



Secondaries of Synovial Sarcoma in Vagina: A Diagnostic Dilemma

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Abstract

Objective/Background Synovial sarcoma (SS) is a clinically, morphologically, and genotypically distinctive neoplasm, accounting for approximately 10% of soft tissue sarcomas, which usually afflicts young-to-middle-aged adults and typically occurs in the deep soft tissues of the extremities, particularly the thigh and knee regions. The aim of this study is to describe a case of metastatic synovial sarcoma of vaginal wall with primary in the thigh. This is the first report documenting its occurrence in the vagina as a metastatic tumour. This is the first case of vaginal synovial sarcoma in the Indian literature.

Method A 57-year-old female presented with vaginal bleed. A thorough workup was done including clinical examination, histopathological examination of the biopsy from vaginal mass, IHC, and review of slides from the thigh swelling. A systematic literature review was conducted by searching the PubMed and National Centre for Biotechnology Information database.

Result Physical examination revealed fleshy mass at the anterior vaginal wall and a thigh swelling. On histopathological examination of the vaginal mass followed by IHC, a diagnosis of synovial sarcoma was made and the slides of the thigh mass were reviewed which revealed similar morphology and IHC profile. Hence, a final diagnosis of synovial sarcoma of thigh with metastasis to vaginal wall was made. Four case reports of primary SS of the vagina were found on reviewing the literature.

Conclusion To the best of our knowledge, this is the first report documenting the occurrence of synovial sarcoma in the vagina as a metastatic tumour and overall fifth report to document its occurrence in the vagina. All other four previously reported cases were primary SS of the vagina.

Keywords Synovial sarcoma · Vagina · Metastatic · TLE-1

Introduction

Synovial sarcoma (SS) is a clinically, morphologically, and genotypically distinctive neoplasm, accounting for approximately 10% of soft tissue sarcomas, which usually afflicts young-to-middle-aged adults and typically occurs in the deep soft tissues of the extremities, particularly the thigh and knee regions [1].

Synovial sarcoma may sometimes arise at unexpected sites, including the vulva in the female genital tract [2]. This is, to the best of our knowledge, the first report

documenting its occurrence in the vagina as a metastatic tumour and overall fifth report to document its occurrence in the vagina, all other four being primary tumours.

Materials and Methods

A 57-year-old female referred from a gynaecologist presented with per vaginal bleed for 15 days.

As per the patient and medical records shown by her, she developed a swelling at the upper part of the right thigh with features of deep vein thrombosis 14 months back. The swelling rapidly increased in size within 15 days, and the patient had limping gait for the same. She visited a clinician 3 months after the development of swelling, and CT scan of the thigh, trutcut biopsy of thigh swelling, and CT scan and chest X-ray were performed. Chest CT and X-ray revealed lung nodules. The trutcut biopsy was then reported as spindle cell sarcoma, for

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which she was given palliative chemotherapy and radiotherapy. Chemotherapy included injection Adriamycin 75 mg for 21 days, injection IFOS 1.2 gm/m²–1.8 gm, and injection Mesma 3 ampoules at 0, 4, and 8 h for 21 days × 3 cycles. Following this treatment, the right thigh swelling reduced in size but bilateral lung nodules persisted on CT. Hence, 12 cycles of radiotherapy were given. Five months after radiotherapy, she developed vaginal bleed.

Clinical examination, pelvic USG, and histopathological examination of the biopsy from the vaginal mass were done. Pathological examination was performed on representative fixed tissue samples embedded in paraffin and stained with H and E. The following histopathological features were evaluated:

- Biphasic pattern with spindle and glandular elements
- Haemangiopericytomatous pattern
- Mitotic activity

Histopathological examination was followed by immunohistochemistry evaluation. IHC markers used were CK, EMA, SMA, CD99, Bcl-2, CD56, TLE-1, desmin, S-100, and CD34. For immunohistochemical analysis, paraffin-embedded sections cut at 5 mm were deparaffinized and rehydrated and peroxidase blocking was done with 3% H₂O₂ freshly prepared. Antigen retrieval was performed for 10 min at 90 degrees treatment in EZ-Retriever System v.3 manufactured by BioGenex. The sections were then stained with automated stainer i6000 manufactured by BioGenex. All antibodies were ready to use; hence, dilution was not mentioned. Intensity, distribution, and source of all the antibodies used are summarized in Table 1. Slides from thigh swelling were also reviewed.

Systematic Review

A systematic literature review was conducted by searching the PubMed and National Centre for Biotechnology Information database using the keyword search term Synovial sarcoma of the vagina and the Medical Subject

Heading term synovial sarcoma of the vagina. All cases published hitherto were included. Excluded were reports published in a language other than English and without an English-language abstract. This yielded a total of four publications (Table 2). This analysis included gender, age at diagnosis, size, occurrence (whether primary or metastatic), clinical history, treatment, and follow-up.

