

Fluoroscopy-Guided Percutaneous Endobiliary Forceps Biopsy for Tissue Diagnosis in Complex Biliary Obstruction: A Consecutive Single-Center Study

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ABSTRACT

Objective: This study evaluated fluoroscopy-guided percutaneous endobiliary forceps biopsy (PEFB) for tissue diagnosis in complex biliary obstruction when no safe extraluminal biopsy target was available or when prior conventional tissue acquisition had been non-diagnostic.

Methods: This retrospective single-center study included consecutive patients who underwent PEFB between January 2024 and December 2025. PEFB was considered after multidisciplinary evaluation, when tissue diagnosis was required and conventional image-guided or endoscopic tissue acquisition was unavailable, unsuitable, or non-diagnostic. Procedures were performed under fluoroscopic guidance using an 8 French introducer sheath and disposable biopsy forceps. Outcomes included technical success, clinically interpretable tissue acquisition, final diagnosis, biopsy-guided management, and adverse events.

Results: Thirteen patients were included (median age 62 years; 9 women). A safe extraluminal biopsy target was absent in 12 patients; the remaining patient underwent rescue PEFB after two non-diagnostic core biopsies of a desmoplastic pancreatic/peribiliary mass. Five patients had prior endoscopic retrograde cholangiopancreatography-based evaluation, plastic stent placement, or non-definitive endoscopic sampling. PEFB was performed in 13 sessions, with 49 biopsy bites across 16 access-site sampling locations. Technical success and clinically interpretable tissue acquisition were achieved in all patients. Final diagnoses were malignant in eight patients, benign/inflammatory in four, and an intraductal papillary neoplastic lesion in one. PEFB findings guided subsequent management in all patients. No biopsy-related major adverse event occurred.

Conclusion: Fluoroscopy-guided PEFB may provide clinically actionable tissue in selected patients with complex biliary obstruction when conventional image-guided or endoscopic tissue acquisition is unavailable, unsuitable, or non-diagnostic.

Keywords: Bile duct obstruction, biopsy, cholangiocarcinoma, cholangiography, drainage, radiology, interventional

INTRODUCTION

Biliary strictures and complex biliary obstructions remain diagnostically challenging because benign inflammatory, postoperative, ischemic, autoimmune, and stone-related processes may mimic malignancy, whereas malignant obstruction may be infiltrative, intraductal, desmoplastic, or too small to form a discrete target for conventional percutaneous core biopsy.¹ This diagnostic overlap has direct clinical

consequences. In the absence of tissue diagnosis, decisions regarding surgery, systemic therapy, metal-stent-based palliation, steroid or anti-inflammatory treatments, therapy for benign strictures, or surveillance may be delayed, uncertain, or potentially misdirected. Although computed tomography (CT), magnetic resonance imaging (MRI)/magnetic resonance cholangiopancreatography (MRCP), positron emission tomography (PET)/CT, tumor markers, and multidisciplinary



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assessment are essential for defining disease extent and likelihood, they may not provide definitive benign-malignant discrimination in selected complex cases.¹⁻⁴

Several tissue acquisition strategies are available, including endoscopic retrograde cholangiopancreatography (ERCP)-guided brush cytology or forceps biopsy, endoscopic ultrasonography (EUS)-guided sampling, cholangioscopy-guided biopsy, conventional image-guided biopsy of an extraluminal lesion, and percutaneous transluminal/endobiliary forceps biopsy. Each approach has limitations. ERCP may be limited by altered anatomy, failed cannulation, proximal or hilar strictures, prior stenting, or non-diagnostic cytology. EUS-guided sampling is valuable for pancreatic, distal extrahepatic, nodal, or metastatic targets, but may be less suitable when the disease is duct-centered, hilar, postoperative, or not associated with a discrete extraluminal mass. Cholangioscopy-guided biopsy provides direct intraductal visualization and targeted sampling; however, it may not be available in all centers, may require additional equipment and expertise, and may be impractical in selected patients with altered anatomy, failed endoscopic access, complex biliary drainage needs, cholangitis requiring percutaneous decompression, or established percutaneous biliary access.⁴

