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CASE REPORT

Permissive Hypotension Strategy in Open-surgery of Abdominal Aortic Aneurysm

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ABSTRACT

Background: Open-surgery in patients with aortic aneurysms has always been a challenge for every anesthesiologist. The risk of massive bleeding, hemodynamic instability, and peripheral perfusion insufficiency are some of the reasons for the need of appropriate perioperative management. The purpose of this case report is to describe the permissive hypotension strategy in open-surgery of abdominal aortic aneurysm.
Case Illustration: A 65-year-old man with radiologic findings of an aneurysm in the abdominal aorta at 3rd-4th lumbar vertebrae level was planned for open-surgery aneurysmectomy and aortic graft. Pre-operative assessment concluded the physical status of ASA III. Patient was planned to receive general anesthesia. Invasive hemodynamic monitoring was performed by placing an arterial line and a central venous catheter. Just before the aortic clamp procedure, permissive hypotension strategy was started by lowering systolic blood pressure using titrated doses of nitroglycerin with target MAP of >60 mmHg. Bleeding management was carried out with intravascular fluid resuscitation until the CVP target of 7-8 mmHg was achieved. When the aortic clamp was released, titrated dose of norepinephrine was administered with target MAP of 65-75 mmHg. Post-operatively, the patient was admitted to the ICU. The patient was discharged on the seventh post-operative day.
Conclusion: This case demonstrated the successful perioperative management of an open surgery aneurysmectomy by maintaining the hemodynamic stability of the patient using permissive hypotension strategy. The successful stabilization of patient's hemodynamic state during surgery resulted in a good and fast post-operative outcome and recovery.

Keywords: abdominal aortic aneurysm; aortic clamping; open surgery; perioperative management; permissive hypotension

INTRODUCTION

Abdominal aortic aneurysm (AAA) is a condition where there is a pathologic widening of a segment of the abdominal aorta due to the weakening of the vessel wall, causing disturbances in the blood flow and pressure, resulting in expansion and bulging of the vessel segment[1,2]. Epidemiologically, the prevalence of AAA varied between 2-12%, and found in 8% of men over 65 years of age. AAA was associated with genetic and environmental risk factors, including advanced age, male, white race, uncontrolled hypertension, low levels of high-density lipoprotein (HDL) cholesterol, history of coronary heart disease, and smoking habit[1,3]. Some of the common symptoms encountered were the presence of a lump in the abdomen that was pulsatile, low back pain, pain in the waist, abdominal pain, or pain in the groin[1,4,5].

Patients diagnosed with AAA accompanied by clinical symptoms need to be considered for immediate aneurysm repair surgery, regardless of the size[1,3,6]. Open-surgery to repair aortic aneurysms has become the standard of care in AAA cases for decades. Although EVAR (Endovascular Aneurysm Repair) method that was introduced about two decades ago was a less invasive approach and has fewer early postoperative complications, the open-surgery was still an option when the anatomical difficulty was encountered or EVAR procedure cannot be managed[1]. The open-surgery intervention also allowed the replacement of the affected aortic segment with a graft[6].

Open-surgery in AAA is a high-risk procedure and has always been a challenge for anesthesiologists.[1,7] Over the 30-day perioperative period, cardiovascular and pulmonary complications became the most common causes of death in aneurysm repair cases. Those risk emphasized the need for adequate preoperative examinations before surgery[1]. Insertion of a central monitoring line and other invasive intraoperative monitoring techniques should always be considered in this case. Intensive intraoperative monitoring is usually facilitated by the insertion of an arterial line and monitoring central venous pressure[8].

