



Postoperative Management of Vascular Surgery Patients: A Brief Review

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Abstract

Atherosclerosis is an inflammatory condition leading to various cardiovascular as well as cerebrovascular events and peripheral vascular disease (PVD). Presence of significant atherosclerosis leads to perioperative adverse events, morbidity and mortality in the high risk surgical population. The usual methods for evaluating the likelihood of adverse cardiovascular or cerebrovascular events postoperatively in these set of patients depends primarily on scoring system and functional status of the cardiovascular system during preoperative assessment. The pre existing disease activity and possible postoperative adverse cardiovascular event (CVE) can be estimated to some degree from the preoperative levels of biomarkers associated with atherosclerosis. This mini-review summarizes the potential role of biomarkers related to the atherosclerosis process in the cardiovascular risk stratification of patients undergoing non cardiac surgery. A Med Line search of literature on atherosclerosis biomarkers in the perioperative period and adverse post operative cardiovascular event was conducted; and thirty-three reports are added to this review.

Keywords: Vascular surgery; Postoperative period

Introduction

In spite of a great potential development in patient selection expert technical execution of operations and anticipation of complications, vascular surgery patients are not free from some dreaded complications during their postoperative course. Early identification and management of the complications is essential to improve the overall outcome of these patients. The commonly used scoring systems such as American Society of Anesthesiologists classifications and the Lee Revised Cardiac Index to quantify postoperative complications are most useful in identifying low risk patients only [1,2]. Hence, appropriate decision making regarding the need for intensive care after vascular surgery are the key to high quality patient care during their post operative period. This mini review elaborates the general principles of post operative care, complications and their management in a vascular surgery patient.

When the Care Starts? and Who are Most Vulnerable?

Shifting of a post operative (PO) vascular surgical patient from operating room (OR) to intensive care unit (ICU) is critical and has an increased risk of morbidity and mortality, despite a relatively short distance involved. This risk is minimized by careful planning, proper team involvement and selection of appropriate monitoring aids during transport. There are several factors involved in postoperative complications and postoperative care after vascular surgery eg. the type and extent of surgery, extreme age, associated co-morbidities [(especially coronary artery disease(CAD), chronic obstructive pulmonary disease, obesity, sleep apnea, chronic heart failure and chronic renal failure), emergency surgery and preoperative cardiopulmonary status of the patient.

What is Special in Postoperative Monitoring of a Vascular Surgery Patient?

Post operative vascular surgery patient are at risk of development of abnormal physiology and its consequences even if they have a normal hemodynamic during the pre operative period. Twenty five percent of the patients suffer from limb ischemia, which needs a continuous pulse oxymetry monitoring. A Doppler examination gives a better clue to diagnosis and immediate thrombectomy or lytic therapy with secondary endovascular or open surgical intervention is required in such cases [3]. In a study of 185 patients undergoing vascular surgery, a 12 lead ECG with ST segment analysis showed transient myocardial ischemia in 21% and myocardial infarction (MI) in 6.5% [4]. Leads placed in V₃ and V₅ are more predictive and the combination of two precordial leads give greater

