

Management Strategies and Outcomes for Duodenal and Proximal Jejunal Injuries in Penetrating Polytrauma: A Single-Center Study

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ABSTRACT

Objective: To evaluate the efficacy and safety of primary repair augmented by Witzel feeding jejunostomy for managing duodenal and proximal jejunal injuries in penetrating abdominal polytrauma at a tertiary trauma center in Pakistan.

Study Design: Prospective analytical study.

Place and Duration of the Study: Combined Military Hospital, Quetta, Pakistan from Aug 2023 to Jun 2025.

Methodology: Patients with penetrating duodenal and/or proximal jejunal injuries were enrolled. Primary repair was performed with adjunctive feeding jejunostomy, nasogastric decompression and drain placement. Data on demographics, injury details, vital signs, surgical procedures, and outcomes were collected from records of patient.

Results: Of 27 patients, 15(55.6%) had duodenal injuries (18.5% first part, 37.0% fourth part), and 19 (70.4%) had proximal jejunal injuries, with 8(29.6%) having concurrent duodenal injuries. All patients presented after sustaining firearm injuries. Mean operation time was 110.1±38.9 minutes. Surgical site infections occurred in 04 patients, with no anastomotic leaks or reoperations. The most common AAST grade in duodenal injury was grade II in 12(80%) patients. Significant associations included ventilatory support with higher injury count ($p<0.001$) and longer hospital stay ($p=0.005$), spleen injury with increased surgical site infection risk ($p=0.049$) and prolonged stay ($p=0.030$), and shock index on arrival with stoma formation ($p=0.002$). No mortality was recorded and there was no anastomotic leak in patients.

Conclusion: Primary repair with Witzel feeding jejunostomy is safe and effective for penetrating duodenal and proximal jejunal injuries, with low complication rates in a resource-limited setting.

Keywords: Abdominal Injuries, Duodenal Injury, Intestinal Injuries, Jejunostomy, Multiple Trauma.

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INTRODUCTION

Although duodenal and proximal jejunal injuries are rare, accounting for only 1-5% of abdominal trauma, yet they bring a great deal of difficulty for surgical teams owing to their close proximity to retroperitoneal pancreatic gland, biliary tree and great vessels.^{1,2} In particular, firearm injuries and polytrauma, prevalent in violence struck areas, make up 53.6-90% of such cases worldwide and are usually associated with injuries to viscera, pancreas and major vasculature.^{3,4} Penetrating injuries to the abdomen are frequently seen in Pakistan's war torn Baluchistan province, with injuries to hollow viscera including duodenum and jejunum, encountered in 30-40% of cases, considerable morbidity, compounded by late presentation.⁵ These injuries bring a 5-30% mortality rate largely due to sepsis, bowel fistulas or multiple-organ dysfunction. 0-21% of these cases end up with duodenal leaks, exacerbated by delay in diagnosis

often more than 24 hours.^{5,6}

Traditionally, complicated surgeries such as pyloric exclusion or pancreaticoduodenectomy were performed for these injuries, but nowadays simpler procedures like primary repair with nasogastric drainage and feeding jejunostomy are gaining traction, particularly for injuries with American Association for the Surgery of Trauma (AAST) grades I-III.^{3,7} In settings with limited resources, this change minimizes operating time and surgical complications which falls in line with the stage approach of damage control surgery.⁸ Although, debate on enteral versus parenteral feeding goes on and better healing is seen in early feeding jejunostomies, high-grade (AAST III-V) injury outcomes still remain inconsistent.^{3,7,9} Paucity of data underlines the necessity of further research on penetrating polytrauma management in Pakistan.^{5,6}

The aim of this study was to evaluate the efficacy of primary repair combined with nasogastric drainage and feeding jejunostomy in managing duodenal and proximal jejunal injuries in penetrating polytrauma,

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hypothesizing that this approach would yield low complication rates and favorable outcomes in a tertiary trauma setting.

METHODOLOGY

This prospective analytical study was conducted at Combined Military Hospital (CMH) Quetta, a tertiary care hospital in Balochistan, Pakistan from Aug 2023 to June 2025 after due approval from the institutional ethical review board (Ref No: CMH QTA-IERB/114 dated 06 August 2025).