Intraoperative anesthetic management is focused on preventing all procedure-related complications, such as renal ischemia, massive bleeding, coagulopathy, and the effects of hemodynamic changes due to the placement and removal of the aortic clamp, such as POCD (Post Operative Cognitive Dysfunction). The responses to aortic cross-clamping depend on preoperative left ventricular function, the collateral circulation function, and the height of the clamp placement. Cross-clamping was performed on the both proximal and distal sides of the lesion. After clamping the aorta, the increase of afterload causes hypertension proximal to the clamp and hypotension distally. Meanwhile, the unclamping procedure will cause a sudden decrease in afterload and a severe ischemia-reperfusion condition. Those procedure can lead to severe hypotension, lactic acidosis, myocardial ischemia, and cardiovascular collapse[3,4,7–9]. Other perioperative complications that might occur include lower extremity embolism and colon ischemia[6]. Therefore, appropriate strategy is necessary to maintain hemodynamic stability of the patient and to prevent complications. This case report aims to describe the permissive hypotension strategy in open-surgery of abdominal aortic aneurysm.

CASE ILLUSTRATION

A 65-year-old man complained of throbbing and abdominal discomfort for 4 months. The CT-Scan angiography of the abdomen showed a saccular type aneurysm measuring 2.9 x 3.2 x 6.7 cm in the abdominal aorta below the renal artery branches down to the abdominal aortic bifurcation, at the level of 3rd-4th lumbar vertebrae. Vascular surgeon planned to perform an aneurysmectomy and open-surgery aortic graft. Preoperative assessment showed that the patient had no complaints of headache, blurred vision, chest pain, shortness of breath, fever, or cold cough. The patient had a history of hypertension with routine treatment using Bisoprolol 5 mg daily, Candesartan 8 mg daily, and Amlodipine 5 mg daily. The blood pressure usually ranged between 110-130 mmHg for the systole and 70-90 mmHg for the diastole. The patient had a history of appendectomy surgery performed in 2008 under general anesthesia without postoperative problem. Preoperative vital signs examination showed the patient was fully conscious with GCS E4V5M6, blood pressure 115/70 mmHg, pulse rate 56 times/minute, respiratory rate 16 times/minute, temperature 36.7^{o}C, oxygen saturation (SpO_2) 98% in room air and supine position, weight 62 kg, and height 170 cm. Physical examination showed the patient's airway was clear, able to open his mouth with 3 fingers, mallampati score II, free neck movement, and the presence of permanent dentures on the upper incisors. Other physical examinations were within normal limits. Preoperative laboratory examination showed hemoglobin 12.3 g/dl, platelet count 176 x 10^3/µl, PT 13 seconds, APTT 27.7 seconds, urea 27 mg/dl, and creatinine 1.4 mg/dl. Screening for COVID-19 infection gave negative result of SARS-CoV-2 PCR (Polymerase Chain Reaction) examination and chest X-ray examination showed normal lung image. The ECG showed sinus bradycardia of 51 bpm, without signs of hypertrophy and ischemia. This case has been consulted to the cardiology department, additional therapy of Lisinopril 10 mg daily and Amlodipine 10 mg daily were added, and the case was approved for high-risk category surgery. The preoperative screening examinations concluded that the patient had an ASA (American Society of Anesthesiologists) III physical status by considering patient's elderly age, history of hypertension, and planned for major vascular surgery. The patient was planned to receive general anesthesia.

Figure 1. Result of abdominal CT-Scan angiography with an aneurysm in the abdominal aorta below the renal artery branches down to the abdominal aorta bifurcation (source: author's documentation)

