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Ex-situ Open Approach Spleen Preserving Splenic Hilum Lymphadenectomy

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Rezumat

Limfadenectomia ex-situ de hil splenic cu preservarea splinei pe cale deschisă - tehnică operatorie: atitudine personală

Context: studii multiple au arătat beneficii importante care decurg din conservarea splenica la pacienții cu cancer digestiv în general şi cu cancer gastric în special. Abordarea minim invazivă rămâne controversată în cazurile de cancer gastric local avansat, în timp ce abordul deschis are încă un rol important. *Scopul* acestei lucrări este de a descrie şi prezenta fezabilitatea unei tehnici chirurgicale deschise care să permită îndepărtarea stațiilor 10 împreună cu 11p şi 11d cu prezervarea splinei şi a vaselor splenice la pacienții operați pe cale deschisă.
Material şi Metodă: Prezentăm o tehnică "ex-situ" de limfadenectomie a hilului splenic cu prezervarea splinei şi pancreasului, realizată pe cale deschisă, ce îndepărtează ganglionii anterior şi posterior de splină, de vasele splenice şi de pancreasul distal în cazurile local avansate de cancer al celor două treimi superioare ale stomacului. Patruzeci şi trei de pacienți consecutivi, începând din 2003, au fost operați de către autor în mai multe centre beneficiind de prezervarea splinei în timpul rezecțiilor de cancer gastric al celor două treimi superioare care au necesitat limfadenectomie la nivelul stației nr. 10.
Rezultate: nu a fost necesară nicio splenectomie. Toate splinele au fost viabile la ecografie Doppler postoperatorie şi la examenele CT de control. Nicio splină nu a migrat şi nici nu a provocat complicații mecanice. Nu au fost observate fistule pancreatice semnificative clinic. Doi pacienți au murit în timpul spitalizării, unul de infarct miocardic şi unul de accident vascular cerebral masiv. Nu au fost disponibile date pertinente de urmărire şi supraviețuire.
Concluzii: Metoda permite limfatidenectomia stațiilor nr. 10 împreună cu 11p şi 11d fără a fi nevoie să fie sacrificată splina.

Toate splinele au fost reataşate cu succes folosind pliul de ligament spleno-renal conservat, nu s-a observat niciun caz de "wandering spleen" sau torsiune postoperator.

Cuvinte cheie: hil splenic, limfadenectomie, prezervare splenica, cancer gastric

Abstract

Background: multiple studies showed important benefices arising from splenic preservation in patients with digestive cancer in general and gastric cancer in particular. The minimally invasive approach remains controversial in locally advanced gastric cancer cases whilst the open approach still has an important role. This paper's aim is to describe and present the feasibility of an open surgical technique that allows removing stations 10 together with 11p and 11d with spleen and splenic vessels preservation in pacients operated upon by open surgery.

Material and Methods: We present an open "Ex-situ" spleen and pancreas preserving surgical technique that removes the anterior and posterior ganglia from the splenic hilum, the splenic vessels and the distal pancreas in locally advanced gastric cancer cases of the upper two thirds of the stomach. Forty-three consecutive patients since 2003 were operated upon by the author in multiple centers. during upper two thirds gastric cancer resections requiring no. 10 lymphadenectomy.

Results: no splenectomy was needed . All the spleens were viable at postoperative Doppler echography and CT scans. No spleen migrated nor caused mechanical complications. No clinically significant pancreatic leaks were noticed. Two patients died during hospital stay, one of miocardial infarction and one of massive stroke. Pertinent follow up data and survival were not available.

Conclusions: The method enables the surgeon to remove the lymph nodes no. 10 along with 11p and 11d without needing to sacrifice the spleen. All spleens were reattached sucessfully using the preserved spleno-renal ligament fold, no wandering spleen was noticed.

Key words: splenic hilum, lymphadenectomy, splenic preservation, gastric cancer

Introduction

During the last decades splenic preservation has been proven to be beneficial for the oncological patient, essentially due to a better immune response. It was also proven to bring better overall survival.

Many randomized gastric cancer surgery studies proved that splenic and caudal pancreatic removal for radical lymphadenectomy is less beneficial than splenic preservation without lymphadenectomy in the splenic territory (1-3).

It has become clear nowadays that there are numerous benefits arising from splenic preservation.

Previously, the station 10 lymphadenectomy was considered impossible without splenectomy (4,5).

There is however the necessity of respecting the principles of radical lymphadenectomy, given the important rate of no. 10 lymph nodes metastasis rate, which lead in time to the concept of spleen preserving station 10 lymphadenectomy (6-8).

The techniques used in open surgery were later described as In-situ and Ex-situ, according to having mobilised the splenopancreatic complex or not (9-11).

Minimally invasive laparoscopic and robotic approaches for station 10 spleen preserving lymphadenectomy developed to an important extent (12-18).

If about 40 years ago the spleen was not

considered an organ of importance for the patients' future, except maybe for the pediatric patients, now there is a consensus concerning the benefits of splenic preservation, in terms of better immunological protection and, in oncological patients, in terms of survival. These data were demonstrated for gastric cancer.

Splenectomy is now known as a cause for severe sepsis (19-23).

Splenic preservation techniques started to be developed for left pancreatectomy (24-27) – generally for endocrine tumors and benign lesions. Many of such techniques consist in removing the corporeal-caudal pancreas In-situ.

As for gastric cancer, the initial attitude of the promoters of extended lymphadenectomy included splenectomy with distal pancreatectomy to allow the removal of the splenic hilum and retropancreatic ganglia (28).

That changed subsequently since diabetes, pancreatic fistula and subfrenic abscesses occured with an important incidence. The modification consisted of preserving the pancreas along with identifying and sparing the artery for the pancreatic tail (29).

Afterwards, many studies demonstrated that splenic removal for reasons of surgical oncological radicality showed to be less beneficial than splenic preservation without lymphadenectomy in the splenic territory. Multicentric studies showed important benefits arising from splenic preservation in patients with gastric cancer (1-3).

So, at this moment, the usefulness of splenic preservation is clearly established.

Material and Method

We used a xipho-subombilical midline incision in our pacients. We use an Ex-situ splenic preservation approach that enables removing all the fatty tissue and ganglia from the splenic hilum, the splenic vessels and the corporeal and caudal pancreas.

Exclusion Criteria

Distant metasthasis; Non resectable cases; Palliative resection cases; Peritoneal spreading; Patients evaluated as not fit for major surgery.

