Case Reports

Journal of INTERNATIONAL MEDICAL RESEARCH

Journal of International Medical Research
49(9) 1–10

DOI: 10.1177/03000605211041509
journals.sagepub.com/home/imr
SAGE

Unusual paediatric sigmoid perivascular epithelioid cell tumour with regional lymph node metastasis treated using gemcitabine and docetaxel: a case report and literature review

Hsiu-Chung Cheng[1], Chia-Yu Kuo[2], Ching-Wen Huang[3], Hsiang-Hung Shih[4], Chih-Hung Lin[5] and Jaw-Yuan Wang[3,6,7,8]

Abstract

Perivascular epithelioid cell tumour (PEComa) is an extremely rare neoplasm with distinctive morphology and specific expression of immunohistochemical markers. The lesion is typically diagnosed in middle-aged women, with few reports of paediatric cases, and there is no standardized treatment for the tumour type. Here, the case of a 17-year-old female, who presented with painless haematochezia for 2 days and was diagnosed with gastrointestinal PEComa of the sigmoid colon with regional lymph node metastasis after serial examination, is presented. She was treated by surgical resection of the tumour and cytotoxic chemotherapy comprising 900 mg/m^2 gemcitabine and 100 mg/m^2 docetaxel every 3 weeks for six cycles. Haematochezia did not recur, and complete response was achieved, with progression-free survival at the 24-month follow-up

[1]School of Medicine, College of Medicine, Kaohsiung Medical University
[2]Department of Surgery, Kaohsiung Medical University Hospital, Kaohsiung Medical University
[3]Division of Colorectal Surgery, Department of Surgery, Kaohsiung Medical University Hospital, Kaohsiung Medical University
[4]Division of General Paediatrics, Department of Paediatrics, Kaohsiung Medical University Hospital, Kaohsiung Medical University
[5]Department of Pathology, Kaohsiung Medical University Hospital, Kaohsiung Medical University
[6]Department of Surgery, School of Medicine, College of Medicine, Kaohsiung Medical University
[7]Graduate Institute of Clinical Medicine, Centre for Cancer Research, Kaohsiung Medical University
[8]Ministry of Health and Welfare Pingtun Hospital

Corresponding author:
Jaw-Yuan Wang, Division of Colorectal Surgery, Department of Surgery, Kaohsiung Medical University Hospital, Kaohsiung Medical University, 100 Tzyou 1st Road, Kaohsiung City 807.
Email: jawyuanwang@gmail.com; cy61412@ms14.hinet.net

examination. Surgical resection with adjuvant conventional cytotoxic chemotherapy may be considered as an option for treating gastrointestinal PEComa.

Keywords
Perivascular epithelioid cell tumour, PEComa, gastrointestinal PEComa, paediatric sigmoid PEComa, PEComa–not otherwise specified, early-stage gastrointestinal PEComa, case report

Date received: 3 May 2021; accepted: 3 August 2021

Introduction

Perivascular epithelioid cell tumours (PEComas) are extremely rare neoplasms of mesenchymal origin, featuring distinctive morphology, immunohistochemistry and ultrastructure, and include angiomyolipomas, lymphangioleiomyomatosis, and clear-cell sugar tumours.[1,2] PEComa–not otherwise specified (PEComa–NOS) refers to clear-cell tumours of anatomic locations that do not qualify for the predominant assemblage of the PEComa family, such as the aforementioned tumour types.[3] PEComas–NOS are typically diagnosed in women aged 38.9–56 years and are focused on the uterus and gastrointestinal (GI) tract, with uterine corpus lesions accounting for 41% of reported cases.[1,4–8]

Immunohistochemically, PEComa–NOS typically exhibits positive melanocytic and myogenic markers, such as human melanoma black-45 (HMB-45), melanoma antigen recognized by T-cells 1 (melan-A), and smooth muscle actin, and is negative for protein S100, cytokeratin, and desmin.[9–11] However, the histogenesis and corresponding normal cellular counterpart of PEComa remain unknown.[1,3]

There is currently no standardized treatment strategy for PEComa,[2] and due to the unpredictable histopathological manifestation, patients with aggressive PEComas have a poor prognosis and do not respond well to chemotherapy.[5,12,13] In addition, mammalian target of rapamycin (mTOR) inhibitor treatment remains controversial in patients lacking the tuberous sclerosis complex (*TSC*) gene mutation.[5,9] To date, radical surgical resection is shown to be an effective treatment for the primary tumour and for local recurrence prevention.[2] Herein, the case of a 17-year-old female patient with an unusual PEComa is described. She presented at Kaohsiung Medical University Hospital with painless haematochezia for 2 days. Colonofibreoscopy and pathology analysis revealed a perivascular PEComa of the rectosigmoid colon with regional metastatic lymph nodes that were successfully treated with complete resection and gemcitabine/docetaxel chemotherapy. No local or distant recurrence was observed at 24 months following surgery.

