Turkish Journal of Trauma & Emergency Surgery
Original Article

Ulus Travma Acil Cerrahi Derg 2009;15(5):467-472
Klinik Çalışma

Management of duodenal injury: our experience and the value of tube duodenostomy

Duodenum yaralanmalarında tedavi: Deneyimlerimiz ve tüp duodenostominin yeri

Sadullah GİRGİN,[1] Ercan GEDİK,[1] Yusuf YAĞMUR,[1] Ersin UYSAL,[2] Bilsel BAÇ[1]

BACKGROUND

The aim of this study was to report our experience with duodenal injuries and determine if primary repair and/or tube duodenostomy are valid options for definitive operative repair of severe duodenal injuries.

METHODS

Sixty-seven patients who underwent surgery for duodenal injuries were evaluated. Management of duodenal injury was classified as primary repair and tube decompression.

RESULTS

Fifty-nine patients were injured by a penetrating mechanism, and eight were injured by blunt mechanism. The most common injury site was in the second portion of the duodenum. There were no significant differences between the two groups with respect to morbidity and mortality rate. In 35 patients without morbidity, the mean length of hospital stay was 18.53±1.85 days in the tube duodenostomy group and 11.45±1.92 days in the primary repair group, and the difference was statistically significant. In the 32 patients with morbidity, the mean length of hospital stay was 47.05±10.46 days in the tube duodenostomy group and 49.86±10.86 days in primary repair group, but there was no statistically significant difference between the groups.

CONCLUSION

Primary repair is suitable in the vast majority of duodenal injuries; tube duodenostomy increases the length of hospital stay and does not improve clinical outcome.

Key Words: Duodenal injuries; primary repair; tube duodenostomy.

AMAÇ

Şiddetli duodenal yaralanmalarda primer onarım ve/veya tüp duodenostomi uygulamalarının etkinliği değerlendirildi ve bu konudaki deneyimlerimiz sunuldu.

GEREÇ VE YÖNTEM

Duodenum yaralanması nedeniyle ameliyat edilen 67 hasta değerlendirildi. Ameliyat tekniği, primer onarım ve tüp duodenostomi uygulanan hastalar olarak sınıflandırıldı.

BULGULAR

Elli dokuz hastada penetran ve sekiz hastada ise künt duodenum yaralanması mevcuttu. En sık yaralanan duodenum kısım ikinci segmentti. Her iki tedavi grubu arasında morbidite ve mortlite oranı açısından bir fark yoktu. Morbidite gelişmeyen 35 hastada hastanede yatış süresi, tüp duodenostomi uygulanan grupta 18,53±1,85 gün ve primer onarım uygulanan grupta ise 11,45±1,92 gün olup, bu sonuç istatistiksel olarak anlamlıydı. Morbidite gelişen 32 hastada hastanede kalış süresi ise tüp duodenostomi uygulanan grupta 47.05±10.46 gün ve primer onarım uygulanan grupta 47,05±10,46 gün idi. Bu sonuç istatistiksel olarak anlamlı değildi.

SONUÇ

Şiddetli duodenum yaralanmalarında primer onarım uygun bir tedavi yöntemidir. Tüp duodenostomi uygulaması, hastanede kalış süresini artırdığı gibi hastanın klinik gidişatına ek bir katkısı olmadığı görülmüştür.

Anahtar Sözcükler: Duodenal yaralanma; primer onarım; tüp duodenostomi.

[1]Department of General Surgery, Dicle University Faculty of Medicine,
[2]Department of Technic Programmes, Dicle University, Diyarbakır, Turkey.

[1]Dicle Üniversitesi Tıp Fakültesi, Genel Cerrahi Anabilim Dalı,
[2]Dicle Üniversitesi, Teknik Program Bölümü, Diyarbakır.