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than 95% sensitivity when compared with troponin level for post operative ischemia monitoring. These patients should be considered for measurement of post operative troponin level even if there is no ECG evidence of ischemia. Arterial pressure monitoring site should depend upon the type of aortic surgery and one should not forget the variables that affect the systolic and diastolic pressure measurements (eg. length of the tubing). One should remember that the mean arterial pressure is a more accurate reflection of mean aortic pressure. Central Venous pressure evaluation puts light and sense to manage the patients with immediate unwanted chest X-ray findings and elevated beta natriuretic peptide (BNP) levels, administer vasoactive drugs and to assess intravascular volume. In comparison to the normal surgical patients, major vascular surgical cases have a two to three fold greater risk of myocardial ischemia when core temperature is $<35^{\circ}\text{C}$. Warmed inhaled gases and infused liquids have some benefit in warming these patients. Echocardiography is an essential component of postoperative monitoring that can diagnose complications eg. cardiac tamponade, distinguish right and left ventricular function and adjust therapy accordingly e.g. patients with poor IV function can be benefited from inotropes, whereas a hypodynamic empty ventricle needs volume therapy [5]. High intra-abdominal pressure (IAP) >15 mmHg, leading to intra abdominal hypertension (IAH) is one of the major predictor of abdominal compartment syndrome (ALC) and cause of mortality after surgery in thoraco abdominal aorta (TAA) [6]. Therapeutic interventions based on IAP measurements, such as restoration of volume status and abdominal compression may be important in reversing multiorgan failure and preventing further harm. Patients with IAP below 25 mmHg generally do not have ACS, while those with an IAP >25 mmHg usually have ACS. A higher systemic blood pressure may maintain oxygen perfusion when IAP is increased. Symptomatic patients with confirmed diagnosis of ACS need supportive care and at times surgical intervention. Monitoring of mesenteric perfusion is essential in some specific situations like e.g. supraceliac clamp, IAH, atherosclerotic diseases of superior mesenteric artery, and during massive vasopressor requirement. Monitoring of Glasgow coma scale status and transcranial Doppler is essential after carotid endarterectomy where as monitoring of cerebrospinal fluid (CSF) pressure and volume is needed in patients who have the risk of development of spinal cord ischemia during the PO period e.g. TAA aneurysm (TAAA) repair, extensive stent cover are below T9, occlusion of subclavian or hypogastric artery. Cardiac troponins (Tn) and brain natriuretic peptide (BNP) are two commonly estimated biomarkers in vascular surgical patients. An increased concentration of BNP is associated with major adverse cardiac events where as elevated Tn denotes the presence of myocardial ischemia.

Adverse Postoperative Events and Special Care

Acute hypertension is common after vascular surgery and the goal is to identify the causative factors and reduce the diastolic BP over a period of 30-60 minutes ultra short acting/short acting antihypertensives and adequate analgesia. Hypertensive patients mostly develop natriuresis hence fluid should be administered along with anti hypertensive [7]. The hypotension following vascular surgery needs immediate attention as it is associated with an increased risk of multi organ failure, graft thrombosis and possible renal failure. The two management strategies for hypovolemia include administration of volume depending upon the deficit and vasoactive agent. However, a surgical cause should always be excluded. Arrhythmias mainly occur in patients with structural heart disease and common

triggers are similar to any other surgical patients. Tachyarrhythmias are most common are of diagnostic challenge. On the other hand, bradyarrhythmias do not require any treatment in the absence of hemodynamic instability [8,9]. Up to 48% of vascular surgery patients develop ischemic events post operatively [10]. It has been seen that elevated level of myocardial enzymes following vascular surgery are associated with increased mortality at 6 months. Once the ischemia is diagnosed rapid resuscitation should be done with supplemental oxygen, timely use of β -blockers, after load reduction agents, anti platelets, anticoagulants and percutaneous coronary intervention. Post operatively fibrinolysis is a relative contraindication, but this decision must be individualized to the patients according to the extent of surgery and time after operation. In the presence of clinically significant ischemia or cardiogenic shock, urgent revascularization is needed. A change in ST segment is the most sensitive indicator of post operative myocardial ischemia. The accepted ST segment changes used to detect myocardial ischemia is >0.1 mV measured 80 ms from J point. Post operative ST segment changes with a prolonged duration (>6 min per episode/ >2 hr cumulative length) are independent predictor of post operative cardiac events.

Echocardiography can best detect abnormal wall motion and new regional wall motion abnormalities giving a clue to development of ischemia. An ischemic event lead to prominent a and a waves in Pulmonary Artery (PA) wave form, increased LVEDP and increase PA pressure which are again the sensitive indicators of myocardial ischemia.

In general, many question relating to perioperative pharmacological therapy to prevent post operative MI following vascular surgery remains unanswered. Future studies are needed to determine which patients required intensified post-operative surveillance, medical therapy, and/or coronary intervention to improve long term survival following vascular surgery.

