sensor using near-infrared radiation. rSO_2 is commonly used to monitor cerebral blood flow. However, it can be used to monitor other regions such as the lower limbs [3, 4]. In addition, because rSO_2 can be monitored non-invasively and continuously, it is widely used in anesthesiology, cardiovascular surgery, and in emergency medicine.

To the best of the authors' knowledge, no study has monitored rSO_2 during an operation using a balloon catheter for total placenta previa. Using rSO_2 monitoring, they hypothesized that they would be able to diagnose lower limb ischemia during vascular occlusion sooner and determine a safe occlusion time. Thus, they monitored lower limb circulation using NIRS during cesarean section with CIABO for total placenta previa.

Materials and Methods

The authors attached an INVOS 5100C device to the lower limbs (Figure 1), and compared rSO_2 values before and after balloon inflation in two patients.

The surgical procedure was as follows: First, a 7Fr sheath was inserted into both inguinal regions. Next, a 6Fr balloon catheter was inserted into the common iliac artery. The following confirmed that vascular occlusion was appropriately performed: (1) the balloon shape changed to a barrel shape (Figure 2A), (2) the SpO_2 values decreased and the pulse wave was nearly flat (Figure 2B), and (3) contrast medium stasis. Cesarean section was performed under general anesthesia. The balloon was inflated just before cutting the myometrium. For hemostasis confirmation, the balloon was deflated before abdominal closure.

Results

Case 1: The patient was in her late 30s with pregnancy after cesarean delivery. She was diagnosed with total placenta accreta by preoperative MRI. At 37 weeks and five

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Figure 1. — Installation of the oxygen saturation and near-infrared spectroscopy monitors in the operating room.
Saturation monitors are placed on both big toes, and near-infrared spectroscopy monitors are placed on both soles of the feet.

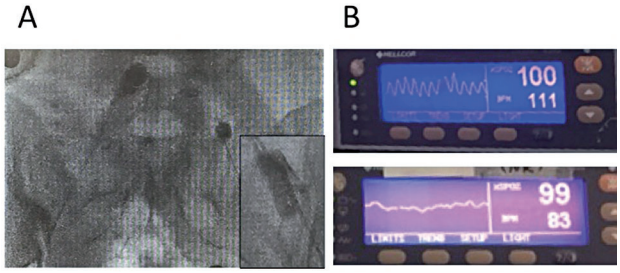

Figure 2. — Spectroscopic image and saturation monitor during balloon inflation.
(A) The balloon changes from a sphere to a barrel shape (right bottom) when the vessel is occluded. The volume of contrast media is also determined.
(B) Change in oxygen saturation during balloon inflation (upper). Saturation level of the big toe before balloon inflation (bottom). After the balloon is inflated and vascular occlusion, the pulse wave on the saturation monitor decreases.

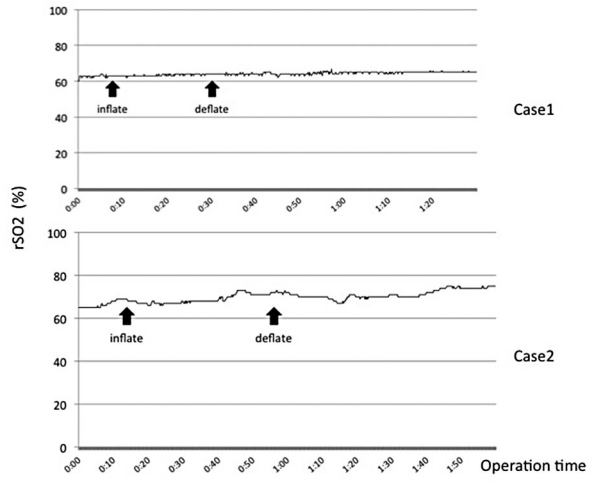

Figure 3. — rSO2 values during operation.
Upper panel shows the change in regional oxygen saturation (rSO_2) during the operation for Case 1. The longitudinal (y) axis represents the rSO_2 value (%), and the horizontal (x) axis represents the operation time. rSO_2 did not decrease before or after inflation. Bottom panel shows change in regional oxygen saturation (rSO_2) during the operation for Case 2. rSO_2 did not decrease before or after inflation.

days of gestation, she underwent elective cesarean section using an indwelling balloon in the common iliac artery. Approximately 30% of the placenta was adhered to the uterus, but the authors were able to detach this part manually. Operation time was one hour and 16 minutes, balloon inflation time was 25 minutes, and hemorrhage volume was 1,390 ml.

