

CASE REPORT

Abdominal teratomas in neonates: a case report and literature review

Ada Gawrychowska¹, Maciej Murawski^{2,3}, Katarzyna Sinacka⁴, Aleksandra Ciarka^{5,6}, Anna Jankowska⁴, Piotr Czauderna^{2,3}, Joanna Stefanowicz^{7,8,9}

¹Department of Pediatrics, St. Adalbert's Hospital, Copernicus Medical Entity Sp. z o.o., Gdansk, Poland

²Department of Surgery and Urology for Children and Adolescents, Faculty of Medicine, Medical University of Gdansk, Gdansk, Poland

³Department of Surgery and Urology for Children and Adolescents, University Clinical Center, Gdansk, Poland

⁴Department of Radiology, University Clinical Center, Gdansk, Poland

⁵Department of Pathomorphology, Faculty of Medicine, Medical University of Gdansk, Gdansk, Poland

⁶Department of Pathomorphology, University Clinical Center, Gdansk, Poland

⁷Department of Pediatrics, Hematology and Oncology, Faculty of Medicine, Medical University of Gdansk, Gdansk, Poland

⁸Faculty of Health Sciences, Medical University of Gdansk, Poland

⁹Department of Pediatrics, Hematology, Oncology and Immunology, University Clinical Center, Gdansk, Poland

ABSTRACT

Due to their rarity and often large size at diagnosis, abdominal teratomas in newborns are often challenging to diagnose and treat. We would like to present the case of a newborn with a massive abdominal mass, initially misdiagnosed as a microcystic mesenteric lymphatic malformation, which revealed to be immature teratoma. This case report highlights the challenges associated with the differential diagnosis and surgical management of neonatal abdominal teratomas. It contributes to the literature by presenting diagnostic dilemmas that ultimately led to the accurate identification of this condition.

KEY WORDS:

teratomas, germ cell tumor (GCT), neonates, abdomen, treatment.

INTRODUCTION

Germ cell tumors (GCTs) constitute a diverse group of neoplasms that encompass a wide range of histopathological types and may arise both in gonadal and extragonadal locations. They account for approximately 3% of malignancies in the pediatric population with the incidence increasing to 15% among adolescents [1]. Germ cell tumors demonstrate a characteristic bimodal age distribution with one peak in children aged 0–5 years followed by a larger peak beginning at the age of 15 into the third or fourth decade of life [2].

Germ cell tumors originate from germ cells in their early developmental stages. Primordial germ cells,

the precursors of the germ cell line, can be identified in the yolk sac wall approximately three to four weeks after conception [3]. These cells subsequently migrate along the body's midline, proliferating *en route*, until they reach the gonadal ridges where they form the gonads. Primordial germ cells that fail to reach their gonadal destinations may persist in various locations and, if not eliminated through apoptosis, can give rise to GCTs. This phenomenon explains both the frequent extragonadal locations of pediatric GCTs and their predominant occurrence along the body's midline [1–3].

Based on their histology, GCTs can be classified into two major categories: seminomatous and nonseminomatous GCTs. Seminomatous GCTs comprise undifferentiat-

ADDRESS FOR CORRESPONDENCE:

Joanna Stefanowicz, Department of Pediatrics, Hematology and Oncology, Faculty of Medicine, Medical University of Gdansk, Gdansk, Poland, e-mail: jstefanowicz@gumed.edu.pl

ed germ cells and are termed seminomas when present in testis and in mediastinum, dysgerminomas in ovaries and germinomas when found in brain. Nonseminomatous GCTs consist of cells with varying degrees of differentiation into embryonic or extraembryonic tissues. They can be further subdivided into embryonal carcinoma, yolk sac tumor, choriocarcinoma and teratoma. Germ cell tumors can occur in a pure form with one histopathological type or as a mixed GCT comprising two or more histopathological components [1].

In newborns, GCTs are predominantly extragonadal, while gonadal sites predominate in older children and adolescents. Extragonadal immature teratomas in neonates exhibit a higher risk of recurrence with a malignant component [4]. The most common location for neonatal GCTs is the sacrococcygeal area, followed by the anterior mediastinum, though they can occur at other sites, primarily along the body's midline [2, 5]. Neonatal teratomas may co-occur with various developmental anomalies involving the central nervous system, the urogenital region, or as part of Currarino triad, which includes developmental abnormalities of the sacral and anogenital regions along with teratoma [5].

In this article, we present the case of a newborn boy with a massive abdominal tumor that proved to be immature teratoma. Our case is unique due to its presentation in a newborn with a large tumor in an uncommon location, successfully treated exclusively with surgery. The differential diagnosis with microcystic mesenteric lymphatic malformation is particularly noteworthy. The case required careful assessment of serum tumor markers in correlation with the patient's age, the use of various diagnostic imaging methods and necessitated extensive surgery, which was extremely challenging due to the patient's age. We have conducted a narrative literature review to support our findings and discussion.

CASE REPORT

A male infant was delivered by cesarean section at 39 weeks of gestation, weighing 3850 g with an Apgar score of 10, and presented with a large abdominal mass at birth. The tumor had not been detected on prenatal ultrasounds. The pregnancy was uneventful except for the mother's COVID-19 infection during the fifth month of pregnancy.