Case report

Written informed consent was obtained from the patient and her parents for publication of the case report and accompanying images, and all details have been deidentified to protect the patient's identity. Ethics approval was obtained from the Institutional Review Board of Kaohsiung Medical University Hospital (IRB No.: KMUHIRB-E(I)-20200366). The manuscript was prepared and revised according

to the CARE Checklist (2016), and the reporting of this study conforms to CARE guidelines.[14]

A 17-year-old female patient visited the emergency room of Kaohsiung Medical University Hospital in May 2019 with painless haematochezia for the previous 2 days. She also had symptoms of dizziness and fainting, but did not present with headache, blurred vision, fever, nausea or vomiting, abdominal pain, chest pain, tachycardia, trauma history, recent weight loss, general numbness or weakness.

The patient had a previous medical history of anaemia, which was diagnosed at a school health examination, but she did not receive further examination or treatment. She reported no history of other gastrointestinal symptoms or signs, or trauma.

At the Kaohsiung Medical University Hospital emergency room, the patient's temperature was 37.2 °C, heart rate was 80 beats per min, respiratory rate was 18 breaths per min, blood pressure was 93/57 mmHg and oxygen saturation in room air was 100%. Consciousness was clear and she scored 15/15 on the Glasgow Coma scale. Her conjunctiva was pale. The clinical abdominal examination showed normoactive bowel sound, no muscle guarding, no tenderness, no rebound pain and tympanic sound to percussion.

Results of blood analyses were as follows: haemoglobin level, 6.0 g/dl (normal range, 11.1–15.1 g/dl); white blood cell count, 5720 cells/mm^3 (normal range, 4140–10 520 cells/mm^3); and platelet count, 384 000 cells/mm^3 (normal range, 160 000–370 000 cells/mm^3). Gross appearance of the stool was bloody, and the faecal occult blood test result was 4+. No Salmonella or Shigella species were isolated in the stool culture, and stool tests for enteric adenovirus and rotavirus antigen were negative. Laboratory tests showed the following: C-reactive protein, 0.35 mg/l (normal range, <5.0 mg/l); aspartate aminotransferase (serum glutamic-oxaloacetic transaminase), 17 IU/l (normal range, 10–42 IU/l); alanine aminotransferase (serum glutamic pyruvic transaminase), 12 IU/l (normal range, 10–40 IU/l); and tumour markers carbohydrate antigen 19-9, <16.1 U/ml (normal range, <37 U/ml) and carcinoembryonic antigen, <0.3 ng/ml (normal range, <5 ng/ml). Blood transfusion was performed for severe anaemia. Tranexamic acid (500 mg/5 ml ampoule), 1 ampoule by intravenous drip every 8 h, for 6 days, was also administered for massive bloody stool.

Ultrasonography revealed a suspicious 2.9-cm ovoid mass in the pelvis region. Further abdominal computed tomography (CT) revealed a large pedunculated polypoid lesion measuring $3.5 \times 3.1 \times 2.8$ cm, with heterogenous enhancement in the rectosigmoid colon and metastatic lymphadenopathy of approximately 0.6 cm in the paracolic region (Figure 1A–D).

Colonofibreoscopy indicated a large submucosal tumour with ulcerations and a large stalk at 10 cm from the anus (Figure 2A and B). The patient received robotic-assisted low anterior resection of the rectosigmoid colon tumour at Kaohsiung Medical University Hospital, with an uneventful postoperative course. Pathology of the resected tumour tissue (Figure 3A) revealed a perivascular epithelioid cell tumour of the rectosigmoid colon with regional metastatic lymph nodes, classified as pT1N1 (American Joint Committee on Cancer staging manual, 8th edition, 2017). The circumferential resection and surgical resection margins were free of tumour cells. Immunohistochemical staining of the tumour cells revealed strong diffuse positivity for HMB-45 (Figure 3B) and negative results for melan-A, cytokeratins (multicytokeratin antibody AE1/AE3), paired box protein Pax-8 (PAX8), discovered on gastrointestinal stromal

