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Surgical challenges of excision of retroperitoneal germ cell tumors in children: a single institutional study with literature review

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Abstract

Background: Retroperitoneal germ cell tumors (GCTs) are rare, commonly large tumors, often diagnosed in infancy. Complete surgical resection may pose a serious challenge as encasement of major vessels and organ displacement can lead to perioperative complications. This study aims to illustrate the surgical challenges of excising retroperitoneal GCTs.

Results: Nine patients were included: six patients with a teratoma, two patients with a mixed GCT with a yolk sac tumor component, and one patient with a pure yolk sac tumor. Six were males and seven were younger than 1 year of age at time of presentation. In all cases, perioperative vascular or organ-related complications occurred in one patient; this resulted in short bowel syndrome. There was no recurrence or mortality during the follow-up period. Relevant literature is reviewed and described.

Conclusions: The anatomical relation of a retroperitoneal GCT to the major vessels and organs is unpredictable. Preoperative radiological evaluation can help to improve the understanding of the vascular anatomy and to plan accordingly. Anteriorly displaced veins may appear insignificant and arteries, such as the superior mesenteric artery may be encased. Preoperative imaging may prevent perioperative complications, leading to safer surgical procedures.

Level IV evidence: Therapeutic study

Keywords: Germ cell tumor, Pediatric, Teratoma, Surgery, Retroperitoneum

Background

Germ cell tumors (GCTs) arise from molecular defects in early germline progenitors known as primordial germ cells. During embryonic development, primordial germline cells migrate from the yolk sac endoderm around the hind gut to the genital ridge in the retroperitoneum [1]. The occurrence of an aberrant pattern of migration can induce persistence of germ cells along this course, leading to GCTs. A common variant of a GCT is a teratoma [2]. Teratomas consist of mixed elements arising from the three germ cell layers. They are identified by the presence of nearly any type of tissue, which may be mature or immature. Mature and immature teratomas are considered benign tumors. When teratomas contain malignant elements [1], they are called mixed GCTs [3]. Another variant of a GCT is a malignant yolk sac tumor. In these patients, highly elevated alpha fetoprotein (AFP) levels are often seen [4]. In pediatric cases, younger than 15 years, most GCTs are found in the gonads, sacrococcygeal region or the brain [4]. Other sites are

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the mediastinum, and extragonadal abdominal—mostly midline—sites, such as the retroperitoneum [4]. By the time retroperitoneal GCTs are identified, they have often reached a considerable size. Usually, they cause non-specific symptoms, such as abdominal distention [5, 6]. In teratomas, the only curative treatment is complete surgical resection [2, 7]. Incomplete resection may lead to recurrence [1]. Chemotherapy is not indicated in the treatment of teratomas [3], but may be part of treatment in their malignant counterparts [7]. During resection of a retroperitoneal GCT, vascular resection and reconstruction of major blood vessels may be required, for example the inferior vena cava (IVC), the aorta, and superior mesenteric artery (SMA). When vascular resection or vascular injury is unavoidable, immediate intraoperative reconstruction may be necessary. Preoperatively, patients with retroperitoneal masses undergo imaging. However, the true extent of vascular involvement may only become clear intraoperatively [8]. Reported complication rates range from 50 to 100% [6]. Thus, resection of a retroperitoneal GCT may present a considerable surgical challenge. The aim of this article is to illustrate these surgical challenges by presenting nine cases and a review of the literature.

Methods

Patients

Between November 2014 and February 2020, 133 patients with extracranial GCTs were treated in our institute. Of these, nine patients presented with primary retroperitoneal GCTs and were included in this retrospective study. These nine patients were treated by two senior pediatric surgeons. Clinical presentation, preoperative imaging, surgical procedure and postoperative outcome, and follow-up information were collected and described in this article.

Review

A literature review was conducted following the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) guidelines [9]. Studies investigating the surgical treatment and outcome of retroperitoneal GCTs in children and adults were identified via a literature search of PubMed, EMBASE, and MEDLINE. Our overall search strategy included the MeSH heading "Neoplasm*, Germ Cell" and subheadings such as "Imaging", "Surger*", "Retroperitone*", and "Vascular" and can be found in Appendix 1. The resulting titles and abstracts were screened for relevance and inclusion and exclusion criteria, and the resulting articles were reviewed.

