An innovative duodenal perforation surgical repair technique: the BIOPATCH technique

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Abstract

The treatment of duodenal perforations has scarce options and it is very difficult with an high failure rate. The aim of this work is to describe a new surgical technique that was used to treat ten patients suffering from duodenal perforation.

The procedure based on the concept to enforce the duodenal suture with remodeling material allowing to the inflamed and oedematous tissues to heal without to be cut by the repairing stitches themselves, is performed with biological prosthesis patches.

90% of patients treated with this innovative technique experienced a complete healing of the duodenal perforation.

This unique surgical technique not only proved to be safe, but it also solved the 90% of duodenal perforations in patients at risk to die.

Introduction

Duodenal perforation is a serious and difficult situation to manage with. Delay in the diagnosis and intervention, leads to significantly higher mortality (8-23%) as a consequence of sepsis and multi-organ failure.[1-13] Traditionally traumatic and non-traumatic duodenal perforations have been managed surgically. However, in the past decade the management has evolved towards a selective approach.[3-8] ERCP induced perforation (major complications 5.4%-23.0%, mortality 0.1-1%)[14-17] may be retroperitoneal (typically in peri-ampullary region due to sphincterotomy or guidewire usage) or intra-peritoneal (typically in the lateral wall and endoscopy related).[1,2,7,9,12,14-17] Depending on the perforation location the treatment can be conservative or operative. Moreover exist cases of duodenal perforations due to different causative events (*i.e.* ingestis, bones fragment, toothpicks, post-traumatic, others). Generally duodenal repair is done with surgical direct suture or duodenal diversion with a great risk of complications. In this paper we will report our original surgical technique in treating ten cases of duodenal perforation.

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Technique description and report of cases

Technique

The first step is to mobilize completely the duodenal portion interested by the perforation with great attention in preserving its vascularization. This is necessary in order to allow the suture without tension or distortion of the normal anatomy (Figure 1).

Once mobilized the perforated duodenal portion and removed the dead tissues, interrupted stitches associated to 3 biological prosthesis patches for each stitch (Figure 2) will be positioned at 0.5 cm one from the other. The porcine dermal collagen non cross-linked biological prosthesis patches (Protexa™, Tecnoss, Giaveno, Italy) should be prepared before starting the suture with dimensions of at least 0.5×0.5 cm. The first passage with a resorbable monofilament (*i.e.* PDS 4-0) is through the first patch and than through one side of the duodenal wall perforation (from outside to inside). Then the stitch is passed through another patch, which therefore lies in the middle of the two flaps of duodenal wall, and so through the other side of the perforation (from inside to outside); lastly the stitch is passed through the third patch, so as to be applied on the external part of the suture (Figure 3). At the end the stitch sequence will be patch-duodenal wall-patch-duodenal wall-patch. Each interrupted stitch will be knotted at the end of the suture separately (Figure 4). The suture, according to the possibilities, should always be done as much transversal to the duodenal axis as possible, in order to reduce the risk of stenosis.

Report of cases

Characteristics of the ten treated patients are showed in Table 1.

The definitive success rate of the technique was 90%. Nine out of the ten treated patients demonstrated no recurrence of the duodenal perforation.

Complication rate was 30%: 1 case of biliary fistula from an already injured biliary duct that was not successfully repaired, 1 case of *ab-ingestis* pneumonitis and 1 case of wound infection.

Three patients (30%) died during the first postoperative month for causes other that the duodenal fistula: 1 patient for respiratory failure due to muscolar dystrophy and 2 patients for aortic rupture. All these patients did not show signs of recurrent duodenal fistula after an average period of 11 days.