Cases of direct invasion of the splenic parenchima, its blood vessels and/or bulky confluent ganglia within its hilum were excluded upon the CT and especially the intra-operative findings; in such cases the spleen needed to be removed.

Inclusion Criteria

Resectable cases of the upper two thirds gastric cancer without peritoneal spreading and without distant metasthasis in patients fit for major surgery.

In between 2002 – 2023, all the author's patients meeting the eligibility criteria were operated upon using this technique.

The other surgeons in the respective centers either performed splenectomy or renounced to the station 10 lymphadenectomy, this being why the total number of patients was not accounted for.

The patients' informed consent was obtained in all cases.

Preoperatively, gastroscopy with biopsy, TAP CT scan, nutritional status check up, CA 19-9, CEA, spirometry, heart ultrasound examination were performed in all patients.

For the upper two thirds gastric cancer resections requiring extended lymphadenectomy including stations 10 and 11 the short gastric vessels are transected, the spleen is then mobilized along with the tail and body of pancreas following the splenic vessels up to the celiac axis implantation of the splenic artery. The spleno-renal ligament is transected taking care to preserve on the posterior aspect of the spleen a fold of this ligament (*Fig. 1*).

During our first case, we have thoroughly mobilized the spleen and we saw that, once the polar vessels were divided, we succeeded to easily remove the hilar lymph nodes and fatty tissues, so that we no longer needed to carry on with removing the spleen.

We had concerns about the issue of a post-operative migrating spleen (wandering spleen), so we used a splenorenal ligament fold existing on the spleen in order to reattach

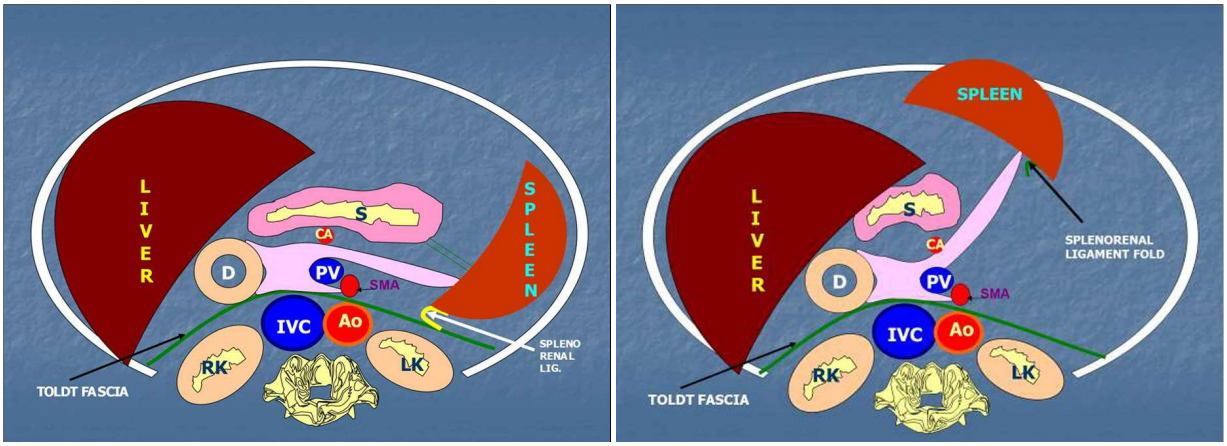

Figure 1. Axial diagram of the mobilisation plan before and after splenopancreatic mobilisation. The splenorenal ligament fold is preserved on the spleen

it by monofilament suture to the diaphragm. Consequently, we applied the same technique to the following patients.

Then, the cleavage plane beneath the corporeal-caudal pancreas and the anterior fascia of the left kidney is entered. Entering the plane below the kidney fascia which might result in injury to the adrenal gland and/or renal vein.

The spleen and corporeocaudal pancreas are then mobilised (*Fig. 2*).

The polar vessels of the spleen which are quite short and maintain the concavity of the visceral aspect of the organ are transected between ligatures in most of the cases (*Figs. 3, 4*).

Subsequently, the spleen becomes easily maneuvrable, especially regarding its polar regions, by losing its cumbersome concavity which tightens it onto the central hilum.

The hilum is now readily accessible on both anterior and posterior sides, and the lymphadenectomy is no longer impaired by the splenic concavity. The ganglia and the fat tissue between the splenic hilum vessels branches are removed, both from anterior and posterior to the hilum, the space in between the splenic and the pancreatic capsule being treated in its totality.

Lymphadenectomy is then performed on the splenic artery and vein, up to the celiac trunk, using sharp dissection and electro-

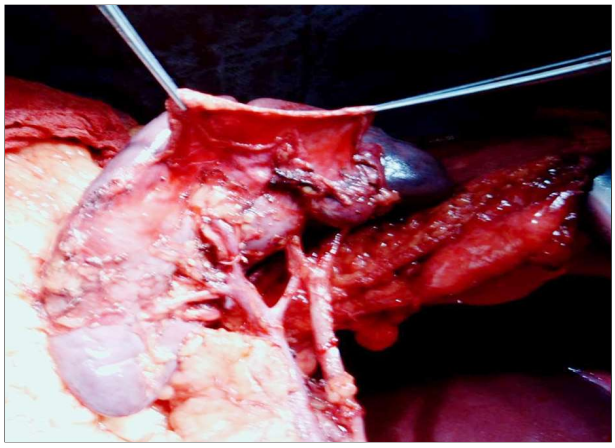

Figure 2. The preserved splenorenal ligament fold holds perfectly the weight of the lymphadenectomized spleen

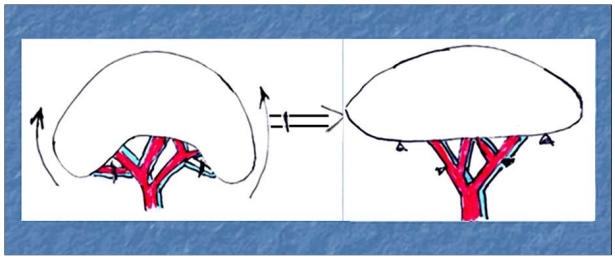

Figure 3. Before and after transecting the polar vessels of the spleen – the concavity no longer impairs the hilar dissection

cautery, in an atraumatic manner. All the fat tissue with the lymph nodes are removed from the splenic vessels and the distal pancreas, both anteriorly and posteriorly. The left gastroepiplooic vessels are ligated at their origin (*Fig. 5*) and care is taken to identify and

