Diagnosis and management of oesophageal granular cell tumour: A case report

RUI JIAN[1*], YANQING SHI[2*], TING LI[3], NANHAO ZHOU[1], XIJIN WANG[2] and SHAN LI[1]

[1]Jiangxi Provincial Key Laboratory of Cell Precision Therapy, School of Basic Medical Sciences, Jiujiang University, Jiujiang, Jiangxi 332005, P.R. China; [2]Department of Gastroenterology, Affiliated Hospital of Jiujiang University, Jiujiang, Jiangxi 332005, P.R. China; [3]Department of Pathology, Affiliated Hospital of Jiujiang University, Jiujiang, Jiangxi 332005, P.R. China

Received November 16, 2024; Accepted February 17, 2025

DOI: 10.3892/etm.2025.12842

Abstract. Granular cell tumours (GCTs) are rare and typically benign neoplasms that can arise in various parts of the body, including the oesophagus. These tumours are considered to originate from Schwann cells and are characterized by their granular cytoplasm. Oesophageal GCTs (EGCTs) are particularly uncommon and often present with non-specific symptoms, making their diagnosis challenging. The present case report documents the case of a 68-year-old male patient who was admitted to the Affiliated Hospital of Jiujiang University (Jiujiang, China) after the incidental discovery of a submucosal oesophageal mass during a routine health examination. Upon diagnostic evaluation, including endoscopy and histopathological analysis, an EGCT was identified. Endoscopic ultrasonography revealed submucosal protrusion of the lower oesophagus, where endoscopic submucosal dissection (ESD) was subsequently performed. Histopathological staining and immunohistochemistry (IHC) indicated the presence of a GCT with positivity for S-100. The patient successfully underwent ESD without any complications. Although EGCTs are typically benign, they have the potential for malignant transformation and therefore require careful evaluation. The present case highlights the importance of differentiating EGCTs from other submucosal oesophageal lesions through histological and IHC methods. In particular, early detection and appropriate management are crucial for optimal patient outcomes. In conclusion, EGCT is a rare entity with a generally favourable prognosis when detected early. The present case underscores the importance of considering EGCTs in the differential diagnosis of oesophageal submucosal lesions and outlines the role of endoscopic and histopathological evaluation in their management.

Correspondence to: Professor Shan Li, Jiangxi Provincial Key Laboratory of Cell Precision Therapy, School of Basic Medical Sciences, Jiujiang University, 551 Qianjin East Road, Lianxi, Jiujiang, Jiangxi 332005, P.R. China
E-mail: slove0408@163.com

*Contributed equally

Abbreviations: GCT, granular cell tumour; EGCT, oesophageal GCT; ESD, endoscopic submucosal dissection; EUS, endoscopic ultrasonography

Key words: oesophageal GCT, ESD, case report, s-100, treatment

Introduction

Oesophageal granular cell tumours (EGCTs) are common benign tumours with potential for malignancy in clinical medicine (1). These tumours are typically found in the submucosal layer of the oesophagus. Although their incidence is low, an increasing number of cases are being diagnosed with the widespread use of endoscopic techniques and routine screening practices (2-4). EGCTs make up a relatively small proportion of all oesophageal tumours, accounting for only 6-10% of all oesophageal tumours (5). Accordingly, they are relatively rare, where there is currently an insufficient understanding of these tumours in clinical practice.

According to the existing literature, there is a certain bias in the sex distribution of EGCTs, with a greater proportion of female compared with male patients. EGCTs typically occur in middle-aged and elderly individuals, with a reported median age of 43 years and a mean age of 44.00±3.48 years based on one case series (6). However, age distribution may vary depending on the population studied. Further research is required to better characterize the epidemiological patterns of EGCTs.

The main origin of EGCTs is Schwann cells (7). These cells form part of the peripheral nervous system and are responsible for forming nerve sheaths, in addition to supporting and protecting the function of nerve fibres (7). GCTs have been proposed to result from the abnormal proliferation of Schwann cells (8). Although the exact pathological mechanism of this process remains to be clarified, their abnormal proliferation may be associated with genetic factors, environmental factors, immune escape and inflammatory responses (2,9). Tumour cells may be influenced by certain immune factors that contribute to the tumour's development, such as eosinophils and transforming growth factor β, both of which have been implicated in promoting tumourigenesis (10). In addition, certain oesophageal diseases, such as oesophagitis, may cause changes in the local inflammatory environment, thereby

promoting the formation of GCTs (11). However, the exact mechanism of their interaction remains to be fully elucidated.

Pathological examination is key in diagnosing EGCTs. This type of tumour is comprised of large polygonal cells with granular cytoplasm that are positive for S-100 protein expression, supporting the neurogenic origin of these tumours (12,13). For symptomatic or growing tumours, endoscopic resection, which is a minimally-invasive treatment with a favorable outcome, results in high rates of complete tumour removal, minimal risk of recurrence and excellent long-term survival (1,14). Studies have suggested that <2% of GCTs, including those in the esophagus, show signs of malignant transformation or metastasis. While the risk of malignancy is extremely low, there is potential for malignancy in a small subset of cases. This may be indicated by factors such as rapid tumour growth, a tumour size >5 cm and histopathological features such as nuclear pleomorphism or increased mitotic activity (15,16). Even asymptomatic tumours should be closely monitored through regular follow-up to detect any potential changes in tumour behavior at an early stage.

The present case report provided a case analysis, contributing to the limited EGCT literature by giving a detailed description of the clinical manifestations, diagnostic methods and treatment plan for a 68-year-old male patient diagnosed with an EGCT discovered during a routine physical examination.

Case report

Case presentation. The patient was a 68-year-old man who was admitted to the Affiliated Hospital of Jiujiang University (Jiujiang, China) in September 2024, after the discovery of an oesophageal submucosal tumour (SMT) during a physical examination 1 day prior. The patient had a history of type 2 diabetes for 30 years and was managed with insulin, although the patient's blood glucose levels were not regularly monitored. The patient had previously undergone cholecystectomy 5 years ago due to cholelithiasis and cholecystitis.

