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Efficacy of percutaneous biliary and pancreatic duct drainage/stenting with double invaginated pancreatojejunostomy after pancreatoduodenectomy

AIM: To evaluate the efficacy and feasibility of preoperative percutaneous pancreatic duct drainage (PPDD) and improve the safety of pancreatojejunal anastomosis, we refer to our experience from 2013 to 2017 that include the last series of 27 cases of PD for 14 pancreatic and 13 ampullary tumors. Apart from the standard "classic" Whipple procedure in 17 cases, and the "modified" pylorus-preserving variant (ppPD) in 10 cases, in 26 cases a pancreatojejunostomy and in 1 case a pancreatico gastrostomy was performed. In last series the percutaneous biliary drainage procedure in 18 cases and dual biliary + pancreatic duct decompression in 4 cases was performed. In 21 cases the biliary drainage was used as transanastomotic stent during hepaticojejunostomy and in 3 cases the pancreatic duct drainage was also used as transanastomotic stent at our method of performing the double invaginated pancreatojejunostomy.

RESULTS: Without operative mortality in our series of PD, there were however some complications requiring in two patients interventional radiologic and intensive care management, and 5 patients died at follow up period (6 months – 3 years). There was no postoperative pancreatic fistula in our last series of PD, where preoperative biliary and pancreatic duct drainage and our modified double invaginated pancreatojejunostomy was performed.

CONCLUSIONS: Despite our limited experience, we can conclude that preoperative percutaneous biliary and pancreatic drainage is feasible, safe, effective and a realistic mini invasive procedure. The preliminary results obtained with the described method of double invaginated pancreatojejunostomy with transanastomotic stent and external pancreatic duct drainage are very encouraging and indicate that this technique is less complicated and time consuming, very safe, simple, easy to perform and also applicable almost to all situations.

KEY WORDS: Invaginated Pancreatojejunostomy Pancreatoduodenectomy, Pancreatic Duct Drainage

Introduction

Pancreatoduodenectomy (PD) is the most invasive and complex operative procedure of GI tract surgery most commonly performed for the pancreatic head and peri-

ampullary area malignancy with morbidity rate 40-50% and mortality on average 5%. Since the first introduction of standard PD by W. Kausch in 1909 and late popularization of A. Whipple in 1935 several modifications of this procedure have been proposed and reported, including pylorus-preserving technique, first described by K. Watson at 1944, which was then popularized by L. Traverso and W. Longmire in 1978^{1-4,6}.

Despite the fact, that PD is definitely difficult and complex surgical technique still associated with high mortality and morbidity, this operative procedure remains to be the treatment of choice and the best chance for man-

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agement and survival in patients with resectable periampullary and pancreatic head tumors. Following the PD the pancreatic anastomosis, which is the most important component of reconstruction, carries the highest risk of leak and cause of morbidity and mortality. The incidence of postoperative pancreatic fistula (POPF) rate is estimated to be 5% to 30% and so, the pancreatic anastomosis is still "Achilles" heel of pancreatic surgery^{1,4-6}. More than 80 different methods of pancreatocentric reconstruction from very simple to more elaborate multi-layer anastomosis have been proposed, illustrating the complexity of surgical techniques as well as the absence of the "ideal" pancreatic anastomosis and gold standard⁵⁻⁷. Recently after the overall and systematic review of special literature of evolution of pancreato-digestive anastomoses following PD it was concluded, that achieving a "zero percent" of POPF rate remains a "dream" of every pancreatic surgeon¹.

Among surgeons there is still no clear consensus: preoperative biliary and pancreatic duct drainage should be performed or not and so, this problem is still debatable⁸⁻¹³. Since biliary drainage procedure is well established and widely accepted the attention was focused at image-guided percutaneous preoperative drainage of pancreatic duct, which recently has been developed as a novel technique and by means of this procedure the inserted pancreatic duct drainage is then used as transanastomotic stent during performing the modified double invaginated pancreatojejunostomy. In a similar way the biliary drainage tube is used during creation of hepaticojejunostomy anastomosis.

So, at the present time there is developed and investigated a new option, which needs to be evaluated: the possibility, feasibility and efficacy of preoperative percutaneous pancreatic duct drainage (PPDD)¹⁴.

