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Surgical management of pancreatic pseudocyst assisted by Da Vinci robot initial experience in a Third Level Center

Manejo quirúrgico del pseudoquiste pancreático asistido por robot Da Vinci experiencia inicial en un Centro de Tercer Nivel

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Keywords: pancreatic pseudocyst, robot-assisted drainage, pancreatitis, cystogastroanastomosis.

Palabras clave: *pseudoquiste pancreático, drenaje asistido por robot, pancreatitis, cistogastroanastomosis.*

ABSTRACT

Introduction: the incidence of pancreatitis has increased worldwide, but despite improvements in diagnosis and treatment, it is still associated with high morbidity and mortality. **Objective:** to present the surgical experience of treating minimally invasive pancreatic pseudocysts assisted by the Da Vinci robot in a third-level medical center. **Material and methods:** a retrospective, descriptive study was performed in which the records of 28 candidates for Da Vinci robot-assisted surgical management were analyzed from November 2014 to October 2018. Statistical analysis was performed with SPSS and GraphPad Prism software. **Results:** in our series of 28 patients with pancreatic pseudocyst and pancreatic necrosis, 15 (54%) underwent cystogastroanastomosis plus cholecystectomy, in six patients (39%) cystogastroanastomosis plus necrosectomy and cholecystectomy; and in seven patients (25%) only cystogastroanastomosis was performed. All surgeries were assisted with the Da Vinci Xi robot. The coupling of the robot (docking) lasted an average of 5.8 minutes, an average surgical time of 210 minutes, an average bleeding of 99 mL, a hospital stay of 72 hours, morbidity of 7%, no conversions, and no patient-required reintervention. **Conclusions:** little evidence exists in the literature on a robot-assisted approach for treating pancreatic pseudocysts and necrosis. In the experience acquired at the Hospital Central Militar in the robot-assisted surgical management of pancreatic pseudocyst and pancreatic necrosis, good results were obtained, including prompt recovery, short hospital stay, and a lower rate of complications.

RESUMEN

Introducción: *se ha incrementado la incidencia de pancreatitis a nivel mundial, pero a pesar de las mejoras en el diagnóstico y en el tratamiento sigue asociada a una alta morbimortalidad.* ***Objetivo:*** *presentar la experiencia quirúrgica en el tratamiento del pseudoquiste pancreático de mínima invasión asistido por robot Da Vinci en un Centro de Tercer Nivel.* ***Material y métodos:*** *se realizó un estudio retrospectivo, descriptivo, en el que se analizaron los expedientes de 28 pacientes que fueron candidatos a recibir manejo quirúrgico asistido por robot Da Vinci, de noviembre 2014 a octubre 2018. El análisis estadístico se realizó con los programas SPSS y GraphPad Prism.* ***Resultados:*** *en nuestra serie de 28 pacientes con pseudoquiste y necrosis pancreáticos, a 15 (54%) se les realizó una cistogastroanastomosis más colecistectomía, en seis pacientes (39%) se realizó cistogastroanastomosis más necrosectomía y colecistectomía, en siete pacientes (25%) sólo se realizó cistogastroanastomosis, todas las cirugías asistidas con robot Da Vinci Xi. El acoplamiento del robot (Docking) con una media de 5.8 minutos, tiempo quirúrgico promedio de 210 minutos, con una media de sangrado de 99 ml, estancia hospitalaria de 72 horas, morbilidad de 7%, sin conversiones y ningún paciente requirió reintervención.* ***Conclusiones:*** *hay poca evidencia en la literatura sobre abordaje asistido por robot para el tratamiento del pseudoquiste y necrosis pancreáticos. En la experiencia adquirida en el Hospital Central Militar en el manejo quirúrgico asistido por robot del pseudoquiste y necrosis pancreáticos se obtuvieron buenos resultados, pronta recuperación, corta estancia hospitalaria y menor tasa de complicaciones.*

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Abbreviations:

OF = organ failure
PA = acute pancreatitis
PP = pancreatic pseudocyst
SIRS = systemic inflammatory response syndrome.

