

Clinical Efficiency of Hemoben Wound Coating for Liver and Spleen Injuries

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Abstract **Aim** of the study was to determine the hemostatic efficacy of the drug "HEMOBEN" in patients with parenchymal organ injuries. **Background.** The small intestine, liver and spleen are most often injured at combined trauma of the abdominal organs. The liver is second only to the intestine in terms of the frequency of injuries. The study included only patients who were admitted with liver or spleen injury on the background of blunt trauma or stab wound, in whom combined injuries of other organs and systems did not threaten their lives (without fatal outcomes on the background of critical condition). **Material and methods.** The patients were divided into two groups: Main Group (n=19) where Hemoben was used for hemostasis; Comparison Group (n=40) where mechanical and physical methods of hemostasis had been used. The cause of parenchymal organs injury (liver and/or spleen) both in isolation and in combination with other organs and tissues in 67.5% of the Comparison Group and in 63.2% of the Main Group were blunt trauma, while stab wounds made up only from 7.5% to 10.5%. **Results.** Comparative analysis showed that hemostasis with the use of Hemoben was significantly more effective ($\chi^2=1.052$; (df=1); $p=0.306$, $p<0.05$) than the use of suturing and /or coagulation of the wound. A similar trend can be traced with the spleen injury: the proportion of splenectomy using Hemoben was significantly lower (36.4%), and hemostasis was higher and made up 63.6%, which was statistically significant ($\chi^2=4.082$; (df=1); $p=0.044$, $p<0.05$). **Discussion.** A feature of the "HEMOBEN" composition is the presence of easily decomposable calcium ions in it, which further accelerates the stopping of bleeding in the affected area upon contact with blood. According to our data, a new domestic wound coating made of cellulose derivatives with prolonged action has a good hemostatic effect when modeling parenchymal bleeding from a spleen wound, providing the formation of a film with tight adhesion to the wound surface. **Conclusion.** If we consider isolated liver injury, the efficiency of hemostasis did not significantly differ both in the main and in the comparison groups.

Keywords Hemostasis, Liver, Spleen, Combined injury

1. Introduction

The small intestine, liver and spleen are most often injured at combined trauma of the abdominal organs. The liver is second only to the intestine in terms of the frequency of injuries [1]. Liver injuries due to special diagnostic difficulties, the severity of the course and the high frequency of complications are the most dangerous among the abdominal cavity closed injuries [2]. Postoperative mortality in liver injury remains high and reaches 12-34%, and various intra-abdominal complications are noted in 17-35% of patients [1,3-5]. The spleen is also often injured in case of a closed injury of the abdomen, and its traumatic defects are more bleeding. The main cause of an unfavorable outcome of liver and spleen injuries is intra-abdominal bleeding, so the timeliness of surgical intervention and the choice of an adequate method of hemostasis are of particular importance.

Tactical and technical errors during the surgery expressed in an unjustified expansion of the intervention volume, lead to an increase of mortality [6-8]. Currently, the main method of treating liver wounds is suturing, which is used according to various authors in 60-80% of surgeries. Its hemostatic effect is due to the fact that the tied thread cuts through the liver parenchyma and vascular formations gather in a bundle. However, suturing the liver has a number of disadvantages: 1) the formation of a necrosis band distal to the suture, respectively, the possibility of abscessing in this area; 2) the likelihood of bleeding with insufficient tightening of the sutures; 3) technical difficulties and the duration of the application; 4) the threat of secondary bleeding [2,3,5,8].

Another commonly used method of hemostasis is electrocoagulation. After its use, a scab is formed with a necrosis zone of 3-5 mm, which serves as a substrate for the development of infectious complications, secondary bleeding [4,6,9]. At the same time, alternative methods of hemostasis are being searched for in case of bleeding from parenchymal organs. Thus, studies were conducted at the

Belarusian State Medical University on the use of inorganic salts to stop bleeding from the liver.

