SURGICAL OUTCOME OF PEDIATRIC EXTRACRANIAL GERM CELL TUMORS: 10 YEARS SINGLE CENTER EXPERIENCE

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III. ACRONYMS AND ABBREVIATIONS

AAU	Addis Ababa University
CHS	College of Health Sciences
CT	Computed Tomography
COG	Children's oncology group
EGGCT	Extra- Gonadal germ cell tumors
GCT	Germ cell tumors
GGCT	Gonadal germ cell tumors
MRI	Magnetic Resonance Imaging
SPSS	Statistical Package for Social Sciences
TASH	Tikur Anbessa Specialized Hospital

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Abstract

Background: Pediatric germ cell tumors are a rare type of cancer in children, and they are classified as a heterogeneous group that exhibits a wide range of clinical behavior, histology, and location characteristics. Although there is sufficient data available on the clinicopathologic characteristics of these tumors, there is a scarcity of information regarding their surgical outcome, and the existing data is mostly based on a single institution's experience. Moreover, there is limited knowledge about the epidemiology and surgical outcome of pediatric germ cell tumors in developing countries, especially in Sub-Saharan Africa. This study aimed to examine the early surgical outcome of pediatric extracranial germ cell tumors and the factors associated with the surgical outcomes.

Methods: We analyzed the clinical data of patients who underwent surgery for extracranial germ cell tumors at TASH. The study was conducted by reviewing the medical records of all patients who were diagnosed with histologically confirmed germ cell tumors from January 1, 2013, to January 1, 2023. We assessed the demographic features, clinical findings, laboratory results, radiographic findings, intraoperative findings, perioperative complications, and pathology results of the patients.

Results: A total of 45 patients with extracranial GCT were included in this study, comprising 35 females (77.8%) and 10 males (22.2%). The age of patients ranged from 1 day to 12 years, with a median age of 12 months. The median duration of hospital stay was ten days, with an IQR of 11. Fifteen patients experienced perioperative complications, including six with intraoperative complications and ten with postoperative complications. On univariate analysis, the rate of perioperative complications was positively associated with the need for intraoperative transfusion ($p = 0.015$), and the rate of intraoperative complications was associated with the degree of tumor maturation ($p = 0.02$).

Conclusions: The surgical treatment of germ cell tumors is associated with a significant rate of perioperative complications. To improve surgical outcomes and reduce the risk of complications, larger prospective studies using our series as a reference point are needed to identify factors that predict surgical outcomes and develop effective strategies.

Keyword; Germ cell tumors, Pediatric, Surgical outcome , Developing countries

Introduction

Background

Pediatric germ cell tumors (GCTs) are a rare and heterogeneous group of pediatric tumors. Only a few recent publications on epidemiologic data showing the trends in the incidence of pediatric GCTs are available. The primordial germ cells in a developing embryo are thought to be the source of GCTs, which move to the gonadal ridges during development along the body's midline. (1)About 60% of cases in pediatric age involve extragonadal locations including the brain, neck, mediastinum, retroperitoneum, and sacro-coccyx with the sacrococcyx being the most common site of origin. The gonadal sites, ovary and testis, represent 40% of cases. (2)

In the Children's Oncology Group (COG), current treatment is risk-based. Management consists of surgical resection for localized disease, chemotherapy for residual or metastatic disease, and neoadjuvant chemotherapy and delayed surgical excision for unresectable lesions. The mainstay of treatment for GCTs is surgery; hence, the surgeon's role in establishing resectability and carrying out an appropriate staging procedure is crucial. The survival for children with germ cell tumors has improved significantly over the past 2 decades. (3)Even in cases of severe disease, the introduction of platinum-based chemotherapy has led to cure rates above 80 %. (4)

Statement of Problem

No previous research, including in sub-Saharan pediatric populations, has examined the relationships between the initial clinical presentation, surgical management, and outcome of pediatric GCTs. There are only a few single-center retrospective studies regarding the surgical outcome of single-site GCTs and the factors associated with the surgical outcomes.

Significance of the study

This research will examine the clinical features and surgical outcomes of patients who underwent pediatric GCT surgery at TASH. It will be the first study of its kind in sub-Saharan countries and will contribute to the scarcity of studies in LMIC on the topic. In the near future, it would also pave the way for prospective studies on the surgical management of pediatric GCTs in our center.