Physical examination revealed a palpable mass extending 4 cm below the left costal arch, with no other abnormalities detected. Abdominal ultrasound showed a well-defined solid-cystic intraperitoneal mass measuring approximately 80 × 75 × 74 mm with multiple cystic areas inside, predominantly located on the left side of the abdomen. Serum α -fetoprotein (AFP) was within normal limits for age at 47,527.59 ng/ml (reference range: 9,120–190,546 ng/ml). An abdominal magnetic resonance imaging (MRI) performed on the fourth day of life demonstrated a polycystic intraperitoneal mass

measuring 77 × 60 × 73 mm with multiple cystic areas up to 17 mm, causing displacement of adjacent organs. The overall picture was suggestive of microcystic mesenteric lymphatic malformation (Figure 1 A).

Follow-up ultrasound examination one week later showed tumor growth to 96 × 66 mm, with several clusters of calcifications detected within the mass. Serum tumor markers remained within age-appropriate normal ranges: AFP 15,404 ng/ml (reference range: 1,480–58,887 ng/ml), β -human chorionic gonadotropin (β -hCG) < 0.16 ng/ml (reference range: < 0.16 ng/ml), and lactate dehydrogenase (LDH) 394 U/l (reference range: 180–430 U/l). Due to the rapid tumor growth a minilaparotomy (open biopsy) was performed on the 16th day of life. Histopathological examination confirmed the diagnosis of an immature teratoma. One week post-biopsy, MRI revealed further tumor growth to 99 × 89 × 100 mm (Figure 1 B). Chest computed tomography (CT) with contrast and bone scintigraphy showed no abnormalities.

Following the diagnosis of immature teratoma, tumor resection was the cornerstone of treatment. To prepare for the surgical procedure, the surgical team requested a CT scan to evaluate the tumor's anatomical relationship with surrounding blood vessels. Contrast-enhanced CT imaging revealed a large intra-abdominal mass comprising cystic and solid components, along with pathological vascular structures and focal areas of calcification (arrow) (Figure 2).

The patient underwent tumor resection *via* laparotomy at 30 days of age. Intraoperatively, a giant, well-defined tumor with cystic and solid components was found, predominantly situated on the left side of the abdomen. While the tumor did not invade surrounding structures, it demonstrated strong adhesions to the stomach and mesentery, making its precise origin indeterminable. During dissection from the stomach, a perforation occurred requiring suture repair. The tumor was dissected from the stomach, mesentery, and pancreas, achieving macroscopically complete removal. However, tumor fluid spillage occurred during the dissection, resulting in local contamination of the surgical field. Histopathological examination confirmed immature teratoma, grade 2 (Figure 3) with teratoma tissue present at the resection margins.

The postoperative course was favorable, and the patient was discharged on the 11th postoperative day. Adjuvant systemic chemotherapy was not recommended. Subsequent surveillance with abdominal ultrasounds and MRI examinations showed no evidence of recurrence. The patient experienced poor weight gain for several months post-surgery, without associated vomiting, diarrhea, or urinary tract infections. Weight gain improved with increased frequency of breastfeeding and gradual introduction of solid foods. At one-year post-resection, the patient remains in complete remission with normal serum tumor markers.

