

Impact of retroperitoneal tumors on the digestive tract (Review)

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Abstract. Primary retroperitoneal tumors are a rare group of neoplasms that often prove to be a real therapeutic challenge. The clinical picture is in most cases nonspecific, being the result of nearby tissue and organ compression, displacement and/or invasion, and it usually includes a variety of deceiving signs and symptoms that may lead to diagnostic errors. During the course of the disease, up to half of the patients diagnosed with retroperitoneal tumors can develop gastrointestinal symptoms, the incidence of such symptoms significantly increasing with tumor size. Therefore, symptoms such as abdominal distension, diffuse abdominal pain or epigastric pain mimicking acute pancreatitis, diarrhea, constipation, jaundice, hematemesis, melena and hematochezia can be found. The mainstream treatment for primary retroperitoneal tumors is surgical excision, chemotherapy and radiotherapy but associated with poor results. Due to their rarity, as well as to the complexity of these tumors, patients should be managed in high volume centers that allow the possibility of a multidisciplinary approach.

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1. Introduction

Being located between the posterior leaf of the peritoneum and the lumbar muscle fascia, the retroperitoneum is one of the largest spaces in the body, hosting a wide variety of pathologies. Cranially, the retroperitoneum is limited by the diaphragm, 12th rib and vertebra, while its caudal limit is the pelvic floor. The external borders of the lumbar muscles, mainly the quadratus lumborum muscles, represent its lateral limit. This space contains the connective tissue, liver, kidneys, ureters, adrenal glands, aorta and its branches, inferior vena cava and its tributaries, a part of the duodenum and lymph nodes (1).

Primary retroperitoneal tumors are a rare group of neoplasms, that originate from the actual retroperitoneal tissue (lymphatic, nervous, vascular, support muscle, connective or fibroareolar tissue) or from embryonic rests of the urogenital ridge (Wolffian or Müllerian ducts, germ cells, primitive notochord). Kidney tumors, adrenal and pancreatic neoplasms, tumors originating from the organs situated partially in the retroperitoneum and retroperitoneum metastasis, although located in the same space, are not included in this category (2).

Primary retroperitoneal tumors, due to the inaccessibility of the retroperitoneum and the fact that these tumors often give no or non-specific symptoms until they have reached a substantial size, usually grow to impressive sizes. The

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retroperitoneal space has been described as being 'adaptable', with more than 50% of tumors originating in this space being larger than 20 cm at the time of diagnosis. Usually, a pseudocapsule is formed by the tumor pushing against the surrounding tissues. These tumors can be either malignant or benign. Benign tumors, including schwannomas, neurofibromas, ganglioneuromas, paragangliomas, fibromatosis and lipomas, are often incidental findings during investigations for unrelated symptoms. More than half of the tumors originating in the retroperitoneum are malignant, approximately two-thirds of the tumors being mesenchymal. Liposarcomas (70%) and leiomyosarcomas (15%) are the two most frequent histological subtypes of sarcomas (3,4). After the lower extremities, the retroperitoneum represents the second most common site of origin for malignant mesenchymal tumors. These tumors grow silently and aggressively, usually invading the surrounding structures. The presence of lymphadenopathy and distant metastases are rarely encountered in primary retroperitoneal tumors. Frequently, patients with retroperitoneal tumors expire due to organ dysfunction (or failure), that usually results as a consequence of local malignant growth rather than of metastases to distant organs. It has been noted that primary retroperitoneal tumors usually occur in the 5th and 6th decade of life; female patients being more frequently affected than man (3,5).

2. Diagnosis

The diagnosis of retroperitoneal tumors is made using imaging investigations and is confirmed by histological examination.

Ultrasound examination. Ultrasound is usually the first-line investigation as it is a fast, accessible, easy to use and a repeatable method. It can describe if the mass is cystic or not, and it can assess its volume and topography. The main disadvantage of this method remains its subjectability, being dependent on the physician's experience (6).