Correspondence *(İletişim):* Sadullah Girgin, M.D. Dicle Üniversitesi Tıp Fakültesi, Genel Cerrahi Anabilim Dalı, 21280 Diyarbakır, Turkey.
Tel: +90 - 412 - 248 80 01 / 4855 Fax *(Faks):* +90 - 412 - 248 85 23 e-mail *(e-posta):* sadullahgirgin@gmail.com

Duodenal injuries are seen with much greater frequency compared to 40 years ago due to the increased incidence of automobile accidents and violent assaults.[1] The majority of duodenal injuries are caused by penetrating trauma; however, blunt injuries, though infrequent, are difficult to diagnose because patients may have subtle findings on admission. The incidence of duodenal injuries varies from 3% to 5%. Most duodenal injuries are accompanied by other intra-abdominal injuries because of the close anatomic relationship of the duodenum with other solid organs and major vessels.[2]

The management of more complex duodenal injuries is controversial. Debridement and primary repair or resection and anastomosis are suitable for the majority of duodenal injuries, especially for penetrating injuries.[1-8] However, duodenal fistulization and increased morbidity related to complex duodenal injuries have prompted surgeons to add a variety of adjunctive operative procedures to protect the duodenal suture line.[1] Duodenal tube decompression was first introduced by Stone and Fabian.[5,9] Other authors later also recommended tube duodenostomy for decompression of the duodenum and protection of the duodenal suture line.[10-12]

This report analyzes our experience with duodenal injuries and determines if primary repair and/or tube duodenostomy are valid options for definitive operative repair of severe duodenal injuries.

MATERIALS AND METHODS

The Dicle University Faculty of Medicine Teaching Hospital in Turkey is an 1100-bed hospital and the only tertiary institution in the region. It serves a city of 1.5 million people, as well as a combined urban and rural population of 7 million. The average number of trauma patients treated at the institution annually is 4000-5000. The subjects of this study were 98 patients who underwent surgery for duodenal injuries between January 1995 and December 2007. Thirty-one patients were excluded (14 who died within 48 h of severe associated injuries, 13 with grade I duodenal injuries, 4 who underwent pyloric exclusion). The remaining 67 patients with duodenal injuries ≥ grade II according to the American Association for the Surgery of Trauma (AAST) criteria 5 (Table 1)[12] were included in this study.

Data were collected regarding patient characteristics, type of injury (blunt or penetrating), presence of shock during admission (systolic blood pressure ≤90 mmHg), injury severity [defined by the Injury Severity Score (ISS) and Revised Trauma Score (RTS)], number of associated intra-abdominal organ injuries, number of associated extra-abdominal organ injuries, operative findings including details about the grade and site of duodenal injury, transfused blood units within the first 24 hours, surgical interventions, length of hospital stay, and outcomes. Pancreatic injury was graded according to the Organ Injury Scaling (OIS) Committee of the AAST.[12]

During the period of the study, the management of patients consisted of initial stabilization in the emergency room followed by early laparotomy. All patients received antibiotics before and during surgery. If warranted, antibiotic therapy was continued in the post-operative period. All patients had peritoneal drainage by Penrose drains or sump tubes placed in the vicinity of the duodenal suture line.

Duodenal injuries were diagnosed and graded during laparotomy in all patients. Operative repair was dictated by surgeon preference. Management of duodenal injury was classified as primary repair (debridement with simple closure and resection with anastomosis) and tube decompression (antegrade or retrograde tube duodenostomy). Duodenal injuries suitable for primary repair were closed in two-layer suture. Complete transections, large lacerations, or injuries involving loss of a portion of the duodenal

Table 1. Duodenum Injury Scale[12]

I	Hematoma	Involving a single portion of the duodenum
	Laceration	Partial thickness, no perforation
II	Hematoma	Involving more than one portion
	Laceration	Disruption <50% of the circumference
III	Laceration	Disruption 50%-75% of the circumference of D2
		Disruption 50%-100% of the circumference of D1, D3, D4
IV	Laceration	Disruption >75% of the circumference of D2 and involving the ampulla or distal common bile duct
V	Laceration	Massive disruption of the duodenopancreatic complex
	Vascular	Devascularization of the duodenum