Inclusion criteria for this review were articles focusing on the surgical treatment and challenges of retroperitoneal GCTs. Age > 18 years was not an exclusion criterion due to scarcity of literature on this specific topic. Exclusion criteria were case reports, literature on metastatic disease, and studies not specifically describing surgical treatment of retroperitoneal GCTs, and letters to the editor, non-English literature, non-Western studies, non-human studies, studies on other cancers. Two authors (CH, JB) performed manual reviews of the identified titles, abstracts, and full-text review. Any disagreement between the two authors was resolved by the third reviewer (AS).

The study characteristics and data points extracted from each study included anatomical tumor location, tumor histology, number of patients included as well as patient age and gender. Also included were details of surgical treatment, complications encountered perioperatively including blood loss, postoperative complications and, if applicable, long-term sequelae.

The initial database searches identified 90 published articles. After removing duplicates and elimination by title and abstract and full-text review, 13 studies were included in this review. The selection process, based on the PRISMA schema, is detailed in Fig. 1.

Results

Clinical characteristics

The clinical characteristics of our patients are presented in Table 1. Seven patients were younger than 1 year of age at the time of presentation, one patient was 2 years old and one patient was 16 years old. Median age was 6 months. The two neonates who were treated at our institute were operated on day 3 and day 9 of life, respectively. All patients presented with a palpable abdominal mass. Eight patients had an abnormal (age-specific) level of alpha fetoprotein and one patient had an abnormal beta human chorionic gonadotropin (bHCG) level. Eight patients underwent a magnetic resonance imaging (MRI) scan, which often demonstrated a solid and cystic mass with fatty and bony or calcified components, enabling the preoperative diagnosis of teratoma. Perioperative complications occurred in all nine patients. In one of these patients, this led to long-term sequelae. Mature and immature teratomas were found in six patients, mixed GCTs with a yolk sac tumor component in two patients, and a pure yolk sac tumor in one patient.

Venous challenges

In one patient, anterior displacement of the IVC was observed during surgery. The IVC was severely compressed between the liver and the mass, displaced anteriorly and cranially, and stretched out over the mass. As a consequence, a large organized thrombus had formed in the IVC and right renal vein. Perioperatively, a partial thrombectomy with caval reconstruction had to be performed, as shown in Fig. 2.

