BRIEF REPORT

QuikClot Combat Gauze Use for Hemorrhage Control in Military Trauma: January 2009 Israel Defense Force Experience in the Gaza Strip—A Preliminary Report of 14 Cases

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Keywords: combat gauze; control; hemorrhage; hemostatic dressing; Israel Defense Force

Abbreviations:
ALS = advanced life support
GSW = gunshot wound
QCG = QuickClot Combat Gauze™
WS = Woundstat™

Received: 06 January 2010
Accepted: 01 March 2010
Revised: 02 March 2010

Web publication:

Abstract

Background: Standard gauze field dressings and direct pressure occasionally are inadequate for the control of hemorrhage. QuikClot® Combat Gauze™ (QCG) combines surgical gauze with an inorganic material and is approved by the Food and Drug Administration and by the Israeli Standards Institute for external hemorrhage control. The purpose of this article is to report clinical use of this dressing during Operation Cast Lead in the Gaza strip during January 2009.

Methods: QuikClot Combat Gauze and the QCG guidelines were issued to advanced life support (ALS) providers during the preparations for the Operation.

All cases of injuries involving hemorrhage were reviewed, as well as interviews with the ALS providers (physicians and paramedics) and injured soldiers.

Results: Fourteen uses of QCG were reported and reviewed (out of a total of 56 hemostatic interventions in 35 cases). Dressings were applied to injuries to the head, neck, axilla, buttocks, abdomen, back, and pelvis in 10 cases, and to extremities in four cases. In 13 cases (93%), injuries were caused by blast or gunshot mechanisms. The success rate was reported as 79% (11/14). Failure to control hemorrhage was reported in three cases in three different locations: neck, buttock, and thigh. All failures were attributed to severe soft tissue and vascular injuries. No complications or adverse events were reported.

Conclusions: This report on the clinical field use of the QCG dressing by ALS providers suggests that it is an effective and safe product, and applicable for prehospital treatment of combat casualties. This report further suggests that QCG should be issued to medics as well as ALS providers. Larger clinical investigations are needed to confirm these findings.

Ran Y, Hadad E, Daher S, Ganor O, Kohn J, Yegorov Y, Bartal C, Ash N, Hirschhorn G: QuikClot Combat Gauze use for hemorrhage control in military trauma: January 2009 Israel Defense Force experience in the Gaza Strip—A preliminary report of 14 cases. ***Prehosp Disaster Med*** **2010;25(6):584–588.**

Introduction

Hemorrhage continues to be the leading cause of preventable death due to military trauma, and the second leading cause of death in civilian trauma.[1–6] Thus, research of measures for hemostasis control have been emphasized by armed forces and the civilian trauma community alike. During the past few years, major advances have been achieved in the development of advanced hemostatic products for use in traumatic bleeding. Different products have been shown to be efficient in this respect in various animal model studies.[7–24] However, documentation of clinical use is scarce.[25–28]

During the two years following the Second Lebanon War (2006), as part of clinical lessons learned,[29] the Israel Defense Force Medical (IDF) Corps tested a variety of hemostatic products. All published reports regarding the different products available at the time were reviewed. In conclusion of these clinical and investigational stages, QuikClot® Combat Gauze™ (QCG) by Z-MEDICA (Figure 1) was chosen for use by the IDF from the published reports regarding the different products available at the time were reviewed. This product combines surgical gauze (non-woven rayon and polyester blend) with an inorganic material (kaolin). Upon application to a hemorrhage, the

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Figure 1—QuikClot® Combat Gauze™