Computed tomography. The imaging test of choice that is used in the evaluation and staging protocol of a primary retroperitoneal mass is contrast-enhanced computed tomography (CT) of the thorax, abdominal and pelvic regions. In order to correctly define a primary retroperitoneal tumor, it is important first to exclude its origin from retroperitoneal organs. Many radiological signs have been described in order to help physicians make a correct differential diagnosis. These include: the beak sign (positive when the mass causes the edge of an adjacent organ to become beak shaped, meaning that the mass arises from that organ), the phantom organ sign (positive when a huge mass arises from a small organ that then becomes undetectable), the embedded organ sign (positive when part of a hollow organ appears embedded in the tumor), the prominent feeding artery sign (particularly useful for hypervascular lesions supplied by arteries which are prominent enough to be visualized on CT examination) (7-9).

CT examination can distinguish between different densities, which suggest the nature of the mass. Ganglioneuromas and malignant fibrohistiocytoma can be suspected when calcifications are present at the CT scan. When homogenous adipose tissue is present, a lipoma is almost a certain diagnosis,

while heterogeneous adipose tissue can indicate the presence of a liposarcoma. A necrotic area in a retroperitoneal tumor usually indicates the presence of a high grade malignancy, such as leiomyosarcoma. Hypervascularization is a strong indicator of a hemangioma or a hemangiopericytoma. Lastly, neurofibroma can be suspected when areas of low homogeneous density are present within a tumor (8,9).

CT can also be used to perform CT-guided biopsies. Malignant retroperitoneal tumors are prone to local recurrence. According to DeMatteo *et al* up to 60% of retroperitoneal tumors will recur after surgical excision (10). A CT scan can detect the presence of local or regional recurrence in patients who have already been treated (6).

Magnetic resonance imaging. Magnetic resonance imaging (MRI) is an adequate method for examining soft tissues. It can suggest the presence of various histological components by evaluating the signal characteristics (intensity and enhancement) of the lesion. For example, a hyperintense lesion in T2, while in T1-weighted images being hypointense, is highly suggestive for a myxoid stroma. Collagen fibers, included in neurofibroma, ganglioneuroma, leiomyosarcoma, malignant fibrohistiocytoma, malignant tumor of the peripheral nerve sheaths, fibrosarcoma and retroperitoneal fibrosis are hypointense in T1- and T2-weighted images. Adipose tissue is hyperintense in T1, moderately hyperintense in T2 and hypointense in fat-suppressed images. The analysis of the signal behavior after contrast injection can offer important information. If no enhancement is present, then the presence of a benign lesion is almost certain. Early enhancement with rapid washout can suggest a benign lesion or Castleman disease. Malignant tumors are characterized by an early enhancement, with slow or no evident washout. Some malignant tumors with a myxoid component or benign masses can have a delayed enhancement (11). If the diagnosis remains uncertain, image-guided needle core biopsy or a surgical exploration using a classic open approach or the laparoscopic approach can be performed.

3. Clinical manifestations

Pain. Usually, the clinical picture of retroperitoneal tumors is nonspecific, being the result of adjacent tissue and organ compression, displacement and/or invasion, and can include a variety of deceiving signs and symptoms which may lead to diagnostic errors that will unfortunately delay proper treatment. In the initial phases, these tumors are usually asymptomatic due to their small size; the symptoms occurring slowly over time as the tumor evolves and it increases its size, either due to the mass effect that it has upon the retro- and intraperitoneal organs or due to their direct invasion (5,7). Therefore, a common finding in such patients in terms of clinical manifestations is abdominal or back pain that can vary in intensity from dull, vague pain to more intense, sharp, persistent or intermittent pain, similar to that found in colic, as well as in terms of its location (diffuse pain or localized pain). Pain is the most frequent complaint and it depends on the tumor size and location. According to literature, the incidence of this complaint among patients with retroperitoneal tumors ranges between 40 and 75%, but these patients can also present a multitude of other symptoms (12).

