Editorial Commentary

The impact of minimally invasive surgery and robot-assisted surgery on distal pancreatic resection: a snapshot on literature review and future technical innovations

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The distal pancreatectomy (DP) with or without splenectomy, has to be considered the standard of care for the treatment of benign, borderline, and malignant lesions of the pancreatic body and tail.

A minimally invasive approach for distal pancreatectomy has been progressively accepted. Nowadays minimally invasive surgery (MIS) had a huge diffusion especially for benign or borderline tumors, and in selected cases for malignant lesions (adenocarcinomas and PNETs). Laparoscopic distal pancreatectomy (LDP) was demonstrated to be a safe and feasible technique, especially in high volume centres (1) as well as in elderly and frail patients (>70 years of age) (2-4).

The advantages of a minimally invasive approach compared to open one is: faster recovery, shorter length of hospital stay, less blood loss, with the same oncologic outcomes (5).

In literature we can also find few series of single incision LDP (6). In a recent international survey, laparoscopy was the most common minimally invasive approach, while robotic technique was rarely used outside of North-America.

More recently the advent of robotic surgery in selected centres was also used for pancreatic surgery, especially for DP. Robotic technology was designed to overcome the limits of conventional laparoscopy. But the high cost and the low availability of the devices are the main reason for comparing this approach to laparoscopy.

Hospital stay and total costs are related to postoperative complications rate too, as it is well known, grade B–C pancreatic fistulas (PFs) are the most important cause of delayed discharge. The study comparing open, laparoscopy and robotic surgery demonstrate a significant better result in shorter hospital stay for robotic approach (7), this probably may be correlated to a reduction in postoperative complications rate (PFs, wound dehiscence, postoperative ileus).

Moreover, worldwide, we can find several different approaches to distal pancreatic resections, not only about the MIS, but also about pancreatic stump treatment. The query about the best technique to perform a safe pancreatic stump closure is a key point in minimally invasive pancreatic surgery because the complication of a PF causes a lack of all benefit of minimally invasive approach with longer hospital stay and a lot of other general complication. Unfortunately, the stump closure is influenced by surgeon's and region's habits rather than by strict protocols, this variability reflects the lack of solid evidence on the benefit of any given strategy (8).

In particular about PF the technique of pancreatic stump closure reported in the literature may be very different. We can use the stapler for closure (with or without reinforcement), or stapler combined with suture or only stump suture (duct suture). In the Maggino survey the preferred technique for pancreatic remnant closure was stapler (8).

About the use of sealant products (Tachosil, Fibrin-glue) or autologous patches (falciform ligament, etc) we have only

a few studies. Finally, a pancreatic stump anastomosis is reported too (7,9).

So, if we compare the outcomes for different approach (open, laparoscopy and robotic) we have to consider these technical aspects too, as they may influence important post-operative outcomes as complications, fistulas, post-operative stay and total costs.

In particular the robotic technology using a magnificent 3D view and stable instruments for suture may provide interesting outcomes especially about stump and duct suture (10,11); so, we will be interesting to compare the same suture techniques in open, laparoscopy and robotic approaches.

About the real impact on hospital-stay for total costs reduction, it is related not only to a minimally invasive approach (demonstrated both for laparoscopy and robotic surgery) but it is related in particular to the application of enhanced recovery program (ERP), so it would be interesting to compare the hospital stay and relative costs between centres who apply an ERP program vs centres who do not apply it. Moreover, it would be hopeful to study how MIS can help the improvement of ERP program if compared with open surgery.

The operative time for robotic distal pancreatectomy was in many studies higher if compared to the laparoscopic approach (12,13), but after a short and appropriate learning curve of the team (including surgeon, anaesthesiologists and operating room staff), the waste of time may decrease significantly. So, one of the most frequent bias analysing waste of time in robotic surgery is to compare learning curve period of surgical team with a well trained one. Another bias in some studies might be when they consider as the same procedure spleno-distal pancreatectomy and spleen-preserving ones, as it is well known as spleen-preserving is associated with a higher morbidity rate especially for high BMI and neuroendocrine tumors (14,15).

