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REVIEW ARTICLE

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Modern Technologies of Endoscopic Hemostasis in the Treatment of Ulcer Gastroduodenal Bleeding: A Literature Review

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Abstract

The treatment of upper gastrointestinal bleeding (UGIB) remains one of the complex problems of clinical practice. In the structure of UGIB, 30%-60% of cases are occupied by bleeding of ulcerative etiology. Success in treating patients with ulcerative gastroduodenal bleeding is possible only with the use of an integrated approach that includes endoscopic, medicinal, endovascular, and surgical hemostasis technologies. In contrast, endoscopic hemostasis (EH) is crucial in the treatment of such patients. The use of modern advances in endoscopy can significantly improve the treatment results of patients with UGIB, reducing the number of operations and mortality in this severely affected group of patients. Modern therapeutic endoscopy has a wide arsenal of tools that can reliably stop bleeding. They differ from each other in the nature of impact, effectiveness, availability, safety, and cost. This article presents an overview of the technological and clinical features of hemostasis, modern views on the choice and application of methods of EH for ulcerative gastroduodenal bleeding.(**International Journal of Biomedicine. 2021;12(1):9-18.**)

Key Words: gastrointestinal hemorrhage • endoscopic hemostasis • peptic ulcer disease • powdered hemostatic systems

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Abbreviations

AGDU, acute gastroduodenal ulcers; **APC**, argon-plasma coagulation; **EH**, endoscopic hemostasis; **GIB**, gastrointestinal bleeding; **LDA**, low-dose aspirin; **NSAIDs**, non-steroidal anti-inflammatory drugs; **OTSC**, over-the-scope-clip; **PUD**, peptic ulcer disease; **PRP**, platelet-rich plasma; **UGIB**, upper gastrointestinal bleeding.

Introduction

The treatment of UGIB is a serious problem of global clinical practice, which is due to the high rates of morbidity and mortality in this pathology. From 40 to 150 cases of gastrointestinal bleeding (GIB) per 100,000 population are registered annually. The overall mortality in this pathology is at a high level and reaches extremely high figures (40%) with the development of recurrent hemorrhage. From an economic point of view, this problem is also very acute, which is associated with the enormous costs of healthcare systems for the treatment of GIB patients.[1-5]

The largest number of cases in the structure of UGIB falls on the share of bleeding of ulcerative etiology – 30%-60% of cases. PUD of the stomach and duodenum is a chronic recurrent disease with various variants of the course, characterized by

the formation of an ulcerative defect in the mucous membrane and submucosal layer, due to a local inflammatory-necrotic process with an imbalance of intragastric factors of aggression and defense.

PUD is chronic, often recurrent, affecting the young and able-bodied. The progression of PUD is inevitably combined with the development of its complications, in the structure of which the first place is occupied by UGIB (40%-51%), developing in every 10 patients with PUD.[6,7]

Gastroduodenal ulcers can also form due to factors unrelated to the pathogenesis of PUD. These lesions of the gastrointestinal tract are commonly referred to as acute or "symptomatic" gastroduodenal ulcers (AGDU), which have a clear connection with provoking factors with a short history of the development of the disease. According to recent publications, more than half of UGIBs of ulcerative etiology develop as a result of AGDU, rather than PUD, and the number of patients with bleeding from AGDU increases from year to year. Bleeding from AGDU is most common in elderly patients, in patients with burns, after severe surgical interventions, with acute myocardial infarction, cardiovascular insufficiency, uremia, sepsis, and other urgent conditions. The occurrence of this formidable complication in patients with urgent conditions significantly worsens the results of their treatment and often leads to fatal outcomes.[8,9]

One of the types of AGDU is drug ulceration of the stomach and duodenum, the so-called drug ulcers or gastropathy. They are most often formed with the prolonged, uncontrolled intake of anticoagulants, LDA, NSAIDs, glucocorticosteroids, etc.[10-12]

Success in the treatment of patients with ulcerative gastroduodenal bleeding, according to many authors, is possible only with the use of an integrated approach. The main factors determining the successful treatment of patients with ulcerative bleeding are EH, drug-induced hemostasis, and endovascular and surgical hemostasis. At the same time, conservative methods of stopping UGID are of crucial importance in the treatment of such patients, in which EH is of leading importance, and surgical treatment should be performed only in cases when all the possibilities of conservative treatment have been exhausted.[13,14] In this regard, the study of modern methods of EH of UGIB is of particular relevance.

