



## Contrast-enhanced ultrasound of a traumatic neuroma of the extrahepatic bile duct: A case report and review of literature

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### Abstract

#### BACKGROUND

Traumatic neuromas result from nerve injury after trauma or surgery but rarely occur in the bile duct. However, it is challenging to diagnose traumatic neuromas correctly preoperatively. Although some previous reports have described the imaging features of traumatic neuroma in the bile duct, no features of traumatic neuromas in the bile duct have been identified by using contrast-enhanced ultrasound (CEUS) imaging before.

#### CASE SUMMARY

A 55-year-old male patient presented to our hospital with a 3-mo history of abdominal distension and anorexia and history of cholecystectomy 4 years ago. Grayscale ultrasound demonstrated mild to moderate intrahepatic bile duct dilatation. Meanwhile, a hyperechoic nodule was found in the upper extrahepatic bile duct. The lesion approximately 0.8 cm × 0.6 cm with a regular shape and clear margins. The nodule of the bile duct showed slight hyperenhancement in the arterial phase and iso-enhancement in the venous phase on CEUS. Laboratory tests showed that alanine aminotransferase and aspartate aminotransferase were increased significantly, while the tumor marker carbohydrate antigen 19-9 was increased slightly. Then, hilar bile duct resection and end-to-end bile ductal anastomosis were performed. The histological examination revealed traumatic neuroma of the extrahepatic bile duct. The patient had an uneventful recovery after surgery.

#### CONCLUSION

The current report will help enhance the current knowledge regarding identifying traumatic neuromas by CEUS imaging and review the related literature.

**Key Words:** Traumatic neuroma; Bile duct; Contrast-enhanced ultrasound; Enhancement; Cholangiocarcinoma; Case report

**Core Tip:** A traumatic neuroma results from nerve injury after trauma or surgery but rarely occurs in the bile duct. Herein, we present some of the sonographic features of ultrasound and contrast-enhanced ultrasound in a case of a traumatic neuroma. We report this unusual case and review the related literature to improve the diagnosis and differential diagnosis of a traumatic neuroma of the bile duct and related imaging findings.

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## INTRODUCTION

A traumatic neuroma is a chronic reparative proliferative response of the nerve after trauma or surgery. It is composed of disorganized nerve fiber bundles with fibrous stroma, Schwann cells, perineural cells, axons, and endoneurial fibroblasts[1]. The common sites of traumatic neuromas are the necks and extremities[2,3]. Although some studies have described traumatic neuromas in the bile duct, cases of sonographic features of contrast-enhanced ultrasound (CEUS) have not been published before. The clinical manifestation and imaging examination of a traumatic neuroma of the bile duct are not specific, which makes it challenging to be accurately diagnosed preoperatively. Herein, we report a traumatic neuroma of the extrahepatic bile duct with detailed ultrasonographic imaging features. We also reviewed the literature on the imaging findings for traumatic neuromas.

## CASE PRESENTATION

### Chief complaints

A 55-year-old man was admitted to our hospital with unexplained abdominal distension and anorexia 3 mo ago.

### History of present illness

The patient suffered from unexplained abdominal distension and anorexia for 3 mo. The patient developed darkened urine 2 mo ago. He experienced a weight loss of 5 kg over the course of the disease. He underwent contrast-enhanced computed tomography (CECT) examination at a local hospital, and a lesion was found in the extrahepatic bile duct, which was believed to be a tumor.

### History of past illness

The patient underwent cholecystectomy for gallbladder stones with an uneventful postoperative recovery 4 years ago. He had a 10-year history of hypertension.

### Personal and family history

There was no other personal or family history of acute or chronic disease.

### Physical examination

The patient showed no tenderness, rebound tenderness or muscle tension on abdominal palpation.

### Laboratory examinations

The liver function tests demonstrated increased levels of alanine aminotransferase (185 IU/L, normal range: < 50 IU/L), aspartate aminotransferase (148 IU/L, normal range: < 40 IU/L) and total bilirubin (37.0  $\mu$ mol/L, normal range: 5  $\mu$ mol/L to 28  $\mu$ mol/L). Tumor markers included carbohydrate antigen 19-9 (98.6 U/mL, normal range: < 22 U/mL), carcinoembryonic antigen (0.97 ng/mL, normal range: < 5 ng/mL), and alpha-fetoprotein (4.67 ng/mL, normal range: < 7 ng/mL).

