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Original article

POSTOPERATIVE PANCREATITIS IN HEPATIC RESECTIONS - ROLE OF PRINGLE'S MANEUVER

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ABSTRACT

Background: The mechanism of postoperative pancreatitis still remains not profoundly explored in the area of liver resections. Three main mechanisms are named for the origin of pancreatitis following liver resections. The first mechanism has its foundation based on intrahepatic bile-ducts lithiasis, which leads to bile-stones or sludge migration during operation, obstructing the duodenal papilla The other mechanism elucidates haemobilia as the main factor, forming blood clots that migrate and obstruct the duodenal papilla. The Pringle maneuver is the third reason for pancreatitis, which causes blood congestion in the splanchnic area, particularly the pancreatic venous vessels.

Aim: to evaluate and define the leading mechanism of developing postoperative pancreatitis in liver resections by statistical retrospective analysis and explore the main complications following pancreatitis.

Methods: For the period from 2018 to 2023, 64 patients developed postoperative pancreatitis after liver resections. The study was conducted in a retrospective study fashion, exploring statistically the reasons and mechanisms leading to pancreatitis, comparing different factors like the type of liver resection, presence or lack of haemobilia, application of Pringle maneuver, time under warm ischemia utilizing the Pringle maneuver. Data was processed with SPSS ver 23.000

Results: Pancreatitis was found predominantly after atypical liver resections and bi-segmental resections. Haemobilia didn't prove to be a factor for pancreatitis. Warm ischemia and the time of its application proved to be one of the main factors for pancreatitis.

Conclusions: Warm ischemia and type of liver resection are the main factors leading to the development of pancreatitis.

Keywords: Liver resections, postoperative pancreatitis, Pringle maneuver,

INTRODUCTION

Postoperative pancreatitis is a severe complication in the postoperative period, which threatens not only the favorable outcome of the surgery but also the patient's life. The mechanism of postoperative pancreatitis remains not profoundly explored in the area of liver resections. Nevertheless, the liver and pancreas are adjacent organs, and they are connected through the bile ducts; there is no directly described connection leading to pancreatitis following liver resections. Three main mechanisms are named to be in the origin of pancreatitis in such cases. The first mechanism has its foundation based on intrahepatic bile-ducts lithiasis. The presence of intrahepatic bile stones or sludge during liver resection can lead to their migration during operation, obstructing the duodenal papilla. [1, 2]

The second mechanism elucidates haemobilia as the main factor. During extensive liver resections like bi-segmentectomies and tri-segmentectomies, blood can penetrate bile ducts through the resection surfaces, especially when applying parenchyma crushing techniques. Caused haemobilia is said to form blood clots which migrating through bile ducts can obstruct the duodenal papilla. Tocchi A, et al. [3]

The Pringle maneuver is the third named reason for pancreatitis causing blood congestion in the splanchnic area and, in particular, the pancreatic venous vessels. Regardless of which type of Pringle maneuver is used to cause warm ischemia of the liver during resection, all that results in blood stasis into the splanchnic area. This artificially causes blood congestion, resulting in stasis of blood in pancreatic blood vessels and local ischemia. Pancreatic ischemia triggers a reaction of activation of the pancreatic enzymes and pancreatitis. [4, 5, 6, 7, 8]

These three theoretical mechanisms don't lead to direct answers on which types of liver resections pancreatitis will develop, and they don't connect specific types of liver resections to a greater incidence of pancreatitis

postoperatively.

The aim of the study is to evaluate and define the leading mechanism of the development of postoperative pancreatitis in liver resections by statistical retrospective analysis. Utilizing collected data to elucidate which liver resections have a higher rate of pancreatitis incidence and explore the main complications following pancreatitis in these cases.

MATERIALS AND METHODS:

A retrospective study covering all liver resections with the incidence of postoperative pancreatitis was performed for six years. A sufficient number of 64 patient cases were examined. Cases were collected based on the criteria of liver resection accompanied by the incidence of development of postoperative pancreatitis. Factors like the type of liver resection, type of technique utilized for liver dissection, lack or presence of haemobilia postoperatively, Pringle maneuver utilization and time of warm ischemia, presence of signs of developing pancreatitis postoperatively, and type of complications developed during the evolution of pancreatitis, were studied and a statistical data processing was done.

RESULTS:

Statistical processing showed a higher incidence of pancreatitis appearing after atypical mono-segmental liver resections in 32.81% of all cases and atypical bi-segmental liver resections in 14.06% of all cases. While in typical liver resections, lobectomies, and hemi-hepatectomies, the rate of pancreatitis incidence didn't exceed 6.25% of all the cases.

Haemobilia was reported in the bile drainages only in three of the studied cases, which points out that haemobilia is not the major factor triggering pancreatitis development.

In all of the described cases, a combination of different techniques for resection was used during different stages of liver resection, and a statistical method could not be applied due to a lack of criteria for differentiation and the combination of used methods.