General issues for technologies of EH of UGIB

Endoscopy for UGIB is the most significant endoscopic procedure. Urgent endoscopic examination of the upper digestive tract plays an important role both in the diagnosis and in the treatment of GID. There is no doubt that the decisive role in providing highly qualified care to patients with UGIB belongs to EH and preventing the resumption of GIB. The use of therapeutic endoscopy in patients with UGIB of ulcerative etiology, especially in patients with severe concomitant pathology, and severe blood loss, avoids surgical treatment and reduces overall mortality.[15-17]

Modern endoscopy has a wide arsenal of tools that can reliably stop bleeding. They differ from each other in the nature of impact, effectiveness, availability, safety, and cost. The ideal remedy for EG in UGIB should meet the following requirements: reliable mechanical compression of the bleeding vessel; protection of ulcers from the aggressive effects of gastric contents; the possibility of its application through an endoscope; high hemostatic properties that persist against the background of various coagulopathies; a large area of contact with blood and bleeding surface; presence of sorption, adhesive and plastic properties; long-term preservation on the surface of the bleeding source; positive effect on trophic and regenerative processes; antimicrobial effect; absence of antigenic and toxic properties; safety during application; cheapness; and ease of production and application.[18-20]

The main methods of EH include injection therapy, thermal therapy, mechanical therapy, topical therapy, and combined methods. The choice of the EH method depends on the etiology, localization of the source of hemorrhage, type of UGID, features of the bleeding lesion, the experience of the endoscopist, and technical equipment of the clinic. At the same time, not only implementing primary hemostasis, but also, most importantly, preventing the resumption of bleeding is crucial in the endoscopic treatment of GIB.[21-23]

Injection therapy

Injection EH is the most common method of stopping UGIB and requires only an endoscopic injector and a solution for injecting the source of hemorrhage, which determines the simplicity, accessibility, and cheapness of using this method of hemostasis. When using drugs for the purpose of injection hemostasis, it is necessary that the drug meet certain requirements: low absorption rate, no locally damaging effect on tissue, availability, and low cost of the drug. Most often, a solution of epinephrine in dilution 1:10000/1:20000, 5% solution of aminocaproic acid, 1% solution of hydrogen peroxide, 5% ascorbic acid, ethanolamine, thrombin, sodium tetradecyl sulfate, etc. are used as a hemostatic agent for injection therapy. The mechanism of action of injection therapy consists in compressing the source of bleeding by infiltrate created during paravasal administration of the medicinal solution, as well as by pharmacological mechanisms of action of the injected drugs.[24]

Most often, in clinical practice, pricking the source of bleeding with epinephrine in a dilution of 1:10000 or 1:20000 is used. Injection therapy with epinephrine leads to bleeding stoppage due to infiltrative compression of the eroded vessel, spasm of the eroded vessels, and stimulation of platelet aggregation at the bleeding site. The injection is made into the submucosa and/or directly into the base of the ulcer in four zones around the eroded vessel in an amount of 0.5 ml to 2 ml of epinephrine solution (1:10000). At the same time, it is important to retreat from the border of the bleeding vessel at least 3 mm. The disadvantages of this method include: within a short period of time, the infiltrate created by the injection resolves, vasospasm is stopped, which leads to the development of a recurrence of hemorrhage. In this regard, this method of EH in the form of monotherapy is not recommended.[25,26]

In recent years, solutions of sclerosants have been actively used for EH: 96% ethanol, ethanolamine, sodium tetradecyl sulfate, polydicanol, etc. The mechanism of action of sclerosants consists in the dehydration and fixation of the wall of the damaged vessel to the surrounding tissues, which leads to the destruction of the endothelial cells of the vessel

and the formation of a dense thrombus. At the same time, the use of sclerosants has a number of significant drawbacks: firstly, the administration of the drug in small doses is often insufficient, and secondly, hemostasis is achieved due to vascular thrombosis, tissue necrosis and inflammation at the injection site, which can lead to perforation of the organ wall (1-3% of cases). These drugs should be used with caution in small quantities due to the fear of developing deep tissue necrosis.[27,28]

