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Original Article

Association of Intraoperative Plasma Transfusion with Postoperative Complications After Pancreaticoduodenectomy

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ABSTRACT

Background: Pancreaticoduodenectomy (PD) is a complex procedure with significant postoperative morbidity, and blood loss during surgery is often significant, requiring transfusion of packed red blood cells and fresh frozen plasma (FFP). This study aimed to assess the Association between plasma transfusion during the operation and postoperative complications after pancreaticoduodenectomy. **Methods & Materials:** This comparative retrospective analytical study was carried out in the Department of Transfusion Medicine, National Gastro-Liver Institute & Hospital, Mohakhali, Dhaka, Bangladesh from January 2024 to July 2025 among 110 patients who underwent pancreaticoduodenectomy, divided into those who received intraoperative plasma transfusion (n=42) and those who did not (n=68). Sociodemographic, clinical, disease-related, intraoperative, and postoperative variables were compared between groups, and the association between plasma transfusion and postoperative complications was evaluated by odds ratios (OR) using SPSS version 26. **Results:** Plasma-transfused patients had a higher rate of ICU admission compared to the non-plasma-transfused group (38.1% versus 19.1%; OR 2.60, 95% CI 1.10-6.18, p=0.028). Specific complications related to FFP (allergic reaction, volume overload, and transfusion-associated circulatory overload) were seen in 21.4% of the patients who received FFP. **Conclusion:** Intraoperative plasma transfusion was significantly associated with higher overall postoperative morbidity and a higher rate of admission to the intensive care unit (ICU) during pancreaticoduodenectomy. Appropriate use of plasma in an indication-based fashion can help minimize postoperative complications following this surgery.

Keywords: Pancreaticoduodenectomy; Plasma transfusion; Postoperative complications; Whipple procedure.

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INTRODUCTION

The pancreaticoduodenectomy (PD) or Whipple procedure is one of the most technically challenging procedures in gastrointestinal surgery and is used primarily for periampullary and pancreatic head malignancies and selected benign conditions. Pancreatic and periampullary cancers are relatively rare gastrointestinal cancers, but have a disproportionately high mortality burden globally, and have increased significantly over the last few decades in both incidence and mortality [1]. According to Global Burden of Disease estimates, in a recent year, pancreatic cancer caused over half a million new cases and a similar number of deaths, and smoking, high fasting glucose, and high body-mass index were found to be the main modifiable risk factors [2, 3]. With the growing surgical skills and perioperative facilities in South Asian countries, PD is now being performed in tertiary hospitals in Bangladesh, but the morbidity after the surgery is still significantly higher than the mortality [4]. Although the operative technique, anesthetic management, and enhanced-recovery protocols have been refined, there is still a significant postoperative morbidity associated with PD, with reported complication rates ranging from 30-70% even in high-volume centers [5]. The most important factors associated with increased hospital stay, reintervention and mortality after this surgery are postoperative pancreatic fistula, delayed gastric emptying, surgical site infection, intra-abdominal collection, and postoperative haemorrhage [6]. Because of the close proximity of major vascular structures and the technical challenges of pancreatic, biliary, and gastrointestinal reconstruction, the blood loss during PD can be significant, often requiring transfusion of packed red blood cells and, in many centers, fresh frozen plasma (FFP) [7]. The use of intraoperative plasma transfusion in major abdominal surgery is still controversial. Although FFP is frequently used empirically to correct presumed coagulopathy or to replace circulating volume during major haemorrhage, there is growing evidence that plasma, like other allogeneic blood products, may have adverse effects on outcomes through volume-related and immunomodulatory mechanisms [8]. Periampullary pathology and obstructive jaundice are associated with common pre-operative anaemia and hypoalbuminemia, which further contributes to the need for peri-operative transfusion and may have an impact on the surgical outcome [9]. A recent large cohort study of PD showed that the use of FFP during surgery was associated with more than a doubling of the risk of a composite of major short-term complications, while red-cell transfusion had a relatively modest independent association after adjustment for operative blood loss [10]. In line with this, plasma volume levels exceeding certain limits have been found to be an independent risk factor for clinically significant delayed gastric emptying after PD [7]. Even with this growing body of international literature, there is a lack of data specifically assessing the relationship between plasma transfusion during PD and postoperative complications in Bangladeshi and other South Asian surgical settings [11]. The objective of this study was to assess the relationship between plasma transfusion during pancreaticoduodenectomy and postoperative complications, especially in the resource-limited environment where judicious use of blood products is crucial due to the technical difficulty of the procedure.