2. Material and Methods

The study included only patients who were admitted with liver or spleen injury on the background of blunt trauma or stab wound, in whom combined injuries of other organs and systems did not threaten their lives (without fatal outcomes on the background of critical condition). Only cases with intraoperative attempt of local hemostasis among patients with spleen damage (that is, splenectomy was not initially used) were analyzed to form comparable study groups. All this allowed to objectively evaluate the hemostatic efficiency of the proposed method.

Aim of the study was to determine the hemostatic efficacy of the drug "HEMOBEN" in patients with parenchymal organ injuries.

3. Results

The predominance of the female sex (67.5%) was noted in the comparison group, while the main one was dominated by males (60.2%). The mean age was 37.3 ± 13.1 years in the comparison group and 35.0 ± 12.8 years in the main group and in both groups ranged from 20-44 years in 78.9% of patients (Tab. 1).

Table 1. Distribution of patients with injuries by sex and age

Age	Male		Female		Total	
	abs.	%	abs.	%	abs.	%
Comparison Group						
Under 19 years	0	0.0%	1	2.5%	1	2.5%
20-44 years	20	50.0%	10	25.0%	30	75.0%
45-59 years	5	12.5%	1	2.5%	6	15.0%
60-74 years	2	5.0%	1	2.5%	3	7.5%
Over 74 years	0	0.0%	0	0.0%	0	0.0%
Total	27	67.5%	13	32.5%	40	100.0%
Main Group						
Under 19 years	0	0.5%	0	0.0%	0	0.0%
20-44 years	8	11.9%	7	15.9%	15	78.9%
45-59 years	1	13.9%	2	22.9%	3	15.8%
60-74 years	1	9.5%	0	15.4%	1	5.3%
Over 74 years	0	4.0%	0	6.0%	0	0.0%
Total	10	39.8%	9	60.2%	19	100.0%

According to parenchymal organs of post-traumatic injury in the comparison group, the spleen injury prevailed up to 55%, while in the main group there was no significant difference between isolated liver and spleen injuries (Tab. 2).

The cause of parenchymal organs injuries (liver and/or spleen) both in isolation and in combination with other organs and tissues in 67.5% of cases in the Comparison

Group and in 63.2% of patients of the Main Group were blunt trauma, while stab wounds made up only from 7.5% to 10.5% (Tab. 3).

Table 2. Structure of patients with liver or/and spleen injury by groups

Wound localization	Comparison Group		Main Group	
	absolute	%	absolute	%
Spleen	22	55.0%	9	47.4%
Liver	15	37.5%	8	42.1%
Liver and spleen	3	7.5%	2	10.5%
Total	40	100.0%	19	100.0%

Table 3. Distribution of patients by type of injury

Type of injury	Comparison Group		Main Group	
	Abs.	%	Abs.	%
Isolated blunt trauma of the liver or/and spleen	19	47.5%	8	42.1%
Isolated stab wound of the liver or spleen	2	5.0%	1	5.3%
Blunt trauma of the liver or/and spleen and other abdominal organs	3	7.5%	1	5.3%
Blunt trauma of the liver or/and spleen and other extra-abdominal organs	8	20.0%	4	21.1%
Blunt trauma of the liver and/or spleen and other extra- and abdominal organs	5	12.5%	3	15.8%
Stab wound of the liver or spleen and other organs of the abdominal cavity	3	7.5%	2	10.5%
Total	40	100.0%	19	100.0%

As a new domestic wound coating with a prolonged hemostatic effect, a cellulose derivative agent, Hemoben, was used, which differs from the previously known Geprocel by including viscose at a concentration of up to 12% in the coating composition.