Percutaneous transluminal forceps biopsy has shown favorable performance for suspected malignant biliary strictures, with high technical success and specificity in prior series and meta-analyses.⁵⁻¹⁰ Its practical value is most apparent when a patient already requires percutaneous biliary drainage or cholangiographic access and the suspected disease is intraductal, infiltrative, postoperative, stent-obscured, or radiologically occult. In that setting, the existing or clinically required percutaneous biliary access can be used as a direct intraluminal sampling pathway, avoiding the need for a separate extraluminal biopsy target such as a mass, lymph node, parenchymal lesion, or metastasis. Therefore, this study evaluated technical success, clinically interpretable tissue acquisition, diagnostic contribution, management impact, and adverse events associated with fluoroscopy-guided percutaneous endobiliary forceps biopsy (PEFB) in consecutive

patients with complex biliary obstruction when conventional image-guided or endoscopic tissue acquisition was unavailable, unsuitable, or non-diagnostic.

MATERIALS AND METHODS

Study Design and Patient Population

The study was approved by the Hacettepe University Health Sciences Research Ethics Committee (approval no.: SBA 26/195, decision no.: 2026/05-24, date: 03.03.2026), and the requirement for study-specific informed consent was waived because of the retrospective, archive-review design. Written procedural consent had been obtained for all clinically indicated biliary interventions.

This retrospective single-center study included all consecutive patients who underwent fluoroscopy-guided PEFB for complex biliary obstruction between January 2024 and December 2025. All completed PEFB procedures were included. One additional patient was referred for a planned PEFB, but biopsy was not performed because interval cholangiographic, imaging, and tumor-marker findings supported regression of the stricture; this patient was excluded from the analytic cohort.

PEFB was considered after multidisciplinary evaluation, when a tissue diagnosis was required and at least one of the following applied: absence of a safe extraluminal biopsy target on cross-sectional imaging; unavailable, failed, non-diagnostic, or unsuitable endoscopic sampling; altered postoperative anatomy limiting endoscopic access; need for biliary drainage or percutaneous cholangiographic access; or non-diagnostic conventional core biopsy despite persistent clinical suspicion.

A safe extraluminal biopsy target was defined as a mass-forming parenchymal lesion, nodal lesion, distant metastasis, or extraductal soft-tissue component that is visible on CT, MRI/MRCP, US, or PET/CT and suitable for conventional image-guided core biopsy. The absence of such a target did not indicate normal imaging, but rather the absence of a discrete lesion safely accessible for percutaneous core biopsy.

Preprocedural Assessment

Preprocedural assessment included clinical history (including prior malignancy or hepatopancreatobiliary surgery), previous endoscopic or percutaneous tissue sampling, laboratory parameters, tumor markers, and all available CT, MRI/MRCP, and PET/CT examinations. Imaging studies were reviewed by an abdominal radiologist with more than 15 years' experience to determine the level and morphology of obstruction, suspicious ductal or periductal findings, stent-related or postoperative anatomic considerations, vascular relationships, and the presence or absence of a safe extraluminal biopsy target.

All procedures were performed under sedation assisted by anesthesia after intravenous prophylaxis with ceftriaxone. A platelet count greater than 80,000/ μ L and an INR less than 1.5 were required; no patient required correction of coagulopathy before biopsy.

MAIN POINTS

- Complex biliary obstruction may lack a safe extraluminal biopsy target despite suspicious imaging, cholangiographic, laboratory, or clinical findings.
- Fluoroscopy-guided percutaneous endobiliary forceps biopsy provided clinically interpretable tissue in all 13 patients in this consecutive cohort.
- Biopsy findings guided subsequent management, including surgery, systemic therapy, stent-based palliation, management of benign or inflammatory strictures, modification of drainage strategy, and avoidance of oncologic escalation.
- PEFB may be useful as a complementary tissue acquisition strategy when percutaneous biliary access is already required or when conventional sampling is unsuitable or non-diagnostic.