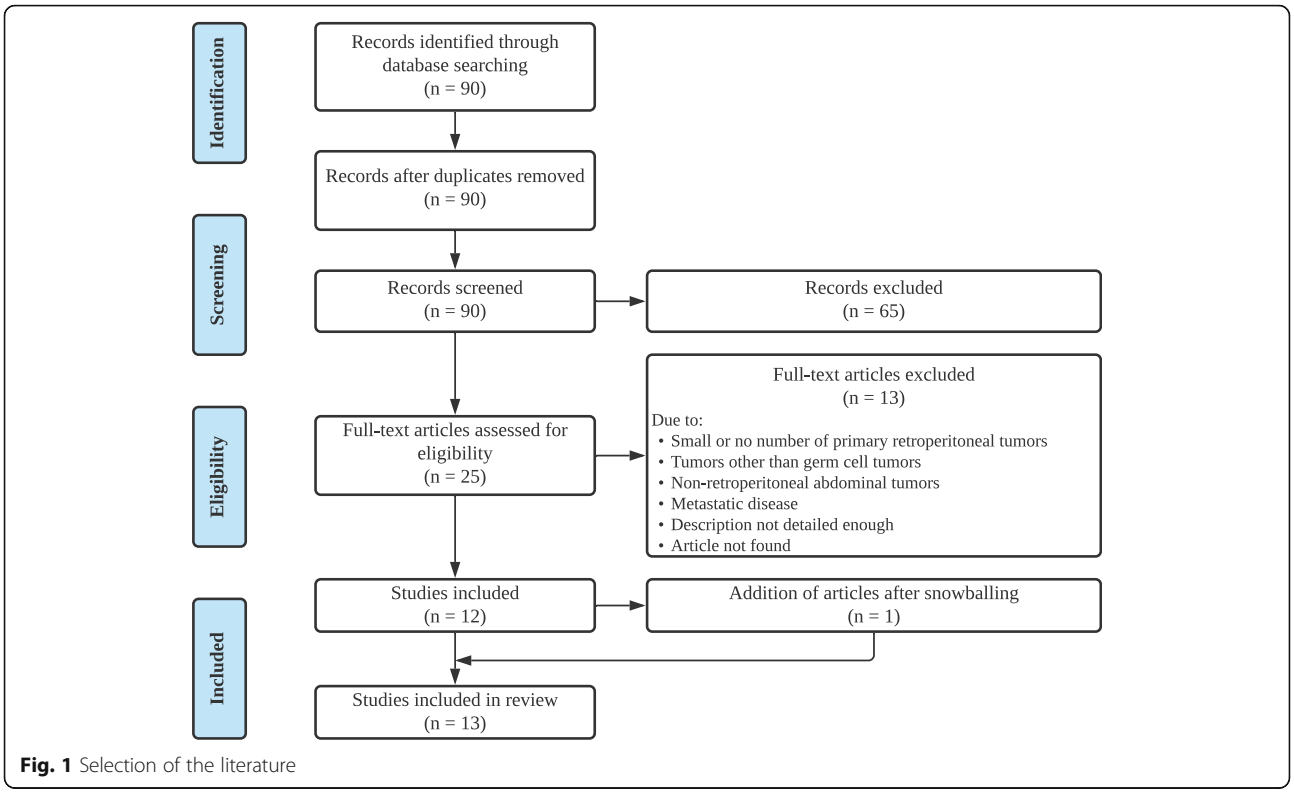

Fig. 1 Selection of the literature

Arterial challenges

The most important arterial complication was the adherence and encasement of the SMA in two patients, as shown in Figs. 3 and 4. In one patient, the identified SMA was displaced dorsally and cranially and was adherent to the tumor. Dissection of the SMA was successful, but resulted in incomplete resection of the tumor; part of the cyst wall was left in situ dorsally in order to spare the SMA. In one patient, two seemingly insignificant encased vessels were ligated. During the course of the procedure, small bowel ischemia occurred. The two vessels previously ligated were then identified as branches of the SMA. A planned second look laparotomy was carried out 1 day postoperatively, revealing ischemic jejunum at 25 cm from Treitz necessitating resection of 20 cm of jejunum, and temporary split stoma formation. One week after the initial resection, an emergency third laparotomy was performed due to sepsis. There was necrosis of the efferent loop stoma necessitating revision, at this point all remaining small bowel was vital. Six weeks after initial resection, a fourth laparotomy was done because of rising inflammatory markers and worsening clinical condition. Fibrosis of the first 23 cm of jejunum was noted and resected, and stenosis at the afferent stoma necessitated refashioning. 140 cm of small bowel remained at this point. Two months afterwards, 4 months after initial resection, an explorative fifth and final laparotomy to assess small bowel condition was carried out and extensive small bowel fibrosis with absence of normal mucosa and luminal obliteration was found. Additional resection and stoma closure resulted in a remaining 30 cm of jejunum and ileum combined with an intact ileocoecal valve.

Challenges in relation to organs

Adherence of the tumor to organs, such as the stomach, duodenum, and pancreas was found in seven patients. In two cases, removal of the adherent structures was required to complete tumor resection; a partial gastrectomy in one patient and an omentectomy and partial fasciectomy of the abdominal wall in the other patient were performed. Injury to the small bowel and stomach occurred in two cases. These injuries were oversewn and did not lead to further complications. Rupture of the tumor capsule is only reported in one case. The spillage was local and limited, consisting of hair and sebum which did not spread into the peritoneal cavity. As a result, we did not see an indication for an adapted follow-up scheme for this patient.

General complications during surgery

Inotropic support was necessary to maintain stable blood pressure in four out of nine patients. Blood loss was estimated by the combination of visual estimation, using calibrated collection pots and weighing gauzes. Values were recorded in the anesthetists' operation

