Surgical Management of Penetrating Duodenal Injury: Role of Primary Repair

Umit Turan and Huseyin Kilavuz

Department of General Surgery, Adana City Training and Research Hospital Adana, Turkey

ABSTRACT

Objective: To evaluate the outcome of primary repair in penetrating duodenal injuries.

Study Design: Descriptive study.

Place and Duration of Study: Adana City Training and Research Hospital, Adana, Turkey, between March 2011 and September 2018

Methodology: Patients with penetrating duodenal injury, who underwent primary repair, were reviewed retrospectively. The patients who had early death, grade 1 duodenum injuries and operative procedures except primary repair, were excluded from the study. Age, gender, mechanism of penetrating injury, grade of the duodenal injury, associated intra-abdominal injuries, length of intensive care unit and hospital stay, duodenum-related mortality and morbidity were analysed. Fisher's exact test was used to compare the outcomes between survivor and non-survivor groups.

Results: Data of 26 patients with primary repair (5 females, 21 males) were reviewed. The mean age was 33.11 ± 12.07 years; and gunshot ($n=19$, 73.1%) was the most common cause of the duodenal injury. Twenty-five had a total of 103 (3.9 injuries per patient) associated intra-abdominal organ injuries. 20 (76.9%) patients had grade 2 duodenal injuries; and the most injured portion of the duodenum was segment IV ($n: 9$, 34.6%). Three (11.5%) patients had duodenal leakage and postoperative complication rate was 53.8%. Duodenum-related mortality (DRM) was 3.8% ($n:1$) and overall mortality was 19.2% ($n:5$). The anatomic localisation of duodenal injury and associated vascular trauma were significantly different between survivor and non-survivor groups ($p: 0.038$, and $p: 0.034$, respectively).

Conclusion: Associated intra-abdominal organ and vascular injuries were predictive factors of overall mortality in duodenal injuries. Duodenum-related mortality was low, for this reason minimally invasive procedures such as primary repair will be more accurate in surgical management of penetrating duodenal injuries.

Key Words: Duodenal injury, Primary repair, Surgical management.

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INTRODUCTION

Duodenal injuries are rare and they represent less than 2% of the abdominal injuries.¹ Most of the duodenal injuries caused by penetrating traumas (75%), especially gunshot wounds.² Most parts of the duodenum are located in retroperitoneal region and it has proximity to the major blood vessels and vital organs. This anatomic position leads to delay in diagnosis; and traumas of duodenum are associated with serious vital organ injuries.³ The duodenum is more difficult to repair than other intra-abdominal luminal organs; and is more likely to leak after repair.

Gastrointestinal contents of about six litres per day pass through the duodenum, which contains pancreatic fluid with enzymatic functions. If duodenal fistula occurs it has severe septic, fluid, electrolyte and nutritional complications.⁴ For this reasons duodenal injuries have high mortality and morbidity, up to 30% mortality and 60% morbidity were reported in previous studies.⁵

Because of duodenum's anatomical and physiological features, there is no optimal surgical treatment option for duodenum traumas. In surgical management, generally the main aim is to prevent duodenal leakage, several surgical modalities such as primary repair, pyloric exclusion, diverticularisation, pancreaticoduodenectomy have been reported.⁶⁻⁹ In this retrospective study, the aim was to present the outcomes of the primary repair in penetrating duodenal injuries.

METHODOLOGY

It was a descriptive study including all duodenal injury patients (age >18 years), admitted to the Adana City Research and Training Hospital between March 2011 and September 2018.

Correspondence to: Dr. Umit Turan, Department of General Surgery, Adana City Training and Research Hospital Adana, Turkey
E-mail: turanumit@gmail.com

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This study was approved by the Ethics Committee of Adana City Research and Training Hospital and was performed in accordance with the ethical standards in the Declaration of Helsinki. The data of patients obtained from hospital records. Age, gender, mechanism of penetrating injury (stabbing or gunshot), grade of the duodenal injury (According to the American Association for the Surgery of Trauma [AAST]), associated intra-abdominal injuries (major vascular structures and the other intra-abdominal organs), operative procedures, length of intensive care unit (ICU) and hospital stay, duodenum-related mortality, overall mortality and morbidity were analysed. Duodenal traumas were graded intraoperatively. The necrotic tissues at the injury areas were debrided and primary repair was performed with via hand sewn or stapler.

The patients who had early death (intraoperative and postoperative deaths within 24 hours), grade 1 duodenum injuries (no perforation at the duodenal wall or hematoma involving single portion of the duodenum) and operative procedures except primary repair (Whipple procedure, primary repair with tube duodenostomy, primary repair with pyloric exclusion, etc.) were excluded from the study.