Material and Methods

Our data from 2013 to 2017 include the last series of 27 cases of PD for 14 pancreatic and 13 ampullary tumors. There were 11 females and 16 males (average age 57, range 43-78 years). The standard "classic" Whipple procedure was performed at 17 cases and "modified" pylorus-preserving variant (ppPD) – in 10 cases. 26 cases of pancreatojejunostomy and 1 pancreaticogastrostomy were created. In our last series the percutaneous biliary drainage procedure was performed at 18 cases and dual: biliary + pancreatic duct decompression - 4 times and so, in 21 cases the biliary drainage was used as transanastomotic stent during hepaticojejunostomy and in 3 cases the pancreatic duct drainage was also used as transanastomotic stent at our method of performing the double invaginated pancreatojejunostomy, which is described below. In 1 unresectable case of pancreatic head tumor - the pancreatic duct drainage was used as guide for the following endoluminal abla-

tion for recanalization and relief of pancreatic duct obstruction.

All patients underwent standard preoperative clinical, hematological, biochemical clinico-laboratory and instrumental investigations and imaging evaluation, which includes: CT, MRI with MRCP, US, Endoscopic examination with biopsy or ERCP.

Since pancreatic duct drainage procedure seems to be a new option in comparison with well established and long-standing biliary drainage procedure, the surgeons focus the special interest and attention on it. This procedure is performed by interventional radiologist by using two approaches: one group of patients in whom the pancreatic duct drain was positioned using combined ultrasound-fluoroscopy guidance technique (n = 15); and another one, who underwent a combined CT-fluoroscopy guidance technique (n = 14). In the case of failure both techniques were attempted. The technical aspects and details of this procedure and thereafter our method of performing the double invaginated pancreatojejunostomy are described below.

PROCEDURE OF COMBINED ULTRASOUND (US) AND FLUOROSCOPY GUIDANCE TECHNIQUE

The procedure performed under moderate sedation using midazolam and diprivan and local anaesthesia. The pancreatic duct was approached in real-time guidance, using either the "Free-Hand" or fixed needle guide technique. The entry point over pancreatic duct was selected over the proximal duct segment as per the permissible safety allowance, to ensure the antegrade placement of catheter tip. The distal segment of the pancreatic duct was punctured only when a safe approach to the proximal segment was not feasible. Due to the anatomical variation, the puncture needle traversed through the various structures as an anterior abdominal wall or abdominal wall and liver or abdominal wall and stomach. The decision regarding the size of the needle was made on the basis of pancreatic duct diameter as 18G diameter needle preferred when pancreatic duct diameter 5 mm and more whilst, a 22G needle used for pancreatic duct diameter less than 5 mm in order to minimize the risk of vessel damage during the needle advancement. In cases where the coaxial application of needles was needed, first 18 G needle used to reach the pancreatic surface followed by a 22G needle inserted coaxially into the pancreatic duct. The successful puncture of pancreatic duct had been confirmed by the observance of pancreatic fluid in the needle cannula and procedure was switched to fluoroscopy guidance, with an injection of contrast for pancreatic duct opacification. A guidewire was advanced (0.035 inch hydrophilic for 18G needles or 0.018 inch for 22G needles) in order to place a size appropriate (6–8.5 Fr diameter) locking loop drainage catheter. The end of the procedure was confirmed by injection of contrast

agent via the drainage catheter to document the successful drainage.

PROCEDURE OF COMBINED CT AND FLUOROSCOPY GUIDANCE TECHNIQUE

The computed tomography (CT)-fluoroscopy guided technique of pancreatic duct drainage were employed in a situation where safe approach using ultrasound guidance was not possible, or CT provided a better delineation of pancreatic duct anatomy thus provided easy access to the proximal segment. That being so the pre-procedure evaluation with contrast CT allowed the selection of the most appropriate access route. The procedure performed under moderate sedation, with a patient in prone or supine position. In a posterior approach, i.e., a prone positioned patient the needle passed through the posterior abdominal wall and retroperitoneal fat. Hydrodissection of retroperitoneal fat was performed with saline injection using 18G puncture needle and a safe passage created between the spleen, large bowel and kidney if they came into the path towards pancreatic duct. In an anterior approach, i.e., a supine positioned patient the anterior abdominal wall or abdominal wall and stomach were pierced by 18G or 22G needles whilst, coaxially applied combination of 18 and 22 G diameter needles used in five cases for pancreatic duct puncture. The guidewire (of 0.035 inch or 0.018 inch diameter) was placed through the cannula into the pancreatic duct and later confirmed by CT. Then patients were transferred to the angiography suite where an appropriate (6–8.5 Fr) locking loop drainage catheter was positioned over the guidewire using real-time fluoroscopy guidance. Later the 0.018 inch guidewire had been exchanged with 0.035 inch guidewire in cases where 22G needle was used to approach pancreatic duct. Day care patients were discharged following the post procedure observation of 3–6 h and daily outpatient's clinics follow up visits were made for next three days to take a note for any post procedure complications.