Ethics: Procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional or regional) and with the Helsinki Declaration of 1975, as revised in 2000.

Results

On gynaecological examination, there was a fleshy mass measuring 4.5 × 4 cm at the anterior vaginal wall and urethral region which bled on touch. The swelling did not extend till cervix though it involved the urethral region. Pelvic USG revealed a fleshy mass at the anterior wall of the vagina with endometrial fluid collection. On general examination, there was a deeply situated swelling at the upper part of the right thigh measuring 10 × 8 cm. According to the patient, this swelling was present for 14 months. Clinical photograph could not be produced as the patient denied giving consent for the same.

CT abdomen pelvis contrast study revealed multiple metastases in the basal lung, large soft tissue mass of size 10.8 × 10.5 cm in the right groin and the upper thigh with areas of calcification and minimal sclerosis, and erosion of pubic bone and ramus.

Biopsy of the vaginal mass done outside reported it as Poorly differentiated malignant tumour? Squamous cell carcinoma.

On resectioning of the received blocks, microscopic examination of the haematoxylin-and-eosin-stained sections from the vagina showed an ulcerated tumour composed predominantly of spindle cells with oval to elongated hyperchromatic nuclei and scanty cytoplasm (Fig. 2c) arranged in fascicles and bundles. In areas, the tumour

Table 1 Distribution, intensity, and source of antibodies used

Sr.	Antibody	Distribution	Intensity	Source
1	CK	Cytoplasmic	Moderate	BioGenex
2	EMA	Membranous and cytoplasmic	Moderate	BioGenex
3	SMA	Cytoplasmic	Moderate	BioGenex
4	CD 99	Membranous	Strong	Dako
5	bcl-2	Cytoplasmic	Strong	BioGenex
6	TLE-1	Nuclear	Strong	Cell Marque
7	Desmin	Cytoplasmic	Negative	BioGenex
8	S-100	Cytoplasmic and nuclear	Negative	BioGenex
9	CD34	Membranous	Negative	BioGenex

Table 2 Previous case reports of synovial sarcoma of the vagina

Sr.	References	Age (years)	Size	Diagnosis	Occurrence	History	IHC	Treatment	Follow-up
1	Okagaki et al. [8]	24	3 × 2.5 × 2 cm	Synovial tumour	Primary	Mass for 2 years	ND	Radical hysterectomy, with bilateral salpingectomy, partial vaginectomy and left pelvic lymph node dissection	ND
2	Pelosi et al. [9]	40	5 × 4 cm	PDSS	Primary	Abnormal vaginal bleed and anaemia	Vimentin, EMA, CD99, CK7 and 19, bcl2, and calretinin +	Wide local resection of anterior vaginal wall	Lung metastasis after 11 months
3	Minig et al. [10]	40	5.5 cm	PDSS	Primary	Necrotic polypoidal lesion at vagina	c/w PDSS	Neoadjuvant followed by radical surgery with post-op brachytherapy and radiation	Lung metastasis at 11 and 16 months. Successfully removed both the times and disease free after 24 months
4	Sumathi et al. [5]	43	8 cm	PDSS	Primary	Long history of mass	Focal CK, EMA+; CD99, bcl-2, and focally+	Resection with hysterectomy. Local recurrence after 2,4,6, and 8 years, resected and given palliation	DOD after 8 years
5	Present case	57	10 × 8 cm	Biphasic SS	Secondary	Vaginal mass with bleeding for 15 days. Thigh swelling for 2–3 years	CK+ EMA+ SMA+ CD99+ Bcl2-desmin-S100-CD34-CD56+ TLE1+	Resection of vaginal mass followed by palliative chemotherapy for thigh mass	DOD after 2 years

showed haemangiopericytomatous pattern (Fig. 1b). Increased mitotic activity was noted ($> 15/10$ hpf) (Fig. 2b). In focal areas, the tumour also exhibited round cell morphology. The tumour also revealed clusters of cells with epithelial morphology arranged focally in glandular pattern. Areas of haemorrhage and tumour necrosis were also noted. With this biphasic morphologic pattern, a differential diagnosis of carcinosarcoma (malignant mixed

Mullerian tumour), SS, malignant mixed tumour, and sarcomatoid carcinoma was made.