Table 2. Characteristics of patients with duodenal injury

Age	Mean	31.97 (16-66)
Gender	Male	56 (84%)
	Female	11(16%)
Mechanism of injury	Penetrating	59 (88%)
	Blunt	8 (12%)
Hypovolemic shock	Presence	22 (33%)
	Absence	45 (67%)
RTS Score	Mean	5.77 (4.21-7.84)
ISS Score	Mean	23.86 (11-75)

RTS: Revised Trauma Score; ISS: Injury Severity Score.

Table 3. Associated intra-abdominal organ injuries

Small bowel	28 (50%)
Stomach	30 (45%)
Liver	37 (55%)
Spleen	2 (3%)
Kidney	13 (19%)
Diaphragm	10 (15%)
Pancreas	20 (30%)
Major abdominal vessels	17 (25%)
Gallbladder	4 (6%)
Colon	27 (49%)

wall were treated with resection and primary anastomosis, with two-layer suture. After primary repair or resection and anastomosis, a tube (size 10-14 Fr) was inserted in to the duodenum in an antegrade or retrograde manner in relation to the injury site. Patients were divided into two groups: patients with only primary repair and those with primary repair and tube decompression.

A duodenal fistula was defined as drainage with both an amylase and bilirubin content greater than that of serum. A pancreatic fistula was defined as being >50 ml of high amylase-containing fluid per day. An intra-abdominal abscess was accepted as an intra-peritoneal collection of pus without any suture line dehiscence or duodenal fistula, and was identified by positive culture at laparotomy or by computed tomography-assisted percutaneous drainage.[13-15] Length of hospital stay was recorded as well as details of postoperative complications.

Data were entered into a computerized spreadsheet and analyzed by SPSS 13.0 for Windows (SPSS Inc., Chicago, IL). Statistical analysis was performed by using the unpaired Student's t-test rank-sum test for continuous variables and chi-square. A correlation coefficient was calculated using Spearman's rho. Results of continuous variables were presented as mean ±SD. Statistical significance was set at $p<0.05$.

RESULTS

During the study period, of the 67 eligible patients, 59 (88%) were injured by a penetrating mechanism (52 gunshot wounds, 7 stab wounds), and eight (12%) were injured by blunt mechanism. There were 56 (84%) males and 11 (16%) females, with a mean age of 31.97 (range 16-66) years. The mean RTS and ISS scores were 5.77 (range 4.21-7.84) and 23.86 (range 11-75), respectively. Twenty-two patients (33%) presented in hypovolemic shock, defined as a systolic blood pressure of less than 90 mmHg (Table 2).

The most common injury site was in the second portion of the duodenum (23 of 67; 34%) (Fig. 1). The remaining injuries were distributed anatomically as follows: first portion, 12 patients (18%); third portion, 21 patients (31%); and fourth portion, 11 patients (16%). None of these wounds involved the ampullary complex.

Concomitant intra-abdominal injuries were present in all patients. In total, 161 associated injuries were identified in these 67 patients (mean 2.4 associated injuries per patient). The liver was the most frequently injured associated organ (55%), but colon (49%), stomach (44%), small bowel (42%), pancreas (30%), major vascular (25%), diaphragm (15%) and kidney (13%) injuries were also common. Gallbladder (6%) and splenic (3%) injuries were less frequent (Table 3).