Duodenal leakages leading to signs of sepsis and metabolic disorders due to the excess drainage were reoperated. Re-operation procedures were determined according to surgeon's preference such as re-primary repair with drainage, re-primary repair with pyloric exclusion, triple ostomies, whipple procedure, duodenum diverticulisation etc.

The statistical analysis was performed by using SPSS 25 (SPSS Inc). Chi-square test was used to compare categorical variables between survivor and non-survivor groups. If the expected value was <5 , Fisher's exact test was used. The Shapiro-Wilk normality test was used to determine if the continuous variables had a normal distribution. The nonparametric Mann-Whitney U-test was used to compare the continuous variables that were not normally distributed. A p value <0.05 was considered statistically significant.

Table I: Associated abdominal injuries.

Organ	N (%) Total patients: 26
Colon	17 (65.4)
Liver	16 (61.5)
Small bowel	16 (61.5)
Stomach	14 (53.8)
Pancreas	9 (34)
Major vascular	9 (34)
Inferior vena cava	6 (23)
Portal vein	2 (7.7)
Renal vein	2 (7.7)
A-V. Iliaca	1 (3.8)
Diaphragma	7 (26.9)
Spleen	6 (23.1)
Kidney	6 (23.1)
Gallbladder	3 (11.5)

Table II: Characteristics of patients.

	n (%)
Age (mean)	33.11 (± 12.07)
Gender	
Female	5 (19.2)
Male	21 (80.8)
Mechanism of penetrating trauma	
Gunshot	19 (73.1)
Stabbing	7 (26.9)
Anatomic localization of the duodenal injury	
Segment I	3 (11.5)
Segment II	6 (23.1)
Segment III	6 (23.1)
Segment IV	9 (34.6)
Multiple	2 (7.7)
Grade	
II	20 (76.9)
III	5 (19.2)
IV	1 (3.8)
Associated intraabdominal organ injury	
Absence	1 (3.8)
Presence	25 (96.2)
Duodenal leak	
Absence	23 (88.5)
Presence	3 (11.5)
Reoperation	4 (15.3)
Duodenal leak	2 (7.7)
Hemorrhage	2 (7.7)
Length of ICU stay (mean)	7.03 (± 7.54)
Length of Hospital stay (mean)	20.84 (± 26.93)
Postoperative complication	14 (53.8)
Duodenum related mortality	1 (3.8)
Overall mortality	5 (19.2)

Table III: Prognostic factors of overall mortality.

		Survivors N (%)	Non-survivors N (%)	p-value
Gender	Male	18 85.7	2 40	0.236*
	Female	3 14.3	3 60	
Mechanism of penetrating trauma	Gunshot	14 66.7	5 100	0.278*
	Stabbing	7 33.3	0 0	
Anatomic localisation of the duodenal injury	Segment I	3 14.3	0 0	0.038*
	Segment II	6 28.6	0 0	
	Segment III	2 9.5	4 80	
	Segment IV	8 38.1	1 20	
	Multiple	2 9.5	0 0	
Grade	2	16 76.2	4 80	0.136*
	3	5 23.8	0 0	
	4	0 0	1 20	
Associated intra-abdominal organ injury	Presence	20 95.2	5 100	1.000*
	Absence	1 4.8	0 0	
Duodenal leak	Presence	2 9.5	1 20	0.488*
	Absence	19 90.5	4 80	
Associated major vascular trauma	Presence	5 23.8	4 80	0.034*
	Absence	16 76.2	1 20	

*Fisher's exact test.

RESULTS

Thirty-one patients were operated with penetrating trauma in the study period. Five patients who had early death ($n=2$ intra-operative death, $n=2$ death in postoperative <24 hours) and one patient had Whipple procedure ($n=1$) due to the grade IV trauma, were excluded. Data for a total 26 patients (5 females and 21 males) were reviewed. The mean age was 33.11 ± 12.07 years. Gunshot ($n=19$, 73.1%) was the most common cause of the duodenal injury, especially shotgun pellet injuries; therefore, associated intra-abdominal organ injuries were high due to the pellet injuries. Twenty five out of 26 patients had a total of 103 (3.9 injuries per patients) associated intraabdominal organ injuries. The most associated injured organs were colon ($n=17$, 65.4%), liver ($n=16$, 61.5%) and small bowels ($n=16$, 61.5%, Table I).

Twenty (76.9%) patients had grade 2 duodenal injuries and the most injured portion of the duodenum was segment IV ($n=9$, 34.6%, Table II). In three patients (all with gunshot wounds), duodenal leaks were detected and 2 of them were re-operated due to the signs of sepsis and triple ostomies with feeding jejunostomy ($n=1$); and R-Y duodenojejunostomy were performed. Two patients had re-laparotomy for hemorrhage leading to hypovolemic shock.

