Original Article

Clinicopathological Characteristics and Histological Patterns of Gonadal Germ Cell Tumors: A Retrospective Comparative Study

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Abstract

Background: Gonadal germ cell tumours comprise a diverse group of neoplasms with marked differences in their age distribution, histological patterns and biological behaviour. Accurate pathological classification is important because treatment and prognosis depend on the anatomical site, histological subtype, tumour stage and presence of mixed components. **Material and Methods:** This retrospective comparative study included all histologically confirmed primary ovarian and testicular germ cell tumours diagnosed at the Department of Pathology, Madurai Medical College and Government Rajaji Hospital, Madurai, between July 2012 and August 2014. Clinical details, radiological findings, serum tumour markers, gross characteristics and histopathological features were reviewed. Routine haematoxylin and eosin-stained sections were examined, and immunohistochemistry using CD117, CD30, alpha-fetoprotein, beta-human chorionic gonadotropin and CD45 was performed in selected diagnostically difficult cases. **Results:** A total of 54 gonadal germ cell tumours were included, comprising 42 ovarian tumours (77.8%) and 12 testicular tumours (22.2%). The highest frequency occurred in the 20–29-year age group. Mature teratoma was the most common ovarian tumour, accounting for 36 cases (85.7%). The remaining ovarian tumours included three yolk sac tumours and one case each of dysgerminoma, grade 3 immature teratoma and gonadoblastoma associated with choriocarcinoma. **Conclusion:** Ovarian and testicular germ cell tumours demonstrate distinct clinicopathological patterns. Ovarian tumours are predominantly benign mature teratomas, while testicular tumours are mainly malignant, with seminoma and mixed germ cell tumour being the leading subtypes.

Keywords: Gonadal germ cell tumour; ovarian germ cell tumour; testicular germ cell tumour; mature teratoma; seminoma; mixed germ cell tumour; immunohistochemistry.

Received: 20 July 2026 **Revised: 01 August 2026** **Accepted: 17 August 2026** **Published: 29 August 2026**

Introduction

Germ cell tumours are a diverse group of benign and malignant neoplasms derived from primordial germ cells. These cells normally migrate during embryonic development from the yolk sac to the developing gonadal ridges, where they later form the reproductive cell population of the testes and ovaries. Abnormal migration, maturation or differentiation of primordial germ cells may lead to the development of germ cell tumours. Although these tumours may occasionally arise at extragonadal midline sites, including the mediastinum, retroperitoneum, pineal region and sacrococcygeal area, the gonads remain their principal site of occurrence.[1]

Gonadal germ cell tumours show considerable variation according to the sex and age of the affected patient. Testicular germ cell tumours constitute the most common solid malignancy among adolescent and young adult males, particularly those between 15 and 40 years of age.[2] In contrast, ovarian germ cell tumours are relatively uncommon and account for only a small proportion of all ovarian neoplasms. However, they represent an important group of ovarian tumours in children, adolescents and young women.[3] Despite their common germ cell origin, testicular and ovarian germ cell tumours demonstrate important differences in their frequency, histological distribution, precursor lesions, clinical presentation and biological behaviour.

The current World Health Organization classification divides germ cell tumours into several major histological categories, including seminoma or dysgerminoma, embryonal carcinoma, yolk sac tumour, choriocarcinoma, teratoma and mixed germ cell tumour.[4,5] Seminoma is the corresponding testicular tumour, whereas dysgerminoma is its ovarian counterpart. Both tumours are composed of relatively uniform primitive germ cells arranged in nests, sheets or cords separated by fibrous septa containing lymphocytes. Yolk sac tumour demonstrates several microscopic patterns, including reticular, microcystic, papillary, solid, glandular and endodermal sinus patterns. The presence of Schiller–Duval bodies and eosinophilic hyaline globules may support its histological diagnosis.[6]

Embryonal carcinoma is a highly malignant tumour composed of primitive epithelial cells with prominent nuclear atypia, frequent

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DOI:
10.21276/amit.2026.v13.i2.1001

How to cite this article: Nisha AS. Clinicopathological Characteristics and Histological Patterns of Gonadal Germ Cell Tumors: A Retrospective Comparative Study. Acta Med Int. 2026;13(2):2024-2032.

mitotic activity and areas of haemorrhage or necrosis. Choriocarcinoma contains both cytotrophoblastic and syncytiotrophoblastic cells and is frequently associated with increased serum beta-human chorionic gonadotropin levels. Teratomas contain tissues derived from one or more embryonic germ layers and may be classified as mature or immature. Mixed germ cell tumours contain two or more malignant germ cell components in varying proportions. Accurate recognition and reporting of each component are clinically important because the biological behaviour and treatment response may depend on the type and proportion of the individual elements.[3,6]

Testicular germ cell tumours are broadly divided into those related to germ cell neoplasia in situ and those unrelated to this precursor lesion. Germ cell neoplasia in situ is recognised as the precursor of most postpubertal seminomas and non-seminomatous germ cell tumours. It is characterised by enlarged atypical germ cells situated along the basement membrane of seminiferous tubules.[7] Prepubertal-type teratomas and yolk sac tumours generally arise through different developmental pathways and are usually unrelated to germ cell neoplasia in situ. The recognition of these pathogenetic groups is important because similar histological appearances may have different clinical meanings depending on the patient's age and tumour setting.[1,7]

In the ovary, mature cystic teratoma is the most common germ cell tumour and is generally benign. Among malignant ovarian germ cell tumours, dysgerminoma is one of the most frequent histological types, followed by yolk sac tumour, immature teratoma and mixed germ cell tumour.[3,8] Ovarian germ cell tumours commonly present with abdominal pain, abdominal distension, a pelvic mass or symptoms related to tumour rupture or torsion. Testicular tumours usually present as a painless testicular swelling or mass, although some patients may experience discomfort, heaviness or acute pain. Differences in the anatomical location of the ovaries and testes may therefore influence the tumour size and stage at the time of diagnosis.