PEFB Technique

All PEFB procedures were performed by an interventional radiologist with more than 10 years of experience in hepatobiliary interventions. The access route and sampling site were selected based on ductal anatomy, existing drainage access, cholangiographic findings, and correlation with cross-sectional imaging. Under fluoroscopic guidance, the target stricture or ductal segment was crossed with a hydrophilic guidewire (RADIFOCUS Guide Wire M; Terumo Corp., Tokyo, Japan). A 0.035-inch Amplatz Super Stiff guidewire (Boston Scientific, Marlborough, MA, USA) was positioned to secure biliary access. A second guidewire was advanced across or adjacent to the target segment, and an 8 French (8-F) Super Arrow-Flex introducer sheath (11- or 24-cm lengths; Arrow International, Inc., Reading, PA, USA) was introduced over this wire and advanced to the stricture or lesion site. The Amplatz wire was maintained alongside the sheath as a safety wire. After removal of the intraluminal guidewire from the sheath, disposable biopsy forceps (Micro-Tech, Nanjing, China) were advanced directly through the sheath lumen to the target segment.

Biopsy bites were obtained from the most suspicious portion of the ductal lesion based on cholangiographic morphology and preprocedural imaging. In patients with multifocal or multi-duct involvement, sampling was directed to the ductal sector or sectors considered most suspicious or clinically relevant. After biopsy, biliary drainage was maintained with either an internal-external or external drainage catheter according to the clinical drainage strategy. Definitive or adjunctive biliary interventions, including metal stent placement, endobiliary radiofrequency ablation, balloon dilatation, or further stent/drainage management, were performed in subsequent sessions when indicated after histopathologic review and multidisciplinary decision-making. This sheath-supported, safety-wire-preserved technique is conceptually related to the previously described percutaneous "cross-and-push" approach, in which the stricture is crossed and the sheath supports forceps advancement into the target lesion.¹⁰

Histopathologic and Cytologic Evaluation

Forceps-derived tissue fragments were fixed in formalin and submitted for histopathologic evaluation by a dedicated gastrointestinal/hepatobiliary pathologist with more than 15 years of experience. When feasible, additional material obtained with the forceps was smeared onto glass slides for cytologic evaluation, according to institutional practice. Cytologic assessment was used as a supportive adjunct and was not analyzed as a separate diagnostic test. Immunohistochemistry was performed when necessary to support a diagnosis, determine tumor origin, or evaluate inflammatory mimics, including IgG4-related disease. No rapid on-site cytopathologic or histopathologic adequacy assessment was performed during PEFB. Clinically interpretable tissue acquisition was defined as retrieval of sufficient tissue for the pathologist to issue a histopathologic interpretation, rather than a report of insufficient or absent tissue. PEFB histopathologic results were categorized as: malignant; suspicious/consistent with

malignancy; benign (inflammatory or fibrotic); neoplastic/premalignant intraductal papillary lesion; inconclusive; or non-diagnostic. A non-diagnostic result was defined as insufficient tissue or absence of interpretable lesional material.

Final Diagnosis, Clinical Impact, and Outcomes

The final diagnosis was determined using a composite reference standard that included surgical pathology when available, PEFB with immunohistochemistry, additional cytologic or histologic sampling, adjudication by a multidisciplinary tumor board, clinical course, tumor marker behavior, treatment response, and imaging follow-up. A Benign final diagnosis required surgical or pathologic confirmation, or clinical or imaging evidence of stability, regression, or absence of malignant progression during follow-up. For patients followed outside the institution, availability of local follow-up data was recorded. Clinical management impact was defined as any biopsy-guided confirmation or change in the treatment pathway, including surgery, systemic therapy, metal stent placement, benign stricture therapy, drainage, stent-strategy modification, steroid or anti-inflammatory treatment, avoidance of oncologic escalation, or follow-up-based management.

The primary outcomes were technical success and clinically interpretable tissue acquisition. Technical success was defined as the successful advancement of the forceps into the target biliary segment with acquisition of tissue. Secondary outcomes included final diagnostic category, number of biopsy bites, access-site sampling locations, biopsy-guided management, and adverse events. Adverse events were identified from procedural reports, inpatient records, laboratory data, imaging follow-up, and clinical notes and were attributed, when possible, to the biopsy maneuver, biliary access or drainage, catheter dysfunction, underlying disease, or unrelated causes. Events were classified according to the 2017 Society of Interventional Radiology adverse event reporting framework.¹¹ Major adverse events were defined as events requiring major therapy or unplanned escalation of care and resulting in permanent sequelae or death; these included clinically significant bleeding, hemobilia requiring intervention or transfusion, bile peritonitis requiring intervention, septic shock, or unplanned intensive care admission. Non-major events included self-limited or medically managed infectious, pain-related, or catheter-related events that did not require escalation of care.

