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RESEARCH HIGHLIGHT

Efficacy of preoperative endoscopic nasobiliary drainage tube placement for liver cancer adjacent to the hepatic hilum

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Abstract

Purpose Surgical resection of liver cancer adjacent to the hepatic hilum is challenging, especially in balancing remnant liver volume preservation with bile duct safety. This study evaluated the efficacy of preoperative endoscopic nasobiliary drainage (ENBD) tube placement as an intraoperative guide for bile duct preservation during liver resection.

Methods Sixteen patients with liver cancer adjacent to the hepatic hilum who underwent preoperative ENBD tube placement and curative liver resection from 2016 to 2023 were retrospectively reviewed. Liver resection was performed along the bile duct where the ENBD tube was placed, preserving that bile ducts and liver section. Risks associated with ENBD tube insertion, the short-term outcomes, and local recurrence incidence were assessed.

Results The ENBD tube was placed a median 3 days preoperatively in the right lobe in 12 patients and the left lobe in four. No patient experienced post-endoscopic retrograde cholangiopancreatography pancreatitis, and all patients underwent surgery as scheduled. Surgeons could preserve the bile ducts nearby the tumor by directly palpating the ENBD tube and/or using air cholangiography in all cases. Clinically relevant bile leakage occurred in one patient (6.3%). The median time to discharge was 12 days, with no significant posthepatectomy liver failure and mortality. All patients achieved negative surgical margins, and only one patient experienced local recurrence (6.3%).

Conclusion Preoperative ENBD tube placement is a safe, collaborative endoscopic-surgical technique that facilitates optimal liver preservation and acceptable local control for liver cancer adjacent to the hepatic hilum.

Keywords Endoscopic nasobiliary drainage tube · Liver cancer · Hepatic hilum · Hepatectomy · Parenchyma sparing surgery

Introduction

Liver cancer is a leading course of mortality worldwide, with incidence rates expected to rise [1]. Surgical resection remains the most effective treatment for liver cancers, including hepatocellular carcinoma (HCC), intrahepatic cholangiocarcinoma (ICC), and colorectal liver metastases (CRLM). Preserving sufficient liver parenchyma while achieving optimal resection margins is essential for favorable outcomes.

Liver cancer located near the hepatic hilum presents challenges in resection due to the need to maintain adequate future liver remnant volume [2]. In such cases, preservation strategies for adjacent liver sections or segments, like bile duct resection and reconstruction via hepaticojejunostomy or duct-to-duct anastomosis, are sometimes employed [3–5]. However, these methods are technically demanding and

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associated with potential short- and long-term postoperative complications [6, 7].

Alternatively, liver resection that spares the tumor-adjacent major Glissonean pedicle exposes the bile duct, increasing the risk of postoperative bile leakage or biliary stenosis [8]. To mitigate these complications, we preoperatively place an endoscopic nasobiliary drainage (ENBD) tube to aid in bile duct preservation and guide resection. This approach allows for intraoperative confirmation of biliary anatomy through direct palpation or indocyanine green (ICG) fluorescence staining, bile duct patency verification with air cholangiography, facilitated bile duct repair, and enhanced recovery from minor bile leaks [9–12].

No study has yet assessed the feasibility and efficacy of ENBD-guided hepatectomy. This study aimed to evaluate the efficacy of preoperative ENBD tube placement in safely preserving bile ducts and liver parenchyma while optimizing surgical margins for hepatectomy in patients with liver cancer near the hepatic hilum.

Materials and methods

Patient selection

This study was approved by the Institutional Review Board of The Cancer Institute Hospital of Japanese Foundation for Cancer Research (approval number: 2023-GB-100) and conducted according to the ethical standards of the Helsinki Declaration. We reviewed our database for patients with pathologically confirmed HCC, ICC, and CRLM who underwent preoperative ENBD tube placement within one week prior to surgery between January 2016 and December 2023. Cases in which ENBD tube was placed for biliary drainage, cholangitis, or choledocholithiasis were excluded.