Urinary symptoms. Considering the fact that these tumors develop and evolve in the retroperitoneal space, where the urinary tract organs are located, these patients are associated quite often with urinary symptoms, such as lumbar pain or renal colic, hematuria, as well as lower urinary tract symptoms, especially if the tumor compresses or invades the bladder (increased urinary frequency, dysuria, the sensation of incomplete bladder emptying, urinary retention, bladder spasms, urinary incontinence). The main mechanism responsible for the appearance of these symptoms is represented by tumor compression, but these symptoms can also appear as a consequence of tumor invasion (13).

Neurological symptoms. These patients can also present important neurological manifestations, especially if the tumor compresses the spinal cord (as a result of intervertebral invasion) or the lumbar and sacral plexus such as paraplegia, lower limb paralysis, diminished or abolished reflexes, urinary incontinence, as well as incontinence for feces, and persistent low back pain that radiates towards the lower limbs (14).

Vascular symptoms. Vascular compressions can affect the venous return, as well as the arterial and the lymphatic flow, therefore favoring the appearance of lower limb edema, varicose veins, venous thrombosis, intermittent claudications, paresthesia, as well as lower limb ischemia (15,16).

Gastrointestinal symptoms. According to the literature, up to half of the patients diagnosed with retroperitoneal tumors may develop gastrointestinal symptoms during the course of the disease, the incidence of such symptoms significantly increasing with tumor size. The onset of these symptoms is determined, as in the case of other clinical manifestations, by the compressive effect that the tumor has, both on the retroperitoneal organs and later, in more advanced phases of the disease, on the intraperitoneal organs, or by tumor invasion (12).

Next we will discuss the impact of retroperitoneal tumors on the digestive organs and their clinical manifestations, considering the affected organ.

Duodenum. The duodenum is the first segment of the small intestine, most of it (the last three segments) being located retroperitoneally. The descending part of the duodenum is one of the most important segments of the digestive tract, because at this level the release of bile and pancreatic enzymes through the hepatopancreatic duct take place, which results from the union of the common bile duct with the pancreatic duct. Complete or partial obstruction of the duodenum interferes with the normal passage of the digestive content from the stomach, as well as with the drainage of the gallbladder, the intrahepatic bile ducts and the pancreatic enzymes, which can lead to severe complications (17).

Therefore, compression of the duodenum will determine digestive stasis and retrograde increased pressure within the digestive tract, which may lead to abdominal distension and onset of symptoms such as bloating, early satiety, nausea, vomiting, gastroesophageal reflux, heartburn, abdominal cramps, constipation or diarrhea, hematemesis and/or melaena the event of tumor invasion. Digestive stasis may interfere with

the intestinal absorption process, which can significantly alter the hydroelectrolytic balance, favoring complications such as cardiac arrhythmias, if they are not properly treated. As the volume of stasis fluid increases progressively, due to duodenal obstruction, the patient complains of digestive reflux and nausea, frequently accompanied by vomiting, which usually has a typical bilious aspect. A partial duodenal obstruction allows the passage of liquids and gas; therefore, these patients usually present with diarrhea, whereas a more severe obstruction is usually accompanied by constipation and in some cases even by the absence of transit for intestinal gas. Persistent vomiting and diarrhea may cause dehydration, which is clinically manifested by dry skin and dry mucous membranes, persistent cutaneous folds and thirst (18).

The clinical examination of such patients commonly reveals a distended abdomen with increased abdominal sensitivity, visible intestinal peristaltic waves (especially in thin patients, due to increased peristalsis), as well as increased intestinal sounds. Abdominal percussion is usually associated with tympanism in the upper third region of the abdomen, this being the result of gastric distension. It is worth mentioning that bile reflux within the pancreatic duct can lead to pancreatitis (17).

Biliary system. Large retroperitoneal tumors can also compress or invade the common bile duct, which can lead to its obstruction, followed by increased pressure within the bile ducts, which will determine biliary stasis and distension of the gallbladder.