INTRODUCTION

Worldwide, an increase in the incidence of acute pancreatitis (AP) has been noted; despite improvements in diagnosis and access to care, acute pancreatitis is still associated with significant morbidity and mortality; it can vary from a mild and self-limited disease that requires no more than supportive measures, to one with severe life-threatening conditions.[1] Acute pancreatitis is the most common pancreatic disease globally, with an estimated incidence of 4.9 cases per 100,000 people. The incidence varies in different geographical regions, depending on alcohol consumption and the frequency of biliary lithiasis. In Mexico, the most frequent cause of AP is biliary origin in up to 66% of cases and alcohol in 15.9% of cases, with hypertriglyceridemia as the third cause in 7.8% of cases.[2] AP results from the premature activation of digestive enzymes released by the exocrine pancreas, mainly trypsinogen to trypsin, within the acinar cells, causing self-digestion and the potent stimulation of macrophages that induce the production of proinflammatory cytokines such as IL and TNF-a, key events in the pathogenesis of AP.[3]

In 80-85% of cases, AP presents as a mild condition, and 15-20% of cases may present as severe cases with a mortality of up to 50%. There are two types of pancreatitis, interstitial or edematous pancreatitis, which occurs in 80-90% of cases and is characterized by acute inflammation of the pancreatic or peripancreatic parenchyma without identifiable necrotic tissue that usually resolves early and is self-limited, and necrotizing pancreatitis which is the inflammation associated with pancreatic and/or peripancreatic necrosis and is the more aggressive form. Pancreatitis has two mortality peaks and is usually associated with its two phases, the first or early phase, which occurs in the first week and is associated with systemic inflammatory response syndrome (SIRS) and/or organ failure (OF) and the second or late phase which lasts weeks or months and is characterized by systemic signs of inflammation, local and systemic complications and/or persistent organ failure.[4]

The Atlanta classification defines *mild AP* as occurs without organ failure, local or systemic complications that are usually resolved within the first week, and mortality is very rare; *moderately severe AP* is characterized by the presence of transient FO or local or systemic complications that may be resolved in the first 48 hours, which does not require prolonged specialized care. Sterile pancreatic necrosis without FO, resolving in week 2 or 3 with morbidity and mortality of less than 8%. Severe AP is characterized by persistent organ failure (single or multiple) and one or more local or systemic complications; it occurs early with a mortality of 36 to 50%.[5]

In this paper, we will focus on the management of local complications of acute pancreatitis, which are clinically suspected by persistent abdominal pain or recurrent pain accompanied by increased pancreatic enzymes, persistent FO, and the presence of SIRS. These local complications are confirmed by a CT scan, a study that describes the complications based on location, content, and wall thickness; it is recommended to be performed 48 hours after the onset of acute symptoms.

Computed tomography (CT) scan is a non-invasive diagnostic tool to detect collections following acute pancreatitis. There are four types of collections: *acute liquid collection*. Most are sterile, usually homogeneous collections of dense fluid, not encapsulated, and within the peripancreatic fascia associated with edematous AP without necrosis, with spontaneous resolution; its management is conservative. *Acute necrotic collection*s can be sterile or infected; in its initial phase, this collection is a mixture of solid and semi-solid tissue, and it is encapsulated. These are usually managed conservatively and only require treatment in case of obstruction of the duodenum or biliary tract; in the absence of symptoms, surgical intervention is deferred for at least four weeks. Suppose the patient

presents SIRS or a septic picture that causes instability or aggravation. In that case, it is recommended to drain the collection percutaneously to stabilize the patient and to complement the definitive treatment through the administration of antibiotics and a minimally invasive debridement called necrosectomy; this can be through percutaneous, endoscopic, laparoscopic, or assisted retroperitoneal approach. A limited number of patients, which must be well selected, can be treated only with antibiotics.[6] The *pseudocyst* is an oval or rounded collection encapsulated with a fibrous wall and well-defined granulation tissue that may contain necrotic tissue. This lesion has progressive growth, usually consolidates, and is detected during the fourth week. Usually, they are asymptomatic or with non-specific symptoms; if asymptomatic, it is managed conservatively since more than 50% of these resolve spontaneously; if the patient has symptoms, becomes infected, or size increases, drainage is recommended for minimal invasion. After four weeks, encapsulated collections may become infected in up to 80% of cases, and these patients may present complications secondary to sepsis or form abscesses. *Abscesses* are heterogeneous and encapsulated, and more than 80% of deaths associated with acute pancreatitis are attributed to septic complications with bacterial infection.[7-10]