Before induction, an arterial line was placed in the right radial artery, and after induction, a triple-lumens central venous catheter was placed in the right jugular vein by an anesthesiologist. A foley catheter was also inserted to monitor urine output. The patient was placed supine, and 2 intravenous lines were attached. NIRS (Near-Infrared Spectroscopy) also attached for continuous monitoring of regional brain oxygenation ($rScO_2$). The obtained baseline $rScO_2$ of the left cerebral was 71% and the right cerebral was 73%. Induction of anesthesia was done by injecting Fentanyl 100 mcg IV, Midazolam 5 mg IV, Atracurium 30 mg IV, and inhalation of Sevoflurane 1-2 vol%. Premedication with 4 mg of ondansetron IV was given to prevent the risk of PONV (Post Operative Nausea and Vomiting). Intubation was performed using an endotracheal tube sized 7.5, with a depth of 20 cm. Throughout the operation, controlled ventilation was done with SIMV (Synchronized Intermittent Mandatory Ventilation) mode, Pressure support of 8 mmHg, PEEP 4 mmHg, and oxygen fraction of 50%. Maintenance of anesthesia was done with rocuronium at 10 mcg/kgBW/minute and morphine at 10-20 mcg/kgBW/hour. Heparinization procedure was done by giving Heparin 3000 IU intravenously just before the clamping was started. When the surgeon freed the aorta, the blood pressure was lowered by titrating nitroglycerin dose started at 0.1 mcg/kg/min. It started the permissive hypotension strategy, also to prevent sudden hypertension in the proximal of the clamp that might caused cardiac ischemia. The aortic clamps was placed proximally and distally of the lesion, which both below the renal artery branches. After the placement of the aortic clamps, titrated dose of nitroglycerin was increased until the target of MAP (Mean Arterial Pressure) >60 mmHg achieved. During the clamping procedure, $rScO_2$ decreased to 11% from the baseline. When grafting the aorta, estimated 3000 ml of bleeding occurred and the CVP (central venous pressure) decreased to 5 mmHg. Those problems were managed with intravascular fluid resuscitation using 2000 ml ringer fundin crystalloid fluids, 1000 ml of colloids, and 3 packs of PRC (Packed Red Cell) transfusions, until the CVP target of 7-8 mmHg was achieved. Titrated dose of nitroglycerin was maintained at the dose of 0.5-1.5 mcg/kg/min to achieve the target of MAP. Once the aortic graft was in place, nitroglycerin dose was titrated down. Total time to perform the aortic clamp was 1 hour and 15 minutes. Immediately after unclamping the aorta, nitroglycerin was stopped and titrated dose of norepinephrine was started at 0.05 mcg/kg/min to compensate the sudden decrease in afterload, with a target MAP of 65-75 mmHg. NIRS also showed that $rScO_2$ returned near the baseline value after the unclamping. Titrated doses of morphine and norepinephrine were maintained until the patient was admitted to the ICU. At the end of the procedure, a blood test was done using i-stat, with the results showing Hb 6.5 g/dl, Hct 19%, pH 7.343, pCO_2 48.6 mmHg, pO_2 312 mmHg, HCO_3 26.4 mmol/L, and SpO_2 100%.

Figure 2. Titrated doses of nitroglycerin, morphine, rocuronium, and norepinephrine were given during surgery with syringe pumps (source: author's documentation)

Hemodynamics of the patient during surgery which lasted for 5 hours had been maintained in a stable state. Throughout surgery, continuous monitoring of blood pressure, heart rate, central venous oxygen saturation ($ScvO_2$), ECG, CVP, temperature, $ETCO_2$ (End-Tidal Carbon Dioxide), and $rScO_2$ was done. Systolic blood pressure ranged from 90-110 mmHg, while diastolic blood pressure ranged from 45-55 mmHg, heart rate 49-56 bpm, CVP between 6-8 mmHgm, and $rScO_2$ ranged from 65-80%. There was no sign of ischemia in ECG throughout surgery. Total amount of fluid given was 4380 ml, including 2500 ml of crystalloid fluid (Ringer fundin), 1000 ml of colloid fluid, 250 ml of mannitol, and 885 ml of PRC transfusion. Fluid output through urine was 1000 ml for 5 hours (>1,5 ml/kgBW/hour), total bleeding was 3500 ml, and perspiration was 175 cc. Other medications administered were dexamethasone 5 mg IV, paracetamol 1 gram IV, and tranexamic acid 1 gram IV.

