Indication, Technique and Results of Tissue Adhesive in Liver, Pancreas and Kidney Resection in Children

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Abstract

We report our experience of tissue adhesive application in resection of the liver, the pancreas and the kidney in children. Different resection techniques using a laser, an ultrasound knife and diathermy for postoperative secretion, bleeding and infections is also reported. The different procedures are compared with each other with the additional use of tissue adhesives.

Introduction

Organ resections in children can lead to bleeding, infection and secretions. The success of resecting parts of the liver, the pancreas or the kidney depends very much upon excluding these post-operative complications, and different resection techniques can be used to avoid them. Since the possibility of using tissue adhesives became available, we have been able to close the surface of resected organs with high security.

The aim of this paper is to compare different resection techniques and to find out the advantages of tissue adhesives.

Material and Methods

We performed liver resections in 61 children, partial resections of the kidney in 29 children and resections of the pancreas in 54 children. The results concerning post-operative bleeding, secretions and infections are compared with a group of children treated with and without tissue adhesives. Regardless of the organ resected, the surface must be completely dry. Application of tissue adhesive has been performed using a double injection system, which makes it possible to achieve an optimal mixture of the two components fibrinogen and thrombin. Special care has to be taken in order to apply this tissue adhesive in a more or less homogenous fashion on the surface of the resected organs. In some cases, tissue adhesive was applied twice.

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Table 1. Different pancreas resection techniques in children

	Haemostasis	Tissue closure	Pancreatic duct closure	Necrotic tissue (mm)
Co_2 laser	–	+	–	< 1
Nd:YAG laser	++	++	+	2–3
Cusa (ultrasound knife)	++	++	–	2–3
Diathermy	+	+	–	< 3

+, moderate; ++, high; –, none.

Different Resection Techniques in Pancreatic Surgery

Different resection techniques were evaluated and performed in pancreatic surgery in children using (a) diathermy, (b) ultrasound knife (Cusa technique; Cavitron, Stanford (A) and (c) laser (CO^2, neudynium: yttrium aluminium garnet, Nd:YAG)

These techniques have been evaluated with respect to post-operative bleeding, post-operative secretion, depth of local necrosis and closure of the pancreas ducts.

ND: YAG proved to be the best tool to achieve haemostasis. The pancreatic duct had to be closed in the normal surgical way in all cases. The area and the depth of local tissue necrosis is a little deeper using the ND:YAG laser compared to the CO_2 laser. With diathermy there were very frequently secretions and post-operative bleeding (Table 1).

Indication and Application of Tissue Adhesive for Abdominal Organ Resections

Liver Resections

Every liver resection must be performed with high security in order to prevent post-operative bleeding; especially in liver trauma and liver rupture, this is extremely important. The laser technique is the most adequate technique in this respect to perform organ-preserving resection. Using the laser in combination with fibrin application is the safest operative procedure to prevent post-operative secretion and post-operative bleeding. These two points were also important in preventing post-operative infections. The laser enables us to permanently close even very small vessels, regardless of whether they are part of the venous or the arterial system, and very small gall capillaries. In addition, the laser is very useful in children who had pre-operatively disturbances in blood clotting. Fibrin application in combination with the laser provides significant additional security for those areas where the laser application has possibly been performed inadequately. Laser application results in a completely dry area, thus creating an ideal surface for tissue adhesive therapy. The additional

Table 2. Liver resection techniques

Treatment	Secretion (ml)			Abscess	Gall secretion	Bloody secretion	Serous secretion
	Day 1	Day 2	Day 3	*(n)*	*(n)*	*(n)*	*(n)*
No tissue adhesive ($n = 20$)	112	75	42	5	6	7	7
Laser without tissue adhesive ($n = 22$)	54	30	20	6	3	5	14
Laser with tissue adhesive ($n = 19$)	55	15	10	0	1	3	15

application of collagen fleece is not necessary. Laser application made the collagen fleece superfluous (Table 2).

Kidney Resection

During the last 10 years partial resection of the kidney has been performed in 29 children. In kidney resections, small vessels belonging to the lymphatic system as well as small vessels belonging to the urinary system are cut and opened. Using the ND:YAG laser we were able to demonstrate by histological and electromicroscopical pictures that these connections and vessels can be closed completely. Cutting the organ using a scalpel or a sapphire knife opens up all these small vessels; there is a high frequency of tumor cell spreading using these techniques and using the diathermy, and the primary coagulation can be reopened by fibrinolysis later on [8]. Tissue adhesive was applied in combination with the laser in 12 children out of our series of 29 children (five who suffered from a kidney trauma, five children with a kidney tumour and two children suffering from a congenital kidney anomaly).

