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THE MANAGEMENT OF THE BLOOD TRANSFUSION IN SPINAL SURGERY

OMURGA CERRAHİSİNDE KAN TRANSFÜZYONU YÖNETİMİ

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ABSTRACT:

Significant blood loss occurs in spine surgery even in routine situations. There are multiple reasons of blood loss and most of them are unpreventable. Blood transfusion to correct blood loss may cause complications and may increase mortality and morbidity. Unfortunately, perioperative unnecessary blood transfusion frequently occurs in clinical practices. In order to decrease blood transfusion there are several techniques which are restrictive blood transfusion strategy, correct patient position, use of antifibrinolytic agents, controlled hypotension, acute normovolemic hemodilution, preoperative autologous blood donation and cell-saver usage. In this article, all these techniques described briefly. The aim of this article is preventing hidden and neglected complications related to blood transfusion.

Key words: Spinal surgery, blood transfusion, autotranfusion

Level of evidence: Review article, Level V

ÖZET:

Spinal cerrahide, rutin uygulamalarda dahi önemli miktarda kan kaybı görülmektedir. Kan kaybının bu girişimlerde engellenemeyen bir çok nedeni vardır.Kan kaybı nedeniyle uygulanan kan transfüzyonunun bir çok komplikasyonları vardır. Bu komplikasyonlar postoperatif mortalite ve morbiditeyi artırabilir. Ne yazık ki perioperatif gereksiz kan transfüzyonu sıklıkla klinik uygulamalarda ortaya çıkar. Kan transfüzyonunu azaltmak için, kısıtlayıcı kan transfüzyon stratejisi, doğru hasta pozisyonu, antifibrinolitik ajanların kullanımı, kontrollü hipotansiyon, akut normovolemik hemodinüsyon, ameliyat öncesi otolog kan bağışı ve hücre koruyucu kullanım olmak üzere birçok teknik bulunmaktadır. Bu yazıda bu teknikler kısaca anlatılmıştır. Bu makalenin amacı, kan nakli ile ilgili gizli ve ihmal edilmiş komplikasyonları önlemektir.

Anahtar Kelimeler: Omurga cerrahisi, kan tranfüzyonu, ototransfüüzyon

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INTRODUCTION:

The scope of spinal surgery is quite extensive in terms of age groups. Both adult and pediatric patients undergo emergency or elective spinal surgery. Due to the long duration of surgical intervention and the causes arising from the operation site, there can be excessive amounts of surgical blood loss. There can be significant surgical bleeding in spinal surgery, even in routine situations [6].

In spinal surgeries, bleeding occurs from both the muscle surface and the bone surface. Elderly patients have more bleeding due to having a thinner periosteum and the osteoporotic bone which has more vascular canals. In pediatric patients with neuromuscular scoliosis and adults with osteoporotic bones, the amount of bleeding is greater [7].

Laminectomy applied during decompression also causes epidural hemorrhage. The commonness of arthritic facet joints in adult patients leads to more osteotomies being performed and therefore to more blood loss from bone tissue. In deformity surgeries performed on adults, surgical blood losses during operations increase due to the deformed structure of many vertebrae.

Patients who are going to undergo spinal surgery often use nonsteroidal anti-inflammatory drugs (NSAIDs). This leads to an increase in blood loss in the perioperative period due to the adverse effects of NSAIDs on platelet functions [1]. In addition, the use of excess herbal extracts known to increase the bleeding by these patients is a factor that increases surgical blood loss.

In conclusion, even in routine cases, significant loss of blood may be seen in spinal surgeries and blood transfusion is often required.

BLOOD TRANSFUSION:

Blood transfusion brings many complications with it as well as being lifesaving (Table-1).

Therefore, techniques to prevent and reduce blood transfusions significantly reduce postoperative mortality and morbidity. Practices have been developed to reduce and prevent blood loss to avoid these negative effects of blood transfusion in major operations requiring blood transfusion, such as spinal surgery [10]. These applications vary from simple precautions to the use of a variety of equipment. The main techniques used to reduce and prevent blood loss and the need for blood transfusion are avoiding unnecessary blood transfusions, correct positioning of the patient, antifibrinolytic agents, controlled hypotension, and autologous blood transfusions. These techniques are as follows;