Discussion

Usually in duodenal perforations, the site and mechanism of injury guides to the management approach.[2,4,8,5,10,12] Duodenal wall full thick perforation (type I injury) requires surgical intervention.[2,4,6,12] These kinds of perforation are usually closed primarily in one or two layers following debridement of devitalized tissue. Perforations that measure less than 1 cm with early diagnosis can usually be treated with direct repair.[1,3,4,6,9] In presence of larger duodenal perforations a viable option could be the positioning of jejunal serosal patch to close the duodenal wall. However, duodenal perforation repair in presence of large defect of with a delayed

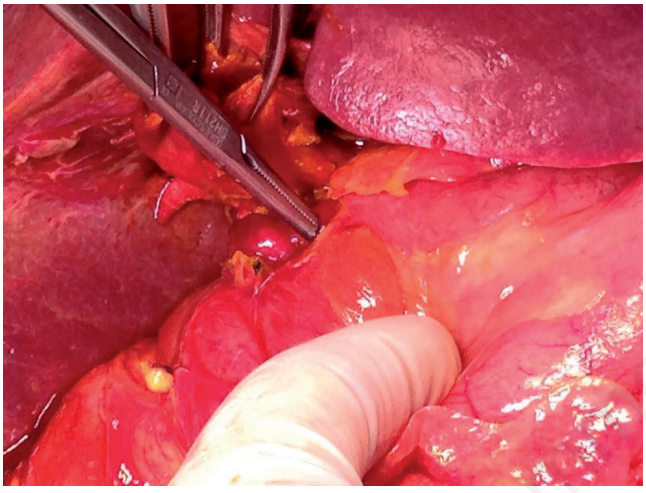

Figure 1. The duodenal perforation evidenced by the tip of the surgical instrument.

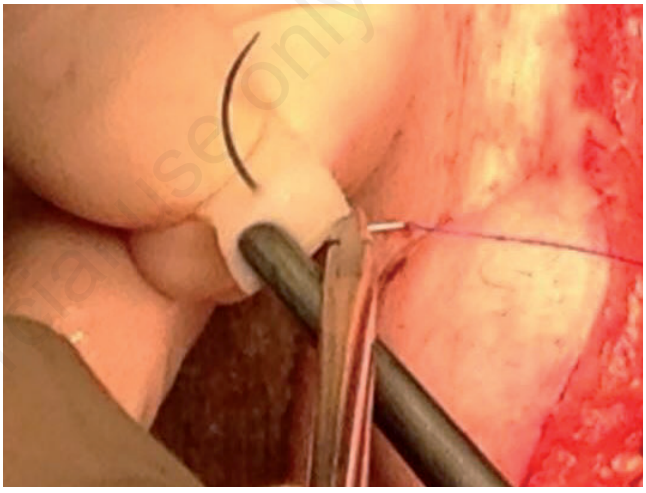

Figure 3. The passage of the stich through the biological patch.

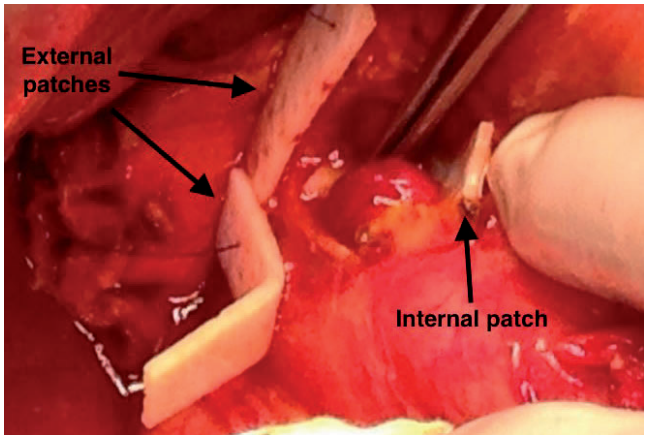

Figure 2. The three biological patches placed to repair the perforation.

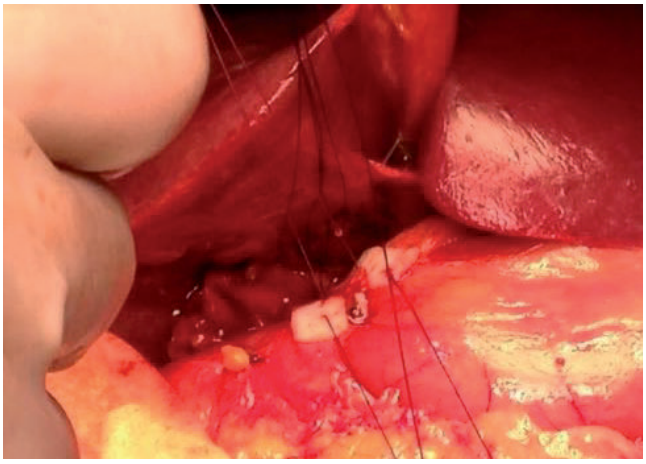

Figure 4. The final separate knotting of the stitches.