PROCEDURE OF DOUBLE INVAGINATED PANCREATOJEJUNOSTOMY

The pancreatojejunostomy creation is to begin after the appropriate mobilization and preparation of proximal jejunum and pancreatic remnant. The pancreatic duct drainage tube is inserted into the lumen of jejunum and I invagination is started by means of first two sutures. The needles are passed through the jejunum from outward to the inside and then followed by S-shaped sutures at the pancreas. These sutures are placed by 2 cm off cut edges (Fig. 1). By gently pushing of jejunal limb and simultaneous tightening of the sutures the pancreatic remnant easily slide ("parachuting") into the lumen of

jejunum and after tying the knots there is a good and thick fixation and adaptation of jejunal wall and pancreas tissue with each other. As a result the pancreatic remnant is invaginated at 4 cm into the jejunal lumen (Fig. 2). Thereafter the II invagination is started by means of four U-shaped sutures (middle and corners), which are placed at jejunum by 1 cm off cut end of jejunal wall with transpancreatic passing of sutures. After tying these knots the 1 cm of serous-muscular cuff is formed, which provides circularly very firm and thick

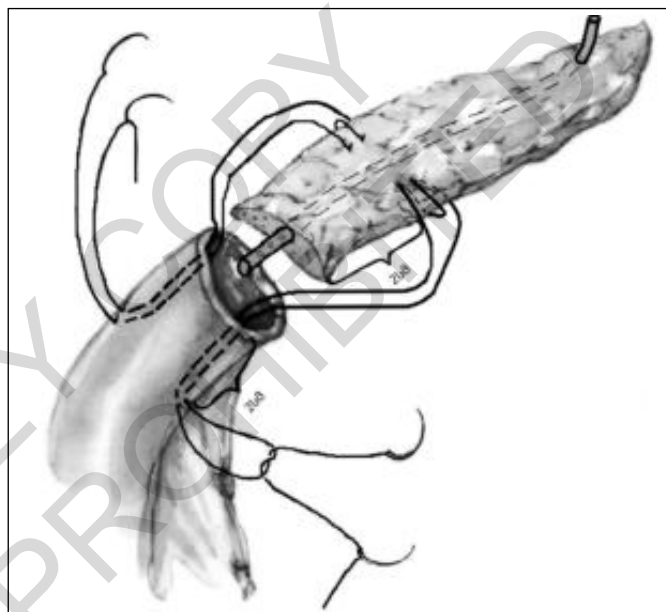


Fig. 1: I invagination sutures.

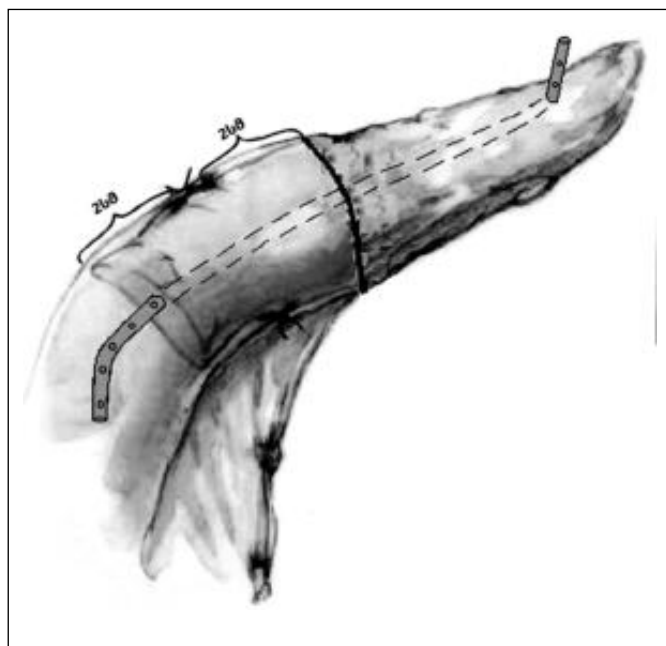


Fig. 2: View of I invagination.

touch and contact with the pancreas stump without dead space between them (Fig. 3, 4).