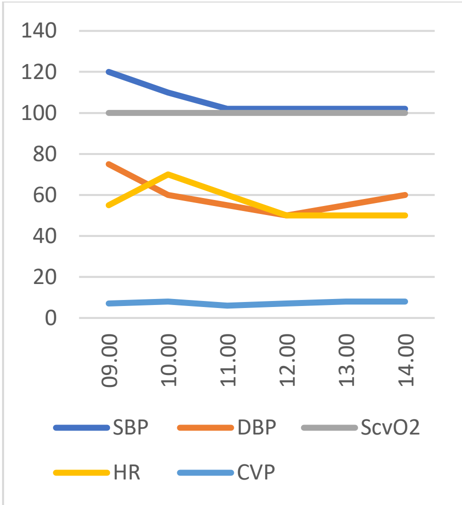

Figure 3. Graph of hemodynamic monitoring during surgery

Figure 4. Monitoring of $rScO_2$ with NIRS before incision (left) and during aortic clamping procedure (right) (source: author's documentation)

Postoperatively, the patient still intubated and admitted to the ICU. The patient was hypotensive (MAP 65 mmHg) with norepinephrine support at 0.1 mcg/kgBW/min. Titrated doses of norepinephrine, morphine, and rocuronium were maintained, and adjusted to the hemodynamic and respiratory conditions of the patient. Postoperative laboratory examinations on day of surgery included routine blood tests, coagulation status, kidney function, and electrolytes. Intravascular fluid correction was done by transfusion of 2 packs of PRC, 4 packs of FFP (Fresh Frozen Plasma), and 4 packs of TC (Thrombocyte Concentrate). Postoperative urine output was maintained >0.5 ml/kgBW/hour. Monitoring for sepsis, acute abdomen, and unstable hemodynamics was performed. By the first 24 hours of treatment in the ICU, the patient was fully conscious, breathing adequately, and then extubated. The patient was hemodynamically stable, with MAP between 65-70 mmHg without norepinephrine support. The patient was transferred to the HCU treatment room on the second postoperative day, and on the fifth day was transferred to the general care ward. The patient was discharged after seventh days postoperatively.

DISCUSSION

Open-surgery in AAA is a high-risk procedure, so it needs optimal preoperative medical examinations before surgery. Patients undergoing vascular surgery had a high incidence of comorbidities, including hypertension, diabetes mellitus, pulmonary disease, and renal impairment, which all should be screened and optimized before the surgery[3]. In this case report, the patient was a 65-year-old man with co-morbid of hypertension controlled by medications. Blood pressure control is paramount in the preoperative screening of patients with aneurysms. A target systolic blood pressure of 100-120 mmHg will reduce aortic wall pressure and prevent rupture while maintaining perfusion to the vital organs[5,10]. The preoperative examinations showed normotensive blood pressure of 115/70 mmHg and the ECG was sinus bradycardia, without any signs of hypertrophy and ischemia. The patient was also treated by the cardiologist for hypertension and was approved for surgery with a high-risk category.

Monitoring with an arterial line is mandatory in cases of surgery involving the aorta. The insertion site was determined by the location of the aortic lesion[3,10]. Indications for invasive blood pressure monitoring through arterial line placement are to anticipate procedures with a risk of hypotension, high risk of intraoperative blood pressure deviation, and the need for continuous beat-to-beat blood pressure monitoring[3,7]. In open-surgery of AAA as in this case report, there was a risk of hemodynamic changes due to bleeding and aortic cross-clamping procedures. Thus, the anesthesiologist must first place an arterial line and a central venous catheter before surgery. In descending aorta surgery, an arterial line is placed in the right radial artery to provide adequate monitoring of upper body blood pressure. Placement in the right radial artery was also the most frequently chosen site because of its superficial location, easy accessibility, and low complication rate[3,10]. In addition, CVC insertion is also indicated for CVP monitoring, optional fluid administration pathway in cases of shock and hypovolemia, and continuous monitoring of central venous oxygen saturation ($Scvo_2$). A very low CVP value might indicate a hypovolemic condition, while a high value may reflect hypervolemia, poor ventricular compliance, or both. Monitoring of CVP changes related to fluid volume administration, in combination with other hemodynamic parameters, can be a good indicator to assess the patient's response to fluid volume administration. Insertion of CVC in the right internal jugular vein provides a good combination of accessibility and safety[3,7].