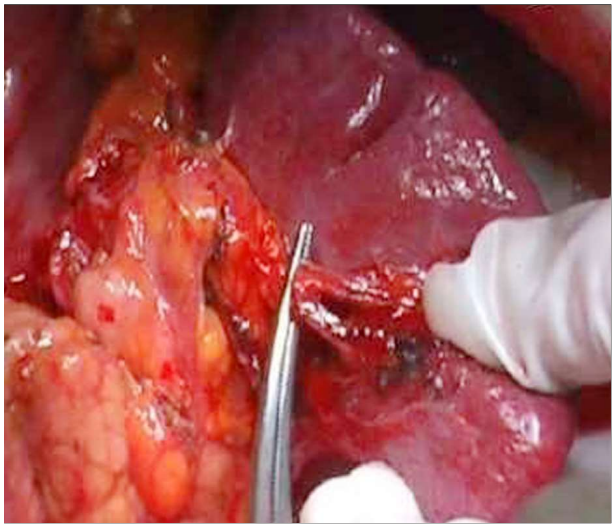

Figure 4. Transecting the polar vessels – intraoperative aspect

preserve the artery for the pancreatic cauda.

The artery for the pancreatic cauda was found to originate from either the splenic artery, the gastroepiplooic artery or a hilar artery branch (*Figs. 5-8*).

Generally, two tipes of hilar anatomy are encountered:

- simple anatomy, with long distal splenic vessels and scarce ramifications (*Fig. 9*);
- Difficult anatomy, with short distal splenic vessels and dense ramifications (*Fig. 10*);

Small decapsulations occured during three out of the first 10 cases, requiring hemosthasis (*Fig. 11*).

In the venous branches of the hilum small openings were rarely produced during dissection, being repaired with 7-0 polypropylene sutures. The spleen and corporeocaudal pancreas are very easy to handle in this Ex-situ manner.

The limits of the hilum lymphadenectomy are the splenic and the pancreatic capsule, respectively, with no risk of it being incomplete with the splenopancreatic complex mobilized. Hilum lymphadenectomy is carried on by sharp dissection and electrocautery on both aspects until only the vascular branches entering the splenic parenchyma remain (*Fig. 12*).

The lymphadenectomy is carried on easily for stations 11p and 11d, both anteriorly and posteriorly, being facilitated by the spleno-pancreatic mobilization, up to the celiac artery origin from the aorta (*Fig. 13*).

In the end, the spleno-pancreatic complex is attached back in place through an X-suture of the preserved spleno-renal ligament fold to the diaphragm (*Figs. 14, 15*).

We do believe that splenic fixation along with intra-abdominal pressure contributes to holding the spleen into its new position,

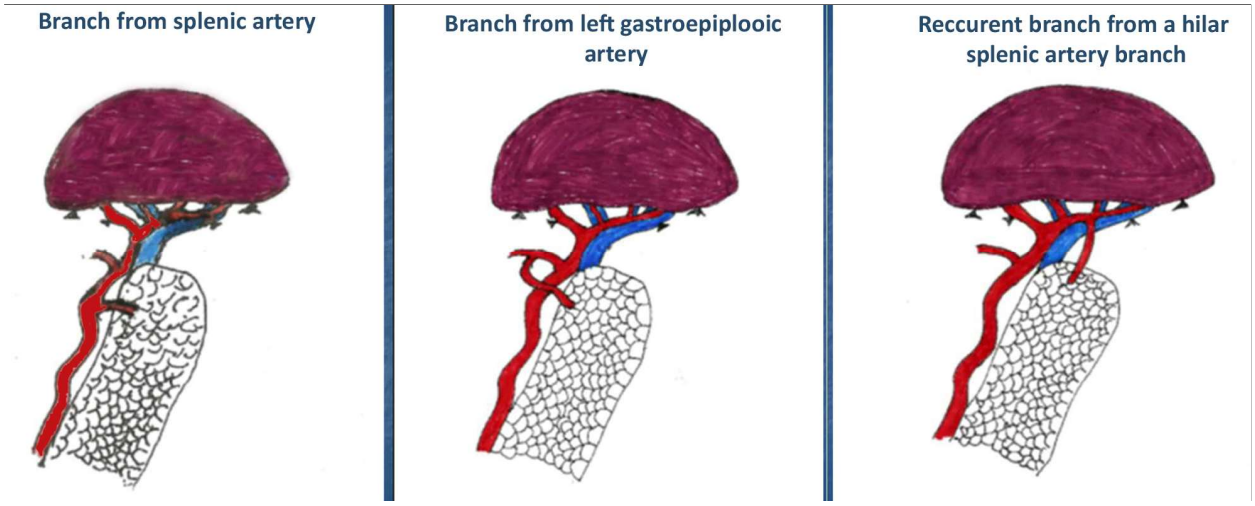

Figure 5. Variants of the pancreatic caudal artery

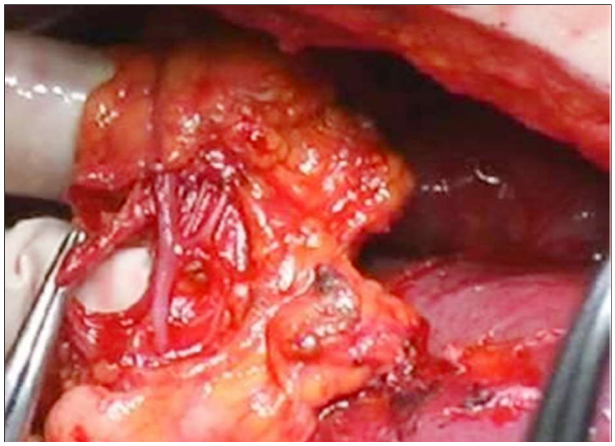

Figure 6. Pancreatic caudal artery from the gastroepiplooic

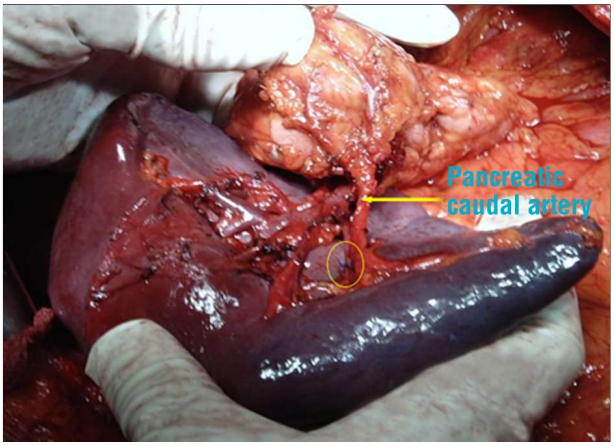

Figure 7. Pancreatic caudal artery from the splenic hilum. Encircled – a repaired veinous branch

