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Iatrogenic Duodenal Injuries, Analysis of the Surgical Treatment

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ABSTRACT

Background: When an iatrogenic duodenal injury occurs, it represents one of the biggest challenges in surgery. The objective of this study is to describe and analyze the surgical treatment of iatrogenic duodenal injuries in a Regional Reference Center.
Methods: A retrospective study was conducted from January 2016 to December 2019.
Results: We found nine patients, mainly were male (n=5), in the sixth decade of life. Most of these injuries were secondary to gallbladder and bile duct procedures (n=5). The average time elapsed between injury and repair was seven days (range, 0-16 days). The first part of the duodenum was more affected (n=5). The principle procedures used were primary closure (n=4), and Whipple procedure (n=2). Morbidity was 55%, and mortality 33%. The intestinal fistula was the most frequent morbidity. In the analysis, the correlation of intestinal fistula with surgical bleeding (p=0.036), low proteins (p=0.043), and post-injury repair time (p=0.044) were found significant, as well as the correlation of surgical bleeding with mortality was found significant (p=0.049).
Conclusion: The iatrogenic duodenal injuries have high morbidity and mortality. Different variables, like low proteins, surgical bleeding, and long post-injury repair time can influence negatively their result.
Key words: iatrogenic injuries, duodenum, perforation, surgery, outcomes

INTRODUCTION

Duodenal injuries are complex, and their management always represents a challenge for the surgeon (1,2). These injuries occur in 4.3% of abdominal trauma patients, with mortality ranges reported from 5.3 to 30% (3,4). Nevertheless, in the literature, the most analyzed injuries are those of traumatic origin, and iatrogenic injuries have remained less studied. Different surgical groups have described some iatrogenic injuries mainly due to endoscopic procedures or post-cholecystectomy, but until now, the mechanisms of iatrogenic injuries, the description of that injuries, the surgical treatment, and the factors that affected the outcomes of these injuries have not been identified (5).

Due to the limited information on iatrogenic duodenal injuries and its complexity, the objective of this study is to describe and analyze the surgical treatment of iatrogenic injuries of the duodenum.

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MATERIAL AND METHODS

Study design

A retrospective study was conducted from January 2016 to December 2019. To carry out this study we adhere to the STROBE guidelines of the EQUATOR network (6). We included all patients wich required surgical treatment for iatrogenic injuries of the duodenum, operated in a Regional Reference Center with a specialty in Hepato-Pancreato-Biliary surgery. All adult patients, with duodenal injuries that occurred secondarily to a surgical or endoscopic procedure that needed surgical treatment, were included. We include open and laparoscopic surgery, as well as endoscopic procedures. In every injury, the mechanisms of injury and their surgical management were evaluated.

Clinical and surgical evaluation

The patient's files were retrospectively reviewed. We evaluate comorbidities, medical history, clinical symptoms, laboratories, and radiographic studies in all patients. We evaluated preoperative variables such as previous surgeries, trans-operative variables such as surgical time, bleeding, the injured part of the duodenum, surgical procedure performed, and post-operative variables. The duodenal injuries were evaluated according to the American Association for the Surgery of Trauma, AAST (7). Injuries that did not require surgical treatment were not included. In-hospital complications after surgery were evaluated, as well as the need for re-operation, follow-up, morbidity, and in-hospital mortality. The follow-up was performed until discharge. In the end, the morbidity and mortality were correlated with the variables analyzed.

Statistical analysis

We use descriptive statistics, T-student, ANOVA for continuous variables, Chi-square test, Fisher exact test, U Mann-Whitney to perform the analysis. Survival analysis was performed using a Kaplan-Meier and Cox regression model. A p-value 0.05 (confidence interval of 95%) was considered statistically significant. All statistical analyses were performed using the program IBM Statistical Package for Social Sciences (SPSS, Statistics version 24.0, Inc, Chicago, IL).

Ethical considerations

The Hospital Local Ethics Committee approved this protocol. This research is subject to specific standards for the type of human studies and ensuring the confidentiality of the data. This study, also adhered to the regulations of the General Health Law on health research and the Declaration of Helsinki, as well as institutional norms and instructions on scientific research. Due to the retrospective nature of this research, informed consent was not required.