Sample size was calculated using WHO online calculator, keeping confidence interval of 90% and power of test to be 80%. The proportion of patients presented in emergency with polytrauma from firearms were 90%.⁴ All patients presenting to the trauma center during study period, with penetrating abdominal polytrauma were screened upon arrival, and enrolled after intraoperative confirmation of duodenal and/or proximal jejunal injuries (within 50 cms from duodeno-jejunal junction), regardless of further injuries to the brain, chest, limbs or blood vessels.

Inclusion Criteria: All patients brought to Accidents and Emergency (A&E) of CMH Quetta having penetrated duodenal and proximal jejunal injuries (within 50 cms from duodeno-jejunal junction), regardless of the Glasow Coma Scale (GCS) and associated injuries were included.

Exclusion Criteria: The patients who had blunt mechanisms of trauma and those who refused to participate in the study were excluded.

These patients brought to A&E department of CMH Quetta were immediately taken to operation theatre after being resuscitated by trauma team. Demographic data, time since trauma, vital signs and GCS were noted on arrival. Patients who were unconscious and unknown were tagged by hospital system and their identities were established later. All cases were immediately operated upon and injuries to brain, chest, limbs and vasculature were managed by respective surgical teams.

After the surgery, patients were shifted to Intensive Treatment Centre (ITC) or High Dependency Unit (HDU) as dictated by the organ support(s) needed. Informed written consent to be part of research was obtained once patient was fully conscious and oriented, yielding a sample of 27 patients based on consecutive convenience sampling.

Primary repair was done for all duodenal and proximal jejunal injuries, augmented with feeding jejunostomy using Witzel technique for enteral access, nasogastric tube for decompression, and closed drain placement adjacent to the repair site for leaks.

The Witzel jejunostomy procedure begins by selecting a segment of the jejunum, typically 20 to 40 cm distal to the Ligament of Treitz. A small incision is made in the bowel wall, and the feeding catheter is inserted into the lumen and secured with a purse-string suture. Next, the essential step of the Witzel technique is performed: the outer layers of the jejunum are folded and sutured over the tube for a length of several centimeters, effectively burying the tube in a tunnel of bowel tissue. This tunnel, or tract, is a crucial safety measure that minimizes the risk of peritonitis or fistula formation when the tube is eventually removed. Finally, the segment of the jejunum containing the buried tube is securely sutured to the inner abdominal wall, and the catheter is brought out through a small, separate skin incision, ensuring the entire apparatus is firmly anchored and positioned correctly for feeding.

Colostomies were performed selectively in cases of obvious fecal spillage or shattered colon, while small intestine perforations were repaired primarily. In patients who were hemodynamically unstable, related injuries (splenic, renal, and hepatic) were managed at the same time using damage control techniques, with perihepatic packing and splenectomy where necessary.

A structured protocol was adopted for postoperative care: For the first 24 hours feeding jejunostomy tube was placed on free drainage. Next day saline feeds were initiated at 20 mL/hour until flatus/stool was passed or stoma was functional; then, liquid feeds (milk, fresh juices, egg flips, meat broth, Ensure® Powder, and/or Beneprotein® Powder) were advanced. Oral honey was given on the second postoperative day (POD) or after extubation once fully conscious, with NG tube removal; oral sips of water started on the third POD along with jejunostomy feeds. Oral fluid intake was gradually increased after the seventh POD, with drains removed on the eighth POD if outputs were low and no overt leakage. After the seventh POD, oral liquids and soft diets were started with progressive quantity increases, tapering jejunostomy feeds accordingly. For AAST grade 3 injuries, oral fluids were delayed until the tenth POD, and drains removed on the twelfth POD. Feeding

tubes were removed on the 21st POD, allowing spontaneous tract closure. Surgical site infections (SSI's), when developed, were managed conservatively with daily dressings, without requiring secondary surgery or debridement (Figure-1).