Pancreatic pseudocyst (PP) is a well-recognized complication of AP. It is usually surrounded by a wall of granulation tissue lacking true epithelium, located mainly in the transcavity of the omentum, adherent to the pancreas and communicating or not with the pancreatic duct. It is present in 2-10% of AP and 10-30% of patients with chronic pancreatitis.[11-13]

The treatment of local complications depends on their characteristics and response to conservative management. Surgical management is recommended for PP that does not resolve or decreases in size and presence of symptoms, as well as encapsulated and infected pancreatic necrosis. The preferred procedure can be open, percutaneous drainage, endoscopic, or minimally invasive. Drainage can be divided into internal drainage, external drainage, and resection.[14]

The treatment choice may depend on the complications associated with pancreatic pseudocysts, such as infection, intestinal and biliary tract obstruction, bleeding, and spontaneous rupture; this depends on the importance of adequate and timely treatment for each patient.[15] The treatment of PP has changed and continues to evolve. Before 2013, drainage was recommended for lesions larger than 6 cm or if they persisted beyond six weeks. Asymptomatic PP can be managed conservatively regardless of size, location, or extension to neighboring structures, and it is advisable to treat those that are complicated or symptomatic due to lesion or extension.[16]

When PP presents clinical symptoms, the most frequent, regardless of their origin, are abdominal pain (75%), nausea (50%), febrile syndrome, and weight loss; palpable masses are frequently found in clinical examinations, usually in the epigastrium, and less regularly jaundice.[17]

Different techniques are available to establish therapeutic management, from external percutaneous drainage, open surgery, and endoscopic approach to laparoscopic surgery (intraluminal cystogastrostomy, anterior cystogastrostomy). Percutaneous drainage, alone or in combination with other minimally invasive techniques, continues to be an essential therapeutic strategy in unstable patients who would not support a transmural endoscopic approach. Percutaneous drainage is successful in 35% of cases. It is only recommended to stabilize the patient and improve his general condition, prolonging the time to allow maturity and thickening of the PP wall.[18,19]

A disadvantage of performing this procedure is related to the length of time the drain is maintained. Unfortunately, the open or closed drain is inserted for over seven days. In that case, it can be complicated by a cutaneous pancreatic fistula, which is, by definition, communication of the PP with the patient's skin at the site where the puncture was performed, allowing pancreatic fluid to leak through the wound.[20]

The recommended surgical treatment where internal drainage is performed using a

cystogastroanastomosis, cystojejunoanastomosis, or cystoduodenoanastomosis, depending on where the PP is located. This procedure has a mortality of 5-9%, with an average complication rate of 11-24% and a recurrence rate of 5-8%. Wound seroma and sepsis, as well as pneumonia, are the three main postoperative complications of the open approach.[21-23]

Endoscopic drainage can be performed by transmural drainage by accessing the pseudocyst through the stomach or duodenum wall and leaving a drain or by transpapillary route draining the PP into the pancreatic duct. These techniques are satisfactory in 90% of cases, with a morbidity rate of 10-15% and a recurrence rate of 10%.[24-29]

The minimally invasive laparoscopic approach can be performed by conventional, hand-assisted, and Da Vinci robot-assisted laparoscopy.[30] During the nineties, interest in the development of minimally invasive approaches was awakened, describing various internal drainage techniques with laparoscopic approaches such as posterior cystogastroanastomosis, anterior or transgastric cystogastroanastomosis, cystogastroanastomosis with endogastric approach and Roux-en-Y cystojejunoanastomosis. In 2007, Aljarabah and Ammori[31] reviewed the literature reporting a complication rate of 4.6%, mortality of 0%, and a reported recurrence of 0% in patients with PP treated by laparoscopic approach.[32-35]

