Case Report

Enterothecal fistula as a rare cause of adult pneumocephalus and meningitis: a case report

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Background: Enterothecal fistulas are pathological connections between the gastrointestinal system and subarachnoid space. These rare fistulas occur mostly in pediatric patients with sacral developmental anomalies. They have yet to be characterized in an adult born without congenital developmental anomaly yet must remain on the differential diagnosis when all other causes of meningitis and pneumocephalus have been ruled out. Good outcomes rely on aggressive multidisciplinary medical and surgical care, which are reviewed in this manuscript.

Case Description: A 25-year-old female with history of a sacral giant cell tumor resected via anterior transperitoneal approach followed by posterior L4-pelvis fusion presented with headaches and altered mental status. Imaging revealed that a portion of small bowel had migrated into her resection cavity and created an enterothecal fistula resulting in fecalith within the subarachnoid space and florid meningitis. The patient underwent a small bowel resection for fistula obliteration, and subsequently developed hydrocephalus requiring shunt placement and two suboccipital craniectomies for foramen magnum crowding. Ultimately, her wounds became infected requiring washouts and instrumentation removal. Despite a prolonged hospital course, she made significant recovery and at 10-month following presentation, she is awake, oriented, and able to participate in activities of daily living.

Conclusions: This is the first case of meningitis secondary to enterothecal fistula in a patient without a previous congenital sacral anomaly. Operative intervention for fistula obliteration is the primary treatment and should be performed at a tertiary hospital with multidisciplinary capabilities. If recognized quickly and appropriately treated, there is a possibility of good neurological outcome.

Keywords: Enterothecal fistula; meningitis; pneumocephalus; sacral anomaly; giant cell tumor of bone

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Introduction

The integrity of dura and the sterility of the cerebrospinal fluid (CSF) space are critical to neurological function. Fistulous connections to the subarachnoid space are typically pathologic and can raise the risk of infection and other intracranial pathology. One such example is a fistulous connection between the subarachnoid space and paraspinal veins termed CSF venous fistula (1,2). Other fistulous connections, such as those occurring between the dura and the middle ear, can lead to pneumocephalus and intracranial abscesses (3).

Here, the authors describe a case report of a patient who presented with meningitis and was discovered to have an enterothecal fistula. These rare fistulas have not been well-described and carry a high risk for significant morbidity and mortality. Successful treatment relies heavily on aggressive multidisciplinary medical and surgical care, which are reviewed in this manuscript. We present this case in accordance with the CARE reporting checklist (available at https://jss.amegroups.com/article/view/10.21037/jss-22-89/rc).

Case presentation

A 25-year-old female presented to our institution with an enterothecal fistula connecting her small bowel to her lumbar cistern. Her past medical history was significant for a sacral giant cell tumor resected via anterior intraperitoneal approach followed by posterior spinopelvic fixation 4 years prior to presentation. She was treated with adjuvant radiation therapy, which resulted in small bowel obstruction treated with resection 3 years prior to presentation. She presented with rapidly worsening headaches and nausea, and she was afebrile with normal vital signs. She was neurologically intact on examination, and laboratory analysis demonstrated a white blood cell count of 9.0×10^9 cells/L. A computed tomography (CT) scan of the head without contrast was ordered, which was negative for acute intracranial pathology. She was admitted to the hospital with a plan to pursue magnetic resonance imaging (MRI) of the brain.

Subsequent CT (*Figure 1*) demonstrated no subarachnoid hemorrhage but did show new pneumocephalus, pneumoventricle, and a convex appearance of the transverse and sigmoid sinuses concerning for intracranial hypotension. She then had worsening lethargy and confusion and development of meningeal signs. Given the lack of trauma, and a negative CT-facial bone scan, a spinal etiology for her pneumoventricle and meningeal pathology was suspected, prompting a CT scan of the lumbar spine. This demonstrated air within the lumbar cistern, as well as a small portion of small bowel that had herniated into the previous giant cell tumor resection cavity. Additionally, much of the previous cement that was used to fill the resection cavity was no longer present, and one of the previous ventral cement screws used to secure the cement to the lumbar spine was also no longer present. These findings raised the suspicion for enteral-to-CSF fistula, or enterothecal fistula.