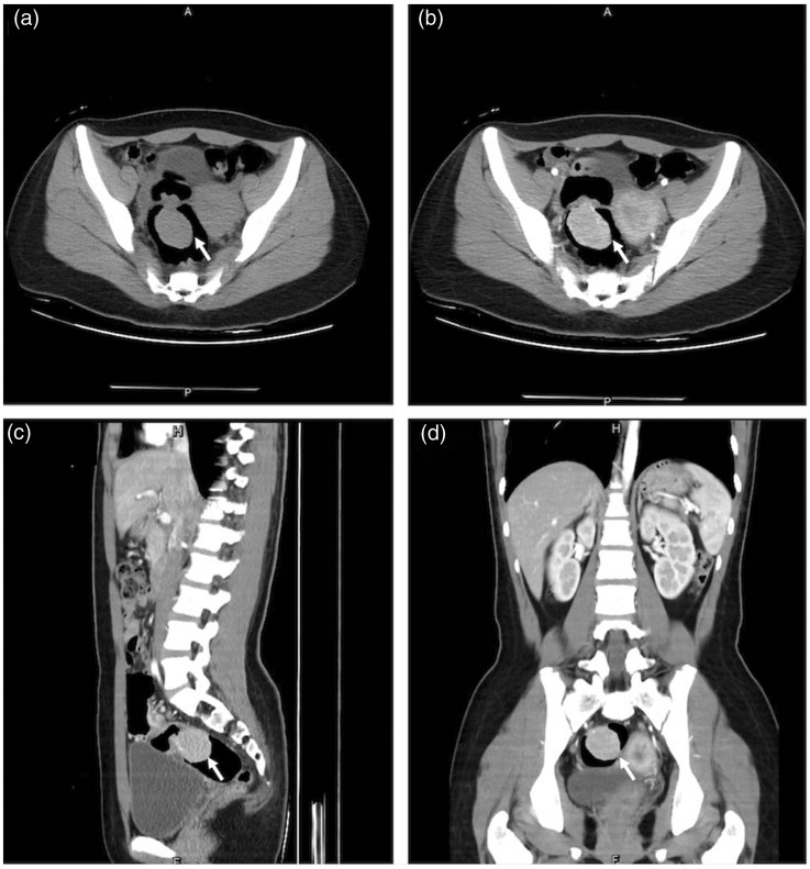

Figure 1. Representative images from abdominal computed tomography (CT) of the primary tumour in the sigmoid colon, showing a large pedunculated polypoid lesion measuring 3.5 × 3.1 × 2.8 cm, with heterogenous enhancement in the rectosigmoid colon (arrow) and metastatic lymphadenopathy of approximately 0.6 cm in the paracolic region: (a) plain CT axial plane; (b) arterial phase axial plane; (c) sagittal plane; and (d) coronal plane.

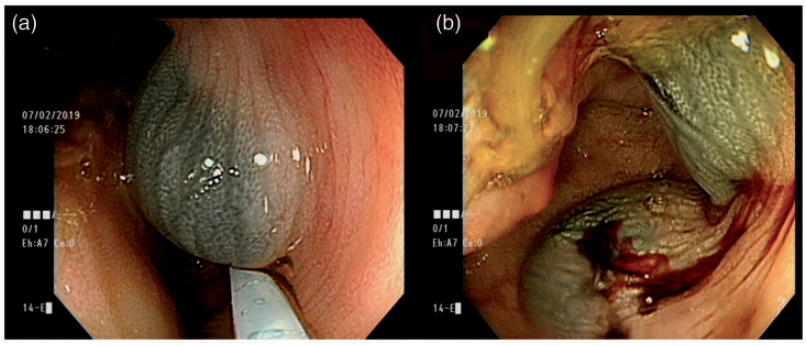

Figure 2. Representative colonofibreoscopy images showing a large submucosal tumour with ulcerations and a large stalk at 10 cm from the anus.

