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ORIGINAL ARTICLE

Robotic digestive tract reconstruction after total gastrectomy for gastric cancer: a simple way to do it

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Abstract

Background Intracorporeal digestive tract reconstruction after minimally invasive total gastrectomy may be challenging, even when using the da Vinci® Surgical System. This may be due to intrinsic difficulties during oesophago–jejunal anastomosis (EJA). The aim of this study was to describe a simple way to perform digestive tract reconstruction after robotic total gastrectomy (RTG) for gastric cancer and the results of its application in a small series of cases.

Methods In the last 2 years, six patients with gastric adenocarcinoma have been treated by RTG, four male and two female, with mean age of 59.8 (range 48–74) years. The tumour was located in the gastric body in three patients, the gastric antrum in two patients and the fundus in one patient with no need of splenectomy. In all cases, D2 lymphadenectomy was completed. A modified robotic reconstruction technique proposed by the authors was used in these operations, which consists in a latero–lateral EJA using a linear stapler. An entero–enterostomy is also performed in the upper abdomen.

Results The mean operative time was 408 (range 340–481) min. The mean time for digestive tract reconstruction was 57 (range 47–68) min. There were no conversions to open or laparoscopic surgery. The number of lymph nodes removed varied in the range 28–52 (average 40). There was no mortality. Postoperative staging showed three T1N0M0s, one T2N0M0, one T3N0M0 and one T3N2M0.

Conclusion This series, which despite being small, demonstrates that this robotic reconstruction technique is safe, with no major complications, demands a relatively short time for its accomplishment, even when dealing with initial experience. Copyright © 2015 John Wiley & Sons, Ltd.

Keywords gastric cancer; total gastrectomy; minimally invasive surgery; robotic gastrectomy; reconstruction

Introduction

Although the incidence of gastric cancer (GC) is decreasing worldwide, it is still considered a disease with a very poor prognosis, especially in emerging countries, due to late diagnosis. In eastern countries (mainly Japan and Korea), the majority of patients diagnosed with GC are in the early stage, ensuring great possibility of cure (1). Since it was first described (2,3), laparoscopic distal gastrectomy (LDG) has been proved to be a reliable oncological approach for patientsat this stage of the disease, with all the advantages of minimally invasive (MI) access.

On the other hand, laparoscopic total gastrectomy (LTG) has not gained the same popularity as LDG, probably because of intrinsic difficulties in the surgical approach to the upper one-third of the stomach and the oesophago–gastric junction (EGJ), especially during oesophago–jejunal anastomosis (EJA) and when performing lymphadenectomy (Ly) along the nodes at the splenic hilum (station no. 10) and along the distant part of the splenic artery (station no. 11d), which must be included in D2 total gastrectomy (4). For EJA there is no standardized accepted procedure and many techniques have been reported (5,6). Most data about LTG consist of hybrid procedures, i.e. the gastric resection and Ly are done laparoscopically, while the digestive tract reconstruction is done extracorporeally, with a small incision. Total intracorporal reconstruction, although safe and feasible, might be challenging even in the most experienced hands (7).

Cadière *et al*. (8) introduced a robotic surgical system in 1997 to overcome the technical drawbacks of conventional laparoscopic surgery. Since then > 3000 da Vinci® Surgical System (DVSS) devices have been employed around the world, with over half a million operations done annually. To date, robotic surgery has been adopted in many fields of complex procedures of cardiac, gynaecological and urological surgery, especially for prostate cancer (9). In general surgery, precisely in GC surgery, robotic gastrectomy (RG) has been reported to be beneficial for patients, with less injury and also with compatible short-term oncological outcomes to open gastrectomy (OG) or laparoscopic gastrectomy (LG) (10,11). Hyung *et al*. (12) conducted a multicentre prospective study with 434 patients, comparing RG (n = 223) versus LG (n = 211) for GC; the short-term outcomes showed similarity in both groups regarding overall complications, mortality and number of harvested lymph nodes, with longer operative time and higher costs in the robotic group. However, this study did not analyse the type of digestive tract reconstruction (intra or extracorporeal) and the method was selected on the basis of the surgeon's preference. It is possible that many patients were treated with assisted minimally invasive surgery, even in the robotic group. Performing the EJA manually (intracorporeal) would require at least two suture layers, which would certainly increase the surgical time, and to perform it extracorporeally with a small incision would increase the chance of complications in the surgical wound. For this reason, we are introducing a simple and fast way to perform robotic digestive tract reconstruction after TG for GC.