Physical examination upon admission revealed the following: i) Body temperature, 36.6˚C (normal range, 36.1-37.2˚C); ii) pulse, 85 beats/min (normal range, 60-100 beats/min); iii) respiratory rate, 19 breaths/min (normal range, 12-20 breaths/min); iv) blood pressure, 124/57 mmHg (normal value, 120/80 mmHg); v) clear state of mind; and vi) no jaundice or sclera throughout the body. No significant abnormalities were detected during cardiopulmonary auscultation. The abdomen was flat and there were no abdominal masses or varicose veins. There were also no intestinal obstructions or gastrointestinal peristaltic waves, no abdominal muscle tension in the liver, spleen or rib areas. In addition, there were no tenderness or rebound pain in the entire abdomen. The Murphy's sign was negative. There was no tenderness at the MacLehose point, no abdominal percussion drum sounds, no percussion pain in the liver area, no percussion pain in the area of either kidney and no egophony of the lungs. Bowel sounds were detected at a rate of 4 times/min (normal range, 3-4 times/min), reflecting normal intestinal motility. No pathological reflexes, such as the Babinski reflex (extension of the great toe in response to stimulation of the sole) were present, suggesting there were no signs of upper motor neuron involvement.

In September 2024, the patient went to Jiujiang University Affiliated Hospital (Jiujiang, China) for a gastroscopy (Fig. 1A and B) and the results were as follows: i) Multiple submucosal elevations in the oesophagus; and ii) chronic nonatrophic gastritis with gastric antral erosion. The patient was admitted to the hospital on the same day to receive further treatment.

After admission, relevant laboratory tests were completed and the results were as follows: i) White blood cell count, $6.43x10^9$/l (normal range, $4.0\text{-}11.0x10^9$/l); ii) neutrophil percentage, 71.8% (normal range, 40-75%); iii) red blood cell count, $3.85x10^{12}$/l (normal range, $4.3\text{-}5.9x10^{12}$/l); iv haemoglobin, 116 g/l (normal range, 130-175 g/l for men and 120-160 g/l for women); v) haematocrit, 35.60% (normal range, 40-50% for men and 36-44% for women); vi) platelet count, $240x10^9$/l (normal range, $150\text{-}400x10^9$/l); vii) liver and kidney function and electrolytes, normal; viii) blood urea nitrogen, 8.40 mmol/l (normal range: 2.5-7.5 mmol/l); ix) creatinine, 170.6 μmol/l (normal range, 44-133 μmol/l for men and 44-124 μmol/l for women); x) uric acid, 425 μmol/l (normal range, 150-420 μmol/l for men and 120-350 μmol/l for women); xi) fasting glucose, 9.66 mmol/l (normal range, 3.9-5.5 mmol/l); xii) total cholesterol, 4.72 mmol/l (normal value, <5.2 mmol/l); xiii) triglycerides, 3.01 mmol/l (normal range, <1.7 mmol/l); xiv) high-density lipoprotein, 1.00 mmol/l (normal range, >1.0 mmol/l for men and >1.2 mmol/l for women); xv) low-density lipoprotein, 2.75 mmol/l (normal value, <3.4 mmol/l); and xvi) glycated haemoglobin, 8.10% (normal value, <5.7%). The levels of tumour markers carcinoembryonic antigen, α-fetoprotein, carbohydrate antigen (CA)199 and CA724 were within normal ranges. No abnormalities were detected in the pretransfusion tests, urinalysis and hepatitis B panel.

A plain chest X-ray and upper abdominal CT scan was subsequently performed. The presence of low-density shadows in both kidneys was detected, prompting further enhanced CT examination (Fig. 2A). No obvious signal could be found in the gallbladder or tail of the pancreas. Emphysema was noted based on a ground-glass nodule in the upper lobe of the right lung (the patient had no history of smoking), where a 3-month follow-up examination was recommended. A small solid nodule in the upper lobe of the right lung was also noted and an annual follow-up examination was recommended. In addition, a calcified lesion in the upper lobe of the right lung was also identified. Fibrous lesions in the upper lobe of the right lung and lower lobe of the left lung, arteriosclerosis of the aorta and coronary arteries and multiple old fractures of the ribs on both sides were observed (Fig. 2B). Routine 12-lead electrocardiogram examination revealed results to be within the normal range. Cardiac ultrasound revealed no significant abnormalities in terms of cardiac structure or blood flow (Fig. 2C). However, decreased left ventricular diastolic function (Grade I) was noted.

In September 2024, the patient underwent painless endoscopic ultrasonography (EUS), which revealed submucosal elevation in the lower oesophagus (suspected fibroma or GCT; Fig. 1C).Ultrasound revealed moderate hypoechoic changes originating from the submucosa, with clear and regular boundaries and an oval shape. In total, 1 day later, the patient underwent endoscopic submucosal dissection (ESD; Fig. 3). The excised oesophageal mucosa was submitted to the pathology department for examination.

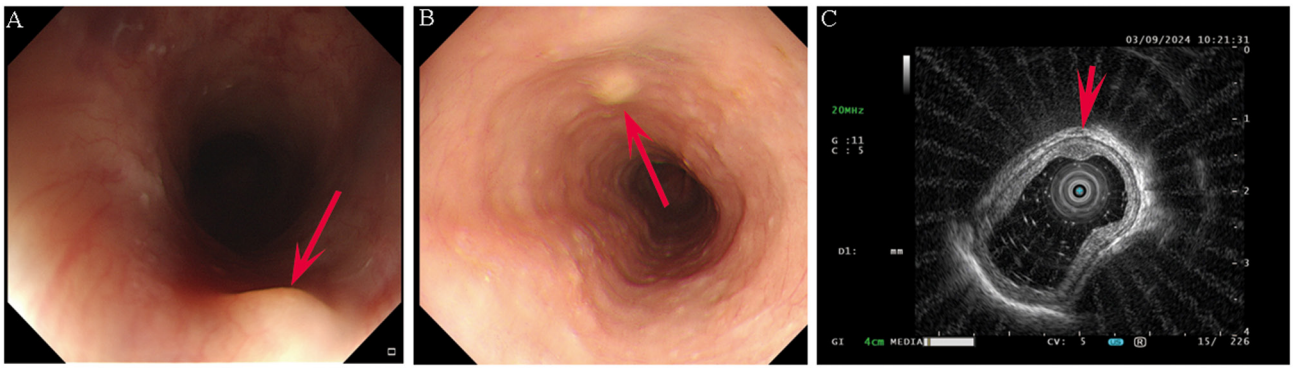

Figure 1. Ultrasound gastroscopy examination. (A and B) Gastroscopy showing submucosal protrusions in the esophagus, indicated by the red arrow. (C) Endoscopic ultrasound examination showing a submucosal protrusion in the lower oesophagus, marked by the red arrow.