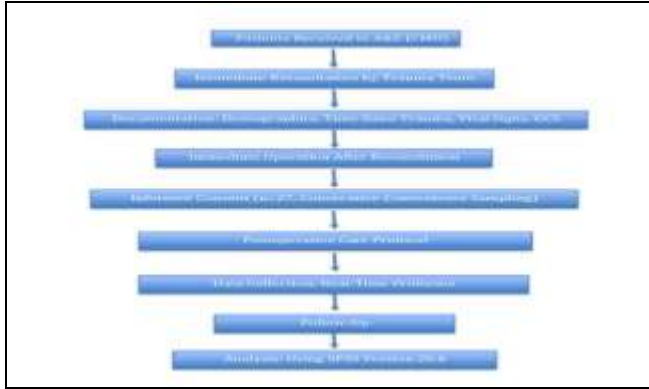


Figure-1: Flow Diagram of Study Methodology

A structured proforma was devised for real-time data collection during admission, surgery, and daily ward rounds, covering demographics, injury details (mechanism, time, associated injuries to limbs, brain, chest, urology, vascular, and other abdominal organs including duodenal segment and proximal jejunum involvement), arrival vital signs, GCS, surgical specifics (procedures, duration, ventilatory support), and outcomes (stoma functionality, complications including anastomotic leakage and re-operations, other morbidity, and total admission days calculated as discharge minus arrival date). Patients were followed over time till removal of jejunostomy tubes, with clinical, laboratory, and imaging assessments being done for complications.

All data was managed and analyzed using the Statistics Package for Social Sciences software, version 26 (IBM Corp., Armonk, NY, USA). Continuous parametric variables as age and surgery time were represented as means with standard deviation whereas proportional values as gender, injury type, surgical site infection and severity score were reported as frequencies and percentages. The continuous variables were checked for normality Shapiro-Wilk test. The non-parametric values were represented as median along with interquartile ratio. Inferential analyses, including Fisher's exact tests and Mann-Whitney U tests, were conducted to assess associations between factors such as injury severity or shock index and outcomes as SSI's or prolonged hospital stay keeping p -value ≤ 0.05 as significant. Odds ratio was

evaluated using Cochran's and Mantel-Haenszel equation keeping confidence interval of 95%.

RESULTS

A total of 27 patients were enrolled in this study, with a mean age of 37.3 ± 11.5 years. Fifteen patients had duodenal injuries, involving the first (18.5%) and fourth parts (37.0%). Proximal jejunal injuries were seen in 19 patients, with 29.6% also having concurrent duodenal injuries. At arrival, the majority (63.0%) presented with grade III hypovolemic shock, followed by grade II (29.6%) and grade IV (7.4%). The ileum was the most frequently injured abdominal viscera (77.8%), followed by the stomach (48.1%), whereas pancreatic injuries were least common (11.1%). Additional injuries included limb (29.6%), chest (18.5%), brain (14.8%), vascular (14.8%) and Kidney Ureter Bladder (KUB) injuries (25.9%). Injury Distribution pattern is given in Table-I.

Table-I: Injury Distribution Among Patients (n=27)

Categories	Subcategories	Frequency (%)	
Non-Abdominal	Limbs	8(29.6%)	
	Brain	4(14.8%)	
	Chest	5(18.5%)	
	Kidney Ureter Badder	7(25.9%)	
	Vascular	4(14.8%)	
Abdominal	Ileum	21(77.8%)	
	Left Colon	9(33.3%)	
	Right Colon	5(18.5%)	
	Transverse Colon	5(18.5%)	
	Pancreas	3(11.1%)	
	Small Intestine Mesentery	9(33.3%)	
	Distal Jejunum	9(33.3%)	
	Stomach	13(48.1%)	
	Liver	12(44.4%)	
	Spleen	9(33.3%)	
	Proximal Jejunum		19(70.4%)
	Duodenum Subcategories	First Part	5(18.5%)
	Fourth Part	10(37.0%)	

The most common AAST grade in the 15 duodenal injuries was grade II in 12(80%) patients followed by grade III in 3(20%) patients. The mean abdominal surgical time was 110.1 ± 38.9 minutes, longer in patients having multiple abdominal visceral injuries. Perihepatic packing due to severe liver trauma was done in 11.3% of cases as a part of damage control surgery (DCS). Stoma was fashioned in 40.7% of the patients due to shattered colon and/or gross fecal contamination. Postoperative ventilatory support was provided to 63% of the patients. Mean hospital stay was 14.9 ± 4.7 days and mean days to bowel/stoma function were 3 days. The rate of post operative

surgical site infection (SSI) was 14.8%, with no occurrence of anastomotic leaks. No major complication was seen and no reoperation was done other than removal of packs. There were no mortalities reported in our cases as well.