Table 1 Characteristics of nine patients with a retroperitoneal germ cell tumor

Patient	Age at presentation	Sex	Clinical presentation	AFP (μg/l)	bHCG (iU/l)	Size (cm)	Imaging (USS, CT or MRI)	Treatment	Perioperative complications	Post-operative complications	Pathology	Outcome, duration of follow-up
1	8 months	M	Palpable mass, abdominal distention	5400[a]	< 2.0	11.9 × 15.7 × 17 on MRI	USS, CT, MRI	Complete resection	Tumor adherent to stomach, duodenum, pancreas. Stomach partially removed, transverse mesocolon opened and restored. Total blood loss: 150 ml.	None	Mature and immature teratoma grade 2, yolk sac component	NED, 4.5 years
2	At birth	F	Palpable mass, abdominal distention, respiratory compromise	9000[a]	2.8	9.2 × 7.7 × 7.8 on MRI	USS, MRI	Complete resection	Pancreas and duodenum strongly adherent. Small bowel injury, oversewn. Retroperitoneal bleed, oversewn. Inotropic support intraoperatively. Major blood loss: 240 ml in a neonate.	None	Immature teratoma grade 3, yolk sac component	NED, 2.5 years
3	5 months	M	Palpable mass, abdominal distention, respiratory compromise, feeding difficulties	990[a]	< 2.0	17.6 × 13.5 × 9.3 on MRI	USS, MRI	Complete resection	Tumor adherent to liver and omentum. Inotropic support intraoperatively. Total blood loss: 20 ml.	None	Mature and immature teratoma grade 2	NED, 2.5 years
4	2 years	M	Palpable mass, abdominal distention, pain, fever	97, 000[a]	< 2.0	6.4 × 13.2 × 9.0 on MRI	USS, MRI	3 times neoadjuvant PEI, complete surgical resection, 1 time post-operative PEI	Tumor adherent left abdominal wall and omentum. Omentectomy and partial fasciectomy of abdominal wall. Total blood loss: insignificant.	None	Yolk sac tumor	NED, 6.5 years
5	6 months	M	Palpable mass, abdominal distention, abdominal pain, nausea and vomiting, feeding problems	24[a]	< 2.0	17 × 11.8 × 10.5 on MRI	USS, MRI	Complete resection	Tumor adherent to stomach and duodenum. Small perforation of stomach. Oversewn. Mesocolon opened and sutured. Total blood loss: insignificant.	None	Immature teratoma grade 3	NED, 3.5 years
6	5 months	F	Palpable mass, abdominal distention, nausea and vomiting	280[a]	< 2.0	10.8 × 10.1 × 9.2 on MRI	USS, MRI	Complete resection	Tumor adherent to liver and hepatoduodenal ligament, stomach and duodenum, blood loss during liver dissection. Hemodynamic instability due to caval compression intraoperatively. Total blood loss: 50 ml	None	Immature teratoma grade 2	NED, 2.5 years
7	At birth	M	Palpable mass, abdominal distention, prenatal findings	140, 000[a]	81[b]	4.4 × 5.7 × 5.2 on MRI	USS, MRI	Near total resection (part of cyst wall left in situ dorsally)	Duodenum and pancreas fixed to tumor. Common bile duct stretched out on top of tumor. SMA needs to be dissected off tumor caudally. Hepatic artery and portal vein adherent to tumor cranially. Inotropic support and hemodynamic instability due	None	Immature teratoma grade 2	Well, 9 months

Table 1 Characteristics of nine patients with a retroperitoneal germ cell tumor *(Continued)*

Patient	Age at presentation	Sex	Clinical presentation	AFP (μg/l)	bHCG (iU/l)	Size (cm)	Imaging (USS, CT or MRI)	Treatment	Perioperative complications	Post-operative complications	Pathology	Outcome, duration of follow-up
									to caval compression. Total blood loss: 25 ml.			
8	16 years	F	Lower back and upper leg pain due to thrombosis, followed by diagnostics revealing a palpable mass, fever, nausea	1.6	< 2.0	19 × 12 × 13 on CT	USS, CT	Complete resection	Extremely large tumor displacing the liver ventrally. Left renal vein completely obliterated, therefore ligated. Aorta, celiac trunk, SMA, right renal artery and IMA all adherent to tumor and dissected off. Organized thrombus in inferior vena cava, partial thrombectomy of cava and right renal vein, with caval reconstruction. Tumor rupture during mobilization, spill of hair and sebum. Intraoperative inotropic support. Total blood loss: 1500 ml.	None	Mature teratoma	Well, 1 year
9	8 months	M	Palpable mass, ongoing excessive crying	18[a]	< 2.0	4.8 × 4.6 × 4.5 on MRI	USS, MRI	Near total resection	SMA situated within tumor capsule, accidental ligation of two branches of SMA. Small part of tumor capsule left in situ in order to spare SMA. Total blood loss: unknown.	Multiple laparotomies and small bowel resections due to ischemia resulting in short bowel	Mature teratoma	Alive, TPN dependent due to short bowel syndrome, 4 years

