

## **Microsurgical approach to pancreatic duct occlusion in the pig by means of a prolamine solution**

G. MONACO, F. RICCARDELLI, M.M. LIRICI, G. PALMIERI, F. D'ANGELO, M. RAGUSA, F. FEDERICO, A. PAOLINI

*IV Clinica Chirurgica, Università "La Sapienza", Roma*

**Key Words:** pancreatic duct occlusion, prolamine, exocrine pancreas sclerosis.

**Prolamine is an alcoholic solution of zein, with the property of polymerizing within 15 minutes in a humid medium. Such a substance has been injected in the pancreatic duct of 10 pigs with a microsurgical technique, causing complete occlusion. The prolamine gel produces a progressive fibrosclerosis of the exocrine pancreatic parenchyma, sparing the endocrine portion. The resulting pancreatic atrophy avoids the occurrence of inflammatory complications that often hamper surgery on such gland. The 10 pigs under study showed post-operative normal values of blood glucose and insulin, and a decrease in serum alpha-amylase levels. Complications occurred in only one case, and the microscopic pattern was similar in all cases. Microsurgical approach and use of prolamine are considered effective both in pancreatic transplantation and in chronic pancreatitis.**

### **Introduction**

Occlusion of the excretory duct is indicated in pancreatic surgery, particularly in transplantation procedures, in order to avoid autolytic phenomena due to enzymatic digestion.

A complete occlusion of the whole ductal system, carried out by means of a specific substance, should cause atrophy and sclerosis of the exocrine portion of the gland, sparing the insular component.

For this purpose various compounds have been used (vaselin, paraffin, acrylic resins, neoprene), that did not provide satisfactory results, mainly for two reasons: difficult injection and inefficient or harmful action on the gland parenchyma [1, 3, 9, 10].

The difficulties of injection depend on a too rapid solidification of the substance

used for the occlusion, whose incomplete reabsorption causes foreign-body reaction and, on a long-term, an inflammatory process involving also the endocrine component. Furthermore, in the same instance fibrosclerosis would not be confined to the exocrine portion, but would involve the insular portion as well.

The aim of our study was to evaluate the results of pancreatic occlusion by means of a prolamine gel. [4, 5, 6, 7, 11].

The work has been carried out on pigs, weighing 16 Kgs. on the average. The pancreas of the pig presents the advantage of having a single excretory duct, separated from the biliary tree permitting an extra-duodenal preparation (Fig. 1). This feature makes the complete occlusion of the organ possible.

The identification of the pancreatic duct, in

the pig requires the aid of the operative microscope, as well as all the steps preliminary to the injection of the gel, and the final repair of the ductal wall.

### Material and methods

The blocking gel is composed as follows: 1 ml contains:

210 mg Zein  
162 mg Sodium-amidotrizoat-tetrahydrate  
145 mg Oleum Papaveris  
6 mg Propylene glycol.

This alcohol-aminoacid solution polymerises immediately in a humid medium, solidification taking 10 minutes. It is completely reabsorbed in about 14 days. We have injected the solution in 10 pigs, in doses varying between 0.7 and 1.3 ml.

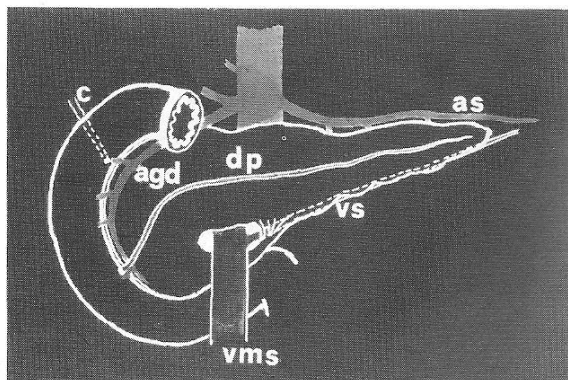
In all the animals the gel injection has been performed after extraduodenal preparation of the duct, using a polyvinyl catheter 0.8 mm in diameter, dressed with a "Luer-lock" connection.

The operations have been carried out with the aid of the Zeiss OP/M I D operative microscope, at the magnifying ratio of 15-20.

In our experimental study the following parameters were evaluated in the serum: glucose, alpha-amylase, insulin, glucagon,

**Fig. 1.** Anatomy of the pancreas in the pig.

SA: splenic artery  
C: common bile duct  
GDA: gastroduodenal artery  
PD: pancreatic duct  
SV: splenic vein  
SMV: superior mesenteric vein.



preoperatively and in 1st, 5th, 10th, 15th postoperative day. The animals were sacrificed in 20th postoperative day for the histological study of the pancreas.