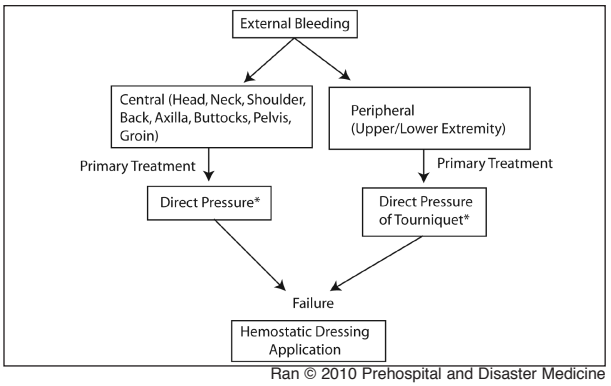

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Figure 2—Protocal for use of QuickClot Combat gauze (hemostatic dressing)
*Direct pressure with personal bandage

water molecules are attracted into internal pores in a non-chemical, physical reaction. This causes a rapid concentration of the larger platelets and clotting factor molecules that promotes rapid clot formation. The gauze is impregnated with a kaolin derivative that activates Factor XII and initiates platelet adhesion to begin the clotting cascade. This product was designated for assimilation by advanced life support (ALS) providers during 2009.

Operation Cast Lead in the Gaza Strip took place during January 2009. During this operation 339 soldiers were injured, among them 10 fatalities.[30] Throughout the conflict, 14 soldiers were treated with QCG to facilitate rapid hemorrhagic control. The objective of this report is to provide the first report of clinical usage of this local hemostatic product.

Methods

A protocol for the use of QCG was provided along with the dressing (Figure 2). The hemostatic dressing was issued to either medical officers or paramedics during preparations for operation Cast Lead (medics were not issued this dressing). All medical personnel who were issued this dressing went through training drills in the days preceding deployment of their units into action. The basic training principle of applying a hemostatic dressing is applying it directly onto the bleeding area. The more contact area between the wound and the large surface area of the dressing, the more successful hemorrhage control should be. After packing a wound fully, caregivers are taught to apply further pressure using a regular combat dressing, which also acts to prevent dislodgement of the hemostatic dressing.

All throughout the conflict and afterwards, data were collected by the Israel Defence Force's Medical Corps. Data collection and analysis were based on several sources, the most important of which was the interviewing the injured personnel and all medical care providers. This was performed by a dedicated group of investigators, enlisted especially for this mission as derived from a lesson learned during the Second Lebanon war, 2006. The uses of QCG were not under any study or study protocol. All applications reported were provided by military personnel for the treatment of soldiers wounded in combat.

Results

A total of 56 interventions (42 tourniquets and 14 hemostatic dressings) in 35 injured soldiers (23 and 13 tourniquets and hemostatic dressings respectively) were investigated. The locations of use of QCG were quite varied, both to the extremities and to areas that could not be treated with tourniquet as shown in Figures 3 and 4. An example of this scenario was a shrapnel injury that included a victim with a penetrating head injury, a partial amputation through the shoulder joint with a severe penetrating chest injury, and an amputation through the contra-lateral forearm. Two attempts were made to control the hemorrhage from the partially amputated shoulder with a tourniquet (an improvised tourniquet and a Combat Application Tourniquet (CAT®). These attempts failed due to the proximity of the injury to the chest wall. A second attempt to control the hemorrhage was done using two QCG dressings. This attempt was reported as "successful". Upon arrival to the Trauma Center, the patient was taken to the operating theatre where his head, chest, and extremity injuries were repaired. The soldier had no direct injury to his subclavian vessels, but other multiple bleeding soft tissue sites were identified and the hemorrhage controlled.

Another example of successful use of this hemostatic dressing was a soldier injured by gun shot wounds (GSWs) to his forearm. This injury resulted in an open comminuted fracture of the radius and ulna and radial and ulnar nerve palsy. Immediate treatment to control hemorrhage was performed via tourniquet due to the severity of injury and combat setting. After evacuating the soldier to a more sheltered location, the tourniquet was replaced by a hemostatic dressing in an attempt to control hemorrhage without further compromising blood supply to the injured extremity.

All of the soldiers treated using the QCG were wounded in a military setting with various penetrating and blast mechanism injuries (Table 1). In three cases treatment with QCG failed to control bleeding. In one case, a soldier was slashed through the neck by the tail-fin of an antitank weapon during its flight. The tail-fin caused penetrating injury to the trachea and to major blood vessels, including aortic arch (information gained through post-mortem computer tomography). The tracheal injury was managed using a cricothyroidotomy. An attempt was made to control bleeding by applying QCG and direct pressure. Due to the severity of the injury, the soldier died en route to the hospital.