Although there is no scientific data on unnecessary blood transfusion, perioperative unnecessary blood transfusion frequently occurs in clinical practices. In order to avoid unnecessary blood transfusion, the patient's clinical condition and accompanying diseases should be taken into account and the correct indication should be determined. There is an indication for blood transfusion in cases where coagulopathy and hemorrhage are uncontrollable and in cases of active hemorrhages causing shock, if there are signs of tissue hypoxia such as lactic acidosis and increased base excess. In the last guideline published by the American Association of Blood Banks, approaches vary according to the Hemoglobin (Hb) level:

a. **Restrictive approach;** Blood transfusion should be considered when the Hb level is below 7-8 g/dL. In this approach, the threshold for blood transfusion in ASA I patients is Hb 7 g/dL. In postoperative patients, the threshold value is 8 gr/dL for chest pain, orthostatic hypotension, tachycardia not responding to fluid resuscitation, and congestive heart failure. A threshold value of 8 g/dL is similarly recommended for orthopedic surgical procedures, cardiovascular surgery and for patients with a previous cardiovascular disease. It does not apply to acute coronary syndrome, severe thrombocytopenia (patients at risk of bleeding who are treated for hematological or oncological reasons), and anemia due to chronic transfusion (not recommended due to inadequate evidence).

b. **In the liberal approach;** the threshold value for blood transfusion is 9-10 g/dL. But in restrictive red blood cell transfusion, meta-analyses have shown improved in-hospital mortality, reduced cardiac events, and reduced bacterial infections [2].

PATIENT POSITION:

The reduction and prevention of blood loss is most simply achieved by correct positioning of the patient. Patient position in spinal surgery can vary according to the level of operation and the nature of the operation. It is very important to keep the venous pressure low in the surgical field to reduce the bleeding. In the posterior approach in lumbar surgeries, the epidural venous pressure should be kept low. Freeing of the abdomen with support from a Wilson frame reduces bleeding. Freeing the abdomen in the same way in posterior approaches of the thoracic vertebra reduces venous pressure in the surgical field. When patients are in the prone and knee chest positions, care should be taken to reduce intra-abdominal pressure. Increased intra-abdominal pressure causes venous congestion in the lumbar region and increases surgical blood loss. The Relton-Hall frame, which allows the intra-abdominal organs to be freely suspended, reduces blood loss by reducing the pressure in the inferior vena cava by one-third. In another study, it was shown that correct positioning of the patient on

the Wilson frame could reduce blood loss at the vertebral level by 50 % [5].

Table-1. Complications of blood transfusion

Early
Haemolytic reactions
Immediate
Delayed
Non-haemolytic febrile reactions
Allergic reactions to proteins, IgA
Transfusion-related acute lung injury
Reactions secondary to bacterial contamination
Circulatory overload
Air embolism
Thrombophlebitis
Hyperkalaemia
Citrate toxicity
Hypothermia
Clotting abnormalities (after massive transfusion)
Late
Transmission of infection
Viral (hepatitis A, B, C, HIV, CMV)
Bacterial (*Treponeum pallidum, Salmonella*)
Parasites (malaria, toxoplasma)
Graft-*vs*-host disease
Iron overload (after chronic transfusions)
Immune sensitization (Rhesus D antigen)

ANTIFIBRINOLYTIC AGENTS:

Synthetic lysine analogues, tranexamic acid, aminocaproic acid, protease inhibitors, and aprotinin have been used in spinal surgery to reduce bleeding. Tranexamic acid and aprotinin has been shown to reduce intraoperative blood loss in a statistically significant manner [8]. Aprotinin is a protein derivative obtained from the bovine lung. It inhibits tissue plasmin and kallikrein. It also protects platelet functions. In 2006, the drug was withdrawn from the market due to acute renal failure, myocardial infarction, heart failure, encephalopathy, and cerebrovascular complications.

Desmopressin reduces bleeding time in platelet function disorders. But there is no evidence that it reduces blood loss due to spinal surgery.

CONTROLLED HYPOTENSION:

Controlled hypotension is defined as a reduction in systolic arterial pressure to 80-90 mmHg, a reduction in mean arterial pressure to 0-65 mmHg, or a 30 % reduction in mean arterial pressure from the basal value. Lowering of blood pressure results in a direct reduction of bleeding in arteries and arterioles, as well as a reduction in venous bleeding due to venous dilation and a reduction of bleeding from venous sinuses in bone structures. Controlled hypotension not only reduces the need for blood transfusion but also facilitates the imaging of the surgical field, allowing for a shorter operation time.

The concept of reducing surgical bleeding by creating hypotension was proposed by Harvey Cushing in 1917 for neurosurgical procedures. In 1946, the definition of a bloodless surgical field with the method of arteriotomy was made by Gardner. In 1948, Griffiths demonstrated that surgical blood loss could be reduced by inducing hypotension with high spinal anesthesia and in 1951 Gillies showed that the same was possible by inducing hypotension with high epidural anesthesia.

In the following years, ganglion blockers such as pentamethonium, hexamethonium, and trimethaphan were used to induce hypotension. In 1962, the use of short-acting sodium nitroprusside and halogenated anesthetic agents enabled controlled hypotension to be more easily achieved and safe.