Treatment strategy

Preoperative assessments included multidisciplinary evaluation of tumor resectability and liver function by ICG retention test at 15 min (ICGR15). The extent of hepatic resection was determined based on an algorithm incorporating ICGR15 and future liver remnant volume [13]. For patients with HCC, anatomical liver resection was considered when the liver function was deemed satisfactory. For patients with ICC or CRLM, limited resection was considered when feasible; however, if the first- or second-order branch of the Glissonean sheath had to be sacrificed at its root, the corresponding region was resected systematically. ENBD tube was preoperatively placed in cases where the tumor was near the hepatic hilum, posing a risk to injure the Glissonean pedicle or bile ducts.

ENBD tube placement

ERCP was performed a few days before surgery under conscious sedation with midazolam and pethidine. A duodenoscope (TJF-Q290 V, JF-260 V; Olympus Medical) was inserted into the duodenum, and biliary cannulation was performed with a wire-guided cannulation technique. An endoscopic sphincterotomy (EST) was performed at the discretion of the endoscopist. The 0.025-inch guidewire was then introduced into the bile duct located near the liver cancer, followed by the placement of the 5 Fr ENBD tube. After completion of the ERCP, rectal non-steroidal anti-inflammatory drugs were used to prevent post-ERCP pancreatitis; however, prophylactic pancreatic duct stenting was not routinely performed. The day after ERCP, blood tests and X-ray examinations were performed to verify the absence of post-ERCP pancreatitis and confirm the location of the ENBD tube.

Liver resection

Surgery was primarily conducted as an open procedure. The hepatic arteries, portal veins, and bile ducts were carefully separated, ligated, and divided, depending on the cases. The ENBD tube facilitated accurate assessment of biliary anatomy in cases with severe hepatoduodenal-ligament adhesions. If definite tumor invasion into the bile duct to be preserved was observed, bile duct resection was considered.

Liver resection was performed using the clamp crushing method with LigaSure sealing system under Pringle's maneuver [14]. The surgeon assessed the positional relationship between the tumor and the bile duct by palpating the ENBD tube. Then, the Glissonean sheath was incised while ensuring that the resection margin was cancer-negative. Even if the small injury occurred in the bile duct, safe repair was performed under the ENBD tube guidance. After completion of the liver resection, bile leakage was confirmed or ruled out using an air leak test or air cholangiogram via the ENBD tube [15]. At least one drainage tube was placed at the resected plane. The ENBD tube was retained postoperatively.

Postoperative ENBD tube management

Postoperative bile leakage was evaluated [16]. The ENBD tube was removed when the total bilirubin concentration in the drainage fluid was less than three times the serum total bilirubin concentration. The drainage tube was subsequently removed.

Data collection

We collected the data regarding patients' backgrounds, ERCP examination, and perioperative data. Clavien-Dindo grade and postoperative bile leakage, were documented using previously reported methods [16, 17].

Results

Clinical data of patients with preoperative ENBD tube placement

This study included 16 patients who underwent preoperative ENBD tube placement. Patient demographics are described in Table 1. Among all patients, 10 (64%) had CRLM, 3 (19%) had HCC, and the remaining 3 (19%) had ICC. The median interval between ENBD tube placement and surgery was 3 days (range, 1–5 days). The ENBD tube was positioned in the left hepatic duct (LHD) in 4 patients (B2 in 3 patients, and B3 in 1 patient), right anterior bile duct in 2 patients (all in B8), and the right posterior bile duct (RPBD) in 10 patients (B6 in 8 patients, and B7 in 2 patients). An EST was performed in 5 patients (31%). The median pre-ERCP and post-ERCP serum amylase levels were 74 IU/L and 113 IU/L, respectively. Post-ERCP hyperamylasemia (above the reference range of 44–132 IU/L) was observed in 5 cases (31%); however, no cases of post-ERCP pancreatitis were observed.

