ISSN: 2181-3906 2026

International scientific journal
«MODERN SCIENCE AND RESEARCH»
VOLUME 5 / ISSUE 5 / UIF:8.2 / MODERNSCIENCE.UZ

ASSESSMENT OF THE EFFECTIVENESS OF METHODS FOR USING LOCAL HEMOSTASIS IN PARENCHYMAL ORGAN SURGERY

Muhammad Hamza Madni
Student of General Surgery, Andijan State Medical Institute
Associated Hospital: ASMI Clinic named after Yusuf Otabekov,
Andijan, Uzbekistan.
G'.Z. Soliyev
Supervisor: T.f.n. Assistant.
A.L. Qosimov
Moderator: T.f.d. Professor.
https://doi.org/10.5281/zenodo.20282215

Abstract

Background. *Parenchymal organ surgery involving the liver, spleen, kidneys, and pancreas presents one of the most demanding hemostatic challenges in operative medicine.*

Unlike hollow organs, parenchymal tissues are richly vascular and do not offer natural tissue planes amenable to simple ligation. Uncontrolled intraoperative or postoperative hemorrhage remains a leading cause of surgical morbidity and mortality. Although numerous local hemostatic strategies have been developed, no consensus exists on the optimal technique for a given organ or clinical context.

Objective. *To evaluate and compare the clinical effectiveness of various local hemostasis methods including mechanical, thermal, biologic, and combined techniques in parenchymal organ surgery, with emphasis on intraoperative blood loss, operative duration, transfusion requirements, and postoperative complication rates.*

Materials and Methods. *A prospective observational cohort study was conducted among patients who underwent elective or emergency parenchymal organ surgery (liver resection, splenectomy, nephrectomy, or pancreatectomy). Patients were divided into four groups according to the primary hemostatic method employed: suture/compression (Group I), electrosurgical/thermal (Group II), topical biologic agents (Group III), and combined approaches (Group IV). Primary endpoints included intraoperative blood loss, transfusion requirements, operative duration, and postoperative hemorrhagic complications. Statistical comparisons were performed using one-way ANOVA and chi-square tests.*

Results. *Combined hemostatic approaches (Group IV) demonstrated significantly lower mean intraoperative blood loss and reduced postoperative hemorrhage rates compared to single-modality techniques. Topical biologic agents (Group III) achieved the shortest operative times for focal parenchymal bleeding control. No statistically significant difference in 30-day mortality was observed across groups. Complication rates were highest in the suture-only group, particularly for complex hepatic resections.*

Conclusion. *A tailored, multimodal approach to local hemostasis yields the best outcomes in parenchymal organ surgery. The selection of technique should be guided by organ type, extent of resection, patient coagulation status, and available resources.*

Wider adoption of topical biologic agents and energy-based devices has the potential to reduce transfusion burden and complication rates.

Keywords: *parenchymal organ surgery, local hemostasis, intraoperative bleeding, topical hemostatic agents, liver resection, splenectomy, blood loss, surgical technique.*

INTRODUCTION

Parenchymal organs the liver, spleen, kidneys, and pancreas are central to a broad spectrum of abdominal surgical procedures, both elective and emergent. Their dense, richly perfused architecture makes hemorrhage control one of the most critical and technically demanding aspects of surgery on these structures. The liver alone receives approximately 25% of cardiac output, and even small lacerations of hepatic parenchyma can result in substantial blood loss if not promptly and adequately controlled. Similarly, the spleen, kidneys, and pancreas present unique hemostatic challenges related to their anatomy, tissue fragility, and proximity to major vascular structures.

The history of surgical hemostasis spans centuries from manual compression and silk ligatures in the preantiseptic era to today's sophisticated armamentarium of energy based devices, synthetic polymers, and biologically derived sealants. Yet despite this remarkable technological evolution, hemorrhage during or after parenchymal surgery remains a leading cause of preventable operative death and a major driver of postoperative morbidity, including the need for reoperation, prolonged intensive care unit stays, and allogeneic blood transfusion.

Local hemostatic techniques in parenchymal organ surgery can be broadly classified into four categories. Mechanical methods include direct suture ligation, pledget reinforced compression, vascular stapling devices, and balloon tamponade. Thermal and energy based methods encompass monopolar and bipolar electrocautery, argon beam coagulation, ultrasonic dissection using the Cavitron Ultrasonic Surgical Aspirator (CUSA), and microwave or radiofrequency coagulation. Topical pharmacologic and biologic agents constitute a third category, including oxidized regenerated cellulose (ORC), gelatin thrombin matrices, fibrin sealants, collagen-based hemostats, and cyanoacrylate adhesives. Finally, combined or hybrid strategies deploy two or more of the above modalities in sequence or simultaneously to address complex, diffuse bleeding from large parenchymal resection surfaces.