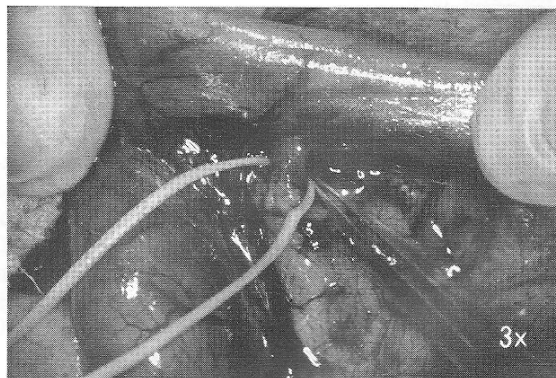
### Surgical procedure

For pre-medication Atropin 0.25 mg + Diazepam 5 mg i.m. have been used. In all animals, the following anesthesia has been performed: induction with Pentotal sodium, Fluothane in O<sub>2</sub> and N<sub>2</sub>O flow for maintenance, after orotracheal intubation.

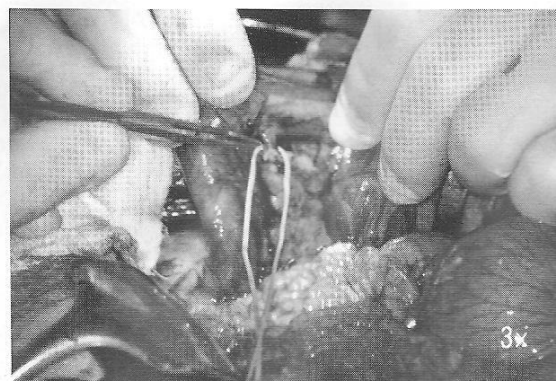
The abdomen was entered through a xipho-umbilical incision. After mobilization of the duodenum, the pancreatic duct has been prepared extraduodenally, with the aid of the operative microscope (Fig. 2).

After exposure of the duct on a silastic

**Fig. 2.** Pancreatic duct exposure and preparation.



**Fig. 3.** The pancreatic duct is opened to permit the introduction of the catheter.



vessel loop, a 0.6 mm incision was done, on its posterior wall. The polyvinyl catheter was then introduced and fixed to the duct by means of a 5-0 silk ligature, in order to avoid gel reflux (Fig. 3, 4, 5).

Prolamine injection was carried out at low pressure (Fig. 6); to complete the occlusion, the polyvinyl catheter was slightly retracted, and left in situ for 10 minutes, until solidification was through. After removal of the catheter, the ductal opening was sutured with 2,3 9-0 polyester stitches\* (Fig. 7). The abdominal wall was closed by layers.

### Results

One of the 10 pigs died in the 5th postoperative day. The other ones completed regularly their postoperative course, and were in

\* The suture material was Kindley supplied by B. Braun S.p.A., Milano, Italy.

good condition when the pancreas was removed, except for a weight loss of about 2 Kgs.

At the opening of the abdomen, 2 animals revealed small-intestine adhesions and a small quantity of ascites. In all cases identification of the pancreas was ready: the aspect and consistency of the gland were typical of advanced sclerosis; pseudocysts or pancreatic fistulas were not detected.

Microscopically, the gland parenchyma revealed periductal fibrosis, monocyte infiltration and epithelial atrophy of the exocrine component, while the endocrine portion appeared morphologically intact. Micropseudocysts from retention of amorphous material were found in some areas [8].

The biochemical parameters under examination confirmed the histological results: glucose remained within normal values (64-122 mg/ml); serum alpha-amylase levels, after a peak in the 1st postoperative day,

Fig. 4. Introduction of the polyvinyl catheter through the wall of the pancreatic duct.

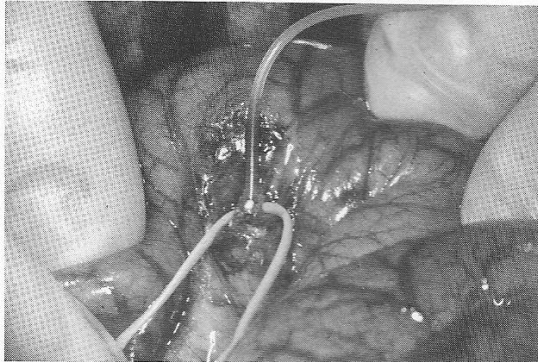


Fig. 5. The catheter has been introduced and temporarily fastened to the duct.

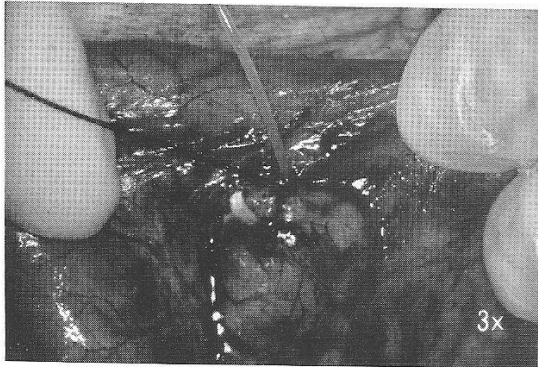


Fig. 6. Injection of prolamine-gel.