POCD (Post Operative Cognitive Dysfunction) refers to a disorder that affects a patient's orientation, attention, perception, awareness, and judgment experienced after surgery. About 25% of the elderly who underwent major surgery will experience cognitive decline. Patients over 65 years old who underwent non-cardiac surgery had a 25% prevalence of developing POCD in the weeks postoperatively. An important prevention strategy for POCD is by monitoring the depth of intraoperative anesthesia, which is done in conjunction with monitoring cerebral oxygenation[11]. Near-Infrared Spectroscopy (NIRS) is a non-invasive monitoring method for assessing regional oxygen saturation using transillumination spectroscopy.[9] NIRS has been recommended as cerebral oximetry for monitoring vital organ perfusion[9]. NIRS provides continuous monitoring of regional brain oxygenation ($rScO_2$). The NIRS has high sensitivity and specificity for predicting cerebral ischemia[12]. The most important value to note in the monitoring of cerebral oximetry is the bilateral baseline, obtained before administering the medication and oxygenation to the patient. Cerebral arterial blood oxygen saturation is 98-100%, while venous blood saturation is approximately 60%. The arterial-venous blood ratio is between 70:30 and 75:25, so the expected normal value of rScO2 is 60-80%. In the case of major vascular surgery, the $rScO_2$ value will decrease during the infrarenal aortic cross-clamping period and will increase again during reperfusion[9]. A deviation of 20-25% from the baseline indicates an abnormal condition and needs attention of the anesthesiologist.[9] In this report, obtained baseline $rScO_2$ of the left cerebral was 71% and the right cerebral was 73%. During the clamping procedure, $rScO_2$ decreased to 11% from the baseline value but then returned near the baseline after the unclamping. The deviation of the $rScO_2$ value < 15% achieved, so the risk of POCD was less.

General anesthesia has always been the chosen method for any open-surgery involving the aortic arch, ascending aorta, and descending aorta[10]. The need for rapid airway control must also be balanced with an adequate depth of anesthesia during airway manipulation to prevent hypertension leading to aneurysm expansion.[10] Induction drugs used in this case report were fentanyl, midazolam, and inhaled sevoflurane. Anesthesia is usually maintained with volatile agents, opioids and benzodiazepines, and muscle relaxants[3,10]. In this case, anesthesia was maintained using rocuronium, morphine, and inhaled sevoflurane. The anesthetic agent chosen also has been considered to maintain hemodynamic stability during the surgery[3,10].

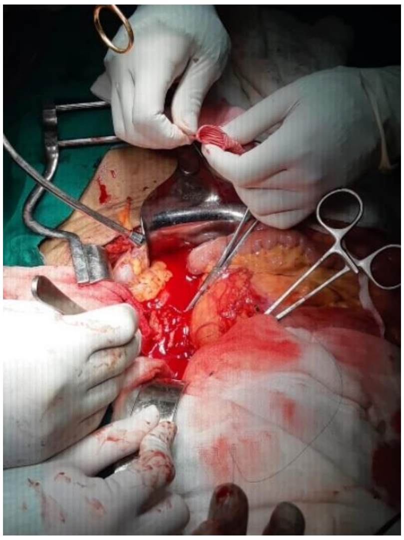

Figure 5. Clamping procedure and placement of aortic graft during surgery (source: author's documentation)