### Imaging examinations

The patient underwent an abdominal ultrasound (US) examination by a Resona7 US system (Mindray Medical International, Shenzhen, Guangdong Province, China) equipped with an SC6-1U (1-6 MHz)

transducer. The US revealed mild to moderate dilatation of the intrahepatic bile duct, and the diameter of the upper extrahepatic bile duct was 1.2 cm (Figure 1A). A hyperechoic nodule sized 0.8 cm × 0.6 cm was found in the upper extrahepatic bile duct with an almost regular shape and slightly clear margins (Figure 1B). The patient underwent CEUS with the patient's consent for further diagnosis. A 2.4-mL US contrast agent SonoVue (Bracco, Milan, Italy) suspension was injected through the left cubital vein followed by a flush with 5 mL saline. In the arterial phase, the nodule showed slight heterogeneous hyperenhancement without rim-like enhancement (Figure 1C). The nodule appeared heterogeneous isoenhancement in the venous phase (Figure 1D). Additional CECT in our hospital showed a hypoenhancement nodule approximately 1.3 cm × 1.0 cm in size in the upper extrahepatic bile duct (Figure 2).

## FINAL DIAGNOSIS

Based on the incidence of bile duct diseases, imaging findings and laboratory tests, the patient's clinical diagnosis was hilar cholangiocarcinoma. However, postoperative pathology of the common bile duct lesion showed a neoplastic proliferation of submucosal nerve tissue and fibrous tissue (Figure 3A), and an immunohistochemistry marker was positive for S-100 (Figure 3B). The above pathological findings indicated that the lesion in the bile duct was a traumatic neuroma.

## TREATMENT

During the surgery, intraoperative frozen pathology showed no tumor cells within the bile duct lesion. Therefore, hilar bile duct resection and end-to-end bile ductal anastomosis (EE) were performed. The patient recovered uneventfully after surgery.

## OUTCOME AND FOLLOW-UP

There was no obvious abnormality on CECT for half a year after the operation.