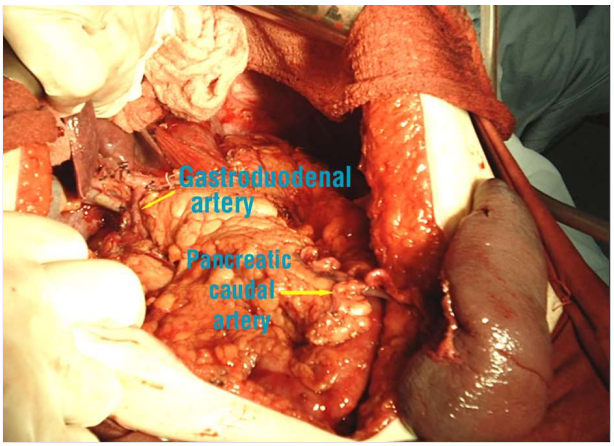

Figure 8. Pancreatic caudal artery from the splenic artery

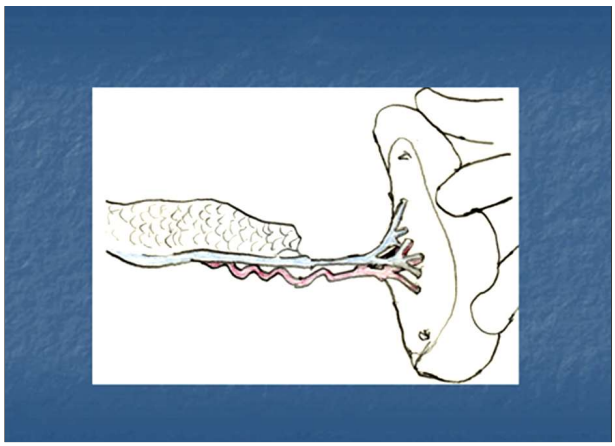

Figure 9. Simple anatomy

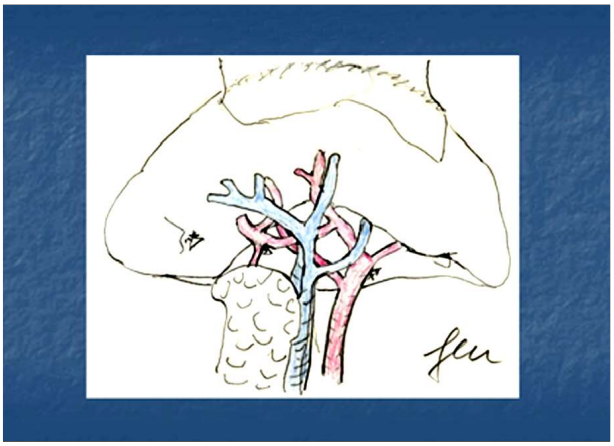

Figure 10. Difficult anatomy

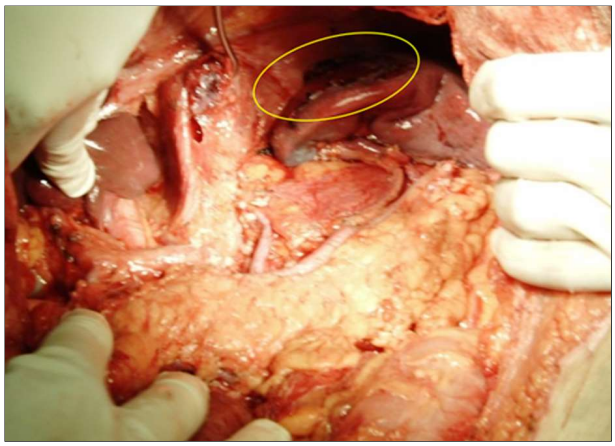

Figure 11. Capsular lesion of the spleen after hemosthasis

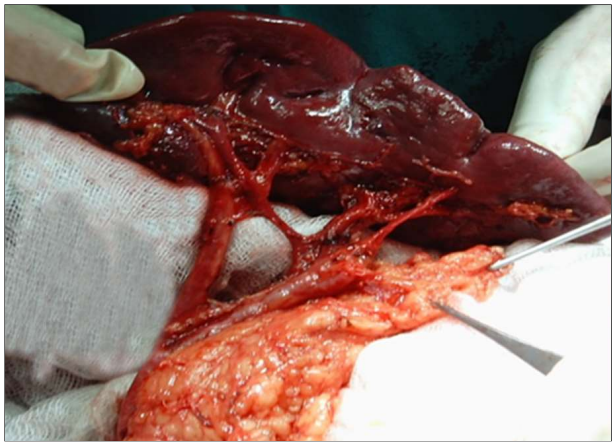

Figure 12. Only the vascular branches entering the splenic parenchyma remain

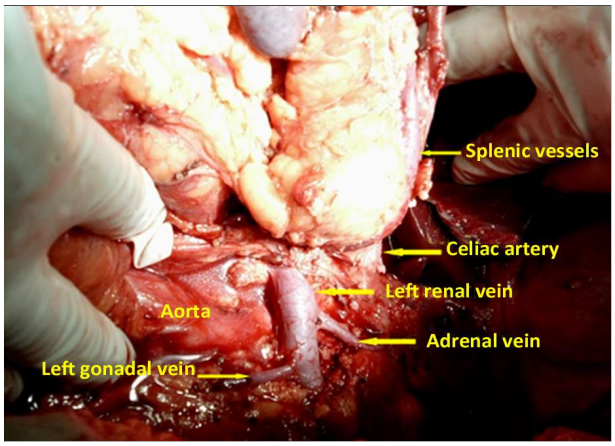

Figure 13. The splenopancreas and the vessels – aspect at the end of the dissection