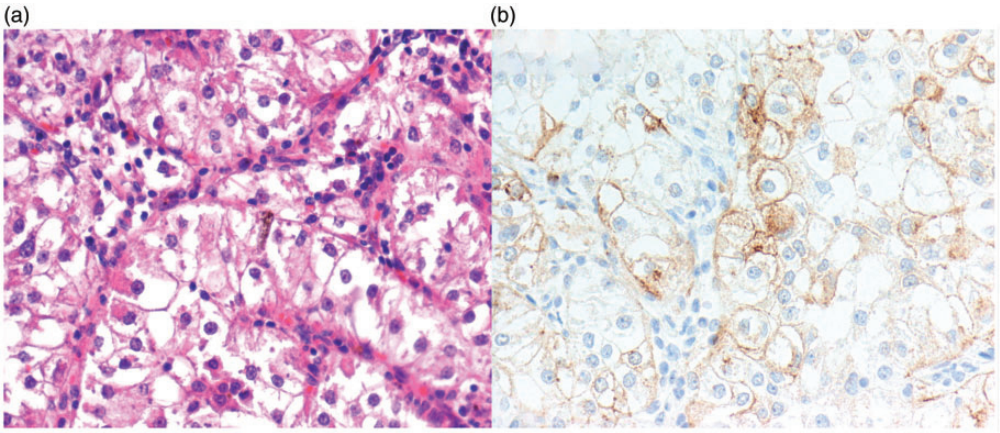

Figure 3. Representative tissue sections of the primary tumour in the sigmoid colon: (a) haematoxylin and eosin-stained section showing nests and sheets of plump round to polygonal cells with a clear cytoplasm, and large vessels with perivascular growth; and (b) cytoplasmic pigmentation and HMB-45 positive immunostaining of the tumour cells (both original magnification, × 400).

tumours protein 1 (DOG-1; also known as anoctamin-1), and synaptophysin.

The final diagnosis of the presented case was sigmoid PEComa, cT1N1M0, stage IIIA, pT1N1. Adjuvant conventional cytotoxic chemotherapy was initiated at 1 month following complete resection, comprising six cycles of 900 mg/m^2 gemcitabine, combined with 100 mg/m^2 docetaxel, every 3 weeks (delivered between August and November 2019).

Repeat abdominal CT scans at 6, 12 and 18 months after surgical resection revealed no local recurrence or distant metastasis. Results of colonofibreoscopy, performed 1 year after surgery, were unremarkable. An abdominal ultrasound scan also showed no specific finding. The patient's clinical condition remained stable after complete resection and treatment with gemcitabine/docetaxel without local or distant recurrence at the 24-month follow-up.

Discussion

Studies on treatments and outcomes specific to PEComa are limited to institutional series and anecdotal case reports. Review of an article by Chen et al,[3] and a PubMed search of articles published up to July 2020, using the following search terms: ("perivascular epithelioid cell tumor" or "PEComa") and ("gastrointestinal tract" or "GI" or "oral " or "mouth" or "esophagus" or "gullet" or "gastric" or "stomach" or "duodenum" or "jejunum" or "ileum" or "cecum" or "colon" or "colorectal" or "sigmoid" or "rectum" or "anus" or "mesentery"), revealed 62 cases of gastrointestinal PEComa–NOS in the literature.[3,12,15–23] the colon was the most commonly affected part of the abdominal cavity, followed by the mesentery, rectum, stomach, duodenum, ileum, cecum, and other locations.[3] The GI tract is the second most frequent location of PEComa, preceded only by the gynaecological tract.[8] In addition, polypoid tumours centred in the mucosa and submucosa principally occur in the cecum and rectum.[24] GI PEComas have a conspicuous female tendency,[11,25] along with an incidence peak in the fourth or fifth decade of life.[3] However, there are limited previous reports of GI

PEComas in children.[24,26–28] The first reported paediatric case of metastatic PEComa of the colon was published in 2008,[27] and described an 11-year-old prepubertal Caucasian boy who underwent resection of a 5.5-cm-long section of the sigmoid colon. At the 5-month follow-up, the results of repeat CT were unremarkable and the boy was asymptomatic.[27] In 2009, a case report similar to the present patient, published in 2009, described a 15-year-old female patient with rectal PEComa and lymph node involvement that was successfully treated with surgical resection and adjuvant chemotherapy (doxorubicin, ifosfamide, and mesna) without recurrence at 9 months following surgery. Regardless of the affected age group, prognostic pathologic markers of GI PEComas are few, due to the rare nature of the neoplasm.[24]

Distinguishing GI PEComa from GI stromal tumour (GIST) or other sarcoma is challenging because PEComa generally presents a biphasic GIST-compatible morphology.[12] The clinical manifestation of PEComa is variable and with little discrimination, and may include abdominal pain or rectal bleeding, or may be asymptomatic.[3,28] Haematochezia was observed in the present patient, whereas intermittent rectal bleeding has been observed in several previously described paediatric patients.[24,26,29] Imaging studies assist in identifying the lesion to a certain degree.[30,31] Arteriovenous hypervascularity may be observed in contrast-enhanced CT, but most areas are seen as homogeneous and well-demarcated masses with clear boundaries in plain CT.[31] Endoscopy may facilitate the detection of a polypoid tumour or fungating mass with irregular ulceration, and tumours are generally observed as a rich vascularization with a hyaline wall or even necrosis.[4,32]