A subsequent CT of the abdomen with oral contrast confirmed this finding, as active contrast extravasation was witnessed between the lumen of the small bowel and the lumbar cistern (*Figure 2*). A follow-up MRI lumbar spine with and without contrast confirmed what appeared to be a possible fecal matter within the lumbar cistern.

Given the concern for active enterothecal fistula resulting in meningitis, operative exploration was pursued. This was performed in conjunction with our institution's general surgery service, who provided wide intraperitoneal abdominal exposure and access to the fistula. Intraoperatively, an 8.5 cm section of small bowel was seen invaginating into the previous defect from the giant cell tumor. Upon removal of the bowel, a 4 cm luminal defect

Highlight box

Key findings

- A 25-year-old female presented to our institution with an enterothecal fistula connecting her small bowel to her lumbar cistern.
- This is the first reported case of meningitis secondary to an enterothecal fistula in a patient without a previous congenital sacral anomaly.

What is known and what is new?

- To date, there have only been cases of enterothecal fistula described in the pediatric population or cases described in patients with Currarino syndrome.
- Combining the lessons learned from previous literature and this case, the authors propose several treatment tenets aimed at accurate diagnosis and effective treatment.
- These patients are at high risk for meningitis and hydrocephalus. If recognized quickly and appropriately treated, there is a possibility of good neurological outcome.

What is the implication, and what should change now?

- Successful treatment of this rare pathology relies heavily on aggressive multidisciplinary medical and surgical care, which are reviewed in this manuscript.

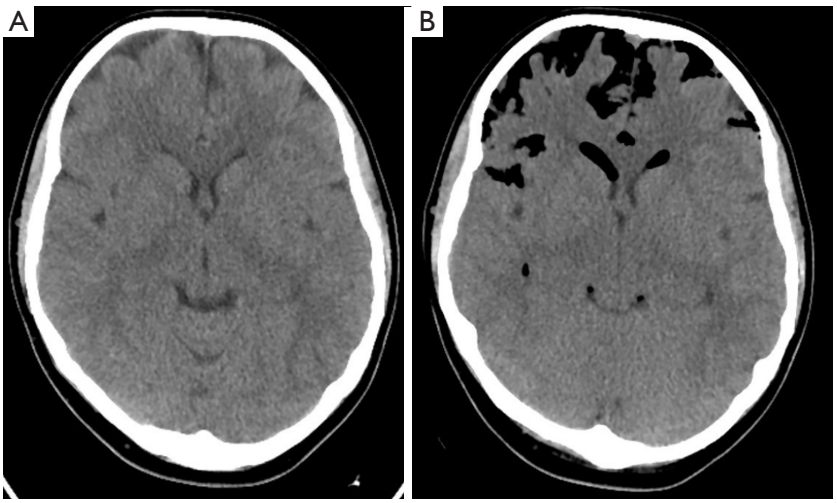

Figure 1 Comparative head CT imaging. (A) Initial CT without contrast at presentation demonstrating no intracranial pathology. (B) Subsequent CT without contrast on hospital day 1 demonstrating pneumocephalus. CT, computed tomography.

was encountered (*Figure 3*). There were copious small bowel contents within the peritoneum, and it was seen to be actively mixing with CSF emanating from the lumbosacral defect. The 8.5 cm section of small bowel was resected and reapproximated using a side-to-side anastomosis. Attention was then turned to repair the dural defect. Due to the patient's sacral slope, the dural defect could not be clearly seen. It was felt that direct repair would not be possible, and thus a 20-cc spherical fat graft was harvested from the abdominal subcutaneous tissue and packed into the defect. This was further covered with polyethylene glycol sealant. No egress of CSF could be seen around this. The wound was then closed, and the patient was brought to the intensive care unit (ICU). Intraoperative cultures of the fluid and bowel contents did not yield positive growth, although antibiotics including vancomycin and cefepime had been started preoperatively. Initial blood and urine cultures were also negative.