The AAA repair procedure causes hemodynamic disturbances of the patient as a result of the bleeding and the technique used in the procedure itself, known as the aortic cross-clamping. The physiological effect of this technique during surgery varies depending on the height of the clamp placement[4,8,10]. The aortic clamp was first placed distally to prevent atheroembolism, and then proximally[5]. Perfusion to the lower extremities and visceral organs depends on collateral circulation. The clamping procedure increased cardiac afterload, causing increased blood pressure on the proximal side of the clamp, decreasing venous capacity, and shunting in blood volume[4,8,10]. Blood pressure can be lowered by increasing the anesthetics dose, administering an opioid agent, or using vasodilators, such as nitroglycerin and sodium nitroprusside. These agents will lower systolic blood pressure and facilitate fluid loading in preparation for the unclamping procedure, which causes blood pressure to decrease as a result of redistribution[4,8,10]. Proper regulation of preload involves careful intravenous fluid administration and titration of vasodilators. Nitroglycerin increases venous capacity better than sodium nitroprusside[3,5]. NTG has a direct vasodilator action on vascular smooth muscle, without central effect. However, these drugs have common side effects such as reflex tachycardia and venous congestion[7,13]. In this report, nitroglycerin became the hypotensive agent of choice in the permissive hypotension strategy, to maintain blood pressure with a target MAP of >60 mmHg.

In permissive hypotension, MAP is intentionally maintained lower, to a state that causes minimal bleeding but still maintains adequate perfusion to vital organs[13–15]. In this case report, a permissive hypotension strategy was done when clamping the aorta. Permissive hypotension can improve myocardial performance, reduce blood loss, reduce the risk of tissue edema caused by ligation or electrocautery, reduce blood transfusion, improve surgical field quality, and shorten the operative time[14,16]. Permissive hypotension adopted a strategy of fluid infusion only to maintain the systolic blood pressure of at least 70 mmHg[15,17]. Previous studies had noted that maintaining the systolic blood pressure of 70-100 mmHg would help to limit internal bleeding, loss of platelets and clotting factors without causing organ ischemia[15,17]. The hypotensive anesthetic method should be initiated at the start of the mucosal incision to achieve the desired MAP and should be restored before the closure of the skin. This hypotensive method has only been recommended to reduce bleeding in operations requiring significant bleeding control. The recommendation was a 30% reduction from the patient's baseline MAP. Therefore in normotensive patients, the systolic blood pressure is reduced to 80-90 mmHg and MAP to 50-65 mmHg. Various techniques to induce hypotension have been used such as applying a tourniquet, controlling venous return by positioning the patient, and using pharmacological interventions such as intravenous anesthetics, vasodilator drugs, volatile anesthetics, calcium channel blockers, adrenoceptor antagonists, and neuraxial blockers. Intravenous anesthesia drugs used are usually a combination of fentanyl and propofol. It can also be achieved by combining fentanyl with inhaled anesthetics agents such as sevoflurane, isoflurane, or desflurane[14].

Intravenous fluid therapy consists of the infusion of crystalloids, colloids, or both. Isotonic crystalloids with balanced electrolyte solutions such as Ringer's lactate or PlasmaLyte were the most often used to replace intraoperative fluids[7]. Crystalloid or colloid fluids replacement should be sufficient to maintain normovolemia. Further blood loss should be replaced by packed red cell transfusion to maintain adequate hemoglobin and hematocrit concentration[5,7]. In the non-massive trauma setting, most clinicians administered Ringer's lactate or Plasmalyte solution about three to four times the volume of blood lost, or colloids in a 1:1 ratio. Transfusion of PRC was not recommended until the hematocrit level drops to 24% or lower (or if Hb < 8.0 g/dL), but still necessary to consider the possibility of further blood loss, the rate of blood loss, and other comorbid conditions[7]. In this report, PRC transfusion was initiated intraoperatively considering the risk of further blood loss during surgery and to maintain intravascular fluid volume, by evaluating changes in the patient's CVP, MAP, and clinical condition.

Hypotension was the most predicted response when the surgeon performed the unclamping procedure. Before the unclamping procedure, the anesthesiologist should have done correction of preoperative fluid deficits, maintained intraoperative fluid requirements, and replaced the blood loss. The dose of vasodilator used should also be gradually reduced and discontinued before the unclamping[3]. When the clamp released, there will be a 70-80% reduction in vascular resistance and preload volume that would lead to hypotension. This risk management strategy was done by releasing the clamp gradually and by loading an adequate volume of fluids before unclamping. The use of vasoconstrictors and inotropes was also necessary to maintain MAP. The myocardial load will increase during this phase, leading to higher oxygen demand. Ensuring a balance between oxygen supply and myocardial oxygen demand prevents myocardial ischemia[4,8,10]. In this report, the titrated nitroglycerin was lowered just before the unclamping procedure. Simultaneously with the unclamping, a titrated dose of norepinephrine was initiated to maintain afterload. The MAP target was 65-75 mmHg, which had been maintained until the end of the surgical procedure.

