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CASE REPORT / ПРИКАЗ БОЛЕСНИКА

# Radical antegrade modular pancreatosplenectomy – report of two cases and review of the literature

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**SUMMARY**

**Introduction** The radical antegrade modular pancreatosplenectomy (RAMPS) procedure was introduced as a modification of standard retrograde pancreatosplenectomy (SRPS). It was designed to establish a new surgical approach, with intension to increase possibility of achieving negative posterior (retroperitoneal) resection margin, as well as to provide complete N1 lymph node clearance.

**Outline of cases** We present two cases with diagnosed left-sided pancreatic tumors, who were surgically treated in our hepato-pancreato-biliary department. Both patients underwent posterior RAMPS procedure. Postoperative course was uneventful in both patients.

**Conclusion** RAMPS is a safe procedure because it provides complete vascular and bleeding control. It is a superior procedure in oncologic terms compared to SRPS, as it increases the rate of R0 resection, and provides larger number of lymph nodes harvested. Furthermore, RAMPS is associated with better overall survival.

**Keywords:** pancreatic carcinoma; left-sided pancreatic tumors; distal pancreatectomy; RAMPS

## INTRODUCTION

Pancreatic cancer is one of the most lethal and aggressive tumors in human pathology, with median survival of 3–6 months in untreated cases, and a five-year survival rate that ranges 6–9% [1, 2]. Left-sided pancreatic cancer is often asymptomatic and more commonly diagnosed at an advanced stage. Surgical resection, often combined with chemo- and/or radiation therapy, is the only method which gives a chance of curing this disease. The first distal pancreatic resection was performed by Trendelenburg in 1882, and was standardized by Mayo in 1913 [3]. It is now well understood and widely accepted that R0 resection is the key factor in the improvement of the long-term survival [4]. Therefore, it has always been a goal and a challenge for pancreatic surgeons to increase the rates of R0 resections and reduce the recurrence rates. RAMPS procedure was designed as an answer to those tendencies in modern pancreatic surgery. It has been performed since 1999 and established by Strasberg et al. [5] as a novel technique in 2003. The three main principles of the operation are N1 lymph node dissection, modular setting of the posterior plan of dissection to improve the probability to achieve negative posterior resection margins, and right-to-left dissection for early and optimal vascular/bleeding control. The posterior plane of dissection can be directly on the left adrenal gland and Gerota's fascia (anterior RAMPS) or can be posterior to the adrenal and Gerota's fascia (posterior RAMPS), depending on the extent of penetration of the tumor on computed tomography (CT) scan (Figure 1). This new procedure and technique has shifted focus from pancreatic head tumors to less frequent but equally aggressive and even more sinister left-sided pancreatic tumors.

## REPORT OF CASES

### Patient 1

A 66-year-old female patient was admitted to our hospital for upper abdominal pain and discomfort, followed by a weight loss of around 10 kg for the last two months. Laboratory findings and tumor-marker serum levels (CEA, CA 19-9) were within the reference range. Abdominal multi-detector computed tomography (MDCT) and magnetic resonance imaging (MRI) detected a large tumor mass (65 × 35 × 45 mm) located in the tail of the pancreas with involvement of the greater curve of the stomach, the spleen, and the left adrenal gland, after which a final decision for surgical resection was made (Figure 2).

The patient underwent posterior RAMPS with wedge resection of the greater curve of the stomach (Figure 3).

It was the very first RAMPS performed at the Clinical Center of Serbia in Belgrade. The

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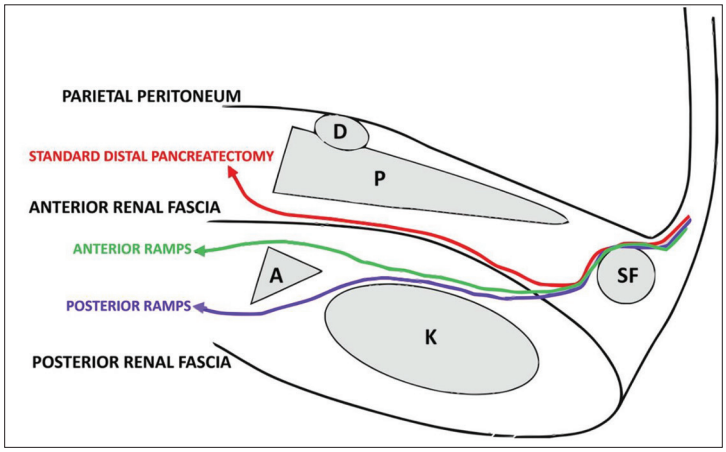