Objectives

General:

1. To review the surgical outcome of pediatric extracranial germ cell tumors.

Specific:

1. To analyze the clinical features of pediatric GCTs.
2. To assess correlations between radiologic findings and intraop findings.
3. To assess correlations between intraop findings and pathologic findings.
4. To evaluate the immediate and early surgical complications..
5. To identify factors associated with perioperative complications in the treatment of pediatric GCTs.

Methodology

Study setting

The study was conducted at Tikur Anbessa Specialized Hospital. TASH is the largest referral teaching hospital, under the administration of Addis Ababa University, located in Addis Ababa, Ethiopia. It has around 800 beds, of which the pediatric surgery unit has 30 beds.

Study design

A hospital-based retrospective, cross sectional study design is used. The study was conducted by reviewing the medical charts of all patients operated from Jan 1, 2013, to Jan 1, 2023, with histologically confirmed germ cell tumors. Data on demographics, clinical findings, tumor location, histopathology, stage, imaging, surgical management, and survival were be reviewed.

Population

Source population: All pediatric patients who underwent elective surgery at TASH.

Study population: All patients who underwent surgery for pediatric germ cell tumors.

Inclusion and exclusion criteria

Inclusion criteria: All patients who got operated for diagnosis of extra cranial pediatric germ cell tumors during the study period.

Exclusion criteria: Data of patients which was found to be incomplete will be excluded

Study variables

Independent Variables: Age, Sex, Symptom at diagnosis, Tumor size, Location of tumor , Stage , Type of surgery, Surgical time, Anesthesia time, Estimated blood loss, Intra operative accident , Histopathology, duration of hospital stay

Dependent variables: Perioperative complications, 7th & 30th day mortality

Sampling Technique

Non-probabilistic convenient sampling technique was utilized.

Data Collection methods

Pediatric surgery Ward admission and operation log books were used to identify patients who were operated on for GCTs in the study period. All patients' medical record numbers were retrieved. This helped get each patient's chart from the electronic medical record (I-care) and paper-based health records. Secondary data was collected using a structured data extraction tool. The data was collected by the researcher and colleagues under the continuous supervision of the supervisor.

Data analysis and interpretation

Statistical analyses was performed by SPSS version 26. Two-tailed *P*-values <0.05 were considered statistically significant. Continuous variables were presented as the median (interquartile range, IQR). Categorical variables were presented as numbers (percentages) and compared using the chi-square test or two-tailed Fisher's exact test as appropriate. Univariate logistic regression model was then used to ascertain the

effect of surgical risk factors on perioperative complications. The results of the study are presented by tables and charts.

Operational definition

Pediatric age group: Age from birth to 13 years

Length of Hospital stay: Period of time from day of admission to hospital discharge.

Intraoperative complications: incidents during time of surgery including tumor rupture, vascular / organ injury, removal of adjacent organs, bleeding requiring massive transfusion or death.

Perioperative complications: Intraoperative or Postoperative problems after surgery, which may (or may not) be directly related to the disease for which the surgery was done or to the surgery itself.

Survival: Being alive at certain point in time

Ethical considerations

Ethical clearance was obtained from the Institutional Review Board of the Faculty of Medicine, AAU with cooperation letters written to the medical recording department of TASH. Health facility records were coded and kept confidential.

Results

Demographic features

A total of 45 patients with extracranial GCT were included in this study, of whom 35 (77.8%) were girls and 10 (22.2%) were boys. The age of the patients ranged from 1 d to 12 years, with a median of 12 months. Of the patients, 64.4% were older than two months. Most of the patients (66.7 %) came from outside Addis Ababa.

Clinical data

The most common symptom at presentation was the presence of a mass at the site of the tumor, with sacral masses accounting for the majority of cases (51.1%) (Table 1) .Other patients presented with local compressive effects of the masses, such as urinary complaints, constipation, and respiratory symptoms. The most frequent sign was the finding of a palpable mass at the site of the tumor, the most common finding being a palpable sacral mass (60%), followed by an abdominal mass (24.4%). Preoperative AFP levels were determined in 32 patients (71.1%). AFP levels were elevated in six patients (13.3). Fifteen patients (33.3%) had perioperative complications and 30 (66.7%) did not have perioperative complications. The rate of perioperative complications was positively associated with the need for intraoperative blood transfusions ($p = 0.016$). Age, sex, initial symptoms, and AFP were unrelated to perioperative complications ($P > 0.05$).