AFP Alpha fetoprotein, *bHCG* Beta human chorionic gonadotropin, *M* Male, *F* Female, *USS* Ultrasound scan, *CT* Computed tomography, *MRI* Magnetic resonance imaging, *PEI* cisplatin (P), etoposide (E) and ifosfamide (I), *SMA* Superior mesenteric artery, *IMA* Inferior mesenteric artery, *NED* No evidence of disease, *TPN* Total parenteral nutrition

[a]Abnormal age-specific AFP value

[b]Abnormal bHCG value

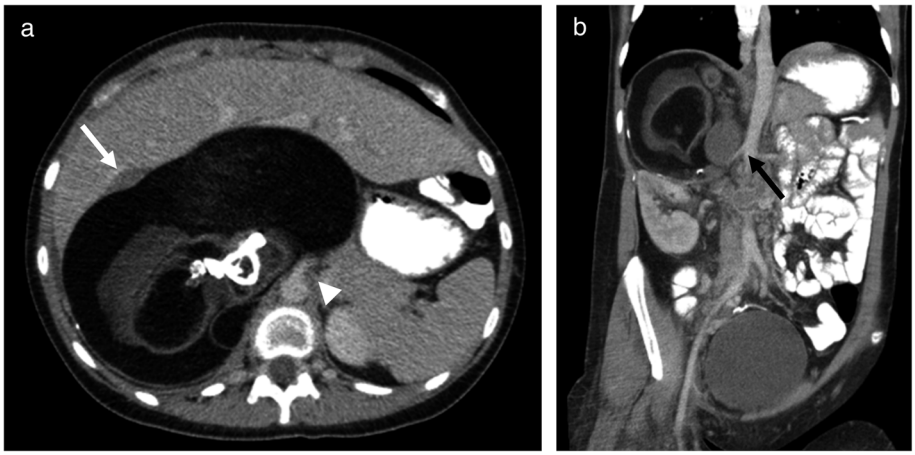

Fig. 2 A 16-year-old girl presenting with lower back pain (patient #8 in Table 1). **a** Axial image: CT after intravenous contrast shows a retroperitoneal mass with internal fat and ossification consistent with a teratoma. There is thrombosis of the IVC (white arrow) and a close relationship with the celiac axis (arrowhead). **b** Coronal reformatted image demonstrates the relationship with the right renal artery (black arrow)

report and were significant (> 30% of estimated total blood volume) in three patients. In two patients, blood loss was moderate (10–20% of total estimated blood volume). In three patients, it was insignificant (unmeasurable perioperatively or < 5% estimated total blood volume). In one patient, blood loss was not recorded.

Histology

One patient, a 2-year old with a heterogeneous tumor and extremely raised AFP level had a malignant yolk sac tumor confirmed by percutaneous ultrasound-guided 16 G tru-cut biopsy under general anesthesia. After three courses of neo-adjuvant cisplatin-containing chemotherapy, a complete resection was carried out. Histopathology of the resected specimen showed completely necrotic tissue without evidence of vital tumor and clear tumor margins. The remaining eight patients underwent an upfront resection without biopsy. Two patients had a mature teratoma, three patients had an immature teratoma grade 2 (two had an R0 resection, one had an R2 resection), one patient had a completely resected immature teratoma grade 3, and two patients had completely resected immature teratoma grade 2–3 with yolk sac microfoci upon careful histological study of the entire resection specimen.

Outcome

In two cases, one with a mature teratoma and one with an immature teratoma grade 2, an R2 resection was carried out in order to spare vascular structures. Because of benign histopathology, no adjuvant treatment was given and the patients were followed up. In all other patients,