Therefore, these patients may develop the following clinical manifestations, depending on the choledochus obstruction degree: abdominal pain located in the right upper quadrant (Murphy's sign is present) that can radiate towards the right scapular region, nausea, vomiting, loss of appetite, fever, chills, sweating, persistent pruritus and jaundice, due to increased bilirubin levels. These patients may also present dark, hyperchromic urine and acholic feces. Biliary stasis can promote infection of the biliary tract with both Gram-negative and Gram-positive bacteria that can lead to severe complications, such as ascending cholangitis and systemic sepsis. Blood tests usually reveal changes specific for biliary obstruction: increased levels of bilirubin, aminotransferases and alkaline phosphatase, as well as leukocytosis and increased values of inflammatory markers (19).

Pancreas. Pancreatic tumor invasion or compression can block the pancreatic duct, thus interfering with the release of pancreatic enzymes in the digestive tract and favoring the onset of acute pancreatitis. The stasis of pancreatic enzymes within its drainage system will eventually trigger its autodigestion, leading to significant pancreatic structural changes, which will cause both exocrine and endocrine pancreatic dysfunction (20).

Exocrine dysfunction occurs as a result of decreased production and secretion of amylases, proteases and lipases in the digestive tract, these being essential in the digestion process, thus favoring the onset of nutrient malabsorption. Therefore, pancreatic exocrine dysfunction can manifest with abdominal discomfort, weight loss, steatorrhea and diarrhea, the latter being the result of an accelerated transit that appears

due to lipid malabsorption. Other clinical manifestations that could be encountered in patients with pancreas compression or invasion from a retroperitoneal tumor include: severe upper abdominal pain which will radiate towards the back, nausea, vomiting, fever, increased heart rate, jaundice, abdominal distension due to intestinal ileus and ascites, bleeding, and breathing difficulty due to pleurisy. Complicated and severe cases can evolve towards multiple organ failure and disseminated intravascular coagulation (21).

Pancreatic endocrine dysfunction results from the destruction of Langerhans islets, which significantly affects the glycemic status, possibly leading to both hyperglycemia and hypoglycemia as a result of pancreatic B cell, respectively, A cell loss (22).

Spleen. Left-sided retroperitoneal tumors can compress/invade the spleen or its vascular pedicle. The occlusion of the splenic vein may interfere with venous splenic drainage, favoring the onset of left-sided portal hypertension, also known as sinistral portal hypertension. In the context of splenic vein obstruction, the splenic venous flow will be redistributed to its collaterals, namely to the short gastric vein and to the left gastroepiploic vein, which leads to the congestion of the gastric submucosal venous plexus, with the appearance of gastric varices. This type of portal hypertension is without esophageal varices, due to the fact that the venous flow is diverted into the portal system by the coronary vein. Usually, splenic vein occlusion is without clinical manifestations, especially in its early stages, but it can lead to hypersplenism, as well as to gastrointestinal bleeding and hematemesis or melena. In fact, it is reported that the incidence of gastrointestinal bleeding associated with gastric varices due to sinistral portal hypertension ranges widely, between 15 and 75% (23,24).

Portal circulation. Another possibility of portal hypertension is the direct compression of the portal vein. An increased pressure within the portal vein may lead to the development of porto-systemic collaterals and arterial vasodilatation in the splanchnic territories, which lead to the development of esophageal and rectal varices, as well as to abdominal wall varices, also known as caput medusa (following the permeabilization of the umbilical vein). These patients may have significant digestive bleeding, because of the rupture of these varicose veins, the rupture of the esophageal varices being a major medical emergency with high vital risk (25,26). The onset of portal hypertension may lead to a series of complications, such as: ascites, hepatic encephalopathy (due to the fact that the digestive venous flow bypasses the liver, thus bringing in systemic circulation toxins and especially nitrogen compounds that would normally be metabolized in the liver), hepatorenal syndrome (a consequence of the splanchnic vasodilatation that leads to the release of the antidiuretic hormone, angiotensin and norepinephrine), pulmonary complications (hepato-pulmonary syndrome, hepatic hydrothorax and porto-pulmonary hypertension), spontaneous bacterial peritonitis due to the infection of ascites liquid, hypersplenism and pancytopenia (27).