Imaging Data

Computed tomography (CT) or magnetic resonance imaging (MRI) was performed in 32 patients. The median tumor size was 11.5 with an IQR of 8.7 (Table 2). The tumor margins were clear in 27 patients (60%). The tumor infiltrated nearby organs in four patients and wrapped around vessels in two patients. There were no significant differences in the rate of perioperative complications, regardless of the imaging characteristics.

Surgical data

All the patients underwent elective surgery. Different surgical procedures were done based on the site of origin of GCTs being either gonadal or extragonadal. The most frequent incision was the posterior sagittal, and the most common position was the prone position (Table 3). Surgery took one–three hours in most cases (73.3%).Complete tumor excision was performed in all but one patient. Twelve patients (26.7%) required intraoperative blood transfusions of one or more blood products. Whole blood was used in 10 patients. One patient received massive transfusion. The incidence of intraoperative complications was 13.3%, which occurred in six patients. The most common complication was tumor rupture, which

occurred in five patients. Pathological data showed that the degree of tumor maturation was related to intraoperative complications (P =0.02).

Histopathology

Most tumors were benign, accounting for 77.8% of cases. Yolk-sac tumors are the most common malignant lesions. Five of the ten malignant tumors were low risk according to COG risk stratification. Pathological data showed that the degree of tumor maturation was related to intraoperative complications (P =0.02). The most prevalent stage at the time of diagnosis was Stage 1 (91.1%).

Post-op Course and Complications

Among the 15 patients with perioperative complications, six had intraoperative complications and 10 had postoperative complications. The most common postoperative complication was wound infection (five patients), followed by postoperative bleeding (two patients). Four patients required reoperation: two patients with wound dehiscence, one postop bleeding and one with wound infection. Five patients with a malignant histology received adjuvant chemotherapy. The median duration of hospital stay was ten days (IQR, 11. The duration of the hospital stay was not related to the rate of perioperative complications.

Analysis of risk factors associated with perioperative complications

The rate of perioperative complications was positively associated with the intraoperative need for transfusion (p = 0.015). On univariate analysis, the rate of intraoperative complications was associated with the degree of tumor maturation (P =0.02). Histopathological patterns and other risk factors were not associated with an increased risk of complications.

Table 1 Demographic and clinical characteristics of patients

Characteristics	Total (n=45)	No PCs (n=35)	With PCs (n=10)	*P* value

Sex				P=0.710 *
Male	10 (22.2%)	6(20%)	4(26.7%)	
Female	35 (77.8%)	24(80%)	11 (73.3%)	
Age in years				P=0.399
□1	23(51.1%)	14 (46.7%)	9(60%)	
>1	22(48.9%)	16 (53.3)	6(40%)	
Residence				P=0.502
Addis Ababa	15(33.3%)	12(34.3%)	3(30%)	
Outside of A.A	30(66.7%)	23(65.7)	7(70%)	
AFP level				P=0.625*
Elevated	6(18.8%)	4/24(16.7%)	2(25%)	
Normal	26(81.3%)	20/24(83.3%)	6(75%)	
Presentation				P=0.708
Sacral mass	27(60%)			
Abdominal mass	11(24.4%)			
Scrotal mass	2(4.4 %)			
Neck mass	2(4.4 %)			
others	3(6.6%)			
Site				P=0.236
Sacrococcygeal	27(60%)	18	9(60%)	
Gonadal	9(20%)	8	1(6.7%)	
Retroperitoneal	4(8.9%)	1	3(20%)	
Mediastinum	3(6.7%)	2	1(6.7%)	
Head and neck	2(4.4%)	1	1(6.7%)	

Table 2 Perioperative complications (pcs) in relation to radiologic and pathologic findings.

Characteristics	Total (n=32)	No PCs (n=20)	With PCs (n=12)	*P* value
Tumor size				P=0.147
Below 5cm	3(9.4%)	3(15%)	0	
5cm to 10cm	10(31.3%)	7(35%)	3(25%)	
Above 10cm	19(59.4%)	10(50%)	9(75%)	
Tumor size (max diameter in cm)	11.5(7-15.8)	8.5(6.6 -16.7)	13(8-15)	P=0.274
Relation to vessels and organs				P=0.023 Likelihood ratio
Clear plane	27(84.4%)	19(95%)	8(66.7%)	
Vessel	1(3.1%)	1(5%)		
encasement	3(9.4%)		3(25%)	
Organ infiltration	1(3.1%)		1(8.3%)	
Organ and vessel involvement				
Pathology				P=0.145#
Mature teratoma	35(7.8%)	26(86.7%)	9(60%))	
Immature	5(11.1%)	2(6.7%)	3(20%)	
teratoma	4(9.9%)	1(3.3%)	3(20%)	
Yolk sac tumor	1(2.2%)	1(3.3%)	0	
Dysgerminoma				