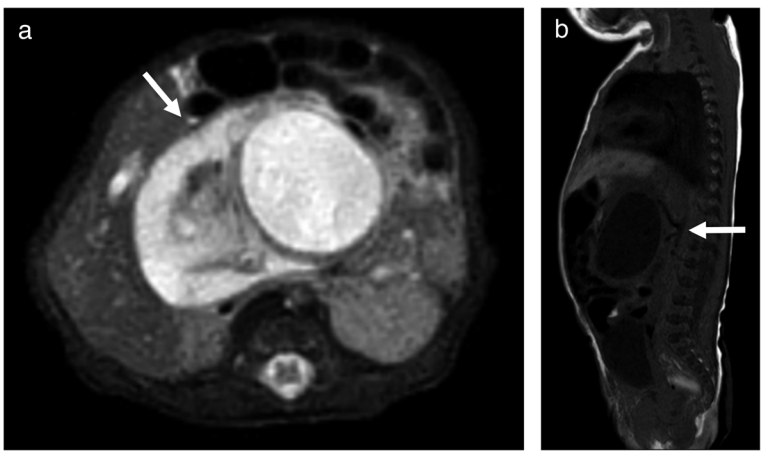

Fig. 3 A 1-day-old boy with antenatally detected mass in the abdomen (patient #7 in Table 1). **a** Axial T2-w image with fat suppression shows a mass with cystic and solid components (arrow) within the mesentery. **b** Sagittal T1-w image shows the close relationship with the celiac axis and superior mesenteric artery (arrow)

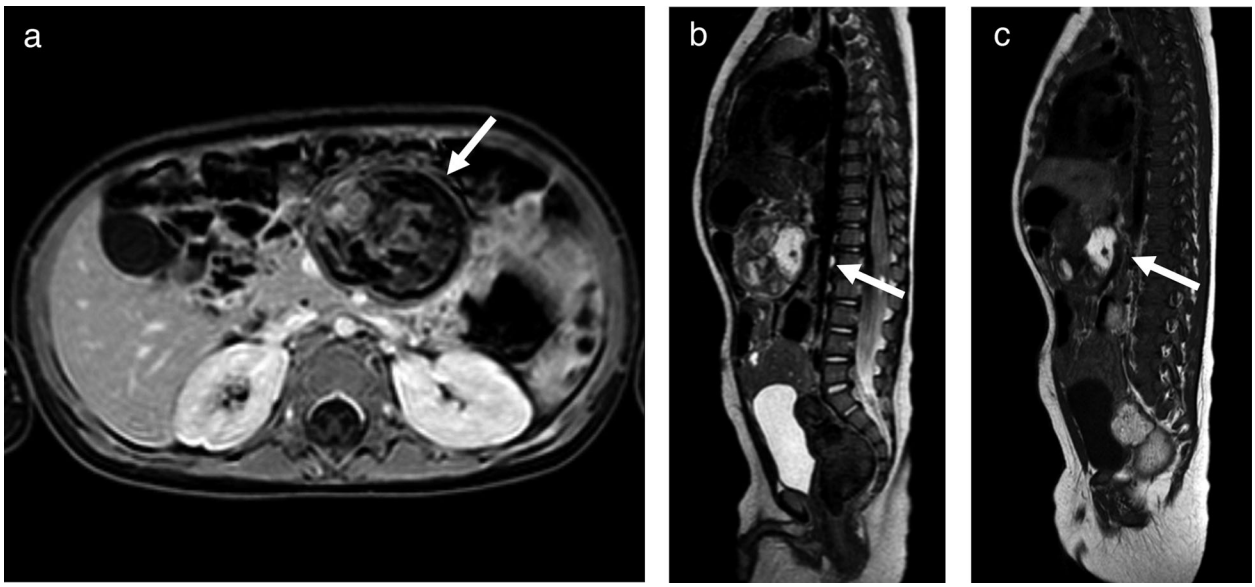

Fig. 4 An 8-month-old boy presenting with excessive crying (patient #9 in Table 1). MRI was performed to further characterize a mass in the upper abdomen detected with ultrasound. **a** Axial T1-w with fat suppression after injection of gadolinium contrast shows a tumor (arrow) within the mesentery. **b** Sagittal T2-w image shows the close relationship with the superior mesenteric artery (arrow). **c** The sagittal T1-w image illustrates the fatty component (high signal; arrow) diagnostic for a teratoma

R0 resections were achieved. Of these, the one mature teratoma, three immature teratomas (2× grade 2, 1× grade 3) and two immature teratomas with yolk sac microfoci did not receive adjuvant chemotherapy as they were completely resected, and were followed up rigidly to detect local recurrence. The patient with biopsy of a yolk sac tumor, followed by neoadjuvant chemotherapy and a complete resection had an additional cisplatin-containing chemotherapy course. None of our patients have had recurrence of disease during a median follow-up of 2 years (range 9 months–6.5 years). All patients are alive, eight without complications, and one with long-term sequelae of short bowel syndrome.