**Figure 1.** Left retroperitoneum plane of posterior margin of the radical antegrade modular pancreatosplenectomy procedure; A – left adrenal gland; SF – splenic flexure of colon; D – fourth part of duodenum; K –left kidney; P – pancreas

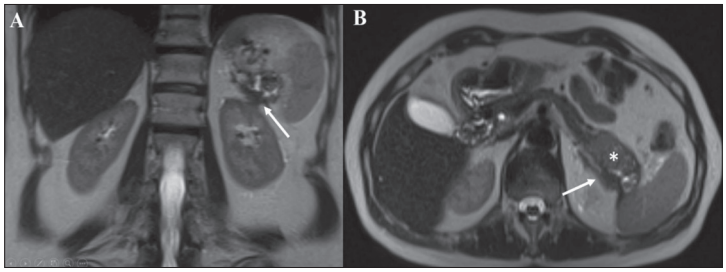


**Figure 2.** Coronal T2-weighted magnetic resonance image (A) shows propagation of the pancreatic tail tumor in perirenal fat plane with infiltration of the renal capsule (arrow); axial T2-weighted MR image in the same patient (B) shows infiltration of the left adrenal gland (arrow); the pancreatic tail tumor is shown on B (asterisk)

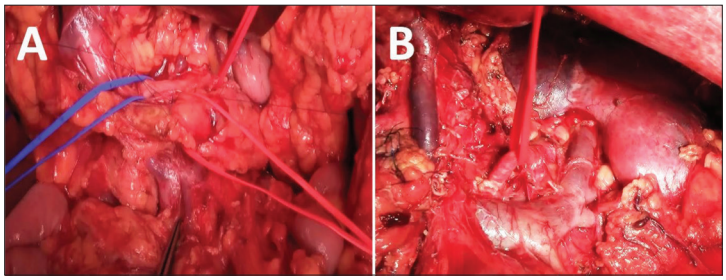


**Figure 3.** A) Early vascular control; B) retroperitoneal plane after removal of the specimen

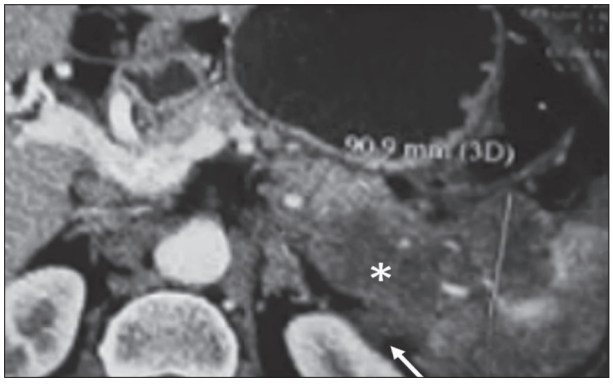

**Figure 4.** Coronal reformatted computed tomography image in the late arterial phase shows a large tumor (asterisk) with infiltration of the perirenal fat on the left adrenal capsule (arrow); also note infiltration of the hilus of the spleen with consequent infarction of the splenic parenchyma

procedure lasted around 250 minutes and no blood transfusions were given. The histopathologic analysis revealed a ductal invasive adenocarcinoma. The postoperative course was uneventful and the patient was discharged from the hospital after 11 days. Regular check-ups were scheduled for every three months during the first postoperative year. The patient received adjuvant chemotherapy (gemcitabine). One year after surgery, three liver metastases were detected on MDCT of the abdomen, two of which in the right liver lobe and one in the left. Palliative chemotherapy treatment was started. Three months later, multiple pulmonary metastases were detected with chest CT, and three months later the patient died from hepatic failure in the terminal stage of the malignant disease.