COG stage Stage 1 Stage 2 Stage 3 Stage 4	 41(91.1%) 1 2 1	 28(93.3%) 1 1 0	 13(86.7%) 0 1 1	P=0.349

Table 3 Perioperative complications (PCs) in relation to surgical indicators

Indicators	Total (N=45)	No Pcs (N=30)	With Pcs (N=15)	*P* Value
Length Of Surgery </= 1hr 1-3 Hr >3hr	 7(15.6%) 33(73.3%) 5(11.1%)	 5(16.7%) 21(70%) 4(13.3%)	 2(13.3%) 12(80%) 1(6.7%)	P=0.724 #
Patient Position Supine Prone Lateral Decubitus Supine And Prone	 17(37.8%) 24(53.3%) 2 2	 11(36.7%) 16(53.3%) 2 1	 6(40%) 8(53.3%) 0 1	P= 0.596

Surgical Approach				P=0.426
PL Thoracotomy	2	2	0	
Clamshell	1	0	1	
Laparotomy	11(24.4%)	7	4	
Posterior Sagittal	25(55.6%)	17(56.7%)	8(53.3%)	
Abdominoperineal	2	1	1	
Cervical	2	1	10	
Inguinal	2	2		
Need For Transfusion		7(23.3%)	9(60%)	P=0.015
Yes	16(35.6%)	23(76.7%)	6(40%)	
No	29(64.4%)			
Duration Of Hospital Stay In Days	10 (7-18)	9.5(7-15.25)	11(7-28)	P=0.27

Table 4. Details of perioperative complications

Type Of Perioperative Complications	Sites	Events	Percentage
Intraoperative Complications			
Tumor Rupture	SCT (2) Retroperitoneal	4	66.7%
	(1) Neck (1)	1	
Massive Blood Transfusion			
Removal Of Adjacent Organ And	SCT		
Tumor Rupture		1	
Total	Retroperitoneal	6	
Postoperative Complications			
Wound Infection	SC(4), Neck (1)	5	50%
Wound Dehiscence	SC(1)	1	
Bleeding	SC(1) ,Retroperitoneal	2	
Pneumonia	(1)	2	
Total	SC(1), Mediastinal (1)	10	
Reoperations	Saccrococcygeal (3) Retroperitoneal (1)	4	

Discussion

The present study aimed to identify the clinicopathologic patterns of pediatric germ cell tumors, evaluate early surgical outcomes, and identify risk factors that predispose patients to unfavorable outcomes. This study revealed the diverse clinicopathological patterns of tumors.

The clinical presentation of GCTs depends on the site of tumor origin. In billimire et al analysis of 142 pediatric GCTs, the primary site was sacrococcygeal in 84 , ovarian in 15 , testicular in 15 , mediastinal in 14 , retroperitoneal in 7 , cervical in 3 and other in 4 .(5) Similarly sacrococcygeal (60%) was the commonest site in our analysis followed by gonadal (20%) GCTS. Symptoms include abdominal or testicular swelling in gonadal GCTs and swelling, pain, and pressure symptoms in the extragonadal site. Patients with mediastinal EGGCT initially presented with dyspnea (25%), chest pain (23%), and cough (17%). Primary retroperitoneal EGGCT patients often have abdominal (29%) and back pain (14%) and a palpable abdominal mass (6%). (6) In another study, abdominal pain and distention were the most frequent presenting symptoms of ovarian GCTs, while a palpable mass was the main symptom of testicular GCTs. (7) In our study, the most common symptom at presentation was the presence of a mass at the site of the tumor, with sacral masses accounting for the majority of cases (51.1%). Other patients presented with pressure symptoms such as urinary complaints, constipation, and respiratory symptoms.