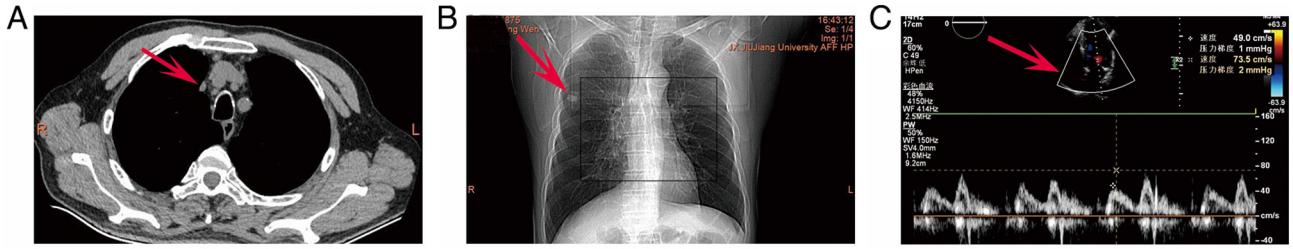

Figure 2. Clinical examination results. (A) A plain CT showing low-density shadows in both kidneys (red arrow). (B) Plain chest X-ray showing ground-glass nodules in the lungs (red arrow). (C) Heart color ultrasound (echocardiogram) revealing the condition of the heart.

The histopathological results revealed mild hyperplasia of the squamous epithelium, with no significant cellular atypia. Spindle cell proliferation in the submucosa with eosinophilic cytoplasm was noted. Mitosis was scarcely observed and the cells contained abundant granular material. The nuclei were small and centrally located, which was consistent with a diagnosis of a GCT (Fig. 4). The immunohistochemical (IHC) findings were as follows: Smooth muscle actin (SMA; -); Desmin (-); S-100 positive (+); discovered on gastrointestinal stromal tumours (GIST)-1 (Dog-1; -); CD117 (-); succinate dehydrogenase B (SDHB; +); and Ki-67, ~2% positive (Fig. 5). The lack of the smooth muscle markers SMA and Desmin ruled out the possibility of leiomyoma or other smooth muscle tumours such as leiomyosarcoma, further supporting the diagnosis of a non-muscle origin of the lesion. Strong positivity for S-100 confirmed the neural origin of the tumour, consistent with a diagnosis of GCT, which is known to originate from Schwann cells (17). The absence of both CD117 and DOG-1 markers effectively excluded GISTs, since these markers are typically expressed in such tumours (18,19). The positive staining for SDHB confirmed that the tumour was benign, since SDH-deficient tumours (frequently associated with malignancy) were excluded by this intact expression (20). The low Ki-67 index (~2%) indicated a low proliferative rate, consistent with the benign nature of the tumour and its low malignant potential (21,22). These IHC findings collectively supported the diagnosis of EGCT, distinguishing it from other potential SMTs, such as GISTs and leiomyomas, further indicating its benign nature. Additionally, it should be noted that SMA, Desmin, Dog-1 and CD117 were negative specifically in tumour cells. Whilst these markers were not expressed in the GCT itself, background positivity may have been observed in non-tumour structures, such as vascular endothelial and immune cells, which is a normal finding and not indicative of tumour origin.

On the basis of the examination results and the patient's medical history, the final diagnosis was EGCT. After undergoing ESD, the patient was kept *nil per os* for 24 h, followed by a liquid diet of water, congee and juice. The patient was discharged on postoperative day 3 and was prescribed oral omeprazole at a dose of 20 mg once daily for 2 weeks to facilitate mucosal healing.

The patient underwent endoscopic submucosal dissection (ESD) on September 4, 2024 and was discharged on September 15. A follow-up endoscopic examination was recommended 6 months post-procedure to assess for recurrence or residual disease. As of now, the patient remains asymptomatic, and there have been no reported complications or new symptoms. We are aware of the patient's condition based on their medical records and follow-up advice provided at the time of discharge. Given that the follow-up date has not yet passed, we are unable to provide further updates at this time.

Histopathology and immunohistochemistry. For histopathological examination, the tissue specimens were initially fixed in 10% neutral-buffered formalin at room temperature for 24-48 h. Following fixation, the tissues were embedded in paraffin. The paraffin blocks were then sectioned at a thickness of 5 μm. Dewaxing of the sections was performed by immersing them in xylene, followed by rehydration through a graded alcohol series (100, 95 and 70%). The sections were stained using hematoxylin and eosin. The staining procedure involved staining with hematoxylin at room temperature for 10 min, followed by