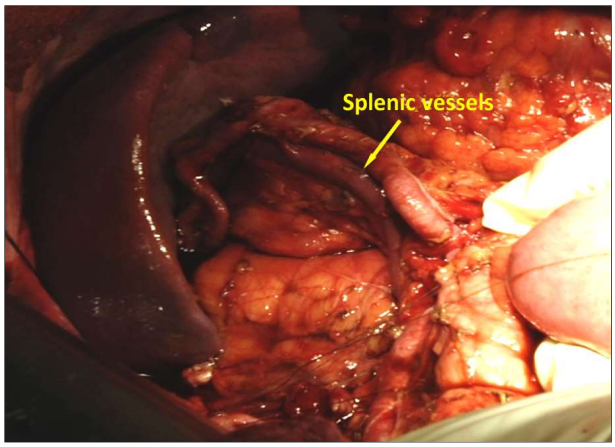

Figure 14. Final aspect with the spleen resewn to the diaphragm

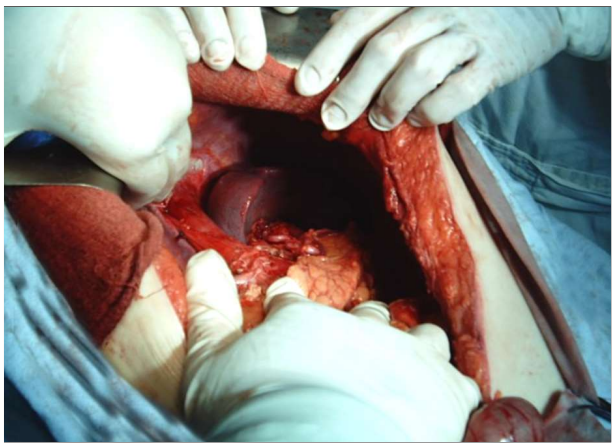

Figure 15. Final aspect with the spleen resewn to the diaphragm

Figure 16. Postop CT scan showing the spleen displaced postero-medially after being resewn to the diaphragm, 15 yrs after radical D2 total gastrectomy with splenic preservation

nearer to the midline than compared to the preoperative position, close to the esojejunal anastomosis (*Fig. 16*).

Results

In between 2002 – 2023, all the author's patients meeting the eligibility criteria were operated upon using this technique. All patients presented with advanced gastric cancer of the upper two thirds of the stomach. All patients underwent total gastrectomy by open approach.

In 43 consecutive cases no splenectomy for hemosthasis was necessary. No spleen migrated, the attachment to the diaphragm via the preserved splenorenal ligament fold was effective, no mechanical intra-abdominal complications occurred. Transecting the polar vessels was necessary in 41 out of the 43 procedures (95%). All spleens proved to be functional and viable postoperatively in Doppler ultrasonography until six months. No splenic infarctions were encountered. Minimal capsular splenic lesions occurred in 3 of the first 10 cases (3 out of 43, i.e. 7%), hemostasis being achieved without splenectomy.

Operation time: in between 20 minutes in cases with simple anatomy to one hour in cases with dificult anatomy. Blood loss was minimal in the cases without splenic decapsulation, maximum 300 ml in the three cases of splenic decapsulation. The hilar limph nodes count provided values between 2 and 6, with a mean of three. They were not analyzed separately. The hospital stay was between 14and 52 days.

Reoperations were necessary for surgical wound breakdown in 5 patients. One duodenal stump fistula healed without reoperation. Massive stroke occurred in one, bronchopnaeumonia in five cases, miocardial infarction in one case. Two patients died in hospital, one of massive stroke and one of miocardial infarction. The two had uneventful surgeries. No other 90 days deaths were noted.

The patients were operated upon in several centers. Pertinent follow-up and survival data were not available. One patient with G2 adenocarcinoma with multiple lymph node metastasis on the greater curvature operated upon in April 2008 was found still alive and well, without reccurence.

Discussion

The benefits of splenic preservation are of immunologic nature and do have impact in terms of oncological patients' survival.

Open approach still has an important role in gastric cancer surgery, especially in advanced cancer cases.

Historically, distal pancreatectomy with splenectomy was considered a necessary gesture in advanced gastric cancer surgery with D2 lymphadenectomy, attitude from which arise the disadvantages of diabetes mellitus and pancreatic leakage (28).

Later on, the authors developed a technique with preservation of the pancreas (29).

Sacrificing the spleen for oncological radicality reasons did not prove expected benefits. Preserving it without performing lympha-denectomy within its hilum and retropancreatic territory was reported to provide better results (30).

What was done in cases of upper two thirds gastric cancer according to the gastric cancer guidelines in Japan was to perform a D2 lymphadenectomy leaving in place the ganglia from the splenic hilum and the retropancreatic territory, referred to as D2-10, based upon the non inferiority of the splenic preservation or, if associating splenectomy, D2 (31,32).

The complete clearance of no. 10 nodes was previously recommended for potentially curable T2-T4 tumors invading the greater curvature of the upper stomach.

The non-inferiority of the splenic preservation was acknowledged. The splenic preservation without no. 10 lymphadenectomy was compulsory downgraded from D2 to D2 minus 10 (31,32).

Since the 5th edition of the Japanese Gastric Cancer Guidelines, the no. 10 lymph nodes were removed from the D2 lymphadenectomy, their inclusion being considered a non-standard gastrectomy, with a lymph node

dissection considered to be performed beyond D2, namely D2 + (33,34).

This does not remove the the no. 10 lymph nodes from the perigastric regional lymph flow nor makes them distant lymphatic structures. Metastasis to station 10 occurs frequently; hence, it cannot be defined as an M1 stage.

In proximal gastric cancer operated radically (according to the former D2 with splenectomy) the metastasis rate in the splenic hilum was 20.9% in one study, 24% in another one (35,36).

The station 10 metastasis rate according to the tumor location and staging was 27% for the posterior wall, 38.5% for the greater curvature, 22.8% for the circumferential involvement, 23.6% for the serosal involvement and 40% in tumors invading the adjacent structures, with a total of 15.4% hilar metastasis with splenectomy performed for no. 10 lymphadenectomy by the former D2 technique (4).

Lymphangiograms confirmed the appartenency of the splenic hilar nodes to the lymph flow of the upper two thirds of the stomach, especially the posterior gastric wall and the greater curvature, no. 10 metastasis being also frequent in circumferential involvement (4).

9.8% of station 10 metastasis were found in advanced cancer (UICC IIIb/IV), with increased frequency in tumors of the greater curvature and of Borrmann type IV cancer (37).

Splenic preservation without no. 10 lymphadenectomy may be followed by reccurence (38). Preserving the spleen with lymphadenectomy of stations 10, 11p and 11d appeared as a logical development in this context.