Within 24 hours postoperatively, the patient developed leg weakness, thus prompting an MRI with and without contrast of her total spine. This demonstrated new central holo-cord T2 hyperintensity concerning for acute syringomyelia. Additionally, her mental status continued to deteriorate, and a subsequent CT brain without contrast demonstrated new development of cerebellar tonsillar herniation and acute hydrocephalus. She subsequently underwent a right frontal ventriculostomy with high opening pressure. CSF was sent for standard cultures and grew pan-sensitive *Escherichia coli*. Her antibiotic approach as indicated by the infectious disease team was maintained. It was felt that the suctioning of fecal matter and CSF from her dural defect had resulted in severe tonsillar herniation, thus causing acute hydrocephalus. Thus, she then underwent a suboccipital craniectomy with C1 laminectomy and intradural exploration, which demonstrated obstruction of the foramen of Magendie with choroid plexus. The cerebellar tonsils were coagulated, the foramen of Magendie was opened, and brisk flow of CSF out of the fourth ventricle was observed. This eventually failed due to scarring of the obex, which was resolved through a repeat craniotomy and placement of a fourth ventricular stent.

Postoperatively, she continued to have headaches and abdominal pain with continued imaging evidence of persistent CSF leak into her abdomen. With the assistance of the interventional radiology service, multiple abdominal drains were placed into the fluid collections, which were inserted to help alleviate the pressure from these collections and monitor for continued CSF leak. Additionally, with the assistance of plastic surgery, a posterior lumbar exploration and L5 laminectomy were performed. Full posterior exposure of the dura at the affected level was performed, but no active CSF leak could be identified at that time as it was ventrally located. Nonetheless, a dural synthetic was wrapped ventrally at the level of the fistula and secured to the exposed dura with suture. The wound was closed with paraspinal muscle advancement flaps. Simultaneously, a lumbar drain was placed to allow for extra CSF diversion.