Table 1 Patient background characteristics and data pertaining to ENBD tube placement

Variables	$n = 16$
Background characteristics	
Male sex, n (%)	13 (81)
Age in years, median (range)	64 (34–78)
Disease, n (%)	
CRLM	10 (63)
HCC	3 (19)
ICC	3 (19)
ICGR15%, median (range)	11.7 (1.9–16.9)
ENBD tube placement	
Technical success, n (%)	16 (100)
Number of days between ENBD placement and surgery, median (range)	3 (1–5)
ENBD tube size, 5 Fr/6 Fr	16/0
ENBD tube type, straight/pig-tail	15/1
Location, n (%)	
B2	3 (19)
B3	1 (6)
B6	8 (50)
B7	2 (13)
B8	2 (13)
EST, n (%)	5 (31)
ERCP procedure time in minutes, median (range)	28 (10–89)
Pre-ERCP amylase level, median (range)	74 (39–228)
Post-ERCP amylase level, median (range)	113 (54–842)
Post-ERCP hyperamylasemia, n (%)	5 (31)
Post-ERCP pancreatitis, n (%)	0 (0)
Delay of planned surgery, n (%)	0 (0)

ENBD endoscopic nasobiliary drainage, *CRLM* colorectal liver metastasis, *HCC* hepatocellular carcinoma, *ICC* intrahepatic cholangiocarcinoma, *ICGR*15 indocyanine green retention test at 15 min, *EST* endoscopic sphincterotomy, *ERCP* endoscopic retrograde cholangiopancreatography

Perioperative and short-term postoperative outcomes

Details of perioperative and short-term outcomes are in Table 2. Fourteen patients underwent anatomical resection: trisectionectomy ($n = 1$, 6%), bisectionectomy ($n = 7$, 44%), sectionectomy ($n = 5$, 31%), and segmentectomy ($n = 1$, 6%). Two patients (12%) underwent limited resection. The bile duct to be preserved was confirmed by directly palpating in 11 patients and/or by air cholangiography in seven patients. There were no cases where the ENBD tube moved preoperatively, but there was one case in which the tip migrated intraoperatively. This case involved an ENBD placed in B8, where the tip moved into the common hepatic duct. ICG fluorescence was used to confirm the bile duct anatomy and preservation. An intraoperative bile leakage test was performed in all 16 cases, and suturing repair was conducted for a total of 22 bile leakage points in 12 patients (75.0%) (median: 1 site, range: 1–4). Significant postoperative complications (Clavien-Dindo grade $\geq$3a) occurred in two patients (13%). One patient developed bile leakage from remnant segment 1 after left hepatectomy, corresponding to isolated bile leakage [18]. The median postoperative hospital stay was 12 days, with no in-hospital deaths. The ENBD tube was removed at a median of 4 days after surgery, and the drainage tube at 5 days. All patients achieved negative surgical margins, with one case (6%) of local recurrence during a median follow-up of 22.5 months.

Representative case in which ENBD tube guidance was effective (Supplementary video)

A 65-year-old man was referred to our hospital because of synchronous liver metastases (11 in total) from transverse colon cancer. The tumors were deemed unresectable due to suspected tumor invasion of both the anterior and posterior Glisson's pedicle, resulting in an insufficient liver volume.

Table 2 Perioperative and short-term postoperative outcomes

Variables	*n* = 16
Surgical procedure, n (%)	
Trisectionectomy	1 (6)
Bisectionectomy	7 (44)
Sectionectomy	5 (31)
Segmentectomy	1 (6)
Limited resection	2 (13)
Operative time in minutes, median (range)	448 (234–699)
Blood loss in mL, median (range)	1,365 (390–7,500)
Blood transfusion, n (%)	7 (44)
Intraoperative bile duct injury repair, median (range)	1 (0–4)
Clavien-Dindo grade ≥ 3a, n (%)	2 (13)
Bile leakage, n (%)	1 (6)
Postoperative bleeding, n (%)	1 (6)
Postoperative hospital stay in days, median (range)	12 (9–36)
Hospital death, n (%)	0 (0)
Days before ENBD tube removal, median (range)	4 (1–10)
Days before drainage tube removal, median (range)	5 (2–9)
Tumor diameter in cm, median (range)	4.8 (0.6–15.0)
Number of tumors, median (range)	2 (1–17)
Negative surgical margins, n (%)	16 (100)
Postoperative local recurrence, n (%)	1 (6)

ENBD endoscopic nasobiliary drainage

After nine cycles of 5-fluorouracil, leucovorin, oxaliplatin, and irinotecan (FOLFOXIRI) and bevacizumab, the tumor shrank and the concentrations of the tumor markers carcinoembryonic antigen and carbohydrate antigen 19 − 9 decreased. Although the tumor still invaded the anterior portal veins (Fig. 1a), it was slightly apart from the posterior Glisson's pedicle (Fig. 1b and c). Therefore, we considered performing extended anterior sectionectomy and several limited resections under the guidance of an ENBD tube placed in the RPBD to preserve it. The ENBD tube was placed in B7 3 days before surgery (Fig. 1d). The surgery was performed as scheduled without any post-ERCP complications.