Patients with high injury severity score (>25) needed ventilatory support as compared to those who had less injuries ($p<0.0001$). Splenic injury increased SSI's risk ($p=0.049$) and hospital stay duration ($p=0.030$). Pancreatic injury ($p=0.049$) and perihepatic packing ($p=0.049$) also showed independent association with increased SSI's risk. Patients with SSI's showed significantly prolonged hospital stay ($p=0.024$) as did ventilatory supported patients ($p=0.005$). Stoma formation correlated with higher shock index ($p=0.002$) which is likely due to the fact that extensive abdominal trauma and gross fecal contamination was the predominant cause of shock. Similarly, perihepatic packing strongly correlated with post operative SSI's ($p=0.049$). Association between injury severity score and hospital stay with ventilatory support was evaluated and shown in Table-II and found to be significant. Similarly association between surgical site infection and splenic, pancreatic and perihepatic packing is shown in Table-III.

Table-II: Association between various Trauma variables with Ventilatory Support, Splenic Injury, Surgical Site Infection, and Stoma Formation (n=27)

Parameters Median(IQR)	Study Groups		p-value
	Ventilatory Support-Yes (n=17)	No Ventilatory Support (n=10)	
Injury Severity Score	36(24)	16 (7)	<0.001
Longer Hospital Stay	16(9)	11(3)	0.005
	Splenic Injury-Yes(n=3)	Splenic Injury-No(n=24)	
Longer Hospital Stay	22(1)	13(6)	0.030
	Surgical Site Infection, -Yes(n=4)	-N Surgical Site Infection, o(n=23)	
Longer Hospital Stay	20(7)	13(6)	0.024
	Stoma Formation-Yes(n=11)	Stoma Formation-No(n=16)	
Shock Index*	1.21(0.16)	1(0.19)	0.002

Mann-Whitney U Test was applied

*Shock Index= (Pulse/Systolic Blood Pressure)

DISCUSSION

Our prospective cohort study on 27 patients with penetrating duodenal and proximal jejunal injuries, showed that primary repair augmented by Witzel feeding jejunostomy revealed efficacy, no anastomotic leaks and a low SSI rate of 14.8%. These results are consistent with growing research that supports simple

repairs for most duodenal injuries, indicating decreased morbidity in resource-constrained working environment.^{1,9,3}

Table-III: Association of Surgical Site Infection, with Splenic Injury Peri-Hepatic Packing and Pancreatic Injury (n=27)

Parameters	Study Groups		p-value	Odds Ratio (CI 95%)
	Surgical Site Infection (n=27)			
	Yes (n=4)	No (n=23)		
Splenic Injury				
Yes	2(50%)	1(4.3%)	0.031	22(1.33-362.9)
No	2(50%)	22(95.7%)		
Peri-Hepatic Packing				
Yes	2(50%)	1(4.3%)	0.031	22(1.33-362.9)
No	2(50%)	22(95.7%)		
Pancreatic Injury				
Yes	2(50%)	1(4.3%)	0.031	22(1.33-362.9)
No	2(50%)	22(95.7%)		

Fischer's Exact Test was applied

The demography (mean age 37.3 years, all males) and patterns of injury in this study group, with 55.6% duodenal and 70.4% proximal jejunal involvement, indicate typical penetrating polytrauma in high-violence regions.² Majority of duodenal injuries were AAST grade II (80%), in keeping with existing literature revealing lower-grade predominance in penetrating mechanisms.^{4,3} Associated injuries documented in most cases (e.g., ileum 77.8%, stomach 48.1%), were found to contribute to grade III shock in 63.0% of patients underscoring the polytrauma burden.^{2,10} Figure-2 shows the proximal jejunal injury being repaired primarily over omentum.