### Patient 2

The other patient was a 64-year-old female who was admitted after a large tumor (45 × 35 × 32 mm) was detected in the tail of the pancreas with abdominal MDCT and MRI. Imaging techniques showed extrapancreatic tumor propagation with infiltration of the splenic artery, splenic hilum, left adrenal gland, and superior pole of the left kidney (Figure 4). Tumor-marker CA 19-9 serum level was elevated with a value of 383 nmol/L. After a preoperative physical status assessment, a decision for a radical surgical procedure was made, and a patient underwent posterior RAMPS with left nephrectomy. Operative time was around 300 minutes and no blood transfusions were given. After histologic examination of the specimen by a pathologist, a diagnosis of pancreatic ductal invasive adenocarcinoma was established. Tumor stage was T3N1(3/27), and resection status was R1. The postoperative course was uneventful and the patient was discharged from the hospital on the 12th postoperative day. The patient is currently receiving the first course of adjuvant chemotherapy (gemcitabine).

All procedures performed involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

## DISCUSSION

Distal pancreatectomy is the standard surgical approach for left-sided pancreatic cancer. However, long-term survival of these patients remains unsatisfactory, with a median survival time of 10–28 months, and a five-year overall survival of 6–30% [6, 7]. In recent years, new surgical

approaches for resectable or borderline-resectable pancreatic head cancer, including the artery-first approach, superior mesenteric vein/portal vein resection and reconstruction, intraoperative radiotherapy and preoperative chemo-radiotherapy, have been increasingly combined with pancreaticoduodenectomy. Despite the highly aggressive nature of the disease, and early regional lymph node metastasis, adenocarcinomas of the body and tail of the pancreas have attracted significantly less clinical attention. However, in 2003, Strasberg et al. [5] described a new distal pancreatectomy technique, termed RAMPS, to achieve negative posterior resection margins and to remove the N1 lymph nodes completely. In the RAMPS procedure, the lymph nodes along the superior and inferior borders of the left-sided pancreas (10, 11, and 18 according to Japan Pancreas Society classification), the celiac lymph nodes (9) and nodes along the front and left side of superior mesenteric artery (14p, 14d) are considered N1 lymph nodes, and are completely removed. In the standard left-pancreatectomy, only lymph nodes 10, 11, and 18 are removed. Further, RAMPS is based on the anatomical architecture of the posterior pancreatic peritoneal fusion fascia (Gerota's fascia, Treitz' fascia, and Toldt's fascia). Using Kocher approaches, the inferior vena cava and the left renal vein along the Treitz' fascia level, behind the Gerota's fascia, the left renal vein, the renal capsule, and the left adrenal gland, are separated to achieve a complete resection of the nerve fiber connective tissue of the tail, the spleen, and lymph nodes, enhancing the rate of R0 resection of the posterior peritoneum.