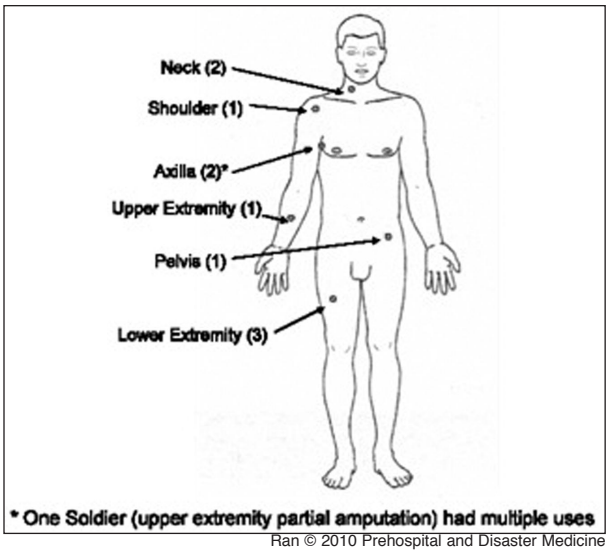

Figure 3—Anatomical locations of use of QuikClot® Combat Gauze™, anterior view

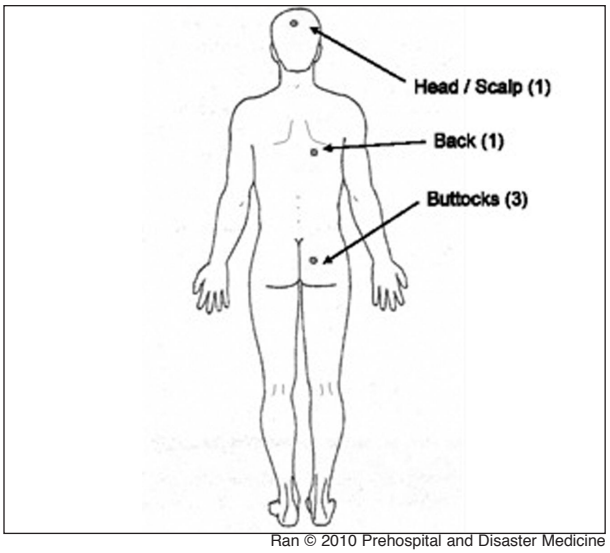

Figure 4—Anatomical locations of use of QuikClot® Combat Gauze™, posterior view

Mechanism	Effectiveness
Blast injury (artillery, rockets, improvised explosive devices)	5/7
Penetrating gunshot wounds	6/6
Penetrating stab wounds	0/1

Table 1—Effectiveness by mechanism of injury

Mechanism	Location
Stab wound	Neck
High-velocity firearm	Buttock
Blast injury	Thigh

Table 2—Ineffective control hemorrhage using Combat Gauze

In another case, there was a combined injury from a GSW and grenade. The casualty had an open comminuted fracture of his right tibia with massive soft tissue loss and posterior tibial vascular injury, which was treated with application of a silicone tourniquet in the field. He also had a penetrating injury to the left gluteal region involving an open comminuted fracture of the proximal femur, the iliac wing, and penetrating rectal trauma. Applying QCG packing and direct pressure was unsuccessful in controlling bleeding at the gluteal injury site. Hemostasis finally was achieved in the operating room only after evacuation to a trauma center.

The third soldier had lacerations to both thighs and the left ankle region from a grenade injury. The left thigh injury was characterized by extensive soft tissue damage, with extensive degloving and deep lacerations of the quadriceps muscle. This site was bleeding profusely. An attempt to control the bleeding with a tourniquet was unsuccessful, since it was too proximal. Another attempt was made with QCG and direct pressure. This was unsuccessful as well. Hemorrhaging was controlled eventually by legating the bleeding vessels in the operating room. The ineffective attempts are listed in Table 2.

