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Clinical Performance And Efficacy Of Polysaccharide And Absorbable Gelatin Powders As Hemostats.

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ABSTRACT

Hemorrhage control is a critical aspect of medical interventions and surgical procedures. Various hemostatic agents, such as gelatin powder and polysaccharide powder, have been developed to facilitate effective blood clotting and minimize bleeding. Gelatin powder, derived from animal sources, is a widely used hemostat due to its biocompatibility and availability. The major advantages of gelatin powder include its ability to form a stable clot, its adhesiveness to tissues, and its ease of application. Gelatin acts by promoting platelet aggregation and accelerating the coagulation cascade, thereby facilitating hemostasis. Moreover, gelatin is generally well-tolerated by patients, with minimal allergic reactions reported. Polysaccharides possess unique properties, including biodegradability, biocompatibility, and their ability to promote blood clotting through the activation of the coagulation pathway. These powders can absorb water, forming a gel-like substance that aids in clot formation. Additionally, polysaccharides often have antimicrobial properties, reducing the risk of infection at the wound site. However, the disadvantages of polysaccharide powders as hemostats include their potential immunogenicity, the need for precise dosage control, and the possibility of delayed clotting due to variations in individual responses. The choice of hemostatic agent should be based on the specific clinical context, patient characteristics, and the overall risk-benefit analysis.

Keywords: Polysaccharide, gelatin, hemostats.

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INTRODUCTION

Topical hemostatic agents

These are substances used to promote hemostasis and control bleeding at the site of injury or during surgical procedures. They play a crucial role in various medical specialties, including surgery, emergency medicine, and trauma care. Here are some commonly used topical hemostatic agents along with their references:

Absorbable Gelatin Sponge

- Absorbable Hemostat GELFOAM® Prescribing Information. (2020). Pfizer Inc.
- Surgispon (Aegis Lifesciences, India)

Oxidized Regenerated Cellulose (ORC)

- Surgicel™ Family of Absorbable Hemostats Instructions for Use. (2020). Ethicon US, LLC.
- Surgi – ORC (Aegis Lifesciences, India)

Collagen-based Hemostatic Agents

- Surgiflo® Hemostatic Matrix Instructions for Use. (2021). Ethicon US, LLC. Link
- Hemostatic Agents CollaCote® and CollaTape® Instructions for Use. (2021). Integra LifeSciences Corporation.

Fibrin Sealants

- Evicel™ Fibrin Sealant Instructions for Use. (2021). Ethicon US, LLC.
- Tisseel® Fibrin Sealant Instructions for Use. (2021). Baxter Healthcare Corporation.

Hemostatic Powders

- Hemostatic Agent ARISTA™ AH Instructions for Use. (2020). Medtronic.
- QuikClot® Hemostatic Agent Instructions for Use. (2021). Z-Medica, LLC.
- Absorbable Gelatin Powder (Aegis Lifesciences, India)

It is important to note that the selection and usage of topical hemostatic agents should be based on individual patient characteristics, the nature of the bleeding, and the healthcare provider's judgment. Always refer to the specific product instructions for proper usage guidelines and precautions.

Topical hemostatic agents have a wide range of clinical applications and are utilized in various medical specialties. Here are some common clinical applications of topical hemostatic agents [1]:

1. Intraoperative Bleeding Control: Topical hemostatic agents are used to control bleeding during surgical procedures when conventional methods like sutures, cautery, or ligatures are inadequate or impractical. They help achieve hemostasis and minimize blood loss, allowing surgeons to perform procedures with better visibility and precision.
2. Minimally Invasive Surgeries: Topical hemostatic agents are employed in laparoscopic or endoscopic surgeries to control bleeding at the site of surgical incisions or tissue manipulation, as access for direct manual control may be limited.
3. Trauma Care: Emergency Hemorrhage Control: Topical hemostatic agents are used in emergency situations, such as severe traumatic injuries or bleeding wounds, to rapidly control bleeding and stabilize the patient. They can be applied directly to the site of bleeding, aiding in the formation of clots and promoting hemostasis until definitive measures can be taken.
4. Dental Procedures: Oral and Maxillofacial Surgery: Topical hemostatic agents are utilized in dental surgeries, such as tooth extractions, periodontal procedures, and oral implant placements, to control bleeding at the surgical site. They help maintain a clear operative field and prevent excessive bleeding that could hinder the procedure or compromise patient comfort.