Immunohistochemical discernment of melanocytic differentiation is the most effective approach to differentiating GI PEComa-NOS from other tumours, such as GIST, angiomyolipoma, paraganglioma, malignant melanoma, and alveolar soft part sarcoma.[2] Although the precursor or normal counterpart of PEComa-NOS remains undefined,[12] HMB-45 continues to be the most sensitive and frequent melanocytic marker in 92–100% of reports.[1,2,33] Other potential melanocytic and myogenic markers are melan-A, smooth muscle actin, and microphthalmia transcription factor, which have been described in 23–88%, 59–93%, and 50–92% of reports, respectively, as well as desmin and caldesmon.[1,2,8,10,24,33] PEComa-NOS is negative for expression of chromogranin A, synaptophysin and protein S100, and thus, may be differentiated from paraganglioma.[2] Diagnosis of GIST can be excluded if either perivascular concentric proliferation or representative granular cytoplasm is present.[3] Less than 50% of GISTs are strongly CD117 positive and GISTs completely lack expression of melanocytic markers, especially HMB-45.[12]

Folpe *et al.*[11] established a series of criteria to distinguish the pathological behaviour of aggressive PEComa, namely high-risk features such as a size of $\geq$5 cm, a mitotic rate of $\geq$1 cells/high power field, an infiltrative growth pattern, high nuclear grade and cellularity, necrosis, and vascular invasion. Another study proposed that a tumour size of $\geq$5 cm and a mitotic rate of $\geq$1 cells/ high power field are crucially associated with prognosis and recurrence.[1,5,30,34] Tumours with $\geq$2 high-risk characteristics are categorized as malignant PEComa, and 81.6% of such lesions may relapse within 23 months.[2,33] The present case involved a pedunculated polypoid lesion in the sigmoid colon that was approximately $3.5 \times 3.1 \times 2.8$ cm, with no evidence of necrosis, and the tumour was well limited in the submucosa, with no further infiltration.

According to National Comprehensive Cancer Network (NCCN) guidlines,[35,36]

removing the sarcoma with a cancer-free surgical margin (R0) is the goal, and additional neoadjuvant or adjuvant treatments, such as radiation therapy, chemoradiation and systemic therapy, might be combined with surgery. Systemic therapies including sirolimus, everolimus and temsirolimus have been suggested for use in cases of PEComa, recurrent angiomyolipoma and lymphangioleiomyomatosis. The guideline concluded that not everyone will receive the same treatment, and treatment options should depend on the location and type of soft tissue sarcoma. Other publications have also shown surgical resection to be the preferred treatment for primary GI PEComa tumours, particularly in benign and chemoradio-resistant groups.[3,4,7,24] Surgical resection is also adopted to manage local recurrence after initial therapy, enabling long-term control of metastatic foci.[12,37]

Most tumours are eradicated at the size of 4–6 cm when excision is performed.[12,28] Cheng *et al.*[34] described the successful treatment of patients with recurrent PEComas of the sigmoid colon and pancreatic metastasis using surgical resection alone, and a 2018 publication reported a patient with rectal PEComa with recurrent liver metastases who was cured through surgery.[38] However, 37.1% of patients treated with surgical resection without adjuvant therapy may develop distant metastases after 6 months.[38] Most of the previously reported paediatric patients were treated with surgery as an initial management strategy.[24,26–28] However, the preferred adjuvant therapy, including doxorubicin, paclitaxel, gemcitabine, and oxaliplatin alone or in combinations, is a matter of contention.[5,9,13,24,39,40] For benign PEComa, no standardized regimen to avoid recurrence after surgery has been described.[3,4] Clinical outcomes in the published literature are varied. Ryan *et al.*[24] reported the case of a 15-year-old patient with rectal PEComa and lymph node involvement. The patient was successfully treated with surgical resection and adjuvant chemotherapy that comprised a combination of doxorubicin, ifosfamide, and mesna, with no recurrence at 9 months postsurgery. Another report, published in 2010, described a patient aged 7 years with ascending colon PEComa who was treated with adjuvant interferon-α2b immunotherapy after resection, with a favourable outcome.[39]