"HEMOBEN" is a fine powder formed from absorbable Na-carboxymethylcellulose (Na-CMC), viscose and calcium ions attached to them. Its carbohydrate biopolymer is almost indistinguishable from protein biopolymers in that it almost does not cause immune responses (inflammatory response reactions), its resorption capacity is high, and its adhesive properties with injured tissue are excellent. This adhesive advantage prevents its "washing out" from the wound surface. Also, unlike protein collagen sponges, these biopolymers have high hygroscopic properties, creating a neutral environment when blood is absorbed in the wound area. It also forms a colloidal solid mixture when it absorbs water from the blood. Based on the theory of osmotic pressures, a certain amount of colloidal mass seeps into the tissue in the affected area or into the capillary vessel in the area of injury. This, in turn, closes the injured capillaries like a "cork" and stops the bleeding. Another equally important property of Na-CMC is pseudoplasticity

(weakening without reversing the apparent viscosity with an increase in the velocity gradient of parallel layers of fluid under isothermal and reversible conditions), which ensures reliable blockage of bleeding parenchymal vessels when the edges of the organ come closer to the hemostatic sponge located between them [1,7,10]. Viscose is an artificial derivative of cellulose and is biodegradable within 3-4 weeks. Note: in 3 cases of the comparison group and in 2 patients of the main group, there was combined injury of the liver and spleen. Interventions were performed on a total of 43 and 21 organs (in 40 and 19 patients), respectively.

Table 4. Distribution of patients according to the type of primary wound treatment

Surgeries	Comparison Group		Main Group	
	Abs.	%	Abs.	%
Coagulation of the spleen wound	25	58.1%	11	52.4%
Coagulation of the liver wound	2	4.7%	2	9.5%
Suturing and coagulation of the liver wound	14	32.6%	7	33.3%
Laparoscopic coagulation of the liver wound	2	4.7%	1	4.8%
Total	43	100.0%	21	100.0%