Many studies demonstrate that robotic approach compared to laparoscopy for distal pancreatectomy with spleen preservation, offers better outcomes and successful rate is similar to open approach (11-16). It is easy to understand that robotic technology allows a better view and surgical control during dissection and suture performing, including 5/0 and 6/0 stiches for small splenic vessels branches (in particular for splenic vein injury during dissection). This is a clear demonstration of the superiority of robotic surgery compared to conventional laparoscopy. Probably if all minimally invasive procedures would be performed with robot assisted techniques, we will find in literature even less cases of spleno-pancreatectomy in favour of spleno-preserving ones.

When lymph node harvesting is required, the robotic approach seems to offer better outcomes in number of nodes collected compared to standard laparoscopic technique (3).

First of all, we have to consider the importance of the latest innovation in the operation room during robotic pancreatic surgery. Regarding vision improvement, we have to analyse near-infrared (NIR) indocyanine green (ICG) fluorescence imaging: camera and designated scopes can be used to detect the fluorescence produced by a laser beam or NIR. In this way, immediately after the injection, we can have a "virtual" real-time angiography and, about 8 minutes later, a virtual cholangiography. In tour era, there are a lot of applications of this technology, for example in complex cases of vascular and biliary anatomy or to evaluate organ perfusion in digestive surgery. Despite it, probably the majority of opportunity of NIR ICG haven't been exploited yet. Besides, about lymphatic system, with an extravascular injection we can have a lymphoscintigraphy that allows the application in sentinel node surgery and fluorescence-guided lymphadenectomy (17).

There is still a long way to go to assess efficacy and productive of ICG in minimally invasive pancreatic surgery.

Now, virtual models based on CT scan are important during pre-operative/operative phase also thanks to the improvement of radiological technique which support robotic platform.

Augmented reality (AR) is the technology that compare live intraoperative images with 3D reconstructed images: it represents an important step for navigation tool and it can help surgeons to analyse target structure and anatomical variations with modular virtual organ transparency (18).

Registration is defined as the overlap of 3D virtual model acquired during preoperative phase and real patient anatomy during intervention, it is a very important step in AR and nowadays it is the part of the process which we have to study more. The simplest method for AR image registration is to manually match a paired-point landmark, such as the umbilicus or a nipple, between the actual organ and the overlaying image. Sometimes during preoperative CT or MRI radiopaque fiducials, markers are attached on the patient's body, in particular on skin or bone, to determinate important landmarks. We can enhance registration during AR with a tracking system, like a global positioning system (GPS). Some new algorithms improve real time intra-operative registration accuracy by using both vessel and

organ surface information to register the abdominal image. This new non-rigid registration technique accurately displays the relative positions of the blood vessels and bile duct as a multi-phase fusion image (19). This new non-rigid registration technique accurately displays the relative positions of the blood vessels and bile duct as a multi-phase fusion image. Initially AR and image-guide surgery were utilized in neurosurgery and maxillofacial surgery because in these districts' structures are clear and, in this way, they make the preoperative model very similar to the real patient. AR presents more difficulties in its use during laparoscopic surgery, mostly in abdominal surgery, due to the respiratory motion and to the deformation of soft tissues during operations (20).

About total costs of robotic surgery in particular, they are higher nowadays if compared to laparoscopy, as the robotic instruments costs are higher (21), except for any comparative studies (22) the minimally invasive approach appears to be more cost-effective than open one (23). In our era indication to robotic approach will increase for all kind of abdominal surgery and especially for distal pancreatic resection, so costs of robotic technology will be even more sustainable in the future. HPB surgeons in high volume centres will be more and more skilled and expert in MIS and robot-assisted procedures.

We agree that conclusions need to wait larger comparative studies and prospective cohorts to provide definitive evidences about benefits of robotic surgery. Anyway, the minimally invasive approach (laparoscopic or robotic) may be considered a valid alternative to open surgery, with advantages either considering short- or long-term outcomes, in particular for the earlier recovery and blood-loss. Robotic distal pancreatectomy according to the current studies and evidences is not only safe and effective, but may reduce overall morbidity, length of hospital stay and spleen-preservation rate; operative time will decrease with surgical team expertise, but costs and devices availability are the most important current limits.

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