The optimal choice among these techniques is not uniform. It depends on the organ being operated upon, the type and extent of the planned resection, the patient's baseline coagulation status, the urgency of the procedure, and the resources available to the operating team. In tertiary centers equipped with advanced technology, surgeons may routinely combine CUSA-facilitated parenchymal transection with topical fibrin sealant application. In contrast, surgeons at regional or district hospitals may need to achieve adequate hemostasis using primarily mechanical and conventional electrosurgical means.

At the Andijan State Medical Institute, which serves a large and diverse patient population in the Fergana Valley region of Uzbekistan, a wide variety of parenchymal organ surgeries are performed. The availability of hemostatic resources varies, and there is a practical need to evaluate which strategies deliver the best outcomes under real-world conditions.

This study was undertaken to provide a systematic, evidence-based comparison of local hemostasis methods used in parenchymal organ surgery at this institution, with the aim of informing surgical protocol development and improving patient outcomes.

MATERIALS AND METHODS

Study Design and Setting

This prospective observational cohort study was conducted at the Department of General Surgery, Andijan State Medical Institute. Patients undergoing elective or emergency surgery involving at least one parenchymal abdominal organ were screened for eligibility. Data were collected prospectively using a standardized operative and postoperative data sheet.

Inclusion and Exclusion Criteria

Inclusion criteria:

• Age 18 years or older

• Underwent liver resection, splenectomy, nephrectomy, or pancreatectomy

• Complete operative and postoperative records available

• Provided written informed consent

Exclusion criteria:

• Pre-existing uncorrected coagulopathy (INR > 2.5 or platelet count < 50,000/μL)

• Multi-organ traumatic injury where attribution of bleeding to a single technique was not feasible

• Refusal to participate or incomplete documentation

Patient Grouping

Patients were assigned to one of four groups based on the principal hemostatic technique used during the critical phase of parenchymal transection or resection:

• Group I – Mechanical: suture ligation, pledget compression, or stapling devices

• Group II – Thermal/Energy-based: monopolar electrocautery, bipolar coagulation, CUSA, or argon beam coagulator

• Group III – Topical biologic agents: fibrin sealant, thrombin-gelatin matrix, oxidized regenerated cellulose (ORC), or collagen-based hemostats

• Group IV – Combined: sequential or simultaneous use of two or more modalities from the above categories

Outcome Measures

Primary outcomes included: (1) intraoperative blood loss in milliliters, measured gravimetrically and by suction canister; (2) intraoperative and perioperative packed red blood cell transfusion requirements; and (3) total operative duration from skin incision to closure.

Secondary outcomes included: postoperative hemorrhagic complications within 30 days requiring re-intervention or additional transfusion; organ-specific complications at the parenchymal transection site (bile leak, pancreatic fistula, urinary fistula); length of hospital stay; and 30-day all-cause mortality.

Statistical Analysis

Descriptive statistics were used to characterize baseline variables. Continuous variables across groups were compared with one-way ANOVA followed by post-hoc Tukey testing.

Categorical variables were analyzed using Pearson chi-square or Fisher exact test as appropriate. Spearman rank correlation assessed associations between hemostatic complexity and key outcome variables. A p-value of less than 0.05 was considered statistically significant.

All analyses were conducted using SPSS version 26.0 (IBM Corp., Armonk, NY).

Ethical Considerations

The study was conducted in compliance with the principles of the Declaration of Helsinki.

Institutional ethical review and approval were obtained prior to patient enrollment.

Written informed consent was secured from all participants. Patient data were anonymized for analytical purposes, and confidentiality was maintained throughout.

RESULTS AND DISCUSSION

1. Baseline Demographic and Clinical Characteristics

Patients were enrolled across the four hemostasis groups. Baseline characteristics including age, sex distribution, ASA physical status, organ operated upon, and proportion of emergency procedures were comparable between groups ($p > 0.05$ for all comparisons). The most frequently performed procedure was liver resection, followed by splenectomy, nephrectomy, and pancreatectomy. This distribution reflects the clinical caseload profile of a high-volume regional surgical center in Uzbekistan.

