Haemostatic agents

Actuality

- Forty percent of traumatic mortality deaths and up to 90% of all civilian deaths took place in pre-hospital settings

Structure of combat death in pre-hospital settings

Post-mortem studies of casualties in Operation Iraqi Freedom (OIF) and World War II suggested that 24% of all battlefield mortalities could have been prevented with improved methods in hemorrhage control, and 85% of them were due to uncontrolled hemorrhage

Structure of civilian death in pre-hospital settings

Uncontrolled hemorrhage from severe injuries is a leading cause of death among children and young adults

Incomplete hemostasis is a leading cause resulting in reoperation for hemorrhage in trauma patient

Requirements for materials

Advantages	Disadvantages
• Sustain hemostasis for at least several hours • Reduce blood loss and decrease mortality • Seal wound site • Induce vasospasm • Absorb water, accelerate the concentration of red blood cells, clotting factors, and platelets at the bleeding site • Induce platelet activation and form clot	• Incapable of stopping bleeding and can cause the formation of thrombi • Can cause an allergic reaction • A short shelf life and has to be prepared just before use • Very specific handling instructions, difficult to utilize in certain environments • Costly

Table 1 Advantages and disadvantages of hemostatic agents[8-18]

Chitosan-based hemostatic materials

Types	Mode of Action
HemCon®	Freeze-dried chitosan acetate salt, mainly used for emergencies to stop blood loss, enhance platelet function
Chitoflex®	Antibacterial and biocompatible wound dressing designed to reduce moderate to severe bleeding by adhering strongly to tissue surfaces, forming a flexible barrier that seals off and stabilizes the wound surface
Chitoseal®	Supported with a cellulose coating for hemorrhage wounds, reduces compressible timing.
Clo-Sur®	Used topically to stimulate wound healing at sites of vascular injury
TraumaStat®	Freeze-dried chitosan containing highly porous silica, proposed for external temporary use to control moderate to severe bleeding.
Syvek-Patch®	Achieves faster hemostasis by agglutinating red blood cells, activates platelets, controls bleeding following catheter removal in diagnostic operations
BST-CarGel®	Chitosan-glycerophosphate hydrogels, biodegradable gel used to repair cartilage impairment
Remedium's Hemogrip™	Adheres to tissues in a very effective manner, soft tissue sealant from transudation and microbial intrusion, able to treat injuries ranging from normal to life-threatening arterial punctures.
Celox	Used in lethal bleeding, is very effective in just 30 seconds, does not generate heat, forms a robust plug when red blood cells react with the agent.
Celox-A	Applicator and plunger delivery system, able to react deep into a small penetrating wound.
Celox Trauma Gauze	Controls traumatic bleeding and helps cool and protect first and second degree burns.
Chitipack S	Widely used for traumatic wounds and surgical tissue defects, reported with no retractive scar formation upon usage, supported on polyethylenetherephthalate, for the treatment of large skin defects, suitable for defects that are difficult to suture.
Chitipack P& C	Cotton-like chitosan obtained by spinning chitosan acetate salt into a coagulating bath of ethylene glycol, ice, and sodium hydroxide, can be used for whole set reconstruction of body tissues by rebuilding normal subcutaneous tissues and regular regeneration of skin
Tegasorb	The dressing contains chitosan particles that swell while absorbing exudates. producing a soft gel
Tegaderm film dressing	A layer of waterproof dressing covers the hydrocolloid, used for leg ulcers, sacral wounds, and chronic wounds
Chitodine	Chitosan powder with adsorbed elementary iodine, for the disinfection and cleaning of wounded skin and surgical dressings
QuikClot®	Adsorbent hemostatic agent that speeds up the coagulation profile, stops blood loss, and is very suitable for larger wounds.

Mechanism of action

Water absorption

Erythrocytes coagulate

Platelet adhesion and aggregation

Hemostatic efficacy of chitosan-based bandage for closure of percutaneous arterial access sites: An experimental study in heparinized sheep model

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Background. Most of the presently used percutaneous arterial closure devices (PACD) for hemostasis after interventional vascular procedures are effective, but carry risk of complications by deposition of a foreign body. A new promising externally applied PACD – chitosan-based HemCon Bandage (HCB) was explored in sheep. The HCB hemostatic efficacy and complications occurring with its use were compared to those with the standard manual compression (SMC).