Ultrasonography (US), computed tomography (CT), and magnetic resonance imaging (MRI) are imaging modalities used to diagnose GCTs. (8)They are more helpful in defining the primary tumor, its relationship to vital organs and vessels, and proper staging. The relatively large tumor size and intimate relationship between tumors and the adjacent vasculature and organs may increase surgical difficulty and contribute to increased perioperative complications. Teratomas encompassing the vasculature and displacing organs are associated with increased perioperative complications (9). In our study, tumor size and imaging findings were unrelated to perioperative complications. Serum AFP is a tumor marker in patients with germ cell tumors composed of or containing endodermal sinus (yolk

sac) tumors, irrespective of their location. Serum alpha-fetoprotein (AFP) levels should be obtained at the time of presentation. Serial serum AFP determination can be used for diagnostic purposes, monitoring the results of treatment, and for the early detection of metastases and recurrences (10) In our series, elevated AFP levels were related to pathology type ($p = 0.006$). AFP was elevated in six patients, and in four of the cases, the pathology was malignant. In Billimire et al report Elevated AFP was seen in all patients with malignancy, three of 6 with immature lesions and 1 of 19 with a benign lesion .this is consistent with our finding. (5)

The benign germ cell tumors were treated with surgical excision alone. Currently, the treatment for malignant germ cell tumors is risk-based. Low-risk tumors are managed with surgery alone, intermediate-risk tumors with surgery and chemotherapy, and high-risk tumors with intensive chemotherapy along with surgery. The survival rate of pediatric germ cell tumors has dramatically improved since the introduction of platinum-based therapy in the 1970s. (11) In our series, all mature teratomas (35 patients) and immature teratomas (4) were treated with surgery alone. The other five patients with malignant histology received adjuvant chemotherapy.

Surgery remains the mainstay of the initial management of GCTs at different sites of origin. For most SCT tumors, the predominant component is the extrapelvic, and the patient is placed in the prone position. It may be appropriate to start with laparotomy or laparoscopy if there is a major intrapelvic or intra-abdominal component, the tumor is highly vascular, and bleeding within the tumor is suspected. (12) Excision of the coccyx is an essential part of the procedure. Gross et al. Initially, a 37% recurrence rate was reported when the coccyx was not removed. In a multicenter retrospective analysis from the Netherlands, which examined 235 children with SCT treated between 1970 and 2010, hemorrhage was found to be responsible for 70% of all newborn mortality. The risk factors for hemorrhagic death were prematurity, tumor volume greater than 1000 cm3, and emergency surgery(13). All patients in our study underwent complete excision of the SCTs. Infection of the wound (55%), wound dehiscence (11%), and bleeding (%) were the most frequent postoperative complications, all of which are in agreement with A. M. Abubakaret's findings. According to A. M. Abubakaret's analysis of 21 sacrococcygeal teratoma patients treated over an 18-year period in

northeastern Nigeria, wound infection was the most common postoperative complication, followed by wound dehiscence and postoperative diarrhea. (14) However the incidence of postoperative complication of 38% is much higher than our study ,22% . Another study from Nigeria analyzed 38 cases of SCTs and the postoperative complication rate was 21 % and there were 3 deaths. (15)

Surgical treatment of retroperitoneal germ cell tumors is inherently risky. In a retrospective analysis conducted at Qingdao University between January 2008 and January 2020, 41% of the patients (44 intraoperative and 7 postoperative) had perioperative complications. The number of organs compressed and distorted by the tumor was positively correlated with perioperative complications. (16) In our study two of four patients had intraoperative complications. This was similar to a study conducted by fumino which analyzed 14 cases and showed perioperative complication rate of 50%. (17) Mediastinal GCTs are approached through either median sternotomy or thoracotomy. Anterior mediastinotomy can be used to access smaller tumors. Primary resection was only possible in 14 cases, according to a pediatric oncology and children's cancer (POG/CCG) intergroup research comprising 38 patients. (18) In our study complete excision was possible in all (3) mediastinal GCTs which were benign type histologically and one patient developed postoperative pneumonia. Surgical management of ovarian GCTs must include oophorectomy or salpingo-oophorectomy; however, conservative treatment is possible for some benign tumors. Surgery is the cornerstone of the care of testicular GCTs and an inguinal approach with a main high orchidectomy for malignant tumors. In our series, all gonadal GCTs were treated with complete excision of the tumor along with the affected gonad.

The overall perioperative complication rate in the present study was 33.3%. Four patients required reoperation: two with wound dehiscence, one with postoperative bleeding, and one with wound infection. No surgery-related mortality was observed in this study. On univariate analysis, the rate of perioperative complications was positively associated with the need for transfusion ($p = 0.016$). The pathologic type was also associated with intracomplications ($p = 0.02$). Age, tumor size, site, pathological type, duration of surgery, and hospital stay were not associated with perioperative complications.