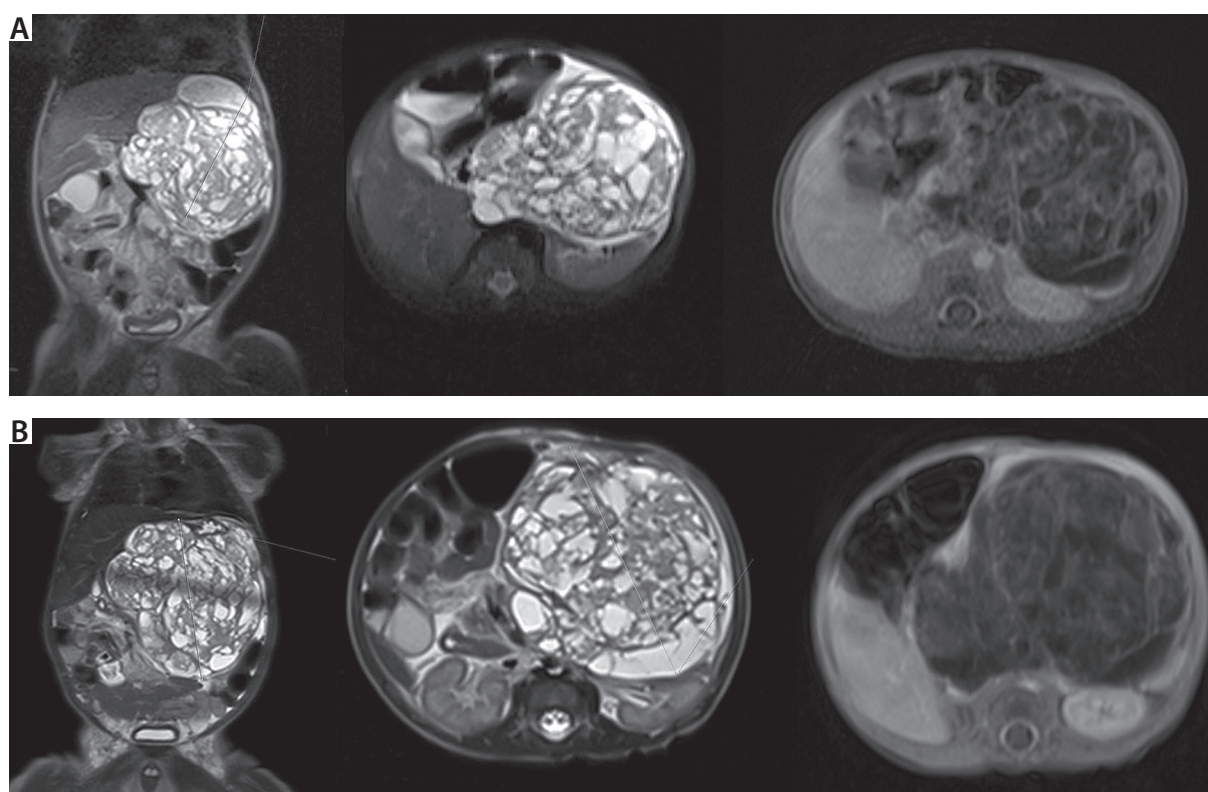


FIGURE 1. A) Abdominal magnetic resonance imaging (MRI) performed on the 4th day of life. MRI T2-weighted images (T2WI) in axial and coronal planes reveal a large intra-abdominal mass, predominantly cystic in nature, with macrocystic features and solid-like microcystic components. Axial contrast-enhanced T1-weighted imaging (T1WI) demonstrates minimal heterogeneous enhancement of the septa and microcystic regions. B) Abdominal MRI performed on the 23rd day of life. MRI T2-weighted images (T2WI) in axial and coronal planes reveal a large intra-abdominal mass, predominantly cystic in nature, with macrocystic features and solid-like microcystic components. Axial contrast-enhanced T1-weighted imaging (T1WI) demonstrates minimal heterogeneous enhancement of the septa and microcystic regions

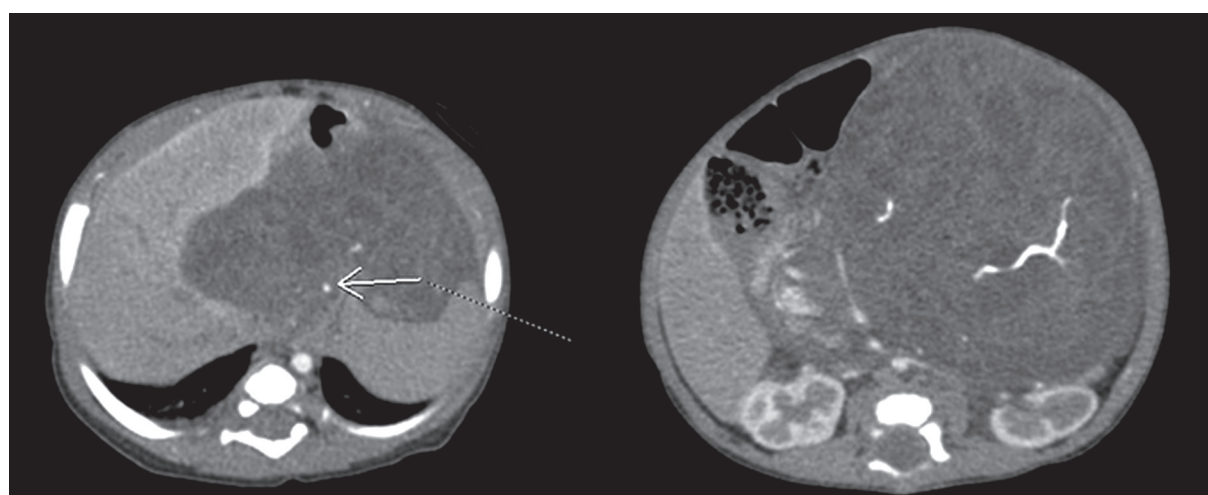


FIGURE 2. Contrast enhanced computed tomography shows a large intraabdominal mas with cystic and solid components with pathological vessels and focal calcifications (arrow)

DISCUSSION

A palpable abdominal mass is a common clinical presentation of malignant solid tumors in children. However, during the neonatal period, these masses are more often benign congenital malformations of the genitourinary or gastrointestinal systems. Among the differential diagno-

ses, GCTs should be carefully considered [6]. Abdominal GCTs, representing approximately 4% of all GCTs in the pediatric population, can occur in both intraperitoneal and retroperitoneal locations [7].

The vast majority are mature or immature teratomas, rarely containing malignant components. Due to their substantial size, precise identification of the tumors' ori-

gin is often challenging [2, 7]. In the case of our patient, the site of origin could not be definitively determined.

Teratomas, the most common histologic subtype of neonatal GCTs, are classified as mature (containing well-differentiated tissues), immature (containing varying degrees of immature fetal tissue, most often neuroectodermal), or malignant (containing at least one malignant germ cell element) [8].