Another class of injectable agents is tissue adhesives, which include thrombin, fibrin, and cyanoacrylate adhesives that clog the site of hemorrhage. Fibrin glue consists of two components: human fibrinogen with coagulation factor XIII and an activator solution containing human thrombin, which are in two separate syringes. During hemostasis, these two components are mixed by agents, which leads to the formation of a clot, thereby simulating the final phase of the physiological cascade of blood clotting. Fibrin glue is commercially used in Europe for EH in bleeding ulcers and varicose veins. It should be noted that the procedure for hemostasis is quite complicated and requires some experience. In some cases, if the glue technology is used incorrectly, glue polymerization is possible in the lumen of the injector or in the working channels of the endoscope, which can lead to damage to endoscopic equipment and failure in hemostasis of UGIB.[29]

A promising method is injectable hemostasis by pricking a bleeding ulcer defect with platelet-rich autoplasm (PRP) of the patient. PRP is obtained immediately before the procedure by centrifugation of the patient's blood. Introducing PRP into the submucosal layer of the periulcer zone for a long time creates compression by infiltration of tissues due to edema, which leads to persistent hemostasis and prevents the development of relapses. In addition, PRP contains autogenic "growth factors" that stimulate intensive recovery of the affected area of the mucous and submucosal layers of the stomach and duodenum. PRP is injected in a volume of 2 ml endoscopically into the submucosal layer of the periulcer zone. The method provides stable hemostasis and significantly reduces the number of relapses, which contributes to improving the quality of life of patients and reducing treatment costs. However, this method is also not without drawbacks: the preparation of PRP requires a certain amount of time, which is not always possible in patients in critical condition; to obtain PRP requires specialized systems that are not always available in clinical practice. In addition, there are no randomized controlled clinical trials showing the effectiveness of this method of EH.[30,31]

It should be noted that none of the types of solutions for endoscopic injection hemostasis has significant pronounced advantages and cannot be used as the "gold standard" of endoscopic treatment.

Thermal therapy

Thermal therapy methods of EH are widely used in clinical practice. The mechanism of action of these methods of hemostasis consists of the use of thermal energy in order to coagulate eroded vessels and stop bleeding. Laser photocoagulation, diathermocoagulation, radiofrequency ablation, and APC have become the most widespread.[32]

One of the methods of thermal therapy of UGIB is laser photocoagulation. As a method of EH, laser coagulation uses laser radiation in order to create coagulation necrosis in the area of the source of GIB. High-power lasers of more than 10 watts are used. The effectiveness of laser photocoagulation in UGID is observed in 80%-90% of cases; the frequency of relapses after successful coagulation is high, reaching 28%. The advantage of laser coagulation is contactless, but this method has technical limitations. Thus, with continued jet bleeding, the blood coming from the eroded vessel scatters the laser beam, thereby weakening the coagulating effect. In the presence of a clot on the surface of the ulcerative defect, it is also impossible to provide laser hemostasis. To stop bleeding with continued bleeding, it is necessary to increase the radiation power and exposure time, which, in turn, increases the risk of perforation. The way out of this problem was the use of contact laser coagulation, but at the same time, the main advantage of this method is lost – it's non-contact. The high cost of using laser photocoagulation, in the presence of other disadvantages of this method, limits the possibility of its use in clinical practice.[33-37]

The most common method of EH is diathermocoagulation. There are several ways to use it: unipolar or bipolar electrocoagulation, multipolar diathermocoagulation, and liquid diathermocoagulation. In bipolar diathermocoagulation, hemostasis is achieved by the formation of coagulation necrosis between two located electrodes when an electrical circuit is closed. During coagulation, a blood clot forms in the vessel, both directly at the site of coagulation and throughout, due to the spread of the zone of coagulation necrosis. When using monopolar coagulation, tissue damage is more extensive and deep than when using the bipolar method. In this regard, it is advisable to use bipolar diathermocoagulation with bleeding from small vessels, and with bleeding from larger vessels, the monopolar method is preferred. Despite the many advantages of diathermocoagulation, this method is not without drawbacks. One of the most formidable complications when using it is deep necrosis of the organ wall, which can lead to perforation.