The median value of lengths of ICU and hospital stay were 5 (IQR, 2-9 days) and 12 days (IQR, 6.75-21.25 days), respectively. The postoperative complication rate was 53.8% ($n=14$) and wound infection ($n=9$, 34.6%) and pulmonary complications ($n=9$, 34.6%) were the most common.

Duodenum-related mortality (DRM) was 3.8% ($n=1$) and overall mortality was 19.2% ($n=5$). The anatomic localisation of duodenal injury and associated vascular trauma were significantly different between survivor and non-survivor groups ($p=0.038$, and $p=0.034$, Table III).

DISCUSSION

In duodenal injuries, which constitute approximately 2% of the abdominal traumas, surgical treatment options are intended to prevent duodenal leakage. Numerous modalities such as primary repair alone, primary repair with pyloric exclusion, triple tube ostomies, diverticulation of the duodenum, pancreaticoduodenectomy were described which proposed for this matter but there is no clear consensus about the ideal surgical treatment of the duodenal injuries.⁶⁻⁹

Due to the anatomical localisation of the duodenum, the duodenal injuries are often associated with multiple intra-abdominal vascular and organ injuries. Ordonez *et al.* identified 113 associated injuries (median 4 injuries per patients) and colon (50%) and small bowel (47.2%) were the most injured associated organs.⁶ Talving *et al.* and Philips *et al.* reported 3.1 and 4.9 concomitant injuries per patients respectively.^{5,10} In total, we found 103 associated intraabdominal injuries in 26 patients (3.9 injuries per patients). Colon (65.4%) and liver (61.5%) were the most concomitantly injured organs.

These associated organ injuries were the most important factors that increase mortality and morbidity. In this study, overall mortality rate was 19.2% and associated major vascular trauma was the predictive factor of mortality. In literature, mortality rates up to 64% were reported and the main predictive factor of mortality was associated organ injuries.¹¹ In duodenal trauma, DRM was low. The DRM rate in this study was 3.8%. Many studies stated DRM between zero to 9.5%.^{12,13} Aiolfi *et al.* reported DRM as 7.5% in 1198 patients who had isolated-duodenal injury.¹⁴ Because of this low DRM, minimally invasive procedures will be more accurate in surgical management of duodenal injuries.

The analysis of this series shows the anatomic localisation of duodenal injury was the predictive factor of overall mortality. In segment 3 injuries, overall mortality was high. This mortality rate likely be higher due to the close proximity of this portion of duodenum to the vascular structures. In 6 patients (23.1%), segment 3 was injured; segment 4 ($n=9$, 34.9%) was the most injured portion of duodenum in this study. In a review, Santos *et al.* analyzed 1042 patients and found that the most common sites of duodenal injury were segment 2 (36%) and segment 3 (18%).¹⁵

The morbidity rates in duodenal injuries were very high and morbidity rates of up to 100% were reported.¹⁶ The morbidity rate was 53.8% and wound infection – pulmonary complications were observed mostly. Due to the high morbidity rate, the lengths of ICU and hospital stay were longer. Therefore in this study, the mean length of ICU stay was 7.03 days and the length of hospital stay was 20.84 days. Ordonez *et al.* found the mean length of ICU and hospital stay as 7.5 and 19.5 days similar to this study.⁶

The major duodenal-related complication is duodenal leak. Three (11.5%) patients had duodenal leakage in this study. All of them were gunshot wounds; and in stab wounds, there was no leak. Duodenal fistula occurred in one of the duodenal leaks and it was healed conservatively, the other two patients were re-operated. In previous studies, duodenal leak rates after the primary repair were reported between 0 and 33%.^{6,16,17} and they were managed by various procedures such as pyloric exclusion and gastrojejunostomy, secondary repair and drainage and retroperitoneal laparostomy. Weale *et al.* stated that duodenal leak increases the overall mortality but in the present study, the authors could not find any difference between survivor and non-survivor groups in terms of duodenal leakage.¹⁷

This study has limitations. First, this was a retrospective non-randomised study. Although in the present study, the sample size was small, it was valuable to evaluate the outcomes of a single surgical procedure.

CONCLUSION

Duodenal segment involvement, associated with intra-abdominal organ and vascular injuries, were the predictive factor of overall mortality in duodenal injuries. Duodenum-related mortality rate was low. For this reason, minimally invasive proce-

dures will be more accurate in surgical management of duodenal injuries.

ETHICAL APPROVAL:

This study was approved by the appropriate Ethics Committee of Adana City Research and Training Hospital and has, therefore, been performed in accordance with the ethical standards in the Declaration of Helsinki.

CONFLICT OF INTEREST:

The authors declared no conflict of interest.