Limitations

A small sample size was the major limitation of our study, and as with other retrospective studies, this study had some inherent and unavoidable limitations, such as the loss of important clinical information. For example, most patients did not have postop AFP measurements. Future prospective studies are needed to address these issues.

Conclusions

The surgical treatment of germ cell tumors is associated with a significant rate of perioperative complications. To improve surgical outcomes and reduce the risk of complications, larger prospective studies using our series as a reference point are needed to identify factors that predict surgical outcomes and develop effective strategies.

References

1. Kaatsch P, Häfner C, Calaminus G, Blettner M, Tulla M. Pediatric germ cell tumors from 1987 to 2011: incidence rates, time trends, and survival. Pediatrics. 2015;135(1):e136–43.

2. Cecchetto. Gonadal germ cell tumors in children and adolescents. J Indian Assoc Pediatr. 2014;

3. Pediatric germ cell tumors - Rescorla - 1999 - Seminars in Surgical Oncology - Wiley Online Library [Internet]. [cited 2022 Oct 9].

4. İncesoy-Özdemir S, Ertem U, Şahin G, Bozkurt C, Yüksek N, Ceyda Ören A, et al. Clinical and epidemiological characteristics of children with germ cell tumors: A single center experience in a developing country. Turk J Pediatr. 2017;59(4).

5. Billmire DF, Grosfeld JL. Teratomas in childhood: Analysis of 142 cases. J Pediatr Surg. 1986 Jan;21(6):548–51.

6. Winter C, Zengerling F, Busch J, Heinzelbecker J, Pfister D, Ruf C, Lackner J, Albers P, Kliesch S, Schmidt S, Bokemeyer C. How to classify, diagnose, treat and follow-up extragonadal germ cell tumors? A systematic review of available evidence. World J Urol. 2022 May 12. doi: 10.1007/s00345-022-04009-z.
7. Lin X, Wu D, Zheng N, Xia Q, Han Y. Gonadal germ cell tumors in children: A retrospective review of a 10-year single-center experience. Medicine (Baltimore). 2017;96(26).
8. Nelson pediatrics - Yahoo Search Results [Internet]. [cited 2022 Oct 29]. Available from: https://us.search.yahoo.com/search?fr=yhs-invalid&p=Nelson+pediatrics
9. Yang T, Li H, Li J, Wu H, Hu C, Tan T, et al. Surgical risk factors of retroperitoneal teratoma resection in children. J Pediatr Surg. 2019 Jul;54(7):1495–9.
10. Talerman A, Haije WG, Baggerman L. Serum alphafetoprotein (AFP) in patients with germ cell tumors of the gonads and extragonadal sites: Correlation between endodermal sinus (yolk sac) tumor and raised serum AFP. Cancer. 1980 Jul 15;46(2):380–5.
11. Pediatric Surgery, 2-Volume Set - 7th Edition [Internet]. [cited 2022 Oct 29]. Available from: https://www.elsevier.com/books/pediatric-surgery-2-volume-set/coran/978-0-323-07255-7
12. Holcomb and Ashcraft's Pediatric Surgery - 7th Edition [Internet]. [cited 2022 Oct 29]. Available from: https://www.elsevier.com/books/ashcrafts-pediatric-surgery/holcomb/978-0-323-54940-0
13. Hemorrhage is the most common cause of neonatal mortality in patients with sacrococcygeal teratoma - PubMed [Internet]. [cited 2022 Oct 29]. Available from: https://pubmed.ncbi.nlm.nih.gov/27502009/
14. Abubakar, A. M., Nggada, H. A., & Chinda, J. Y. (2005). Sacrococcygeal teratoma in Northeastern Nigeria: 18-years experience. Pediatric Surgery International, 21(8), 645–648. doi:10.1007/s00383-005-1486-6
15. Chirdan L, Uba A, Pam S, Edino S, Mandong B, Chirdan O. Sacrococcygeal teratoma: Clinical characteristics and long-term outcome in Nigerian children. Ann Afr Med. 2009;8(2):105.

16. Liu Y, Hao X, Lu H, Duan Y, Dong Q, Qiao L. Factors Associated With Perioperative Complications in the Treatment of Pediatric Retroperitoneal Teratoma. J Surg Res. 2021 Mar;259:458–64.