Clinical evaluation of gonadal germ cell tumours includes radiological examination, histopathological assessment and measurement of serum tumour markers. Alpha-fetoprotein is commonly increased in yolk sac tumours and tumours containing a yolk sac component, whereas beta-human chorionic gonadotropin may be increased in choriocarcinoma and tumours containing syncytiotrophoblastic cells. Lactate dehydrogenase may be elevated in patients with a large tumour burden, particularly in seminoma and dysgerminoma.[2,6] Nevertheless, tumour markers are not entirely specific and must be interpreted together with morphological, radiological and clinical findings.

Histopathological examination remains essential for establishing the definitive diagnosis, identifying mixed histological components and distinguishing germ cell tumours from sex cord-stromal, epithelial, metastatic and other poorly differentiated malignancies. Immunohistochemical markers such as OCT3/4, SALL4, placental alkaline phosphatase, CD117, D2-40, alpha-fetoprotein, glypican-3 and beta-human chorionic gonadotropin may assist in difficult cases.[6,9] However, the selection and interpretation of these markers should be guided by the microscopic appearance because no single immunohistochemical marker can independently classify every type of germ cell tumour.

The clinical outcome of gonadal germ cell tumours has improved greatly because of accurate pathological diagnosis, effective platinum-based chemotherapy and multidisciplinary management. However, prognosis may vary according to the patient's age, tumour site, histological type, stage, presence of mixed components and metastatic disease.[2,8] Local clinicopathological studies remain valuable because the relative frequency and presentation of different histological patterns may vary according to population characteristics, referral practices and age distribution.

A retrospective comparison of ovarian and testicular germ cell tumours can provide useful information regarding their demographic profile, presenting features, tumour size, laterality, histological spectrum and malignant potential. It may also identify similarities and differences between the corresponding tumours of the two gonads. Therefore, the present study was undertaken to evaluate and compare the clinicopathological characteristics and histological patterns of gonadal germ cell tumours diagnosed during the study period, with particular emphasis on their age distribution, clinical presentation, anatomical site and microscopic subtypes.

Materials and Methods

Study design and setting: The present investigation was designed as a retrospective, observational and comparative study of gonadal germ cell tumours. It was based on the finalized clinical and histopathological database generated during the original dissertation work conducted in the Department of Pathology, Madurai Medical College and Government Rajaji Hospital, Madurai, Tamil Nadu, India. The source study included specimens received from Government Rajaji Hospital and other hospitals in and around Madurai between July 2012 and August 2014. Although the original dissertation collected the cases prospectively, the present manuscript retrospectively analysed the completed dataset to compare ovarian and testicular germ cell tumours.

During the study period, 8,762 benign and malignant neoplasms were received in the department. The original database contained 66 lesions evaluated as possible germ cell neoplasms. Following final histopathological assessment, 64 cases were confirmed as germ cell tumours. For the present gonadal analysis, 10 extragonadal tumours were excluded. The final study population therefore consisted of 54 primary gonadal germ cell tumours, including 42 ovarian and 12 testicular tumours. The study used a census sampling method in which all eligible cases diagnosed during the defined period were included.

Eligibility criteria: All patients, irrespective of age, with a histologically confirmed primary germ cell tumour of the ovary or testis were eligible. Included materials comprised ovarian cystectomy, ovariotomy, oophorectomy, unilateral or bilateral salpingo-oophorectomy, total abdominal hysterectomy with unilateral or bilateral salpingo-oophorectomy, orchidectomy and high inguinal orchidectomy specimens.

Extragonadal germ cell tumours, non-neoplastic gonadal lesions,

non-germ cell gonadal neoplasms and lesions that did not receive a final histopathological diagnosis of germ cell tumour were excluded. Metastatic germ cell tumours diagnosed only in an extragonadal biopsy without a confirmed primary gonadal tumour were also excluded from the comparative analysis. Cases with insufficient clinical information, inadequate tissue or severely compromised morphology were to be excluded when reliable classification was not possible.

Clinical data collection: Clinical information was obtained from the records of the concerned clinical departments, the Medical Records Department and the registers maintained in the Department of Pathology. Data were recorded using the structured proforma provided in the dissertation.

The variables collected included age, sex, presenting complaints, relevant medical and family history, menstrual and marital history in female patients, clinical examination findings and provisional diagnosis. Presenting symptoms were categorized as abdominal or testicular mass, pain, abnormal uterine bleeding and other recorded symptoms. Available radiological findings from ultrasonography, computed tomography, magnetic resonance imaging and chest radiography were reviewed.

Serum tumour marker results were recorded when available. These included alpha-fetoprotein, beta-human chorionic gonadotropin and lactate dehydrogenase. Information on the surgical procedure, operative findings, tumour laterality, lymph-node involvement, metastatic disease and clinical stage was also extracted when documented.

Specimen handling and gross examination: All surgical specimens were fixed in 10% neutral buffered formalin. Each specimen underwent a systematic gross examination. The specimen type, laterality, overall specimen dimensions and maximum tumour diameter were recorded. The external surface, capsule, cut surface and relationship of the tumour to the surrounding gonadal tissue were examined.

Gross characteristics were documented as solid, cystic or mixed. The presence of haemorrhage, necrosis, calcification, hair, teeth, bone, cartilage, pultaceous material and other visible tissue components was recorded. Particular attention was given to variegated areas because these could represent different components of a mixed germ cell tumour.