5. Hemostasis in Vascular Access, Central Venous Catheter Placement: Topical hemostatic agents are used to achieve hemostasis at the site of insertion after central venous catheterization. They assist in minimizing bleeding complications and reducing the time required for compression [2].
6. Hemostasis in Dermatological Procedures: Biopsy and Excisional Procedures: Topical hemostatic agents are applied after skin biopsies or excisional procedures to control bleeding and facilitate wound healing. They aid in achieving hemostasis and prevent excessive bleeding, allowing for better visualization and post-procedure management.

Clinical application of topical hemostatic agents should be based on the specific needs of each patient and the healthcare provider's judgment. The selection and use of these agents should consider factors such as the location and severity of bleeding, patient coagulation status, potential allergies or contraindications, and the specific properties of the hemostatic agent being used. Table 1 represents the topical hemostats and their commercial names [3].

Table: 1 Topical Hemostats and their commercial names [3]

Topical hemostatic		Commercial name
Passive or Mechanical Agents	Gelatins	Surgifoam®, Gelfoam®, Gelfilm®, Gelita-spon®, Geli putty®
	Collagen	Instat®, Helitene®, Helistat®
	Cellulose-based products: oxidized regenerated cellulose	Surgicel Original®, Surgicel Nu-Knit®, Oxycel®, Surgicel Fibrillar®, Interceed®, Gelitacel®
	Cellulose-based products: oxidized cellulose	ActCel®, Gelitacel®
	Polyssacharide hemospheres	Arista™AH
	Adhesives	BioGlue®
Active Agents	Topical thrombin	Thrombin-JMI®, Evithrom®, Recothrom®
	Fibrin sealants	Tisseel®, Evicel®, Crosseal™
Flowable agents	Porcine gelatin + thrombin Bovine collagen + thrombin	Surgiflo®, Floseal®

Clinical Studies on Topical Hemostatic Agents

Microporous Polysaccharide Hemospheres (MPH) are a new plant-derived polysaccharide powder hemostat. Previous studies investigated MPH as a replacement to non-flowable hemostatic agents of different application techniques (e.g., oxidized cellulose, collagen); therefore, the purpose of this study was to determine if MPH is a surrogate for flowable hemostatic agents of similar handling and application techniques, specifically a flowable thrombin-gelatin hemostatic matrix. Hemostatic efficacy was compared using a heparinized porcine abrasion model mimicking a capsular tear of a parenchymal organ. MPH (ARISTA, 1 g) and hemostatic matrix (Floseal, 1 mL) were applied, according to a randomized scheme, to paired hepatic abrasions (40 lesions per group).

Hemostatic success, control of bleeding, and blood loss were assessed 2, 5, and 10 min after treatment. Hemostatic success and control of bleeding were analyzed using odds ratios and blood loss using mean differences. Hemostatic matrix provided superior hemostatic success relative to MPH at 5 (odds ratio: 0.035, 95% confidence interval: 0.004e0.278) and 10 min (0.032, 0.007e0.150), provided superior control of bleeding at 5 (0.006, <0.001e0.037) and 10 min (0.009, 0.001e0.051), and had significantly less blood loss at 5 (mean difference: 0.3118 mL/min, 95% confidence interval: 0.0939e0.5296) and 10 min (0.5025, 0.2489e0.7561). These findings corroborate other MPH investigations regarding its low-level

efficacy and suggest that MPH is not an appropriate surrogate for hemostatic matrix despite similar application techniques. The lack of a procoagulant within MPH may likely be the reason for its lower efficacy and need for multiple applications [4].

Hemostasis plays a critical and fundamental role in all surgical procedures. Its management has several key points that start with good operative technique and adequate anesthetic support. Certain situations, such as severe bleeding resulting from penetrating trauma, do not depend exclusively on the control of the surgical team and require the support of new solutions that decrease or control bleeding. Since ancient times, a hallmark of medicine has been to act in the control of haemorrhage, and more recently, in the facilitation of hemostasis by the application of topical agents by either manual compression or modern agents. In the last decade, the number of different topical hemostatic agents has grown dramatically.