Bleeker *et al.*[5] demonstrated that conventional cytotoxic chemotherapy is not effective in malignant PEComas and emphasized the superiority of mTOR inhibitor therapy. The mTOR pathway regulates cell growth and is associated with inactivation of the *TSC1* and *TSC2* genes.[1,12] Deletions or loss of heterozygosity (LOH) are observed at locus *TSC2* in some PEComa cases, leading to the loss of tuberin activity.[1,2,41] LOH at the *TSC1* locus, encoding hamartin, has been less described.[5] However, both proteins regulate the activation state of GTPase, acting as an inhibitor of the mTOR signalling pathway.[41] The loss of tuberin and hamartin function leads to excessive activity of mTOR serine/threonine kinase, which is a target for mTOR inhibitors in treating patients with advanced PEComa.[5] Compared with *TSC1* or *TSC2* somatic mutations in PEComa–NOS and malignant PEComa, the germ-line mutation inactivating the *TSC1* or *TSC2* genes in tuberous sclerosis showed a closer association with lymphangioleiomyomatosis or angiomyolipomas.[2] Tuberous sclerosis has been shown to occur in only 0–6.25% of patients with PEComa.[2,5,11] Characterization of *TSC1* and *TSC2*, along with their downstream products,[2,13] may help develop targeted therapeutic agents, such as sirolimus or tacrolimus. However, contradictory results were observed when a 58-year-old female patient with metastatic PEComa was

treated with a combination of topotecan, temsirolimus (mTOR inhibitor), and bortezomib.[40] Moreover, a 23-year-old male patient with colon PEComa demonstrated resistance to mTOR inhibitor therapy but maintained stable prognosis when treated with a combination of doxorubicin and ifosfamide for 9 months.[13] The reported experience utilizing mTOR inhibition in PEComa-NOS is limited, and the responses are shown to be inconsistent.[11] The present authors suggest maintaining a conservative evaluation and appraisal of the research results in these published articles. Additionally, in accordance with the published literature and the authors' own experience at Kaohsiung Medical University Hospital, the authors suggest surgical resection with adjuvant conventional cytotoxic chemotherapy as the first-line treatment for early-stage GI PEComa. For tumours manifesting $\geq$2 aggressive pathological behaviors,[5,11] the *TSC* gene might be considered, to identify and evaluate the need for mTOR inhibitor therapy.

Metastasis may be observed even 10 years following tumour resection in some patients. Thus, such patients, and particularly those with tumours measuring >8 cm, require monitoring for several years after surgical treatment.[2,12] The NCCN 2020 guidelines recommend the following in cases of soft tissue sarcoma: (1) re-imaging after surgery using magnetic resonance imaging or CT with contrast to assess primary tumour and rule out metastatic disease; and (2) chest imaging using x-ray or CT every 3–6 months for 2–3 years, then every 6 months for the next 2 years.[35] Freeman *et al.*[42] documented the longest follow-up of 180 months in a patient with PEComa of the sigmoid colon measuring 6 cm, who was successfully treated with radical excision. Other studies have suggested physical examination and CT scans every 6 months, and endoscopy every year after surgery, to monitor local recurrence and distant metastasis.[3,27]

Conclusion

Studies on PEComas are few and demonstrate high heterogeneity, thus, a comparative study to determine the optimal treatment remains challenging. The present study suggests surgical resection with adjuvant conventional cytotoxic chemotherapy as a treatment option for early-stage GI PEComa. However, well-documented clinical trials should be performed to accumulate immunohistochemical evidence and suggest empirical therapy. The current findings may be extrapolated to practice procedures.

Author contributions

Hsiu-Chung Cheng, Chia-Yu Kuo, Ching-Wen Huang, and Hsiang-Hung Shih collected and assembled the patient data; Chih-Hung Lin collected and interpreted pathological data; Hsiu-Chung Cheng and Chia-Yu Kuo reviewed the literature; Jaw-Yuan Wang revised and corrected the manuscript; and all authors wrote and approved the final version of the manuscript.

Declaration of conflicting interest

The authors declare that there is no conflict of interest.

Funding

The authors disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This work was supported by grants through funding from the Ministry of Science and Technology (MOST 109-2314-B-037-035, MOST 109-2314-B-037-040, MOST 109-2314-B-037-046-MY3, MOST110-2314-B-037-097) and the Ministry of Health and Welfare (MOHW109-TDU-B-212-134026, MOHW109-TDU-B-212-114006, MOHW110-TDU-B-212-1140026) and funded by the health and welfare surcharge of on tobacco products, and the Kaohsiung Medical

University Hospital (KMUH109-9R32, KM UH109-9R33, KMUH109-9R34, KMUH109-9M30, KMUH109-9M31, KMUH109-9M32, KMUH 109-9M33, KMUHSA10903, KMU HSA11013, KMUH-DK(C)110010, KMUH-DK (B)110004-3) and KMU Center for Cancer Research (KMU-TC109A04-1) as well as and a KMU Center for Liquid Biopsy and Cohort Research Center Grant (KMU-TC109B05), Kaohsiung Medical University. In addition, this study was supported by the Grant of Taiwan Precision Medicine Initiative, Academia Sinica, Taiwan, R.O.C.