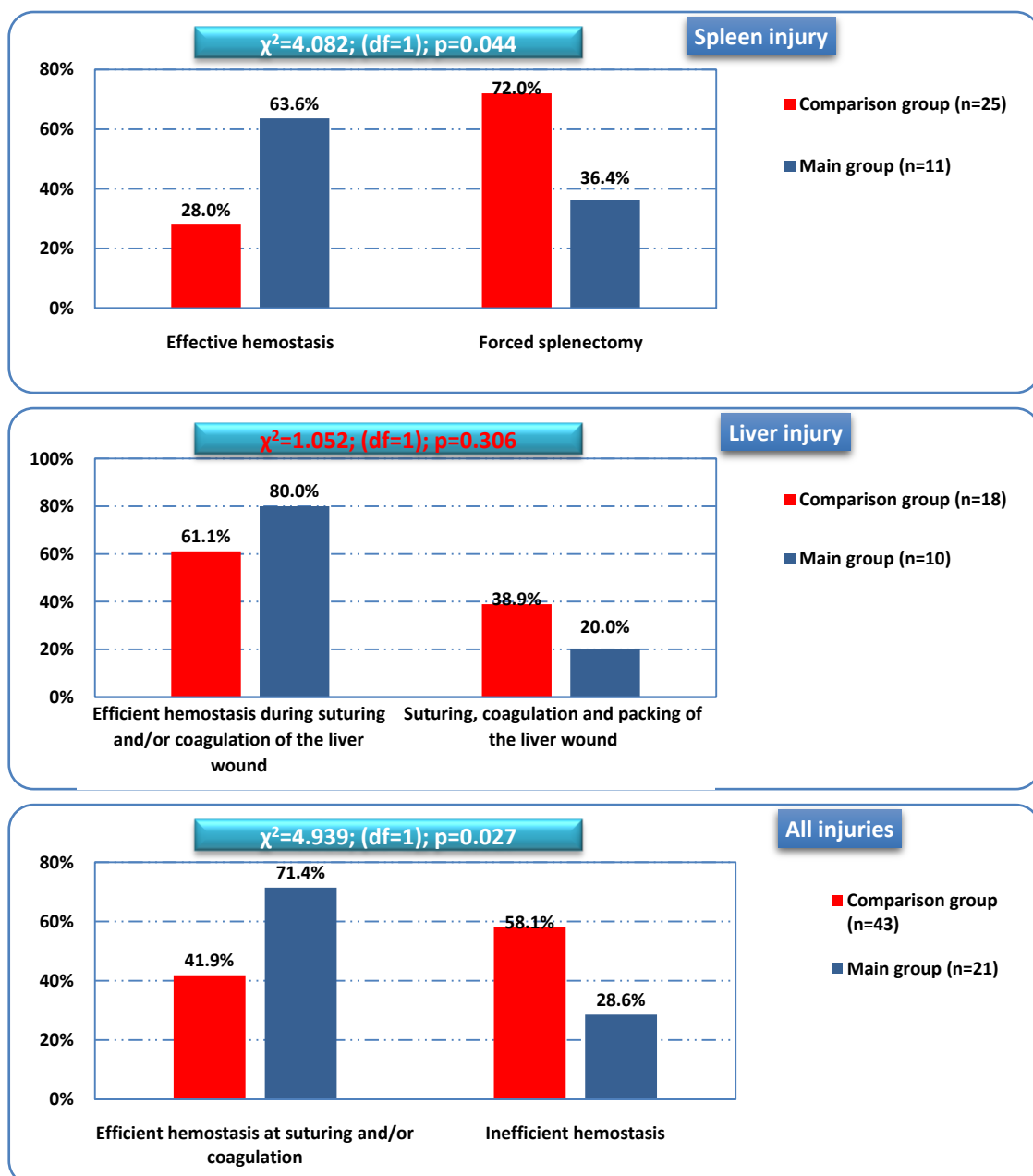


Figure 1. The efficiency of local hemostasis attempts at injury of the liver parenchyma and (or) spleen

Table 4 shows that in the Comparison Group, physical and mechanical methods of hemostasis were used in 43 patients, whereas in the Main Group, Hemoben wound coating was used to stop bleeding.

The amount and parameters of hemoglobin separated from the abdominal cavity through drainage tubes were evaluated in patients to estimate the efficiency of hemostasis in the postoperative period. The other indicators were the average period of the abdominal cavity drainage and the duration of the hospital period. Tampons were removed from the abdominal cavity after 3-5 days.

The comparative analysis given in Figure 1 showed that hemostasis when using Hemoben was significantly more effective ($\chi^2=1,052$; (df=1); $p=0,306$, $p<0.05$) than the use of suturing and / or coagulation of the wound. A similar trend was observed with spleen injury: the proportion of splenectomy using Hemoben was significantly lower than 36.4%, and hemostasis was higher and made up 63.6%, which is statistically significant ($\chi^2=4.082$; (df=1); $p=0.044$, $p<0.05$). If we consider isolated liver injury, the efficiency of hemostasis did not significantly differ both in the Main and in the Comparison groups.