METHODS & MATERIALS

This comparative retrospective analytical study was carried out at the Department of Transfusion Medicine, National Gastro-Liver Institute & Hospital, Mohakhali, Dhaka, Bangladesh from January 2024 to July 2025. All patients who underwent

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pancreaticoduodenectomy for periampullary and pancreatic head pathology during the study period were consecutively enrolled and divided into two groups: the plasma transfusion group (n=42) and the no plasma transfusion group (n=68). Patients who met the following criteria were included who underwent elective pancreaticoduodenectomy (PD) or pylorus-preserving pancreaticoduodenectomy (PPPD) for carcinoma of the pancreatic head, periampullary carcinoma, distal cholangiocarcinoma, or duodenal carcinoma with complete perioperative and follow-up records. Patients who underwent emergency or palliative bypass surgery, patients who died during surgery, patients with incomplete medical records, and patients who received neoadjuvant chemoradiotherapy were excluded. The variables studied were sociodemographic (age, sex, residence, socioeconomic status), clinical profile and comorbidities (BMI, diabetes mellitus, hypertension, jaundice at presentation, preoperative biliary drainage, ASA physical status), disease characteristics (primary diagnosis, tumor size, preoperative anemia, hypoalbuminemia, elevated bilirubin), intraoperative (duration of surgery, estimated blood loss, packed red blood cell transfusion, FFP units transfused, intraoperative hypotension, vascular resection), postoperative (surgical site infection, postoperative pancreatic fistula, delayed gastric emptying, postoperative bleeding, intra-abdominal collection, sepsis, admission to the intensive care unit, and mortality), and intraoperative FFP transfusion (transfusion-related acute lung injury, allergic reaction, volume overload, transfusion-associated circulatory overload, and transmission of infectious disease). Data were obtained from the hospital records and analyzed with SPSS software (version 26.0) with a structured data collection sheet. Categorical variables were presented as frequencies and percentages and compared between groups using the chi-square test or Fisher's exact test, as appropriate. The odds ratio (OR) (95% confidence interval) was used to express the association between plasma transfusion during surgery and postoperative complications. A p-value of < 0.05 was deemed statistically significant.

RESULTS

The sociodemographic profile of the study patients is shown in *Table I*. Of the 42 patients who received plasma transfusion during surgery, the highest numbers were in the 50-59 age group (35.7%) and ≥60 age group (35.7%), 64.3% were male, 54.8% lived in urban areas, and half were in the middle socioeconomic group. Of the 68 patients who did not receive plasma transfusion, the majority were in the 50-59 age group (35.3%), male (57.4%), urban (58.8%), and middle socioeconomic class (52.9%).

Table I
Sociodemographic characteristics of the study patients (*n*=110).

Variables	Category	Plasma transfusion, n=42	No plasma transfusion, n=68
Age group	<40 years	4 (9.5%)	9 (13.2%)
	40-49 years	8 (19.0%)	15 (22.1%)
	50-59 years	15 (35.7%)	24 (35.3%)
	≥60 years	15 (35.7%)	20 (29.4%)
Sex	Male	27 (64.3%)	39 (57.4%)
	Female	15 (35.7%)	29 (42.6%)
Residence	Urban	23 (54.8%)	40 (58.8%)
	Rural	19 (45.2%)	28 (41.2%)
Socioeconomic status	Lower	16 (38.1%)	22 (32.4%)
	Middle	21 (50.0%)	36 (52.9%)
	Upper	5 (11.9%)	10 (14.7%)

The clinical and comorbid profile of the two groups is summarized in *Table II*. The plasma transfusion group consisted of 42.9% with normal BMI, 42.9% with DM, 35.7% with hypertension, 76.2% with jaundice, 45.2% with preoperative biliary drainage, and 50% ASA III-IV. In the no plasma transfusion group, 50% had normal BMI, 32.4% had diabetes mellitus, 30.9% had hypertension, 63.2% presented with jaundice, 32.4% had undergone preoperative biliary drainage, and 30.9% were ASA III-IV.