AUTHORS' CONTRIBUTION:

UT: Conception and design of the work, analysis of data, revising it critically, final approval of the version to be published.

HK: Interpretation of data, drafting the work, final approval of the version to be published.

Both authors agreed 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.

REFERENCES

- Malhotra A, Biffl WL, Moore EE, Schreiber M, Albrecht RA, Cohen M, et al. Westerntrauma association critical decisions in trauma: Diagnosis and management of duodenal injuries. *J Trauma Acute Care Surg* 2015; **79(6)**: 1096-101.
- Ivatury RR, Nassoura ZE, Simon RJ, Rodriguez A. Complex hyperlink "<http://www.ncbi.nlm.nih.gov/pubmed/8782473>" pancreatic hyperlink "<http://www.ncbi.nlm.nih.gov/pubmed/8782473>" injuries hyperlink "<http://www.ncbi.nlm.nih.gov/pubmed/8782473>". *Surg Clin North Am* 1996; **76(4)**:783-95.
- Asensio JA, Stewart BM, Demetriades D. Penetrating injuries to the duodenum. In: Ivatury RR, Cayten CG, editors. Textbook of penetrating trauma. Chap. 49. Philadelphia: Lea & Febiger 1995; 610-30.
- Lucas CE, Ledgerwood AM. Factors influencing outcome after blunt duodenal injury. *J Trauma* 1975; **15(10)**: 839-46.
- Talving P, Nicol AJ, Navsaria PH. Civilian duodenal gunshot wounds: Surgical management made simpler. *World J Surg* 2006; **30(4)**:488-94.
- Ordoñez C, García A, Parra MW, Scavo D, Pino LF, Millán M, et al. Complex penetrating duodenal injuries: Less is better. *J Trauma Acute Care Surg* 2014; **76(5)**:1177-83.
- Seamon MJ, Pieri PG, Fisher CA, Gaughan J, Santora TA, Pathak AS, et al. A ten-year retrospective review: Does pyloric exclusion improve clinical outcome after penetrating duodenal and combined pancreaticoduodenal injuries. *J Trauma* 2007; **62(4)**:829-33.
- Berne CJ, Donovan AJ, White EJ, Yellin AE. Duodenal diverticulisation for duodenal and pancreatic injury. *Am J Surg* 1974; **127(5)**:503-7.
- Asensio IA, Petrone P, Roldán G, Kuncir E, Demetriades D. Pancreaticoduodenectomy: A rare procedure for the management of complex pancreaticoduodenal injuries. *J Am Coll Surg* 2003; **197(6)**:937-42.
- Phillips B, Turco L, McDonald D, Mause A, Walters RW. Penetrating injuries to the duodenum: An analysis of 879 patients from the national trauma data bank 2010 to 2014. *J Trauma Acute Care Surg* 2017; **83(5)**:810-7.
- Wynn M, Hill DM, Miller DR, Waxman K, Eisner ME, Gazzaniga AB. Management of pancreatic and duodenal trauma. *Am J Surg* 1985; **150(3)**:327-32.
- Rathore MA, Andrabi SI, Najfi SM, Chaudhry Z, Chaudhry AM. Injuries to the duodenum-prognosis correlates with body Injury Severity Score: A prospective study. *Int J Surg* 2007; **5(6)**:388-93.
- Carrel T, Lerut J, Niederhauser U, Schweizer W, Blumgart LH. Diagnosis and treatment of traumatic injuries of the duodenum and pancreas: 21 cases. Carrel T, Lerut J, Niederhauser U, Schweizer W, Blumgart LH.
- Aiolfi A, Matsushima K, Chang G, Bardes J, Strumwasser A, Lam L, et al. Surgical trends in the management of duodenal injury. *J Gastrointest Surg* 2019; **23(2)**:264-9.
- García Santos E, Soto Sánchez A, Verde JM, Marini CP, Asensio JA, Petrone P. Duodenal hyperlink "<http://www.ncbi.nlm.nih.gov/pubmed/25443151>" hyperlink "<http://www.ncbi.nlm.nih.gov/pubmed/25443151>" injuries hyperlink "<http://www.ncbi.nlm.nih.gov/pubmed/25443151>" due to trauma: Review of the literature. *Cir Esp* 2015; **93(2)**:68-74.
- Cogbill TH, Moore EE, Feliciano DV, Hoyt DB, Jurkovich GJ, Morris JA, et al. Conservative management of duodenal trauma: A multicenter perspective. *J Trauma*; **30(12)**: 1469-75.
- Weale RD, Kong VY, Bekker W, Bruce JL, Oosthuizen GV, Laing GL, et al. Primary repair of duodenal injuries: A retrospective cohort study from a major trauma centre in South Africa. *Scand J Surg* 2019; **108(4)**:280-4.

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