No statistical difference in duodenal injury grade between groups was identified (primary repair [PR], 2.70±0.70 vs. tube duodenostomy [T], 2.78±0.71, p=

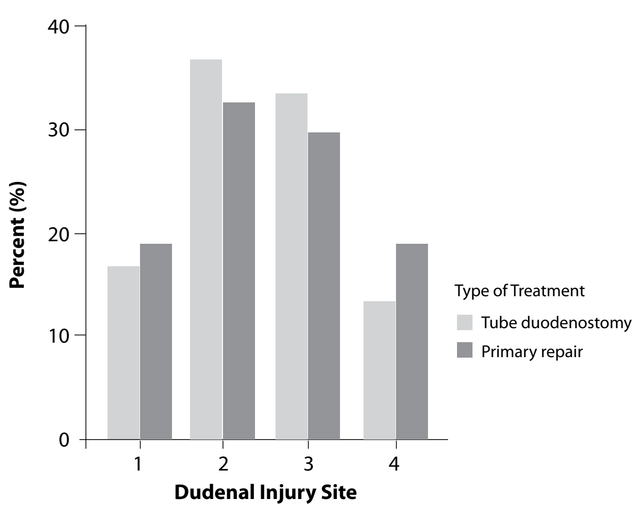

Fig. 1. Duodenal injury sites of primary repair and tube duodenostomy.

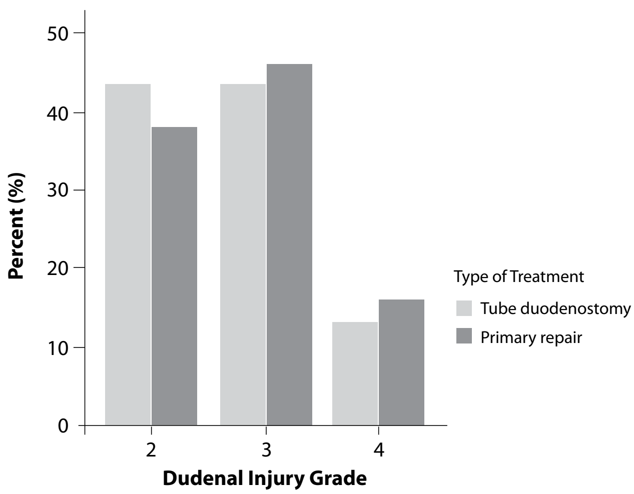

Fig. 2. Duodenal injury grades of primary repair and tube duodenostomy.

0.632). Twenty-seven patients (43%) suffered grade II duodenal injuries, of which 13 had primary repair and 14 patients were repaired with duodenal tube. Thirty of the 67 patients (45%) had grade III injuries. Thirteen patients of this group were primarily repaired, and another 17 were treated with duodenal tube. Ten (15%) patients suffered severe grade IV duodenal injuries, of which four were repaired primarily and six repaired with duodenal tube (Fig. 2).

Patients repaired primarily (PR, n=37) and with tube duodenostomy (T, n=30) were similar with respect to age, ISS, RTS, presence of shock, units of blood transfusion in 24 hours, morbidity, and injury mechanism (p=0.142, p=0.637, p=0.077, p=0.099, p=0.129, p=0.189, p=0.414, respectively) (Table 4).

Twenty of the 67 patients suffered combined pancreaticoduodenal injuries. Eleven of these 20 (55%) patients underwent duodenal tube, whereas nine (45%) patients had primary repair alone. Patients suffering combined pancreaticoduodenal injuries had similar pancreatic injury grades between comparison groups (PR: 2.77±0.83 vs. T: 2.81±0.98, p=0.922).

Rates of duodenal fistula, pancreatic fistula, abdominal morbidity, and mortality among patients treated with primary repair were 5 (13.5%), 2 (5.4%), 8 (21.6%), and 4 (10.8%), respectively. In the tube duodenostomy group, these values were 4 (13.3%), 3 (10%), 10 (33.3%) and 3 (10%), respectively, and no statistically significant differences were determined between the two groups (p=0.983, p=0.477, p=0.282 and p=0.832, respectively) (Table 5).