Materials and methods

Surgical technique

Our method for RG for GG is performed while the patient is under general anaesthesia, in a modified lithotomy position, with the legs apart and flexed slightly and with a 30° tilt-down position; the assistant is positioned between the patient's legs. After pneumoperitoneum is established, six ports are placed; a 12 mm port is placed below the patient's umbilicus for the camera, and one 8 mm left subcostal port (R3) and two low abdominal 8 mm bilateral ports (R1 and R2). A 12 mm port is placed right and below the patient's umbilicus for the assistant. Finally, a 5 mm port is placed in the subxiphoidal area for the liver retractor (Figure 1). Intracorporeal pressure is maintained at 12–15 mmHg. The gastrectomy begins with the traction of the greater curvature along the

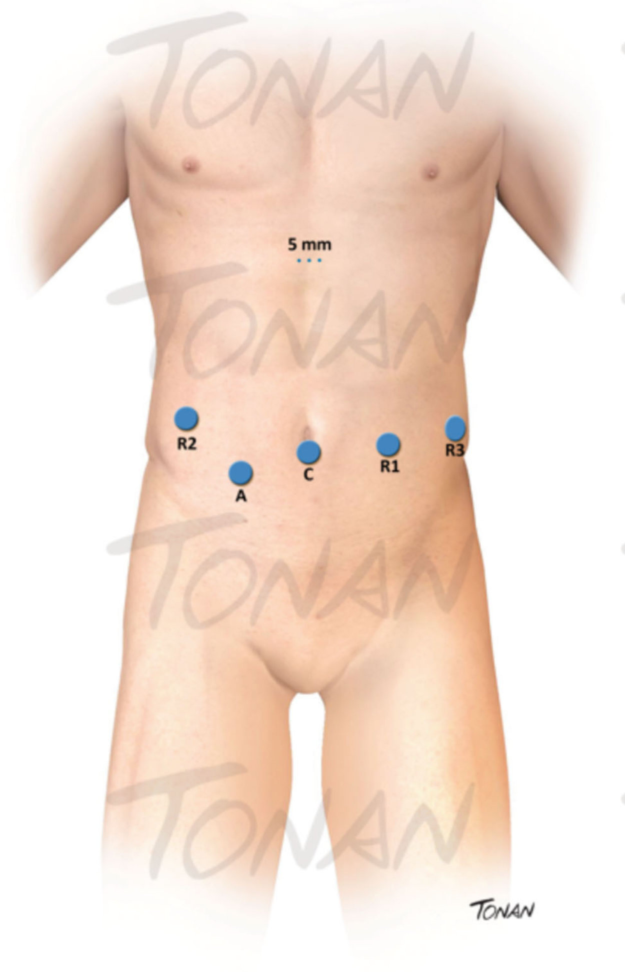

Figure 1. Distribution of ports on the abdominal wall

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transverse colon (R3) and the dissection of the gastrocolic ligament (LN station no. 4d), carried out via R1 and R2. The infrapyloric lymph nodes (LN station no. 6) are dissected and the vessels are ligated with double clips placed by the assistant. During this exposure, lymph nodes of the mesenteric artery and vein (LN station nos 14v and 14a) can be easily removed if necessary. Strategically, after this dissection, we move through the dissection of the upper part of the duodenum to facilitate the introduction of a 60 mm endoscopic linear stapler by the assistant for duodenal transection. The reinforcement of the linear stapler is routinely performed with separated or continuous unabsorbed sero-muscular suture. The dissection of the right gastric vessels (LN station no. 5) is performed by dividing them with clips and removing the lymph nodes along the hepatic artery in the hepatoduodenal ligament (LN station no. 12a). Dissection continues on the anterior superior lymph node group along the common hepatic artery (LN no. 8a) and left gastric vessels, which are clipped and divided (LN no. 7), and the coeliac artery lymph nodes (LN no. 9). Lymphadenectomy proceeds in the direction of the splenic artery towards the splenic hilum (LN no. 11p, 11d and 10). This dissection is necessary to complete D2Ly in TG for GC and the DVSS allows a far better and easier Ly, especially in this part of the procedure, which would require a very skilled laparoscopic surgeon to accomplish it. After exposure and traction of the oesophagus with a Penrose drain, the vagal nerves are easily identified and divided. The remainder of the great omentum is released from the transverse colon (LN no. 4sb, 4sa). The oesophagus is transected by the assistant with a 60 mm linear stapler with blue cartridge. By this step, the gastric resection is completed and the specimen can be removed by a small supra-pubic Pfannenstiel incision.