Discussion

The Israel Defence Force's Medical Corps continually searches for the most effective local hemostatic agent that could control bleeding in the field. The ideal qualities of such an agent have been described by Pusateri *et al* and are listed in Table 3.[23] Although different products have been proven superior to control in various animal model studies.[10–24] In summation of many comparative studies between different products, two have shown the greatest advantage: Woundstat™ (WS) by TraumaCure and QCG by Z-MEDICA.[8,11,12,14,15,18,20,21,24] Both of these products promote hemorrhage control by mechanism of water adsorption and concentration of clotting factors. Woundstat™ also exerts a negative electrostatic charge that may activate the intrinsic pathway and accelerate the clotting process, and QCG activates the coagulation cascade (Factor XII) via a kaolin derivative coating. One major difference between WS and QCG is the form of application. Woundstat™ is a granular agent, while QCG (formerly named X-Sponge) combines the inorganic material within a surgical gauze, which provides packing qualities as well as hemostatic qualities. Another advantage of QCG over WS is the absence of intravascular thrombo-emboli formation in the vicinity of application.[31] Due to these qualities and several disadvantages of granular formulations (Table 4), the final decision was to equip ALS providers with QCG.

This is the first reported series of Combat Gauze use in a military setting to control bleeding. Most uses were in areas where tourniquets could not be applied (Figures 3 and

Stop large vessel bleeding within 2 minutes
No requirement for pre-application preparation
Simplicity of application
Light weight and durable
Long shelf life
No collateral tissue injury
Inexpensive

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Table 3—Ideal qualities for hemostatic dressings

Dispersion of product outside wound area
Difficult handling in the field
Granules remain in wound after saline washout
Penetration into vascular lumen and risk of thrombo-emboli
Decreased effectiveness in wounds where bleeding vessel is situated at the bottom of a narrow wound tract

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Table 4—Granular formulation disadvantages

4) and direct pressure was insufficient to control the external bleeding. Overall, 79% of the applications were effective in controlling the bleeding as reported by the ALS providers on-site. Three ineffective uses were reported. In each of these cases, the wounds were of a nature that prevented applying the product directly onto the source of bleeding. One of these injuries resulted in death en route to hospital. These cases cannot be regarded as ineffectiveness of the product, as it cannot be expected to work unless properly delivered to the source of bleeding. These data suggest that QCG plays a major role in controlling external hemorrhage in complex injuries.

QuikClot Combat Gauze was issued to ALS providers only (medical officers and paramedics) and not to every platoon medic. Although ALS providers were abundant during operation "Cast Lead", in an all-out conflict in several theaters, there only will be one forward medical team at the battalion level. This will result in an injured soldier being treated by a medic for a longer period of time before reaching a medical officer or paramedic. These facts, as well as the effectiveness demonstrated in hemorrhage control in this series, suggest that QCG should be issued to medics as well.

Earlier formulations of QuikClot (QuikClot®, QuikClot ACS™, QuikClot ACS+™) have been reported to cause an exothermic local reaction that had the potential to cause second and third degree burns.[11,19–22,25] This adverse event was a result of the zeolite-based compounds. When water is adsorbed by the zeolite and trapped by a hydrogen bond formation heat is generated. QuikClot Combat Gauze is coated by a kaolin derived mineral, and application generates no hydrogen bonds and no heat.[19,22] None of the ALS providers in the field or trauma center physicians reported any short-term complications related to the use of this dressing.

Limitations

This is a case series, based on reports received from treating medical personnel, and thus, may be biased due to several factors. First and foremost, the size of the series was only 14 uses. A recall bias also is probable, although an attempt was made to question all medial personnel as soon as possible.

Conclusions

This work suggests that QCG is safe and effective in controlling external hemorrhage in complex injuries. As with any tool available for medical use, obtaining adequate training is preferred before implentation in the field whenever possible. Effectiveness and safety of use of this product suggests it should be issued to medics as well as ALS providers. Further, larger-scale investigations and reports are needed.

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