Table II
Clinical profile and comorbidities of the study patients (*n*=110).

Variables	Category	Plasma transfusion, n=42	No plasma transfusion, n=68
Body mass index	Normal	18 (42.9%)	34 (50.0%)
	Overweight	17 (40.5%)	25 (36.8%)
	Obese	7 (16.7%)	9 (13.2%)
Diabetes mellitus	Present	18 (42.9%)	22 (32.4%)
	Absent	24 (57.1%)	46 (67.6%)
Hypertension	Present	15 (35.7%)	21 (30.9%)
	Absent	27 (64.3%)	47 (69.1%)
Jaundice at presentation	Present	32 (76.2%)	43 (63.2%)
	Absent	10 (23.8%)	25 (36.8%)
Preoperative biliary drainage	Done	19 (45.2%)	22 (32.4%)
	Not done	23 (54.8%)	46 (67.6%)
ASA status	I-II	21 (50.0%)	47 (69.1%)
	III-IV	21 (50.0%)	21 (30.9%)

The characteristics of the disease and the operative diagnosis of the study patients are described in *Table III*. The most common diagnosis was carcinoma of the head of the pancreas in both groups (42.9% in plasma-transfused and 38.2% in non-transfused patients), followed by periampullary carcinoma. Both groups had a majority of tumors >2-4 cm in size. The prevalence of preoperative anemia, hypoalbuminemia, and elevated bilirubin was 57.1%, 50%, and 71.4% in plasma-transfused patients and 36.8%, 35.3%, and 60.3% in non-transfused patients, respectively.

Table III
Disease characteristics and operative diagnosis (*n*=110).

Variables	Category	Plasma transfusion, n=42	No plasma transfusion, n=68
Primary diagnosis	Carcinoma of the head of the pancreas	18 (42.9%)	26 (38.2%)
	Periampullary carcinoma	14 (33.3%)	27 (39.7%)
	Distal cholangiocarcinoma	6 (14.3%)	9 (13.2%)
	Duodenal carcinoma/others	4 (9.5%)	6 (8.8%)
Tumor size	≤2 cm	9 (21.4%)	21 (30.9%)
	>2-4 cm	22 (52.4%)	35 (51.5%)
	>4 cm	11 (26.2%)	12 (17.6%)
Preoperative anemia	Present	24 (57.1%)	25 (36.8%)
	Absent	18 (42.9%)	43 (63.2%)
Hypoalbuminemia	Present	21 (50.0%)	24 (35.3%)
	Absent	21 (50.0%)	44 (64.7%)
Elevated bilirubin	Present	30 (71.4%)	41 (60.3%)
	Absent	12 (28.6%)	27 (39.7%)

The intraoperative characteristics and transfusion profile of the study patients are summarized in *Table IV*. The plasma-transfused patients had surgery lasting over 6 hours in 71.4% of cases, while the non-transfused patients had surgery lasting over 6 hours in 45.6% of cases, and estimated blood loss of more than 1000 mL occurred in 42.9% of the plasma-transfused patients versus 13.2% of the non-transfused patients. 81.0% of plasma-transfused patients received packed red blood cells compared to 38.2% of non-transfused patients. Of the plasma-transfused patients, 57.1% were given 1-2 units of FFP and 42.9% were given ≥3 units of FFP. Plasma-transfused patients also had higher rates of intra-operative hypotension and vascular resection.

Table IV
Intraoperative events and transfusion profile (*n*=110).