One other hemodynamic indicator that also needs to be considered during surgery is urine output, as an indicator of renal perfusion. The incidence of postoperative AKI was 20-37% in the setting of open aneurysm surgery[18] Mannitol, loop-diuretics, and dopamine have been practically used to maintain renal function during aortic surgery. Although not clinically proven, the pharmacological protective effect prior to aortic cross-clamping was considered beneficial and was still frequently administered perioperatively to prevent renal injury[3,18]. In this report, mannitol infusion was given as an adjunct to prevent AKI due to renal tissue hypoperfusion during the cross-clamping procedure. The mannitol use of 12.5 g/70 kg before aortic cross-clamping to induce osmotic diuresis was commonly used in clinical practice[3]. Althought both of the clamp was placed below the renal artery branches (infrarenal clamping), mannitol still considered beneficial. Mannitol induced renal vasodilation by decreasing renal vascular resistance, resulting in increased renal cortical blood flow during infrarenal aortic clamping. It also reduced edema of renal vascular endothelial cells induced by ischemia and vascular congestion. Mannitol also degraded free radicals and played a role in decreasing renin secretion and increasing renal prostaglandin synthesis[3,18]. Mannitol also exerted a protective effect on the kidneys in open-surgery pararenal AAA with renal insufficiency requiring suprarenal clamping[18,19].

Postoperative care should be done in the ICU. Most patients undergone open-surgery of the aorta would be treated in an intubated state within 24 hours postoperatively.[7] Postoperative supportive care includes optimization and maintenance of circulating volume and maintenance of graft function with adequate heparinization. Kidney function, coagulation status, hemoglobin, and acid-base balance also need to be monitored closely[4,7]. In the first 12 postoperative hours, it is necessary to administer aggressive fluid volumes to replace extravascular fluids[5]. In this report, the patient's postoperative care was done in the ICU. The replacement of intravascular fluids used crystalloids and blood components (PRC, FFP, and TC). The results of post-operative laboratory examinations also showed normal urea and creatinine values, evidenced by urine output of >0.5 ml/kgBW/hour. Medical staff should be alert to early postoperative complications. The aortic cross-clamping procedure inducing hypotension may cause myocardial ischemia, heart failure, or arrhythmias. A wide abdominal incision and prolonged ventilation during surgery increased the risk of atelectasis, pneumonia, and respiratory failure. Intraoperative and postoperative fluid shifts could also cause AKI[1]. Postoperative management goals included hemodynamic stability, adequate blood volume replacement, correction of electrolyte imbalances and acid-base status, and adequate pain control.[8] In this report, the patient was monitored in the ICU for 2 days. Physical examination and investigations showed that the patient was fully conscious, hemodynamically stable, with adequate spontaneous breathing, resolved blood volume replacement, good function of the bladder and gastrointestinal, and acute pain had been resolved. Vasopressor support therapy had been discontinued <12 hours postoperatively. The patient with a stable condition was then transferred to the HCU treatment room on the second day and could be discharged on the seventh postoperative day.

CONCLUSION

Perioperative management of open-surgery aneurysmectomy aims to control bleeding, maintain cardiac output, and maintain perfusion to peripheral tissues, especially during aortic clamping and unclamping procedures. The strategy of permissive hypotension during the aortic clamping procedure, fluid resuscitation, and administration of vasopressors during the unclamping procedure can be carried out to maintain the hemodynamics of the perioperative patient. With this strategy, hemodynamic stabilization of the patient can be maintained, prevent complications in end-organs, and accelerate the postoperative recovery process.

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