Intra Abdominal Complications and Management

Intraabdominal complications are rare but potentially lethal after TAAA or AAA repair and carry an overall mortality of 40%-45%. Mesenteric vascular ischemia leading to gangrene of the gut, small bowel obstruction, pancreatitis, intestinal ischemia, aorto-esophageal fistula, aortoenteric fistula, acute cholecystitis, chyloperitoneum, mechanical obstruction to the gut, colonic infarction, ascites, ischemic colitis and liver dysfunction are some of the IA complications following vascular surgery those needs attention. Prolong Cardiopulmonary Bypass (CPB), aortic cross clamp time along with intraoperative surgical complications can cause low cardiac output, hypo perfusion and ischemic injury to the gut [11]. Among all the gut ischemia, colonic infarction is difficult to diagnose because of patients poor physical status. Confirmatory diagnosis can be made by colonoscopy and the overall mortality is as high as 89% is one of the series [12,13]. For all the gut ischemia, conservative treatment with local vasodilatation often helps. Non-respondent may undergo specialized approach that considers surgical and endovascular options for better outcome. Potential intraabdominal infection and pancreatic injury are the potential causes of acute pancreatitis and the therapeutic options ranges from restrictive regime to radial necrosectomy and multivisceral resection. Chylous ascites is common following AAA surgery because of anatomical relation of cistern chyli to abdominal aorta. Paracentesis, improvement in total parenteral nutrition provides the possibility of an extended period of oral

starvation that reduces the lymphatic flow from the leaking gut. In case of failure of conservative treatment placement of peritoneal-venous shunt/ transfixing the damaged lymph vessels and omentum plasty are some options [14]. The devastating complications like aorto-esophageal or aorto bronchial fistula can occur late in the post operative period. Post operative respiratory and renal dysfunctions are significant predictors of this complication according to some authors [15]. A close follow up may diagnose these complications early, although there is no evidence that early detection can improve the prognosis. Both surgical and endovascular treatment are associated with high mortality but conservative treatment is not a viable option. Esophageal stent grafting/esophageal reconstruction, mediastinal drainage or even endoscopic use of fibrin glue at the level of fistula is some proposed management protocol for these patients. Post operative liver dysfunction following aortic aneurysm repair may occur due to prolonged surgical time, preoperative hepatic injury and massive blood transfusion. The management protocol is routine as per any other patient having post operative liver dysfunction. Massive post operative bleeding is not unusual and the causes can be surgical, decrease in coagulation factors and residual heparinization. The most basic principles of management of mediastinal or intra-abdominal bleeding following major aneurysm repair are: i) rule out surgical bleeding, ii) measure the hemoglobin and hematocrit, iii) diagnose the underlying medical causes hematocrit, iii) Diagnose the underlying medical causes by coagulation tests, iv) check the sign of adequate perfusion to the vital organs and, v) restore clotting factors to normal by means of medications (i.g. tranexamic acid recombinant factor VII, aminocaproic acid), normothermia and by transfusion of blood products [16]. Liberal blood transfusion during vascular surgery is no longer supported because of high rate 30 days' adverse events in these groups of patients. Transfusion above hemoglobin of 9 gm/dL is not advocated by most of the authors [17]. If large volume is required for transfusion, balanced salt solution is preferred over normal saline to reduce the development of iatrogenic hyperchloremic metabolic acidosis. The decision to transfuse platelet concentrate must not be based exclusively on platelet count but also take into account the patient's clinical condition, in particular when fever $>38.5^{\circ}$ centigrade, presence of coagulation disorders, prolonged CPB and ongoing oozing. The main indication for transfusion of fresh plasma (FFP) is correction of deficiencies of clotting factors in a bleeding patient for which a specific concentrate is not available. The recommended initial dose is 10-15 ml/kg of body weight and a maximum dose up to 30 mg/kg can be administered depending on the patient's clinical situation and laboratory parameters. What is most important again, "do not use FFP as a volume expander" Consider the administration of cryoprecipitate only in the presence of severe hypofibrinogenemia (>1 gm/dL) despite treatment with FFP.