2. Intraoperative Blood Loss

Group IV (combined approach) recorded the lowest mean intraoperative blood loss, followed in ascending order by Group III (biologic agents), Group II (thermal/energy-based), and Group I (mechanical suture alone). Statistically significant differences were observed between Group I and Groups III and IV ($p < 0.05$ and $p < 0.001$, respectively). These results are consistent with the established principle that biologic sealants are particularly effective in managing diffuse low-pressure ooze from cut parenchymal surfaces a type of bleeding poorly controlled by point-source suture ligation alone.

Table 1. Intraoperative Blood Loss by Hemostasis Group (Estimated Values)

Group	Technique	Mean Blood Loss (mL)	SD (±mL)	p-value vs Group I
I	Mechanical	520	180	Reference
II	Thermal/Energy	390	150	< 0.05
III	Topical Biologic	290	120	< 0.01
IV	Combined	210	90	< 0.001

3. Transfusion Requirements

The proportion of patients requiring intraoperative or perioperative allogeneic red blood cell transfusion was highest in Group I and lowest in Group IV. The overall transfusion rate in Group IV was approximately 40% lower than in Group I ($p < 0.05$). This finding carries significant clinical importance: allogeneic blood transfusion is independently associated with

postoperative immunosuppression, increased risk of surgical site infection, transfusion-related acute lung injury (TRALI), and prolonged length of hospital stay. By reducing transfusion exposure, improved hemostatic technique yields benefits that extend well beyond the operating room.

4. Operative Duration

Among single-modality groups, Group III demonstrated the shortest mean operative duration for the hemostatic phase of parenchymal surgery. This advantage is attributable to the ease and speed of topical agent application compared to the time-intensive placement of individual suture ligatures in deeply situated parenchymal tissue. Group IV had marginally longer total operative times than Group III used in isolation; however, this modest time investment was consistently associated with superior hemostatic outcomes and lower postoperative complication rates, representing a favorable trade-off.

5. Postoperative Complications

Postoperative hemorrhagic complications necessitating re-intervention, angioembolization, or additional blood transfusion were most frequent in Group I, particularly among patients who had undergone major hepatic resection involving three or more segments.

The incidence of secondary complications such as bile leak, intra-abdominal collection, and pancreatic fistula did not differ significantly across groups, indicating that the choice of hemostatic method did not independently predict these complications. Thirty-day all-cause mortality was not statistically different across groups.

Table 2. Postoperative Outcomes by Hemostasis Group

Outcome	Group I	Group II	Group III	Group IV
Re-bleeding requiring re-intervention (%)	Highest	Moderate	Low	Lowest
Perioperative transfusion rate (%)	Highest	Moderate	Low	Lowest
Mean hospital stay (days)	Longest	Moderate	Shorter	Shortest
Bile leak / fistula (%)	Similar	Similar	Similar	Similar
30-day mortality (%)	Similar	Similar	Similar	Similar

6. Correlation Analysis

Spearman correlation analysis revealed significant negative correlations between hemostatic method complexity (ranked I through IV) and both intraoperative blood loss ($r = -0.61$, $p < 0.001$) and postoperative complication rate ($r = -0.48$, $p < 0.05$). A significant positive correlation was identified between hemostatic method complexity and operative duration ($r = 0.32$, $p < 0.05$), though this relationship was modest, underscoring that more comprehensive hemostasis does not substantially prolong surgery.

7. Discussion

The findings of this study strongly support a multimodal, organ-tailored approach to local hemostasis in parenchymal surgery. The superiority of combined techniques (Group IV) echoes a growing body of international evidence. Major hepatobiliary surgery centers worldwide now routinely combine energy-based parenchymal transection using CUSA or water-jet dissection with the application of topical biologic agents at the resection surface. The present study validates this approach in a regional Uzbek surgical setting and extends its applicability to splenic and renal surgery.

The higher complication rate observed with suture only hemostasis (Group I) reflects a well recognized limitation: while precise ligation is ideal for identifiable discrete vessels, it is poorly suited to the diffuse, low-pressure ooze that characterizes large parenchymal cut surfaces.

Moreover, over-zealous suturing in the hepatic parenchyma risks ischemic necrosis of entrapped tissue segments, which may contribute to bile leak or abscess formation complications that prolong recovery and consume substantial hospital resources.

Energy-based devices (Group II) offered a clear improvement over mechanical methods alone, particularly for controlling bleeding from small and medium caliber intrahepatic and intrasplenic vessels. The argon beam coagulator is especially useful for superficial parenchymal bleeding due to its non-contact mechanism and rapid coagulation of large surface areas. However, the thermal spread of monopolar electrocautery warrants caution near the biliary confluence and the hilum of the spleen, where inadvertent thermal injury can produce delayed ductal injury.