An In-situ technique was described in 2002, removing lymph nodes of the anterior aspect of the hilum (7,8). Uyama reported 5 cases in 1996, performed with en bloc mobilizing the spleen and the left kidney. Dissection was performed by an ultrasonic device (6).

Spleen-preserving splenic hilar lymphadenectomy performed for a high-priority group (defined as with tumor invading the greater curvature, patients with a tumor size>5 cm, circumferential involvement and clinically positive locoregional lymph nodes) by minimally invasive approach appeared to provide better survival than patients treated by D2 without no. 10 lymphadenectomy (39-41).

Locally advanced gastric cancer cases (i.e. invading deeper than the muscularis propria and causing large tumors) are difficult to handle with minimally invasive surgery; this approach is controversial in such cases; when dealt with by minimally invasive approach, locally advanced gastric cancer appeared to be a factor of nature to independently increase the complications rate (42,43).

The latest gastric cancer Japanese reccomendations favour laparoscopy for early distal gastric cancer as one of the standard treatment options, based upon its demonstrated non-inferiority (44,45).

Robotic gastrectomy was performed successfully in advanced gastric cancer cases (46).

However, minimally invasive total or proximal gastrectomy is weakly recommended in the current Japanese guidelines which inferres that open surgery maintains an important role in upper two thirds gastric cancer surgery (47,48).

Spleen-preserving splenic hilum lymphadenectomy gradually came into discussion; however, due to the splenic anatomy and its vascular complexity, open spleen-preserving splenic hilum lymphadenectomy is considered to still pose great challenges and require expert skills (49).

Conversion rate is not detailed in the multiple laparoscopy splenic hilum lymphadenectomy articles neither is the attitude (i.e. carrying on with spleen preserving station 10 lymphadenectomy by open aproach or giving up splenic preservation) if conversion were to be required (12-18).

Ex-situ dissections were found to harvest more lymph nodes than In-situ dissections (8-10).

Ex-situ dissections were found to be safer than splenectomies and more adapted to cases of later-stage disease, with superior effectiveness in lymphadenectomy than In-situ technique (9). The reported operation time

was longer (10). Compared with pancreas preserving + splenectomy and pancreas and spleen resections station 10 lymphadenectomies, Ex-situ spleen preserving station 10 dissections proved safer and showed better 5 years survival, with the same number of harvested lymph nodes (8).

The surgery is performed under direct vision enabling the easier removal of the lymphatic structures posterior to the splenic hilum and distal pancreas with better control should bleeding occur (10). It is considered to require high level operative skills and also feared to induce a potential risk of postoperative torsion of the splenic pedicle, i. e. an iatrogenic hipermobile (wandering) spleen (10).

Prophilactic no. 10 lymphadenectomy with splenic preservation did not improve long-term survival in a study (50).

The usefulness of the no. 10 lymphadenectomy with splenic preservation was underlined in a high priority group of patients, with the following characteristics: tumors larger than 5 cm, evident regional lymph node metastasis, circumferential involvement and greater curvature involvement (51,52).

A wider use of the spleen-preserving no. 10 lymph node dissection is foreseen to become part of the surgical armamentarium in the Western world as well, as the West has gradually adopted the Asian standards in the past for gastric cancer (53).

We used an effective inexpensive Ex-situ technique of preserving both the spleen and the distal pancreas along with the splenic artery and vein. We used monopolar and bipolar electrocautery.

The operation time was detailed above. The initial part of this spleen preserving technique is similar to the station 10 lymphadenectomy with splenectomy technique, namely the splenopancreatic mobilisation. This enables the surgical team to carry on with splenectomy, should problems impeding preservation arise (54).

An Ex-situ approach comes indeed with the problem of an extremely mobile spleen needing to be reintegrated into the abdomen.

There are few reports regarding the manner in which the splenopancreatic complex is reattached in the abdomen to avoid torsion or migration.

Neither a “peritoneal pillowcase”, a mesh nor a ”retroperitoneal pocket” (55-57) were used by us as the splenorenal fold suture appears to be at hand, simple and effective.

This provided an effective splenopexy with technical simplicity in the end of the procedure, which avoided the postoperative wandering spleen.

The splenorenal fold we always preserved allowed reattaching the spleen which, in the end, is nearer to the esophagus and the midline since it is sutured to the upper posterior left hemidiaphragm. This detail is of nature to solve the splenic hypermobility issue in our experience.

Since minimally invasive surgery is not yet the standard of surgical care, the lymphadenectomy of station 10 by open technique without splenic and/or pancreatic sacrifice deserves to be integrated in the surgical armamentarium for selected cases.

Aditionally, in minimally invasive gastric cancer surgery reports we found no data regarding the attitude in cases of conversion (12-18).

Minimally invasive approaches offer excellent vision, magnification and they adress the posterior hilar lymph nodes as well as the Ex-situ open technique, but without requiring splenopancreatic mobilisation (15,16).

On the other hand, they require more important resources, especially robotic approach.

Changing a surgical approach with another if the situation requires, namely minimally invasive with open, should not alter the objectives of the intervention.

Or, the attitude if conversion were to be required is not mentioned in the minimally invasive spleen preserving no. 10 lymphadenectomy reports.

If the reason for conversion were not to be important splenic bleeding, spleen preserving no. 10 lymph node dissection could be carried on by open approach using an Ex-situ

technique. We believe this approach may be useful in order to carry on with the dissection of station 10 without splenic sacrifice in minimally invasive cases requiring conversion.

Conclusions

The above-presented technique was useful in the surgical treatment of advanced cases of gastric cancer by open approach. We think it integrates within the arsenal of splenic preservation techniques, bringing in the advantages of splenic vessels conservation along with the spleen, and radical stations' 10, 11p and 11d. lymphadenectomy as well. We do believe that polar vessels' transection along with the splenorenal fold use to reattach the mobilized organ simplifies a lot of the concerns with the Ex-situ approach.

We recommend the use of this technique in any gastric cancer localization which requires lymphadenectomy within the distal pancreatic and splenic territory, with the advantage of oncological radicality without need of spleen and splenic vessels sacrifice.

Conflict of Interest

The author declares no conflict of interest.