Sharing the experience in this publication opens a treatment option of PP and allows to expose the usefulness of the Da Vinci robot, a platform that has contributed to the surgical management in complex gastrointestinal procedures. With this platform, an anterior or posterior approach to performing a cystogastroanastomosis by using instruments that allow manipulation with seven degrees of freedom can be done, having a great advantage to performing anastomosis with suture; it offers better ergonomics, more precision, and speed compared to conventional laparoscopic surgery, offers a three-dimensional view and magnification of the images, allows better coordination, eliminates the surgeon's tremor, facilitates the operation in narrow spaces and angles that are not possible in conventional laparoscopy, allowing a more precise suture, eliminating the need for staplers, which many times are not useful due to the thickness of the gastric wall that makes the procedure difficult. There are few reports on these approaches, and few authors have attempted them. So far, this is the most extensive series in Mexico describing this Da Vinci Xi robot-assisted approach.[36-39]

A large body of evidence has shown that minimally invasive surgery is superior to an open approach, as it is associated with less postoperative pain, a shorter hospital stay, early discharge of the patient, early recovery, and fewer complications associated with the surgical procedure.[40,41]

Surgical technique

All surgeries were performed entirely with the Xi model of the da Vinci surgical system *(Intuitive Surgical, Inc.)* by a hepatopancreatobiliary surgeon with accumulated experience, performing more than 280 robot-assisted procedures. The patients were placed in an inverted Trendelenburg position with an open technique; the Hasson trocar was placed in the umbilical scar, which will be the camera port (C), the pneumoperitoneum was established at 14 mmHg. Under direct vision, three 7 mm trocars were placed, which correspond to the robot arms; the port for the first robot arm (R1) is placed 10 cm from the midline of the patient's left side, 5 cm above the umbilical scar, the second port (R2) is placed 10 cm from the midline on the patient's right side, 5 cm above the umbilical scar. The port (R3) is placed 10 cm from trocar R2 below the costal border on the mid-axillary line on the right side. A 12 mm accessory port is placed 5 cm from the midline between trocar R1 and the camera, 2 cm below the umbilical scar *(Figure 1)*. Once the trocars are placed, the docking of the robot arms is performed; in all patients, a retro gastric approach is performed, starting with the opening of the gastrocolic ligament with an ultrasonic scalpel to enter the lesser sac exposing the anterior surface of the pancreas, usually observing inflammatory tissue and fibrosis in intimate contact with

the posterior face of the stomach. With the ultrasonic scalpel the opening of the PP is performed, The contents are aspirated, which commonly have a cloudy grayish aspect and sometimes purulent yellow; necrosectomy is performed by debriding the free tissue, avoiding forcing or tearing the tissue to prevent bleeding, then proceed to perform the opening of the posterior aspect of the stomach of similar dimensions to the opening of the anterior wall of the PP; hemostasis is controlled. With a continuous suture, a V-Loc™ barbed suture with a 2-0 bearded suture is done to reinforce the vertexes. Then, it follows with a continuous suture on the anterior aspect with barbed suture in two planes, continually monitoring hemostasis, placing a safety drain, removing the trocars under direct vision and closing the access sites of the trocars, taking special care to close the aponeurosis in the umbilical scar and the site where the accessory trocar enters *(Figures 2-4)*.

Objectives: to share our experience in the surgical treatment of PP and complications associated with pancreatitis that do not respond to conservative management and are susceptible or have the surgical indication to be drained by minimally invasive surgery

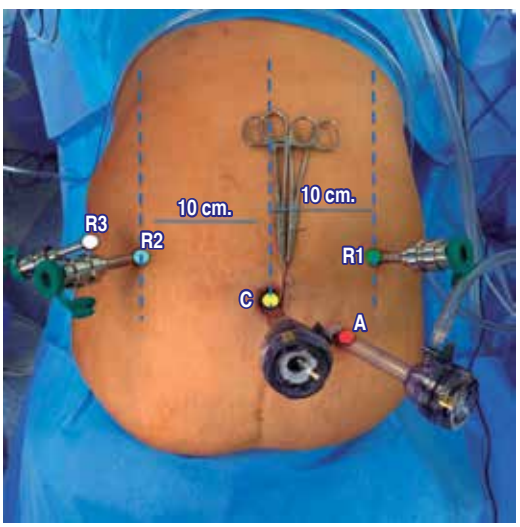

Figure 1: Port placement site and marking distances before surgery.
Image from the author's personal archive.

Figure 2: Necrosis of the pancreas, abundant grayish secretion, debridement with harmonic scalpel.