The mean length of hospital stay in the 35 patients without morbidity was 18.53±1.85 days in the tube duodenostomy group (n=13) and 11.45±1.92 days in

Table 4. Comparison of primary repair versus tube duodenostomy

		Primary Repair	Tube Duodenostomy	p
Age		33.91±16.97	29.56±9.27	0.142
ISS		23.24±11.55	24.63±12.21	0.637
RTS		5.53±0.88	6.06±1.51	0.077
SBP ≤90 mmHg		13/37	9/30	0.099
<24 h blood transfusion units		1.94±3.07	1.16±1.59	0.213
Morbidity		15/37	17/30	0.189
Mechanism of injury	Blunt	3/8	5/8	
	Gunshot	29/52	23/52	0.414
	Stab wound	5/7	2/7	
Duodenal injury grade	mean±SD	2.70±0.70	2.78±0.71	
	II	14/27	13/27	0.632
	III	17/30	13/30	
	IV	6/10	4/10	
Pancreas injury grade		2.77±0.83	2.81±0.98	0.922
Segment of duodenal injury				
	I	7/12	5/12	
	II	12/23	11/23	0.915
	III	11/21	10/21	
	IV	7/11	4/11	
LHS in patients with morbidity		49.86±10.86	47.05±10.46	0.64
LHS in patients without morbidity		**11.45±1.92**	**18.53±1.85**	0.0001*

SD: Standard deviation; ISS: Injury Severity Score; RTS: Revised Trauma Score; SBP: Systolic blood pressure; LHS: Length of hospital stay.

* Statistically significant.

Table 5. Complications and outcomes of primary repair and tube duodenostomy

Complications and Outcomes	Primary repair n (%)	Tube duodenostomy n (%)	p
Duodenal fistula	5 (13.5%)	4 (13.3%)	0.983
Pancreatic fistula	2 (5.4%)	3 (10%)	0.477
Abdominal morbidity	8 (21.6%)	10 (33.3%)	0.282
Mortality	4 (10.8%)	3 (10%)	0.832

the primary repair group (n=22), and the difference was statistically significant ($p<0.0001$). In contrast, the mean length of hospital stay in the 32 patients with morbidity was 47.05±10.46 days in tube duodenostomy group (n=17) and 49.86±10.86 days in the primary repair group (n=15), and the difference was not statistically significant ($p=0.64$) (Fig. 3).

DISCUSSION

Duodenal injury management is a challenging problem in acute surgery because of the complex treatment and infrequent occurrence.[16] Duodenal injury is the indication for 3.7% of all laparotomies for trauma and is rarely an isolated injury.[17] The liver was the most frequently injured associated organ in our series. The major mechanism of injury was penetrating trauma (88%), and gunshot wounds accounted for 88% of penetrating injuries in this study.

Morbidity and mortality rates following trauma to the duodenum continue to be higher. Approximately 80% of duodenal wounds can be safely repaired primarily. Approximately 20% are severe injuries that require more complex procedures.[17] Duodenal injuries cause morbidity in up to 65% and mortality up to 20%.7,14

In the management of duodenal injuries, simple

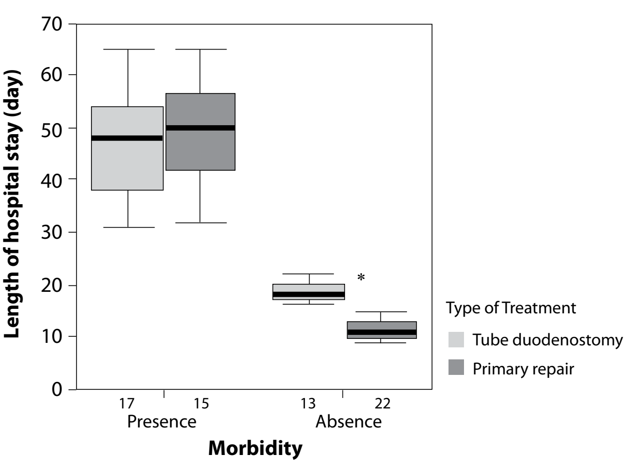

Fig. 3. Length of hospital stays related to morbidity in two groups. **Statistical significant difference between the two groups (p<0.0001).*