On immunohistochemistry evaluation, the tumour cells expressed CK, EMA, SMA, CD99, Bcl-2, and CD56 and showed bright nuclear expression for TLE1 (Fig. 3). The tumour cells were negative for desmin, S-100, and CD34 (Fig. 4). With this morphology and IHC profile, a diagnosis of synovial sarcoma was made on review. The slides of the

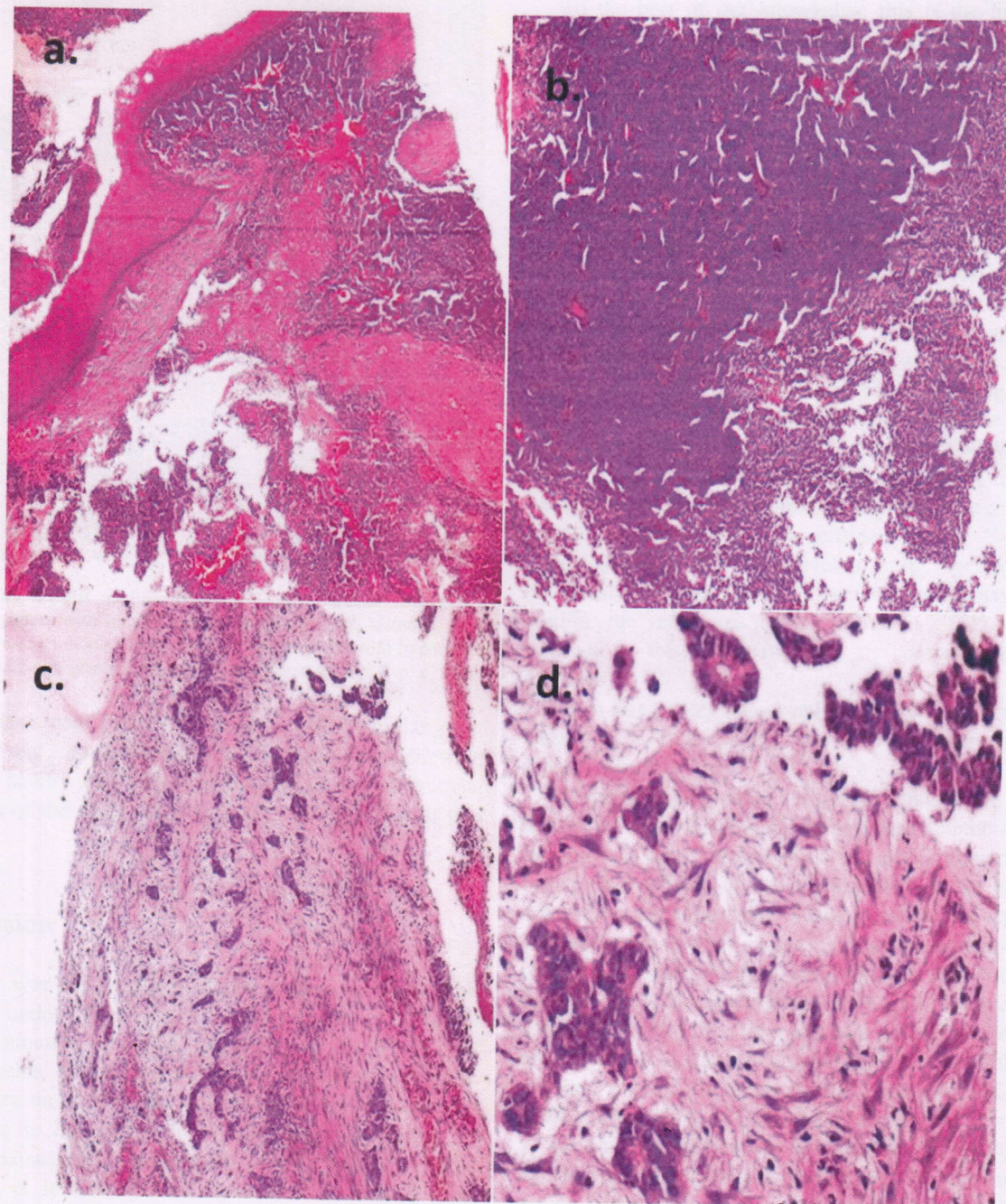


Fig. 1 H&E-stained sections from the vagina showing a tumour: a submucosally located, b spindle cell element with haemangiopericytomatous pattern, c, d showing glandular differentiation. Magnification: a $\times 4$, b, c $\times 10$, d $\times 40$