References

1. Sano T, Sasako M, Mizusawa J, Yamamoto S, Katai H, Yoshikawa T, et al. Randomized Controlled Trial to Evaluate Splenectomy in Total Gastrectomy for Proximal Gastric Carcinoma. Ann Surg. 2017;265(2):277-283.
2. Yu W, Choi GS, Chung HY. Randomized clinical trial of splenectomy versus splenic preservation in patients with proximal gastric cancer. Br J Surg. 2006;93(5):559-63.
3. Fatouros M, Roukos DH, Lorenz M, Arampatzis I, Hottentrott C, Encke A, et al. Impact of spleen preservation in patients with gastric cancer. Anticancer Res. 2005;25(4):3023-30.
4. Sasada S, Ninomiya M, Nishizaki M, Harano M, Ojima Y, Matsukawa H, et al. Frequency of lymph node metastasis to the splenic hilus and effect of splenectomy in proximal gastric cancer. Anticancer Res. 2009;29(8): 3347–51.
5. Vasilescu C, Trandafir B. Current problems in surgical oncology 2. A lesson from Japan. D2 lymphadenectomy in gastric cancer. Chirurgia (Bucur). 2011; 106(2):163-70. Romanian
6. Uyama I, Ogiwara H, Takahara T, Kikuchi K, Iida S, Kubota T, et al. Spleen- and pancreas-preserving total gastrectomy with superextended lymphadenectomy including dissection of the para-aortic lymph nodes for gastric cancer. J Surg Oncol. 1996;63(4):268-70.
7. Schwarz RE. Spleen-preserving splenic hilar lymphadenectomy at the time of gastrectomy for cancer: technical feasibility and early results. J Surg Oncol. 2002;79(1):73-6.
8. Qin H, Lin C. Radical resection of gastric carcinoma with pancreas and spleen preservation and functional cleaning of lymph nodes. Chin Med J (Engl). 2002;115(5):736-9.
9. Ji X, Fu T, Bu ZD, Zhang J, Wu XJ, Zong XL, et al. Comparison of different methods of splenic hilar lymph node dissection for advanced upper- and/or middle-third gastric cancer. BMC Cancer. 2016;16(1):765.
10. Yang K, Lu ZH, Zhang WH, Liu K, Chen XZ, Chen XL, et al. Comparisons between different procedures of no. 10 lymphadenectomy for gastric cancer patients with total gastrectomy. Medicine (Baltimore). 2015;94(33):e1305.
11. Li C, Kim S, Lai JF, Oh SJ, Hyung WJ, Choi WH, et al. Lymph node dissection around the splenic artery and hilum in advanced middle third gastric carcinoma. Eur J Surg Oncol. 2009;35(7):709-14.
12. Hyung WJ, Lim JS, Song J, Choi SH, Noh SH. Laparoscopic spleen-preserving splenic hilar lymph node dissection during total gastrectomy for gastric cancer. J Am Coll Surg. 2008;207(2):e6-11.
13. Sakuramoto S, Kikuchi S, Futawatari N, Katada N, Moriya H, Hirai K, et al. Laparoscopy-assisted pancreas- and spleen-preserving total gastrectomy for gastric cancer as compared with open total gastrectomy. Surg Endosc. 2009;23(11):2416-23.
14. Okabe H, Obama K, Kan T, Tanaka E, Itami A, Sakai Y. Medial approach for laparoscopic total gastrectomy with splenic lymph node dissection. J Am Coll Surg. 2010;211(1):e1-6.
15. Li Y, Wang J. Station 10 lymph node dissections in laparoscopic-assisted spleen-preserving radical gastrectomy for advanced proximal gastric cancer. Chin J Cancer Res. 2013;25(4):465-7.
16. Huang CM, Chen QY, Lin JX, Zheng CH, Li P, Xie JW. Huang's three-step maneuver for laparoscopic spleen-preserving No. 10 lymph node dissection for advanced proximal gastric cancer. Chin J Cancer Res. 2014;26(2): 208-10.
17. Huang CM, Huang ZN, Zheng CH, Li P, Xie JW, Wang Jb, et al. Huang's three-step maneuver shortens the learning curve of laparoscopic spleen-preserving splenic hilar lymphadenectomy. Surg Oncol. 2017;26(4): 389-394.
18. Ma Z, Shi G, Chen X, Zhao S, Yang L, Ding W, et al. Laparoscopic splenic hilar lymph node dissection for advanced gastric cancer: to be or not to be. Ann Transl Med. 2019;7(14):343.
19. Van Wyck DB. Overwhelming postsplenectomy infection (OPSI): the clinical syndrome. Lymphology. 1983;16(2):107-14.
20. Leonard AS, Giebink GS, Baesl TJ, Krivit W. The overwhelming post-splenectomy sepsis problem. World J Surg. 1980;4(4):423-32.
21. King H, Shumacker Jr HB. Splenic studies. I. Susceptibility to infection after splenectomy performed in infancy. Ann Surg. 1952;136(2):239-42.
22. Cullingford GL, Watkins DN, Watts AD, Mallon DF. Severe late post-splenectomy infection. Br J Surg. 1991;78(6):716-21.
23. Schwartz PE, Sterioff S, Mucha P, Melton LJ, Offord KP. Postsplenectomy sepsis and mortality in adults. JAMA. 1982;248(18):2279-83.
24. Kimura W, Inoue T, Futakawa N, Shinkai H, Han I, Muto T. Spleen-preserving distal pancreatectomy with conservation of the splenic artery and vein. Surgery. 1996;120(5):885-90.
25. Shoup M, Brennan MF, McWhite K, Leung DH, Klimstra D. Conlon KC.The value of splenic preservation with distal pancreatectomy. Arch Surg. 2002; 137(2):164-8
26. Warshaw AL. Conservation of the spleen with distal pancreatectomy. Arch Surg. 1988;123(5):550-3.
27. Schein M, Freunkel W, D'Egidio A. Splenic conservation in distal pancreatic injuries: stay away from the hilum! J Trauma. 1991;31(3):431.
28. Maruyama K, Okabayashi K, Kinoshita T. Progress in gastric cancer surgery in Japan and its limits of radicality. World J Surg. 1987;11(4):418-25.
29. Maruyama K, Sasako M, Kinoshita T, Sano T, Katai H, Okajima K. Pancreas-preserving total gastrectomy for proximal gastric cancer. World J Surg. 1995;19(4):532-6.
30. Sano T, Sasako M, Mizusawa J, Yamamoto S, Katai H, Yoshikawa T, et al. Randomized controlled trial to evaluate splenectomy in total gastrectomy for proximal gastric carcinoma. Ann Surg. 2017;265(2):277-283.
31. Japanese Gastric Cancer Association. Japanese gastric cancer treatment guidelines 2010 (ver. 3). Gastric Cancer. 2011;14(2):113-23.
32. Japanese Gastric Cancer Association. Japanese gastric cancer treatment