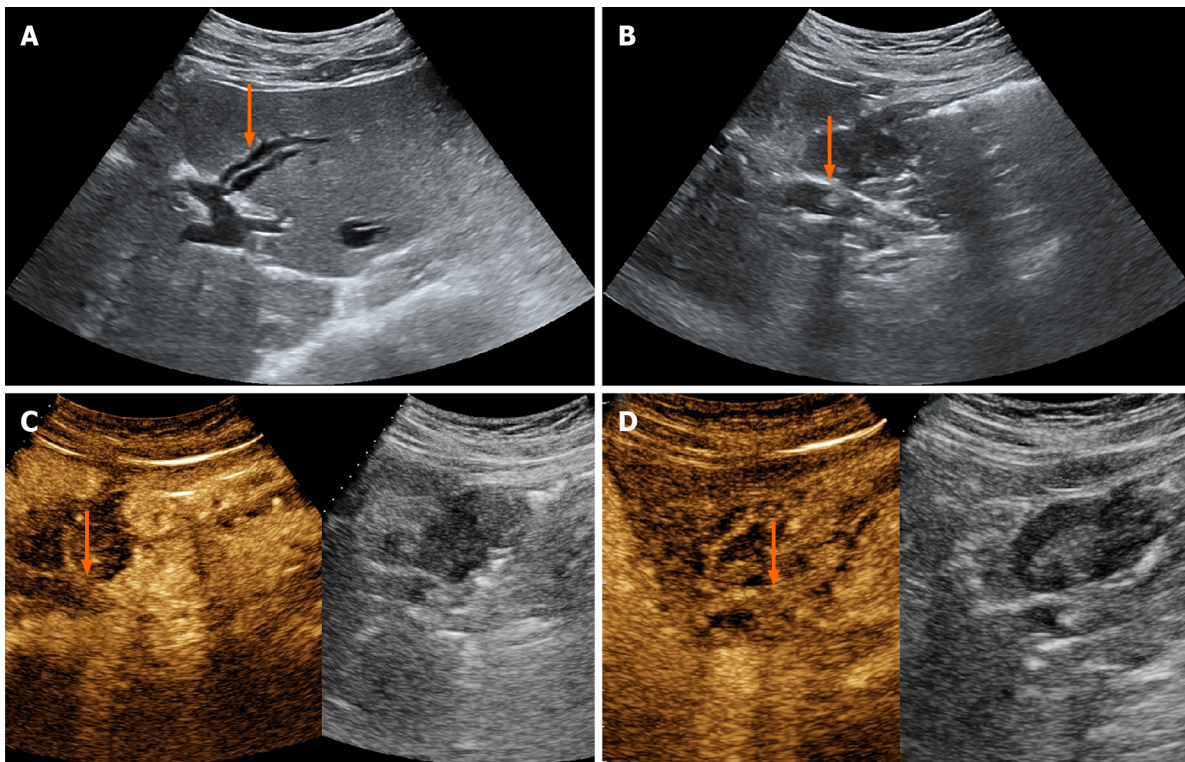
## DISCUSSION

Extrahepatic bile duct masses are commonly malignant tumors, while benign tumors account for only 6% [4-7]. Consequently, the possibility that extrahepatic bile duct lesions are traumatic neuromas is easily overlooked. It has been reported that most traumatic neuromas of the biliary tract arise in the cystic duct stump after cholecystectomy [8]. If a nerve is transected and its continuity cannot be reestablished, a traumatic neuroma may develop [9].

We reviewed the literature from 2000 to 2021 and found 18 publications regarding the imaging features of traumatic neuromas in the bile ducts [2,10-26]. The clinical findings and imaging features of these 18 reported cases are summarized in Table 1. Finally, 22 patients were included in the literature review for further analysis. The age of patients ranged from 17 to 81 years of age, and there was a significant male predominance, with 15 males (68.2%), 2 females, and 5 patients of unreported sex. Most cases were secondary to cholecystectomy, but a few were secondary to liver transplantation, hepatectomy and hilar cholangiocarcinoma. The major symptoms found in these patients were jaundice, abdominal pain, and weight loss, while some patients had no apparent symptoms.

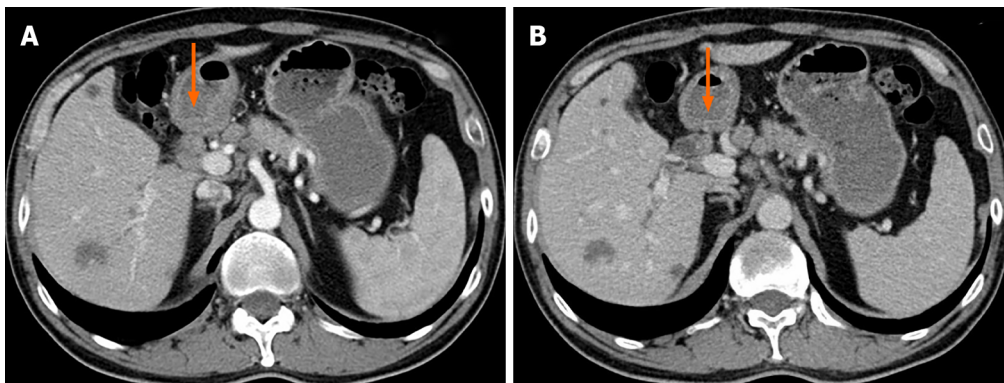
Unfortunately, no specific imaging features for traumatic neuromas of the bile duct have been found at present. Although some imaging modalities, such as US, computed tomography (CT), and nuclear magnetic resonance imaging (MRI), are valuable to some extent, it remains a challenge to diagnose traumatic bile duct neuromas preoperatively [17]. Imaging findings in these 22 patients varied from nodules or masses to localized bile duct stenosis with dilatation of the upper bile duct. It has been reported in the literature that the US imaging findings of extraabdominal nerve tumors and traumatic neuromas are generally hypoechoic masses, larger than the nerve trunk and continuous with the nerve [27]. However, the nerve injury related to cholecystectomy may be too small, so we could not find that the nerve is connected to traumatic neuroma of the bile duct. US was performed in 5 of the 22 patients, 2 of whom showed hypoechoic nodules, and the remaining 3 patients showed stenosis and dilatation of the bile ducts. However, our patient's US sonogram showed a hyperechoic nodule, indicating that the echogenicity of the nodule of traumatic neuroma was variable.

CECT was performed in 2 of the 18 cases, and an enhancing nodule was seen, which was consistent with the CECT findings of our patient. Traumatic neuromas also show enhancement on MRI when a contrast agent is used [28], which may be related to a damaged peripheral nerve blood barrier that occurred during a prior insult to the nerve [29-32]. One of these 18 cases described the enhancement



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**Figure 1** Ultrasound images of the patient. A and B: The ultrasound (US) showed mild to moderate intrahepatic bile duct dilatation (orange arrow) and a hyperechoic nodule sized 0.8 cm × 0.6 cm (orange arrow) in the extrahepatic bile duct; C and D: In the arterial phase, contrast-enhanced US (CEUS) showed slight hyperenhancement (orange arrow); in the venous phase, CEUS showed isoenhancement (orange arrow).