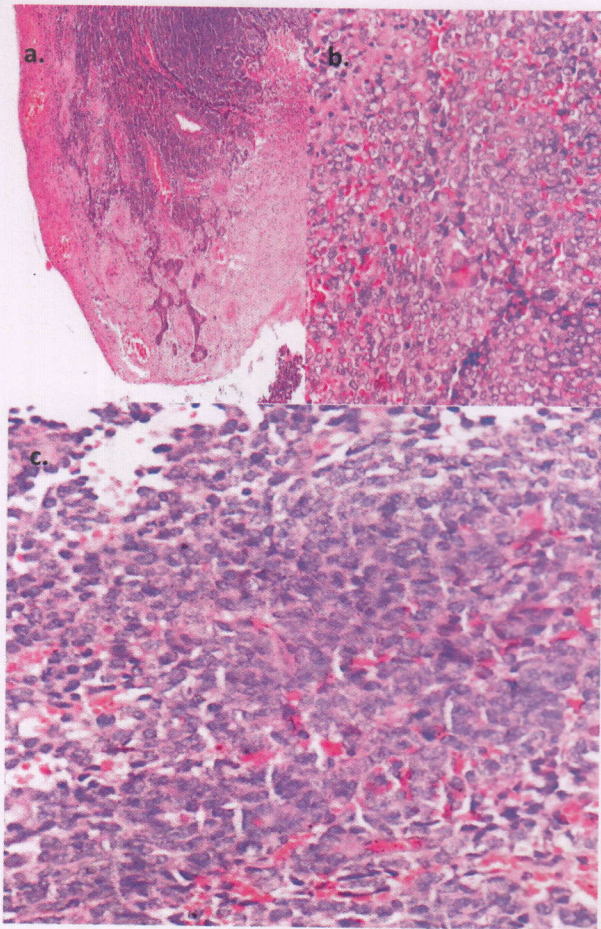


Fig. 2 H&E-stained sections from the vaginal tumour revealed: **a** biphasic pattern with spindle and glandular elements, **b** tumour cells with increased mitotic activity, **c** oval spindle cells with hyperchromatic nuclei and scanty cytoplasm. Magnification: **a** $\times 4$, **b**, **c** $\times 40$

thigh mass were reviewed which revealed similar morphology and immunoprofile (Fig. 5). Hence, on reviewing clinical history and slides, a final diagnosis of synovial sarcoma of the thigh with metastasis to vaginal wall was made.

Discussion

Primary synovial sarcomas of the vagina are very rare, grouped under “other rare tumours” category of “Miscellaneous tumours of vagina” according to the WHO 2014 classification of tumours of female reproductive organs. Secondary tumours of the vagina are defined as tumours spreading to the vagina from other anatomical sites by direct extension, implantation from primary pelvic tumours, or lymphovascular dissemination. Among these secondary tumours, synovial sarcomas have not been mentioned in the WHO 2014 classification of tumours of

female reproductive organs [3]. Synovial sarcoma is defined as a mesenchymal tumour, which displays a variable degree of epithelial differentiation, including gland formation, and has a specific chromosomal translocation $t(X; 18)(p11; q11)$ that leads to formation of a SS18-SSX fusion gene [4].

There are 16 cases of synovial sarcomas reported in the English literature, occurring in the female genital tract including vulva, vagina, and fallopian tubes [5–7, 10].

To the best of our knowledge, this is the first report documenting its occurrence in the vagina as a metastatic tumour and overall fifth report to document its occurrence in the vagina. All other four previously reported cases were primary SS of the vagina. This is the first case of vaginal synovial sarcoma in the Indian literature. Previously reported cases of synovial sarcoma in the vagina are summarized in Table 1.

Schiffman et al. [11] reported a case of biphasic synovial sarcoma in the vaginal wall in a 49-year-old female which on further investigations was found to be extending from a thigh tumour. The author labelled it as vaginal extension of SS from the thigh; hence, we have excluded it from the literature of secondary SS of the vagina. The patient was given orthovoltage irradiation of the left hip, and she died within 5 months of appearance of symptoms. Also, the author mentioned that in the case of malignant vaginal tumours, the possibility of spread from an extravaginal site should always be considered.

Synovial sarcomas can develop at any age [4]. In the previously reported cases of synovial sarcomas of the vagina, the mean age of occurrence is 36.75 years. In contrast to this, the patient in the present case aged 57 years.

Mean size of the tumour among the previously reported cases is 5.37 cm, while that in our case report is 4.5×4 cm.

Morphologically, most synovial sarcomas are characterized by a highly cellular, monotonous spindle cell proliferation, at times deceptively bland, either throughout the lesion (monophasic type) or admixed with an epithelial component (biphasic type). A dual mesenchymal–epithelial differentiation is also evident immunohistochemically in most monophasic variants; they typically show coexpression of vimentin, cytokeratins, and epithelial membrane antigen (EMA) [12]. Other markers which have emerged are CD99, bcl2, calponin, and TLE1 [13]. In the case reported herein, the tumour cells expressed CK, EMA, SMA, CD99, Bcl-2, CD56, and TLE1.

Most synovial sarcomas fall into the morphologic categories of biphasic, monophasic (the most common), and poorly differentiated types, the latter characterized by areas of high cellularity, nuclear pleomorphism, numerous mitoses, necrosis, and round cell morphology (seen in 75%