Extensive sampling was performed. Between 10 and 20 tissue blocks were examined per case, with approximately one block submitted for every centimetre of the greatest tumour dimension. Additional sections were taken from solid, haemorrhagic, necrotic and visually different areas. When a specimen consisted of multiple small fragments, the tissue was embedded in its entirety. In orchidectomy specimens, the upper resection margin was sampled. The involvement of the tunica albuginea, tunica vaginalis, epididymis, spermatic cord, scrotum and lymphovascular spaces was assessed whenever these structures were represented.

For ovarian specimens, the tumour capsule, ovarian surface, adjacent ovarian tissue and any suspicious areas of rupture or invasion were evaluated. Bilateral ovarian involvement, capsular invasion, vascular invasion, ascites and lymph-node involvement were documented when information or tissue was available.

Histopathological examination: Representative tissue samples were processed using routine paraffin-embedding techniques. Sections of approximately 4–5 µm thickness were prepared from each paraffin block and routinely stained with haematoxylin and eosin. All sections were examined for tumour architecture, cytological features, stromal characteristics, necrosis, haemorrhage, mitotic activity, lymphovascular invasion and involvement of adjacent structures.

Tumours were categorized as benign or malignant and classified according to the World Health Organization classification applied in the source dissertation. Ovarian tumours were assessed for mature cystic teratoma, immature teratoma, monodermal teratoma, dysgerminoma, yolk sac tumour, gonadoblastoma with a malignant germ cell component and other identified subtypes. Testicular tumours were assessed for seminoma, yolk sac tumour, embryonal carcinoma, teratoma and mixed germ cell tumour.

A tumour containing only one germ cell component was categorized as a pure germ cell tumour. Tumours containing two or more distinct malignant germ cell components were categorized as mixed germ cell tumours. Each identifiable component of a mixed tumour was separately recorded. Periodic acid–Schiff staining was performed in selected cases to demonstrate glycogen or diastase-resistant hyaline material when required for morphological confirmation.

Immunohistochemistry: Immunohistochemistry was used selectively in diagnostically challenging cases and was not applied as a routine screening panel to every tumour. The markers used in the source study were alpha-fetoprotein, CD117 or c-KIT, CD30, beta-human chorionic gonadotropin and CD45. CD117 was used to support seminomatous differentiation, while CD45 was used in cases requiring differentiation between seminoma and lymphoma. CD30 was applied to identify an embryonal carcinoma component. Alpha-fetoprotein was used to support yolk sac differentiation, and beta-human chorionic gonadotropin was used in tumours showing trophoblastic or choriocarcinomatous differentiation. Immunohistochemical findings were interpreted together with the clinical information and haematoxylin-and-eosin morphology. No diagnosis was established solely from a single immunohistochemical marker.

Study outcomes: The primary outcome was the distribution of histological patterns among ovarian and testicular germ cell tumours. Secondary outcomes included differences in age at diagnosis, clinical presentation, tumour laterality, tumour size, benign or malignant behaviour, pure or mixed histological composition, local invasion, pathological stage and the diagnostic contribution of immunohistochemistry.

Statistical analysis: Ovarian and testicular germ cell tumours were analysed as two comparative groups. Categorical variables were summarized as frequencies and percentages. Continuous variables, including age and tumour size, were to be assessed for distribution and presented as mean with standard deviation or median with interquartile range, as appropriate.

The chi-square test was used to assess associations between categorical variables when its assumptions were met. Fisher's exact test was preferred when expected cell frequencies were below five. Normally distributed continuous variables were compared using the independent-samples t test, while non-

normally distributed variables were compared using the Mann–Whitney U test. Effect estimates were to be reported with 95% confidence intervals wherever appropriate. All tests were two-sided, and a p value below 0.05 was considered statistically significant. Missing information was analysed using available-case analysis without statistical imputation. Because of the limited number of testicular cases and the rarity of several histological subtypes, subgroup findings were interpreted cautiously.

Ethical considerations: The source study received approval from the Institutional Review Board/Independent Ethics Committee of Government Rajaji Hospital and Madurai Medical College, Madurai, under reference number 68/E4/2/2014, dated 26 February 2014. Patient confidentiality was maintained, and only de-identified information was used for the manuscript analysis.

Results

During the study period, 8,762 neoplastic specimens were examined. A total of 64 cases were confirmed as germ cell tumours, giving an overall institutional frequency of approximately 0.7%. Of these, 54 cases were primary gonadal germ cell tumours and formed the final study population, while 10 extragonadal tumours were excluded from the present comparative analysis.

Ovarian germ cell tumours accounted for 42 of the 54 gonadal cases (77.8%), whereas 12 cases (22.2%) were testicular germ cell tumours. The 42 ovarian germ cell tumours constituted 19.0% of the 221 ovarian neoplasms received during the study period. In comparison, the 12 testicular germ cell tumours represented 80.0% of the 15 testicular neoplasms. The proportion of germ cell tumours among testicular neoplasms was significantly greater than that among ovarian neoplasms ($p<0.001$, Fisher's exact test).

Table 1: Distribution and institutional frequency of gonadal germ cell tumours

Study parameter	Number	Percentage
Total neoplasms examined	8,762	100.0
All confirmed germ cell tumours	64	0.7 of all neoplasms
Gonadal germ cell tumours included	54	84.4 of all GCTs
Extragonadal germ cell tumours excluded	10	15.6 of all GCTs
Ovarian germ cell tumours	42	77.8 of gonadal GCTs
Testicular germ cell tumours	12	22.2 of gonadal GCTs
Ovarian GCTs among all ovarian neoplasms	42/221	19.0
Testicular GCTs among all testicular neoplasms	12/15	80.0

Gonadal germ cell tumours occurred over a wide age range, from infancy to the seventh decade. The highest combined number was observed in patients aged 20–29 years, comprising 18 of the 54 cases (33.3%). This was followed by the 30–39-year age group, with 10 cases (18.5%).