Post-operative complications, such as bleeding, infections and urinary fistulae, were significantly lower in those children treated with a combination of the laser and tissue adhesive application (Table 3) [6].

Table 3. Pancreas and kidney resection in children

	without tissue adhesive		with tissue adhesive	
	P	K	P	K
Bleeding	10/34	4/17	0/20	1/12
Infection	12/34	9/17	1/20	0/12
Fistulae	9/34	8/17	2/20	0/12

P, pancreas; K, kidney.

Pancreas Resection

Pancreas resections were necessary following pancreatic trauma, pancreatic tumours, pancreatic cysts and severe pancreatitis. Especially acute hemorrhagic pancreatitis is an indication to perform an urgent operation [3]. Pancreatic tumours in children are mostly adenomas necessitating a partial or subtotal pancreas resection [5, 7].

Pancreatic ruptures are primarily sequelae of abdominal trauma in children. The pancreas lying just in front of the vertebral column is compressed and sometimes ruptured completely in front of the vertebral column. In such an abdominal trauma, multiple organs sometimes have to be controlled for organ rupture, especially the liver and the spleen. We have to distinguish between four different degrees of pancreatic rupture (Fig. 1). Contusion of the pancreas leaves the pancreas capsule intact; these children can be treated conservatively, but the peripancreatic region has to be drained in order to avoid accumulation of pancreatic secretion in the retroperitoneal area. Subcapsular rupture of the pancreas leaves the pancreatic ducts intact and is treated by superficial sutures and tissue adhesives being applied on the surface of the pancreas. In cases of pancreatic rupture (complete or incomplete), a resection of this part is necessary. In these cases we use the laser resection technique in combination with fibrin sealing. The ultrasound technique (Cusa) enables us to separate pancreatic tissue. However, microruptures are caused in the whole area where the

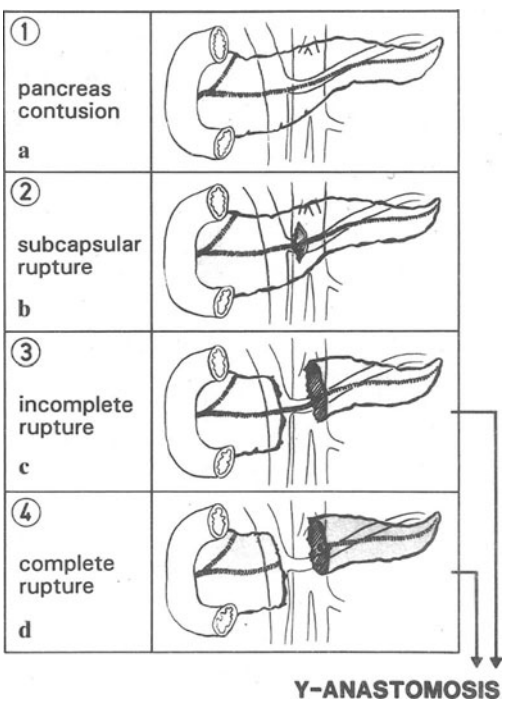

Fig. 1a–d. Survey of different types of pancreatic trauma in children. **a** Contusion of the pancreas. **b** Subcapsular rupture of the pancreas. **c** Incomplete rupture of the pancreas. **d** Complete rupture of the pancreas

ultrasound knife has been applied, leaving the tissue open. In pancreatic ruptures, the resection line is performed in an absolutely clean area and the Y-anastomosis of Roux is only indicated if a pancreas cyst is present. The application of fibrin or prolamin in the open pancreatic duct is not performed, because this occlusion is only temporary [2, 4]. The pancreatic duct is closed with a double ligature. The additional application of tissue adhesive gives the patient high security to prevent post-operative secretion at the resection line. As demonstrated in Table 3, this procedure has proved to be the safest one as far as post-operative infections, bleeding and secretion in pancreas resection are concerned (Fig. 1).

Discussion

The post-operative course depends very much on whether post-operative complications occur or can be avoided, i.e. bleeding, secretions and infections. Post-operative bleeding after liver or pancreas resections have a high mortality rate [1]. Post-operative infections lead to abscesses within the abdomen and organs and, furthermore, can lead to sepsis. Using the laser for organ resection, organs can be separated without any bleeding and without any secretion, thus creating an absolutely sterile surface. The additional use of a tissue adhesive with the laser provides the highest security rate.

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