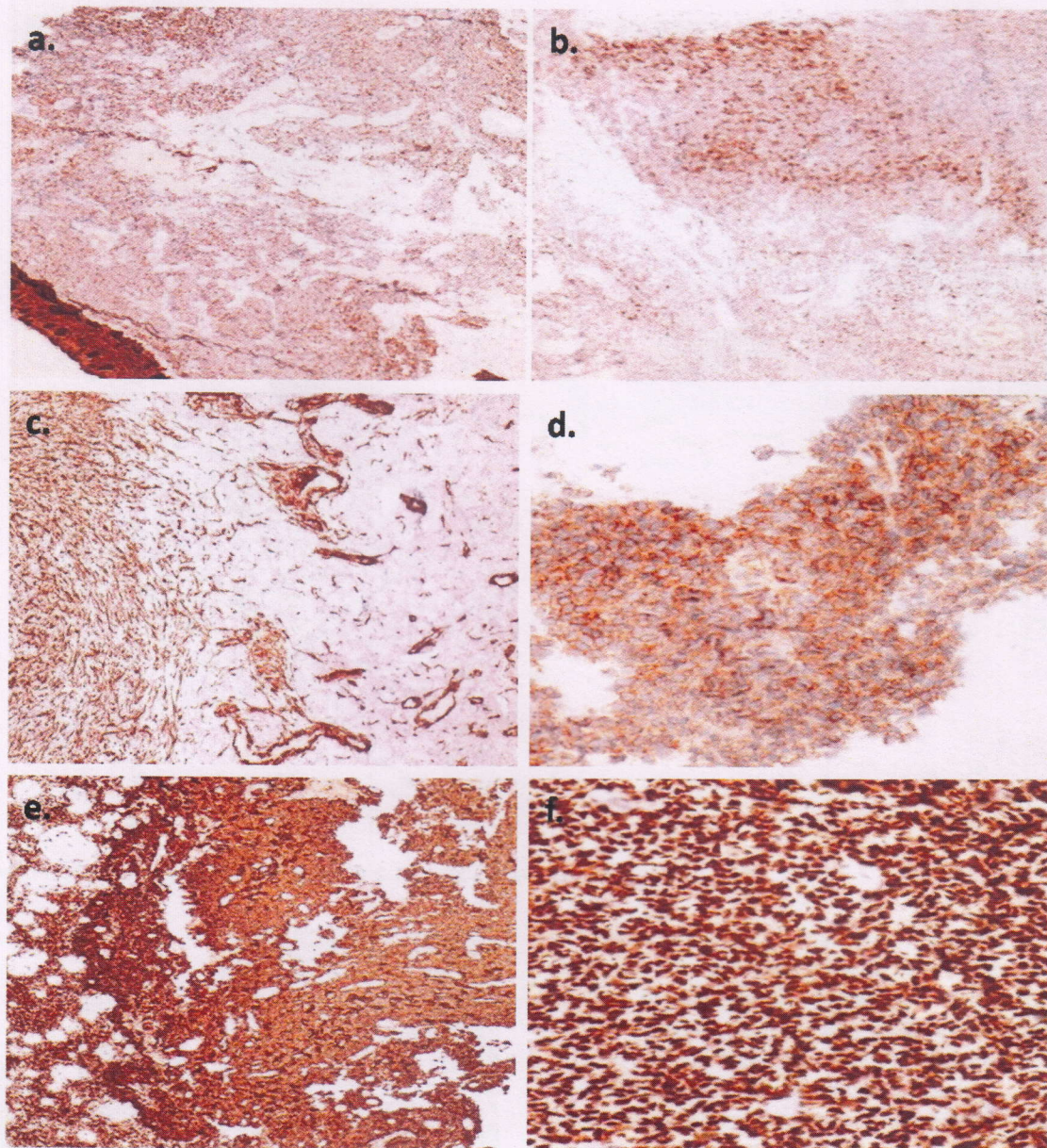


Fig. 3 Tumour cells expressed the following IHC markers: **a** CK, **b** EMA, **c** SMA, **d** CD99 [membranous positivity], **e** Bcl-2, and **f** TLE-1 [nuclear expression]. Magnification: **a–c**, $\times 10$, **d, f** $\times 40$

of the previously reported cases of vaginal synovial sarcomas), and areas of typical biphasic or monophasic synovial sarcoma. Purely epithelial variants are extremely rare [12]. Those synovial sarcomas reported in the female genital tract have been a mixture of biphasic, monophasic, and poorly differentiated (Table 1). The case reported herein is of biphasic type.

The differential diagnosis of synovial sarcoma in the vagina includes several spindle to small round cell tumours, but leiomyosarcoma (accounting for the most common histology in single tumour series in the vagina

[14]), the spindle cell variant of squamous cell carcinoma, and the rare mixed tumour of the vagina, either benign or malignant [8], represent the most important and difficult differential diagnoses. The chief differential diagnoses of synovial sarcoma in the vulvovaginal region are somewhat different from those in other locations and depend largely on whether the tumour is monophasic or biphasic [5]. The biphasic pattern with a high-grade spindle cell mesenchymal component admixed with epithelial elements raises the possibility of a carcinosarcoma (malignant mixed Mullerian tumour). Most carcinosarcomas in the female genital