primary repair such as simple closure or duodenorrhaphy is an adequate method in the majority of patients. If there is risk that primary repair would narrow the lumen of the duodenum, pedicled mucosal grafts, jejunal serosal patches (side-to-side jejunoduodenostomy) or omental only, duodenal diverticulization, pyloric exclusion, and Roux-en-Y reconstructions can provide an alternative.[1,3,5,6,7,12,18,19] Pyloric exclusion is used by many centers, but in our series, only four patients underwent pyloric exclusion. Since the number is so small, we did not evaluate these patients and they were excluded. This procedure probably offers little advantage over adequate nasogastric drainage when primary duodenal repair is carried out, and is associated with increased operative time, an extra-intestinal anastomosis and gastric suture line ulcers.[14]

Ivatury and colleagues[5-7,19] have published several reports regarding the management of duodenal injuries. In their recent report,[7] they classified treatment according to the hemodynamic status of the patients, and pointed out that in the hemodynamically unstable patient, a damage control approach consisting of hemorrhage control, rapid sealing or resection of gastrointestinal perforations without establishing continuity, temporary abdominal closure, and intensive care unit resuscitation should initially be done, and gastrointestinal tract integrity restoration should be accomplished in a second operation. In hemodynamically stable patients, lower grade lesions of the duodenum and pancreas, low velocity penetrating wounds with no delay in diagnosis and treatment, simple primary repair is adequate treatment for the majority of duodenal injuries. If the duodenal defect is large (>3 cm), primary closure of the defect may narrow the lumen of the bowel or result in undue tension and subsequent suture line breakdown. Segmental resection and primary end-to-end duodenoduodenostomy are usually feasible when dealing with injuries to DI, DIII, or DIV. Pyloric exclusion is the operation of choice in delayed surgical treatment due to tissue inflammation, technical difficulty in suturing of perforations and lacerations or resection, and possibility of extensive retroperitoneal abscess formation.[7]

The tube decompression can be either antegrade, proximal to the injury site or retrograde via a jejunostomy. Tube duodenostomy was first introduced by Stone and Fabian[9,20] as triple ostomy (gastrostomy, duodenostomy and jejunostomy). They had 237 patients and observed only one duodenal fistula when tube decompression was used; however, among 44 patients without the decompression, eight patients had duodenal fistula. The idea of tube duodenostomy is to protect the suture line in the duodenum. Some authors have supported tube duodenostomy[10-12] while others have not.[4,7,21] Ivatury and colleagues found an increased incidence of duodenal fistula and complications when duodenal decompression was used and accepted this technique as particularly valuable when dealing with high-grade lesions in the difficult region of DII. Their current preference was to avoid duodenostomy tubes.[4,5,7]

Snyder and co-workers[21] did not find a statistically significant difference in duodenal fistula rate between patients treated with duodenorrhaphy and tube decompression and those treated with duodenorrhaphy alone. We did not find any significant difference between patients treated with tube decompression (n: 4; 13.3%) and those treated with primary repair (n: 5; 13.5%) in relation to duodenal fistula. However, tube duodenostomy increased the length of hospital stay and the cost of treatment when compared to primary repaired patients. Van Ginhoven and colleagues[18] in a recent report used Foley catheter in the treatment of duodenal injury with delay in diagnosis and thus in surgery. Safe closure of the duodenal perforation was impossible and a Foley catheter was inserted in the duodenal perforation, and the balloon was inflated. The catheter remained in place until a fistula track was formed. After 2-3 months, the balloon was deflated and the catheter was removed gradually. All three patients were successfully treated.

In conclusion, we advise simple primary repair in the vast majority of duodenal injuries. The performance of tube duodenostomy increased the length of hospital stay and did not improve the clinical outcome. Although the statistical conclusions are valid, the number of patients was small. For more correct statistical conclusions, large series are required.