Teratomas consist of tissues derived from three germ layers: ectoderm, mesoderm, and endoderm. Although a variety of tissues can be found, the most frequently observed include skin and its derivatives, fatty tissue, neural components, and different types of glandular epithelium. Hematopoietic, pancreatic, and pituitary tissues are commonly associated with mediastinal tumors but are rarely seen in teratomas located elsewhere. Immature teratomas are most often found in extragonadal regions, particularly in newborns. While their macroscopic appearance is similar to that of mature teratomas, they are distinguished by the presence of immature tissues, usually of neuroepithelial origin, which is essential for diagnosis [4, 9].

Immature teratomas are graded according to the proportion of immature neural elements present, ranging from grade 1 to 3 [10]. Current guidelines do not require grading of immature teratomas in neonates, as it does not influence prognosis or management in this patient group [5]. The presence or absence of a malignant component serves as a more significant prognostic factor [4]. Additional factors negatively affecting the prognosis in congenital teratomas include the presence of a solid component (vs. cystic components, which carry a better prognosis), tumor size, the presence of hydrops fetalis and incomplete resection [11, 12]. Congenital large teratomas (> 10 cm) are associated with an increased risk of fetal hydrops and neonatal mortality [13].

In pediatric cases, complete surgical removal alone remains the mainstay of treatment for both mature and immature teratomas, with chemotherapy rarely indicated [2, 14–16]. However, achieving complete tumor resection can be challenging, with various postoperative complications reported [15, 17]. The large tumor size and strong adhesions to surrounding organs often complicate the achievement of negative margins and prevention of tumor rupture during surgery [15]. Notably, positive tumor margins and intraoperative cyst fluid spillage alone do not necessitate chemotherapy [2, 14–16]. While the majority of relapses occur in grade 3 tumors, adjuvant chemotherapy has not been shown to decrease recurrence risk in the pediatric population [18].

To optimize our patient's treatment approach, we conducted a comprehensive narrative literature review focusing on abdominal teratomas in neonates. We searched three major databases – PubMed, Web of Science, and Scopus – covering publications from the past decade. The search strategy employed the keywords “abdominal teratoma” and “neonates.”

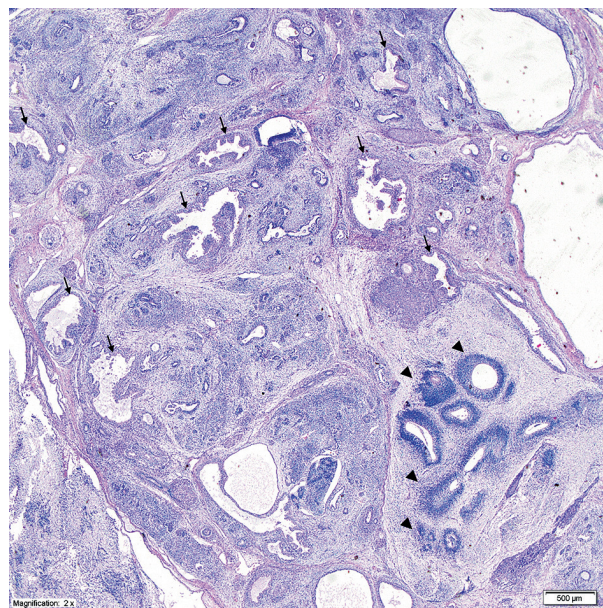


FIGURE 3. Immature teratoma containing components of immature glandular (arrows), mesenchymal (stromal cells) and nervous tissue (arrow heads) (HE, magnification 2×)

This narrative review aimed to establish differential diagnosis and identify optimal treatment strategies. Table 1 summarizes the case reports of neonatal abdominal teratomas identified in our review. We found 33 documented cases, comprising 16 mature teratomas, 16 immature teratomas, and one unspecified teratoma. Surgical intervention was the primary treatment modality in all cases. Among these cases, only two patients (patient 16 and patient 17) received chemotherapy (bleomycin, etoposide, and cisplatin) due to the presence of yolk sac tumor foci, followed by surgical resection [29, 30].

Of the reported cases, four patients died: three due to immediate postoperative complications (patients 9, 13, and 25), and one at four months post-surgery due to a coexisting cardiac anomaly (patient 21) [22, 26, 34–35].

The spectrum of neonatal and pediatric abdominal masses is broad, encompassing both congenital and acquired lesions that may be benign or malignant. Optimal imaging strategies are essential and should be tailored to the suspected tumor type [6]. In our case, abdominal ultrasound revealed a well-defined solid-cystic intraperitoneal mass measuring approximately 80 × 75 × 74 mm, with multiple cystic areas predominantly located on the left side of the abdomen. Abdominal MRI further demonstrated a polycystic intraperitoneal mass measuring 77 × 60 × 73 mm, containing multiple cystic areas up to 17 mm in size and causing displacement of adjacent organs. This imaging initially suggested a diagnosis of microcystic mesenteric lymphatic malformation. However, contrast-enhanced CT, performed after biopsy and during preoperative preparation, revealed a large intra-abdominal mass with cystic and solid components, pathological vessels, and focal calcifications, findings more consistent with

TABLE 1. Abdominal teratomas in neonates: summary of cases published and found in 3 databases: PubMed, Web of Science, Scopus during last 10 years. Review of literature