Among testicular tumours, the highest frequency was recorded in the 20–29-year group, with five cases (41.7%), followed by three cases (25.0%) in the 30–39-year group. No testicular germ cell tumour was recorded between 40 and 59 years. Ovarian germ cell tumours had a wider distribution and were identified in every age group. The age-by-histological-subtype table in the thesis showed 13 ovarian tumours in the 20–29-year group, representing 31.0% of ovarian cases.

Table 2: Age-wise distribution of ovarian and testicular germ cell tumours

Age group	Ovarian GCTs, n (%)	Testicular GCTs, n (%)	Total, n (%)
<10 years	2 (4.8)	1 (8.3)	3 (5.6)
10–19 years	7 (16.7)	2 (16.7)	9 (16.7)
20–29 years	13 (31.0)	5 (41.7)	18 (33.3)
30–39 years	7 (16.7)	3 (25.0)	10 (18.5)
40–49 years	7 (16.7)	0 (0.0)	7 (13.0)
50–59 years	5 (11.9)	0 (0.0)	5 (9.3)
60–69 years	1 (2.4)	1 (8.3)	2 (3.7)
Total	42 (100.0)	12 (100.0)	54 (100.0)

Seminoma was the most frequent testicular germ cell tumour, accounting for five cases (41.7%). Four cases (33.3%) were mixed germ cell tumours. The remaining three tumours consisted of one yolk sac tumour, one pure embryonal carcinoma and one immature teratoma.

Eight of the 12 testicular tumours (66.7%) contained a single histological type, while four (33.3%) were mixed germ cell tumours. All four mixed tumours contained embryonal carcinoma and yolk sac tumour components. One of these also contained immature teratoma as a third component.

Seminoma was present from the second to the fourth decades. Three of the four mixed germ cell tumours occurred between 20 and 29 years, whereas one occurred in the seventh decade. The pure embryonal carcinoma occurred in a 13-year-old patient, the immature teratoma in a 3-year-old child and the pure yolk sac tumour in a 35-year-old adult.

Table 3: Histological patterns of testicular germ cell tumours

Histological type	Number	Percentage	Recorded age distribution
Seminoma	5	41.7	10–39 years
Mixed germ cell tumour	4	33.3	20–29 years and 60–69 years

Yolk sac tumour	1	8.3	35 years
Embryonal carcinoma	1	8.3	13 years
Immature teratoma	1	8.3	3 years
Total	12	100.0	—

Composition of mixed testicular germ cell tumours	
Histological composition	**Number of cases**
Embryonal carcinoma and yolk sac tumour	3
Embryonal carcinoma, yolk sac tumour and immature teratoma	1
Total mixed GCTs	4

Mature teratoma was the dominant ovarian histological pattern and accounted for 36 of the 42 cases (85.7%). Three patients had pure yolk sac tumours, representing 7.1% of the ovarian cohort. Dysgerminoma, immature teratoma and gonadoblastoma associated with choriocarcinoma accounted for one case each.

No pure or mixed ovarian embryonal carcinoma was identified. One mature cystic teratoma was associated with a benign serous cystadenoma, while another showed monodermal differentiation in the form of struma ovarii. The single immature ovarian teratoma was classified as grade 3. None of the mature cystic teratomas showed malignant transformation.

Table 4: Histological patterns of ovarian germ cell tumours

Histological type	**Number**	**Percentage**
Mature teratoma	36	85.7
Yolk sac tumour	3	7.1
Dysgerminoma	1	2.4
Gonadoblastoma with choriocarcinoma	1	2.4
Immature teratoma, grade 3	1	2.4
Total	42	100.0

Important associated findings	
Finding	**Number**
Mature cystic teratoma with serous cystadenoma	1
Struma ovarii within the teratomatous group	1
Mature teratoma with malignant transformation	0
Pure ovarian embryonal carcinoma	0
Mixed malignant ovarian germ cell tumour	0

Benign tumours were considerably more frequent in the ovary, where 36 of 42 tumours (85.7%) were benign. In contrast, only one of the 12 testicular tumours (8.3%) was categorized as benign in the source study. Malignant tumours accounted for 11 testicular cases (91.7%) compared with six ovarian cases (14.3%). This difference was statistically significant ($p<0.001$).

Mixed germ cell histology was found in four testicular tumours but was not recorded as a mixed malignant germ cell tumour in the ovary ($p=0.002$). However, one ovarian tumour represented a mixed sex cord–germ cell lesion consisting of gonadoblastoma and choriocarcinoma and was not classified as a conventional mixed germ cell tumour.

Teratomatous tumours dominated the ovarian group, accounting for 37 cases when mature and immature teratomas were combined. Only one testicular tumour had teratoma as the primary diagnosis. The difference in teratomatous predominance between ovarian and testicular tumours was significant ($p<0.001$).

Table 5: Comparison of major pathological characteristics between ovarian and testicular germ cell tumours

Characteristic	**Ovarian GCTs (n=42)**	**Testicular GCTs (n=12)**	***p* value**
Benign tumours	36 (85.7)	1 (8.3)	<0.001
Malignant tumours	6 (14.3)	11 (91.7)	<0.001
Pure/single germ cell histology	42 (100.0)	8 (66.7)	0.002
Mixed malignant germ cell histology	0 (0.0)	4 (33.3)	0.002
Teratoma as primary diagnosis	37 (88.1)	1 (8.3)	<0.001
Seminomatous counterpart: dysgerminoma/seminoma	1 (2.4)	5 (41.7)	<0.001
Peak age group	20–29 years	20–29 years	—
Most frequent histological type	Mature teratoma	Seminoma	—

Testicular seminomas were solid and nodular and had an average gross measurement of approximately 12 × 8 × 6 cm. Necrosis was observed in two cases. Microscopically, the tumours were composed of uniform cells arranged in sheets and separated by fibrous septa containing lymphocytes. Selected seminomas showed strong CD117 expression.