Review

We identified 13 relevant studies, describing a total of 222 patients with retroperitoneal GCTs, mostly teratomas. The number of patients per study ranged from 1 to 152. The age of diagnosis ranged from prenatal to 18 years old, except for a 24-year-old and a 30-year-old patient. Preoperative imaging modalities used were ultrasound scan (USS), MRI scan, and computed tomography (CT) scan. The most frequent perioperative complications described were massive blood transfusion, organ injuries, and vessel injuries.

Discussion

Surgical treatment of children with retroperitoneal tumors is challenging. This is partially due to adhesions to organs and structures, such as the stomach, liver, pancreas, mesocolon, spleen and diaphragm [5, 8], but also due to the inaccessible location and the close involvement of retroperitoneal masses with the major blood vessels, causing unpredictable vascular distortion [3]. Yang et al. presented the largest retrospective study to date describing 152 patients. The most frequent perioperative complication in their study was massive blood loss, followed by vessel injury and gastrointestinal organ injury [6]. Surgical procedures of large retroperitoneal GCTs cannot be compared to those used in other retroperitoneal tumors, such as neuroblastoma [8]. This is due to a different pattern in vascular involvement to that seen in GCTs. Since retroperitoneal GCTs are rare, there is no uniform surgical approach.

Venous structures most frequently involved in and distorted by retroperitoneal tumors are the IVC, portal vein, renal veins, and superior mesenteric veins. About two thirds of the retroperitoneal masses infiltrating the IVC are malignant tumors or mature teratomas [3]. Earlier studies have shown that changes in vascular anatomy found intraoperatively were often poorly demonstrated by preoperative CT imaging [8, 10]. In one patient, the IVC was displaced anteriorly, while the aorta remained posteriorly. The same pattern of displacement has been described in several publications [8, 10, 11]. This pattern applies to some of the IVC's tributaries as well. Jones, Kiely et al. described six patients with tumors displacing the renal arteries posteriorly, whereas the corresponding veins ran over the anterior aspect of the tumor [12]. Anteriorly displaced veins, even major ones, are often

elongated and thinned, thus appearing insignificant or occluded. On contrast-enhanced CT, occlusion is suggested by failure of opacification of the IVC and the presence of potential collateral vessels [10]. True occlusion of a vein may occur due to pressure of the mass and is common when the tumor is large. Also, obvious occlusion on imaging is typically associated with anterior displacement of the IVC. Chronic obstruction of the IVC often leads to the development of collaterals by the time the tumor is resected. Therefore, when IVC resection is required in order to successfully resect the tumor, the collaterals will usually expand after ligation without serious sequelae [13]. This was the case in one patient in our series where the IVC was obstructed by a thrombus which could not be removed completely. However, over time, sufficient collaterals had developed. This resulted in enough venous flow during mobilization of the IVC perioperatively, to prevent acute hypovolemia.

Arterial structures most commonly involved in retroperitoneal GCTs are the aorta and its branches, most notably the SMA and celiac trunk. Arteries usually show less displacement than veins, but may still be hard to find on imaging. As described previously, the aorta often remains posterior to the tumor, in contrast to the IVC. When the tumor is localized centrally or bilaterally, the aorta will stay in the midline. However, an unilateral tumor may displace the aorta contralaterally. The celiac trunk and SMA are often found traversing the tumor [10]. This is seen in one of our patients, in whom the SMA was encased, ultimately leading to short bowel syndrome. Awareness of the possibility of vessel encasement is therefore important [6, 10]. Yang et al. described nine patients enduring venous injuries, in contrast to only one arterial injury, of the SMA [6]. Branches of the aorta and essential visceral and lumbar arteries need to be isolated and preserved [1]. Debulking surgery may be an alternative if this cannot be achieved. In one of our patients, the renal arteries were hard to identify on imaging, due to an extensive system of collaterals. Perioperatively, they could be recognized and mobilized. Renal artery injury can lead to polar ischemia, making identification crucial [13]. Another perioperative arterial complication is arterial injury leading to hemorrhage. In our review of the literature, bleeding from the aorta occurred once and was diffused. Bleeding perioperatively resulting in circulatory collapse and death in a newborn was also described once [5, 8]. In the latter case, it is not clear whether this was the result of arterial or venous injury or diffuse bleeding.