Before inflation of the balloon, the average rSO_2 value of the right and left side was 63%, during inflation it was 66%, and after deflation, the value was 65%. Thus, there was no change before or after inflation of the balloon (Figure 3). Her postoperative course was positive, and without complication. Seven days post-operation, the patient and her baby were discharged.

Case 2: The patient was in her late 30s. She had undergone prior uterine surgery for uterine myoma. She was diagnosed with total placenta accrete by preoperative MRI. At 36 weeks and one day of gestation, she underwent an elective cesarean section using an indwelling balloon in the common iliac artery. Approximately 50% of the placenta was adhered to the uterus, but the authors were able to detach this part manually. Operation time was one hour and 46 minutes, balloon inflation time was 42 minutes, and the hemorrhage volume was 2,600 ml.

Before inflation of the balloon, the average rSO_2 value of the right and left side was 73%, during inflation it was 70%, and after deflation, the value was 65%. Thus, there was no change before or after inflation of the balloon (Figure 3. Her postoperative course was positive, and without complication. Seven days post-operation, the patient and her baby were discharged.

Discussion

There are many methods for diagnosing lower limb ischemia including physical examinations (e.g., skin temperature and color, and time for microvascular filling), measurement of serum myogenic enzymes, such as creatine phosphokinase and myoglobin, and contrast computed tomographic scanning examination (contrast-CT) [5]. However, during vascular occlusion by a balloon, it is difficult to detect the pulse of the dorsalis pedis artery using a pulse oximeter and palpation.

Recent studies reported the utility of NIRS for assessing lower limb artery occlusion [6], diagnosing compartment syndrome [7, 8], and assessing abdominal aortic aneurysm and lower limb ischemia during surgery of the lower limb artery [9-11].

Wong *et al.* showed that lower limb ischemia was detected in six of 17 patients, and performed fasciotomy in four of 17 in whom rSO_2 values in the lower limb were < 40% or decreased by 25% or more during veno-arterial extracorporeal membrane oxygenation (VA-ECMO) [12].

In the two patients in the current study, balloon inflation time was 25 minutes (case 1) and 45 minutes (case 2). The

average rSO_2 value during vascular occlusion by balloon was 60–70%. There was no significant change in rSO_2 before balloon inflation, during balloon inflation, and after balloon deflation. Both patients did not meet the criteria for diagnosis of lower limb ischemia proposed by Wong *et al.* (i.e., < 40%).

The largest advantage of rSO_2 is that it is non-invasive and can be continuously monitored. Therefore, it is able to provide prompt findings and signal intervention for ischemia. Despite decreasing rSO_2 values, it has been reported that avascular necrosis can be avoided by releasing vascular occlusion immediately [13]. However, because the precise time that rSO_2 can be lowered leading to avascular necrosis is unknown, monitoring in real-time is essential. The criteria Wong *et al.* have proposed are based on an evaluation of rSO_2 for VA-ECMO; evaluation for CIABO has not yet been performed. The present authors consider that CIABO is less likely to elicit ischemia compared with ECMO. Therefore, the vascular occlusion time can be longer, because of the difference in thickness of the sheath used in ECMO and CIABO (sheath of ECMO, 16–24 Fr, 5.3–8.0 mm; sheath of CIABO, 6 Fr, 2.0 mm), and developmental stage of the collateral circulation in total placenta previa [14, 15]. In the present institution, the authors have set the balloon inflation time for CIABO within 60 minutes, but this is not based completely on evidence.

The present authors have experienced a case of massive bleeding and hypotension because of balloon deflation, because the balloon inflation time exceeded 60 minutes in a difficult surgery. By monitoring rSO_2, the balloon can be kept inflated continually at least until rSO_2 begins to decrease. The present authors consider that vascular necrosis can be prevented if rSO_2 is < 40% or decreased by 25%, as we can deflate immediately and confirm the increase in rSO_2. Further, if the time until rSO_2 decrease can be accurately determined, it may be possible to perform longer vascular occlusions and avoid massive bleeding.

Conclusion

Measurement of rSO_2 by NIRS can be used to evaluate limb ischemia by balloon occlusion in real-time, and could be used to determine the appropriate vascular occlusion time in CIABO.

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