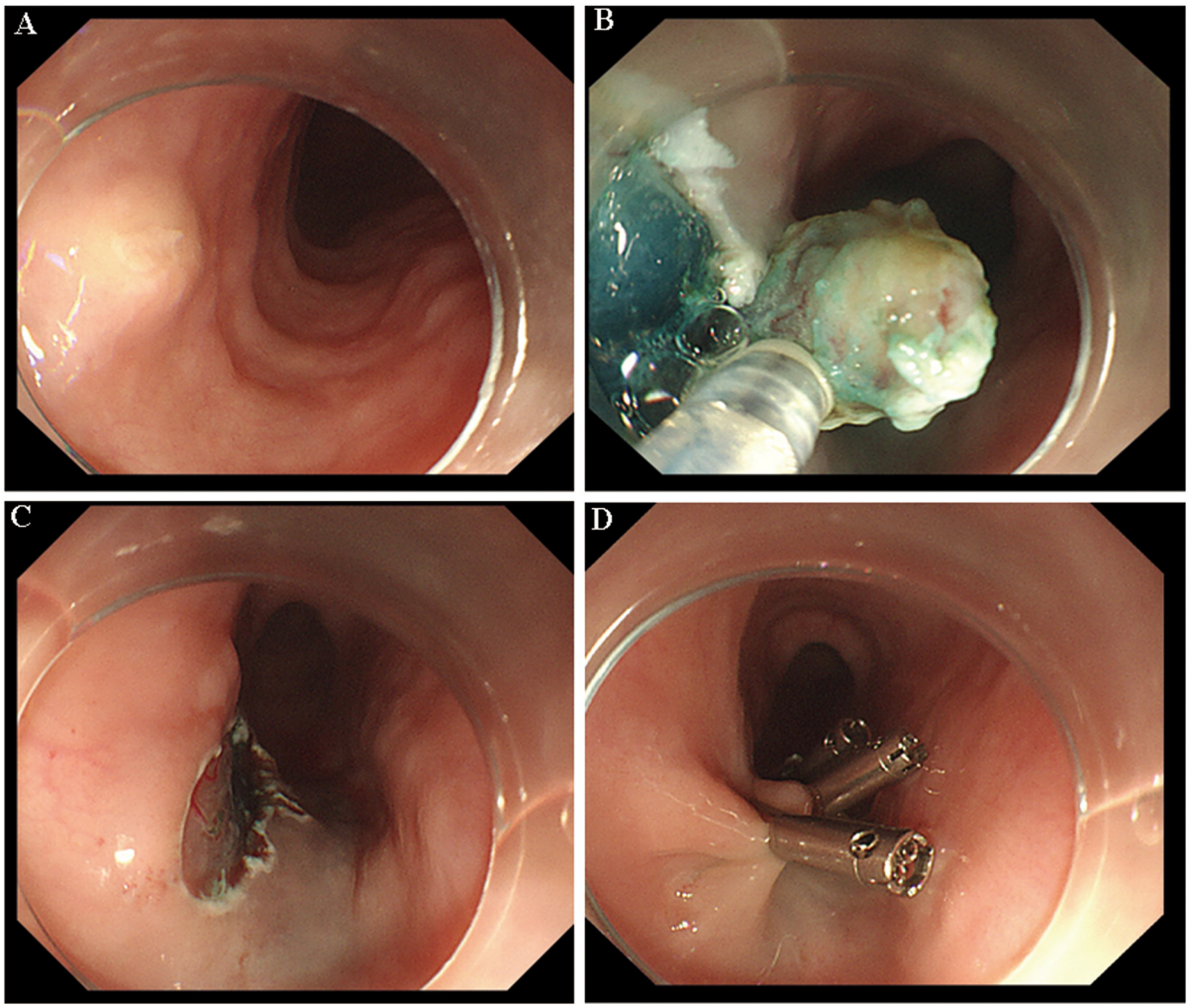

Figure 3. Endoscopic submucosal dissection surgery. (A) White light endoscopic image of the tumour. (B) Intraoperative condition during ESD. (C) Post-ESD wound site. (D) Titanium clip used to close the wound site. ESD, endoscopic submucosal dissection.

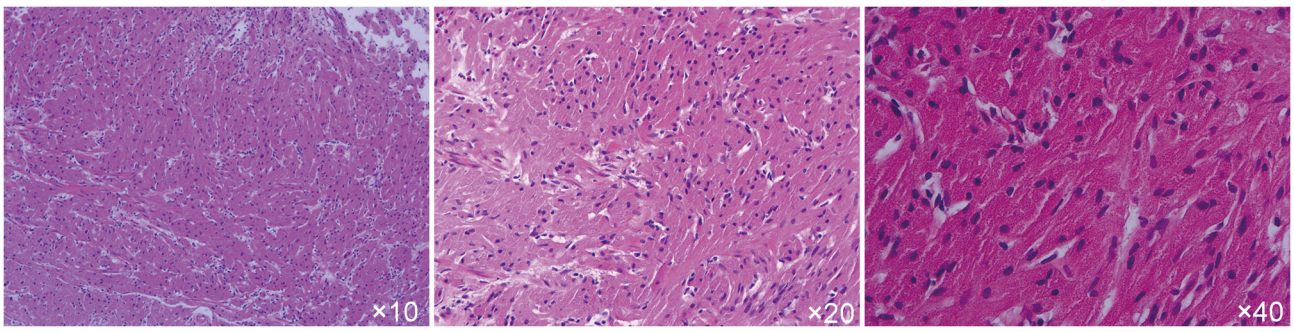

Figure 4. Histopathology results. The tumour cells exhibit typical granular cytoplasm, which is due to the presence of numerous lysosomal granules within the cytoplasm. The cell nuclei are small and uniform, with no visible mitotic figures. The tumour cells are arranged in nests, surrounded by fibrous tissue or infiltrating inflammatory cells. The higher-magnification images are derived from the same original image (haematoxylin and eosin staining; magnification, x10, x20 and x40).

eosin for 3 min. The stained slides were examined under a light microscope with a magnification of x400.

Antigen retrieval was performed on the paraffin-embedded tissues using the Heat-Induced Epitope Retrieval technique in citrate buffer (pH 6.0) at 95-100˚C, and then cooled at room temperature for 10 min. The sections were subsequently washed with xylene and rehydrated in a graded alcohol series. Permeabilization was carried out using 0.1% Triton X-100 at room temperature for 10 min, followed by washing with phosphate-buffered saline (PBS) for intracellular antigen detection. To block non-specific binding, a blocking reagent (5% BSA) was applied at room temperature for 30 min. Primary antibodies were diluted according to the manufacturer's recommendations: Rabbit antibodies against SMA