No.	Age at presentation [days]	Sex (F/M)	Tumor location	Tumor size [cm]	Histopathology	Serum tumor markers at diagnosis	Treatment	Follow-up	Article
1.	1	M	Retroperitoneal space	11 × 10 × 9	IT	↑AFP – 35,350 ng/ml (N 33,130 ± 32,503) β-hCG-N	TR	Recurrence in the FU MRI of the abdomen at 4 m ≥ resection; no recurrence at 12-m FU	Ibrahim <i>et al.</i> [19]
2.	Mass detected at 32 weeks of gestation	M	Stomach	Endogastric 2 × 3 cm, exogastric 6 × 7 cm	MT	AFP, β-hCG-N	CTR	No recurrence at 3-y FU	Aihole <i>et al.</i> [20]
3.	28	F	Stomach	10 × 8	IT, G1	AFP, β-hCG, LDH-N	CTR	No recurrence at 4-y FU	Aihole <i>et al.</i> [20]
4.	Mass detected antenatally	F	Umbilical cord	7	MT	AFP, β-hCG-N	TR	Another 3 laparotomies to deal with intestinal malformations, 4 th laparotomy on the 134 th d of life with removal of 2 masses close to pancreas – MT; No recurrence at 23-m FU	Doktor <i>et al.</i> [21]
5.	1	F	Stomach	No data	IT	No data	TR	No recurrence at FU (no data regarding FU time)	Saleem <i>et al.</i> [22]
6.	15	M	Stomach	No data	MT	No data	TR	No recurrence at FU (no data regarding FU time)	Saleem <i>et al.</i> [22]
7.	7	F	Stomach	No data	MT	No data	TR	No recurrence at FU (no data regarding FU time)	Saleem <i>et al.</i> [22]
8.	25	M	Stomach	No data	MT	No data	TR	No recurrence at FU (no data regarding FU time)	Saleem <i>et al.</i> [22]
9.	15	F	Stomach	No data	MT	No data	TR	Death in the postoperative period due to septicemia	Saleem <i>et al.</i> [22]
10.	1	M	Stomach	10.1 × 13.2 × 8.2	IT, G3	AFP-N	CTR	No recurrence at 15-m FU	Caballes <i>et al.</i> [23]
11.	Mass detected antenatally	M	Right subhepatic region	3 × 5	Fetiform MT	AFP-N	TR	The patient was diagnosed with contralateral adrenal neuroblastoma at 5 m of age and undergone 1 cycle of chemotherapy and resection of the tumor	Newcomb <i>et al.</i> [24]

TABLE 1. Cont.

No.	Age at presentation [days]	Sex (F/M)	Tumor location	Tumor size [cm]	Histopathology	Serum tumor markers at diagnosis	Treatment	Follow-up	Article
12.	1	F	Retroperitoneal space	11 × 9 × 5	IT with microscopic YST	↑ AFP (no precise data) β-hCG-N	CTR	no recurrence at 3-y FU	Majjiga <i>et al.</i> [25]
13.	Mass detected antenatally	F	Exophytic mass originating from the anterior abdominal wall close to the origin of omphalocele sac	20 × 15 × 8	IT	No data	ligation of the supplying artery to the tumor followed by excision of the tumor	Death 14 hours after surgery due to hypovolemic shock caused by hemorrhage at ligation site	Werner <i>et al.</i> [26]
14.	20	M	Stomach	14 × 10 × 10	MT	AFP, β-hCG-N	CTR	No recurrence at 1-y FU	Kharga <i>et al.</i> [27]
15.	Mass detected at 22 weeks of gestation	M	Abdominal mass proximally to the left internal inguinal ring in a cryptorchid testis	1.8 × 1.3 × 1.4	Teratoma	No data	TR	No data	Janda <i>et al.</i> [28]
16.	1	F	Hepatoduodenal ligament	7.6 × 7.9 × 7.5; tumor progression during CHT- 10.6 × 10.5 × 9.4	At excisional biopsy – IT with YST elements; final histopathology after chemotherapy – MT	↑ AFP – 212,340 ng/ml (N 40,000–80,000)	CHT (bleomycin, etoposide, cisplatin) ≥ growth of the tumor during CHT-> microscopically non-radical TR with cholecystectomy	No recurrence at 7-m FU	De Roo <i>et al.</i> [29]
17.	1	M	Stomach	10 × 8 × 7	IT, G3	↑ AFP – 17111 ng/ml (no data regarding normal limits) β-hCG-N	CTR, followed by adjuvant CHT with 4 cycles of bleomycin, etoposide, cisplatin	No recurrence at 3-y FU	Roh <i>et al.</i> [30]
18.	Mass detected antenatally	M	Stomach	8 × 6	MT	AFP, β-hCG-N	CTR	No recurrence at 6-m FU	Bhardwaj <i>et al.</i> [31]
19.	15	M	Stomach	9.5 × 5 × 3	IT	No data	CTR	No recurrence at FU (no data regarding FU time)	Kumar <i>et al.</i> [32]
20.	Mass detected antenatally	M	Hepatoduodenal ligament	No data	IT, G3	↑ AFP – 20,000 units β-hCG – 1.2 units	TR	No data	Ravikumar <i>et al.</i> [33]
21.	First days of life	M	Retroperitoneal space	7.5 × 7	IT, G2	AFP, β-hCG-N	CTR	The patient died at the age of 4 m due to ventricular tachycardia attack resulting from the existing cardiac anomaly	Karaman <i>et al.</i> [34]

TABLE 1. Cont.