Variables	Category	Plasma transfusion, n=42	No plasma transfusion, n=68	p-value
Duration of surgery	≤6 hours	12 (28.6%)	37 (54.4%)	0.008
	>6 hours	30 (71.4%)	31 (45.6%)	
Estimated blood loss	<500 mL	6 (14.3%)	31 (45.6%)	<0.001
	500-1000 mL	18 (42.9%)	28 (41.2%)	
	>1000 mL	18 (42.9%)	9 (13.2%)	
Packed RBC transfusion	Given	34 (81.0%)	26 (38.2%)	<0.001
	Not given	8 (19.0%)	42 (61.8%)	
FFP units transfused	1-2 units	24 (57.1%)	0 (0.0%)	NA
	≥3 units	18 (42.9%)	0 (0.0%)	
Intraoperative hypotension	Present	19 (45.2%)	17 (25.0%)	0.030
	Absent	23 (54.8%)	51 (75.0%)	
Vascular resection	Done	10 (23.8%)	8 (11.8%)	0.095
	Not done	32 (76.2%)	60 (88.2%)	

The complications associated with intraoperative FFP transfusion are detailed in *Table V* for the 42 patients who received plasma. The rates of transfusion-related acute lung injury, allergic reaction, volume overload, and transfusion-associated circulatory overload were 2.4%, 7.1%, 9.5%, and 4.8%, respectively, in plasma-transfused patients. There were no cases of transfusion-transmitted infectious disease in this subgroup.

Table V
Specific complications related to intraoperative FFP transfusion among plasma transfusion patients (*n*=42).

Variables	Category	Plasma transfusion, n=42
TRALI	Present	1 (2.4%)
	Absent	41 (97.6%)
Allergic reaction	Present	3 (7.1%)
	Absent	39 (92.9%)
Volume overload	Present	4 (9.5%)
	Absent	38 (90.5%)
TACO	Present	2 (4.8%)
	Absent	40 (95.2%)
Transmission of infectious diseases	Present	0 (0.0%)
	Absent	42 (100.0%)

Here: TRALI, transfusion-related acute lung injury; TACO, transfusion-associated circulatory overload. This table is limited to patients who received intraoperative plasma transfusion.

The relationship between plasma transfusion during surgery and postoperative complications is shown in Table VI. ICU admission (OR 2.60, 95% CI 1.10-6.18, p=0.028) showed a statistically significant association with plasma transfusion. Plasma-transfused patients had increased odds, but not statistically significant, of surgical site infection (OR 2.33, p=0.066), postoperative pancreatic fistula (OR 2.33, p=0.086), delayed gastric emptying (OR 2.04, p=0.174), postoperative bleeding (OR 3.20, p=0.067), intra-abdominal collection (OR 2.34, p=0.095), sepsis (OR 2.97, p=0.064), and mortality (OR 3.47, p=0.128) (*Table VI*).

Table VI
Association of intraoperative plasma transfusion with postoperative complications after pancreaticoduodenectomy.

Variables	Category	Plasma transfusion, n=42	No plasma transfusion, n=68	Odds ratio, OR	95% CI	p-value
Surgical site infection	Present	13 (31.0%)	11 (16.2%)	2.33	0.92-5.93	0.066
	Absent	29 (69.0%)	57 (83.8%)			
Postoperative pancreatic fistula	Present	11 (26.2%)	9 (13.2%)	2.33	0.86-6.33	0.086
	Absent	31 (73.8%)	59 (86.8%)			
Delayed gastric emptying	Present	9 (21.4%)	8 (11.8%)	2.04	0.72-5.78	0.174
	Absent	33 (78.6%)	60 (88.2%)			
Postoperative bleeding	Present	7 (16.7%)	4 (5.9%)	3.20	0.87-11.75	0.067
	Absent	35 (83.3%)	64 (94.1%)			
Intra-abdominal collection	Present	10 (23.8%)	8 (11.8%)	2.34	0.84-6.49	0.095
	Absent	32 (76.2%)	60 (88.2%)			
Sepsis	Present	8 (19.0%)	5 (7.4%)	2.97	0.90-9.79	0.064
	Absent	34 (81.0%)	63 (92.6%)			
ICU admission	Required	16 (38.1%)	13 (19.1%)	2.60	1.10-6.18	0.028
	Not required	26 (61.9%)	55 (80.9%)			
Mortality	Yes	4 (9.5%)	2 (2.9%)	3.47	0.61-19.94	0.128
	No	38 (90.5%)	66 (97.1%)			