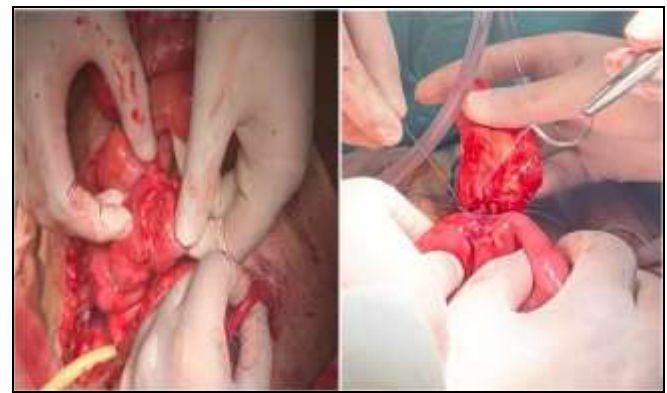


Figure-2: Proximal Jejunal Injury Repaired primarily over Omentum

Primary repair with adjuncts leads to favorable outcomes such as mean hospital stay of 14.9 days, stoma function by day 3, and no leaks/reoperations. This holds up recent multicenter data signifying that primary repair brings down leaks (8% vs. 21% for complex repairs) and mortality.^{11,12} Early enteral

nutrition through jejunostomy enhanced recovery, as demonstrated by rapid stoma function, in line with trials showing reduced catabolism and sepsis.^{9,12} The early commencement of enteral feed is paramount in reducing morbidity as bacterial colonic translocation is limited. Moreover, electrolyte imbalance is also mitigated thus enhancing recovery.¹¹ However, SSI's (14.8%) was noteworthy, associated with splenic ($p=0.049$) and pancreatic injuries ($p=0.049$), coinciding with research that links these injuries to contamination and prolonged hospital stay.^{4,8} Perihepatic packing (11.3%) correlated with stoma formation ($p<0.001$) and SSI's ($p=0.049$), reflecting damage control in unstable patients.^{7,13} It is pertinent to mention here that our cases did not witness any mortality nor any anastomotic leak. This may signify the importance of early enteral feed in trauma patients although further research is required to proof the direct causal relationship.

Ventilatory support (63.0%) was found to be associated to a higher injury burden ($p=0.00096$) and longer hospital stay ($p=0.005$), while stoma formation correlated to higher shock index ($p=0.002$), highlighting the effect of hemodynamic instability.^{10,14} Compared to South African cohorts with 7.7% leaks in primary repair, our zero-leak rate may stem from adjunctive drainage and jejunostomy, although comparison is limited by small sample size.^{8,15} Morbidity seen in splenic injuries (prolonged hospital stay $p=0.049$) reiterates global data, highlighting multidisciplinary management.^{2,6,16}

Recent literature underlines the efficacy of non-operative management for low-grade injuries and primary repair for higher grades, with evidence supporting DCS in improving outcomes in polytrauma.^{17,18,19} Furthermore, lower leak rates are seen with primary repair as compared complex surgeries, supporting our approach.^{20,21,22} Our findings add to recent evidence advocating minimally invasive approach in resource-constrained settings, where penetrating trauma prevails.²³

Limitations entail a small sample ($n=27$) potentially underpowered for rare events like leaks, and single-center bias, limiting generalizability to non-conflict regions. Convenience sampling may introduce selection bias, though prospective data minimized recall issues. Multiplicity of univariable analyses risks Type I errors; future studies should use multivariable adjustment. Despite limitations, results cautiously support primary repair with adjuncts in penetrating

polytrauma, aligning with trends toward a simpler approach for optimizing outcomes in high-burden environments.^{1,3,11}

CONCLUSION

Primary repair augmented by Witzel feeding jejunostomy is a safe, effective strategy for penetrating duodenal and proximal jejunal injuries in polytrauma, yielding low SSI's rates and no leaks in this cohort. Associated injuries like spleen and pancreas drive morbidity, warranting tailored damage control. Larger multicenter studies are needed to validate these findings in similar settings.

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Authors Contribution

Following authors have made substantial contributions to the manuscript as under:

TMF & MWAB: Data acquisition, data analysis, drafting the manuscript, critical review, approval of the final version to be published.

FK & ZA: Study design, data interpretation, drafting the manuscript, critical review, approval of the final version to be published.

ABS & RK: Conception, data acquisition, drafting the manuscript, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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