The pure testicular yolk sac tumour measured 2.5 × 2 × 2 cm and showed a predominantly reticular–microcystic architecture. The pure embryonal carcinoma measured 2.5 × 2 × 1.5 cm and demonstrated solid, papillary and glandular patterns, marked nuclear pleomorphism and increased mitotic activity. The tumour cells showed strong membranous CD30 expression.

Mixed testicular germ cell tumours were larger, with an

average size of approximately 11 × 10 × 8 cm. All four showed a variegated appearance with haemorrhage and necrosis. Two demonstrated spermatic-cord involvement, two were associated with retroperitoneal lymph-node metastasis, and one showed tumour at the upper resection margin.

The mature ovarian teratomas had an average diameter of approximately 7.5 cm. They were predominantly cystic and contained hair and pultaceous material. Well-formed teeth, cartilage or bone were identified grossly in 14 cases. The largest ovarian teratoma measured 14 × 10 × 8 cm. Histologically, structures derived from the ectoderm, mesoderm and endoderm were observed.

The ovarian yolk sac tumours most frequently showed reticular and microcystic patterns. The single dysgerminoma showed sheets of uniform polygonal cells separated by lymphocyte-containing fibrous septa. The grade 3 immature teratoma contained prominent primitive neuroepithelial and immature mesenchymal elements. The gonadoblastoma associated with choriocarcinoma showed extensive haemorrhage and necrosis, with cytotrophoblastic and multinucleated syncytiotrophoblastic cells; the trophoblastic component was positive for beta-human chorionic gonadotropin.

Table 6: Major morphological, immunohistochemical and advanced-disease findings

Tumour type	Gross features	Major microscopic pattern	IHC/important clinical finding
Testicular seminoma, n=5	Solid, nodular; average 12 × 8 × 6 cm; necrosis in 2 cases	Uniform sheets separated by lymphocyte-rich fibrous septa	Strong CD117 positivity in selected cases; all recorded as stage I
Testicular yolk sac tumour, n=1	Grey-white, ill-defined; 2.5 × 2 × 2 cm	Reticular and microcystic pattern	Occurred in a 35-year-old adult
Testicular embryonal carcinoma, n=1	Grey-white; 2.5 × 2 × 1.5 cm; necrosis present	Solid, papillary and glandular patterns with marked atypia	Strong CD30 positivity; stage IV with lung and brain metastases
Mixed testicular GCT, n=4	Variegated; average 11 × 10 × 8 cm; haemorrhage and necrosis in all	Embryonal carcinoma and yolk sac tumour in all; immature teratoma in 1	Cord involvement in 2; nodal metastasis in 2; upper margin involved in 1
Ovarian mature teratoma, n=36	Mainly cystic; average diameter 7.5 cm; hair and pultaceous material	Mature tissues from all three germ layers	Teeth, bone or cartilage grossly identified in 14 cases; no malignant transformation
Ovarian yolk sac tumour, n=3	Predominantly solid and variegated	Reticular and microcystic patterns; Schiller–Duval-type structures described	Three pure tumours; predominantly adolescents and young adults
Ovarian dysgerminoma, n=1	Enlarged, nodular tumour	Uniform polygonal cells with lymphocyte-rich septa	Occurred in an adolescent
Ovarian immature teratoma, n=1	Solid and cystic areas	Prominent immature neuroepithelial and mesenchymal tissue	Histological grade 3
Gonadoblastoma with choriocarcinoma, n=1	Haemorrhage and necrosis	Cytotrophoblasts and syncytiotrophoblasts	Beta-hCG positive; normal karyotype recorded

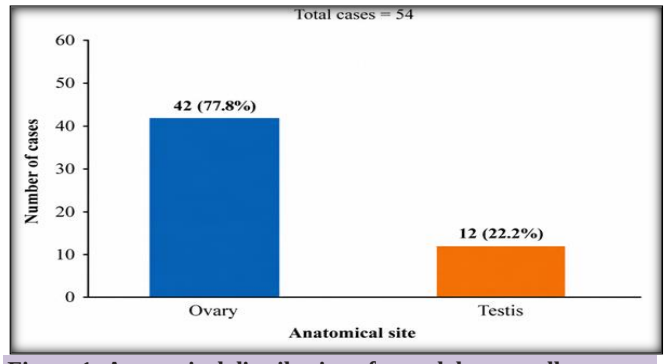

Figure 1: Anatomical distribution of gonadal germ cell tumours

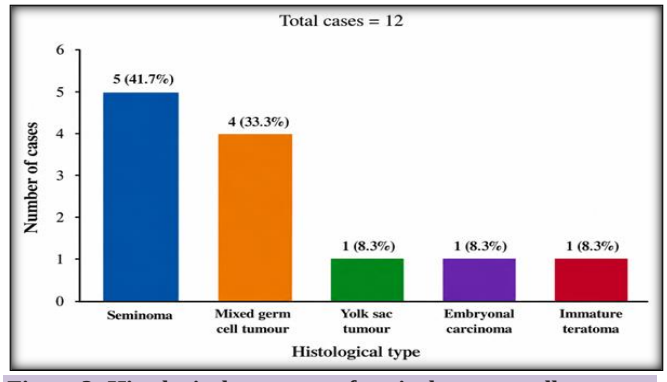

Figure 2: Histological spectrum of testicular germ cell tumours

[Figure 1] Distribution of the 54 gonadal germ cell tumours according to anatomical site. Ovarian tumours accounted for 42 cases (77.8%), whereas testicular tumours accounted for 12 cases (22.2%).