The method of diathermocoagulation is a contact method, and when the electrocautery is withdrawn, bleeding may resume due to the separation of the formed thrombus.[38,39]

The solution to the main drawback of the electrocoagulation method in the form of sticking the electrode to the source of bleeding was a method of "liquid" diathermocoagulation, developed by the staff of the Department of Faculty Surgery of the Voronezh N.N. Burdenko State Medical University. Coagulation of the bleeding source when using "liquid" diathermocoagulation occurs through an electrolyte, which makes it possible to coagulate the bleeding vessel directly without subsequent separation of the electrode from the coagulation scab. In addition, this method is more gentle and causes less damage to surrounding tissues than traditional electrocoagulation.[40,41]

An alternative to the electrocoagulation method is heater probe thermocoagulation, which consists in cauterizing the source of bleeding with a heated aluminum cylinder-probe coated with Teflon.

Closing the electrical circuit leads to the aluminum cylinder heating to 150 degrees. With the help of a red-hot tip, the source of bleeding is cauterized, resulting in coagulation hemostasis. The use of Teflon as a sprayer reduces the possibility of tissue burning to the probe and increases the effectiveness of this method. However, this method is also a contact method, and the possibility remains that the coagulation scab will be separated during its application. In addition, local exposure to high temperature leads to deep destructive processes forming in the area surrounding the source of bleeding tissues, which worsens the reparative processes in the area of ulcerative defect and is a prerequisite for the development of repeated bleeding.[42-44]

Argon-plasma coagulation (APC) is an effective non-contact method of EH. It is based on the application of high-frequency electric current in the flow of ionized argon. The absolute advantage of this method is that it is a non-contact mode since the impact is made at a distance of 2mm to 10mm from the source of hemorrhage, and when removing the electrode, there is no threat of clot separation. In addition, the coagulation depth does not exceed 3 mm, which avoids the possibility of perforation of the organ wall. The disadvantage of APC is the high cost of the equipment, which limits the possibilities of its use. The effectiveness of primary EH when using APC reaches 95%-98%, but the occurrence of hemorrhagic relapses, even after a successful primary stop of bleeding, reaches 12.5%-15% of cases, which may be due to the effect of coagulation on the source of bleeding, as well as the lack of protection of the coagulation scab from the aggressive environment of gastric juice.[45-48]

The method of radiofrequency ablation, based on the effect of radio waves, has become widespread. When using radiofrequency ablation, radiofrequency evaporation of tissues occurs by forming a surface layer of necrosis. With this method, the electrode remains cold all the time and does not cause burns to the surrounding tissues. The effect of coagulation is also associated with vasoconstriction and evaporation of an intercellular fluid, which leads to additional spasms of the eroded vessels. The advantage of radiofrequency ablation is its safety and low risk of perforating the organ wall. Radiofrequency ablation allows for primary EH in 95%-97% of cases, but the recurrence rate remains high (10%-13% of cases), which is explained by disadvantages similar to APC.[49,50]

Mechanical therapy

One of the effective methods of EH in UGIB is clipping, which consists in squeezing the source of bleeding with the endoscopic hemoclips (endoclips). Hemoclips can be used for active bleeding of Forrest IA-IB, in the presence of thrombosed vessels of the Forrest IIA ulcerative defect area, as well as for closing perforations and fistulas. They were first introduced into clinical practice in Japan, and later their use expanded after certain technical improvements. Currently, the use of endoclips is considered a safe and effective method of EH - an alternative to surgical treatment of patients.[51,52]

The mechanism of hemostasis with the use of endoclips is similar to the mechanism of surgical stitching of a bleeding vessel. The clip is carried out through the instrumental channel of the endoscope and fixed with a clip on the base of the vessel, while achieving a reliable stoppage of bleeding. There is a direct clipping – when the clip is applied directly to the base of the bleeding vessel; and indirect – the capture of the vessel together with the tissues surrounding the source of bleeding. Endoscopic clips directly squeeze the source of bleeding without causing tissue damage. The available clips differ in several functions (opening and closing, turning the clip, disposable or not) with a total minimum channel size (2.8mm). Their jaw length varies from 9mm to 11mm, which makes them ideal for defects from 10mm to 15mm. The advantage of clipping is its effectiveness in stopping bleeding from large eroded vessels, and its effectiveness in patients with severe hypocoagulation. Currently, a large number of devices for endoscopic clipping with different hole diameters, ease of rotation, and the possibility of re-opening have been developed. However, the disadvantages of this method of EH include technical complexity, which requires high training of endoscopists. Hemoclips are difficult to use in hard-to-reach areas, such as the small curvature of the stomach, the cardia and the posterior wall of the duodenum. With large and callous ulcers, in which the defect tissues are dense and rigid, the imposition often fails to completely compress the source of bleeding when clips are applied, which can lead to insufficient hemostasis or repeated bleeding. It should be noted that even after successful endoclipping, bleeding relapses occur in 1.8%-37% of cases.[53,54]