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**Figure 2** Contrast-enhanced computed tomography images of the patient. Contrast-enhanced computed tomography showed a hypoenhancement nodule in the upper extrahepatic bile duct (orange arrow).

pattern of traumatic neuroma on MRI in detail, which showed a marked homogeneously enhanced nodule that was iso-intense to the aorta in the atrial phase and a homogeneously enhanced nodule that was iso-intense to the aorta in the portal phase. There have been a few reports of other imaging techniques for diagnosing traumatic neuromas, such as magnetic resonance cholangiopancreatography, endoscopic US, contrast-enhanced harmonic endoscopic ultrasonography, intraductal ultrasonography and percutaneous transhepatic cholangiography. None of these imaging methods revealed specific features for traumatic neuromas.

It is challenging to distinguish bile duct traumatic neuroma from other lesions before surgery, so it is often misdiagnosed. The diagnosis of bile duct traumatic neuroma was correctly diagnosed in 1 of the 18 cases examined and confirmed by biopsy. The remaining cases were not correctly diagnosed, and it was difficult to distinguish between benign and malignant lesions in most cases. Therefore, surgery would be performed on a large proportion of patients. Once the patient underwent surgery, an intraoperative frozen section examination helped to confirm that the lesion was benign and extensive surgical



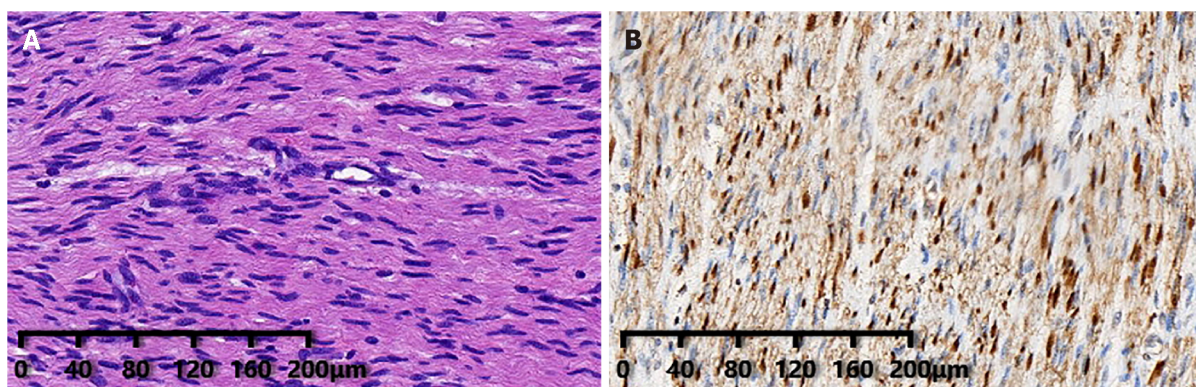
Table 1 Traumatic neuroma of the bile duct reported in the literature between 2000 and 2020