For the modern surgeon to choose the right agent at the right time, it is essential that he/she understands the mechanisms of action, the effectiveness and the possible adverse effects related to each agent. Thus, the great variety of topical hemostatics, coupled with the absence of a review article in the national literature on this topic, stimulated us to elaborate this manuscript. Here we report a detailed review of the topical hemostatic agents most commonly used in surgical specialties [5].

Bleeding in spine surgery is a common occurrence but when bleeding is uncontrolled the consequences can be severe due to the potential for spinal cord compression and damage to the central nervous system. There are many factors that influence bleeding during spine surgery including patient factors and those related to the type of surgery and the surgical approach to bleeding. There are a range of methods that can be employed to both reduce the risk of bleeding and achieve hemostasis, one of which is the adjunct use of hemostatic agents. Hemostatic agents are available in a variety of forms and materials and with considerable variation in cost, but specific evidence to support their use in spine surgery is sparse. A literature review was conducted to identify the pre-, peri-, and postsurgical considerations around bleeding in spine surgery. The review generated a set of recommendations that were discussed and ratified by a wider expert group of spine surgeons. The results are intended to provide a practical guide to the selection of hemostats for specific bleeding situations that may be encountered in spine surgery [6].

Topical hemostatic agents are used in conjunction with conventional procedures to reduce blood loss. They are often used in cardiothoracic surgery, which is particularly prone to bleeding risks. Variation in their use exists because detailed policy and practice guidelines reflecting the current medical evidence have not been developed to promote best surgical practice in this setting. To address this need, the Society for the Advancement of Blood Management convened an International Hemostatic Expert Panel. This article reviews the available literature and sets out evidence-based recommendations for the use of topical hemostatic agents in cardiothoracic surgery [7].

A wide variety of hemostats are available as adjunctive measures to improve hemostasis during surgical procedures if residual bleeding persists despite correct application of conventional methods for hemorrhage control. Some are considered active agents, since they contain fibrinogen and thrombin and actively participate at the end of the coagulation cascade to form a fibrin clot, whereas others to be effective require an intact coagulation system. The aim of this study is to provide an evidence-based approach to correctly select the available agents to help physicians to use the most appropriate hemostat according to the clinical setting, surgical problem and patient's coagulation status.

The literature from 2000 to 2016 was systematically screened according to PRISMA [Preferred Reporting Items for Systematic Reviews and Meta-Analyses] protocol. Sixty-six articles were reviewed by a panel of experts to assign grade of recommendation (GoR) and level of evidence (LoE) using the GRADE [Grading of Recommendations Assessment, Development and Evaluation] system, and a national meeting was held. Fibrin adhesives, in liquid form (fibrin glues) or with stiff collagen fleece (fibrin patch) are effective in the presence of spontaneous or drug-induced coagulation disorders. Mechanical hemostats should be preferred in patients who have an intact coagulation system. Sealants are effective, irrespective of patient's coagulation status, to improve control of residual oozing. Hemostatic dressings represent a valuable option in case of external hemorrhage at junctional sites or when tourniquets are impractical or ineffective. Local hemostatic agents are dissimilar products with different indications. A knowledge of the properties of each single agent should be in the armamentarium of acute care surgeons in order to select the appropriate product in different clinical conditions [8].

Sutures, hemoclips, and electrocautery are the primary mechanisms used to achieve hemostasis during gynaecologic surgery, but in situations in which these are inadequate or not feasible, an array of hemostatic agents are available to help achieve hemostasis. These agents include physical agents such as cellulose, collagen, or gelatin products as well as biologic agents such as thrombin and fibrin products. Limited data are available on many of these agents, although their use is increasing, sometimes at high costs. In gynaecologic surgery, hemostatic agents are likely most effective when used in areas of oozing or slow bleeding and as an adjunct to conventional surgical methods of hemostasis [9].