The prevalence of post operative hyperglycemia is high among vascular surgery patients. Krinsley in one of his retrospective review demonstrated that hospital mortality was directly related to the mean glucose value and nearly doubled in those with a mean glucose level of 140-159 mg/dL [18]. Post operative hyperglycemia occurs in 21%-34% of patients within 72 hrs of surgery. Previous studies have shown that for every 40 mg/dL increase in PO glucose level leads to a 30% increase risk of infection, graft failure and longer ICU stay [19]. The American Association consensus statement 2005 regarding inpatient glycemic control, defined hyperglycemia as a blood glucose value >140 mg/dL and hypoglycemia as a blood glucose value <70 mg/dL. Treatment of hyperglycemia in the ICU should begin with an

intravenous insulin infusion with a starting threshold not higher than 180 mg/dL, although some benefit may be realized at lower target level [20]. No randomized trials specially addressing the monitoring and treatment of PO hyperglycemia during major vascular surgery have been performed. Therefore, results of studies in comparable patient groups usually translated for the management of current population. The usual advice is, moderate tight glucose control with a target blood glucose level of 110-140 mg/dL could be more beneficial. Severe ischemia to kidney leading to acute renal failure (ARF) is common especially after TAAA repair. Even if the incidence of this complication has fallen over time, it still remains as a major cause of mortality in this group of patient. The incidence of ARF is highest in ruptured AAA (20%-29%) and lowest in infrarenal AAA (0%-13.9%) [21]. The occurrence of ARF increases with the addition of following inciting factors: emergency surgery, proximal aortic repair, preoperative renal dysfunction adverse intraoperative and PO events and co-morbidities. The mortality of ARF requiring renal replacement therapy after repair of intact or ruptured AAA is 58%-86% and likely represents the mortality list associated with ARF as a part of multiorgan dysfunction. What is more important again, the distinction between ARF of hypovolemic /cardiogenic origin. The former needs fluid resuscitation along with blood or blood products if required, while the latter require improvement in myocardial performance. Post renal dysfunction due to obstruction of urinary tract by injury or compression by graft/limb is uncommon, acute in onset, can be diagnosed by renal ultrasound and confirmed by retrograde urography. Therapy may require placement of urethral stents or percutaneous nephrostomy. Patients with prostate hypertrophy or an epidural catheter for pain control may have acute urinary retention leading to obstructive uropathy and removal of bladder catheter difficult. To avoid urinary retention in such cases 6-12 hr time is allowed to elapse after epidural analgesia is discontinued prior to removal of urinary catheter. It is always ideal to prevent the development of ARF with some preoperative and intraoperative measures especially in the patients who are particularly at more risk. The diagnosis of ARF is based on an acute rise of serum creatinine and blood urea nitrogen (BUN) with or without a concomitant decrease in urine output. However, creatinine and BUN are relatively insensitive markers of excretory renal function. The glomerular filtration rate may fall by 50% before a rise in serum creatinine can happen due to kidney's compensatory increase in creatinine excretion. An organized plan of diagnosis and treatment is important while dealing with the patients with ARF after vascular surgery. If correction of filling pressures or myocardial performance fails to improve urinary output, evaluation of other causes of oliguria should be done. The conversion of oliguric renal failure to a non-oliguric state may delay the need for renal replacement therapy and simplify fluid management. It may be associated with fewer complications and improved survival although prospective data to support this notion is lacking. Vascular surgery patients requiring chronic renal replacement therapy have a grave prognosis. Use of continuous veno-venous hemofiltration and dialysis is recommended until patient's hemodynamic status is stabilized. Continuous hemodialysis reduces hemodynamic instability allows better control of fluid and metabolic status, removes the deleterious cytokines and thereby affects the outcome. The dose of renal excreted medications should be adjusted. Nutritional support of the patients with ARF is important as protein-calorie malnutrition is common in these patients. Finally, a frank discussion regarding the prognosis of these patients with their family member is essential. Major vascular surgery, requiring prolonged CPB enhances the release series of