During the surgery, the infraportal type of the RPBD was taped prior to the hepatic hilum, with the ENBD tube in place (Fig. 2a). Liver resection was first performed along the major portal fissure, with subsequent ligation and division of the right anterior bile duct. The liver was then resected along the right portal fissure, partially excising to the posterior section. Upon completion of the liver parenchymal resection, the tumor remained connected only to the connective tissue of the RPBD. Cold dissection between the tumor and the RPBD was performed to maintain the optimal surgical margin, and the resection was completed (Fig. 2b). Any small orifices of the RPBD were safely repaired using 6 − 0 monofilament absorbable sutures, facilitated by the presence of the ENBD tube inside the RPBD (Fig. 2c and d). The operation was finished after remnant liver limited resections were done with negative surgical margins. No bile leakage occurred, allowing for the removal of the ENBD tube on POD 3, and the drainage tube on POD 4. The patient was discharged uneventfully on POD 11. In the 1 year since surgery, there has been no local recurrence near the RPBD.

Discussion

We reported outcomes of 16 patients with liver cancer who underwent preoperative ENBD tube placement followed by curative hepatectomy. All tumors were adjacent to the hepatic hilum, requiring dissection along the bile duct containing the ENBD tube. This method allowed for successful bile duct and liver parenchyma preservation with negative surgical margins. None of the patients experienced delays in surgery due to ERCP complications, and all were discharged without mortality. Our results indicate that this collaborative endoscopic-surgical approach is both feasible and effective for safely resecting liver cancer near the hepatic hilum.

Liver cancers near the hepatic hilum often require combined hepatic and/or bile duct resection to achieve clear surgical margins. Hepaticojejunostomy, a standard biliary reconstruction method, has limitations, including prolonged operative time and risks of repeat cholangitis or bowel obstruction [3, 19]. Alternatively, duct-to-duct anastomosis offers fewer complications but is technically demanding [4, 20]. Preserving the bile duct adjacent to the tumor contributes to maintain future liver function but requires precise dissection of the Glissonean sheath wrapping the bile duct [5]. ENBD-guided dissection supports achieving a safe margin and minimizes bile duct injury risk. Although HCC generally tolerates tumor exposure better than CRLM or ICC, bile duct injury risk increases if the tumor compresses the Glissonean sheath [21]. Therefore, ENBD tube placement is particularly valuable in selected HCC cases, enabling safe bile duct repair if injury occurs.

This ENBD tube placement technique is valuable for intraoperative identification of the biliary anatomy during hepatectomy. While alternative techniques like ICG fluorescence and intraoperative cholangiography assist in recognizing biliary structures and preventing injury, they have limitations [22–25]. ICG fluorescence identifies bile ducts only at shallow depths, and cholangiography provides only a two-dimensional view. In contrast, ENBD tube allows continuous visual and tactile guidance of the tumor-bile duct relationship. In this study, despite tumors being near the hepatic hilum, negative margins were achieved by precise dissection near the bile duct.