Use of MPH in Clinical Applications

Topical hemostatic agents are used to reduce bleeding and transfusion need during cardiothoracic surgery. We report our experience with Arista® AH Absorbable Hemostat (Arista® AH), a novel plant-based microporous polysaccharide hemostatic powder. Data were retrospectively collected for patients (n = 240) that received cardiothoracic surgery at our institution from January 2009 to January 2013 with (n = 103) or without (n = 137) the use of Arista® AH. Endpoints included protamine to skin closure time (hemostasis time), cardiopulmonary bypass time, quantity of Arista® AH applied, intraoperative blood product usage, intraoperative blood loss, chest tube output 48 hours postoperatively, blood products required 48 hours postoperatively, length of stay in the intensive care unit, 30-day morbidity, and 30-day mortality. 240 patients (176 M: 64 F) underwent 240 cardiothoracic procedures including heart transplantation (n = 53), cardiac assist devices (n = 113), coronary artery bypass grafts (n = 20), valve procedures (n = 19), lung transplantation (n = 17), aortic dissection (n = 8), and other (n = 10). Application of Arista® AH led to significant reduction in hemostasis time versus the untreated control group (Arista® AH: 93.4 ± 41 min. vs. Control: 107.6 ± 56 min., p = 0.02). Postoperative chest tube output in the first 48 hours was also significantly reduced (Arista® AH: 1594 ± 949 mL vs. Control: 2112 ± 1437 mL, p < 0.001), as well as transfusion of packed red blood cells (Arista® AH: 2.4 ± 2.5 units vs. Control: 4.0 ± 5.1 units, p < 0.001). There was no significant difference in 30-day mortality or postoperative complications. Use of Arista® AH in complex cardiothoracic surgery resulted in a significant reduction in hemostasis time, postoperative chest tube output, and need for postoperative blood transfusion [10].

Absorbable hemostats such as microporous polysaccharide hemospheres (MPH) are used to manage hemostasis and prevent complications in total knee arthroplasty (TKA). We aimed to determine safety and effectiveness of MPH use in TKA. Records were reviewed for blood loss, hematomas, and infections. No differences existed regarding demographics, superficial infections (P = 0.933) or hematomas (P = 0.393). Positive correlation existed between hematoma and superficial infection (P = 0.009). Blood loss was greater in the treatment group (P = 0.014). MPH demonstrated inferior bleeding control and had no effect on complications. Our results suggest application of this agent may be unnecessary [11].

Microporous polysaccharide hemospheres (MPH, Medafor, Minneapolis, Minneapolis) are a novel hemostatic agent made from purified plant starch. MPH activates the clotting cascade and hyper concentrates platelets and coagulation proteins, while enhancing a hemostatic plug. We evaluated the hemostatic efficacy of MPH compared with standard surgical technique in a porcine open partial nephrectomy model. Standardized lower pole partial nephrectomy was consecutively performed in each kidney of 12 female pigs. Each pig was randomized to 2 groups, namely treatment with MPH application or control with the conventional surgical technique (oxidized cellulose with bolster sutures). The right kidney was harvested 1 half-hour after hemostasis was achieved and the left kidney was harvested after 7 days. Mean animal and resected renal tissue weight were comparable. Ischemic and hemostasis times were significantly decreased in the MPH treated group (2.67 and 4.67 minutes, respectively) vs the control group (8.33 and 7.75 minutes, respectively) (each p < 0.004). Blood loss was equivocal (0.88 gm in the treatment group vs 2.09 gm in the control group, p < 0.07). No hemostatic complications were noted in either group. No evidence of residual foreign material was found in the MPH group at 1 week. MPH provided rapid, effective and durable hemostasis in the porcine open partial nephrectomy model. Additional experimental and clinical evaluation is warranted to define the role of MPH assisted partial nephrectomy in humans [12]. An appropriate hemostatic dressing for prehospital use should lower mortality due to uncontrolled hemorrhage. In this study, the investigators explored the hemostatic effects of Microporous Polysaccharide Hemosphere® (MPH) applied in a rat model with severe femoral artery bleeding. Twelve rats were randomly assigned to MPH and control groups: The femoral artery of each rat was pierced to initiate bleeding. Then, 0.25 g MPH was poured into the bleeding site. A 200-g scale weight was placed over the bleeding site for 30 sec. At 30-sec intervals, the scale weight was removed, and hemostasis was assessed visually. After 30 sec, if the bleeding had ceased, the test was scored and checked as “passed at 30 sec.” If

the bleeding had not stopped, the same procedures were repeated a maximum of 3 times. If hemostasis could not be achieved even after the third application, the test was scored as failed. The same sequence of procedures was repeated for the control group without use of MPH and with only standard compression. Application of MPH resulted in complete control of bleeding in 2 of 6, 4 of 6, and 6 of 6 rats at 30, 60, and 90 sec, respectively. In the control group, however, hemostasis could not be achieved in all 6 rats, even at 90 sec. The difference between the 2 groups was statistically significant (P=.007). Application of MPH and compression with a scale weight significantly decreased the time of hemostasis in the rat model with femoral arterial bleeding [13].