Over the ensuing weeks, there were multiple attempts to

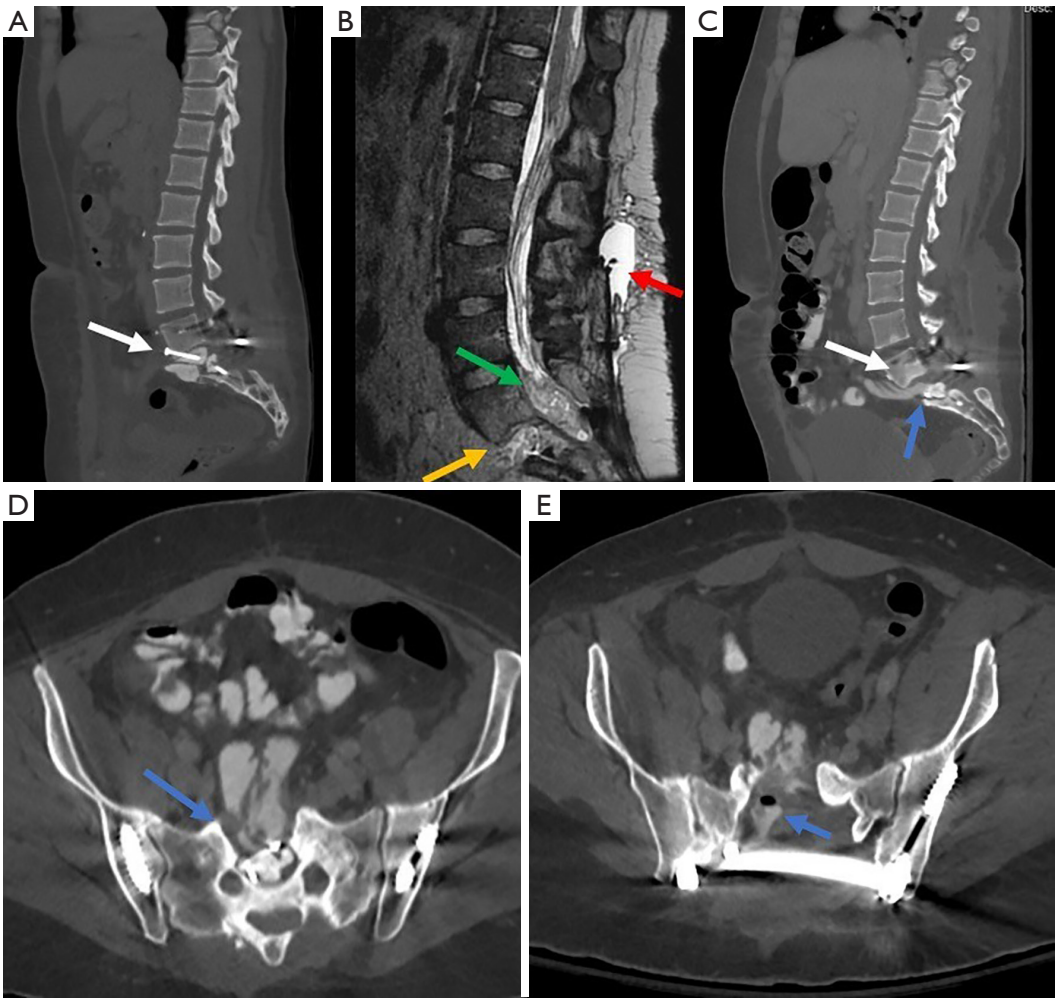

Figure 2 Demonstrative CT images revealing patient's presenting pathology. (A) Previous postoperative non-contrasted CT following giant cell tumor resection and small bowel resection demonstrating bone cement within the resection cavity secured with a ventral bone screw (white arrow). This CT was obtained 4-year prior to current presentation. (B) Sagittal T2 MRI L spine from present admission indicating small bowel invaginating through the previous lumbar defect (orange arrow), new development of posterior pseudomeningocele (red arrow) and fecal matter in the lumbar cistern (green arrow). (C-E) Sagittal and axial CT abdomen and pelvis with oral contrast from present admission demonstrating a loop of small bowel invaginating into the previous lumbosacral spine defect with direct communication (blue arrows) with the thecal sac. Note that the previous bone cement as well as the ventral cement screw seen on the lumbar spine CT in panel A are no longer present (white arrow). It was presumed to have eroded through the small intestine and been eliminated during a bowel movement. CT, computed tomography.

wean the patient's external ventricular drain. These attempts were not successful. As a result, a right frontal ventriculopleural shunt with a Medtronic Strata II adjustable pressure valve set at 0.5 was placed, and the external CSF diversion drain was removed.

Over the course of her remaining hospitalization, the patient underwent aggressive rehabilitation with physical therapy, treatment of meningitis with antibiotics, and nutritional support with the assistance of our institution's dieticians. She was discharged to an acute rehabilitation center after 79 inpatient days and a total of five operations. At the time of discharge, she was alert and oriented, with nonfocal diffuse 4 out of 5 strength in all four extremities, and only able to stand with maximum assistance. Unfortunately, at approximately 20 weeks following her index presentation, she developed wound drainage