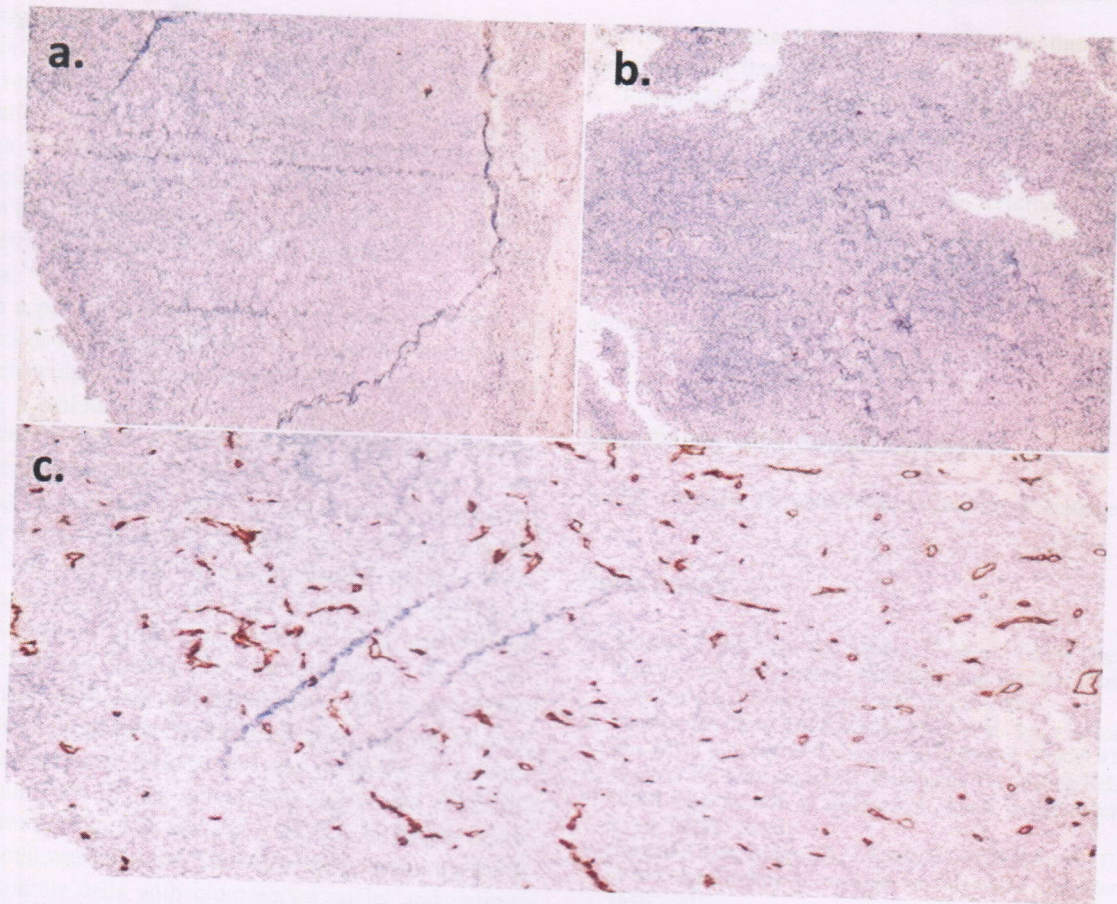


Fig. 4 Tumour cells were negative for: **a** desmin, **b** S-100, and **c** CD34. Magnification: **a–c** $\times 10$

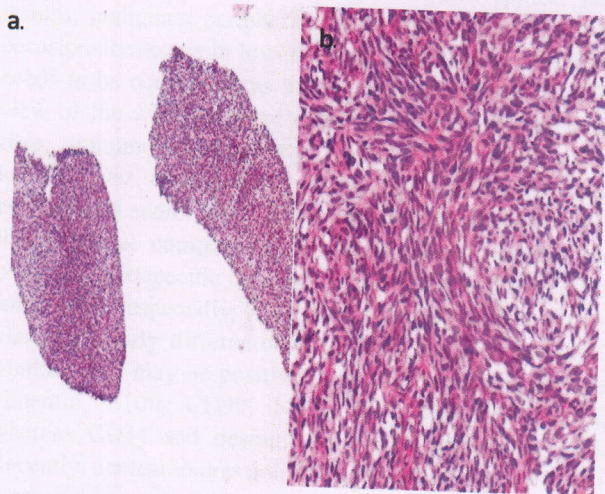


Fig. 5 H&E-stained sections from the thigh swelling revealed: **a**, **b** monophasic spindle cell sarcomatous morphology. Magnification: **a** $\times 4$, **b** $\times 40$

tract involve elderly women and arise in the uterus but may spread to involve the vulva or vagina. In carcinosarcoma, both the epithelial and mesenchymal elements are typically

of a higher grade and more anaplastic than in most synovial sarcomas, although there may be an overlap. In both the tumours, there is typically a sharp demarcation between the two components and there may be an immunohistochemical overlap. Heterologous mesenchymal elements in the form of malignant cartilage, bone, or skeletal muscle are a feature of some carcinosarcomas; however, cartilaginous or osseous elements are also rarely present in synovial sarcoma [15]. Mixed tumour of the vagina (spindle cell epithelioma) may also enter the differential diagnosis of biphasic synovial sarcoma [16]. This lesion typically occurs in premenopausal women and arises close to the hymenal ring in the lower vagina. Mixed tumour of the vagina is composed of an admixture of well-differentiated epithelial elements, often of both squamous and glandular types, and spindle-shaped cells. The spindle cell component usually predominates over the epithelial elements, and both components are usually bland without atypia or mitotic activity. In most instances, the spindle cell element in the mixed tumour of the vagina shows diffuse immunoreactivity with cytokeratin markers [17].