[Figure 2] Seminoma was the most frequent testicular histological type, followed by mixed germ cell tumour. Yolk sac tumour, embryonal carcinoma and immature teratoma each accounted for one case.

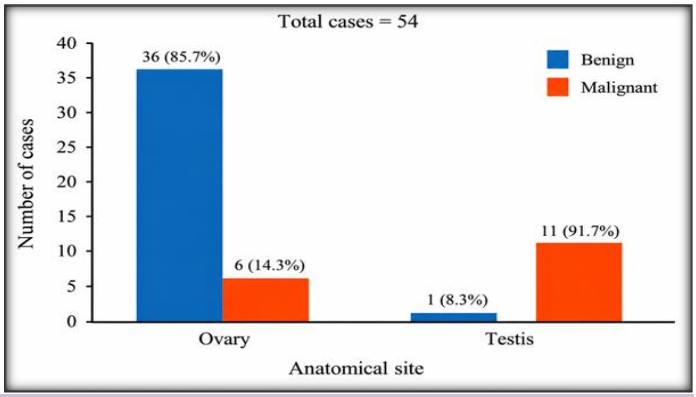

Figure 3: Comparison of benign and malignant gonadal germ cell tumours by anatomical site

[Figure 3] Benign histology predominated in the ovary, while malignant histology predominated in the testis. The difference in

tumour behaviour between ovarian and testicular germ cell tumours was statistically significant ($p<0.001$).

Discussion

The present study examined 54 primary gonadal germ cell tumours, including 42 ovarian and 12 testicular tumours. Ovarian tumours formed 77.8% of the gonadal cohort, mainly because of the high number of mature cystic teratomas. However, when each site was assessed against all neoplasms arising in that organ, germ cell tumours represented 80.0% of testicular neoplasms but only 19.0% of ovarian neoplasms. The findings therefore show that germ cell tumours were numerically more common in the ovary, but they represented a substantially greater proportion of all neoplasms of the testis.

The predominance of germ cell histology among testicular neoplasms agrees with other institutional studies. Paramita et al. found that germ cell tumours represented 95.34% of testicular neoplasms in their series, while seminoma and mixed germ cell tumour were the two leading male histological patterns.[10] Similarly, an Indian clinicopathological study by Beigh et al. reported that germ cell tumours formed 89.2% of testicular and paratesticular neoplasms.[11] The lower proportion of 80.0% in the present study may be related to the small number of testicular specimens, the inclusion of neoplasms from all age groups and differences in referral patterns.

The largest number of gonadal germ cell tumours occurred between 20 and 29 years of age, accounting for one-third of the total cohort. This peak was seen in both ovarian and testicular groups. Paramita et al. similarly found that most gonadal germ cell tumours occurred before 30 years of age, with the highest proportions in the 11–20- and 21–30-year age groups.[10] A recent study of 145 ovarian germ cell tumours from North-Western India also reported the greatest frequency between 21 and 30 years, with a mean patient age of 24.77 years.[12] These comparisons support the strong relationship between germ cell tumours and adolescence or young adulthood. However, ovarian tumours in the present series occurred across all age groups because benign mature teratomas were also identified in infants, middle-aged women and older adults.

A major finding was the difference in tumour behaviour between the two anatomical sites. Of the ovarian tumours, 36 of 42 cases were benign, while only six were malignant. In contrast, 11 of the 12 testicular tumours were malignant. This difference reflects the distinct histological composition of the two groups rather than a simple difference in case number. Mature cystic teratoma, which is usually benign, accounted for most ovarian cases. Postpubertal testicular germ cell tumours, including seminoma, embryonal carcinoma and mixed germ cell tumour, generally possess malignant potential. Sulaniya et al. also found that 85.5% of ovarian germ cell tumours were benign,[12] which is almost identical to the 85.7% recorded in the present study.

Seminoma was the most frequent testicular subtype and constituted 41.7% of testicular germ cell tumours. This was followed by mixed germ cell tumour, which accounted for 33.3%. The findings are comparable with those of Paramita et al., who reported seminoma as the most common male germ cell tumour, forming 34.78% of cases, followed by mixed germ cell tumour at 26%.[10] The predominance of seminoma in the present series also explains the concentration of testicular cases in young adults. Histologically, the seminomas showed sheets of uniform tumour cells separated by fibrous septa containing lymphocytes, while selected cases demonstrated strong CD117 expression. These morphological and immunohistochemical features supported the diagnosis, especially where the tumour required distinction from embryonal carcinoma, lymphoma or other poorly differentiated malignancies.

Mixed germ cell tumours formed an important part of the testicular spectrum. Every mixed tumour contained embryonal carcinoma and yolk sac tumour, while one also showed immature teratoma. The presence of haemorrhage, necrosis, spermatic-cord involvement, resection-margin involvement and retroperitoneal lymph-node metastasis in selected cases demonstrated their clinically aggressive nature. Gopalan et al. showed that testicular mixed germ cell tumours may contain several histological components, with embryonal carcinoma, yolk sac tumour and teratoma being especially frequent.[13] They also demonstrated that overlapping morphology and poor tissue preservation may make some components difficult to recognize. Therefore, extensive gross sampling and careful microscopic examination are essential because failure to identify a small but clinically relevant component may result in incomplete classification.

The selected use of immunohistochemistry was particularly valuable in mixed and poorly differentiated tumours. CD30 supported embryonal carcinoma, CD117 supported seminoma, alpha-fetoprotein supported yolk sac differentiation and beta-human chorionic gonadotropin identified trophoblastic differentiation. Paramita et al. found that additional immunohistochemical staining led to the reclassification of some morphologically diagnosed yolk sac tumours as mixed germ cell tumours after an embryonal carcinoma component was detected.[10] Gopalan et al. likewise demonstrated the diagnostic value of immunohistochemical panels in separating the components of mixed testicular germ cell tumours.[13] These observations indicate that immunohistochemistry should be interpreted as an adjunct to morphology rather than as a substitute for adequate sampling and histological assessment.