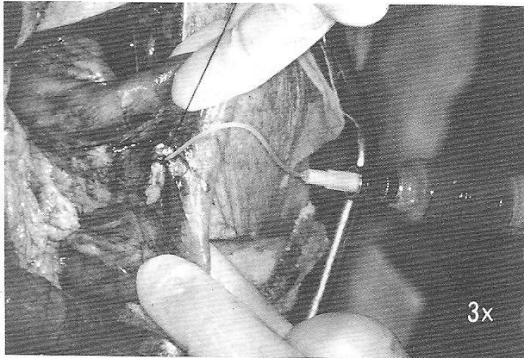
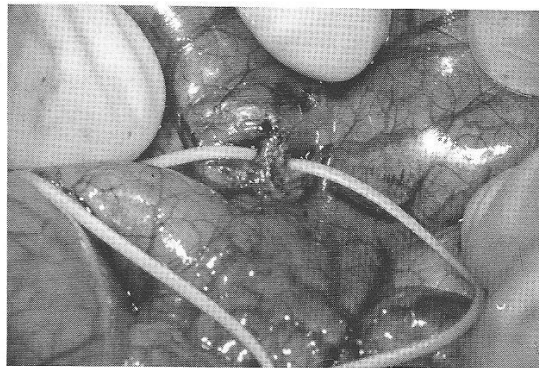


Fig. 7. The wall on the pancreatic duct is sutured with 9-0 polyester stitches.



followed a decreasing trend towards values below normal; in two cases they could not be measured in the 15th postoperative day. IRI and IRG showed constant values in all controls [8].

### Discussion

The experimentally used aminoacid gel, has clinical applications in pancreatic surgery, particularly in organ transplantation and in the endoscopic therapy of chronic pancreatitis by transpapillary injection.

The plastic properties of prolamine (slow solidification in about 10 min.) permit an easier and more complete injection, if compared to other substances.

Prolamine gel is biologically inert and degraded and reabsorbed by the duct in 14 days on the average.

Such characteristics avoids a continuous foreign-body action on the tissue. In our experience the injection caused slight edema and no acute pancreatic reaction followed even when bacterial contamination of the duct was present. The experimented substance is provided by the manufacturer in a syringe dressed with a "Luer-lock" connection, in a sterilized package (Ethiblocr). Such a feature enables to work as much as possible in aseptic conditions, without changing the physical properties of the substance.

As for the influence of glucose metabolism, hyperglycemia did not occur in any of the pigs operated with microsurgical technique, as demonstrated by blood tests control.

From the histological study we expected informations about the inflammatory and atrophic phenomena, their extension and distribution (centrally and peripherally) in the exocrine parenchyma and the possible involvement of Langherans' islets in order to evaluate the validity of the microsurgical procedure of pancreatic duct occlusion and the efficacy of the injected substance.

The analysis of results showed many points in common and a few differences with the histologic patterns of other Authors [5, 7, 11].

Epithelial necrosis, increase in connective tissue of the exocrine parenchyma, interstitial monocyte infiltration were all confirmed. The presence of areas at various degrees of involution or with slight microscopic da-

mage, accounts for a certain irregularity in the sclerotic process. Micropseudocysts are explained with the hyperdistension of the ductal system.

These features led us to consider the role played by the route of injection of the substance. This step should be monitored radiologically (prolamine solution is available with a iodated contrast medium) in order to stop the inoculation as soon as the system is filled.

On the other hand, the comparison between our values of serum alpha-amylase levels and those of other Authors, has evidenced in our study a minimal enzyme peak in the 1st postoperative day [2].

This confirms that the microscopical procedure permits to perform the occlusion avoiding nearly all manipulations of the gland that are in most instances responsible for the rise in serum alpha-amylase levels.

The importance of preventing autolytic reactions after surgery on the pancreas and the results obtained blocking the duct by injection of a prolamine gel, suggest that this technique, carried out under operative microscope control, could be a preliminary step in every operation on the gland.

Furthermore, the operative microscope is of even greater importance in pancreas transplantation, as vascular microanastomoses can avoid the use of patches and permit a better suture of the intima, so reducing the possible formation of thrombi [10].

Finally, in autotransplantation, only the microsurgical approach permits to work on structures of such a small caliber.

*Requests for reprints should be addressed to:*

Dr. F. Riccardelli  
Via Pietro Aretino 33  
00137 Roma, Italia

### Italian Abstract — Occlusione del dotto pancreatico nel suino per mezzo di prolamina: metodica microchirurgica

La prolamina è una soluzione alcolica di zeina che ha la proprietà di polimerizzare in ambiente umido in circa 15 minuti. Tale sostanza è stata usata in 10 suini iniettandola nel dotto pancreatico con metodica microchirurgica, provocando una totale occlusione.

La sostanza provoca una graduale fibro-

sclerosi del parenchima esocrino pancreatico, lasciando indenne la componente endocrina. L'atrofia pancreatica così ottenuta consente di evitare le complicanze infiammatorie che spesso compromettono la chirurgia su questa ghiandola. I 10 suini studiati hanno mostrato nel postoperatorio normali valori glicemici ed insulinemici ed un decremento dell'alfa-amilasi serica. Complicanze si sono verificate in un solo suino, ed il quadro microscopico è risultato sovrapponibile in tutti i casi.

La metodica microchirurgica e l'uso della prolamina sono ritenute valide al fine della chirurgia del trapianto di pancreas e della pancreatite cronica.

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