A modern variant of endoscopic clips is the "over-the-scope-clip" (OTSC) system. Due to their design, size, and high compression force, the OTSC system can be much better fixed in chronic callous ulcerative defects. The OTSC system is effective in 84.9% of cases, and is also effective in the difficult localization of ulcers in the posterior wall of the duodenum. These results show that the OTSC system is a possible method of choice for patients who are at high risk for an operation.[55-57]

Topical therapy

The topical therapy method of EH is one of the earliest in therapeutic endoscopy. For application to the surface of a bleeding ulcer, vasoconstrictive and hemostatic drugs are used: Thrombin, Firrogen, Caprofer, Amifer, Feracril, Fibrin, medical adhesives, etc. However, adhesive compositions have water-repellent properties; the rejection of the polymer film from the bleeding defect occurs within a few hours to one day, so the time of its therapeutic effect is sharply limited. At the same time, it should be noted that film-forming polymers do not have local hemostatic properties, and implementing the therapeutic procedure itself has certain difficulties.[58-60]

The advantages of using the topical therapy method are ease of use, easier access to complex anatomical zones of the gastroduodenal region, not necessarily accurate targeting of the source of hemorrhage, the possibility of covering large bleeding eroded surfaces with decaying tumors of the digestive tract. At the same time, the effectiveness of the application of EH methods to stop ongoing ulcerative bleeding is considered low. However, the possibility of protecting the ulcerative defect from aggressive factors of gastric and duodenal contents allows this method to be widely used in order to prevent recurrence of bleeding.[61-63]

In recent years, an increasing number of publications have appeared in the literature on the use of modern powdered hemostatic systems TC-325 (Hemospray; Cook Medical Inc., Winston-Salem, NC, USA), EndoClot (EndoClot Plus Inc., Santa Clara, CA, USA) for EH of GIB. The use of powdered hemostatic systems shows promising results in the treatment of patients with UGIB.[64]

Hemospray (TC-325) is a granular, inorganic, natural, mineral absorbent powder made from a material known as bentonite clay (aluminum phyllosilicate). TC-325 has high biocompatibility, is even edible, does not contain organic substances, and has strong absorbent properties. The drug is applied to the source of gastroduodenal bleeding in powder form using a device powered by CO2 cartridges under pressure. The mechanism of action is based on the absorption of water from the surrounding tissues by TC-325 powder, which becomes an adhesive aggregate that creates a mechanical barrier over the bleeding site. After application, Hemospray naturally exfoliates from the surface of the source of hemorrhage and is removed within 1 to 3 days after insufflation. The effectiveness of Hemospray with continued bleeding reaches from 75% to 95%, while the recurrence rate of hemorrhage reaches 8.8% to 22.8%.[65,66]

Another biocompatible hemostatic powder system for flexible endoscopy is EndoClot. EndoClot is a powdered polysaccharide hemostatic system, the chemical substrate of which is dextran, obtained from starch, which manufacturers call "absorbable modified polymers." EndoClot has been specially developed as a powdered hemostatic agent for the treatment of GIB. The mechanism of hemostasis when using EndoClot is based on the chemical properties of dextran, the ability to adsorb blood, thereby concentrating clotting factors and cellular elements on the surface of the granules, which accelerates the clotting process. A comparative study conducted by Vitali et al.[67] showed that Hemospray and Endoclot powders are equally effective as local hemostatics in the treatment of GIB, without differences in short-term or long-term success and repeated bleeding.