One unusual finding was a pure testicular yolk sac tumour in a 35-year-old man. Pure yolk sac tumour is a typical germ cell tumour of infancy and early childhood, whereas in adults yolk sac differentiation is more often found as part of a mixed germ cell tumour. Behera et al. reported a comparable pure yolk sac tumour in a 37-year-old man and emphasized the rarity of the pure postpubertal form.[14] The adult tumour in the present study therefore represents an uncommon but recognized histological presentation. Its identification requires extensive sampling to exclude small embryonal carcinoma, teratomatous or other germ cell components.

The only pure embryonal carcinoma in the present series occurred in a 13-year-old patient and was associated with distant metastases involving the lungs and brain. Histologically, it demonstrated solid, glandular and papillary patterns, marked nuclear atypia, increased mitotic activity and strong membranous CD30 positivity. This case illustrates the potentially aggressive

behaviour of embryonal carcinoma and the importance of integrating morphology with tumour stage and serum-marker findings. The detection of lymphovascular invasion, involvement of the spermatic cord and metastatic disease should be clearly recorded because these features directly contribute to staging and clinical management.

In the ovary, mature teratoma was the dominant tumour and represented 85.7% of ovarian germ cell tumours. This proportion is close to the findings of Rathore et al., in whose 25-year Indian series mature cystic teratoma constituted 78.5% of ovarian germ cell tumours.[15] Their mean age was 32.5 years and mean tumour size was 8.6 cm, while the present series recorded an average age of approximately 31 years and an average tumour diameter of 7.5 cm. Sulaniya et al. also found mature teratoma in 118 of 145 ovarian germ cell tumours, confirming its clear predominance in an Indian population.[12] These similarities strengthen the reliability of the present histological distribution despite the smaller sample size.

Grossly, the mature ovarian teratomas were mainly cystic and contained hair and pultaceous material. Teeth, cartilage or bone were identified in 14 cases, while microscopy confirmed mature tissues derived from ectodermal, mesodermal and endodermal layers. No malignant transformation was detected. Rathore et al. identified malignant transformation in 3.5% of mature cystic teratomas.[15] The absence of malignant transformation in the present study should therefore not be interpreted as evidence that it does not occur. It is more likely related to the relatively small number of cases and the rarity of this complication. Thorough sampling remains necessary, particularly in large tumours, older patients or lesions containing suspicious solid areas.

The malignant ovarian germ cell tumours comprised three yolk sac tumours and one case each of dysgerminoma, grade 3 immature teratoma and gonadoblastoma associated with choriocarcinoma. Their low number reflects the overall predominance of benign teratoma in the ovarian cohort. In an Indian malignant ovarian germ cell tumour series, Agarwal et al. reported mixed germ cell tumour and immature teratoma as the leading subtypes, followed by dysgerminoma and yolk sac tumour.[16] Differences between studies may result from whether benign mature teratomas were included, the age distribution of patients, referral to oncology centres and the limited number of malignant cases in individual institutions.

The three ovarian yolk sac tumours showed mainly reticular and microcystic patterns. These architectural patterns, together with Schiller–Duval bodies and alpha-fetoprotein expression when available, are useful for diagnosis. The dysgerminoma showed uniform polygonal cells arranged in sheets with lymphocyte-containing fibrous septa, closely resembling testicular seminoma. The immature teratoma was classified as grade 3 because of the prominent primitive neuroepithelial and immature mesenchymal components. Accurate grading is clinically important because the amount of immature tissue influences risk assessment and postoperative management.

The gonadoblastoma associated with choriocarcinoma was an uncommon and diagnostically important tumour. It occurred in a 17-year-old patient and showed extensive haemorrhage and necrosis, along with cytotrophoblastic and multinucleated syncytiotrophoblastic cells. Beta-human chorionic gonadotropin positivity confirmed trophoblastic differentiation. This case emphasizes that germ cell tumours may demonstrate unusual combinations and that young patients with gonadal tumours may require correlation with serum tumour markers, clinical findings and, when indicated, assessment for disorders of sex development.

The pathological diversity observed in the ovarian malignant group has clinical importance because prognosis differs according to histological subtype, age and disease stage. A SEER-based analysis of 1,963 malignant ovarian germ cell tumours found that histological type, patient age, grade and stage were independent prognostic factors.[17] Dysgerminoma showed the most favourable outcome, whereas embryonal carcinoma had the poorest survival in that analysis. Although outcome analysis was not available in the present study, the wide range of histological subtypes supports the need for exact classification rather than reporting all malignant tumours under a general germ cell category.

The present study has several limitations. It was based on a relatively small number of gonadal tumours from a single institution, particularly only 12 testicular cases and six malignant ovarian cases. Immunohistochemistry was performed only in selected cases, and a uniform modern marker panel was not applied to every tumour. Complete serum-marker, molecular, treatment and long-term follow-up information was not available for all patients. Consequently, survival analysis and reliable assessment of prognostic factors could not be performed. The retrospective use of the completed thesis dataset also limited control over missing clinical information. Nevertheless, the study provides a direct comparison of ovarian and testicular germ cell tumours from the same institutional setting and demonstrates clear differences in their age distribution, histological spectrum and malignant potential.

Overall, the findings show that ovarian and testicular germ cell tumours share a common cellular origin but display markedly different clinicopathological patterns. Ovarian tumours were more numerous and were largely composed of benign mature teratomas, whereas testicular tumours were predominantly malignant, with seminoma and mixed germ cell tumour forming the main subtypes. Careful gross examination, extensive tissue sampling and morphology-directed immunohistochemistry are essential for recognizing mixed components, confirming unusual subtypes and producing a complete pathological report.