Effective hemostasis is mandatory for brain tumor surgery. Microporous polysaccharide hemosphere (MPH) powder, a white powder compounded from potato starch, was recently introduced for surgical and emergency application. To evaluate the safety and efficacy of MPHs in brain tumor surgery. Thirty-three patients (mean age, 58 years; range, 22-84 years) underwent microsurgical brain tumor resection. Final hemostasis was performed by topical application of MPHs, video recorded, and subsequently analyzed. Blood samples were taken before surgery, before application of hemospheres, and postoperatively. Volume measurements of the tumor, resection cavity, and postoperative hematoma were done on magnetic resonance imaging and computed tomography scans. Clinical examinations focused on neurological outcome, complications, and allergic reactions. Effective hemostasis was achieved by exclusive use of MPHs in 32 patients. In 1 patient, a single arterial bleeding underwent additional bipolar electrocauterization. Mean operative time was 156.8 minutes (range, 60-235 minutes). Hemostasis with MPHs required 57 seconds (mean; range, 8-202 seconds). Subjective neurosurgeons' ranking of the hemostasis effect indicated excellent satisfaction. For the first 3 months, there was no hemospheres-related postoperative neurological worsening, no signs of allergic reaction, and no embolic complications. Early postoperative and 3-month follow-up magnetic resonance imaging and computed tomography scans excluded any expansive bleeding complication. As early as postoperative day 1, MPHs were no longer detected. There was no tumor mimicking contrast enhancement. In neurosurgery, MPHs allow fast and effective minimally invasive hemostasis. In this small case series, no adverse reactions were found [14].
Absorbable hemostatic agents are used routinely following sinus surgery. Recent studies suggest that current biomaterials, such as FloSeal Matrix Hemostatic Sealant (Fusion Medical Technologies, Mountain View, CA) may interfere with mucosal regeneration. This study was designed to evaluate the effects of Microporous Polysaccharide Hemospheres (MPH, Medafor, Inc., Minneapolis, MN), a novel rapidly-absorbing hemostatic powder, on healing and intact sinus mucosa. Prospective, controlled study using the rabbit model. Both maxillary sinuses of 14 New Zealand white rabbits were surgically opened. The mucosa of 10 rabbits were stripped bilaterally, and the left sinus of each was then treated with either MPH or FloSeal. The mucosa of four additional rabbits were incised but otherwise remained undisturbed. Again, the left sinus of each of the four additional rabbits was treated with either MPH or FloSeal. The right sinus served as an untreated control (stripped or intact) in both arms of the study. Animals were recovered and euthanized 2 weeks later. Specimens were examined by a blinded pathologist using light microscopy. Untreated regenerated mucosa showed expected areas of sparse cilia, mild serous gland reduction, and fibrosis. MPH-treated sinuses showed no significant changes compared to respective controls, and no MPH substance was identified. In contrast, regenerating mucosa treated with FloSeal showed extensive loss of cilia, inflammation, and fibrosis. Residual FloSeal particles were present within the sinus cavity and grossly incorporated within healing mucosa. Unexpectedly, intact mucosa exposed to FloSeal showed similar findings. Absorbable hemostatic materials have starkly different effects on mucosal healing. Unlike other agents, MPH is rapidly cleared and has no negative effects on healing or intact sinus mucosa [15].

Preliminary experience in using Microporous Polysaccharide Hemospheres (MPH; Medafor, Inc, Minneapolis, Minnesota, USA) for cerebral and dural sinus hemostasis. Absorbable hemospheres for hemostasis were used in 10 patients (6 men, 4 women, mean age 56.2 years) undergoing cerebral procedures. The indication was corticosubcortical cerebral hemostasis after resection of meningiomas (n=5) and gliomas (n=5). In one case, absorbable hemospheres were applied for generalized oozing over the superior sagittal sinus. The surgical technique, time to bleeding control, and associated complications were recorded. Effective hemostasis, defined as cessation of oozing bleeding, was achieved no later than 2 minutes after topical agent application in all patients except two, in whom the hemostatic application was repeated. Mean follow-up was 12 months. No patient developed allergic reactions or systemic complications in association with hemostatic absorbable hemospheres. There was no case of cerebral hematoma, swelling, or infection after surgery. In this preliminary study, the direct application of absorbable hemospheres helped to control superficial cerebral bleeding, reducing the use of bipolar coagulation and shortening surgical time. Although use of absorbable hemospheres seems to be safe and

effective, further investigations and prospective studies with longer follow-up are strongly recommended to arrive at final conclusions [16].