REFERENCES

1. Ivatury RR. Duodenal injuries: Small but lethal lesions. Cirujano General 2003;25:59-65.
2. Acosta J. Management of Specific Injuries, Injuries to the Duodenum. In: Townsend CM, Beauchamp RD, Evers BM, Mattox KL. Sabiston Textbook of Surgery. 18th ed. Philadelphia: Saunders-Elsevier; 2008. p. 505-6.
3. Astarcioğlu H, Koçdor MA, Sökmen S, Karademir S, Ozer E, Bora S. Comparison of different surgical repairs in the treatment of experimental duodenal injuries. Am J Surg 2001;181:309-12.
4. Cogbill TH, Moore EE, Feliciano DV, Hoyt DB, Jurkovich GJ, Morris JA, et al. Conservative management of duodenal trauma: a multicenter perspective. J Trauma 1990;30:1469-75.
5. Ivatury RR, Gaudino J, Ascer E, Nallathambi M, Ramirez-Schon G, Stahl WM, et al. Treatment of penetrating duodenal injuries: primary repair vs. repair with decompressive enterostomy/serosal patch. J Trauma 1985;25:337-41.
6. Ivatury RR, Nassoura ZE, Simon RJ, Rodriguez A. Complex duodenal injuries. Surg Clin North Am 1996;76:797-812.
7. Ivatury RR, Malhotra AK, Aboutanos MB, Duane TM. Duodenal Injuries: A Review. Eur J Trauma Emerg Surg 2007;33:231-7.
8. Velmahos GC, Constantinou C, Kasotakis G. Safety of repair for severe duodenal injuries. World J Surg 2008;32:7-12.
9. Stone HH, Garoni WJ. Experiences in the management of duodenal wounds. South Med J 1966;59:864-7.
10. Donohue JH, Crass RA, Trunkey DD. The management of duodenal and other small intestinal trauma. World J Surg 1985;9:904-13.
11. Flint LM Jr, McCoy M, Richardson JD, Polk HC Jr. Duodenal injury. Analysis of common misconceptions in diagnosis and treatment. Ann Surg 1980;191:697-702.
12. Moore EE, Cogbill TH, Malangoni MA, Jurkovich GJ, Champion HR, Gennarelli TA, et al. Organ injury scaling, II: Pancreas, duodenum, small bowel, colon, and rectum. J Trauma 1990;30:1427-9.
13. Feliciano DV, Martin TD, Cruse PA, Graham JM, Burch JM, Mattox KL, et al. Management of combined pancreatoduodenal injuries. Ann Surg 1987;205:673-80.
14. Rickard MJ, Brohi K, Bautz PC. Pancreatic and duodenal injuries: keep it simple. ANZ J Surg 2005;75:581-6.
15. Talving P, Nicol AJ, Navsaria PH. Civilian duodenal gunshot wounds: surgical management made simpler. World J Surg 2006;30:488-94.
16. Weigelt JA. Duodenal injuries. Surg Clin North Am 1990;70:529-39.
17. Jurkovich GJ, Bulger EM. Duodenum and Pancreas. In: Trauma Moore EE, Feliciano DV, KL Mattox, editors. 4th ed. New York: McGraw-Hill; 2003. p. 709-32.
18. van Ginhoven T, Schepers T, Obertop H, van Eijck CH. Delayed closure of complex duodenal injuries by a Foley balloon catheter duodenostomy. Dig Surg 2006;23:150-3.
19. Ivatury RR, Nallathambi M, Gaudino J, Rohman M, Stahl WM. Penetrating duodenal injuries. Analysis of 100 consecutive cases. Ann Surg 1985;202:153-8.
20. Stone HH, Fabian TC. Management of duodenal wounds. J Trauma 1979;19:334-9.
21. Snyder WH 3rd, Weigelt JA, Watkins WL, Bietz DS. The surgical management of duodenal trauma. Precepts based on a review of 247 cases. Arch Surg 1980;115:422-9.