Ref.	Age	Sex	Symptoms	Location	Imaging findings	Preoperative diagnosis	Treatment
Shimura <i>et al</i> [10]	70	F	Abdominal discomfort	Extrahepatic bile duct	US: Hypoechoic tumor, bile duct slightly dilated  CT: Round, hyperdense, distinct margin tumor  Angiography: No encasement of the surrounding major vessels  Endoscopic retrograde cholangiography: A protuberant nodule  Intraductal ultrasonography: A smooth hypoechoic tumor	Did not indicate bile duct carcinoma	Bile duct excision and a Roux-en-Y hepaticojejunostomy
Watanabe <i>et al</i> [11]	48	M	Jaundice	Extrahepatic bile duct	Cholangiogram <i>via</i> the percutaneous transhepatic biliary drainage tube: The extrahepatic bile duct severely stenotic	ND	Bile duct excision and a Roux-en-Y hepaticojejunostomy
Iannelli <i>et al</i> [12]	81	M	Jaundice	Common bile duct	US: Dilatation of the intrahepatic bile ducts  MRCP: A focal stricture	ND	Bile duct excision and a Roux-en-Y hepaticojejunostomy
Ueno <i>et al</i> [2]	60	M	Jaundice	Mid-common bile duct	US: Dilatation of the bile ducts, a mildly echogenic mass  CT: Dilatation of the bile ducts, a markedly enhanced nodule  MRI: Dilatation of the bile ducts. Homogeneous enhanced nodule with an iso-intense to the aorta, both in the arterial and portal phase  Percutaneous transhepatic cholangiography: Dilatation of the bile ducts and a smooth stricture	Could not confirm benign or malignant nature	Bile duct excision and a hepato-jejunal anastomosis
Choi <i>et al</i> [13]	46	M	Increased liver enzymes	Right hepatic duct	CT: A mass approximately 2 cm  MRI: A mass approximately 2 cm	A bile duct cancer could not be excluded	Right hemihepatectomy
Kim <i>et al</i> [14]	76	M	ND	Mid-bile duct	CT: A small enhancing nodule  MRC: Eccentric wall thickening of the bile duct consistent with a neoplasm	ND	Segmental resection with a Roux-en-Y hepaticojejunostomy
Cheng <i>et al</i> [15]	33	F	Jaundice and weight loss	Remnant choledochal cyst	MRI: A mass	Cholangiocarcinoma	Excision of the remnant choledochal cyst and a new hepaticojejunostomy
Cheng <i>et al</i>	56	M	Jaundice, abdominal	Distal	US: Dilatation of bile	Ampullary or	Pancreaticoduodenectomy

[16]			pain and weight loss	extrahepatic bile duct	duct	perampullary carcinoma	
					MRI: Dilatation of bile duct, a filling-defect in the distal bile duct and a thickened biliary wall around the ampulla of Vater		
Cheng <i>et al</i> [17]	68	M	Progressive jaundice and abdominal pain	Bifurcation of the left and right hepatic duct	MRI: A mass with enhancement, a stricture of the hilar bile duct, dilatation of bile ducts	Cholangiocarcinoma	Excision of the mass and a new Roux-en-Y hepaticojejunostomy
Navez <i>et al</i> [18]	ND	ND	Jaundice (3 patients) or liver function test alteration (1 patient), a retro-obstructive choleperitoneum on the downstream biliary stenosis (1 patient)	Anastomotic biliary stricture	CT: Anastomotic biliary stricture (4 patients)	ND	Traumatic biliary neuromas resection combined with hepaticojejunostomy (1 patient); traumatic biliary neuromas resection and duct-to-duct biliary reconstruction protected by a T-tube (4 patients)
					MRI: A markedly homogeneous high intensity nodule enhanced on portal-phase (1 patient), anastomotic biliary stricture (4 patients)		
Terzi <i>et al</i> [19]	17	F	Persistent elevated transaminase and bilirubin levels	Anastomotic biliary	Percutaneous transhepatic cholangiography: A biliary stricture at the anastomosis	ND	Resection of the bile duct stricture and a Roux-en-Y hepaticojejunostomy
Toyonaga <i>et al</i> [20]	76	F	A bile duct nodule	Proximal common bile duct	CT: An 8 mm, smooth, and uniformly enhanced nodule	Submucosal tumor	Biopsy, observation for 1 year, no changes to the nodule
					Contrast enhanced endoscopic ultrasonography: A clear boundary and a low echoic nodule, uniformly enhanced at early		
					Cholangioscopy: A smooth elevated lesion, covered with normal mucosa		
Yang <i>et al</i> [21]	65	M	Jaundice	Right bile duct	MRI: A 1.0 cm × 1.5 cm mass	Cholangiocarcinoma	Resection of the mass and Roux-en-Y hepaticojejunostomy.
Hirohata <i>et al</i> [22]	60	F	No chief complaint	Junction of the cystic duct	US: A 6 mm round tumor, surrounding lymph nodes were not swollen	Cholangiocarcinoma	Surgery
					MRI: A slightly high signal on T2 and the periphery remnant cystic duct of the tumor presented as a high-intensity lesion on T2		
					EUS: A residual cystic duct tumor with enhancement		
					ERCP: Not invade the common bile duct		
Yasuda <i>et al</i> [23]	76	M	ND	Stump of the dilated cystic duct	EUS: A hypoechoic oval mass with a hyperechoic rim on the surface, 14 mm in	Amputation neuroma	Biopsy, observation