Another possible complication that could appear in the context of portal hypertension is portal hypertensive

gastropathy, which is characterized by the appearance of vascular ectasia in the gastric mucosa and submucosa. Similar lesions can also be identified in the small intestine, as well as in the colon (28). Therefore, these patients are associated with an increased risk of chronic and acute digestive bleeding.

Colon. Compression of the colon by a nearby retroperitoneal tumor or its direct invasion can lead to intestinal transit disorders (constipation, diarrhea), abdominal distension, nausea, subocclusive syndrome or intestinal occlusion and also to intestinal bleeding (29,30).

4. Treatment

The mainstream treatment for primary retroperitoneal tumors is surgical excision, chemotherapy and radiotherapy associated with poor results. Complete surgical resection is essential in order to achieve disease control, especially in retroperitoneal tumors, such as leiomyosarcoma, liposarcoma or malignant fibrous histiocytoma. Yet, this may prove difficult due to the fact that it depends on several factors, such as tumor size and extent, the invasion of nearby organs or vessels, tumor histology and surgeon experience (7). A high percentage of these patients may develop postoperative recurrence, especially those cases for whom complete tumor excision was not possible. Therefore, further surgery may be necessary, especially in symptomatic patients, in order to relieve their symptoms, but also to control the disease, thus preventing complications that might occur as a consequence of nearby organ compression or tumor invasion (31). Due to their rarity, as well as to the complexity of these tumors, such patients should be managed in high volume centers that allow the possibility of a multidisciplinary approach. The idea of directing such cases in special dedicated centers is associated with several advantages, which have been highlighted over time. This will allow physicians to increase their experience in terms of managing these rare tumors and especially surgeons, who may improve their surgical skills, and it also offers the possibility of research on larger groups of patients, favoring more relevant results. It has been reported that patients who are managed in such centers are associated with significant better surgical outcomes, lower tumor recurrence rates, as well as superior overall survival rates compared to patients who have undergone surgery in low volume centers (32).

In numerous cases, the surgical management of retroperitoneal tumors proves to be very challenging even for experienced surgeons, due to the fact that these patients usually present in advanced stages (due to the tumor's insidious evolution), when the tumor is large and it often invades neighboring organs, as well as large vessels, especially the inferior vena cava (33). Therefore, the surgical management usually consists in the en bloc resection of the retroperitoneal tumor with the nearby tumor-invaded organs and vessels, followed by the reconstruction of the latter (34). Imaging investigations as part of the preoperative assessment are essential for establishing a surgical plan, because these investigations allow surgeons to evaluate the tumor's impact on nearby structures and possibly their invasion, thus being able to anticipate the complexity of the intervention and the organs that must be excised during

surgery. In spite of this, quite often these investigations are unable to identify tumor invasion in neighboring organs, this being observed directly during surgery (35,36).

The tumor histological type is another important element that can be considered during the preoperative assessment, as it may predict the pattern of tumor growth, tumor behavior in terms of recurrence (either local or distant recurrence), as well as overall survival. In terms of establishing the histological subtype, imaging investigations alone have their limitations. Therefore, image-guided percutaneous needle core biopsy should be considered. The risk of tumor cell dissemination during this procedure is negligible, as it has been demonstrated in several clinical trials (37-39). Therefore, surgeons should consider these previously mentioned facts when planning the extent of the surgical excision, but there are situations when this may prove difficult, as in the case of retroperitoneal liposarcoma (34). This type of tumor is associated with a high recurrence rate, which is largely attributed to the fact that the tumor, especially the well-differentiated form, is practically indistinguishable from normal retroperitoneal fat, thus making its complete excision very difficult, if not impossible. It has been proposed that in such cases, in order to reduce the risk of local recurrence, as well as to improve patient outcome, surgeons should consider a more extensive excision, that will include the retroperitoneal tumor en bloc with all the retroperitoneal fat located on the same side, and also the ipsilateral psoas muscle, kidney and even the colon (5,40).