No.	Age at presentation [days]	Sex (F/M)	Tumor location	Tumor size [cm]	Histopathology	Serum tumor markers at diagnosis	Treatment	Follow-up	Article
22.	1	M	Stomach	$9.2 \times 8.2 \times 7.3$	IT, G2	No data	TR	No recurrence at FU (no data regarding FU time)	Mathur <i>et al.</i> [35]
23.	4	M	Stomach	$10.5 \times 7.5 \times 6.5$	MT	No data	TR	No recurrence at FU (no data regarding FU time)	Mathur <i>et al.</i> [35]
24.	2	M	Stomach	$7 \times 6.5 \times 5.5$	MT	No data	TR	No recurrence at FU (no data regarding FU time)	Mathur <i>et al.</i> [35]
25.	15	M	Stomach	$14 \times 9 \times 6$	IT, G1	No data	TR	The patient died in the postoperative period due to septicemia	Mathur <i>et al.</i> [35]
26.	5	M	Stomach	$9.5 \times 5 \times 3$	MT	AFP-N	TR	No recurrence at 6-m FU	Chatterjee <i>et al.</i> [36]
27.	Mass detected at 33 weeks of gestation	M	Abdominal mass proximally to the right internal inguinal ring in a cryptorchid testis	3.8×2.8	IT	AFP, β -hCG-N	TR	No recurrence at 3-y FU	Yada <i>et al.</i> [37]
28.	Mass detected antenatally	F	Retroperitoneal space	No data	MT	$\uparrow$ AFP (no precise data)	CTR	No recurrence at 7-y FU	Paradies <i>et al.</i> [38]
29.	28	M	Retroperitoneal space	$15 \times 15 \times 15$	MT	AFP, β -hCG-N	CTR	No recurrence at 1-y FU	Joshi <i>et al.</i> [39]
30.	Mass detected at 37 weeks of gestation	M	Retroperitoneal space	$9 \times 8.4 \times 9$	IT	$\uparrow$ AFP – 76000 ng/ml (no data regarding normal limits) β -hCG-N	TR	No recurrence at 2-m FU	Sato <i>et al.</i> [40]
31.	2	M	Retroperitoneal space	$8 \times 10 \times 10$	IT	AFP-N	CTR	No recurrence at 2.5-y FU	Tainaka <i>et al.</i> [41]
32.	26	M	Kidney	No data	MT	No data	Nephrectomy	No recurrence at 1-y FU	Modi <i>et al.</i> [42]
33.	7	F	Duodenum	$3 \times 2 \times 2$	MT	AFP-N	CTR	No recurrence at 5-m FU	Joshi, <i>et al.</i> [43]

C – component, CHT – chemotherapy, CTR – complete tumor resection, d – days, F/M – female/male, FU – follow-up, G – grade, IT – immature teratoma, m – months, MT – mature teratoma, TR – tumor resection, y – years, YST – yolk sac tumor

a teratoma. It is important to emphasize that the differential diagnosis of cystic abdominal lesions includes lymphatic malformations, teratomas, and liver hamartomas.

Serum tumor markers – AFP, β -hCG, and LDH – play crucial roles in GCTs management, facilitating risk stratification, treatment response assessment, and early relapse detection. These markers require measurement at diagnosis and regular monitoring throughout and after treatment [44–47]. Elevated β -hCG levels typically indicate choriocarcinoma, while LDH serves as a non-specific marker correlating with disease burden. Serum α -fetoprotein elevation commonly occurs in yolk sac tumors but may also present in embryonal carcinoma or immature teratoma with yolk sac tumor microfoci [2, 44, 45, 47]. Importantly, AFP upper limit is elevated in all infants, gradually declining to adult levels during the first two years of life [46]. Similarly, β -hCG levels are physiologically elevated in newborns, reflecting maternal concentrations, but normalize within weeks given its 24–36-hour half-life [44]. Lactate dehydrogenase levels also demonstrate age-related variations [44, 47].

Our case presented a particular interest due to its challenging differential diagnosis, especially considering lymphatic malformation of the abdomen as a primary alternative based on imaging studies. The correct diagnosis proved crucial for determining treatment.

The number of databases used for a literature review and time are limitations of our study.

CONCLUSIONS

Abdominal immature teratomas, though rare, present significant diagnostic and therapeutic challenges. Successful management requires multidisciplinary collaboration among oncologists, surgeons, pathologists, and radiologists. While complete surgical excision typically suffices as primary treatment, careful post-operative monitoring through imaging and serum tumor markers remains essential. This case report contributes to the understanding of neonatal teratoma management, though its generalizability is limited by the small number of documented cases in the literature.

DISCLOSURES

1. Institutional review board statement: None.
2. Assistance with the article: None.
3. Financial support and sponsorship: None.
4. Conflicts of interest: None.