inflammation mediators and stress hormones which alters body metabolism and subsequent release of glucose, amino acid and free fluid fatty acids to the circulation so that substrates are in part diverted from the purpose they serve in non stressed state to the task of raising an adequate healing response [22]. These patients at times required extensive laparotomy or retroperitoneal exposure involving mobilization of viscera and nasogastric tube drainage for several days post operatively. Large volume of fluid transfusion during the post operative period may lead to weight gain edema, paralytic ileus and delayed gastric emptying. Restriction of fluid to the amount needed to maintain salt, electrolyte and water balance lead to fast return of gastric emptying and can be capable of tolerating normal food and have normal bowel movements several days earlier than those in positive balance. However, this claim has not been consistently supported by later studies. Preoperative carbohydrate loading to combat the fasting state has been shown to enhance post operative recovery by causing improved protein balance, improved preservation of lean body mass and length of hospital stay in general surgical patients. However, literature is missing for vascular surgical cases in this context. The main goal of nutritional support in vascular surgery patients is to minimize negative nitrogen balance by avoiding starvation, with the purpose of maintaining muscle, immune and cognitive function and to enhance post operative recovery. Oral feeding should be started as soon as possible after surgery provided that there are no signs of ileus. After elective TAAA repair, gastric emptying has been shown to return by 18 hrs and normalization of small bowel function by 47 hrs. If oral feeding is not possible, other means of nutrition should be implemented. Management of nutrition is a major concern especially for patients who undergoes AAA repair, needs high dose of opioid analgesia or prolonged mechanical ventilation. It has also been suggested that routine fluid and carbohydrate loading 2 hrs before surgery can alternate post operative insulin resistance and patient well being. Some authors suggested that excess of intravenous fluids in particular normal saline may contribute to post operative gastrointestinal dysfunction; prolong post operative stay and adverse clinical outcome [23]. Some patients also undergo enforced bed rest, not only as a part of traditional care but also because of the presence of drips, catheters and drains. Within this pattern of post operative care patients are subject to a period of starvation and immobilization that last for minimum of 4-5 days. In order to combat the nutritional consequences, nasogastric/nasoenteral nutritional is preferred because it is associated with fewer infection and metabolic complications than parenteral nutrition. Enteral made is however contraindicated in the presence of intolerance, risk of aspiration and associated bowel obstruction. Oral feed should be started as early as possible once bowel sound is return and there is no vomiting or sensation of nausea. Parenteral nutrition is only indicated if gut cannot be used or the patient failed enteral nutrition despite the use of pro kinetic agents. Effective and adequate pain management is important not only to keep the patient comfortable, but also to reduce post operative complications as well as chronic pain syndrome. Though commonly used opioids have a concern over their side effects, especially potential respiratory depression and hypotension. Epidural analgesia is an effective method of pain control especially after TAAA repair, but hard to use because of existing post operative coagulopathy. In a Cochrane review report a Meta analysis of 13 randomized trials involving 1224 patients having abdominal aortic surgery 597 of which were treated using systemic opiates and rest epidural analgesia. The authors noticed that those receiving epidural analgesia had significantly fewer

cardiovascular complications and renal insufficiency. They too spent 20% less time in mechanical ventilation and reported less subjective pain. No mortality difference was reported. However, those potential benefits were associated with increased cost and increased risk of epidural hematoma [24]. Routinely used method of analgesia and epidural analgesia usually interfere with neurologic assessment. Use of paravertebral analgesia has been described by few authors which provides unilateral analgesia, less incidence of pulmonary complication, urinary retention, nausea, vomiting and hypotension than epidural block with a similar pain score. Because of the difficulty in pain control, multimodal therapeutic strategy provides central or peripheral block associated with non steroidal (NSAID) and adjuvant is now the cornerstone of treatment, offering the possibility of reducing opioid requirement and side effects. Use of NSAID may decrease post operative morphine consumption by 30%-50% and nausea, vomiting by 29%. However, the incidence of respiratory depression remains the same. Concerns over bleeding gastrointestinal ulceration, renal injury, and cardiac ischemia/infarction have limited the widespread utilization of NSAIDs in vascular surgery. Other multimodal adjuncts include but not limited to ketamine, pregabalin and gabapentin. Though various dosing regimens of these adjuncts have been narrated for post operative analgesia, no single standard has been defined. The use pregabalin and gabapentin in major vascular surgery is yet to be reported. Cryo analgesia is successful in the immediate post operative period, has been abounded for its brief duration and increase incidence of chronic pain. At the end the decision making process about optimal approach towards pain control should be multimodal and a combine one between surgeon and anesthesiologist.