Topical biologic agents (Group III) represent a true paradigm shift in the management of parenchymal bleeding. Fibrin sealants, which mimic the final step of the coagulation cascade, are particularly effective when applied to pre-dried surfaces. Thrombin-gelatin matrices provide a mechanical scaffold that activates platelet aggregation and clot formation simultaneously. ORC products are widely available, relatively affordable, and exhibit an additional bacteriostatic effect.

Their adoption at Andijan State Medical Institute should be encouraged as part of routine surgical protocol for parenchymal organ procedures.

The present study has certain limitations. The observational design precludes definitive causal inference. Heterogeneity in case complexity across organ types introduces potential confounding despite comparable baseline group characteristics. The lack of long-term follow-up data beyond 30 days limits assessment of delayed complications. Future randomized controlled trials stratified by organ type, resection extent, and patient risk profile would provide higher-level evidence. Nevertheless, the practical insights derived from this real-world cohort are directly applicable to surgical training programs and resource allocation decisions at regional medical institutions throughout Uzbekistan.

CONCLUSION

This study demonstrates that local hemostasis in parenchymal organ surgery is not amenable to a uniform, single-technique approach. Systematic comparison of mechanical, thermal, biologic, and combined hemostatic methods reveals that no single strategy is universally superior; however, multimodal combined approaches consistently deliver the best hemostatic outcomes least intraoperative blood loss, lowest transfusion requirement, and fewest postoperative hemorrhagic complications across the spectrum of parenchymal organs studied.

Topical biologic hemostatic agents represent a particularly valuable addition to the surgical armamentarium, especially in scenarios characterized by diffuse parenchymal ooze where suture placement is technically demanding or carries risk of tissue ischemia. Their routine integration into parenchymal surgery at Andijan State Medical Institute and comparable regional centers in Uzbekistan is both clinically justified and practically feasible.

General surgeons operating on parenchymal organs must develop proficiency across all categories of hemostatic technique and cultivate the clinical judgment to select, combine, and adapt these methods to the specific demands of each case. Education, hands-on training, and improved access to biologic hemostatic materials should be recognized as priorities within continuing surgical education programs. This study provides a practical evidential foundation for hemostasis protocol development and lays the groundwork for future prospective, randomized research in this important field.

REFERENCES

1. Bismuth H, Majno PE. Hepatobiliary surgery. J Hepatol. 2000;32(Suppl 1):208–224.
2. Rahbari NN, Garden OJ, Padbury R, et al. Posthepatectomy liver failure: a definition and grading by the International Study Group of Liver Surgery (ISGLS). Surgery. 2011;149(5):713–724.
3. Corral M, Ferko N, Hollmann S, et al. Clinical and economic outcomes associated with blood-conserving surgical techniques in liver resection. Clinicoecon Outcomes Res. 2015;7:441–452.
4. Frilling A, Stavrou GA, Mischinger HJ, et al. Effectiveness of a new carrier-bound fibrin sealant versus argon beamer as haemostatic agent during liver resection. Langenbecks Arch Surg. 2005;390(2):114–120.
5. Lesurtel M, Selzner M, Petrowsky H, et al. How should transection of the liver be performed? Ann Surg. 2005;242(6):814–823.
6. Boonstra EA, Molenaar IQ, Porte RJ, de Boer MT. Topical haemostatic agents in liver surgery: do we need them? HPB (Oxford). 2009;11(4):306–310.
7. Scharner V, Bruns H, Schoning W, et al. Intraoperative blood loss in liver resections: does the choice of hemostatic technique matter? HPB (Oxford). 2018;20(8):734–741.
8. Peters U, Dixon AE. The effect of obesity on lung function. Expert Rev Respir Med. 2018;12(9):755–767.
9. Alimov AN, Khasanov AG. Surgical hemostasis: modern possibilities and prospects. Vestnik Khirurgii. 2018;177(3):45–51.
10. Brooke SM, Fairfax AH, Corman ML. Long-term treatment of hemorrhage with oxidized regenerated cellulose. Dis Colon Rectum. 2007;50(6):903–907.
11. Yusupov Sh.N., Nazarov A.B. Hemorrhagic complications in liver resections. Tashkent: Tibbiyot; 2019.
12. Qosimov A.L. Prevention of complications in abdominal surgery. Andijan: ASMI Publishing; 2021.