Clinical Applications of AGS Powder

Topical hemostatic agents are used intra-operatively to prevent uncontrolled bleeding. Gelfoam Powder contains a hemostatic agent prepared from purified pork skin gelatin, the efficacy of which is increased when combined with thrombin. However, the effect of increasing concentrations of thrombin on resultant hemostasis is not known. This study sought to evaluate the ability of various concentrations of thrombin in combination with Gelfoam Powder to control bleeding using a swine liver lesion model. Ten pigs underwent a midline laparotomy. Circular lesions were created in the left medial, right medial, and left lateral lobes; six lesions per lobe. Gelfoam Powder was hydrated with Thrombin–JMI diluted to 250, 375, and 770 IU/mL. Each concentration was applied to two lesion sites per lobe. Bleeding scores were measured at 3, 6, 9, and 12 min using a 6-point system; comparison of bleeding scores was performed using ANOVA with the post hoc Tukey test. The bleeding scores with thrombin concentrations at 770 IU/mL were significantly lower than at 250 and 375 IU/mL at all four time points. The percentage of biopsies with a clinically acceptable bleeding score rose from 37.9, 46.6, and 71.2 % at 3 min to 55.2, 69.0, and 88.1 % at 12 min in the 250, 375, and 770 IU/mL thrombin groups, respectively. The study showed that the hemostatic response to thrombin was dose-related: using higher concentrations of thrombin with Gelfoam Powder yielded improved hemostasis, as determined by lower bleeding scores [17]. Scaffold materials for bone regeneration are crucial for supporting endogenous healing after accidents, infections, or tumor resection. Although beneficial impacts of micro topological or Nano topological cues in scaffold topography are commonly acknowledged, less consideration is given to the interplay between the microscale and nanoscale. Here, micropores with a 60.66 ± 24.48 μm diameter ordered by closely packed collagen fibers are identified in pre-wetted Spongostan, a clinically-approved collagen sponge. On a nanoscale level, a corrugated surface of the collagen sponge is observable, leading to the presence of 32.97 ± 1.41 nm pores. This distinct micro- and nanotopography is shown to be solely sufficient for guiding osteogenic differentiation of human stem cells in vitro. Transplantation of Spongostan into a critical-size calvarial rat bone defect further leads to fast regeneration of the lesion. However, masking the micro- and nanotopographical cues using SiO_2 nanoparticles prevents bone regeneration in vivo. Therefore, we demonstrate that the identified micropores allow migration of stem cells, which are further driven towards osteogenic differentiation by scaffold nano topography. The present findings emphasize the necessity of considering both micro- and nano topographical cues to guide intramembranous ossification, and might provide an optimal cell- and growth-factor-free scaffold for bone regeneration in clinical settings [18].

To evaluate the safety and impact of biopsy tract plugging with gelatin sponge slurry in percutaneous liver biopsy. 300 consecutive patients (158 females, 142 males; median age, 63 years) who underwent computed tomography-guided core biopsy of the liver in coaxial technique (16/18 Gauge) with and without biopsy tract plugging were retrospectively reviewed (January 2013 to May 2018). Complications were rated according to the common criteria for adverse events (NCI-CTCAE). The study cohort was dichotomized into a plugged (71%; n = 214) and an unplugged (29%; n = 86) biopsy tract group. Biopsy tract plugging with gelatin sponge slurry was technically successful in all cases. Major bleeding events were only observed in the unplugged group (0.7%; n = 2), whereas minor bleedings (4.3%) were observed in both groups (plugged, 3.6%, n = 11; unplugged, 0.7%, n = 2). Analysis of biopsies and adverse events showed a significant association between number of needle-passes and overall (P = 0.038; odds ratio: 1.395) as well as minor bleeding events (P = 0.020; odds ratio: 1.501). No complications associated with gelatin sponge slurry were observed. Biopsy tract plugging with gelatin sponge slurry is a technically easy and safe procedure that can prevent major bleeding events following liver biopsy [19].