Conclusion

Gonadal germ cell tumours showed clear clinicopathological differences between the ovary and testis. Of the 54 gonadal germ cell tumours examined, ovarian tumours were more frequent and accounted for 77.8% of cases. Mature teratoma was the predominant ovarian tumour, resulting in a high proportion of benign lesions. In contrast, most testicular germ cell tumours were malignant, with seminoma being the most common histological type, followed by mixed germ cell tumour. The highest frequency of tumours was observed among adolescents

and young adults, particularly in the 20–29-year age group. Testicular mixed germ cell tumours frequently contained embryonal carcinoma and yolk sac tumour components and showed aggressive features, including haemorrhage, necrosis, spermatic-cord involvement and nodal metastasis. Malignant ovarian germ cell tumours were less common but demonstrated varied histological patterns, including yolk sac tumour, dysgerminoma, immature teratoma and gonadoblastoma associated with choriocarcinoma.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Oosterhuis JW, Looijenga LHJ. Human germ cell tumours from a developmental perspective. Nat Rev Cancer. 2019;19(9):522-537. doi:10.1038/s41568-019-0178-9.
2. Cheng L, Albers P, Berney DM, Feldman DR, Daugaard G, Gilligan T, et al. Testicular cancer. Nat Rev Dis Primers. 2018;4(1):29. doi:10.1038/s41572-018-0029-0.
3. Nogales FF, Dulcey I, Preda O. Germ cell tumors of the ovary: an update. Arch Pathol Lab Med. 2014;138(3):351-362. doi:10.5858/arpa.2012-0547-RA.
4. WHO Classification of Tumours Editorial Board. Female genital tumours. 5th ed. Lyon: International Agency for Research on Cancer; 2020.
5. WHO Classification of Tumours Editorial Board. Urinary and male genital tumours. 5th ed. Lyon: International Agency for Research on Cancer; 2022.
6. Ulbright TM. Germ cell tumors of the gonads: a selective review emphasizing problems in differential diagnosis, newly appreciated, and controversial issues. Mod Pathol. 2005;18 Suppl 2. doi:10.1038/modpathol.3800310.
7. Berney DM, Looijenga LHJ, Idrees M, Oosterhuis JW, Rajpert-De Meyts E, Ulbright TM, et al. Germ cell neoplasia in situ: evolution of the current nomenclature for testicular pre-invasive germ cell malignancy. Histopathology. 2016;69(1):7-10. doi:10.1111/his.12958.
8. Smith HO, Berwick M, Verschraegen CF, Wiggins C, Lansing L, Muller CY, et al. Incidence and survival rates for female malignant germ cell tumors. Obstet Gynecol. 2006;107(5):1075-1085. doi:10.1097/01.AOG.0000216004.22588.ce.
9. Lobo J, Gillis AJM, Jerónimo C, Henrique R, Looijenga LHJ. Human germ cell tumors are developmental cancers: impact of epigenetics on pathobiology and clinic. Int J Mol Sci. 2019;20(2):258. doi:10.3390/ijms20020258.
10. Paramita P, Preeti A, Mili J, Ridhi J, Mala S, Goel MM. Spectrum of germ cell tumor: 5 years' experience in a tertiary care center and utility of OCT4 as a diagnostic adjunct. Indian J Surg Oncol. 2022;13(3):533-541. doi:10.1007/s13193-022-01522-w.
11. Beigh A, Junaid S, Beg A, Farooq S, Wani LA, Manzoor F. Clinicopathological study of testicular tumors: an experience in a tertiary care hospital in Kashmir Valley, Jammu and Kashmir, India. Int J Res Med Sci. 2017;5(6):2741-2746. doi:10.18203/2320-6012.ijrms20172480.
12. Sulaniya C, Lakhera KK, Babu A, Patel P, Singh S, Mehta D, et al. Ovarian germ cell tumors in North-Western India: a comprehensive 3-year retrospective study of 145 cases at a tertiary cancer hospital. Indian J Surg Oncol. 2024;15(2):288-295. doi:10.1007/s13193-024-01889-y.
13. Gopalan A, Dhall D, Olgac S, Fine SW, Korkola JE, Houldsworth J, et al. Testicular mixed germ cell tumors: a morphological and immunohistochemical study using stem cell markers, OCT3/4, SOX2 and GDF3, with emphasis on morphologically difficult-to-classify areas. Mod Pathol. 2009;22(8):1066-1074. doi:10.1038/modpathol.2009.66.
14. Behera P, Ahuja A, Bhardwaj M. Pure yolk sac tumor of testis with lung metastasis in an adult patient: case report. Med Pharm Rep. 2021;94(2):252-255. doi:10.15386/mpr-1470.
15. Rathore R, Sharma S, Arora D. Clinicopathological evaluation of 223 cases of mature cystic teratoma, ovary: 25-year experience in a single tertiary care centre in India. J Clin Diagn Res. 2017;11(4):EC11-EC14. doi:10.7860/JCDR/2017/23909.9612.
16. Agarwal R, Rajanbabu A, Keechilattu P, Nair IR, Vijaykumar DK, Unnikrishnan UG. A retrospective analysis of the pattern of care and survival in patients with malignant ovarian germ cell tumors. South Asian J Cancer. 2019;8(1):35-40. doi:10.4103/sajc.sajc_6_18.
17. Guo H, Chen H, Wang W, Chen L. Clinicopathological features, prognostic factors, survival trends, and treatment of malignant ovarian germ cell tumors: a SEER database analysis. Oncol Res Treat. 2021;44(4):145-153. doi:10.1159/000509189.