guidelines 2014 (ver. 4). Gastric Cancer. 2017;20(1):1-19.
33. Japanese Gastric Cancer Association. Japanese gastric cancer treatment guidelines 2018 (5th edition). Gastric Cancer. 2021;24(1):1-21.
34. Japanese Gastric Cancer Association. Japanese Gastric Cancer Treatment Guidelines 2021 (6th edition). Gastric Cancer. 2023;26(1):1-25.
35. Ikeguchi M, Kaibara N. Lymph node metastasis at the splenic hilum in proximal gastric cancer. Am Surg. 2004;70(7):645-8.
36. Sakaguchi T, Sawada H, Yamada Y, Fujimoto H, Emoto K, Takayama T, et al. Indication of splenectomy for gastric carcinoma involving the proximal part of the stomach. Hepatogastroenterology. 2001;48(38):603-5.
37. Mönig SP, Collet PH, Baldus SE, Schmackpfeffer K, Schröder W, Thiele J, et al. Splenectomy in proximal gastric cancer: frequency of lymph node metastasis to the splenic hilus. J Surg Oncol. 2001;76(2):89-92.
38. Nishino M, Okano M, Hoshino H, Kawada J, Okuyama M, Kim Y, et al. A case of splenic-hilum lymph node recurrence after spleen preserving total gastrectomy for gastric cancer following neoadjuvant chemotherapy. Gan To Kagaku Ryoho. 2016; 43(12):2222-2224. Japanese
39. Zhong Q, Chen QY, Xu YC, Zhao G, Cai LS, Li GX, et al. Reappraise role of No. 10 lymphadenectomy for proximal gastric cancer in the era of minimal invasive surgery during total gastrectomy: a pooled analysis of 4 prospective trial. Gastric Cancer. 2021;24(1):245-257.
40. Huang CM, Chen T, Lin JX, Chen QY, Zheng CH, Li P, et al. The effects of laparoscopic spleen-preserving splenic hilar lymphadenectomy on the surgical outcome of proximal gastric cancer: a propensity score-matched, case-control study. Surg Endosc. 2017;31(3):1383-1392.
41. Yang K, Zhang WH, Chen XZ, Chen XL, Zhang B, Chen ZX, et al. Survival benefit and safety of no. 10 lymphadenectomy for gastric cancer patients with total gastrectomy. Medicine (Baltimore). 2014;93(25):e158.
42. Kodera Y, Yoshida K, Kumamaru H, Kakeji Y, Hiki N, Etoh T, et al. Introducing laparoscopic total gastrectomy for gastric cancer in general practice: a retrospective cohort study based on a nationwide registry database in Japan. Gastric Cancer. 2019;22(1):202-213.
43. Roh CK, Lee S, Son SY, Hur H, Han SU. Risk factors for the severity of complications in minimally invasive total gastrectomy for gastric cancer: a retrospective Cohort Study. J Gastric Cancer. 2021;21(4):352-367.
44. Kim H-H, Han S-U, Kim M-C, Kim W, Lee HJ, Ryu SW, et al. Effect of laparoscopic distal gastrectomy vs open distal gastrectomy on long-term survival among patients with stage I gastric cancer: the KLASS-01 randomized clinical trial. JAMA Oncol. 2019;5(4):506-513.
45. Katai H, Mizusawa J, Katayama H, Morita S, Yamada T, Bando E, et al. Survival outcomes after laparoscopy-assisted distal gastrectomy versus open distal gastrectomy with nodal dissection for clinical stage IA or IB gastric cancer (JCOG0912): a multicentre, non-inferiority, phase 3 randomised controlled trial. Lancet Gastroenterol Hepatol. 2020;5(2):142-151.
46. Vasilescu C, Procopiuc L. Robotic surgery of locally advanced gastric cancer: a single-surgeon experience of 41 cases. Chirurgia (Bucur). 2012; 107(4):510-7.
47. Japanese Gastric Cancer Association. Japanese Gastric Cancer Treatment Guidelines 2021 (6th edition). Gastric Cancer. 2023;26(1):1-25.
48. Japanese Gastric Cancer Association. Japanese gastric cancer treatment guidelines 2018 (5th edition). Gastric Cancer. 2021;24(1):1-21.
49. Ji X, Fu T, Bu ZD, Zhang J, Wu XJ, Zong XL, et al. Comparison of different methods of splenic hilar lymph node dissection for advanced upper- and/or middle-third gastric cancer. BMC Cancer. 2016;16(1):765.
50. Oh YJ, Kim DH, Eom BW, Yoon HM, Kim YW, Ryu KW. Is splenic hilar lymph node dissection without splenectomy essential for proximal advanced gastric cancer?. Ann Surg Oncol. 2021;28(13):8952-8961.
51. Zhong Q, Chen QY, Xu YC, Zhao G, Cai LS, Li GX, et al. Reappraise role of No. 10 lymphadenectomy for proximal gastric cancer in the era of minimal invasive surgery during total gastrectomy: a pooled analysis of 4 prospective trial. Gastric Cancer. 2021;24(1):245-257.
52. Guner A, Hyung WJ. Advantages of splenic hilar lymph node dissection in proximal gastric cancer surgery. J Gastric Cancer. 2020;20(1):19-28.
53. Greer JB. Less than ten: defining the role of splenic hilar lymph node dissection in gastric cancer. Ann Surg Oncol. 2023;30(7):3869-3870.
54. Vasilescu C. D3 lymphatic dissection in surgery for gastric cancer. Chirurgia (Bucur). 2007;102(3):327-30. Romanian
55. Appu S, Young AB, Lawrentschuk N. Peritoneal "pillowcase" for the displaced spleen post-distal pancreatectomy. Appu S; Young AB; Lawrentschuk N. J Hepatobiliary Pancreat Surg. 2005;12(6):470-3.
56. Hedeshian MH, Hirsh MP, Danielson PD. Laparoscopic splenopexy of a pediatric wandering spleen by creation of a retroperitoneal pocket. J Laparoendosc Adv Surg Tech A. 2005;15(6):670-2.
57. Ganarin A, Fascetti Leon F, La Pergola E, Gamba P. Surgical approach of wandering spleen in iInfants and children: a systematic review. J Laparoendosc Adv Surg Tech A. 2021;31(4):468-477.