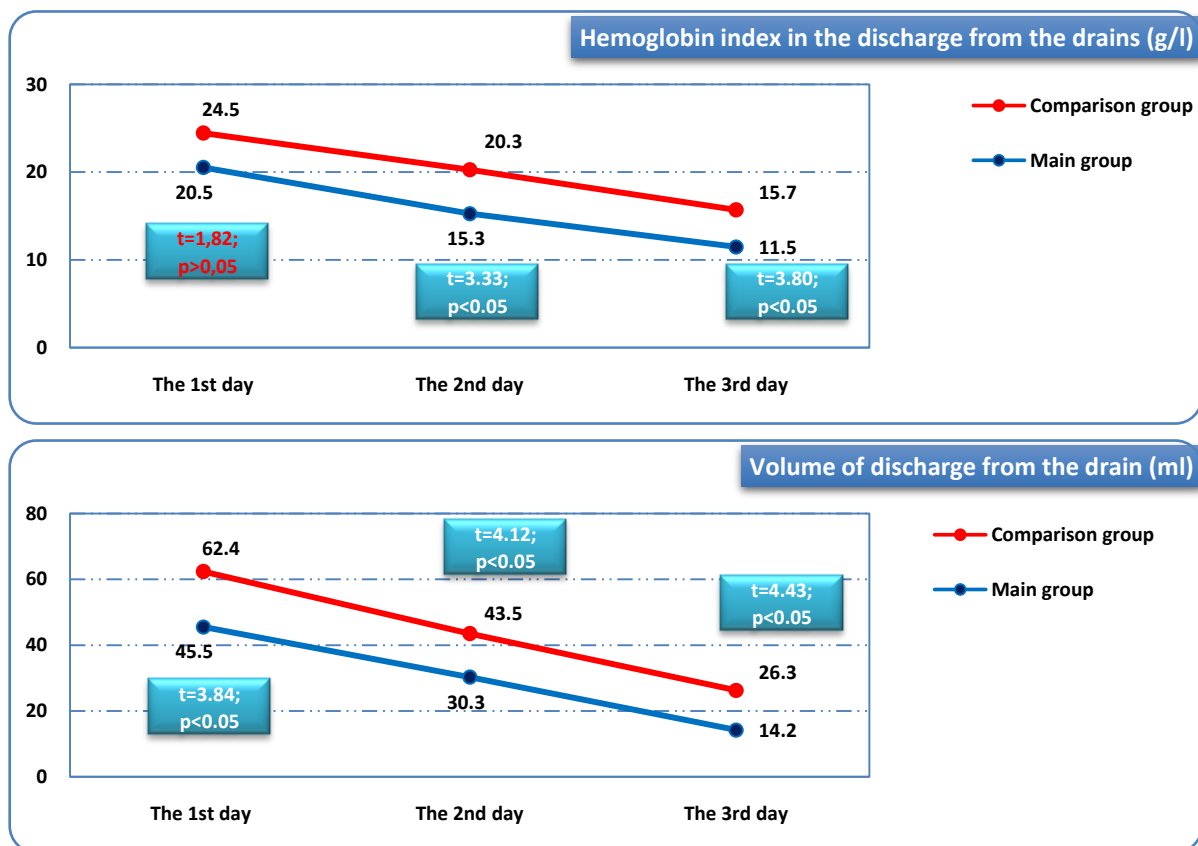


Figure 2. The volume and index of hemoglobin in the discharge from the drains

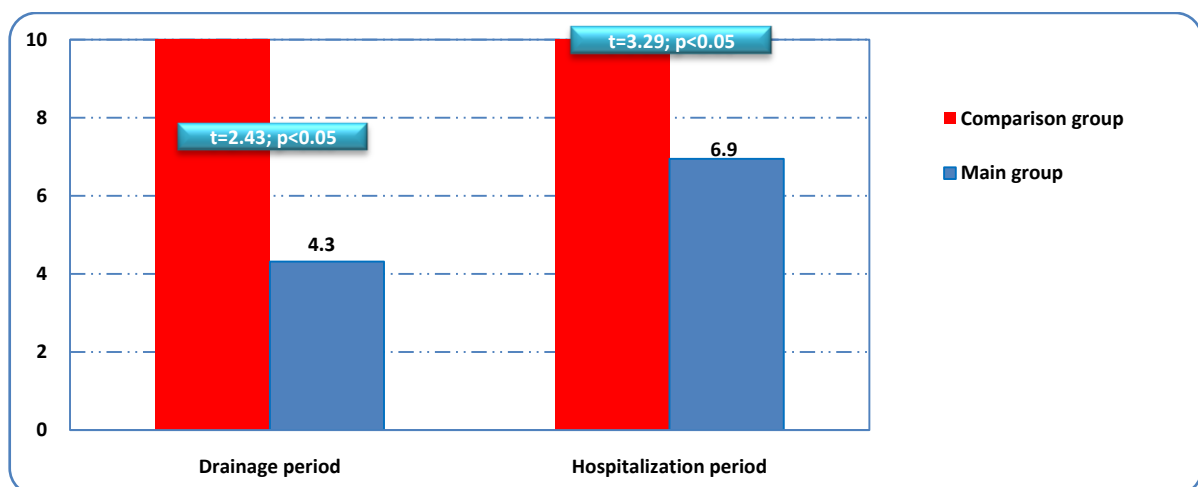


Figure 3. Average drainage period and duration of the hospital stay (days)

Analysis of the quantitative index of hemoglobin in the drainage tubes showed that on the 1st day in both groups there was no significant difference, while on the 2nd and 3rd day the hemoglobin values significantly ($p<0.05$) decreased in the Main group. The volume of discharge from the first day was significantly lower in the main group (Fig. 2).

When analyzing the duration of drainage and hospital stay, it was found that both of these indicators were significantly higher in the Comparison Group (Fig. 3).

Thus, the average drainage period in the main group made up 4.3 days, and in the comparison group this index made up 5.8 days ($p<0.05$), as well as the hospitalization period was 6.9 and 8.3 days, respectively ($p<0.05$).

4. Discussion

From the biomechanism of blood coagulation, it is known that the formation of fibrin protein, which enhances its adhesion and the framework of a thrombus during the formation of platelets, depends in parallel on the concentration of calcium ions. For this reason, a feature of the "HEMOBEN" composition is the presence of easily decomposable calcium ions in it, which further accelerates the stopping of bleeding in the affected area upon contact with blood. This has been shown by the above studies. According to our data, a new domestic wound coating made of cellulose derivatives with prolonged action has a good hemostatic effect when modeling parenchymal bleeding from a spleen wound, providing the formation of a film with tight adhesion to the wound surface. At the same time, the initial application completely stops capillary bleeding, and additional application of the powder to a limited surface ensures complete hemostasis, eliminating the possibility of blood leakage with the formation of hematomas in the area of interest and blood congestion, as well as infection and inflammatory reaction from surrounding tissues.