REFERENCES

1. Pierce JL, Lindsay Frazier A, Amatruda JF. Pediatric germ cell tumors: a developmental perspective. *Adv Urol* 2018; 2018: 9059382.
2. Shah R, Weil BR, Weldon CB, Amatruda JF, Frazier AL. Neonatal malignant disorders: germ cell tumors. *Clin Perinatol* 2021; 48: 147–165.
3. Mamsen LS, Bröchner CB, Byskov AG, Møllgaard K. The migration and loss of human primordial germ stem cells from the hind gut epithelium towards the gonadal ridge. *Int J Dev Biol* 2012; 56: 771–778.
4. Heerema-Mckenney A, Harrison MR, Bratton B, Farrell J, Zaloudek C. Congenital teratoma: a clinicopathologic study of 22 fetal and neonatal tumors. *Am J Surg Pathol* 2005; 29: 29–38.
5. Lakhoo K. Neonatal teratomas. *Early Hum Dev* 2010; 86: 643–647.
6. Kim HHR, Hull NC, Lee EY, Phillips GS. Pediatric abdominal masses: imaging guidelines and recommendations. *Radiol Clin North Am* 2022; 60: 113–129.
7. Billmire D, Vinocur C, Rescorla F, Colombani P, Cushing B, Hawkins E, et al. Malignant retroperitoneal and abdominal germ cell tumors: An intergroup study. *J Pediatr Surg* 2003; 38: 315–318.
8. Marina NM, Cushing B, Giller R, Cohen L, Lauer SJ, Ablin A, et al. Complete surgical excision is effective treatment for children with immature teratomas with or without malignant elements: a pediatric oncology group/children's cancer group intergroup study. *J Clin Oncol* 1999; 17: 2137–2143.
9. Harms D, Zahn S, Göbel U, Schneider DT. Pathology and molecular biology of teratomas in childhood and adolescence. *Klin Padiatr* 2006; 218: 296–302.
10. Norris HJ, Zirkin HJ, Benson WL. Immature (malignant) teratoma of the ovary: a clinical and pathologic study of 58 case. *Cancer* 1976; 37: 2359–2372.
11. Benachi A, Durin L, Vasseur Maurer S, Aubry MC, Parat S, Herlicovitz M, et al. Prenatally diagnosed sacrococcygeal teratoma: a prognostic classification. *J Pediatr Surg* 2006; 41: 1517–1521.
12. Harding M, Hole D, Gillis C. The epidemiology of non-seminomatous germ cell tumours in the west of Scotland 1975–89. *Br J Cancer* 1995; 72: 1559–1562.
13. Ayed A, Tonks AM, Lander A, Kilby MD. A review of pregnancies complicated by congenital sacrococcygeal teratoma in the west midlands region over an 18-year period: population-based, cohort study. *Prenat Diagn* 2015; 35: 1037–1047.
14. Mann JR, Gray ES, Thornton C, Raafat F, Robinson K, Collins GS, et al. Mature and immature extracranial teratomas in children: the UK children's cancer study group experience. *J Clin Oncol* 2008; 26: 3590–3597.
15. Kawano T, Sugita K, Kedoin C, Nagano A, Matsui M, Murakami M, et al. Retroperitoneal teratomas in children: a single institution experience. *Surg Today* 2022; 52: 144–150.
16. Göbel U, Calaminus G, Engert J, Kaatsch P, Gadner H, Bökke-riink JP, et al. Teratomas in infancy and childhood. *Med Pediatr Oncol* 1998; 31: 8–15.
17. Augé B, Satgé D, Sauvage P, Lutz P, Chenard MP, Levy JM. Les tératomes rétropéritonéaux de la période périnatale. *Ann Pédiatr* 1993; 40: 613–621.
18. Pashankar F, Hale JP, Dang H, Krailo M, Brady WE, Rodriguez-Galindo C, et al. Is adjuvant chemotherapy indicated in ovarian immature teratomas? A combined data analysis from the Malignant Germ Cell Tumor International Collaborative. *Cancer* 2016; 122: 230–237.
19. Ibrahim H, Huda S, Northcutt A, Sorells D. Retroperitoneal immature teratoma. *J La State Med Soc* 2015; 167: 50–53.
20. Aihole JS, Babu MN, Jadhav V, Javaregowda D. Gastric teratoma: an unusual presentation and location. *Indian J Med Paediatr Oncol* 2017; 38: 563–565.
21. Doktor F, Gosemann JH, Zimmermann P, Siekmeyer M, Stepan H, Lacher M. Umbilical cord teratoma presenting as ruptured omphalocele. *Eur J Pediatr Surg Rep* 2022; 10: e6–8.
22. Saleem M, Mirza B, Talat N, Sharif M. Gastric teratoma: our 17 year experience. *J Pediatr Surg* 2018; 53: 234–236.