Agents used successfully alone are inhalation anesthetics, sodium nitroprusside, nitroglycerin, trimethaphan camsylate, alprostadil (prostoglandin E1), adenosine, and remifentanil. Agents used alone or in combination are calcium channel antagonists (e.g., Nicardipine) and beta adrenoceptor antagonists (propranolol, esmelol) and fenoldopam. ACE inhibitors and clonidine are used as adjuvants.

Controlled hypotension is an easy and reliable method of reducing blood loss and the need for blood transfusion in spinal surgery procedures. It is fairly safe to reduce the mean arterial pressure to 50-65 mmHg or to reduce the basal mean arterial pressure by 30 % in patients with an American Society of Anesthesiologists risk classification of I (ASA I).

On the other hand, patients diagnosed with chronic hypertension cannot tolerate a 25 % reduction in the mean arterial pressure. Controlled hypotension should not be applied in patients with cerebrovascular, cardiac, hepatic, and renal disease, respiratory failure, severe systemic hypertension, anemia, hemoglobinopathies, and polycythemia.

Although controlled hypotension is safe, the patient has more risk of cardiac arrest when massive hemorrhage and surgical complications such as tension pneumothorax occur. Care should be taken when using controlled hypotension in spinal surgery that neurological deficits present or occurring at the surgical level or below may worsen.

Following the motor stimulated potentials of the anterior spinal cord and the sensorial stimulated potentials of the posterior spinal cord is a standardized method of monitorization in spinal surgery today. Controlled hypotension should be terminated promptly when a deterioration is detected at the basal level of electrical potential measurements during a surgical procedure.

When the controlled hypotension procedure is being performed, V5 derivation should especially be monitored along with ST segment analysis on ECG. Oxygen saturation should be monitored due to ventilation perfusion incompatibility and hypoxemia. Central venous pressure and invasive arterial pressure monitoring should be performed. Body heat should be watched closely. Monitoring of the motor and sensorial potentials of the medulla spinalis should be done.

In the postoperative period, attention should be paid to the continuity of the airway, oxygenation, analgesia, reactive bleeding, and fluid balance. An eye should be kept open for rebound hypertension after insufficient analgesia and the risk of postoperative bleeding related to this.

Clinical studies have shown that controlled hypotension reduces the need for blood transfusion in spinal surgery by 2-3% [4].

AUTOLOGOUS BLOOD TRANSFUSION:

Autologous blood transfusion is defined as the collection of the patient's own blood or blood products and their subsequent re-delivery. Autologous blood transfusion techniques are listed below;

a. Acute Normovolemic Hemodilution
b. Predeposit autologous transfusion
c. Cell saver use

a. ACUTE NORMOVOLEMIC HEMODILUTION:

It is described as the drawing of blood from the patient immediately before or at the beginning of the operation, and its transfusion to the patient again after the operation. Messer et al. first described the technique of preoperative hemodilution in surgical patients in 1974. They withdrew 1500-2000 ml of venous blood in the 20-30 minutes before surgery after anesthesia induction from patients with Hct levels above 35 % and replaced it with the same volume of 5 % Albumin solution. After surgery, the blood was returned to the patient. They showed that there was less red blood cell loss in hemodiluted patients during surgical procedure compared to normal hematocrit levels [3].

In this technique, between 1 and 3 units of blood is drawn according to the patient's basal hematocrit and Hb level. The estimated blood volume is 75 ml/kg for men and 70 ml/kg for women. The target Hb level is preferred as 9 g/dL. For each 1 ml of blood withdrawn, 2-4 ml of crystalloid/colloid volume should be replaced. Ringer's Lactate, 5 % Albumin, 6 % dextran 70, or 6 % hetastarch are used for the volume replacement.

Physiological changes:

Withdrawing blood from the patient and replacing it with an acellular fluid causes a decrease in arterial oxygen content. The acute decrease in the Hb level leads to hemodynamic changes through compensation mechanisms and causes the oxygen dissociation curve to shift to the right, resulting in an increase in the oxygen extraction of Hb. As a result, the oxygenation of peripheral tissues increases thanks to this. The hemodynamic changes are increased cardiac output, increased heart rate, increased stroke volume and contractility, decreased peripheral vascular resistance, and decreased blood viscosity [9].

Acute and marked reduction in hematocrit, which can lead to hemodynamic instability, can cause myocardial ischemia in susceptible patients. Complications arise from the physiological effects of acute hemodilution.

Indications:

Normovolemic hemodilution is used in operations with a high probability of blood transfusion, in patients with preoperative hemoglobin levels above 12 g/dL, in those without clinically significant coronary, pulmonary, hepatic, renal and liver disease, in persons without severe hypertension, and in patients with no infections or bacteremia.

Normovolemic hemodilution significantly reduces the need for blood transfusion in spinal surgery.