Thus, the introduced anastomosis is “end to end” double invaginated pancreatojejunostomy with transanastomotic stenting and external pancreatic duct drainage, which is characterized by the following advantages:

- is simple and easy to teach and perform;
- is hermetic and thereafter safe anastomosis;
- there is a good “serosal” touch and adaptation;
- it takes short operative time (10-12 min);

- it is applicable almost to all situations;
- minimal traumatizing of pancreas;
- unobstructed passage for the flow of the pancreatic secretions.

Results

There was no operative mortality in our series of PD. Two patients developed surgical site infection, 2 - dehiscence of abdominal wound closure and 3 patients experienced pancreatic leak and abscess, which required interventional radiologic and intensive care management. Two patients required reinterventional surgical procedure: 1 case of necrohaemorrhagic pancreatitis and 1 - of arrose bleeding and 5 patients died at follow up period (6 months – 3 years). The main operative time was 5 hours and the median length of stay was 12 days overall. There was no postoperative pancreatic fistula in our last series of PD, where preoperative biliary and pancreatic duct drainage and our modified double invaginated pancreatojejunostomy was performed. The transanastomotic biliary and pancreatic catheters were removed 3-4 weeks after surgery when control X-ray examination revealed complete capacity and leak resistance of both anastomoses without any contrast extravasation (Fig. 5).

Discussion

There is consensus among surgeons that pancreatic fistula is a leading cause of morbidity and mortality after pancreatoduodenectomy^{1,5-7,15-18}. Therefore over the years

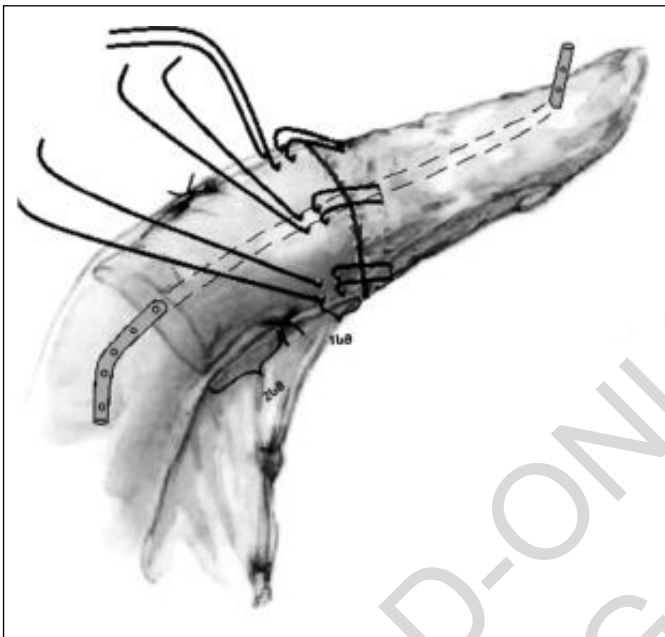


Fig. 3: II invagination sutures.

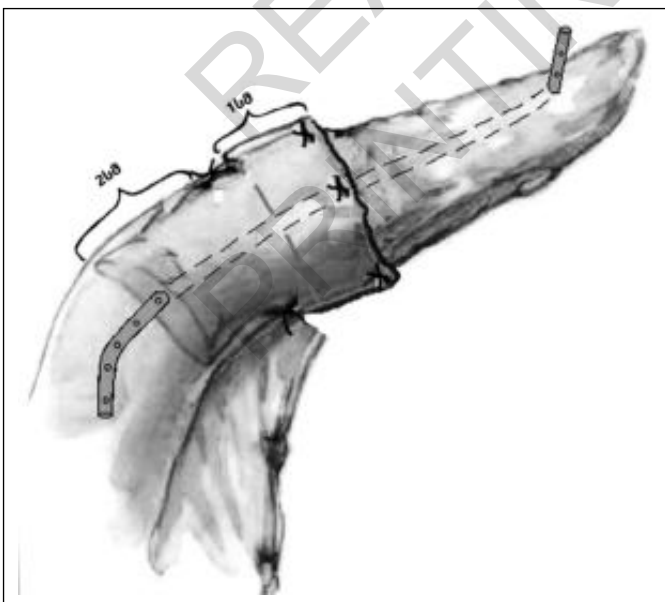


Fig. 4: Complete view of pancreatojejunostomy.