In the past decade, the RAMPS procedure has been increasingly performed, particularly in Japan and Korea. Multiple studies from different centers have compared RAMPS to SRPS, evaluating postoperative complications, R0 resection rates, and long-term survival after each type of procedure [7, 8]. A large meta-analysis from 2019 compared RAMPS to SRPS [9]. Seven studies containing 474 patients have been enrolled in this meta-analysis, including 168 patients who underwent RAMPS and 306 patients who underwent SRPS. Three were prospective and four were retrospective studies. The studies were conducted in five countries, China, Italy, Japan, Korea, and the USA. The pooled analysis showed that RAMPS patients had better overall survival compared to the SRPS group of patients. This, however, did not apply to disease-free survival (DFS), which did not improve in the RAMPS patient group. Further, blood loss in the RAMPS group was significantly less than in the SRPS group, emphasizing the importance of early vascular control of major blood vessels in the RAMPS technique. Regarding the number of harvested lymph nodes, significantly more lymph nodes were harvested in the RAMPS than in the SRPS group. It is calculated that at least 21 lymph nodes should be removed and analyzed, to ensure a reliable assessment of the nodal status. Although it has been showed that extended lymphadenectomy does not improve survival, more harvested lymph nodes may result in more accurate node and tumor staging, thus more precisely identify the group of patients who could benefit from postoperative chemotherapy. Recurrence rate in the RAMPS group is significantly lower than that in the SRPS group. Since RAMPS uses a so-called "no-touch isolation technique," it is fair to assume that this might result in the reduction of distant tumor cells' spread. Surprisingly, this meta-analysis, in contrast to that of Cao et al. [10] from 2017, did not show any significant difference in R0 rate between the RAMPS and the SRPS patient groups. Meta-analysis and systemic review by Cao et al. [10] included six retrospective cohort studies with a total of 378 patients. RAMPS was done in 152 patients and 226 patients underwent standard procedure. In this study, R0 resection rates were significantly higher in the RAMPS group. However, no statistically significant difference between the groups was detected with respect to the recurrence rate. Furthermore, there was no significant difference regarding the OS rate between the two groups of patients, which also applies to the comparison of DFS between the groups. As expected, the number of lymph nodes harvested in RAMPS patients was significantly higher than in those in the standard group. Despite of higher multivisceral resection rate in RAMPS patients, incidence of postoperative complications did not increase. Also, there was no significant difference in the length of hospital stay, when comparing the two groups of patients [10]. RAMPS procedures required greater technical skills, as well as longer operative times, but not in the terms of statistical significance; RAMPS group exhibited a tendency towards improvement of a median survival but no improvement in recurrence rates. Also, DFS rates were similar in the two groups. It should be stated here that laparoscopic or robotic RAMPS have also been performed with satisfactory oncological results and survival outcomes [11, 12]. However, this approach should be limited to highly selective cases. Lee et al. [11] proposed Yonsei criteria by which only the following groups of patients should be treated with minimally invasive RAMPS: a) tumor confined to the pancreas, b) intact fascia layer between the distal pancreas and the left adrenal gland and kidney, and c) tumor is localized at least 1–2 cm from the celiac axis.

RAMPS is a safe surgical procedure providing superior vascular and bleeding control compared to SRPS. RAMPS is also a superior procedure in oncologic terms compared to SRPS since it increases the rate of R0 resections, and provides a larger number of lymph nodes harvested. Further, RAMPS does not increase the rates of postoperative complications. Also, there seemed to be an improvement in the overall survival with the RAMPS technique. However, further randomized controlled clinical trials of high quality are needed to draw more solid conclusions regarding the long-term survival benefit.

**Conflict of interest:** None declared.

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# Радикална антероградна модуларна панкреатоспленектомија – приказ два болесника и преглед литературе


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**САЖЕТАК**

**Увод** Радикална антероградна модуларна панкреатоспленектомија (РАМПС) уведена је као модификација стандардне ретроградне панкреатоспленектомије (СРПС). Осмишљена је као нови хируршки приступ са намером да се повећа могућност за постизање негативне постериорне (ретроперитонеалне) ресекционе маргине, као и са циљем комплетног уклањања свих лимфних нодуса *N*1.

**Прикази болесника** Приказујемо два болесника са туморима тела и репа панкреаса дијагностикованим мултидетекторском компјутеризованом томографијом и магнетном резонанцом која су оперисана на нашем одељењу за хепато-билио-панкреатичну хирургију. Код оба болесника урађен је задњи РАМПС. Постоперативни ток код оба болесника протекао је без компликација.

**Закључак** РАМПС је безбедна хируршка процедура зато што омогућава потпуну контролу васкуларних елемената и могућег крварења. То је онколошки супериорна техника у односу на СРПС зато што резултира знатно већим стопама R0 ресекција и знатно већим бројем уклоњених лимфних нодуса. Такође, РАМПС је удружен са бољим дугорочним преживљавањем у односу на СРПС.



**Кључне речи:** карцином панкреаса; тумори тела и репа панкреаса; дистална панкреатектомија; РАМПС