Unlike collagen protein hemostatic sponges, a fine powder formed by absorbable Na-carboxymethylcellulose (Na-CMC), viscose and calcium ions "HEMOBEN" attached to them when applied to parenchymal organ injuries provides full-fledged long-term hemostasis.

5. Conclusions

Clinical evaluation of the use of the new domestic biocoating Hemoben showed an improvement in the local hemostatic effect in traumatic injuries of the liver or spleen parenchyma from 41.9% (18/43) of patients in the Comparison group to 71.4% (15/21) in the Main group.

In the remaining 58.1% of cases of the Comparison group versus 28.6% of cases of the Main group ($\chi^2=4.939$; $df=1$; $p=0.027$), forced splenectomy (for the spleen injuries) and packing (areas of liver injury) were performed.

There was a more pronounced decrease in the level of hemoglobin in the discharge from the drainage in dynamics (on the 3rd day up to 15.7 ± 6.2 g/l in the Comparison group and up to 11.5 ± 2.2 g/l in the Main group; $t=3.80$; $p<0.05$), as well as its volume (on the 3rd day up to 26.3 ± 15.5 ml in the Comparison group and up to 15.5 ± 5.1 ml in the Main group; $t=4.43$; $p<0.05$). It allowed to reduce the drainage duration from 5.8 ± 2.2 days in the Comparison group to 4.3 ± 2.1 days in the Main group ($t=2.43$; $p<0.05$), and, accordingly, to reduce the duration of the hospital stay from 8.3 ± 1.6 days in the Comparison group to 6.9 ± 1.4 days in the Main group ($t=3.29$; $p<0.05$).

The authors declare no conflict of interest.

This study does not include the involvement of any budgetary, grant or other funds.

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