Digestive tract reconstruction

The continuity of the digestive tract is enabled by the performance of a totally robotic Roux-en-Y diversion. To facilitate this manoeuvre, Treitz's angle is identified at 30–40 cm distal from it and a jejunal loop is identified, anchored by a Penrose drain and transposed by the assistant through the supra-mesocolic space, using a trans-mesocolic or precolic route. It is helpful if the jejunal loop is anchored by a stitch to the left lateral wall of the abdominal transected oesophagus (Figure 2). The anaesthesiologist introduces a 32 French bougie orally for easier exposure of the oesophageal stump. A 60 mm linear stapler with white cartridge is utilized to perform the latero–lateral EJA. It is very important that, in this part of the procedure, the assistant who is holding the stapler stands still while the surgeon in the console manipulates the jejunal limb and the oesophagus into the stapler (Figure 3A). After

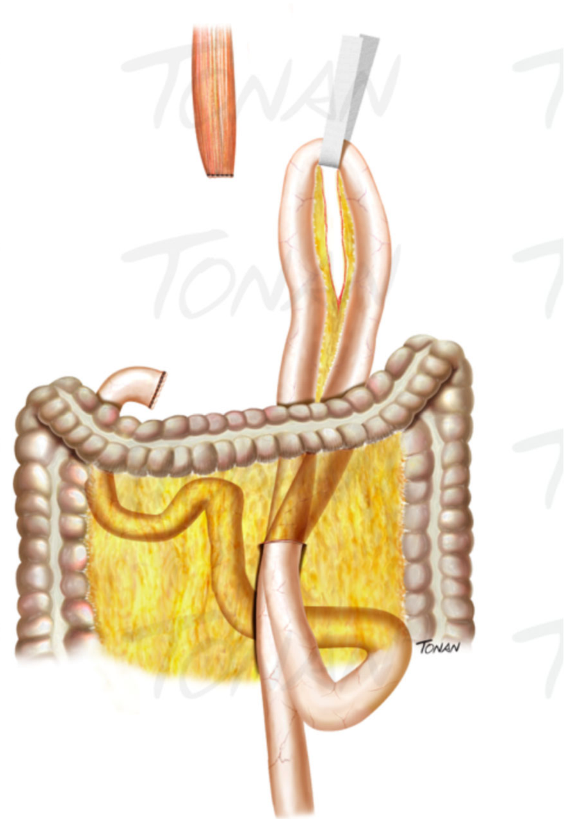

Figure 2. Pulling up the alimentary and biliary jejunal limb to the supramesocolic space

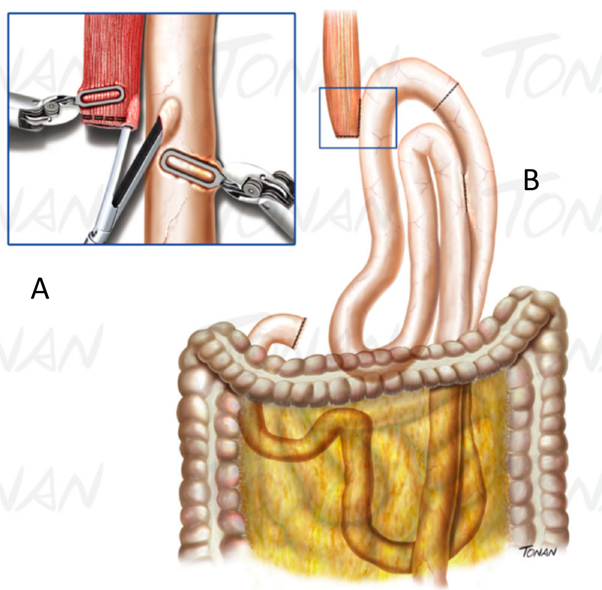

Figure 3. Oesophago–jejunal anastomosis made with linear stapler (A) and then the enteroenteral anastomosis of the biliary and alimentary limb (B), always in the upper abdomen

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completion of the mechanical anastomosis, the bougie already exposing the oesophagus is introduced into the jejunal loop to ensure the diameter of the anastomosis and facilitate the closure of the common entry hole by hand sewing with an extra-mucosal 3-0 PDS® (polydioxanone) suture. Next, an alimentary limb is isolated with a length of about 70 cm, brought into the upper abdomen, close to the biliary limb, in order to perform the jejuno–jejunostomy of the Roux-en-Y reconstruction (Figure 3B). This anastomosis is performed with a 45 mm white cartridge linear stapler, once more with the assistant holding the stapler and the surgeon on the console manipulating the bowel into the stapler. The stapler entrance is closed by hand sewing with extramucosal 3-0 PDS®. After both anastomoses have been completed, they are tested by instilling methylene blue solution through the oesophageal bougie to ensure their integrity without leaks. Once tested, the biliary and alimentary limbs are divided and separated by utilizing the linear stapler with a 45 mm white cartridge (Figure 4). In the trans-mesocolic route, the alimentary limb is tractioned and the entero–enterostomy is placed in the infra-mesocolic space. The mesenteric gap is closed with a manual interrupted suture (Figure 5). All patients receive a naso-enteral tube that is placed beyond the biliary anastomosis.