The Pringle maneuver was applied in 30 of all 64 examined cases. Through statistical analyses using the Pearson x2 test, a direct, significant connection was observed between Pringle maneuver utilization during liver resection and the appearance of pancreatitis.

Table 1 presents a direct statistical correlation between the Pringle maneuver and the incidence of pancreatitis after liver resection.

Table 1. Pearson x^2 test correlation between Pringle maneuver utilization and postoperative pancreatitis incidence.

	Number of cases	Ei	Row Totals
No pringle	34 (25.00) [3.24]	16 (25.00) [3.24]	50
Pringle 10 min	6 (11.00) [2.27]	16 (11.00) [2.27]	22
Pringle 20 min	16 (16.00) [0.00]	16 (16.00) [0.00]	32
Pringle 20+	8 (12.00) [1.33]	16 (12.00) [1.33]	24
Column Totals	64	64	128 (Grand Total)

The chi-square statistic is 13.6921. The *p*-value is .003356. The result is significant at $p < .05$

Table 2 shows a direct correlation between the volume of resection of the liver and Pringle maneuver utilization during liver resection are the leading factors for pancreatitis development in the postoperative period.

Table 2. Statistical connection between the volume of resection and Pringle maneuver as factors for pancreatitis

	mono-segmentectomy	bi-segmentectomy	lobectomy	hemihepatectomy	Row Totals
No pringle	25 (15.89) [5.22]	5 (10.39) [2.80]	2 (3.06) [0.36]	1 (3.67) [1.94]	33
pringle	1 (10.11) [8.21]	12 (6.61) [4.39]	3 (1.94) [0.57]	5 (2.33) [3.05]	21
Column Totals	26	17	5	6	54 (Grand Total)

DISCUSSION

Various techniques are used to reduce or completely occlude blood flow entering the liver during major liver resections. These techniques, with various modifications, are mainly based on Pringle's maneuver - to clamp the hepatoduodenal ligament and reduce to the minimum the blood flow entering the liver through the portal vein and hepatic artery. This results in less intraoperative bleeding and, consequently, less blood loss during liver resection. However, many authors have reported that Pringle-maneuver and its various modifications are one of the major causes of postoperative pancreatitis after liver resections. [9, 10, 11] Abdalla EK, et al. [4] as well as Kubota K, et al. [5] theorized that hyperamylasemia after Pringle application is due to the venous congestion in the splanchnic area and the pancreas in particular.

In their study, Unalp OV, et al. directly demonstrated both a plasma alteration - an increase in alpha-amylase levels after administered Pringle maneuver - and direct histological damage to the pancreas, resulting in glandular edema and the appearance of infiltrates of inflammatory polymorphonuclear cells within the gland. [7, 8] These changes are directly related, according to the authors, to the duration of clamp time and the severity of venous congestion. [7, 8] Regarding the severity of venous congestion achieved with Pringle maneuver utilization, Kubota K, et al. present a randomized study of two groups of patients. In the first, they performed hepatic resection with the Pringle maneuver application; in the second, in addition to Pringle, they also applied a superior mesenteric artery flap. Consequently, venous congestion in the second group was less due to the reduced arterial blood supply to the pancreas. Respectively, serum amylase levels in the second group were less elevated postoperatively. [5, 12, 13, 14, 15, 16]

The causes of pancreatic inflammation following liver resection are not directly related to pancreatic damage, despite the relative anatomical proximity of the two organs and their connection via the biliary system. Hashimoto N, et al. [6] presented a study of patients with hepatic resections utilizing Pringle's maneuver performed before the start of the resection and compared these results to a group of patients who underwent hemi-hepatectomies with a previously achieved vascular occlusion of one hemiliver. The results showed a direct relationship between the time of warm ischemia and, respectively, vascular congestion in the portal system and the subsequently developed postoperative pancreatitis. [6, 17, 18 19, 20]. This fact elucidated that the greater the time of warm ischemia due to the applied Pringle maneuver, the more pronounced the postoperative changes in the pancreas are. [19, 20, 21, 22] Furthermore, Hashimoto N, et al. and Miyagawa S, et al. 100 observed and described a relationship between the severity of postoperative pancreatitis and the number of perfusion-ischemia-reperfusion cycles done during relaxation and sequential tensioning of the Pringle loop. [6, 19]

CONCLUSIONS:

The incidence of pancreatitis after liver resection is often a severe complication. The mechanism inducing postoperative pancreatitis remains not profoundly explored in the area of liver resections. Technical aspects and maneuvers applied during liver resections are named to act as a precursor for pancreatitis incidence. The pringle maneuver utilized to diminish portal blood flow creates a stasis of blood into the pancreatic blood vessels, inducing ischemia into pancreatic parenchyma, which is one of the major factors for pancreatitis occurrence.

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