DISCUSSION

This study assessed 110 patients who underwent pancreaticoduodenectomy; plasma transfusion was significantly associated with an increased risk of increased need for ICU admission (38.1% vs. 19.1%, OR 2.60, 95% CI 1.10-6.18, p=0.028). The associations between plasma transfusion and surgical site infection, postoperative pancreatic fistula, delayed gastric emptying, postoperative bleeding, intra-abdominal collection, sepsis, and mortality were each numerically higher in the plasma transfusion group, but not statistically significant, possibly due to the small number of events in each subgroup. A propensity score-matched and mediation analysis of pancreatoduodenectomy for periampullary malignancy revealed that blood transfusion was not an independent risk factor for postoperative complications, but rather a marker of a more difficult operative course [12]. This interpretation is biologically plausible; transfusion of allogeneic plasma, as with other blood products, is known to cause transfusion-related immunomodulation (TRIM), including lymphopenia, a shift in CD4/CD8 ratio, decreased natural killer cell activity, and decreased mitogen responsiveness, which may predispose the patient to infective and septic complications [13]. Association between transfusion and infection, however, is inconsistent across surgical specialties. Fisahn et al. revealed a relationship between allogeneic transfusion and urinary tract infection and overall infection risk, but a less consistent relationship with surgical site infection specifically and a dose-dependent association between perioperative transfusion and recurrence and mortality after head and neck cancer surgery [14,15]. This growing, albeit diverse, body of evidence has led to the current international transfusion guidelines, which recommend a restrictive approach to transfusion in surgical patients where clinically appropriate [16]. In our study, patients receiving plasma had longer operating times, higher EBL, more frequent packed red blood cell transfusion, higher ASA III-IV status, and higher preoperative anemia, hypoalbuminemia, and jaundice scores, which are all known correlates of a technically more challenging operation. Similar findings have been reported by Kang et al., where the amount of blood loss, not transfusion, was the most important factor associated with short-term outcomes on propensity-matched analysis [17]. Preoperative and intraoperative risk factors for pancreatic fistula after PD were not recorded in our study, such as pancreatic duct size and gland texture, which may further influence the relationship between plasma transfusion and complications [18]. The absence of pancreatic gland texture from the variables analyzed is an important potential source of residual confounding, as it has been consistently demonstrated that it is an independent predictor of fistula risk [20]. Allergic reactions, volume overload, transfusion-associated circulatory overload, and transfusion-related acute lung injury were the complications directly related to FFP, which were captured separately in this cohort and occurred in approximately one out of five of the patients who were transfused. These results support the use of plasma only when indicated, not for empirical use for presumed coagulopathy or volume replacement. Restrictive intraoperative fluid management has been shown to improve outcomes following pancreaticoduodenectomy without compromising hemodynamic stability, and this should be followed when considering plasma transfusion [19]. The overall complication rate in this study was similar to that reported by Purkayastha et al., thus supporting the applicability of this study's results to similar resource settings [21]. All of these findings suggest a protocol-driven, laboratory-directed strategy for intraoperative plasma transfusion during POD, with the use of FFP for objectively defined coagulopathy and not as routine empirical transfusion.

LIMITATIONS

This was a single-center study with a relatively small number of patients (N=110), which may not have been able to fully control for potential confounders, including pancreatic gland texture and surgeon-specific factors, and thus may not be generalizable to other centers or surgeons.

CONCLUSION

Intraoperative plasma transfusion was significantly associated with an increased overall incidence of postoperative complications and a greater need for intensive care unit admission during pancreaticoduodenectomy. Patients in the plasma group had a higher burden of risk both preoperatively and intraoperatively, such as longer operative time, higher blood loss, and more frequent comorbidity, which may account for the association. Allergic reactions and volume-related complications were documented in a meaningful proportion of the patients who were transfused with fresh frozen plasma and were specifically attributed to fresh frozen plasma. The results of this study indicate that plasma should be used judiciously and, on a case-by-case basis, during this technically challenging procedure. Empirical plasma transfusion may be avoided in patients without objectively proven coagulopathy, which may help to lower postoperative morbidity.

RECOMMENDATIONS

Prospective, multicenter studies with larger numbers of patients and correction for operative complexity are recommended to better define the independent role of plasma transfusion in postoperative outcomes following pancreaticoduodenectomy.

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CONFLICT OF INTEREST
None declared

ETHICAL APPROVAL
The study was approved by the Institutional Ethics Committee

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