Monitoring:

Oxygen saturation, invasive arterial pressure monitoring, ST segment analysis and V5 derivation on ECG, CVP measurement (for adequate fluid resuscitation), and urine output and cardiac output measurements should be performed during acute normovolemic hemodilution.

b. PREOPERATIVE AUTOLOGOUS BLOOD DONATION:

Autologous blood donation is the collection, storing, and re-delivering in case of need of the patients own blood before elective surgery. Collecting blood begins 3-5 weeks prior to elective surgery. The last donation should be performed at least 48-72 hours before surgery to allow rebalancing of blood

volume. The blood is stored in citrated phosphate dextrose blood bags in traditional manner in a blood bank. In this way, 3-4 units of blood is collected depending on the need and is stored. Oral or intravenous iron supplementation may be required to maintain erythropoiesis [12].

It is possible to increase red blood cell production and increase the amount of blood collected preoperatively or to be withdrawn in normovolemic hemodilution by administering erythropoietin in the preoperative period. There are studies which have shown that the use of erythropoietin before surgery reduces the need for blood transfusion in orthopedic and spinal surgeries [13]. Erythropoietin is administered on the 1st, 4th, and 7th days preoperatively in the form of 300-600 IU/kg epoetin alfa and surgery is performed on the 13th day. Preoperative blood donation almost completely eliminates the risk of viral infections and immune-mediated fever, hemolysis, and allergic reactions. In addition, the immunomodulation that occurs after allogenic blood transfusion does not occur. This can reduce the risk of infection and cancer recurrence in the postoperative period.

Disadvantages: Blood collected in the preoperative period is not used at rates of approximately 50 %. Blood collected for autologous blood donation is rarely used in other patients. Therefore, it leads to higher costs per unit when compared to allogenic blood. In addition, complications such as hemolysis and bacterial contamination can also occur due to the collection, transportation, storage or transfusion technique.

Suitability:

The patient should be able to tolerate repeated phlebotomies and the hematologic and cardiovascular problems that occur after it. It is contraindicated in the case of anemia, cyanotic heart disease, ischemic heart disease, aortic stenosis, or severe hypertension. Children under 30-40 kg are not eligible for the technique.

Those with acute systemic infections should not donate, as well as patients with diarrheal disease in the period before donation or long-term diarrhea, as bacterial contamination may occur in these patients. Fainting and dizziness reactions are common during donation and this is rarely serious [11].

c. CELL SAVER USE:

The cell salvage technique consists of collecting blood lost from a surgical field in a reservoir, preventing the collected blood from clotting using citrate or heparin, filtering the collected blood in order to purify it from large particles, centrifuging it afterwards, washing it with 0.9 % NaCl, collecting it in a bag for reinfusion, and re-delivering it to the patient. It is used intraoperatively, postoperatively, or in both cases. Although cell saver is usually used in conjunction with normovolemic hemodilution, the benefit of using them together is disputable. Today cell salvage can be obtained by simple aspiration system (solotrans), semi-automatic system (Haemonetics, Cell Saver) and continuous auto-transfusion system (CATS).

Indications for the use of Cell Salvage: It is recommended for use when the estimated blood loss is 1000 mlt or more than 20% of the total blood, in surgical procedures requiring blood transfusions in more than 10% of patients, and in surgical procedures with an average blood requirement of more than 1 unit.

Factors related to the patient should also be considered when deciding on the use. These are the rejection of allogenic blood transfusion by the patient, difficulties in finding suitable blood, low hemoglobin in the patient, and increased risk of bleeding.

Cell Salvage can be used in all elective and emergency surgical procedures if there is no contraindication.

The main contraindications to Cell Salvage are that the surgical site is contaminated with intestinal content or infected material. When heparin is used as an anticoagulant, it is heparin induced thrombocytopenia. Citrate solution can be used as an anticoagulant in this case.

The points to be considered in intraoperative cell salvage use:

a. The use of iodine, cement, topical clotting agents, and antibiotics not suitable for intravenous use

b. Avoiding aspiration of infected areas

c. Not aspirating gastric and pancreatic secretions as this may cause hemolysis

d. Not aspirating the pleural effusion

e. There are concerns about its use in patients with sickle cell anemia. It should be taken into consideration that sickling may occur in these patients.

f. Amniotic fluid should not be aspirated because it will cause amniotic embolism

g. Intraoperative cell salvage is not recommended by the manufacturers in the presence of malignant conditions because the malignant cells can be reinfused in the patient and metastasize. However, there are publications in the literature suggesting that it can be used.

In conclusion, measures to reduce and prevent bleeding should be chosen according to the patient and the nature surgical procedure to be performed in those procedures where bleeding is unavoidable, such as spinal surgery. The methods to be applied can be used alone or in combination. Blood transfusions have negative effect on postoperative mortality and morbidity negatively. It is known to increase relapses due to immune modulation in cancer surgery. For this reason,

these methods should be considered in all surgical procedures where blood loss may be excessive.

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