RESULTS

We found nine patients operated on iatrogenic injuries of the duodenum. The majority were male (n=5), with an average age of 59 years (range, 30 - 65 years). Comorbidities found in 3 patients of these were for type 2 diabetes, and systemic arterial hypertension. The iatrogenic injuries occurred mostly after abdominal surgeries (n=7), and in two patients were after endoscopic procedures (n=2). Elective surgery was the main cause of the iatrogenic injuries (n=5), followed by emergency surgery (n=2). Of the abdominal surgeries analyzed, the majority of these injuries were secondary to gallbladder and bile duct procedures (n=5). Of these, three injuries occurred after laparoscopic cholecystectomy, one after laparoscopic bile duct exploration, and one after choledoco-duodenal anastomosis. Just two injuries occurred after non-biliary surgeries, this one after gastric surgery, and another after left nephrectomy.

The laparoscopic cholecystectomies were reported difficult due to fibrosis, adhesions, and intense inflammation at the dissection site. Two of them presented a diagnosis of purulent cholecystitis, and one presented a diagnosis of the perforated gallbladder. In these cholecystectomies, the mechanisms of injury observed in the videos, were by dissection, and the use of electrocautery. In the case of injury after laparoscopic bile duct exploration, this patient presented excessive post-cholecystectomy fibrosis, and the mechanism of injury was due to difficult dissection and retraction. The injury after choledoco-duodenal anastomosis was presented due to dehiscence. This patient underwent surgery in another hospital, and five days later, the patient was admitted to our hospital and was urgently reoperated due to abdominal sepsis, where anastomotic dehiscence was found. The non-biliary surgeries were two, one after non-traumatic gastrorraphy due to abundant inflammatory tissue (n=1), and the other in the fourth part of the duodenum after performing a left nephrectomy (n=1) with xanthogranulomatous pyelonephritis diagnosis. Regarding the injuries after endoscopic procedures, one was after unsatisfactory ERCP, where a

stent was placed, and this subsequently migrated, causing injury in the second part of the duodenum. In the other patient, the injury was after conventional ERCP.

Of these injuries, the most affected duodenal part was the first part in 5 patients, followed by the second part in 3 patients, and the fourth part in one patient. According to AAST classification, grade II was the most frequent injury (n=6), followed by grade III (n=3). At the moment of the reoperation, most of these patients presented added injuries to other organs (n=6). This added injuries involving bile duct injuries in two patients, one patient with biliary fistula, one patient with perforation of the left colic flexure, one patient with perforation of the right colic flexure, and in one patient perforation of the pyloric portion of the stomach.

The average post-injury repair time was seven days (range, 0-16 days). Most of these injuries were reoperated and treated in a second procedure (n=6), and just three injuries were repaired immediately. Besides, three of these patients were previously reoperated, trying to repair the injury without success. Regarding the repair techniques, the primary closure of the duodenum was the most repair procedure performed (n=4). In addition to the primary closure, in one patient drainage jejunostomy was needed, and in two patients with bile duct injury, external drainage of the main bile duct was performed. In two patients, a classic Whipple procedure was required; these cases presented type III injury. One patient has an injury in the fourth part, and the other one presented an injury in the second part of the duodenum. The gastrojejunal anastomosis was performed in two patients, one case for type III injury in the first part, and another for type II injury in the first part of the duodenum. In one patient due to hemodynamic instability, damage control was performed with lavage and drainage of collections due to retroperitoneal abscess after injury of the second part. Average operative time of 4.8 hours (SD 2.21), and average bleeding of 544.4 ml (range, 25 - 1,000 ml) were reported.

After surgery, we found morbidity of 55.5% and mortality of 33.3%. The most frequent complication was the intestinal fistula in three patients. Other complications were biliary and pancreatic fistula (n=1), and hemoperitoneum (n=1). In the analysis of morbidity, we found that the presence of excessive surgical bleeding (p = 0.036), decrease in total proteins (p = 0.043), and the time elapsed injury and repair (p=0.044) showed to be independent predictors of a postoperative intestinal fistula after surgical treatment. Other morbidity variables did not show statistical analysis. *Table 1* shows the factors associated with the presence of a postoperative fistula.

Table 1 - Associating factors with presence of intestinal fistula

Factor	p	Total
Albumin (range)	0.142	1.3 - 3.0 g/dl
Total proteins (range)	0.043	3 - 6.2 g/dl
Post-injury repair time (range)	0.044	7 days (0-16)
Surgical bleeding (mean)	0.036	544.4 ml
Operative time, mean, (SD)	0.695	4.8 hr (SD + 2.21)

Abbreviations: ml= milliliters, hr= hours, SD= Standard deviation.