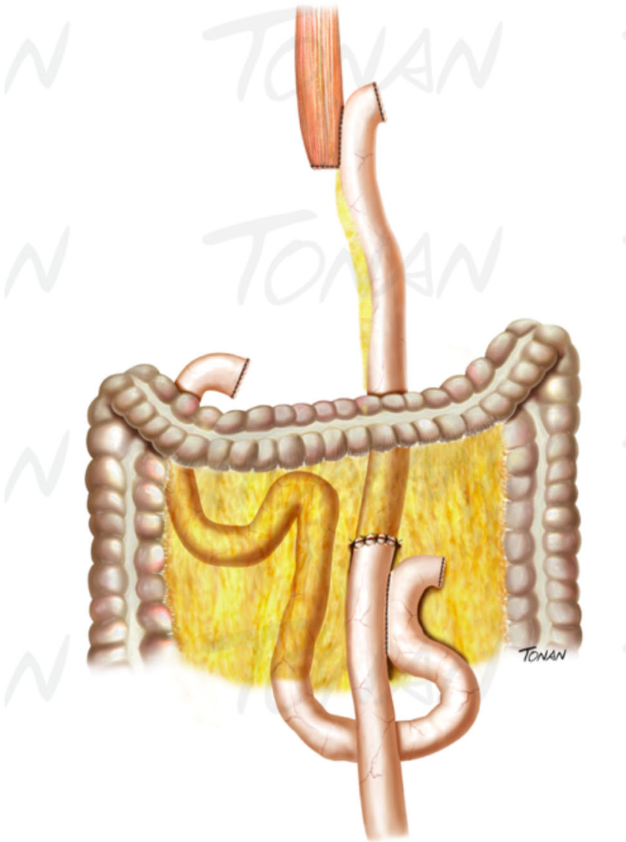

Figure 5. Final aspect of the reconstruction of digestive continuity with Roux-en-Y diversion after total robotic gastrectomy

Results

Up to now, during a 2 year period, six patients with gastric adenocarcinoma have been treated by RTG, four males and two females, with mean age of 59.8 (range 48–74) years. The tumour was located in the gastric body in three patients, the gastric antrum in two patients and the fundus in one patient with no need of splenectomy. All of them received RTG with this type of digestive tract reconstruction. D2 Ly was feasible in all cases, with a mean of 40 (range 28–52) lymph nodes removed. The mean operative time was 408 (range 340–481) min. The mean time for digestive tract reconstruction was 57 (range 47–68) min. There were no conversions to open or laparoscopic surgery and the mortality rate was 0%. All patients were sent to the intensive care unit. The intra-operative and immediate postoperative evolution were uneventful except for one case of excessive haematic drainage through the drain, with no haemodynamic repercussions, where re-intervention was not needed. Postoperative staging showed three T1N0M0s, one T2N0M0, one T3N0M0 and one T3N2M0.

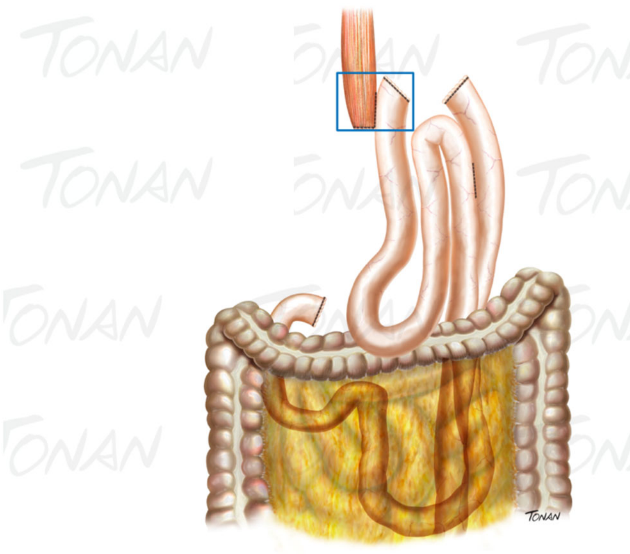

Figure 4. Transection of the biliary limb after methylene blue solution test was performed

In the first 24 h after operation, all patients were able to walk by themselves. Enteral feeding was started on postoperative day 3 and lasted until day 7, when an oral methylene blue test was performed to confirm the integrity of the EJA. Then, in the absence of anastomotic leakage, oral feeding was started. The abdominal drains

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were removed 48 h after oral feeding had begun. The patients were discharged between postoperative days 10 and 14.