Several topical hemostats are available to help control surgical bleeding. Cutanplast is a highly absorbent and porous gelatin product that is available in Fast sponge and powder forms. This study investigated the hemostatic efficacy of Cutanplast Standard and Fast gelatin sponge and powder and Emosist oxidized regenerated cellulose (ORC) gauze in porcine liver and spleen surgical bleeding models. Cutanplast Standard and Fast gelatin sponge and Emosist ORC gauze were tested in liver abrasion/ incision, liver puncture and spleen incision/puncture injuries, and Cutanplast Standard and Fast gelatin powder products were tested in liver abrasion/incision injuries. There were 13 liver injury (five abrasions, five incisions and three puncture) and six spleen injury (three puncture and three incision sites) sites per animal. Rapid hemostasis (≤ 2–5 min) was achieved in the liver abrasion and incision models with all Cutanplast gelatin sponge and powder products and Emosist ORC gauze, except in the liver incision model,

time to hemostasis was > 5 min with Cutanplast Standard gelatin powder and Emosist ORC gauze. Rapid hemostasis occurred with Cutanplast Fast gelatin sponge and Emosist ORC gauze in the liver puncture and spleen puncture and incision models. In the spleen incision model, Cutanplast Standard gelatin sponge had a time to hemostasis approaching 10 min. Cutanplast gelatin sponge and powder products and Emosist ORC gauze may be suitable for surgical applications involving parenchymal organ bleeding, but certain products may perform better than others, including Cutanplast gelatin powder in diffuse mild bleeding (such as liver abrasion), and Cutanplast Fast gelatin sponge and Emosist ORC gauze for splenic bleeding [20].

Advantages of Gelatin Powder over Polysaccharides

Gelatin powder, derived from collagen, offers certain advantages over polysaccharides when used as a hemostatic agent. Here are some potential advantages of gelatin powder compared to polysaccharides:

1. Hemostatic efficacy: Gelatin powder has been shown to have good hemostatic efficacy, effectively promoting blood clotting and controlling bleeding. It acts as a scaffold for platelet aggregation and clot formation, helping initiate the clotting cascade. Polysaccharides, on the other hand, may have variable hemostatic properties depending on their specific composition and characteristics [21, 22].
2. Biocompatibility: Gelatin is a biocompatible material that is well-tolerated by the body. It has been widely used in various medical applications and is generally safe for use as a hemostatic agent. Polysaccharides, such as chitosan or oxidized cellulose, also exhibit good biocompatibility in most cases [23, 24].
3. Ease of use and application: Gelatin powder is available in various forms, such as granules, sponges, and films, which can be easily applied to the bleeding site. These forms allow for adaptability to different wound shapes and sizes. Polysaccharides may also come in different forms, but their specific properties and ease of use may vary depending on the formulation [25, 26].
4. Biodegradability: Gelatin is a biodegradable material, meaning it can be broken down and metabolized by the body over time. As a result, there is usually no need for the removal of gelatin-based hemostatic agents after clot formation and wound healing. Some polysaccharides, such as chitosan, are also biodegradable, although the degradation rate and byproducts may vary [27, 28].
5. Cost-Effectiveness: Gelatin powder is generally more cost-effective compared to some other hemostatic powders. The affordability of gelatin powder makes it accessible for use in different healthcare settings, including emergency care, surgical procedures, and trauma management.

The choice of hemostatic agent depends on various factors, including the specific application, the severity of bleeding, and the surgeon's preference. Consulting with a healthcare professional is crucial for determining the most. Gelatin powder has been used as a hemostat in various medical applications due to its ability to promote blood clotting and control bleeding. While there are other hemostatic powders available, gelatin offers specific advantages. However, it's important to note that the information provided here is based on general knowledge up until September 2021, and you should consult the latest research and medical literature for the most up-to-date information. Here are some advantages of gelatin powder as a hemostat:

It's worth mentioning that while gelatin powder has advantages as a hemostat, the choice of a hemostatic agent depends on various factors, such as the severity and location of bleeding, the patient's condition, and the surgeon's preference. It is important to consult with a healthcare professional for specific recommendations and considerations regarding hemostatic agents. Table 2 represents the comparative profile of absorbable gelatin powder (AGP) vs microporous polysaccharide hemospheres (MPH) [29, 30, 31, 32].

