2012

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Recommended Citation

Open Cardiovasc Thorac Surg 2012;5:8-10.

Vascular Site Hemostasis in Percutaneous Extracorporeal Membrane Oxygenation Therapy

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Abstract: Bleeding is a well described complication of percutaneous extracorporeal membrane oxygenation support (ECMO). In an effort to prevent ongoing percutaneous-cannula blood loss, we tried multiple methods to achieve hemostasis and obtained the best results with QuikClot® Combat Gauze™ (Z-Medica Corp, Wallingford, CT). This product is made of kaolin, white alumina silicate clay, which initiates activation of the intrinsic clotting cascade. We reviewed our experience in 21 ECMO patients and found 5 patients who required 17 applications of QuikClot® Combat Gauze™ to percutaneous catheter insertion sites and demonstrated a significant reduction in both localized bleeding complications and the need for blood transfusion. QuikClot Combat Gauze™, used for the dual purpose of a dressing and hemostatic agent, is a simple valuable method to control pericatheter bleeding in the ECMO population with demonstrated cost savings and clinical utility.

Keywords: ECMO, bleeding, blood-coagulation, anticoagulation, blood transfusion.

INTRODUCTION

Extracorporeal membrane oxygenation support (ECMO) has become the procedure of choice to support or rescue patients with end-stage respiratory failure and/or cardiogenic shock. Bleeding complications on ECMO have been well described in the literature, ranging from intracranial hemorrhage to gastrointestinal bleeding to bleeding from cannula insertion sites [1, 2]. Although percutaneous cannulae have significantly decreased surgical site bleeding, prolonged percutaneous ECMO support has increased bleeding complications from the vascular access sites. Risk factors for vascular access complications include age, obesity, peripheral vascular disease and cannula insertion into non-targeted puncture zone (femoral bifurcation or superficial femoral artery). ECMO patients require heparin and can develop coagulopathies from a variety of reasons, adding bleeding risks at the percutaneous cannula site(s).

In an effort to prevent ongoing blood loss from percutaneous insertion site, we have attempted multiple methods to achieve hemostasis, including manual compression, suturing, pressure bags, and multiple biologic hemostatic products such as Surgicel®, Gelfrom®, and Fibrillar®. Through our experiences, we achieved consistent local hemostasis with QuikClot® Combat Gauze™ (Z-Medica, Wallingford, CT). This product is made of kaolin, white alumina silicate clay, which initiates activation of the intrinsic clotting cascade due to interaction with factor XII (Hageman factor) [3-6]. Kaolin impregnated gauze has been previously described as having much success when used for hemostasis of external bleeding sites. It has been used in the battlefield and is recommended as first line treatment of choice for military bleeding [7, 8]. We have extended the application of these kaolin derived products to provide peri-cannula hemostasis in a series of 5 patients with prolonged ECMO support.

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BANDAGE DESCRIPTION

QuikClot® hemostatic bandages are absorbent non-woven rayon coated gauze (Fig. **1**), approved by the Food and Drug Administration for external use to control bleeding. Each dressing is a multiple-ply rayon/polyester construction coated with kaolin, aluminum silicate clay, which is a potent coagulation initiator. Dressings come in several forms which can be tailored for usage. Since kaolin is an inert mineral that does not contain animal or human proteins, no allergic reaction at the site of application was reported. Contact between kaolin and blood triggers electrostatic re-arrangement of Factor XII, making Factor XII to become activated and initiate intrinsic coagulation pathway [5]. QuikClot® hemostatic bandages are available on the market for $50 per piece [3].

METHODS

The application site was cleaned with Chloroprep. QuikClot® Combat Gauze™ was applied over the bleeding site with firm manual compression on the femoral artery or vein. After 10 minutes of manual compression, the dressing was kept over the access site and was covered with a non-compressive dressing. The dressing was checked at 15minutes, 1, 4 and 12 hour intervals. When bleeding saturated the dressing again, repeat procedures were undertaken. QuikClot® Combat Gauze™ was also applied to bleeding occurring from a tracheostomy and gastrostomy sites in patients while on ECMO with dramatic cessation of bleeding. Hemostasis was considered to be successful if the dressing was no longer saturated with blood and if dressing

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changes at cannulation sites were needed less than three times daily.

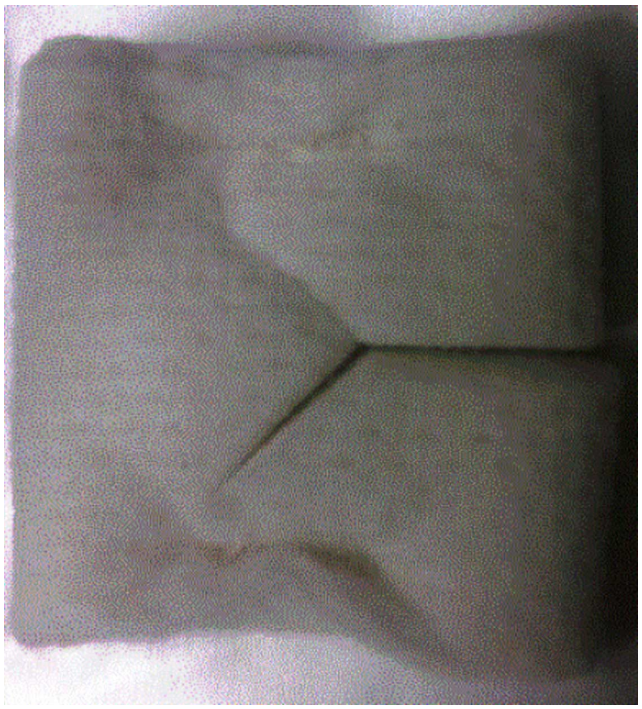

Fig. (1). An example of the QuikClot® Combat Gauze™ dressing.