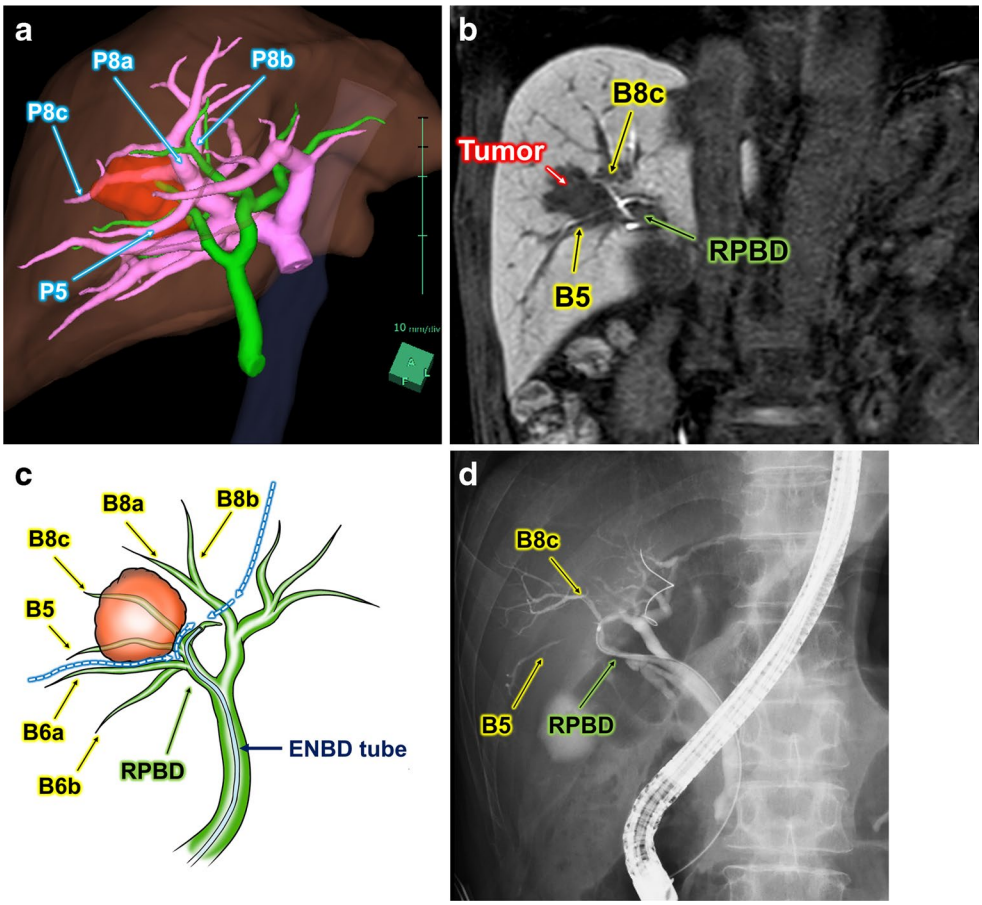

Fig. 1 Preoperative imaging of representative case. (**a**) On 3D reconstructed CT images, the tumor (red color) is in contact with the main branch of the segment 8 portal vein. P8a: ventral side of segment 8. P8b: dorsal side of segment 8. P8c: lateral side of segment 8. (**b**) Although the tumor is adjacent to the RPBD, there is no evidence of invasion on a coronal section of gadolinium ethoxybenzyl diethylenetriamine pentaacetic acid-enhanced magnetic resonance imaging. B8c and B5 are joined to the RPBD. B8c: lateral side of the segment 8 bile duct. (**c**) Preoperative schema of the tumor and biliary system. The planned resection line is along the RPBD (dashed arrow) with the ENBD tube inside. (**d**) ERCP findings. The ENBD tube was placed in the B7 segment 3 days before surgery RPBD, right posterior bile duct. ERCP, endoscopic retrograde cholangiopancreatography. ENBD, endoscopic nasobiliary drainage