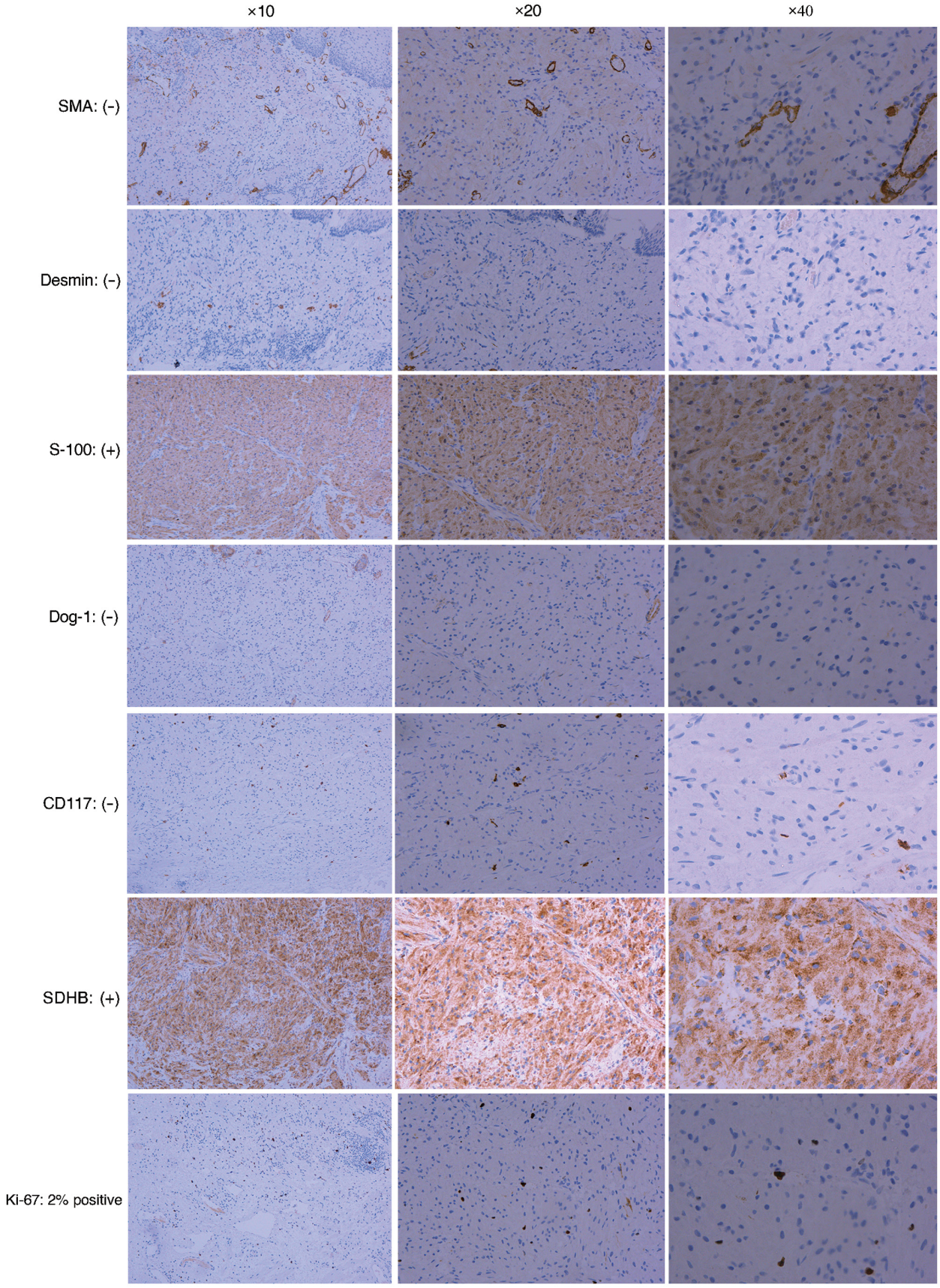

Figure 5. Immunohistochemical results. SMA: Negative, indicating no smooth muscle differentiation. Desmin: Negative, further supporting the absence of smooth muscle differentiation. S-100: Positive, confirming the neural origin of the tumour cells. Dog-1: Negative, ruling out the possibility of a GIST. CD117: Negative, further excluding GIST and other related tumours. SDHB: Positive, confirming the benign nature of the tumour and excluding SDH-deficient malignancies. Ki-67: ~2% positive, indicating a low proliferative index, which is consistent with the benign nature of the tumour. These results collectively support the diagnosis of an oesophageal granular cell tumour and help exclude other potential diagnoses. The higher-magnification images are derived from the same original image (magnification, x10, x20 and x40). GIST, gastrointestinal stromal tumour; SMA, smooth muscle actin; Dog-1, discovered on gastrointestinal stromal tumours; SDHB, succinate dehydrogenase B.

(1:1,000), Desmin (1:1,000), S-100 (1:1,000), Dog-1 (1:1,000), CD117 (1:1,000), SDHB (1:1,000) and Ki-67 (1:1,000) (all Cell Signaling Technology, Inc.). The primary antibodies were incubated at 4˚C overnight, after which the sections were washed in PBS. Secondary goat anti-rabbit antibodies (cat no. RGAR011; Proteintech Group, Inc.), were used at a dilution of 1:2,000 and incubated at room temperature for 1 h, followed by another wash in PBS. Visualization was achieved using 3,3'-diaminobenzidine (DAB) as the chromogen with HRP/DAB detection. The HRP/DAB reaction was allowed to proceed for 5-10 min at room temperature, and the sections were counterstained with hematoxylin for 2 min. Observations were made under an optical microscope at x400 magnification, with a scale bar of 50 μm included in the legend.

Discussion

EGCTs are rare, benign lesions originating from Schwann cells (23). Other submucosal oesophageal lesions, such as leiomyomas, GISTs and malignant oesophageal tumours, while also uncommon, their unique clinical and pathological features render it essential for clinicians to accurately identify and differentiate these conditions. The clinical presentation of GCTs is typically non-specific. In the majority of cases, these tumours are small and asymptomatic, where numerous lesions are discovered incidentally during endoscopic examinations. In rare instances, clinical symptoms only appear when the tumour reaches a relatively large size (24,25). Endoscopic biopsy frequently fails to obtain adequate deep-tissue samples, complicating the preoperative diagnosis and making accurate identification challenging (26,27). Consequently, misdiagnosis is not uncommon (28).

The patient in the present case report was a 68-year-old male who was asymptomatic. The oesophageal lesion was discovered incidentally during a routine health check. This highlights the potential for GCTs to remain undiagnosed in clinical practice, with diagnoses frequently made during unrelated examinations. EUS revealed a submucosal mass in the lower oesophagus, which was confirmed as a GCT through histopathological examination. The characteristic findings included large polygonal cells with abundant granular cytoplasm. The positive immunohistochemical staining for S-100 further confirmed that the tumour originated from Schwann cells. EGCTs originate from Schwann cells, which are derivatives of neural crest cells (29). The S-100 protein is a specific marker widely expressed in tissues associated with neural crest derivatives (30). Its positive staining strongly supports the Schwann-cell origin of the tumour and provides direct evidence for the diagnosis of EGCT. S-100 positivity effectively distinguishes EGCTs from other SMTs, such as GISTs, leiomyomas and lipomas (15,31). Unlike GISTs, which typically express CD117 and Dog-1, EGCTs are negative for these markers but are consistently positive for S-100 (31). This characteristic is crucial in establishing a definitive diagnosis and ruling out other entities with overlapping morphological features. EGCTs are histologically characterized by eosinophilic granules within the cytoplasm, which are consistent with lysosomal accumulation (32). The positive staining for S-100 protein, in conjunction with the histological findings, significantly enhances the diagnostic accuracy of EGCTs (10). In summary, positive S-100 protein expression is not only a hallmark feature for the pathological diagnosis of EGCTs, but also a key element in differentiating these tumours from other morphologically similar SMTs. This highlights the critical role of IHC in accurately diagnosing EGCTs and guiding clinical decision-making.