The use of powdered hemostatic systems is not possible with spurting hemorrhage FIA, since these hemostatic agents are washed off by a stream of blood and cannot attach to the source of hemorrhage. Clinical studies have shown that the use of these drugs is possible as an intermediate option for temporary hemostasis, since they are safe and effective, but have a temporary effect. It should be noted that sufficient experience has not yet been accumulated in the clinical use of the hemostatic systems Hemospray and EndoClot, which would require larger-scale, randomized controlled clinical trials to determine the effectiveness of their use in clinical practice.[68,69]

The Voronezh City Specialized Center for the Treatment of Patients with GIB has been using powdered granular sorbents (Aseptisorb, Aseptisorb-A, Aseptisorb-D, Sefadex, etc.) for the endoscopic treatment of UGIB for 30 years. The founder of sorption-insufflation therapy of GIB is professor EF Cherednikov.[70-72]

According to scientists in this field, the mechanism of hemostatic action of granular sorbents consists of sorption, absorption, and concentration of platelet and coagulation factors on the surface of sorbent granules. Granular sorbents are chemically neutral compounds that can be used without causing damage to the mucous membrane of the digestive tract. Having a high adhesive activity, granular sorbents are retained in the area of bleeding defects for 3-5 days, after which they are naturally removed from the digestive tract. The application of the sorbent promotes cytoprotective protection of the source of hemorrhage from the aggressive effects of gastric and duodenal contents, creating conditions for the healing of gastroduodenal ulcers. A number of sorbents are endowed with additional pharmacological properties – antiseptic, analgesic, proteolytic, etc.– which expands the indications and effectiveness of their use. However, the use of granular sorbents in the form of monotherapy can lead to repeated bleeding, which the authors attribute to their insufficient hemostatic activity.[73-75]

The improvement of the sorption-insufflation direction of endoscopic treatment of GIB was the combined use of granular sorbents with local hemostatics. In an experimental clinical study conducted on 15 laboratory animals and 115 patients with bleeding from gastroduodenal ulcers, a team of scientists from Voronezh N.N. Burdenko State University showed the effectiveness of granular sorbent Aseptisorb-D in combination with powdered hemostatic in treating ulcerative UGIB, which allowed for final hemostasis in 94.9% of cases, with a recurrence rate of 5.1%.[76-78]

S.V.Barannikov and co-authors used combined endoscopic insufflation of granular sorbent Aseptisorb-A in combination with PRP of patients in an experimental clinical study with a morphological examination of the processes of reparative regeneration of gastroduodenal ulcers. It has been shown that the use of the developed technology based on sorption cytoprotection of ulcerative defects in combination with the use of biologically active hemostatic PRP containing autogenic growth factors contributes to the achievement of final hemostasis in 96.5% of cases, reduces the frequency of resumption of bleeding to 3.5%, while reducing the time and improving the quality of healing of gastroduodenal ulcers.[79-81]

Combined EH

To increase the reliability of EH in ulcerative UGIB, a combination of several methods of stopping bleeding that complement each other is used. This method is called combined EH. The most commonly used injection therapy is used in combination with thermal therapy (APC, diathermocoagulation, laser photocoagulation, etc.). Combination therapy (dual therapy), that is, infiltration in combination with coagulation of the bleeding source, or mechanical compression using hemoclips, remains the optimal endoscopic therapy recommended in the main international clinical guidelines for the treatment of GIB patients.[82,83]

The Cochrane review in 2014 evaluated the results of 19 randomized clinical trials involving 2033 patients and concluded that the use of dual endoscopic therapy significantly reduces the risk of bleeding recurrence and the need for emergency surgical treatment, compared with monotherapy with epinephrine injection therapy. The mortality of patients with gastric bleeding was also lower in the group of combined

EH; the results were not statistically significant. Similar results have been demonstrated in some other meta-analyses. Thus, scientists came to the conclusion that injection therapy with epinephrine should not be used as monotherapy, but only in combination with other methods of EH.[84-86]

The modern technology of combined EH of ulcerative GIB is the use of triple endoscopic therapy in the complex treatment of unstable-stopped gastroduodenal bleeding. Scientists of the Voronezh N.N. Burdenko State Medical University in randomized clinical trials applied an individual approach with combined methods of emergency and preventive EH, including first stopping bleeding by injection therapy with ε-aminocaproic acid, followed by APC and insufflation on the source of hemorrhage of granular sorbents (Aseptisorb-D, Aseptisorb-A) in combination with hemostatic agents Zhelplastan and PRP. The application of the developed technologies made it possible to ensure effective hemostasis of ongoing bleeding (FIA-FIB) in 95.2% of cases, to increase the reliability of preventing recurrence of hemorrhage (FIIA-FIIB) to 95.5%, with a total frequency of recurrence bleeding of 4.5% and activity involving operations of 1.5%.[87]