Statistical Analysis

Analyses were descriptive because of the small sample size and the selected clinical characteristics of the cohort. Continuous variables are reported as median (range). Categorical variables are reported as counts and percentages. No formal comparative testing was planned. Sensitivity, specificity, and predictive values were not calculated because of the small cohort size, clinical heterogeneity, non-uniform composite reference standard, and the study's focus on feasibility, tissue acquisition, safety, and clinical actionability rather than on diagnostic accuracy testing. Descriptive statistics were generated using IBM SPSS Statistics for Windows, version 23.0 (IBM Corp., Armonk, NY, USA).

Use of Artificial Intelligence (AI)-Assisted Technologies

During the preparation of this manuscript, the authors used ChatGPT (OpenAI) for English-language editing and clarity. The authors reviewed and edited the manuscript as needed and took full responsibility for its content.

RESULTS

Patient Cohort and Diagnostic Context

Thirteen consecutive patients who underwent technically completed PEFB were included in the analysis. The median age was 62 years (range, 46-78 years), and nine patients were women. No completed PEFB procedures were excluded. One additional patient was referred for planned PEFB, but a biopsy was not performed because interval cholangiographic, imaging, and tumor marker findings supported regression of the stricture. Baseline clinical, imaging, procedural, and outcome data are summarized in Table 1. In 12 of 13 patients, no safe extraluminal percutaneous biopsy target was identified. The remaining patient had a large desmoplastic pancreatic or peribiliary mass, but two prior conventional core biopsies were

non-diagnostic, prompting PEFB as a rescue tissue acquisition strategy.

Five patients had prior ERCP-based evaluation, plastic stent placement, or endoscopic sampling without definitive tissue diagnosis. A representative case illustrating PEFB after non-definitive ERCP-based management is shown in Figure 1. Preprocedural MR/MRCP demonstrated suspicious or indeterminate ductal/periductal abnormalities in 10 patients. Diffusion restriction was present in five patients, all with final malignant diagnoses; however, three malignant cases lacked a diffusion-restricted target suitable for conventional core biopsy. PET/CT was available in five patients; in two of these the scans were negative or interpreted as inflammatory despite a final diagnosis of malignancy. Cancer antigen 19-9 (CA19-9) and cancer antigen 125 (CA125) were elevated or borderline elevated in nine of 12 patients with available tumor marker data. Imaging, PET/CT, and tumor markers were used to guide the indication for biopsy rather than to serve as independent predictors of malignancy. Biopsy targets were hilar, proximal hepatic duct, or hepaticojejunostomy/anastomotic in seven patients; distal or mid common bile duct/periapillary in five patients; and segmental intrahepatic in one patient.

Table 1. Cohort-level summary of indications, procedural characteristics, histopathologic outcomes, management impact, and safety

Domain	Variable	Result
Study cohort	Study design and period	Retrospective, single-center, consecutive study; January 2024-December 2025
	Patients included	13
	Completed PEFB procedures excluded	0
	Planned PEFB not performed	1; canceled because interval cholangiographic, imaging, and tumor marker findings supported regression
	Age	Median 62 years; range, 46-78
	Sex	9 women/4 men
Diagnostic indication	No safe extraluminal percutaneous biopsy target	12/13
	Rescue PEFB after non-diagnostic conventional core biopsy despite a mass	1/13
	Prior ERCP, plastic stent placement, or non-definitive endoscopic sampling	5/13
Preprocedural diagnostic context	MR/MRCP suspicious or indeterminate ductal/periductal abnormality	10/13
	Diffusion restriction on MRI	5/13; all had final malignant diagnoses
	Malignancy despite no diffusion-restricted target suitable for conventional core biopsy	3 patients
	PET/CT performed	5/13
	Focal or indeterminate peribiliary/hilar PET uptake	3/5
	PET/CT negative or interpreted as inflammatory despite final malignant diagnosis	2 patients
	Tumor marker data available	12/13
Target and access	CA19-9 and/or CA125 elevated or borderline elevated	9/12
	Biopsy target level	Hilar/proximal/HJ-anastomotic, 7; distal/mid CBD or periapillary, 5; segmental intrahepatic duct, 1
	Patient-level access route	Right-sided, 10; left-sided, 3
	Access-site sampling locations	16 total; right-sided, 13; left-sided, 3
	Multi-duct or multi-access sampling	2 patients