23. Caballes AB, Dungca LBP, Uy MEV, Torralba MGC, Embuscardo CMG, Hydrops fetalis and neonatal abdominal compartment syndrome continuum from immature gastric teratoma: a case report. *BMC Pediatr* 2020; 20: 1-6.
24. Newcomb LK, Rhee EHJ, Bean SM, Kim J, Tracy ET, Kuller JA. Pregnancy complicated by foetal abdominal mass: fetiform teratoma versus foetus-in-fetu. *J Obstet Gynaecol* 2017; 37: 815-817.
25. Majjiga VS, Bhatt N, Kavarianian A, Batton B. A newborn with massive intra-abdominal haemorrhage. *BMJ Case Rep* 2015; bcr2015211279.
26. Werner H, Mocarzel C, Sá RA, Tonni G, Novoa y Novoa VA, Avvad-Portari E, et al. Antenatal diagnosis of a large immature abdominal wall teratoma by 2D-3D ultrasound using HDlive and magnetic resonance imaging. *Fetal Pediatr Pathol* 2016; 35: 434-441.
27. Kharga B, Kumar V, Santosh Prabhu P, Sundeep PT, John SK. Neonatal gastric teratoma: a rare entity. *J Clin Diagnostic Res* 2014; 8: 185-186.
28. Janda GM, Najdzionek JS, Kozielski R, Greenfield SP, Williot PE. Early prenatal detection of an intra-abdominal cryptorchid testicular teratoma. *Urology* 2014; 83: 214-216.
29. De Roo AC, Siddiqui S, Mychaliska GB. Hepatoduodenal ligament teratoma with immature elements. *Pediatr Surg Int* 2017; 33: 1023-1026.
30. Roh CK, Jung MJ, Kim J, Chin S, Moon A. Spontaneous rupture of immature gastric teratoma with hemoperitoneum in a newborn with 3-year follow-up. *Rom J Morphol Embryol* 2020; 61: 253-256.
31. Bhardwaj P, Thattaruparambil VP, Vellaisamy G, Mahadevaiah S, Hegde S. Gastric teratoma presenting as melena in the newborn: a case report. *J Neonatal Perinatal Med* 2022; 15: 667-669.
32. Kumar S, Yadav H, Rattan KN, Srivastava D, Chandana A, Prakash S. Immature gastric teratoma in a newborn: a case report. *J Neonatal Surg* 2016; 5: 21.
33. Ravikumar VR, Rajamani G, Raju V, Sundar R, Ravikumar S, Maniam R. Teratoma arising from hepato duodenal ligament in the newborn with transection of portal vein, hepatic artery and common bile duct: a surgical challenge. *J Indian Assoc Pediatr Surg* 2018; 23: 45-47.
34. Karaman I, Kara YA, Balci O, Ozyazici A, Keles B, Tasci-Yildiz Y, et al. Congenital retroperitoneal immature teratoma in a male neonate: a case report. *J Ped and Neonatal Ind Med* 2022; 11: e110136.
35. Mathur P, Gupta R, Prabhakar G, Agrawal LD, Rao RS, Goyal RB. Gastric teratoma in children: our experience. *Formos J Surg* 2015; 48: 86-93.
36. Chatterjee R, Singh A, Gharpure V. Case report of gastric teratoma masquerading as neonatal intestinal obstruction. *Ann Pediatr Surg* 2020; 16: 4.
37. Yada K, Ishibashi H, Mori H, Shimada M. Laparoscopic resection of prenatally detected intra-abdominal testicular teratoma: report of a neonatal case. *J Pediatr Surg Case Reports* 2017; 23: 43-45.
38. Paradies G, Zullino F, Orofino A, Leggio S. Rare extragonadal teratomas in children: complete tumor excision as a reliable and essential procedure for significant survival. Clinical experience and review of the literature. *Ann Ital Chir* 2014; 85: 56-68.
39. Joshi J, Mushtaq OA, Roy S, Rao SS. A neonate with retroperitoneal mature cystic teratoma – a case report. *J Nepal Paediatr Soc* 2022; 42: 147-150.
40. Sato K, Fukuzawa T, Wada M, Sasaki H, Kudo H, Ando R, et al. Rapidly growing immature retroperitoneal teratoma in a neonate. *J Pediatr Surg Case Rep* 2021; 69: 101891.
41. Tainaka T, Ono Y, Yamada Y, Mutoh D, Uchida H. Large retroperitoneal immature teratoma leading to renovascular hypertension. *Pediatr Int* 2016; 58: 1363-1364.
42. Modi J, Modi D, Bachani M, Bachani L. Congenital renal teratoma with cystic dysplasia in a neonate: rare entity. *J Clin Neonatol* 2015; 4: 126-128.
43. Joshi P, Parelkar S, Shetty S, Sanghvi B, Mundada D, Kapadnis S, Oak S. Mature duodenal teratoma in a neonate with exomphalos minor with intestinal obstruction: first case report. *Eur J Pediatr Surg* 2014; 24: 187-189.
44. Jezierska M, Gawrychowska A, Stefanowicz J. Diagnostic, prognostic and predictive markers in pediatric germ cell tumors – past, present and future. *Diagnostics* 2022; 12: 1-16.
45. Trigo JM, Taberner JM, Paz-Ares L, Garcia-Llano JL, Mora J, Lianes P, et al. Tumor markers at the time of recurrence in patients with germ cell tumors. *Cancer* 2000; 88: 162-168.
46. Blohm ME, Vesterling-Hörner D, Calaminus G, Göbel U. Alpha 1-fetoprotein (AFP) reference values in infants up to 2 years of age. *Pediatr Hematol Oncol* 1998; 15: 135-142.
47. Sandoval JA, Malkas LH, Hickey RJ. Clinical significance of serum biomarkers in pediatric solid mediastinal and abdominal tumors. *Int J Mol Sci* 2012; 13: 1126-1153.