Ki-67 is a nuclear protein intimately associated with cell proliferation and serves as a pivotal marker for evaluating the biological behaviour of tumours (33,34). Its expression is particularly important in GCTs, including EGCTs, which are characterized by a low Ki-67 proliferation index (22,35). This low index is indicative of their benign nature and indolent biological behaviour, offering a valuable criterion for distinguishing benign GCTs from more aggressive SMTs. The Ki-67 index is also instrumental in prognostic assessments (36). Although the majority of GCTs are benign, rare cases of malignant GCTs have been documented. In these instances, an elevated Ki-67 index is associated with increased aggressiveness, an increased risk of metastasis and poorer clinical outcomes (37,38). Consequently, monitoring Ki-67 expression can serve a crucial role in identifying atypical or malignant features in GCTs. The incorporation of Ki-67 into a comprehensive diagnostic and pathological evaluation provides critical insights into tumour behaviour, enhancing the ability to differentiate between benign and malignant variants and informing optimal clinical management strategies.

Whilst EGCTs are generally benign and exhibit slow growth and low malignant potential, they can appear similar to SMTs with greater malignant potential, such as GISTs, on imaging and endoscopic examination (39,40). Therefore, accurate differentiation between benign and malignant lesions is essential for developing appropriate treatment strategies. SMTs, such as GISTs, frequently display increased proliferative activity (elevated Ki-67 index) and the expression of specific IHC markers, such as CD117 and Dog-1 positivity. By contrast, GCTs typically show S-100 positivity but are negative for CD117 and Dog-1 (41). Therefore, precise identification through differential diagnosis helps prevent the unnecessary overtreatment of benign lesions whilst enabling the early detection and timely intervention for malignant tumours.

ESD is a minimally invasive procedure that allows for the complete resection of tumours with well-defined margins (42,43). ESD facilitates the *en bloc* resection of lesions, providing high-quality specimens for comprehensive histopathological and IHC evaluation, which would otherwise be unattainable with less invasive biopsy methods, such as fine-needle aspiration (44). In addition, ESD allows for simultaneous diagnosis and treatment, particularly for unclear lesions, such as GCTs. Complete histological examination allows for the precise differentiation between benign GCTs and malignant or potentially malignant SMTs, such as GISTs (45,46). As a minimally invasive technique, ESD reduces unnecessary interventions and surgical trauma, particularly when GCTs are confirmed to be benign. Compared with traditional surgical methods, including laparotomy and laparoscopic surgery, which can lead to complications such as infection, blood loss and adhesions, ESD results in less morbidity and faster recovery. In brief, differential diagnosis is pivotal in the management of oesophageal tumours, particularly in distinguishing benign GCTs from malignant lesions, such as GISTs. ESD serves as a valuable tool in achieving a precise diagnosis

by providing adequate tissue for analysis whilst simultaneously enabling effective treatment. Its minimally invasive nature further enhances patient outcomes and optimizes clinical management strategies.

In a previous study, amongst 330 patients with oesophageal tumours, 12 patients with GCTs underwent treatment with ESD. The results revealed that all 12 patients achieved complete tumour resection, with no significant postoperative complications (1). ESD has a high complete resection rate, indicating that the majority of patients can have their tumours entirely removed, thereby reducing the risk of recurrence. Furthermore, patients in the ESD group demonstrated increased postoperative survival rates and improved quality of life compared to those undergoing traditional surgical procedures, such as laparotomy or laparoscopic surgery. No significant cases of recurrence were observed during the postoperative follow-up period, highlighting the advantages of ESD in terms of faster recovery, fewer complications and better long-term outcomes when compared to more invasive surgical methods. The pathological results of the endoscopic resections indicated that both endoscopic mucosal resection and ESD can achieve complete resection rates of ≤92.9%. This suggests that the majority of patients do not have residual tumour tissue postoperatively, further reducing the risk of tumour recurrence. In addition, another previous study reported that ~48.6% of patients with GCTs who underwent ESD experienced no discomfort postoperatively, demonstrating the overall safety and efficacy of ESD for the treatment of oesophageal GCTs (1). In a separate study, follow-up endoscopic examinations conducted 9 months postoperatively revealed that all patients who underwent endoscopic resection for oesophageal GCTs had achieved complete mucosal healing at the resection sites, with no signs of recurrence, metastasis or oesophageal stenosis, demonstrating the effectiveness and safety of the procedure (47).

Although the likelihood of malignant transformation in EGCTs is rare, a thorough histological assessment remains necessary. Malignant GCTs exhibit specific characteristics, such as increased mitotic activity, nuclear pleomorphism and tumour necrosis. However, these features were not observed in the case of the present study. Therefore, the benign nature of the tumour was confirmed, indicating a good prognosis. However, owing to the rare possibility of malignant transformation or incomplete resection, regular follow-up is recommended to monitor for recurrence.

In conclusion, the present case emphasizes the importance of considering GCT in the differential diagnosis of submucosal lesions in the oesophagus. The use of endoscopic techniques, such as ESD, provides a safe and effective means of diagnosis and treatment, with the lowest incidence rate of postoperative complications, such as bleeding, infection and oesophageal stenosis, compared to more invasive surgical procedures. ESD serves an important role in improving patients' quality of life through high-integrity resection and favourable postoperative recovery. Early detection and intervention (even for asymptomatic patients) are key to ensuring optimal outcomes and preventing complications.

Acknowledgements

Not applicable.

Funding

The present study was supported by the National Natural Science Foundation of China (grant no. 32360888), the Jiujiag Science and Technology Program project (grant no. S2024ZDYFN0004) and the Jiangxi Students' Platform for Innovation and Entrepreneurship Training Program (grant no. 202411843023).