5. Discussion

Several studies have investigated the role of compartmental surgery for retroperitoneal tumors, but the published results are contradictory. This type of surgery implies extensive resection that includes all nearby organs, even if there is no obvious intraoperative evidence of their invasion. It is reported that this approach can significantly reduce the risk of local recurrence, which is estimated to be up to three times lower (41). On the contrary, other studies have demonstrated that this approach does not improve the recurrence rate or overall survival, and furthermore it has been pointed out that this approach is associated with considerably higher risks of intraoperative bleeding, postoperative complications, as well as higher mortality rates (42).

According to the literature, the incidence of multi-organ resection in large retroperitoneal tumors is estimated to be up to 80%, whereas the incidence of vascular involvement that requires concomitant resection is significantly lower, being less than 20% (41,43).

A retrospective clinical trial, which focused on the surgical excision of retroperitoneal tumors, reported a rate of complete tumor excision of 95%, out of which 58% needed multi-organ excision and in 8% of these cases vascular resection was also performed (41). The authors reported that the most frequent organs resected in order to achieve complete tumor excision were the kidney (30%), the colon (17%) and the pancreas (7%), followed by the small intestine and adrenal glands (each with 5% of the cases), bladder (3%), liver, spleen, diaphragm and iliac crest (each with 2%). In terms of vascular involvement that required vascular resection, the most commonly affected was

the inferior vena cava (7%), followed by the iliac vessels (2%). The number of patients who required multi-organ resection or vascular resection was significantly higher among patients with primary retroperitoneal tumors, compared to those with tumor recurrence (71 vs. 62%) (41).

Another similar study, which included 41 patients (90% with primary retroperitoneal tumors and 10% with tumor recurrence), reported a rate of complete tumor excision of 90%, out of which 21% needed multi-organ resection (44). As in the previous article, the most common resected organs included the kidney and the colon (each representing 9.75% of all cases), followed by the small intestine, spleen and adrenal glands (each with approximately 5%). Other organs less frequently affected were: the stomach, liver, pancreas, diaphragm, ureters and bladder (only one patient for each case). Out of these 41 cases, 49% had malignant retroperitoneal tumors. Liposarcoma was the most common histological type, accounting for 45% of the malignant cases, followed by B-cell lymphoma (10%) and leiomyosarcoma, rhabdomyosarcoma, sarcoma, malignant fibrous histiocytoma, adrenal cortical carcinoma, malignant paraganglioma, extra-gastrointestinal stromal tumor and primitive neuroectodermal tumor (each representing 5%). Among the patients with malignant retroperitoneal tumors, half of them developed tumor recurrence following surgery, over a median period of time of 11 months, but only 25% of them have undergone further surgery to remove the tumor recurrence. Another important aspect is that 15% of the patients with malignant tumors developed distant metastases during the follow-up period (44).

A multi-center retrospective study focused on the incidence of pancreaticoduodenectomy (PD) in patients diagnosed with primary retroperitoneal sarcoma who underwent surgery (45). Out of the 2,068 retroperitoneal tumor cases, which were identified by the authors, PD was performed only in 29 patients, representing 1.4%. In terms of the retroperitoneal tumor histological subtype identified in these patients, for whom PD was also performed, leiomyosarcoma and liposarcoma were more frequently encountered, representing 97% of all histological types. In all of the 29 PD cases, a multi-organ resection was performed, which included an average of two organs. The colon and the kidney were the most frequently resected organs, colon resection being done in 83% of the cases, whereas nephrectomy was performed in 79% of the cases. The authors also reported that 45% of the PD cases were associated with inferior vena cava tumor invasion, thus resection being necessary. The histopathological examination revealed the presence of tumor microscopic invasion at the level of the duodenum, as well as in the pancreas in 84% of cases, the definite invasion of the pancreas being identified in 72% of cases. Regarding the postoperative complications, it was noted that within the first month following surgery, 55% of the patients had developed at least one complication. Postoperative pancreatic fistula was identified in 28% of the patients, and one patient expired due to septic shock. A high percentage of these PD patients developed tumor recurrence during the follow-up period (66%) (45).