diagnosis is a high-risk procedure. In fact a great amount of fluids passes through the duodenum each day. About 6 liters of fluid including saliva, gastric and pancreato-biliary juice easily lead to high output fistula in case of dehiscence of duodenal suture repair. This is absolutely frequent especially in those cases where the duodenal wall is inflamed with a full thick edema and friable tissues.[1,3,4,6,9] Frequently surgeons prefer duodenal diversion in high-risk patients with a delayed in diagnosis or with large defects.

Biological materials have already demonstrated their usefulness and versatility in many fields.[18-28] Biological meshes differ in terms of tissue ingrowth, the likelihood of subsequent infection, and the time to scaffold complete remodeling. Biological meshes are typically comprised of several different materials: porcine dermal collagen, human dermal collagen, bovine dermal or pericardium collagen and swine intestinal sub-mucosa. The differences in remodeling times should be kept in mind when considering these

Table 1. Patients' characteristics.

Patients characteristics (N=10)	N (%)	
Gender	Male	3 (30)
	Female	7 (70)
Age	Mean (SD), yrs	70.3 (±7.4)
	Median (range), yrs	71 (55-80)
Surgical indications	Duodenal perforation	10 (100)
	Post-ERCP	2
	After cholecystectomy	2
	Aorto-duodenal fistula	3
	Spontaneous in corticosteroid therapy	2
	Jejunal volvolus after remnant gastrectomy	1
Comorbidities*	Immunodepression	4
	Abdominal aortic aneurism	3
	Malignancy	3
	Cardiopathy	2
	Muscolar dystrophy	1
	None	1
Peritonitis	Localized	2 (20)
	Generalized	6 (60)
	No	2 (20)
MPI at the first laparotomy (N=10)	MPI mean (SD)	25 (±8.3)
	MPI median (range)	22 (15-37)
	<21	5 (50)
	21-29	1 (10)
	>29	4 (40)
Open abdomen (OA) management	Yes	8 (80)
	No	2 (20)
Time to closure of OA	Mean (SD), dys	10.4 (±8.8)
	Median (range), dys	5 (2-20)
Bjorck classification at the first laparotomy (N=10)	Ia	4 (40)
	Ib	1 (10)
	IIa	4 (40)
	IIb	1 (10)
	III	0 (0)
	IV	0 (0)
Bjorck classification at the closure (N=8)	Ia	5 (50)
	Ib	0 (0)
	IIa	0 (0)
	IIb	1 (10)
	III	2 (20)
	IV	2 (20)
Complications	Wound infection	1 (10)
	Biliary fistula from a biliary duct	1 (10)
	Ab ingestis pneumonitis	1 (10)
Recurrent duodenal fistula	Yes	1 (10)
	No	9 (90)
Mortality (N=10)	Peri-operative	3 (30)
	Acute respiratory failure	1
	Aortic rupture	2
	6-months	0 (0)

SD, standard deviation; pts, patients; yrs, years; ERCP, endoscopic retrograde cholangiopancreatography. *More than one patient experienced more than one comorbidity.

materials. These prosthesis permit and encourage host tissue ingrowth. Prosthesis could be physically modified with cross-linkages between the collagen fibers to strengthen the prosthesis.[19] Biological prostheses have the lowest adhesiogenic power among all prosthetic materials available for intra-peritoneal use.[20]

The present paper presented a new, original surgical technique for the management of duodenal perforations. This procedure has proven to be safe, considering that the 90% of perforations healed without major complications. This procedure also confirmed the versatility, safety and usefulness of biological prosthesis in atypical situations.

The success observed in these nine cases is probably attributable to the capability of the biological materials to favor the tissue ingrowth also in contaminated/infected fields while sealing the sutured perforation and preventing at the same time the cutting of the inflamed and friable duodenal wall by the stiches.

Conclusions

This unique surgical technique not only proved to be safe, but it also solved the 90% of the duodenal perforations treated in patients at risk to die. This technique confirmed that porcine not-cross-linked dermal biological prostheses can be used safely and effectively in this kind of use.

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