Table 1. Continued

Domain	Variable	Result
Procedure	Biopsy sessions	13
	Total forceps biopsy bites	49
	Bites per patient	Median 3; range, 3-6
	Biopsy during index biliary access session	1/13
	Delayed biopsy after biliary access/drainage	12/13
	Interval from initial biliary access/drainage to biopsy	Median 7 days; range, 0 days-6 months
	Interval among delayed biopsies only	Median 11 days; range, 5 days-6 months
	Technique	8-F Super Arrow-Flex introducer sheath and disposable Micro-Tech biopsy forceps
	Drainage after biopsy	Internal-external catheter, 10; external catheter, 3
Technical and histopathologic outcomes	Technical success	13/13
	Clinically interpretable tissue acquisition	13/13
	Immunohistochemistry	Performed when required for tumor characterization, tumor-origin confirmation, or inflammatory mimics
	Cytologic smear assessment	Performed when feasible as a supportive adjunct; not analyzed separately
	Final malignant diagnosis	8/13
	Final benign/inflammatory diagnosis	4/13
	Intraductal papillary neoplastic lesion	1/13
	Surgical pathology reference standard	2 patients
	Local imaging, clinical, or surgical outcome data available	11/13
Clinical impact	Outside follow-up after tissue diagnosis	2/13
	Management guided by PEFB findings	13/13
	Malignancy-directed management	Surgery, 2; systemic therapy and/or metal stent-based palliation, 6
	Benign/inflammatory management	Steroid or anti-inflammatory treatment, benign stricture therapy, drainage/stent strategy modification, or follow-up-based avoidance of oncologic escalation, 4
	Neoplastic/premalignant lesion management	Tissue diagnosis enabled continuation of management at an outside center, 1
Safety	Biopsy-related major adverse event	0
	Clinically significant bleeding or hemobilia requiring treatment	0
	Transfusion requirement	0
	Septic shock or unplanned ICU admission	0
	Procedure-related death	0
	Non-major access-, drainage-, or catheter-related events	4 non-major events; all managed without ICU admission, major intervention, or permanent sequelae

Cohort-level summary of diagnostic context, procedural characteristics, histopathologic outcomes, management impact, and safety. Data are presented as number of patients unless otherwise specified. A safe extraluminal biopsy target was defined as any of the following, each suitable for conventional image-guided core biopsy: a mass-forming parenchymal lesion, a nodal lesion, a distant metastatic lesion, or an extraductal soft-tissue component. Imaging findings, PET/CT uptake, and tumor markers were considered clinical triggers for PEFB rather than independent predictors of malignancy. Adverse events were, when possible, attributed to biopsy-related, biliary access/drainage-related, catheter-related, disease-related, or unrelated causes. No biopsy-related major adverse event occurred. CBD, common bile duct; ERCP, endoscopic retrograde cholangiopancreatography; HJ, hepaticojejunostomy; ICU, intensive care unit; MR/MRCP, magnetic resonance imaging/magnetic resonance cholangiopancreatography; PEFB, percutaneous endobiliary forceps biopsy; PET/CT, positron emission tomography/computed tomography.

Procedural Characteristics

PEFB was performed in 13 biopsy sessions, including 16 access-site sampling locations, because two patients underwent multi-duct or multi-access sampling. A total of 49 forceps biopsy

bites were obtained, with a median of 3 bites per patient and a range of 3-6.