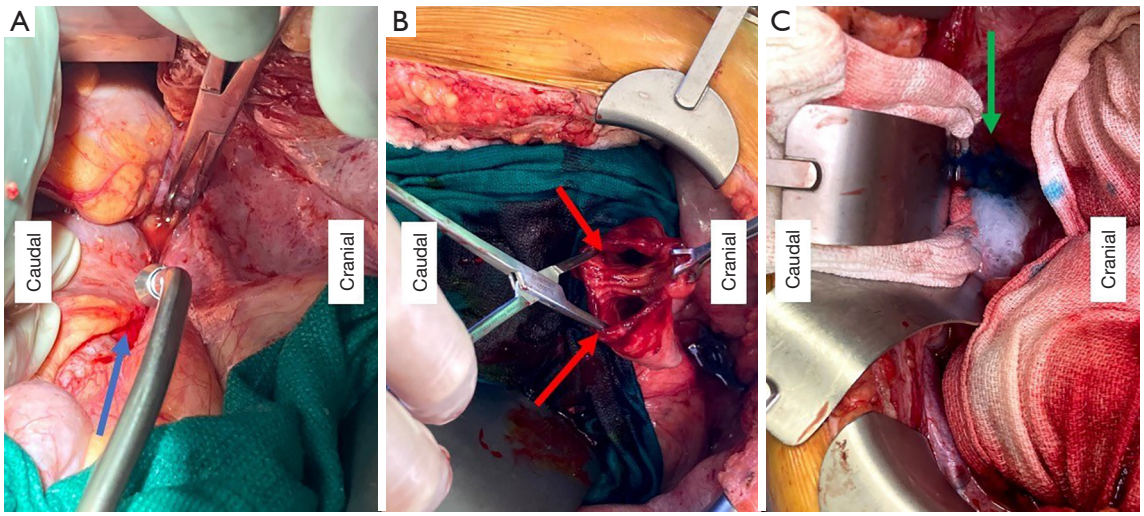

Figure 3 Intraoperative imaging for lumbosacral defect repair. (A) View of the bowel loop (blue arrow) diving into the previous surgical defect (end of suction device). (B) Removal of entrapped small bowel, demonstrating clear bowel wall defect with proximal and distal lumen (red arrows). The surgeon's sponge-stick instrument is cannulating both proximal and distal bowel lumens. (C) The lumbosacral defect has been packed with a large fat graft and covered with polyethylene glycol sealant (green arrow).

which required re-exploration of her posterior incision. At this time, decision was made to remove her previous instrumentation without replacement. At her 10-month follow-up, she was awake, oriented, ambulatory with assistance, and able to independently participate in all basic activities of daily living.

All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee(s) and with the Helsinki Declaration (as revised in 2013). As this is a retrospective case report without risk to the patient, no IRB approval is required. Informed consent was obtained from the patient for publication of this case report and any accompanying images, and no identifiable information was included in the manuscript or images. A copy of the written consent is available for review by the editorial office of this journal.

Discussion

The authors present the first documented case of an enterothecal fistula in an adult patient without prior congenital defect. The presumed etiology of this connection was thought to be due to small bowel herniation through a bony cavity created through a tumor resection within the ventral lumbosacral spine. The tumor itself was a giant cell tumor of the bone. This resulted in local bone invasion that was also expansile and causing some local mass effect. The nature of the original resection was to remove as much of the bony tumor as possible. This left a unstable and large osseous defect, which was filled with bone cement and secured with anterior vertebral body screws. This filled the defect with a solid cement which was anchored to the bone by the screws. Combined with previous radiation therapy, the subsequent extensive scarring led to the formation of the fistulous connection between the small bowel and the lumbar cistern. During the course of these events, one of the metallic anchor screws used to secure the cement used in the original giant cell tumor resection was also somehow eliminated.

To date, there have only been cases of enterothecal fistula described in the pediatric population or cases described in patients with Currarino syndrome, which is an autosomal dominant hereditary condition characterized by a triad of sacral agenesis abnormalities, anorectal malformation, and a presacral mass. In a 2019 case report, Jeltema *et al.* described this phenomenon in a 6-year-old patient with history of Currarino syndrome resulting in partial sacral agenesis, anorectal malformation, and anterior meningocele (4). This patient was treated with a diverting loop ileostomy, and the dural defect was found to have spontaneously closed without additional intervention. This patient developed fulminant meningitis due to *Streptococcus anginosus* (*milleri*) and *Bacteroides fragilis* and was treated with prolonged intravenous ceftazidime and metronidazole. She also

developed hydrocephalus, although this ultimately resolved with intermittent lumbar punctures and did not require permanent shunting. She eventually made an excellent recovery and had reversal of her ileostomy. Literature review demonstrated additional cases of meningitis in patients with Currarino syndrome, many of which were due to fistulous connections between bowel and the anterior meningocele. A previous study reported an enterothecal fistula in an adult patient as an acute complication following sacral mass resection; however, this patient was found to have undiagnosed partial Currarino syndrome (5). Across these studies, no general consensus was made on the method or timing, as some fistulas were treated medically, some with early surgery, and some with late surgery (6-10). Unlike these patients, the patient described in this report did not have any congenital sacrococcygeal anomaly. As part of her medical treatment, the surgical resection of her sacral tumor thus resulted in a defect, however, that predisposed her to the development of the enterothecal fistula. Thus, the authors believe that any surgeon performing spinal oncology surgery from a transperitoneal approach should pay careful attention to buttressing the posterior peritoneal wall and spinal column with additional mesh or synthetic products. This is especially important for patients who will subsequently receive radiation therapy, which can further induce scarring and raise the risk for the development of iatrogenic fistulas.