					diameter, hypervascularity		
					Cholangiogram: A hemispherical defect		
					Cholangioscopy: A hemispherical mass covered with thin normal cystic duct epithelium		
Lalchandani <i>et al</i> [24]	41	M	Epigastric pain, weight loss, tea-colored urine	Common hepatic duct	US: Dilation of the bile ducts	Acute cholangitis	First: Biliary stent Finally: Bile duct resection and hepaticojejunostomy
					ERCP: A 3-4 cm stricture		
Kim <i>et al</i> [25]	72	M	A duodenal subepithelial tumor during a medical checkup	Near the duodenal wall and the cystic duct stump	CT: A 1.4 cm mass	Duodenal subepithelial tumor	Resection of the mass and duodenal wall, en-block resection of the mass and cystic duct origin
					EUS: An 18 mm hypoechoic mass		
Nechi <i>et al</i> [26]	76	M	Jaundice	The transition zone between the common hepatic duct and the main bile duct	US: Dilation of the bile ducts, a 5 mm hypoechoic nodule	Could not confirm benign or malignant nature	Resection of the main bile duct with a choledocho-duodenal anastomosis
					MRI: Dilation of the common hepatic duct		

ND: Not described; US: Grayscale ultrasound; CT: Computed tomography; CECT: Contrast-enhanced computed tomography; MRI: Magnetic resonance imaging; MRC: Magnetic resonance cholangiogram; MRCP: Magnetic resonance cholangiopancreatography; EUS: Endoscopic ultrasonography; ERCP: Endoscopic retrograde cholangiopancreatography.



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**Figure 3** Postoperative histopathological images of the patient. A: Hematoxylin and eosin staining showed proliferation of submucosal nerve tissue (magnification,  $\times 100$ ); B: Immunohistochemical staining displayed S100(+) (magnification,  $\times 100$ ).

resection of the traumatic neuroma was avoided[2,3]. The primary treatment reported in the literature consists of bile duct excision and hepaticojejunostomy (HJ). Although HJ is frequently recommended for reconstruction, the indications, surgical options and suture selection are also controversial. Some investigators also recommend EE because it is more physiological and can maintain physiological balance [33]. It is possible to achieve excellent long-term results and high quality of life using both HJ and EE when it is feasible for the proximal and distal ductal ends to permit EE[34]. Therefore, the choice of the optimum method is strictly correlated with the morphological nature of the lesion, which is different from one stage to the other, depending upon the moment of detection, and therefore have different surgical implications[35]. The surgeon found that the anastomosed edges blood supply was good and that there was no tension of the anastomosed edges in this patient. Therefore, according to the actual conditions of patients, as well as to maintain physiological balance, our hospital professor implemented EE for this patient.

In this patient, the symptoms of anorexia, weight loss and jaundice mimicked those often caused by malignant tumors of extrahepatic bile ducts. CEUS and CECT showed enhancement of the nodule. Based on the incidence of bile duct diseases and imaging findings, the surgeons misdiagnosed it as cholangiocarcinoma. Periductal infiltrative cholangiocarcinomas account for the majority of extrahepatic cholangiocarcinomas[36]. Extrahepatic cholangiocarcinomas may show hyperenhancement, isoenhancement, or hypoenhancement in the early phase of CEUS, and most of them show hypoenhancement in the late phase[37]. If we find a nodule in the bile duct, we should rule out the diagnosis of cholangiocarcinoma when the nodule does not show hypoenhancement in the late phase of CEUS. However, when traumatic neuroma presents as localized bile duct stenosis, it is relatively difficult to distinguish it from malignant lesions. When a patient has a history of biliary system surgery and the tumor markers are not significantly elevated, suspicion of traumatic neuroma increases. If conditions permit, patients can be protected from unnecessary surgeries by confirming the diagnosis with a biopsy. CEUS is beneficial for differentiating cholangiocarcinoma from traumatic neuromas, but more cases are needed to summarize the sonographic features of this disease. Recognizing of traumatic neuromas may aid in preoperative work up, planning, and patient counseling[24].

## CONCLUSION

It is difficult to correctly diagnose traumatic neuroma of the bile duct before surgery. We should rule out malignant differential diagnoses, such as cholangiocarcinoma preoperatively, to avoid unnecessary surgery. The enhancement mode of CEUS may provide information to distinguish traumatic neuromas from malignant lesions. We need to combine the history of biliary tract surgery, clinical findings, imaging findings and laboratory tests to diagnose this disease.

## FOOTNOTES

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