Biopsy was performed during the index biliary access session in one patient and as a delayed procedure in 12 patients. The

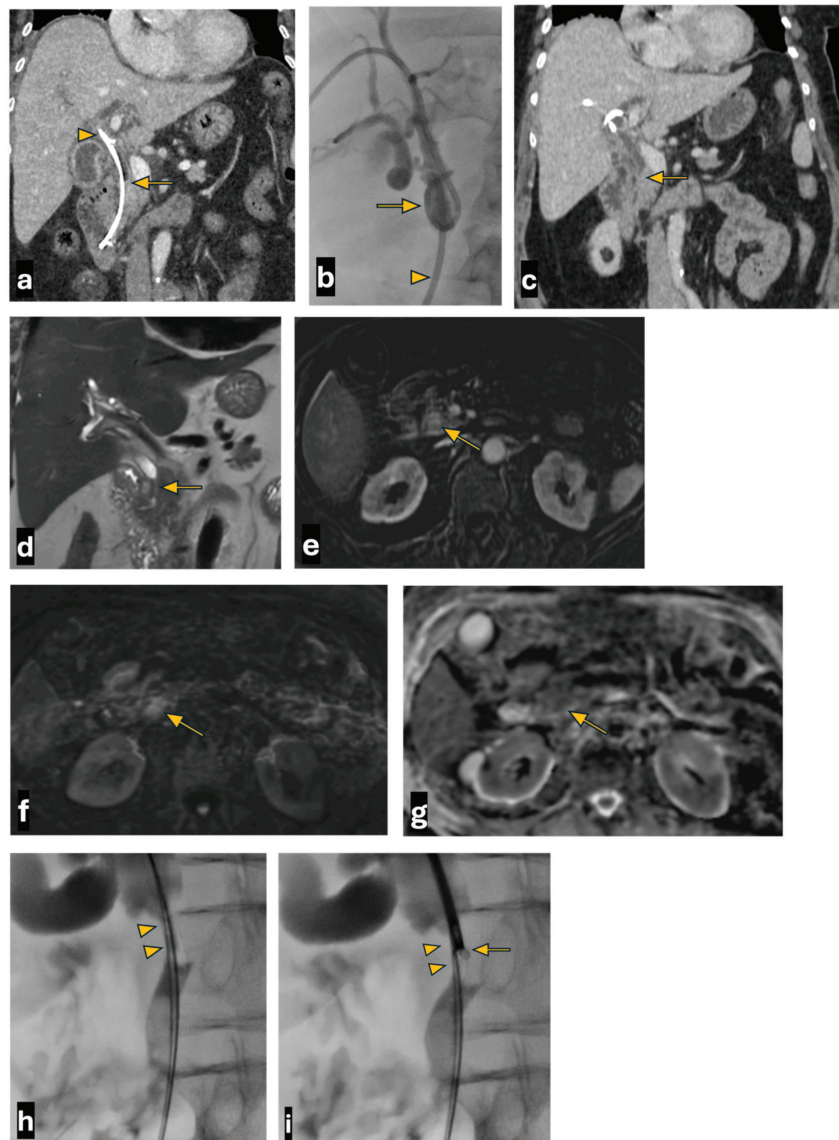


Figure 1. Representative PEFB case after non-definitive ERCP-based management.

A 78-year-old woman presented with cholangitis after ERCP with plastic biliary stent placement, but without a definitive tissue diagnosis. (a) Coronal CT shows the plastic biliary stent (arrowhead) and an abrupt distal common bile duct luminal cut-off with focal mural thickening (arrow). (b) Percutaneous cholangiography shows the external biliary drain (arrow) and plastic stent (arrowhead). (c) CT performed after biliary drainage and stent removal demonstrates persistent distal common bile duct narrowing or occlusion and wall thickening (arrow). (d) Coronal T2-weighted image shows narrowing/occlusion of the distal common bile duct. (e-g) Subtraction, diffusion-weighted, and ADC images demonstrate pathologic mural enhancement and restricted diffusion in the distal common bile duct lesion (arrows). (h) Cholangiography shows the target distal common bile duct stricture or occlusion. (i) Sheath-supported PEFB was performed from the stenotic segment; the arrow indicates the biopsy forceps, and the arrowheads mark the stricture. PEFB yielded histopathologic findings consistent with adenocarcinoma; Whipple pathology confirmed a biliary-type distal common bile duct adenocarcinoma.