ORCID iD

Jaw-Yuan Wang https://orcid.org/0000-0001-6218-3760

References

1. Utpatel K, Calvisi DF, Kohler G, et al. Complexity of PEComas: diagnostic approach, molecular background, clinical management. *Pathologe* 2020; 41: 9–19.
2. Sobiborowicz A, Czarnecka AM, Szumera-Ciećkiewicz A, et al. Diagnosis and treatment of malignant PEComa tumours. *Oncol Clin Prac* 2020; 16: 22–33.
3. Chen Z, Han S, Wu J, et al. A systematic review: perivascular epithelioid cell tumor of gastrointestinal tract. *Medicine (Baltimore)* 2016; 95: e3890.
4. Zizzo M, Ugoletti L, Tumiati D, et al. Primary pancreatic perivascular epithelioid cell tumor (PEComa): a surgical enigma. A systematic review of the literature. *Pancreatology* 2018; 18: 238–245.
5. Bleeker JS, Quevedo JF and Folpe AL. "Malignant" perivascular epithelioid cell neoplasm: risk stratification and treatment strategies. *Sarcoma* 2012; 2012: 541626.
6. D'Andrea D, Hanspeter E, D'Elia C, et al. Malignant perivascular epithelioid cell neoplasm (PEComa) of the pelvis: a case report. *Urol Case Rep* 2016; 6: 36–38.
7. Armah HB and Parwani AV. Malignant perivascular epithelioid cell tumor (PEComa) of the uterus with late renal and pulmonary metastases: a case report with review of the literature. *Diagn Pathol* 2007; 2: 45.
8. Kanazawa A, Fujii S, Godai TI, et al. Perivascular epithelioid cell tumor of the rectum: report of a case and review of the literature. *World J Surg Oncol* 2014; 12: 12.
9. Starbuck KD, Drake RD, Budd GT, et al. Treatment of advanced malignant uterine perivascular epithelioid cell tumor with mTOR inhibitors: single-institution experience and review of the literature. *Anticancer Res* 2016; 36: 6161–6164.
10. Bennett JA, Braga AC, Pinto A, et al. Uterine PEComas: a morphologic, immunohistochemical, and molecular analysis of 32 tumors. *Am J Surg Pathol* 2018; 42: 1370–1383.
11. Folpe AL, Mentzel T, Lehr HA, et al. Perivascular epithelioid cell neoplasms of soft tissue and gynecologic origin: a clinicopathologic study of 26 cases and review of the literature. *Am J Surg Pathol* 2005; 29: 1558–1575.
12. Lin KH, Chang NJ, Liou LR, et al. Successful management of perivascular epithelioid cell tumor of the rectum with recurrent liver metastases: A case report. *Medicine (Baltimore)* 2018; 97: e11679.
13. Scheppach W, Reissmann N, Sprinz T, et al. PEComa of the colon resistant to sirolimus but responsive to doxorubicin/ifosfamide. *World J Gastroenterol* 2013; 19: 1657–1660.
14. Gagnier JJ, Kienle G, Altman DG, et al. The CARE guidelines: consensus-based clinical case reporting guideline development. *Headache* 2013; 53: 1541–1547.
15. Uhlenhopp DJ, West J, Heckart J, et al. Rapidly enlarging malignant abdominal PEComa with hepatic metastasis: a promising initial response to sirolimus following surgical excision of primary tumor. *Oxf Med Case Reports* 2020; 2020: omaa013.
16. Marano A, Maione F, Woo Y, et al. Robotic wedge resection of a rare gastric perivascular epithelioid cell tumor: a case report. *World J Clin Cases* 2019; 7: 4011–4019.
17. Xu J, Yan Y, Xiang X, et al. Gastric perivascular epithelioid cell tumor (PEComa). *Am J Clin Pathol* 2019; 152: 221–229.
18. Han X, Sun MY, Liu JH, et al. Computed tomography imaging features of hepatic perivascular epithelioid cell tumor: a case report and literature review. *Medicine (Baltimore)* 2017; 96: e9046.