Combining the lessons learned from previous literature and this case, the authors propose several treatment tenets aimed at accurate diagnosis and effective treatment. Most importantly, patients with pneumoventricle or pneumocephalus in the absence of trauma or other iatrogenic intervention must have a thorough and complete workup, including magnetic resonance imaging of the entire neural axis. As air can enter the intrathecal space from otherwise unknown sinus or tegmen defects, it is also important to obtain fine-cut CT scans of the skull base (11,12). Patients with previous history of anterior abdominal surgery and anterior spinal surgery should undergo consideration of CT abdomen and pelvis with oral contrast to assess for fistulous connections to the intrathecal space, especially if such a connection is suggested by the previously obtained MRIs.

Following diagnosis of enterothecal fistula, immediate broad-spectrum antibiotics at central nervous system (CNS) penetration dosing should be initiated. This typically consists of vancomycin, cefepime, and metronidazole, but may vary slightly based on trends in local antibiotic resistance. In cases of enterothecal fistula, every attempt at operative exploration and repair should be made. The primary goal of operative intervention is elimination of the fistula with a bowel resection followed by re-anastomosis versus temporary diverting loop ileostomy based on the condition of the affected bowel. This should be followed by direct repair of the dural defect, if able, or packing of the defect if direct repair is not feasible. Another potential target for treatment could revolve around the communication between the enteric nervous system of the gastrointestinal tract and the central nervous system, which has shown to be vital in maintaining systemic homeostasis. Studies have revealed that certain neurologic injuries such as ischemic stroke, spinal cord injury, and hemorrhagic cerebrovascular lesions can all lead to gut dysbiosis, thereby increasing proinflammatory molecules and clotting factors (13-16). Additionally, gut dysbiosis is a possible contributing factor to various neurologic diseases and injuries. While the link between the gut and the brain is not yet fully understood, recent animal and clinical trials have shown that interventions such as probiotics and fecal microbiota transplant could aid in the recovery process from neurologic injury (17-20). That being said, further work is needed to understand the benefits and risks of these treatment options especially in the setting of an enterothecal fistula.

Postoperative management involves ICU-level care due to high likelihood of fulminant meningitis. Hydrocephalus is also a possible complication and may require CSF diversion with an external ventricular drain. In cases where the fistula results in a tethered cord, the tethered cord release may be performed in a more elective fashion and can be done after the patient recovers from the critical illness and meningitis (21).

As was evident in the care of this patient, multidisciplinary involvement is crucial to the success of medical and operative intervention. In this case, the involvement of neurological surgery, general surgery, plastic surgery, interventional radiology, infectious disease, hospital medicine, surgical intensive care, neurocritical care, neuroradiology, dieticians, and physical therapists were required to deliver comprehensive care to the patient. Her encouraging outcome in the midst of the otherwise high morbidity and mortality rate for bacterial meningitis is likely due to the expertise contributed by these services, as well as the recognition by the emergency medicine team that her symptoms required additional workup beyond a negative head CT. Consequently, the authors recommend that patients with suspected meningitis secondary to

enterothecal fistulas should be transferred to tertiary care centers that have the capability of multidisciplinary care. With prompt diagnosis and treatment, it is possible to achieve good outcomes.

Conclusions

This is the first case of meningitis secondary to enterothecal fistula in a patient without a previous developmental anomaly. Operative intervention for fistula obliteration is a feasible and recommended treatment option and should be performed at a hospital with multidisciplinary capabilities. These patients are at high risk for meningitis and hydrocephalus. If recognized quickly and appropriately treated, there is a possibility of good neurological outcome.

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Footnote

Reporting Checklist: The authors have completed the CARE reporting checklist. Available at https://jss.amegroups.com/article/view/10.21037/jss-22-89/rc

Peer Review File: Available at https://jss.amegroups.com/article/view/10.21037/jss-22-89/prf

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://jss.amegroups.com/article/view/10.21037/jss-22-89/coif). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee(s) and with the Helsinki Declaration (as revised in 2013). As this is a retrospective case report without risk to the patient, no IRB approval is required. Informed consent was obtained from the patient for publication of this case report and any accompanying images, and no identifiable information was included in the manuscript or images. A copy of the written consent is available for review by the editorial office of this journal.

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