ADC, apparent diffusion coefficient; CBD, common bile duct; CT, computed tomography; ERCP, endoscopic retrograde cholangiopancreatography; PEFB, percutaneous endobiliary forceps biopsy.

median interval from initial biliary access or drainage to biopsy was 7 days (range, 0 days to 6 months). Among delayed biopsies, the median interval was 11 days (range, 5 days to 6 months). All procedures were completed using an 8-F introducer sheath and disposable biopsy forceps. After the biopsy, biliary drainage was maintained with an internal-external catheter in 10

patients and an external catheter in three patients. Definitive or adjunctive biliary interventions were performed in subsequent sessions, when indicated, following histopathologic review and multidisciplinary decision-making. Technical success was achieved in all patients.

Histopathologic Findings and Clinical Outcomes

All 13 biopsy procedures yielded clinically interpretable tissue. Immunohistochemistry was performed when required.

Final diagnostic categories were malignant disease in eight patients, benign or inflammatory disease in four, and an intraductal papillary neoplastic lesion of the bile duct in one. Among malignant cases, PEFB demonstrated adenocarcinoma or malignant tissue consistent with cholangiocarcinoma in seven patients. In one patient with a large desmoplastic pancreatic/peribiliary mass and two prior non-diagnostic core biopsies, PEFB showed dysplasia and a dense desmoplastic inflammatory reaction; after immunohistochemical assessment and multidisciplinary tumor board review, the findings were interpreted as favoring adenocarcinoma in the clinical and imaging context. Accordingly, one of the eight final malignant diagnoses was established by multidisciplinary adjudication rather than by unequivocal malignant histopathology obtained by PEFB.

Two malignant diagnoses were confirmed by surgical pathology after the Whipple procedure. Benign or inflammatory diagnoses were supported by pathology, clinical course, tumor marker behavior, treatment response, and follow-up imaging that showed no new or progressive malignant lesions. Local imaging, clinical, or surgical outcome data were available for 11 patients; two patients continued follow-up outside the institution.

PEFB findings guided subsequent clinical management in all patients. Tissue diagnosis supported decisions regarding surgery, systemic therapy, metal stent placement, combined oncologic and biliary palliation, steroid-based therapy or benign stricture therapy, drainage/stent strategy modification, or avoidance of oncologic escalation during follow-up.

Safety

No biopsy-related major adverse event occurred. There were no clinically significant bleeding events, hemobilia requiring treatment, transfusion, bile peritonitis requiring intervention, septic shock, unplanned intensive care admission, or procedure-related death. Four non-major access-related, drainage-related, or catheter-related events occurred: early cholangitis after initial biliary access/drainage, mild postprocedural leukocytosis treated with antibiotics, non-abscessed tract/cutaneous cellulitis, and catheter dislodgement-related segmental cholangitic changes. All events were managed without intensive care admission, major intervention, or permanent sequelae.

DISCUSSION

The principal finding of this consecutive single-center study was that fluoroscopy-guided PEFB provided technically successful and clinically interpretable tissue acquisition in all patients with complex biliary obstruction requiring tissue diagnosis. Most patients lacked a safe extraluminal target for conventional image-guided core biopsy; one patient underwent PEFB after two non-diagnostic core biopsies, despite the presence of a desmoplastic pancreatic/peribiliary mass. PEFB findings guided subsequent clinical management in all patients, and no major biopsy-related adverse events occurred.

The practical value of PEFB in this cohort was related to the diagnostic setting rather than to technical novelty. These were not routine mass-forming biliary tumors with straightforward biopsy targets. Most patients had duct-centered, infiltrative, postoperative, stent-associated, or radiologically occult disease; several had undergone prior ERCP, plastic stent placement, non-definitive endoscopic sampling, or non-diagnostic conventional core biopsy. In this context, tissue-related uncertainty directly affected multidisciplinary decisions regarding surgery, systemic therapy, metal stenting, therapy for benign strictures, steroid-based treatment, drainage strategy, or surveillance. PEFB provided histologic tissue from the ductal abnormality via the existing or clinically required percutaneous biliary route.