19. Hekimoglu K and Haberal M. Liver perivascular epithelioid cell tumor with an unusual location: diagnostic characteristics with multidetector computed tomography and magnetic resonance imaging. *J Clin Imaging Sci* 2017; 7: 36.
20. Zhang S, Chen F, Huang X, et al. Perivascular epithelial cell tumor (PEComa) of the pancreas: a case report and review of literature. *Medicine (Baltimore)* 2017; 96: e7050.
21. Shin SA, Choi J, Moon KC, et al. Perivascular epithelioid cell tumor in the stomach. *J Pathol Transl Med* 2017; 51: 428–432.
22. Iwamoto R, Kataoka TR, Furuhata A, et al. Perivascular epithelioid cell tumor of the descending colon mimicking a gastrointestinal stromal tumor: a case report. *World J Surg Oncol* 2016; 14: 285.
23. Kiriyama Y, Tsukamoto T, Mizoguchi Y, et al. Intrahepatic peribiliary perivascular epithelioid cell tumor (PEComa) associated with heterotopic pancreas: a case report. *Diagn Pathol* 2016; 11: 81.
24. Ryan P, Nguyen VH, Gholoum S, et al. Polypoid PEComa in the rectum of a 15-year-old girl: case report and review of PEComa in the gastrointestinal tract. *Am J Surg Pathol* 2009; 33: 475–482.
25. Folpe AL and Kwiatkowski DJ. Perivascular epithelioid cell neoplasms: pathology and pathogenesis. *Hum Pathol* 2010; 41: 1–15.
26. Baek JH, Chung MG, Jung DH, et al. Perivascular epithelioid cell tumor (PEComa) in the transverse colon of an adolescent: a case report. *Tumori* 2007; 93: 106–108.
27. Pisharody U, Craver RD, Brown RF, et al. Metastatic perivascular epithelioid cell tumor of the colon in a child. *J Pediatr Gastroenterol Nutr* 2008; 46: 598–601.
28. Gross E, Vernea F, Weintraub M, et al. Perivascular epithelioid cell tumor of the ascending colon mesentery in a child: case report and review of the literature. *J Pediatr Surg* 2010; 45: 830–833.
29. Hornick JL and Fletcher CD. PEComa: what do we know so far? *Histopathology* 2006; 48: 75–82.
30. Doyle LA and Hornick JL. Mesenchymal tumors of the gastrointestinal tract other than GIST. *Surg Pathol Clin* 2013; 6: 425–473.
31. Okamoto K, Okada Y, Ohno K, et al. A rare case of perivascular epithelioid cell tumor (PEComa) of the greater omentum. *World J Surg Oncol* 2018; 16: 113.
32. Pan CC, Jong YJ, Chai CY, et al. Comparative genomic hybridization study of perivascular epithelioid cell tumor: molecular genetic evidence of perivascular epithelioid cell tumor as a distinctive neoplasm. *Hum Pathol* 2006; 37: 606–612.
33. Martignoni G, Pea M, Reghellin D, et al. PEComas: the past, the present and the future. *Virchows Arch* 2008; 452: 119–132.
34. Cheng J, Deng M, Gao J, et al. A recurrent perivascular epithelioid cell tumor of sigmoid colon with pancreatic metastasis: an extremely rare case report and review of the literature. *Int J Colorectal Dis* 2016; 31: 1237–1240.
35. Von Mehren M, Kane JM, Bui MM, et al. NCCN Guidelines Insights: Soft Tissue Sarcoma, Version 1.2021. *J Natl Compr Canc Netw* 2020; 18: 1604–1612.
36. von Mehren M, Randall RL, Benjamin RS, et al. Soft Tissue Sarcoma, Version 2.2016, NCCN Clinical Practice Guidelines in Oncology. *J Natl Compr Canc Netw* 2016; 14: 758–786.
37. Rutkowski PL and Mullen JT. Management of the "Other" retroperitoneal sarcomas. *J Surg Oncol* 2018; 117: 79–86.
38. Tynski Z, Chiang W and Barrett A. An inguinal perivascular epithelioid cell tumor metastatic to the orbit. *Case Rep Pathol* 2018; 2018: 5749421.
39. Park SJ, Han DK, Baek HJ, et al. Perivascular epithelioid cell tumor (PEComa) of the ascending colon: the implication of IFN-α2b treatment. *Korean J Pediatr* 2010; 53: 975–978.
40. Subbiah V, Trent JC and Kurzrock R. Resistance to mammalian target of rapamycin inhibitor therapy in perivascular epithelioid cell tumors. *J Clin Oncol* 2010; 28: e415.
41. Dickson MA, Schwartz GK, Antonescu CR, et al. Extrarenal perivascular epithelioid cell tumors (PEComas) respond to mTOR inhibition: clinical and molecular correlates. *Int J Cancer* 2013; 132: 1711–1717.
42. Freeman HJ and Webber DL. Perivascular epithelioid cell neoplasm of the colon. *World J Gastrointest Oncol* 2010; 2: 205–208.