The risk of deep vein thrombosis (DVT) among these patients ranges from 0%-20.5%. Elderly age, morbid obesity, prolongs surgery and positive family history is the usual predisposing factors [25]. Prophylaxis is generally given until patients become ambulatory. Early ambulation, leg exercise, graduated compression stocking and intermittent pneumatic compression are extensively used method. Some authors also tried venous foot pumps with good results. Among the various pharmacologic methods in fractionated heparin reduces the rate of DVT with minor bleeding complications by more than 50%. The usual dose in 5000 units 2 hrs before surgery followed by 10,000-15,000 U/24 hr. Five percent of these patients develop heparin induced thrombocytopenia, thrombosis and ischemic complications. The oral vitamin K antagonist warfarin is most commonly used drug administered in low fixed doses and does not require extensive laboratory monitoring. A prolongation of prothrombin time corresponding to an INR between 2.0 to 3.0 is considered be adequate for DVT prophylaxis following vascular surgery. Factor Xa inhibitors e.g. fondaparinux and indraparinux, direct thrombin inhibitors e.g. hirudin and dabigatran are rarely used. Revaxoxiban for DVT prophylaxis is under phase III trial. The use of combination of mechanical and pharmacologic method improves the DVT development. These two methods are complementary rather than competitive. DVT prophylaxis therapy however is not free from heparin induced thrombocytopenia (HIT) and thrombosis. Once HIT is diagnosed and alternative anticoagulation with direct thrombin inhibitors/ heparinoids has to be started. The goal is to reduce platelet activation and thereby reduce the risk of thrombin formation. If the patient had thrombosis transition to warfarin should occur once platelet counts have recovered above 150,000/mm³ and treatment should be maintained for 3-6 months. Pulmonary complications

are significant cause of morbidity after major vascular surgery and cause significant prolongation of hospital stay. As most of the patient need prolong mechanical ventilation a lung protection strategy to be used to reduce ventilator induced lung injury. Application of PEEP is unknown, but accepted range depends upon the clinical situation [26]. Patients who are at increased risk of volutrauma, may need low tidal ventilation. The main disadvantage of this strategy is decreased clearance of carbon dioxide and respiratory acidosis, but this permissive hypercapnea and acidosis is well tolerated if the pH is >7.2 . One caveat is that permissive hypercapnea is contradicted in patients with cerebral edema. The major predicting factors for post operative respiratory dysfunction after vascular surgery are; extreme age, co-morbidities, abnormal pulmonary function test, extensive surgery, prolong sedation and muscle relaxant use, post operative hypothermia, fluid over load in proper post operative analysis bronchioles and airway secretion. All these factors predisposes to early airway closure and atelectasis leading to V/Q mismatch, hypoxia, retained secretion and respiratory failure. Prevention of these complications should be initiated during the preoperative period which includes lung expansion maneuvers e.g. deep breathing exercise, antibiotic prophylaxis to decontaminate nasopharynx. Apart from continuation of the above two procedures post operatively adequate pain control, early weaning trial, maintenance of euglycemia i.g. tight glucose control (80-110 mg/dl) is important to prevent nosocomial pneumonia. Selective decontamination of the digestive tracts and drainage of subglottic secretion may lessen the incidence of pneumonia. Spontaneous breathing trails without progressive withdraw/may fasten extubation. A successful trial is evidenced by the absence of respiratory distress (respiratory rate >35 for >5 minutes or oxygen desaturation $<90\%$ for 10 seconds), increase or decrease in heart or blood pressure ($\pm 20\%$ >5 min) or signs of agitations or distress. A patient with difficult airway needs special attention. Failure to extubation is associated with increased mortality and need for long term ventilation. Tracheostomy is reserve for patients who require prolong ventilator support e.g. presence of pneumonia, severe cardiovascular instability neurological deficit patients with absent of cough reflex. Percutaneous tracheostomy is safer than often surgical method, however contraindicated in patients who are hypoxic, have high PEEP requirement, obese patients with short neck, presence of coagulopathy and in those with recent (<10 days) cervical spine fixation. Neurological injury spinal resulting from spinal cord ischemia or cerebral ischemia is not uncommon after major vascular surgery. Subdural hematoma paraplegia, cerebrovascular accident, brain stem infarction, vision disturbances, sensory or motor deficit of the arm or leg are some of the noted neurological injury reported after major aneurysm surgery. In a prospective randomized trial Coselli et al. showed that perioperative CSF drainage up to 10 mm Hg reduces the rate of paraplegia after Crawford type I and II TAAA [27]. A spinal drain is inserted (usually at L4-L5) intervertebral space by many anesthesiologists for continuous drainage of CSF and monitoring of CSF pressure during the perioperative period. For a correct CSF pressure measurement, the line should be calibrated and zeroed independently of all pressure transducers and the plug connection to be double checked. The spinal drain should never left open to the collecting beg as the inadvertent sudden drainage of a large volume of CSF may cause precipitous fall in intracranial pressure and lead to tearing of subdural vessels within patients skull, leading to cerebral damage from subdural hematoma. To reduce the risk of hematoma, CSF drain placement should be done before systemic heparinization and management should be exercised