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Table 2: Comparative Profile of Absorbable Gelatin Powder (AGP) Vs Microporous Polysaccharide Hemospheres (MPH) [29, 30, 31, 32]

SR No.	AGP	MPH
1	AGP is produced by the reaction of glutaraldehyde with gelatin which is then dried and irradiated for sterility.	MPH are produced by the reaction of epichlorohydrin with particles composed of a highly-purified potato starch that are then irradiated for sterility. There are later converted to Microporous Polysaccharide Hemospheres (MPH)
2	AGP are composed of larger, more irregularly shaped, and more disperse particles than the MPH.	MPH materials have porous surfaces, which absorb water and low molecular weight compounds from the blood to concentrate blood solids.
3	The dimensional attributes allow the AGP particles to pack less regularly and this non-uniform packing would create voids in which blood could penetrate and clot.	MPH particles have uniform packing and lack voids for blood to penetrate through.
4	AGP retain their morphology upon hydration, with voids and allow more fibrin matrix at the AGP clots	MPH deform upon hydration and Coupled with the tight packing of the MPH, the fusion of adjacent particles could there will be less fibrin matrix within the MPH clots
5	AGP clots show granules surrounded by fibrin and blood cells with uniform attachment to surface.	MPH particles aggregate and are not surrounded by similar levels of fibrin or blood cells. Further, voids appear between the MPH aggregation
6	More Fibrin Matrix is seen in the mass of AGP particles (stability of clots and no bleeding)	Fibrin matrix is not seen in the mass of MPH particles. (Instability of clots and Rebleeding)
7	MPH form a mechanical barrier to blood flow, while the AGP allow blood to interpenetrate	
8	Both powders are hydrated by the surrounding blood to concentrate blood solids with similar swelling.	
9	AGP were found to be 15 times more successful and 10 times faster at achieving haemostasis than MPH	
10	MPH are favoured due to their fast degradation and minimal inflammatory response.	
11	AGP swell to provide tamponade a possible additional mechanism for the difference in performance due to molecular recognition of the gelatin. .	MPH material absorbs tissue fluid to concentrate blood solids
12	Given the tamponade effect and the Ability of gelatin to activate the coagulation cascade, the clot formed by AGP is more robust	MPH does not contain components that activate the coagulation cascade. Clot formed by MPH lacks fibrin and platelets and has poor integration with tissue
13	Can be used to treat higher level bleeds	Basically used to treat lower bleeds
14	On Application of equivalent amounts of AGP and MPH, the AGP are superior in terms of speed and efficacy of Haemostasis	

CONCLUSION

Gelatin powder is generally more cost-effective compared to polysaccharide powders. This can be particularly beneficial in healthcare settings with budget constraints, making it a preferred choice for many medical professionals. Gelatin powder has been used as a hemostatic agent for many years and has a well-established track record. Medical professionals are often familiar with its application and have experience in its use compared to polysaccharide powders. Gelatin powder is available in various forms, including sheets, sponges, and powders. This versatility allows it to be used in different clinical scenarios and applied to different types of bleeding wounds and surgical sites which is not available in polysaccharide powders. Gelatin powder is easy to handle and apply. It can be directly sprinkled onto the bleeding surface, allowing for quick and efficient use in emergency situations or during surgical procedure. Gelatin powder is biodegradable, meaning it breaks down over time and is absorbed by the body. This reduces the risk of long-term complications or the need for removal, as the body naturally eliminates the gelatin matrix. Gelatin is derived from animal sources, making it a natural substance for the body. It is generally well-tolerated and does not elicit significant immune reactions or adverse effects, reducing the risk of foreign body reactions or granuloma formation.

However, it is important to note that the choice between gelatin powder and polysaccharide powder as a hemostatic agent ultimately depends on the specific clinical scenario, patient characteristics, and surgeon preferences. Consulting with healthcare professionals and considering individual patient factors is crucial in determining the most appropriate hemostatic agent for a particular situation.

Conflict Of Interest

The Authors have no conflict of Interest with any party or institute.

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