Availability of data and materials

The data generated in the present study may be requested from the corresponding author.

Authors' contributions

RJ, YQS and NHZ contributed to the drafting of the manuscript and the design of the study. YQS, TL and XJW provided clinical data and performed relevant diagnoses and surgery. TL and YQS conducted the literature review, revised the manuscript and obtained medical images. SL was responsible for conceptualization, visualization and funding acquisition. SL reviewed and edited the manuscript for final submission. All authors have read and approved the final manuscript. YQS and TL confirm the authenticity of all the raw data.

Ethics approval and consent to participate

Not applicable.

Patient consent for publication

Written informed consent for publication of their clinical details and/or clinical images was obtained from the patient.

Competing interests

The authors declare that they have no competing interests.

References

1. Ryu DG, Choi CW, Kim SJ, Hwang CS, Kang DH, Kim HW, Park SB and Son BS: Clinical outcomes of esophageal granular cell tumors with different endoscopic resection methods. Sci Rep 13: 10738, 2023.
2. Lu W, Xu MD, Zhou PH, Zhang YQ, Chen WF, Zhong YS and Yao LQ: Endoscopic submucosal dissection of esophageal granular cell tumor. World J Surg Oncol 12: 221, 2014.
3. Shibagaki K, Ishimura N and Kinoshita Y: Endoscopic submucosal dissection for duodenal tumors. Ann Transl Med 5: 188, 2017.
4. Dogom SA, Thongpiya J, Elmassry M, Feist M, Sharma M and Rateb G: Successful endoscopic submucosal dissection of an esophageal granular cell tumor in a pediatric patient: A case report and a therapeutic insight. JPGN Rep 5: 384-388, 2024.
5. Tipirneni K, Mehl A, Bowman B and Joshi V: Esophageal granular cell tumor: A benign tumor or an insidious cause for concern? Ochsner J 16: 558-561, 2016
6. Wang HQ and Liu AJ: Esophageal granular cell tumors: Case report and literature review. World J Gastrointest Oncol 7: 123-127, 2015.
7. Benchekroun Z, Akammar A, Bennani H, Haloua M, Lamrani YA, Boubbou M, Chbani L, Maâroufi M and Alami B: Atypical esophageal granular cell tumor: Case report. Radiol Case Rep 16: 3995-3999, 2021.