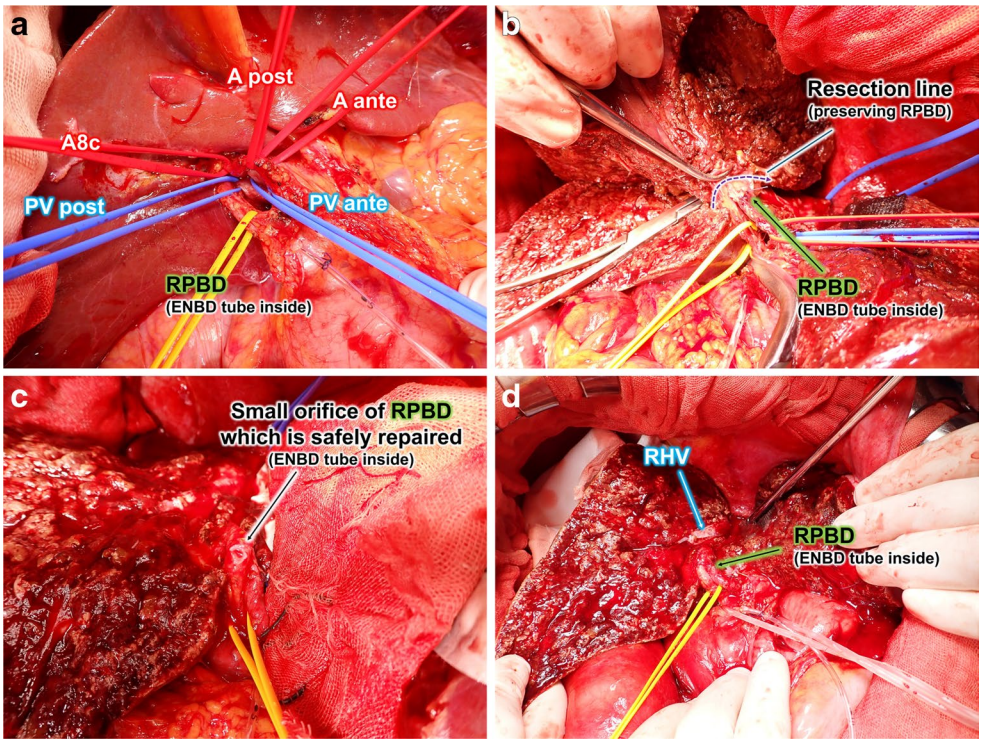

Fig. 2 Intraoperative photographs of the case. (**a**) The hepatic arteries, portal veins, and RPBD are separated and taped at the hepatic hilum. A8c: lateral side of the segment 8 hepatic artery. (**b**) The liver resection is completed, and the tumor is connected only to the RPBD. The estimated resection line is delineated by the dashed arrow. (**c**) The small orifice of the RPBD is safely repaired under the ENBD tube inside the RPBD. (**d**) Post-resection photograph showing that the RPBD is preserved and the right hepatic vein is exposed RPBD, right posterior bile duct. ENBD, endoscopic nasobiliary drainage. RHV, right hepatic vein

Preoperative ENBD tube placement also aids in preventing and managing postoperative bile leakage, a common complication after hepatectomy with an incidence of 3.6–12% [26]. The ENBD tube enables intraoperative bile leakage testing and immediate repair if leaks are detected [15, 27]. Additionally, it serves as a treatment option for postoperative bile leakage [28, 29]. In this study, all cases underwent intraoperative leakage testing using the ENBD tube, allowing for timely repaired in as many as 75% of cases. However, one patient experienced clinically significant bile leakage from segment 1 after left hepatectomy, highlighting a limitation of intraoperative testing and postoperative drainage via the ENBD tube in this case. Another advantage of ENBD tube placement is the prevention of stricture by leaving it in place for several days postoperatively. In this study, none of the 16 cases experienced postoperative bile duct stricture.

Complications from ENBD tube placement in non-morbid biliary conditions can delay scheduled surgery, with post-ERCP pancreatitis being a notable risk, occurring in 3.5–10% of cases [11, 30]. Careful assessments of risks versus benefits are essential when considering ERCP, as normal biliary conditions and lack of chronic pancreatitis are associated with higher post-ERCP pancreatitis risk [31, 32]. Although none of our patients developed post-ERCP pancreatitis, hyperamylasemia occurred in 31% of patients (5 of 16 cases), indicating some risk. However, this didn't delay surgery. The use of non-steroidal anti-inflammatory drugs in all cases after ERCP, the use of a thin 5 Fr ENBD tube instead of a 6 Fr tube in all cases, and the placement of an EST in five cases may have contributed to prevent post-ERCP pancreatitis [33].

The limitations of this study are as follows. First, it is descriptive research based on a small number of cases (16) from a single institution. To more robustly demonstrate the effectiveness of this technique, a prospective multicenter study should be planned. Second, this study is a retrospective, non-comparative study. Since there is no comparison with a group that did not undergo preoperative ENBD tube placement for tumors adjacent to the hepatic hilum, it is difficult to strongly support the efficacy of this approach.

Conclusion

Preoperative ENBD tube placement can be safely performed, and this collaborative endoscopic-surgical technique ensures an optimal preservation of the bile ducts and liver parenchyma, achieving acceptable local control for liver cancer adjacent to the hepatic hilum.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s00423-025-03774-w.

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Data availability No datasets were generated or analysed during the current study.

Declarations

Competing interests The authors declare no competing interests.

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