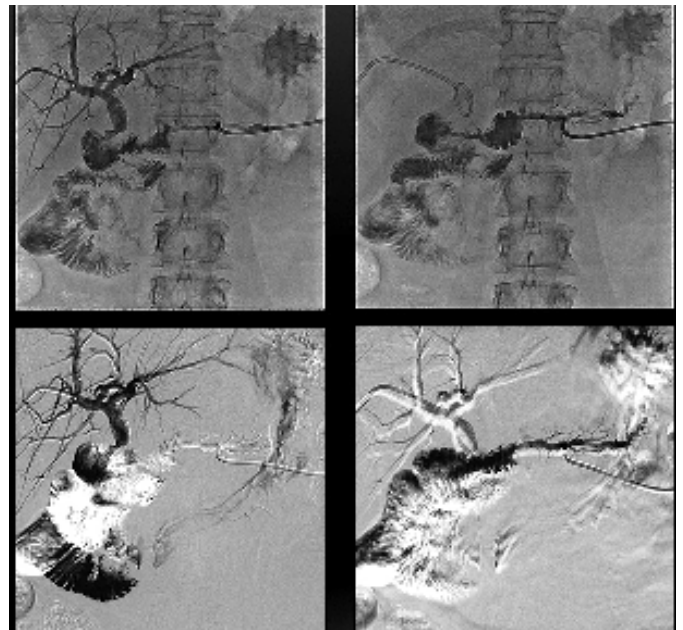


Fig. 5: Biliary and Pancreatic duct drainage catheters 4 weeks after surgery before withdrawal.

many considerable efforts and attempts were undertaken to mitigate these negative factors, associated with POPF by developing the optimal perioperative strategy (use of somatostatin, transanastomotic stents, magnification), improving the technique of performing the pancreatico-enteric anastomosis and introducing the different types and modifications of pancreatic anastomoses. Although the best method for dealing with the pancreatic stump after pancreatoduodenectomy remains in question, recent reports described the advantages of invagination method to decrease the rate of pancreatic fistula significantly compared to the duct-to-mucosa anastomosis^{2,5,6,17,18}. That is why our interest was to develop very secure, the most simple, reliable and effective invaginated pancreatic anastomosis. Controversial question is still today the necessity of preoperative biliary drainage (PBD) and despite the fact, that there is as yet no optimal method for this procedure many surgeons welcome routine performing of PBD prior to PD. There are several reports in recent relevant literature, that percutaneous transhepatic biliary drainage (PTBD) is superior and preferred to endoscopic retrograde biliary drainage (ERBD) procedure^{10,26}. But today, the main question, which needs to be clarified, is as follows: does the addition of pancreatic stenting contribute to a higher or lower morbidity after PD than biliary stenting alone? As regards the simultaneous biliary and pancreatic drainage, which is very rarely performed, their effect and influence on postoperative pancreatic fistula rate are largely unknown and must be evaluated by surgeons^{8,14,20}.

Controversies also accompany the stenting of biliary and pancreatic anastomoses. The problem of stenting the anastomosis, whether to stent and whether to use internal or external drainage, is still unresolved^{8,16,19,20,24}. It is achieved mainly by variety of endoscopic approaches as placement of a stent in common bile duct and pancreatic duct during endoscopic retrograde cholangiopancreatography (ERCP) procedure and in cases of failure another alternative is the endoscopic ultrasound guided drainage and stent placement. There are two types of stents commonly used for drainage: plastic stents and self-expanding metal stents which can be covered or uncovered¹⁴.