Figure 3: The open pseudocyst and the posterior aspect of the stomach are visible, ready to perform the barbed continuous suture for the cystogastroanastomosis.

Figure 4: Ninety percent of the pancreatic body is necrosed, and high mortality is associated with *Acinetobacter baumannii*.

assisted with the da Vinci Si robot platform in a third-level center.

MATERIAL AND METHODS

An observational, descriptive, retrospective, and cross-sectional study was performed, analyzing the clinical records of 28 patients who suffered pancreatitis and presented complications associated with the disease, who did not resolve with medical management and attended for the presence of symptomatology related to intra-abdominal lesions, and who had imaging studies confirming the presence of PP and pancreatic necrosis. They underwent a surgical referral and were assisted with a Da Vinci robot in a third-level center from November 2014 to October 2018; the statistical analysis was performed using SPSS and GraphPad Prism software.

RESULTS

Twenty-eight files of patients with a diagnosis of pancreatic pseudocyst and infected and non-infected pancreatic necrosis of biliary, alcoholic, or metabolic origin who met the criteria for surgical treatment, who underwent cystogastroanastomosis, necrosectomy plus minimally invasive cholecystectomy assisted by Da Vinci robot, after diagnosis by dynamic computed tomography of the pancreas were reviewed. Of these, n = 13 (46.4%) were female and n = 15 (53.6%) males, with a minimum age of 15 years and a maximum of 91 years with a mean of 45.5 years. Their minimum weight was 40 kg, with a maximum of 116 kg and a mean of 68.1 kg, a minimum height of 1.44 m, a maximum of 1.77 m, with a mean of 1.61 m. The surgical indication was the diagnosis of PP greater than 6 cm in 22 (78.5%) patients and n = 6 (21.4%) for pancreatic necrosis. Three (10.7%) patients presented infected pancreatic necrosis. It should be noted that radiological criteria with dynamic computed tomography of the pancreas were used for the diagnosis.

Regarding the etiology of BP, 21 patients were diagnosed with pancreatitis of biliary origin, and seven were due to other causes, including alcohol, metabolic, and drug toxicity *(Table 1)*. From our series, nine (32%) patients presented multiple comorbidities such as obesity, type 2 diabetes, high-blood pressure, hypothyroidism, and chronic kidney disease *(Table 2)*. Of the surgical procedures performed, 15 patients (54%) underwent pseudocyst drainage with cystogastroanastomosis plus Da Vinci robot-assisted laparoscopic cholecystectomy, six patients underwent necrosectomy plus cholecystectomy, and seven patients (25%) underwent only pancreatic pseudocyst drainage plus cystogastroanastomosis, performing only 21 cholecystectomies concomitantly out of the 28 patients considered *(Table 3)*.

Table 1: Etiology of pancreatitis (N = 28).

Etiology	n (%)
Biliary	21 (75)
Intoxication (Brazil seed)	1 (3.57)
Alcoholic	4 (14.2)
Metabolic	2 (7.1)

Table 2: Comorbidities associated with the complication of pancreatitis (N = 28).

	n (%)
No comorbidities	19 (67.9)
HBP	2 (7.1)
T2D	1 (3.6)
T2D/hypertriglyceridemia	1 (3.6)
T2D/obesity	1 (3.6)
HBP/obesity	1 (3.6)
HBP and ERC	1 (3.6)
HBP/T2D/hypothyroidism	1 (3.6)
Obesity grade II	1 (3.6)
Total	28 (100)

T2D = type 2 diabetes. CKD = chronic kidney disease. HBP = high blood pressure.