Promising technologies of EH

Some authors consider three important areas to be the latest achievement in the issues of EH of GIB: the use of Doppler scanning, modern large clips, and powdered hemostatic systems.[88]

Recently, there has been an increase in the interest of scientists in using the capabilities of ultrasound Doppler scanning in the issues of EH of GIB, which is due to the technological development of diagnostic equipment and increased availability of the Doppler probe in flexible endoscopy. The assessment of the source of UGIB using a Doppler probe is more accurate than the classical endoscopic assessment by Forrest, when predicting the risk of recurrence of bleeding, which can improve the quality of treatment of patients with GIB. The Doppler assessment allows establishment of the features of the blood supply to the source of gastroduodenal bleeding and to establish the rate of Doppler-positive arterial flow, which is an important predictor of the development of recurrent hemorrhage and determines the tactical tasks of EH. So, an interesting circumstance is that with the type of bleeding FIIC, which classically has a low risk of recurrence of hemorrhage, in 40.5% of cases, there is a positive arterial Doppler signal, which indicates a high risk of recurrence of hemorrhage and requires endoscopic intervention. The frequency of the positive Doppler signal in the FIA type is 100%, in FIB - 46.7%, FIIA - 90.7%, FIIB - 68.4%, and FIII - 8.3%, which must be taken into account in clinical practice. Repeated Doppler evaluation after primary EH also has prognostic value: maintaining a constant arterial flow in the area of the source of hemorrhage is associated with an increased risk of repeated bleeding. The Doppler scanning technique in GIB endoscopy looks very promising. The use of a Doppler probe makes it possible to more accurately determine the risk of repeated bleeding, facilitates the tracking of artery feeders, and allows evaluating the effectiveness of EH. The importance of Doppler scanning in modern therapeutic endoscopy requires further research and evaluation, but, apparently, this method has some advantages in certain clinical situations.[89-91]

In Japan, in 2012, a technique for hemostasis of UGIB by endoscopic hand suturing (EHS) was developed. In this technique, a bleeding defect is sutured with a continuous suture similar to the surgical stitching of a bleeding vessel. The rigid absorbable suture material is used, which excludes the spontaneous formation of nodes. Using a special flexible endoscopic needle holder (Olympus Co., Ltd., Tokyo, Japan), the endoscopist can securely grip and smoothly rotate the needle. The EHS technique was successfully carried out in experimental studies in vivo on a model of bleeding stomach defects in pigs and in 30 patients with bleeding defects of the gastroduodenal zone. The use of the EHS technique in 97% of cases showed positive results, hemostasis was reliable and final, there was no resumption of bleeding, regardless of the state of the blood clotting system. The EHS duration is 50 minutes with 8.0 stitches.[92]

An alternative to the EHS technique is the Overstitch™ technology (Apollo Endosurgery, Inc., Austin, Texas, USA). The Overstitch™ stitching system is designed to close the hole created for transluminal intervention (transgastric endoscopic appendectomy, transvaginal endoscopic cholecystectomy). In the 2010s, the use of the Overstitch™ system decreased due to the decline in the popularity of transluminal interventions, but Overstitch™ began to be used for intraluminal stitching of gastrointestinal tract tissues. Endoscopic suturing of the defects of the mucous membrane of the gastroduodenal region is useful for stopping GIB. Overstitch™ seems promising in the field of therapeutic endoscopy, since it is easy to use, requires a short suturing time (13 minutes per 1.6 stitches), and provides reliable, long-lasting closure of the defect for the entire wall thickness of the hollow organ. However, it is expensive and inaccessible in some parts of the world.[93]

It is expected that the development of endoscopic stitching techniques for bleeding defects will reduce the risk of bleeding recurrence in patients with high risk of needing an operation. Further studies of the use of EHS and Overstitch™ in hemostasis of GIB and the expansion of indications for the use of these methods are needed.

Conclusion

Thus, to date, there is no single universal method for arresting ulcerative gastroduodenal bleeding endoscopically. In this regard, the development of new, and the improvement of already used, methods of EH is an urgent task of modern emergency surgery.

Competing Interests

The authors declare that they have no competing interests.

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