To analyze the mortality, we compared the perioperative variables with mortality. Regarding the group of patients who died, the average age of these was eight years older (p=0.323), they presented twice as many added injuries (p=0.357), and they also presented twice as many previous interventions as patients who survived (p=0.405). However, none of these variables presented statistical significance. Other variables such as the male/female ratio (p= 0.357), part of the duodenum (p=0.487), degree of injury (p=0.405), added injuries (p=0.357), surgical time (p=0.390), and elapsed time from injury to repair (p=0.455), showed some similarity between surviving and non-surviving patients, without showing statistical significance. Just the presence of high surgical bleeding was significantly greater in the group of patients who died (p=0.049), showing statistical significance in the mortality analysis. *Table 2* shows the characteristics of the mortality correlation, and in *fig. 1*, we show a Kaplan-Meier survival curve of the injuries.

Table 2 - Characteristics of the correlation with the mortality

Factor	Survivors	Non-survivors	p	Total
Age (mean)	54 (30 – 63)	62 (30 – 65)	0.323	59 (30 – 65)
Gender (M/F)	3/2	2/2	0.357	5/4
Duodenal part affected:				
1st part	3	2		5
2nd part	1	2		3
4th part	1	0	0.487	1
AAST grade				
Type II	4	2		6
Type III	1	2	0.405	3
Added injuries	22.2%	33.3%	0.357	55.5 %
Reoperations	11.1%	22.2%	0.405	33.3 %
Previous surgeries	22.2%	33.3%	0.357	55.5 %
Surgical bleeding	516.6 ml	633.3 ml	0.049	544.4 ml
Operative time, mean (SD)	5 (+2.3)	4.5 (+2.39)	0.422	4.8 hr (+2.21)

Abbreviations: M= male, F= female, AAST= American Association for the Surgery of Trauma, ml= milliliters, hr= hours, SD= Standard deviation.

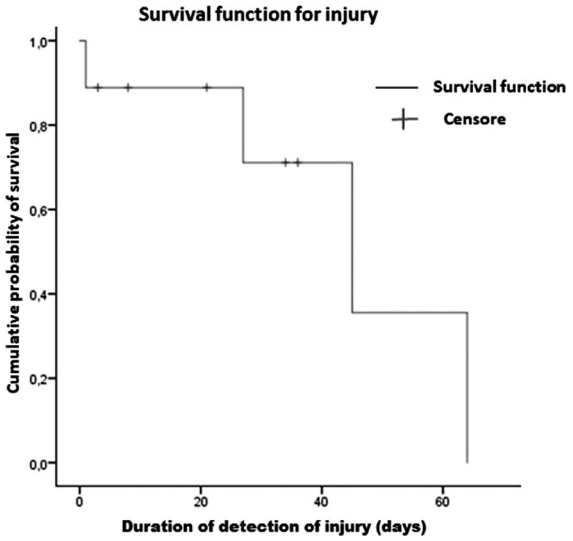

Figure 1 - In the figure we shows the survival function for duodenal injuries

DISCUSSION

Despite the evolution of surgical procedures, the use of new technologies, and the effort to improve surgery quality, incidental injuries of the duodenum continue to occur after different procedures. In the worldwide literature, some surgical groups have described iatrogenic injuries in the biliary ducts, esophagus, or colon, mainly due to endoscopic procedures or surgical procedures like cholecystectomy. However, iatrogenic duodenal injuries are less reported, and in the literature exists little evidence about these feared injuries (5,8). This is probably because it occurs in a very low frequency, as found in our series. In these series also, we observed that iatrogenic duodenal injuries could be presented indistinctly in elective surgery, emergency surgery, and endoscopic procedures, and like traumatic injuries, these lesions are difficult to control representing a big challenge (2).

Regarding the origin of these iatrogenic injuries, the causes and mechanisms found were diverse. Due to the high prevalence of biliary lithiasis, cholecystectomy and procedures in the bile ducts continue to be the most widely performed procedures in surgical services worldwide (9). In our cases, most of the injuries presented after cholecystectomy and bile ducts manipulation. In a literature review carried out in 2018, 74 cases of post-cholecystectomy duodenal injuries were found, thus evidencing their low frequency. The mortality reported was 10% and the injuries were mostly presented in the second part of the duodenum, with the mechanism of injury due to the use of electrocautery and dissection. Unlike these data in our series, the most affected part was the first part of the duodenum, and in the same way, the mechanisms involved that were most present were by dissection and use of electrocautery (10). Other procedures secondary to gallstones are also susceptible to presenting accidental injuries in the duodenum, as post-bile duct exploration or after choledoco-duodenal anastomosis. The choledoco-duodenal anastomosis reported by different surgical groups as safe anastomoses in expert hands, present a frequency of leakage up to 13%. When complete dehiscence occurs, it quickly deteriorates due to sepsis, representing a great challenge in controlling these injuries (11,12). In our series, one post-choledoco-duodenal anastomosis injury was found. However, this being not easy to control.