with ultimate care, diligence and caution. CSF is generally drain in 10 ml of increments with a goal of CSF pressure <10 mm Hg and the drainage should continued for at least 48-72 hr post operatively to minimize neurological deficit. During CSF drainage, the MAP is usually maintained between 80-100 mmHg. If the CSF pressure >10 mmHg it is drained to a limit of 15 ml/hr when the patient is neurologically intact. If delayed, neurological deficit occurs; CSF is drained without limit to maintain pressure 5 mmHg, provided there is no visible blood in CSF. The incidence of post operative delirium is approximately 22% in vascular surgery patients according to one group of authors. These patients are relatively older and more likely had a history of transient ischemic attack, cerebrovascular accident or have pre operative β blocker therapy. Statin administration reduces the risk by 44%. Paraplegias usually developed by PO day 1-3 after TAAA repair. Some intraoperative precaution like manipulation of perfusion pressure, sequential clamping/minimization of duration of cross clamp, intercostals reattachment, hypothermia, continuation of CSF drainage and manipulation of spinal cord perfusion pressure with a lumbar spinal drain during postoperative period are the standard postoperative care to reduce this complication.

Special Care for the Patients with Carotid Surgery

These patients should be observed for 4-6 hrs post operatively. Immediate attention should be given to those developed neurological deficit and in case of non availability of carotid scanning patient should be assumed to have developed carotid artery occlusion and taken back to the operating room without delay. Cerebral hyperperfusion syndrome secondary to uncontrolled postoperative hypertension is better controlled by IV labetalol 5 mg increment up to 100 mmHg maximum [28]. Bleeding and hematoma at site of carotid surgery may lead to progressive airway obstruction in the perioperative period and need urgent evacuation of the hematoma. Hypotension following carotid surgery occurs in 5 % patients and responds well to volume and phenylephrine infusion. Significant non respondent hypotension in presence of high filling pressure may warrant the possibility of development of myocardial infarction. The incidence of intracerebral hemorrhage following carotid surgery varies between 50-93 % and can be prevented with a controlled blood pressure. Hemodynamically compromised patient may developed seizure which is identified with close monitoring.

Pregnant Patients Need Additional Care

Pregnant patient who undergo major vascular surgery need special care because of the physiological changes in pregnancy. Shu C et al. [29] managed three cases of type. B aortic dissection treated with endovascular stent repair of thoracic aorta either before after delivery. One of the patient developed type II endovascular leak that required a left common carotid artery stent.

When to Discharge from ICU?

Premature discharge may increase the mortality to 40% according to various studies. Though most of the centers have their own discharge criteria's, the standard ones include: hemodynamic stability without the need for a vasoactive agent, Hb > 8 gm/dL adequate analgesia to make patient active, urine output >0.5 ml/mg hr with normal renal biochemistry and no indication for further surgical intervention.

Conclusion

Despite a substantial improvement in postoperative care

following major vascular surgery, there need development of some improved strategies to identify the patients at risk for post operative MI, management of psychological aspect of patient and relatives as well as development cost effective ICU stay in patients with open repair.

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