8. Barat M, Pellat A, Dohan A, Hoeffel C, Coriat R and Soyer P: CT and MRI of gastrointestinal stromal tumors: New trends and perspectives. Can Assoc Radiol J 75: 107-117, 2024.
9. Çolak S, Gürbulak B, Çelik G, Bektaş H and Dursun N: Gastrointestinal tract schwannomas and brief review of literature. Turk J Surg 37: 408-412, 2021.
10. Riffle ME, Polydorides AD, Niakan J and Chehade M: Eosinophilic esophagitis and esophageal granular cell tumor: An unexpected association. Am J Surg Pathol 41: 616-621, 2017.
11. Malik F, Bernieh A and Saad AG: Esophageal granular cell tumor in children: A clinicopathologic study of 11 cases and review of the literature. Am J Clin Pathol 160, 106-112, 2023
12. Yu-Fong Chang J, Hwang MJ, Sun A and Chiang CP: Granular cell tumor: Case report. J Dent Sci 16: 1018-1019, 2021.
13. Stefansson K and Wollmann RL: S-100 protein in granular cell tumors. (Granular cell myoblastomas). Cancer 49: 1834-1838, 1982.
14. Zhong N, Katzka DA, Smyrk TC, Wang KK and Topazian M: Endoscopic diagnosis and resection of esophageal granular cell tumors. Dis Esophagus 24: 538-543, 2011.
15. Stašek M, Aujeský R, Škarda J, Švébišová H, Vrba R, Szkorupa M and Neoral C: Malignant granular cell tumor of the esophagus: A case report. Ann Thorac Cardiovasc Surg 26: 359-364, 2020.
16. Menon L and Buscaglia JM: Endoscopic approach to subepithelial lesions. Therap Adv Gastroenterol 7: 123-130, 2014.
17. Solomon LW and Velez I: S-100 negative granular cell tumor of the oral cavity. Head Neck Pathol 10: 367-373, 2016.
18. Chelliah A, Kalimuthu S, Szentgyorgyi E and Chetty R: Granular cell tumour of the colon with extensive sclerosis. Diagn Histopathol 22: 279-281, 2016.
19. Wei J, Wang D, Zhang R and Xu C: Granular cell tumor of the ampulla of Vater: Report of a unique case with emphasis on immunohistochemistry for TFE3 antigen expression. Int J Clin Exp Pathol 9: 318-323, 2016.
20. Ding CKC, Chan S, Mak J, Umetsu SE, Simko JP, Ruiz-Cordero R, Saunders T and Chan E: An exploration in pitfalls in interpreting SDHB immunohistochemistry. Histopathology 81: 264-269, 2022.
21. Ferreira JCB, Oton-Leite AF, Guidi R and Mendonça EF: Granular cell tumor mimicking a squamous cell carcinoma of the tongue: A case report. BMC Res Notes 10: 14, 2017.
22. Chrysomali E, Nikitakis NG, Tosios K, Sauk JJ and Papanicolaou SI: Immunohistochemical evaluation of cell proliferation antigen Ki-67 and apoptosis-related proteins Bcl-2 and caspase-3 in oral granular cell tumor. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 96: 566-572, 2003.
23. Duvuru S, Sanker V, Pandit D, Khan S, Alebrahim S and Dave T: Granular cell tumor of the brain: Case report and review of literature. J Surg Case Rep 2023: rjad701, 2023.
24. Matsuzawa N, Nishikawa T, Ohno R, Inoue M, Nishimura Y, Okamoto T, Shimizu T, Shinagawa T, Nishizawa Y and Kazama S: Paraganglioma of the urinary bladder initially diagnosed as gastrointestinal stromal tumor requiring combined resection of the rectum: A case report. World J Surg Oncol 20: 185, 2022.
25. Gagliardi F, Spina A, Barzaghi LR, Bailo M, Losa M, Terreni MR and Mortini P: Suprasellar granular cell tumor of the neurohypophysis: Surgical outcome of a very rare tumor. Pituitary 19: 277-285, 2016.
26. Koizumi E, Goto O, Nakagome S, Habu T, Ishikawa Y, Kirita K, Noda H, Higuchi K, Onda T, Akimoto T, *et al*: Technical outcomes and postprocedural courses of mucosal incision-assisted biopsy for possible gastric gastrointestinal stromal tumors: A series of 48 cases (with video). DEN Open 4: e264, 2023.
27. Krutsri C, Iwai T, Kida M, Imaizumi H, Kawano T, Tadehara M, Watanabe M, Okuwaki K, Yamauchi H and Wasaburo K: Pancreatic granular cell tumor diagnosed by endoscopic ultrasound-guided fine needle aspiration biopsy. Clin J Gastroenterol 12: 347-354, 2019.
28. Inokuchi Y, Watanabe M, Hayashi K, Kaneta Y, Furuta M, Machida N and Maeda S: A case of esophageal granular cell tumor diagnosed by mucosal incision-assisted biopsy. Clin J Gastroenterol 15: 53-58, 2022.
29. Finnegan DK, Cartoceti AN, Hauck AM and LaDouceur EEB: Meningeal granular cell tumour in a green tree python (morelia viridis). J Comp Pathol 174: 54-57, 2020.
30. Yamada S, Katayama Y, Fujimoto Y, Kobori I, Kusano Y, Soga K, Sato T, Matsushima J, Ban S and Tamano M: A case of a granular cell tumor arising in a patient with long-segment Barrett's esophagus. Intern Med 64: 557-561, 2025.
31. Martin-Broto J, Martinez-Marín V, Serrano C, Hindi N, López-Guerrero JA, Bisculoa M, Ramos-Asensio R, Vallejo-Benítez A, Marcilla-Plaza D and González-Cámpora R: Gastrointestinal stromal tumors (GISTs): SEAP-SEOM consensus on pathologic and molecular diagnosis. Clin Transl Oncol 19: 536-545, 2017.
32. Saito R, Chambers JK and Uchida K: Immunohistochemical study of autophagy associated molecules and cell adhesion molecules in canine intracranial granular cell tumors. J Vet Med Sci 84: 1474-1479, 2022.
33. Zhang M, Sun ZQ and Zou XP: Esophageal granular cell tumor: Clinical, endoscopic and histological features of 19 cases. Oncol Lett 8: 551-555, 2014.
34. Maekawa H, Maekawa T, Yabuki K, Sato K, Tamazaki Y, Kudo K, Wada R and Matsumoto M: Multiple esophagogastric granular cell tumors. J Gastroenterol 38: 776-780, 2003.
35. Lazăr D, Tăban S, Sporea I, Dema A, Cornianu M, Lazăr E, Goldiş A and Vernic C: Ki-67 expression in gastric cancer. Results from a prospective study with long-term follow-up. Rom J Morphol Embryol 51: 655-661, 2010.
36. Sun X and Kaufman PD: Ki-67: More than a proliferation marker. Chromosoma 127: 175-186, 2018.
37. Ocal I, Avci A, Cakalagaoglu F and Can H: Lack of correlations among histopathological parameters, Ki-67 proliferation index and prognosis in pheochromocytoma patients. Asian Pac J Cancer Prev 15: 1751-1755, 2014.
38. Graefe C, Eichhorn L, Wurst P, Kleiner J, Heine A, Panetas I, Abdulla Z, Hoeft A, Frede S, Kurts C, *et al*: Optimized Ki-67 staining in murine cells: A tool to determine cell proliferation. Mol Biol Rep 46: 4631-4643, 2019.
39. Trinidad CM, Wangsiricharoen S, Prieto VG and Aung PP: Rare variants of dermatofibrosarcoma protuberans: Clinical, histologic, and molecular features and diagnostic pitfalls. Dermatopathology (Basel) 10: 54-62, 2023.
40. Sandeford J, Anderson L, Burling M and Carter J: Vulvar granular cell tumour in a recently post-partum woman: A case report. Eur J Gynaecol Oncol 43: 96-100, 2022.
41. Fahim S, Aryanian Z, Ebrahimi Z, Kamyab-Hesari K, Mahmoudi H, Alizadeh N, Heidari N, Livani F, Ghanadan A and Goodarzi A: Cutaneous granular cell tumor: A case series, review, and update. J Family Med Prim Care 11: 6955-6958, 2022.
42. Okada M, Kitaoka M, Sakaeda H, Aono R, Satake T, Ohkawa Y, Umeshita J, Yano K, Tashima M and Nakashima J: A case report of esophageal granular cell tumor complicated with esophageal intramural pseudodiverticulosis successfully resected by ESD. Gastroenterol Endosc 66: 29-35, 2024.
43. Takaya H, Kawaratani H, Kaneko M, Takeda S, Sawada Y, Kitade M, Moriya K, Namisaki T, Sawai M, Mitoro A, *et al*.: Gastric granular cell tumor in a youth excised by endoscopic submucosal dissection: A case report and literature review. Acta Gastroenterol Belg 80: 317-319, 2017.
44. Li QL, Zhang YQ, Chen WF, Xu MD, Zhong YS, Ma LL, Qin WZ, Hu JW, Cai MY, Yao LQ and Zhou PH: Endoscopic submucosal dissection for foregut neuroendocrine tumors: An initial study. World J Gastroenterol 18: 5799-5806, 2012.
45. Sarker S, Gutierrez JP, Council L, Brazelton JD, Kyanam Kabir Baig KR and Mönkemüller K: Over-the-scope clip-assisted method for resection of full-thickness submucosal lesions of the gastrointestinal tract. Endoscopy 46: 758-761, 2014.
46. Kono Y, Hirata I, Katayama T, Uemura H, Hirata T, Gotoda T, Miyahara K, Moritou Y and Nakagawa M: Current evidence and issues of endoscopic submucosal dissection for gastric neoplasms during antithrombotic therapy. Clin J Gastroenterol 13: 650-659, 2020.
47. Fan X, Jiao J, Luo L, Zhu L, Zheng Z, Chen X, Wang T, Liu W and Wang B: Role of endoscopic ultrasound and endoscopic resection in the diagnosis and treatment of esophageal granular cell tumors. Scand J Gastroenterol 57: 1264-1271, 2022.