Endometriosis may be considered in the differential diagnosis of a biphasic synovial sarcoma in the

vulvovaginal region [18], although the glands in synovial sarcoma do not typically resemble endometrioid glands. Moreover, endometriosis in this region rarely forms a mass of significant size and the stromal element in synovial sarcoma is typically composed of plumper, more mitotically active cells than in endometriosis. ER and PR positivity of both the epithelial and stromal elements is usual in endometriosis and would not be expected in synovial sarcoma.

With a purely monophasic synovial sarcoma involving the vulva or vagina, the differential diagnostic possibilities are much wider. Given the morphologic appearances and the site, a cellular smooth muscle tumour is likely to be considered as well as a variety of other spindle cell lesions that characteristically or almost exclusively arise in the vulvovaginal region [19, 20]. The latter include aggressive angiomyxoma, angiomyofibroblastoma, cellular angiofibroma, and superficial myofibroblastoma of the lower female genital tract [21, 22]. The morphologic features of all these lesions differ significantly from monophasic synovial sarcoma in that they are typically of lower cellularity and show less mitotic activity. The immunophenotype of synovial sarcoma has been discussed, but most of the aforementioned lesions and the majority of smooth muscle tumours in the vulva and vagina are diffusely positive for desmin, ER, and PgR [19–22]. As stated, in our case, desmin was negative. Smooth muscle tumours usually contain spindle cells with blunt-ended nuclei and eosinophilic cytoplasm, the morphology differing from the case we describe. In cases of overtly malignant spindle cell lesions, malignant peripheral nerve sheath tumour, which occasionally occurs in lower female genital tract sites, also needs to be considered as a diagnostic possibility [12]. In view of the wide range of differential diagnoses at these sites, immunohistochemistry evaluation is often most helpful. Our case showed focal immunostaining with cytokeratins and/or EMA in the spindle cell element and in the epithelial components. However, these markers are obviously not specific for synovial sarcoma, and moreover, some cases, especially of monophasic type and in particular, the poorly differentiated variants, may be negative. Markers that may be positive in synovial sarcoma include vimentin, S100, CD99, bcl-2, and calponin [23–26], whereas CD34 and desmin are typically negative [27]. Recently, nuclear expression of TLE1 has been proposed as a promising immunohistochemical marker with high sensitivity and specificity in distinguishing synovial sarcoma from its histologic mimics [28].

Factors that are predictive of a worse outcome include tumour size greater than 5 cm, age above 20 years, proximal location, extensive tumour necrosis, and in particular, poorly differentiated morphology [5]. Since few cases of

synovial sarcoma have been reported in the vagina, the prognosis for these is uncertain.

Pathologists should avoid misdiagnosing it for other more common primary lesions developing in the vagina. Every attempt must be made to differentiate between primary and metastatic tumours as the treatment options and prognosis are entirely different in these two scenarios. Thorough clinical workup, high degree of suspicion, and complete relevant IHC profile are helpful in reaching accurate diagnosis.

Compliance with Ethical Standards

Conflict of interest The authors have no conflict of interest to declare.