Injuries secondary to nephrectomy have also been reported. These mostly occur after radical nephrectomy associated with locally advanced tumors and range from splenic injuries, colonic injuries, and, rarely, duodenal injuries (13,14). In our series, one injury after nephrectomy was found. Unlike other post-nephrectomy injuries which the most important causes are the treatment for renal tumors, in our case, the injurie appears after xanthogranulomatous pyelonephritis. Xanthogranulomatous pyelonephritis is a pathology where surgical treatment becomes complicated due to the abundant inflammatory tissue it triggers, however post-nephrectomy injuries in this cases are very low reported (15).

ERCP is also not without complications. These are well known and range from pancreatitis, bleeding, and duodenal perforation. This perforation has been extensively studied. A frequency of 0.35% has been reported, identifying factors that increase the risk that includes the suspected sphincter of Oddi dysfunction, higher age, dilated bile duct, sphincterotomy, and longer duration of the procedure (16).

The treatment of duodenal injuries persists as controversial and not yet completely standardized. This is because it depends on different factors, which surgeons must consider, such as the location of the injury, affected duodenal section, the extension of the injury, added injuries, evolution time, presence of sepsis, among others. The procedures described for this type of injury range from primary repair, pyloric exclusion, gastrojejunostomy, and even duodenopancreatectomy (11,17). In our patients, the most used repair was the primary closure, gastrojejunostomy, and in patients with severe injuries, a duodenopancreatectomy was necessary.

Our patient's complications occur in 55.5%, and

mortality in 33.3%, close figure to those reported in patients undergoing reoperations. Based on this, we must remember that six of our patients underwent surgery on a second attempt, three of them had previous attempts at repair, and five had added injuries, circumstances that further complicated their treatment. These factors are undoubtedly critical and determining when evaluating the results. Some of these factors have already been studied, such as the effect of reoperation in patients undergoing major surgery, which substantially increases the complications and mortality than in non-reoperated patients (18).

One of the most critical complications in abdominal surgery is an intestinal fistula. Intestinal fistula has been significantly related to increased morbidity and mortality in abdominal surgery. Some series have reported intestinal fistula ranges from 5.5% to 14% (16,18). In our series, fistulas were reported in a range high, than that reported in some other series of duodenal injuries. This range of fistula in our series was found due to some factors such as low proteins, increased surgical bleeding, and post-injury repair time, which has been shown to even increase mortality in patients with iatrogenic duodenal injuries after cholecystectomy (10,20).

Our mortality was 33.3% a little high than other series reported, and to analyze the factors that influenced this number, we carried out an analysis. In this analysis, we found that the patients who survived were younger than the patients who died. Besides, the surviving patients had fewer added injuries than non-surviving patients, but these comparisons were not significant. Another critical variable reported in the literature is the time between the injury and its repair. Injuries repaired within the first 24 hours have been reported to show longer survival (9). However, in our series, this comparison did not report statistical significance either, probably because some of these patients were reoperated in a different period, which depended on the different surgeon's criteria. In our mortality analysis, the only variable that showed statistical significance was profuse surgical bleeding.

Due to their complexity, these iatrogenic injuries should be a focus of alarm for all surgeons who perform surgeries in the abdominal cavity. Of all the operations that we present here, the mortality of each one of them is relatively low. However, when an accidental injury occurs in another structure such as the duodenum, it is completely modified. Due to this, it is necessary to avoid these injuries as much as possible, and, after presented, to close evaluate to prevent high morbidity and high mortality.

Besides, we would like to mention that this study is subject to different limitations. One is undoubtedly due to retrospective design, as well as considering that in this study, the small sample of patients limited the statistical analysis and the comparison with the world-wide literature. Evidence for this type of injury is still lacking. Further studies with a larger number of patients are required to increase the accuracy of the analyses and evaluate these fearsome injuries.

CONCLUSION

The presence of an iatrogenic injury of the duodenum can be catastrophic. These injuries have high morbidity and mortality. Different variables, like low proteins, surgical bleeding, and large post-injury repair time can influence negative in the outcomes of surgical treatment.

Statement of author contribution

Each author declares to have participated and complied with the authorship criteria.

Conflicts of interest

The authors declare no conflicts of interest.

Financial support

The authors did not receive funding to carry out this study.

Informed consent

In this of retrospective research, informed consent was not required.

Author's contribution

Jair Díaz-Martínez: design of the work; acquisition, analysis, interpretation of data, final approval. Antonio Merlin-Gallegos: design, acquisition data, final approval. Nayeli Pérez-Correa: acquisition data, analysis data, final approval. Berenice Edelmira Carbajal-López: analysis data, interpretation data, final approval.

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