17. Fumino S, Maniwa J, Takeuchi Y, Sakai K, Higashi M, Aoi S, et al. Surgical intervention and perioperative risk factors of retroperitoneal teratomas in children: a single institution experience. Pediatr Surg Int. 2016 Sep;32(9):909–14.

18. D B, C V, F R, P C, B C, E H, et al. Malignant mediastinal germ cell tumors: an intergroup study. J Pediatr Surg [Internet]. 2001 Jan [cited 2022 Oct 29];36(1). Available from: https://pubmed.ncbi.nlm.nih.gov/11150432/

Data collection checklist

1. Socio-demographic Characteristics

No	QUESTIONS	CODE
100	Card number	___________________
101	Sex	1. Male 2. Female
102	Residence	1. Urban 2. Rural
103	Age	……….
104	Weight	………..
105	Nutritional status	1.Normal 2. SAM 3.MAM

2. Symptoms at Presentation

No	QUESTIONS	CODE
201	Local symptoms	1. Abdominal pain 2. Abdominal mass 3. Scrotal mass 4. Chest pain 5. Sacral / gluteal swelling 6. Others (specify)
202	Metastatic symptoms	Specify

3. Physical findings

No	QUESTIONS	CODE
301	Physical findings	1. Scrotal mass 2. Abdominal mass 3. Sacrococcygeal mass

4. Laboratory investigations

No	QUESTIONS	CODE
401	AFP level	
402	b-Hcg level	

5. Imaging findings

No	QUESTIONS	CODE
501	Does the patient have MRI /CT	1. Yes 2. No
501.1	If yes, what was the finding?	…..

	(Tumor Size ,Margin, Site , Relation With Vessels And Adjacent Organs)	

6. Pre-op chemotherapy & diagnosis

No	QUESTIONS	CODE
601	Pre Op biopsy	1. Yes 2. No
601.1	If yes , what was the pathologic result	…………..
602.	Pre Op chemotherapy	1. Yes 2. No
602.1	What Regimen was used?	…..
602.2	How many cycles were given?	…..

7. Operative details

	QUESTIONS	CODE
701	Surgery done on	1.Emergency basis 2. Elective basis
702	Duration of surgery in hours	…….
704	Duration of anesthesia	…….
705	Patient position	…….
706	Surgical site	…….

707	Incision	…….
708	Was it completely excised?	1. Yes 2. No
707	Lymph node dissection?	1. Yes 2. No
707.1	If yes, which lymph nodes?	…..
708	Intra op accident	1. Yes 2. No
708.1	If yes, what was it?	1.Tumor rupture 2. Vascular injury 3. Massive transfusion 4. Removal of adjacent organ 5 specify
709	Intra-op transfusion?	1. Yes 2. No
709.1	If yes how many units	…….
709.2	What blood product was used?	1.Whole blood 2. PRBCS 3.FFP 4.Platelets
710	Intra-op death	1.Yes 2.No

8. Post Op status

No	QUESTIONS	CODE
801	Did the patient develop post op complications?	1.Yes 2.NO
801.1	If yes , specify	…..
802	How many days did the patient stay in hospital before discharge?	………..
803	Reoperation	1.Yes 2.NO
803.1	If yes, indication for reoperation	………

9. Condition on discharge

No	QUESTIONS	CODE
901	Dead or alive	1. Alive 2. Dead
901.1	If dead , cause of death	…………..

10. Histopathology diagnosis

No	QUESTIONS	CODE
101	Location of tumor	1.Gonadal 1.1, Testis 1.2, Ovary 2.Extra-gonadal

		2.1,Mediastinum 2.2, Retroperitoneal 2.3, Others
102	Stage of tumor (COG)	…..
103	COG histological type	1. Low risk 2. Intermediate risk 3. High risk
104	Resection margin	1.Negative 2.Positive

11. Follow up

No	QUESTIONS	CODE
111	Adjuvant Chemotherapy given	1.Yes 2.NO
111.1	If yes, Chemotherapy	1. Regimen … 2. Cycles …………
112	Adjuvant Radiotherapy	1.Yes 2.NO
113	Post-op recurrence	1.Yes 2.NO
113.1	If yes , interval between surgery and recurrence	…..
114	Day 7 status	1. Alive 2. Dead
114.1	If dead , cause of death	……
115	Day 30 status	1. Alive 2. Dead

115.1	If dead , cause of death	……
116	Patient status @ 5 years	3. Alive 4. Dead 5. Lost to follow up
116.1	If dead , cause of death	……