In imaging, CT scans are often used to diagnose retroperitoneal masses; the typical aspects and local extension of GCTs are identified relatively well [11, 13]. In addition, due to fast acquisition of current CTs, in most instances no sedation or anesthesia is needed [10]. However, vascular involvement is not always detected preoperatively [11]. Even newer CT modalities such as 3D CT do not improve diagnosis of vascular involvement, specifically of effaced and obstructed veins [12]. Furthermore, the major disadvantage of CT is the use of ionizing radiation in these often very young patients. Bellin et al. described the correlation of MRI features with CT, and concluded that MRI has several advantages [14]. MRI is known for its excellent soft tissue contrast and therefore is able to characterize teratoma with more diagnostic confidence and illustrates its extension, as well as demonstrating displacement of the vascular anatomy [14]. However, in young patients, general anesthesia is needed in order to complete MRI scans adequately. MRI was the preferred method of imaging in all of our patients, except one (see Table 1). Given the two techniques have their own advantages and disadvantages, performing both preoperatively might prepare the surgeon in the best possible way accepting exposure to pediatric doses of radiation and the need for a general anesthesia.

Other abdominal organs that can be involved in a retroperitoneal GCT are the liver, gallbladder, stomach, duodenum, small and large intestine, spleen, pancreas, and kidney. Perioperative complications involving organs vary from organ injury to organ loss. In Yang et al. series, six stomachs, two intestines, one common bile duct, and one renal pelvis were injured [6]. In that study, organ excision had to take place in five patients; three left kidneys, one right kidney, and a left adrenal gland required resection [6]. In our study, one patient demonstrated rupture of the tumor capsule. In larger cystic tumors, especially with dense adhesions, it is extremely difficult to avoid rupture of the tumor. Rupture of a thin-walled cyst and spillage in teratomas is not expected to adversely affect the long-term outcome [6, 13]. Our small cohort of patients with a retroperitoneal GCT shows a male predominance, although it is known in literature that retroperitoneal GCTs occur more frequently in females [6]. This might be considered as a bias due to the small size of our cohort.

Conclusion

Surgery of retroperitoneal GCTs is challenging. Most large retroperitoneal GCTs have a close relationship to major vessels. The extent of vascular distortion is hard to predict. Preoperative radiological evaluation can help ascertain the vascular anatomy. During this assessment, it should be kept in mind that anteriorly displaced veins may be occluded or effaced and seem insignificant, and that arteries such as the SMA may be encased. Careful preoperative imaging reduces vascular as well as non-vascular complications such as organ injury, leading to safer surgical procedures.

Appendix

The composed search was as followed:

((Neoplasm*, Germ Cell [MeSH]) OR (Germ Cell Tumor*) OR (Tumor*, Germ Cell) OR (Germ Cell Neoplasm*) OR (Gonadoblastoma*) OR (Endodermal Sinus Tumor*) OR (Teratoma*) OR (Dermoid Cyst*)) AND ((Imaging) OR (Surger*) OR (Radiolog*)) AND ((Abdominal) OR (Retroperitone*)) AND ((Vessel*) OR (Vein*) OR (Great arter*) OR (Arter*) OR (aorta) OR (Inferior Vena Cava) OR (IVC) OR (Superior Mesenteric Artery) OR (Vascular))) NOT (Testi*) NOT (Dysgerminom*) NOT (Ovari*)) filtered on language: English.

We included all the results published until March 2020.

Abbreviations

GCT: Germ cell tumor; AFP: Alpha fetoprotein; IVC: Inferior vena cava; SMA: Superior mesenteric artery; bHCG: Beta human chorionic gonadotropin; MRI: Magnetic resonance imaging; USS: Ultrasound scan; CT: Computed tomography

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None.

Authors' contributions

CCCH, AMCMG, and JFB conceived the study conception and the design of the study. JFB, CDK, CCCH, and AMCMG performed data collection. JFB, CCCH, and AMCMG performed data analysis and interpretation. JFB, CCCH, and AMCMG performed the drafting of the manuscript. CCCH, AMCMG, JZ, ASL, AFWS, and MHWAW provided revisions to scientific content of manuscript and stylistic grammatical revisions to the manuscript. All authors read and approved the final manuscript.

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Availability of data and materials

Data sharing is not applicable to this article as no new data were created or analyzed in this study.

Declarations

Ethics approval and consent to participate

The need for ethics approval was waived by our local ethics committee, as the study is of retrospective nature analyzing anonymized data only.

Consent for publication

Patients signed informed consent regarding publishing their data and photographs.

Competing interests

The authors declare they have no competing interests.

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