In terms of gastrointestinal symptoms associated with the presence of retroperitoneal tumors, there are several articles that have presented such cases. Ventura and his colleagues reported the case of a 68-year-old male patient, known with diverticulosis and high blood pressure, who presented for

nausea, abdominal pain and intermittent hematochezia (29). During upper endoscopic exploration, it was observed that the second part of the duodenum presented with a reduced lumen due to extrinsic compression, but without any lesions in the duodenal mucosa and no other changes in the upper digestive tract. Colonoscopy was also performed and it revealed the presence of rectal varices, diverticulosis; and, at the level of the ascending colon, a large mass with signs of necrosis, which was surrounded by varices, was discovered. CT examination revealed the presence of a large retroperitoneal tumor, right ureterohydronephrosis, slightly distended small intestines and multiple liver lesions. Biopsy from the liver lesions was performed and it revealed that the tumor was a retroperitoneal leiomyosarcoma. Surgical excision was attempted, without success, the patient being deemed inoperable (29).

A similar case was reported by Wanchick and Lucha (30). The authors presented the case of a 70-year-old male patient with significant rectal bleeding, nausea, abdominal distension and cramps, as well as significant weight loss in a short period of time. CT examination revealed the presence of a large retroperitoneal tumor, which extended from the upper abdomen towards the pelvic region, compressing both ureters, the inferior vena cava, the distal segments of the small intestine and the colon. Colonoscopy indicated significant extrinsic compression at the level of the sigmoid, but without any signs of bleeding. The patient underwent an exploratory laparotomy, during which it was observed that the tumor had invaded both kidneys, as well as both ureters, the aorta, the inferior vena cava, the bladder, the ileum, cecum and the sigmoid colon, practically the complete excision of this tumor being impossible. During surgery, only right hemicolectomy and resection of the sigmoid were performed. The histopathological examination established the diagnosis of dedifferentiated liposarcoma (30).

Sato *et al* reported the case of a retroperitoneal tumor invading the ascending colon. He presented the case of a patient who sought medical attention for persistent melena. During colonoscopy, the presence of a white multinodular tumor in the ascending colon was observed. CT examination revealed a large retroperitoneal tumor which had a compressive effect on the intestinal loops, as well as on the right kidney, causing their displacement. The patient underwent surgical exploration, during which tumor excision was performed, en bloc with the right kidney and the ascending colon. Following the anatomopathological analysis of the resected portion, the diagnosis was well-differentiated liposarcoma for the large retroperitoneal mass, whereas the tumor located in the ascending colon was a dedifferentiated liposarcoma (46).

Gan and Huang reported the case of retroperitoneal tumor that was initially misdiagnosed as a gastric stromal tumor. The authors presented the case of a 39-year-old female patient, who complained of abdominal discomfort and abdominal distension. Laboratory investigations revealed only the presence of slightly increased α -fetoprotein. During upper digestive tract endoscopic exploration, it was noted, at the level of the gastric fundus, a local bulge, but without any anomalies at the level of the gastric mucosa. After performing a CT examination, the authors concluded

that it was a stromal gastric tumor. The tumor was resected using a laparoscopic approach. It is worth mentioning that the tumor was located in the retroperitoneal space, between the aorta and the lesser gastric curvature. The histopathological examination showed that the tumor, which was initially thought to be a stromal gastric tumor, was in fact a retroperitoneal teratoma (47).