The robot docking time was a minimum of 5 minutes and a maximum of 11 minutes, with a mean of 5.8 minutes; surgical time was a minimum of 105 minutes and a maximum of 360 minutes, with an average of 210 minutes. During the surgeries, there was a maximum bleeding of 700 ml in one procedure, and it was quantified as a minimum of 10 ml with a mean of 99 ml. The hospital stays ranged from a minimum of three days to a maximum of 20 days associated with comorbidities, with a mean hospital stay of seven days. Two patients (7%) presented complications. One patient developed in the late postoperative period a biloma secondary to distal obstruction of the common bile duct in its intrapancreatic portion, associated with inflammation of the pancreatic tissue, after having undergone a cystogastroanastomosis plus cholecystectomy; this case was resolved by placing percutaneous drainage decreasing the collection once the inflammation of the pancreatic parenchyma decreased. The second patient presented bleeding secondary to erosion of small branches of the pancreatic parenchyma, minimal bleeding without hemodynamic repercussions that self-limited without the need for reintervention. The first patient was classified as Clavien-Dindo IIIa and the second as Clavien-Dindo II. In our series, a patient who presented morbid obesity with necrosis of 90% of the pancreatic tissue died. The patient had a persistent fever of up to 42° centigrade, which did not respond to antipyretic drugs or physical therapy. Percutaneous drainage was performed without improvement according to the protocol for managing infected pancreatitis. The patient continued with systemic inflammatory response and fever; in the absence of response, it was decided to perform a necrosectomy and drain the collection by advanced laparoscopy, obtaining purulent liquid; the purulent secretion was sent for culture and evidence of an infection associated with *Acinetobacter baumannii* was obtained. After a stay of more than a week in the intensive care unit, the patient continued with fever, with no response to antibiotics; the patient died secondary to the infection associated with the underlying condition and not to the surgical procedure.

Table 3: Surgical procedure performed.

Procedures	n (%)
Necrosectomy plus cystogastro-anastomosis plus cholecystectomy	6 (21)
Cystogastro-anastomosis plus cholecystectomy	15 (54)
Cystogastro-anastomosis	7 (25)
Total	28 (100)

DISCUSSION

A meta-analysis showed that the endoscopic approach has high success rates;[42] however, it has a recurrence rate of up to 14.4% compared to the laparoscopic approach of 2.5%.[43-45] Mohammad Khreiss and colleagues reported in a cohort study 20 cystogastroanastomosis secondary to pancreatic pseudocyst by laparoscopy and robot-assisted; a complication rate of 20% in which bleeding, perforation, and infection are noted, also reported having performed a concomitant cholecystectomy in 60% of the patients in the series. In our series, the complication rate was 7%; we also performed 22 concomitant cholecystectomies (71%) due to the diagnosis of pancreatitis secondary to biliary etiology.[7]

Parekhet et al. reported a series of 19 patients with a mortality of 19%; in our series, there was only one death due to the progression of the disease associated with a microorganism classified as Gram-negative pathogenic coccobacillus, which is associated in reports with a mortality of 100%; in this case, the mortality was not related to the surgical procedure. There is little evidence in the literature of this procedure; there are only reports of cases of cystogastroanastomosis for pancreatic pseudocyst and laparoscopic necrosectomy

assisted by da Vinci robot, this series being the first reported in our country.

Alexa Cárdenas and associates,[39] Russell C. Kirks Jr and his team,[37] and Parekh D and colleagues[38] describe the robot-assisted laparoscopic approach with cystogastroanastomosis. However, they do not report the surgical time; in our series, we report an average time of 210 minutes and average bleeding of 100 ml, with an average hospital stay of seven days, presenting excellent results compared to the series reported for conventional laparoscopy.[46-48]

The Da Vinci robot-assisted laparoscopic procedure is a safe and reliable approach, improves vision, and facilitates complex procedures such as gastrocystic anastomosis, with a lower rate of complications, less bleeding, and shorter hospital stay in the treatment of PP and necrosectomy, allowing safe debridement of encapsulated necrosis and infected necrosis. This report shows us a preliminary initial series, so it is necessary to increase the number of patients to be able to make strong statements; however, it is the first step in offering this therapeutic strategy.

CONCLUSION

Robot-assisted laparoscopic surgery has contributed to minimally invasive surgical management in complex gastrointestinal procedures; it is useful and favors the resolution of complications associated with pancreatitis and facilitates definitive drainage of the PP and necrosectomy. AP with encapsulated and infected pancreatic necrosis allows drainage of the collections. It complements the definitive treatment using cystogastric or retrogastric cystogastric anastomosis. This procedure allows better visualization, facilitating adequate aspiration of the liquid and debridement of the necrotic and infected tissue, making it possible to perform a cystoenteric anastomosis more easily, in addition to performing other additional procedures associated with the condition to facilitate definitive surgical treatment.

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