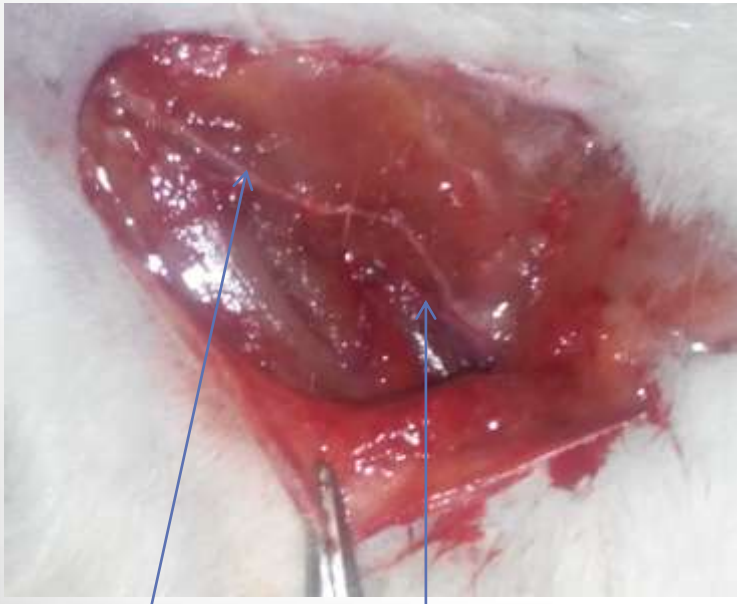
Material and methods. Both superficial femoral arteries (SFA) of 9 heparinized sheep were catheterized with an 8F sheath for 5 minutes. After the sheath withdrawal, hemostasis with the HCB was compared with hemostasis achieved with SMC in the contralateral SFA. Iliac angiograms performed by carotid artery approach determined the hemostasis time.

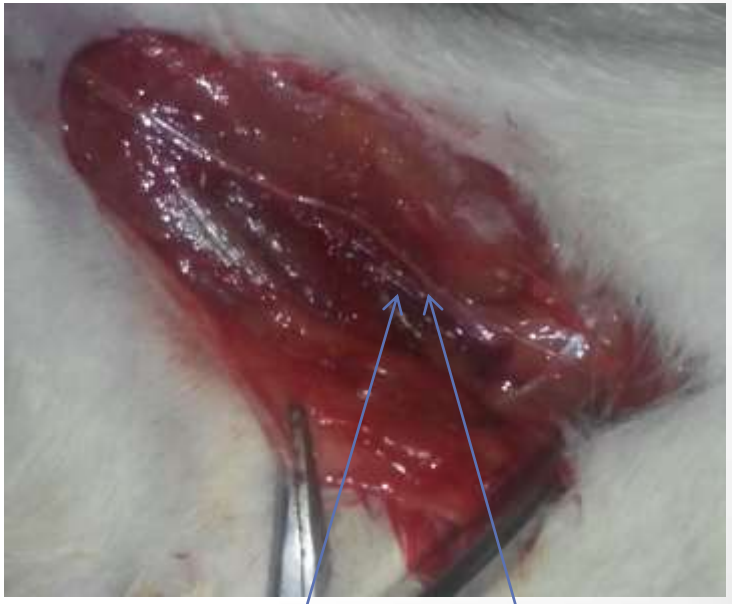
	HCB group			Control group		
AnimalNo.	ACT	Hemostasis	Hematoma	ACT	Hemostasis	Hematoma
1	348	5	0	344	12.5	+
2	268	5	0	412	7.5	+
3	447	5	0	257	12.5	+
4	800	12.5	+	1061	12.5	++
5	361	15	+	244	12.5	++
6	480	5	0	205	10	+
7	262	5	0	260	12.5	+
8	272	5	0	469	5	0
9	433	5	0	388	12.5	+
Mean+/-	**372±73.1**	**6.94±3.9**		**404±262**	**10.8±2.8**	

ACT values in seconds, hemostasis time in minutes; Hematoma grades 0 = none, + = minor, ++ = significant

Draft experiment

- **Aim** – development of transcutaneous access to the femoral artery





Casual experiment

5 min

- the presence of bleeding
- amount of blood loss

Results

Material	presence of bleeding	amount of blood loss (mg)
Gauze	+	1350
Chitosan	-	240
Chitosan after gauze	+	120