References

1. Fletcher CDM, Unni KK, Mertens F. World Health Organization classification of tumours. Pathology and genetics. Tumours of soft tissue and bone. Lyon: IARC Press; 2002.
2. Nielsen GP, Shaw PA, Rosenberg AE, et al. Synovial sarcoma of the vulva: a report of two cases. *Mod Pathol*. 1996;9:970–4.
3. Kurman RJ, Carcangiu ML, Herrington CS, Young RH, editors. WHO classification of tumours of female reproductive organs. Lyon: IARC; 2014.
4. Fletcher CDM, Bridge JA, Hogendoorn PCW, Mertens F, editors. WHO classification of tumours of soft tissue and bone. Lyon: IARC; 2013.
5. Sumathi VP, Fisher C, Williams A, Meis JM, Ganesan R, Kindblom L, et al. Synovial sarcoma of the vulva and vagina: a clinicopathologic and molecular genetic study of 4 cases. *Int J GynecolPathol*. 2011;30:84–91.
6. Kawauchi S, Ihara K, Nishikawa K, Sugino N, Takahashi M, Sasaki K. Synovial sarcoma arising in the vulva cytogenetically confirmed by SYT break-apart rearrangement fluorescence in situ hybridization: a case report and discussion of diagnostic methods. *Oncol Lett*. 2012;4:955–9.
7. Asher V, van Schalkwyk G, Bali A. Synovial sarcoma of the vulva: a case report. *J Med Case Rep*. 2011;5:95.
8. Okagaki T, Ishida T, Hilgers RD. A malignant tumor of the vagina resembling synovial sarcoma: a light and electron microscopic study. *Cancer*. 1976;37:2306–20.
9. Pelosi G, Luzzatto F, Staffa N, et al. Poorly differentiated synovial sarcoma of the vagina: first reported case with immunohistochemical, molecular and ultrastructural data. *Histopathology*. 2007;50:808–10.
10. Minig L, Farnetani G, Peiretti M, Roviglione G, Zanagnolo V, Pelosi G, et al. Poorly differentiated synovial sarcoma of the vagina: a case report and a clinical literature review. *Ecancer*. 2008;2:99.
11. Schiffman R, Chong TWS. Vaginal bleeding as a presenting symptom of synovial sarcoma. *Cancer*. 1980;45:2428–33.
12. Fisher C. Synovial sarcoma. *Ann Diagn Pathol*. 1998;2:401–21.
13. Goldblum JR, Folpe AL, Weiss SW. Enzinger and Weiss's Soft tissue tumors. Malignant soft tissue tumors of uncertain type. 6th ed. Amsterdam: Elsevier; 2014. p. 1065–7.
14. Curtin JP, Saigo P, Slucher B, et al. Soft-tissue sarcoma of the vagina and vulva: a clinicopathologic study. *Obstet Gynecol*. 1995;86:269–72.

15. Milchgrub S, Ghandur-Mnaymneh L, Dorfman HD, et al. Synovial sarcoma with extensive osteoid and bone formation. *Am J Surg Pathol*. 1993;17:357–63.
16. Branton PA, Tavassoli FA. Spindle cell epithelioma, the so called mixed tumor of the vagina. A clinicopathologic, immunohistochemical and ultrastructural analysis of 28 cases. *Am J Surg Pathol*. 1993;17:509–15.
17. Oliva E, Gonzalez L, Dionigi A, et al. Mixed tumours of the vagina: an immunohistochemical study of 13 cases with emphasis on the cell of origin and potential aid in differential diagnosis. *Mod Pathol*. 2004;17:1243–50.
18. Buda A, Ferrari L, Marra C, et al. Vulvar endometriosis in surgical scar after excision of the Bartholin gland. *Arch Gynecol Obstet*. 2008;277:255–6.
19. McCluggage WG, Patterson A, Maxwell P. Aggressive angiomyxoma of pelvic parts exhibits oestrogen and progesterone receptor positivity. *J Clin Pathol*. 2000;53:603–5.
20. McCluggage WG. A review and update of morphologically bland vulvovaginal mesenchymal lesions. *Int J Gynecol Pathol*. 2005;24:26–38.
21. Ganesan R, McCluggage WG, Hirschowitz L, et al. Superficial myofibroblastoma of the lower female genital tract: report of a series including tumors with a vulval location. *Histopathology*. 2005;46:137–43.
22. McCluggage WG, Ganesan R, Hirschowitz L, et al. Cellular angiofibroma and related fibromatous lesions of the vulva: report of a series of cases with a morphological spectrum wider than previously recognised. *Histopathology*. 2004;45:360–8.
23. Dei Tos AP, Wadden C, Calonje E, et al. Immunohistochemical demonstration of glycoprotein p30/32 mic2 (CD99) in synovial sarcoma. A potential cause of diagnostic confusion. *Appl Immunohistochem*. 1995;3:168–73.
24. Fisher C, Montgomery E, Healy V. Calponin and h-caldesmon expression in synovial sarcoma; the use of calponin in diagnosis. *Histopathology*. 2003;42:588–93.
25. Guillou L, Kraus MD, Dei Tos AP, et al. S-100 protein reactivity in synovial sarcomas—a potentially frequent diagnostic pitfall: immunohistochemical analysis of 100 cases. *Appl Immunohistochem*. 1996;4:167–75.
26. Suster S, Fisher C, Moran CA. Expression of bcl-2 oncoprotein in benign and malignant spindle cell tumors of soft tissue, skin, serosal surfaces and gastrointestinal tract. *Am J Surg Pathol*. 1998;22:863–72.
27. Ordonez NG, Mahfouz SM, Mackay B. Synovial sarcoma: an immunohistochemical and ultrastructural study. *Hum Pathol*. 1990;21:733–49.
28. Terry J, Saito T, Subramanian S, et al. TLE1 as a diagnostic immunohistochemical marker for synovial sarcoma emerging from gene expression profiling studies. *Am J Surg Pathol*. 2007;31:240–6.

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