RESULTS

Over a 6 month period, 5 patients among a total of 21 ECMO cases required QuikClot® dressings to control ECMO cannula site bleeding (Fig. **2**). There were 3 males and 2 females with an age range of 21-55 (mean 44). Three patients required veno-arteial ECMO and 2 required veno-veno ECMO. The length of ECMO support was 67 days (mean 13.4, rage 9-26 days). QuikClot® Combat Gauze™ was utilized in 17 applications with hemostasis varying from 4-24 hours before a second application was necessary. The sites of application were: femoral artery (9), femoral vein (3), internal jugular vein (2); other bleeding sites associated with percutaneous procedures while on ECMO included tracheostomy (2), gastrostomy (1). All bleeding sites were controlled with QuikClot® Combat Gauze™ within 24 hours. Packed red blood cell (PRBC) transfusion of the patients with excessive site bleeding was 1-5 units of PRBCs/day; however, once the sites were controlled, no more than 1 unit of PRBC/day was required to maintain the hemoglobin level of the patient. No patients required surgical intervention for hemostatic control. There was no site infection or complications related to prolonged application of the hemostatic dressing. All patients were successfully weaned off ECMO and discharged from hospital.

DISCUSSION

Bleeding from percutaneous catheter insertion sites is a common problem in patients with prolonged ECMO support. Prolonged cannulation to the vessel causes peri-catheter fibrosis, dilatation of the vessel, and catheter dislodgement, which results in continuous oozing from the cannulation sites. Additionally, patients on ECMO always require therapeutic anticoagulation to prevent thrombosis in the oxygenator and circuit. Since platelets adhere to the foreign surfaces of the ECMO cannula and tubing, platelets activation and aggregation is always seen in ECMO patients. This leads to initiation and activation of the clotting cascade and consumption of platelets, often resulting in thrombocyto-penia and disseminated intravascular coagulopathies. Severity of patient illness and the presence of preexisting conditions such a liver dysfunction, acidosis and renal failure, may also increase the severity of coagulopathies. Taken together, these factors increase the risk of hemorrhage in patients on ECMO.

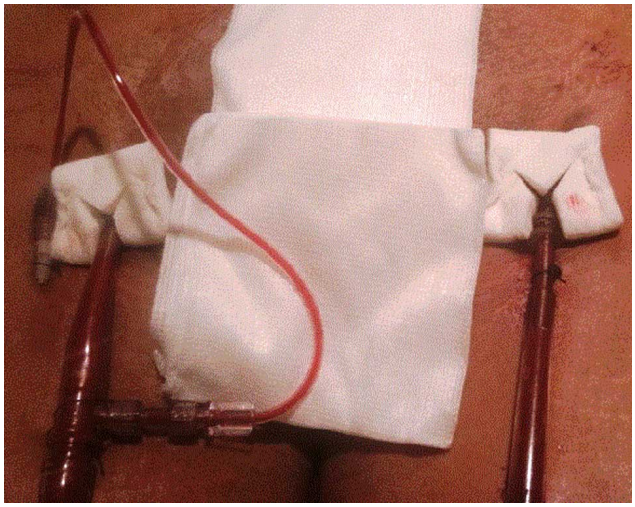

Fig. (2). QuikClot® Combat Gauze™ is applied to the arterial and venous ECMO cannula of the groin.

QuikClot® Combat Gauze™ is a simple and effective local hemostatic agent used in the battlefield with success without any serious complications [8, 9]. Direct contact of the QuikClot® Combat Gauze™ to the bleeding site with manual pressure was enough to control the bleeding in majority of patients [8, 9]. In an animal model, Quick Clot successfully controlled bleeding from a large vessel injury to the femoral artery and vein [10]. In a swine model, catheter-related femoral vessel injuries were successfully controlled within 5 minutes by QuikClot® [11]. Other than trauma, QuikClot® Combat Gauze™ has been used for hemostasis after catheterization, dialysis and interventional radiology. Pahari reported appropriate hemostasis with QuikClot® in 97% of patients who underwent catheterization [11]. However, application of QuikClot® Combat Gauze™ to ECMO cannulation sites has not been described. QuikClot® Combat Gauze™ is the most cost-effective product compare to other hemostasis products. Other hemostatic products such asSurgicel®, Gelfrom®, and Fibrillar®.

Our protocol for peri-cannula bleeding in patients with ECMO is simple. The bleeding from the cannulation sites is effectively controlled without the need for surgical exploration. Our observation might result in a reduction of multiple blood transfusions, a lower healthcare cost and faster patient recovery. This technique is now used routinely at our institution for patients on ECMO.

ACKNOWLEDGEMENT

Declared none.

CONFLICT OF INTEREST

Declared none.

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Received: December 5, 2011 Revised: January 7, 2012 Accepted: January 10, 2012