Krick and his colleagues reported the case of an infantile hemangioma in a 7-week female infant, who manifested recurrent rectal bleeding, feeding intolerance and abdominal distension (48). Imaging investigations revealed the presence of a large retroperitoneal mass, which involved the pancreas, the inferior vena cava and the aorta. The authors raised the suspicion of retroperitoneal neuroblastoma. An exploratory laparotomy was performed and during surgery, multiple erythematous nodular lesions were noted located throughout the small intestine mesentery, in the small intestine walls, in the omentum, as well as in the pancreatic head. Several tissue samples from these lesions were taken during surgery, in order to establish the diagnosis. The histological investigation revealed that the tumor was in fact an infantile hemangioma (48).

There are also several cases of retroperitoneal tumors in the literature that initially present in the form of acute pancreatitis. Arakawa *et al* reported the case of a 74-year-old male patient, who presented at the emergency room for intense abdominal pain and abdominal distension (49). The blood tests revealed high serum amylase levels. A CT examination was performed and it revealed the presence of a large retroperitoneal tumor located in the right retroperitoneal space, which spread around the duodenum and the pancreas, compressing and displacing them. The peri-pancreatic fatty tissue was modified, as well as the pancreatic tissue, and the presence of fluid in the left pararenal space was also noted. Therefore, the authors established a diagnosis of acute pancreatitis secondary to a retroperitoneal tumor. After managing the acute pancreatitis episode, the patient underwent surgery. Complete tumor excision was achieved, en bloc with the right kidney and right adrenal gland. The histopathological examination established that the tumor was a dedifferentiated liposarcoma (49).

Kitagawa and Miyakawa presented the case of a male patient, known with four episodes of acute pancreatitis within the last two months, who sought medical help for upper abdominal pain, which appeared more frequently after eating. CT examination showed specific acute pancreatitis changes in the pancreatic tissues and the presence of a retroperitoneal tumor with fatty tissue density, which surrounded and compressed the duodenum, therefore explaining the recurrence of acute pancreatitis (intra-duodenal increased pressure that interfered with the normal drainage of pancreatic enzymes). After the surgical excision of the retroperitoneal mass, it was noted that the patient did not develop other episodes of acute pancreatitis. In terms of the tumor histological type, the authors stated that this was a retroperitoneal lipoma (50). Another case of retroperitoneal tumor that presented as acute pancreatitis was reported by Vijayan and colleagues (51). Clinical examination and ultrasonography raised the suspicion of a tumor located in the presacral area. After managing the acute pancreatitis episode, a CT examination was subsequently

performed, which revealed the presence of a retroperitoneal tumor located in the presacral region. The patient underwent surgery, with complete excision of the tumor, without damaging other structures, and the diagnosis was retroperitoneal schwannoma (51).

Complete surgical excision represents the mainstream treatment for advanced retroperitoneal tumors that invade nearby organs, and it usually is associated with en bloc multi-organ extensive resection, the most common resected organs being the kidneys, the colon and the pancreas (52-55).

6. Conclusions

Primitive retroperitoneal tumors are rare. They often prove to be extremely challenging in terms of management, due to the fact that they are usually discovered in advanced stages, as well as their high recurrence rate. Preoperative imaging investigations are essential when managing such patients, because although these methods do not determine the tumor histological type, they can provide important clues that can guide physicians in terms of the tumor's nature and they also reveal tumor extension within nearby organs and tissues, offering the possibility of establishing a proper surgical plan.

Quite often, retroperitoneal tumors can lead to the onset of digestive symptoms, which can mislead physicians regarding the correct diagnosis, often delaying the initiation of an appropriate treatment. This is encountered more frequently in large and advanced stage tumors, which invade and/or compress neighboring digestive organs.

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DM, LI, and CD reviewed the literature data. DM, OB and IB prepared the draft of the manuscript in light of all of the literature data. CD, FIR, SB and NB reviewed the final version of the manuscript after reviewing the literature findings. All the authors read and approved the final version of the manuscript for publication.

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