M. Mizandari et al.,¹⁴ recently have reported their experience of a total of 30 cases of percutaneous pancreatic duct drainage (PPDD) procedure with excellent results. They have concluded, that PPDD is a safe and effective procedure which can be used as an independent treatment option for pancreatic duct decompression or as a bridge to the subsequent procedures especially in cases, where endoscopic retrograde pancreatic duct cannulation fails or not feasible. They didn't encounter any technique specific complications, such as haemorrhage, vessel injury, visceral injury or infection, even in the cases where the transgastric route sought. In the study period, a total of 30 patients underwent

PPDD in whom either endoscopic approach was not possible. The PPDD was attempted in all patients with success of 96.7% (29/30 cases) as an independent therapeutic intent or as a bridge to further procedures. Similar results were reported by other investigators with pancreatic duct drainage procedure^{21,22}.

Recently several studies have revealed, that external pancreatic duct drainage can effectively reduce the morbidity of POPF and the overall complications after PD^{16,19,20,23-25}. This encouraging fact stimulates our group to use the previously percutaneously inserted pancreatic duct drainage tube as transanastomotic stent during performing our modified double invaginated pancreatojejunostomy and thereafter was using the PBD at hepaticojejunostomy. These transanastomotic external-internal stents at immediate postoperative period are operating like controllable and manageable catheters, which can be used for decompression, instillation and control X-ray cholangio- and pancreatography.

Conclusions

The impact of preoperative biliary and pancreatic duct drainage on perioperative morbidity and mortality in pancreatic surgery is still under debate. The optimal method of PBD and PPD is also controversial question still today. Based on our limited experience we can conclude, that preoperative percutaneous biliary and pancreatic drainage is feasible, safe, effective and realistic minimally-invasive procedure. Our analysis of early curative effect and outcomes has shown that external biliary and pancreatic duct drainage with a stents can effectively reduce the POPF and overall morbidity rates in patients undergoing pancreatoduodenectomy. Despite the fact, that our data is restricted, the preliminary results obtained with the described method of double invaginated pancreatojejunostomy with transanastomotic stent and external pancreatic duct drainage are very encouraging and indicate that this technique is less complicated and time consuming, very safe, simple, easy to perform and also applicable almost to all situations.

Riassunto

Per valutare l'efficacia e la fattibilità del drenaggio del dotto pancreatico percutaneo preoperatorio (PPDD) e migliorare la sicurezza dell'anastomosi pancreatico-digiunale, facciamo riferimento alla nostra esperienza dal 2013 al 2017 che include l'ultima serie di 27 casi di PD per 14 tumori del pancreas e 13 tumori periampollari. A parte la procedura standard "classica" di Whipple adottata in 17 casi, e la variante "modificata" del protoplasma (ppPD) in 10 casi, in 26 casi si è realizzata una

pancreatico-digiunostomia e in 1 caso una pancreatico-gastrostomia.

Nell'ultima serie è stata eseguita la procedura di drenaggio biliare percutaneo in 18 casi e la decompressione biliare + pancreatico del dotto pancreatico in 4 casi. In 21 casi il drenaggio biliare è stato utilizzato come stent transanastomotico della epatico-digiunostomia e in 3 casi il drenaggio del dotto pancreatico è stato utilizzato anche come stent transanastomotico nel nostro metodo di esecuzione della pancreato-giunostomia pancreatico invaginata.

In assenza di mortalità operatoria, nella nostra serie di PD ci sono state comunque alcune complicazioni che hanno richiesto in due pazienti la radiologia interventiva e la terapia intensiva, e 5 pazienti sono morti al follow up (6 mesi - 3 anni). Non ci sono state fistole pancreatiche postoperatorie nella nostra ultima serie di PD, in cui è stato eseguito il drenaggio biliare e pancreatico preoperatorio dei dotti e la pancreato-digiunostomia invaginata a doppio strato.

In conclusione, nonostante la nostra limitata esperienza, possiamo concludere che il drenaggio percutaneo biliare e pancreatico preoperatorio è fattibile, sicuro, efficace ed è una procedura mini invasiva realizzabile. I risultati preliminari ottenuti con il metodo descritto di pancreato-digiunostomia invaginata con stent transanastomotico e drenaggio del dotto pancreatico esterno sono molto incoraggianti e indicano che questa tecnica è meno complicata e dispendiosa in termini di tempo, molto sicura, semplice, facile da eseguire e applicabile quasi a tutte le situazioni.

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