Discussion

Despite the benefit to the patient obtained by the laparoscopic approach, it is known that this pathway often causes greater physical effort and wear of the medical team, in addition to other drawbacks, e.g. the view in two dimensions. In this regard, robotic surgery has been introduced as a minimally invasive method for the treatment of GC, which is useful in many cases today, since it provides the surgeon with a more ergonomic position, wristed instruments that allow seven degrees of freedom, tremor filtering and a three-dimensional view of the surgical field.

It is clear that surgery with DVSS is safe and feasible, as this device has been designed to assist surgeons in complex laparoscopic procedures. However, unlike other cancers, e.g. prostate, lower rectal and gynaecological, the role of the DVSS in GC remains unclear (13–15). Robotic systems have been used for several years in GC surgery, especially in Korea. In data published by Yonsei University, probably the centre with the most experience with RG for cancer in the world, Woo *et al*. (16) compared 591 operations by laparoscopy with 236 cases operated robotically. The operative time was longer in the second group. However, the blood loss was smaller, short-term surgical results were better and oncological results were similar.

In a recent meta-analysis, Marano *et al*. (17) analysed 1967 patients operated for GC, with 404 RG, 718 OG and 845 LG, and concluded that RG for GC reduces intra-operative blood loss and time of postoperative hospital stay compared with LG and OG, at a cost of longer surgical time and a much more expensive budget; RG also provides an adequate oncological lymphadenectomy.

Most data on minimally invasive TG is about the safety, feasibility, morbidity/mortality and oncological outcomes (18–20). The literature is quite sparse about reconstruction methods of the digestive tract following TG, especially when it comes to robotic surgery. There are a variety of technical options, such as intra- or extracorporeal hand-sewn, circular-stapled end-to-side, linear-stapled side-to-side anastomoses, and the use of various technical adjuncts, such as OrVil® (which allows for transoral introduction of the circular stapler anvil) (5). Probably the most used in both RG and LG are hybrid procedures, where reconstruction is performed by open access with mini-laparotomy, where the EJA is made manually or using a circular stapler (21). The circular-stapling method has been discussed in many previous reports (22,23). However, some intra-operative distress may occur by making a proper purse-string suture at the oesophageal stump and inserting an anvil into the oesophageal lumen through a mini-laparotomy, especially in obese patients. Also, several complications, such as oesophageal injury during insertion and risks of oral bacterial contamination, have been reported with use of the OrVil® system method (24).

The intracorporeal linear-stapled side-to-side EJA was first described by Uyama *et al*. (25) as a reconstruction method following proximal gastrectomy, and has been adapted by Zilberstein *et al*. (26) in digestive tract reconstruction after LTG. Shim *et al*. (27) compared four types of intracorporeal EJA after LTG for GC in 48 patients: a conventional anvil head method (type A), OrVil® system method (type B), a hemi-double-stapling technique with anvil head (type C) and side-to-side EJA with a linear stapler (type D) (types A, B and C using circular stapler and type D with linear stapler). Although it was a retrospective study, the results showed that the first two methods (A and B) had longer operating time ($p < 0.05$); anastomosis leakage occurred in types A, B and C but not in type D ($p = 0.044$), and anastomosis stricture requiring intervention was more common in types A and B ($p < 0.05$).

The type of laparoscopic anastomosis presented here may be an optional method, even in RG, that, although it is manually performed more easily than in laparoscopy, generally requires two lines of sutures, which entails a longer operating time and is demanding in terms of skill. This series, despite being small, demonstrates that this reconstruction technique is safe, with no major complications, and demands a relatively short time for its accomplishment, even when dealing with initial experience. One possible setback for using this reconstruction method is the occurrence of tumours that invade up the thoracic oesophagus, making this technique impractical. For such cases, another technique may be required, including thoracoscopic oesophagectomy.

In conclusion, robotic digestive tract reconstruction after TG for GC is technically feasible and safe when performing side-to-side EJA with a linear stapler. The high cost is still a hindrance to the large-scale use of robotics. This advanced technological platform is nothing more than a sophisticated laparoscopic working tool for more complex procedures. It is an evolution in technology and improvement of instruments that may facilitate procedures such as the EJA. The knowledge gained from laparoscopic surgery should be used and incorporated into robotic surgery, which surely will result in an improvement of outcomes obtained in the minimally invasive treatment of gastric cancer.

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Conflict of interest

The authors have stated explicitly that there are no conflict of interest in connection with this article.

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