These findings are consistent with prior literature supporting percutaneous transluminal forceps biopsy as a feasible and highly specific technique for malignant biliary strictures. Jeon et al.⁷ reported pooled sensitivity of 81%, specificity of 100%, and technical success of 100% in a meta-analysis of 14 studies including 1762 patients. Fohlen et al.⁶ reported successful drainage and tissue sampling in all 50 patients undergoing percutaneous transluminal forceps biopsy during biliary drainage, with 100% specificity. Augustin et al.,¹² in a 13-biopsy cohort similar in size to the present study, reported 100% technical success and adequate histopathologic material in 12 of 13 biopsies. Liu et al.¹³ reported 100% technical success, 82.35% sensitivity, 100% specificity, and 86.05% accuracy for percutaneous intraluminal forceps biopsy after ERCP failure. The present study differs from these broader suspected malignancy cohorts by focusing on a selected clinical scenario: tissue acquisition when imaging did not show a safe extraluminal biopsy target or when prior tissue sampling was non-diagnostic.

This problem remains clinically relevant despite the increasing role of cholangioscopy-guided biopsy. Cholangioscopy permits direct intraductal visualization and targeted biopsy, but it may not be available in all centers and may be impractical in selected patients with altered postoperative anatomy, failed or non-diagnostic ERCP, complex hilar drainage requirements, cholangitis requiring percutaneous decompression, or established percutaneous biliary access.⁴ This role should therefore not be interpreted as competing with cholangioscopy-guided biopsy, but rather as complementary in situations where percutaneous biliary access is already required, or where endoscopic/cholangioscopic sampling is not feasible or has not provided a definitive diagnosis.

The clinical contribution of PEFB in this cohort extended beyond confirming malignancy. Benign and inflammatory tissue diagnoses also guided management by supporting steroid or anti-inflammatory treatment, providing benign stricture therapy, modifying drainage or stent strategies, and avoiding unnecessary oncologic escalation. Similarly, in malignant cases, PEFB guided surgery, systemic therapy, metal stent-based palliation, or combined oncologic and biliary management. Because PEFB provides forceps-derived tissue fragments suitable for routine histopathology and immunohistochemistry, it may provide information beyond cytology alone, including confirmation of tumor origin and evaluation of inflammatory mimics.

Most biopsies in this cohort were performed as delayed procedures after biliary access or drainage. Prior studies have reported greater diagnostic yield when bilirubin levels are lower and sepsis is absent.^{14,15} The present observations are consistent with a selective, staged approach in clinically complex patients, but they do not establish superiority of delayed biopsy over same-session biopsy because timing was not assigned or compared.

Technical factors may have contributed to the high tissue acquisition rate. The procedure employed an 8-F sheath-supported approach, incorporating disposable forceps, direct cholangiographic targeting, imaging correlation, and preservation of biliary access with a safety wire. This approach is related to the "cross-and-push" technique described by Patel et al.,¹⁰ which was associated with improved sensitivity and accuracy in suspected malignant biliary strictures. Inchingolo et al.¹⁶ described a dedicated forceps system using a sheath-supported cross-and-push technique, reporting high diagnostic accuracy and no major complications. Because a small sample size and crush artifacts are recognized limitations of forceps biopsy, adjunctive cytologic assessment may be useful in selected cases. Boos et al.¹⁷ reported that tandem brush cytology and forceps biopsy improved sensitivity compared with either method alone, with preserved specificity. In the present cohort, cytologic smears from forceps-derived material were used only as an adjunct and were not analyzed as a separate diagnostic test.

No biopsy-related major adverse event occurred. The non-major events observed in this cohort were attributable to biliary access or drainage, catheter dysfunction, or the access tract, rather than to the biopsy maneuver itself. This distinction is important because patients undergoing biliary intervention frequently have cholangitis, severe cholestasis, prior instrumentation, complex drainage needs, or tumor-related obstruction. Published series report low but non-negligible rates of hemobilia, bile leak, infection, and other adverse events after percutaneous biliary biopsy.^{6,7} Careful event attribution is necessary when evaluating the safety of PEFB in this population.

Study Limitations

This study has limitations. It was a retrospective, single-center study that included a small, highly selected cohort. The population was heterogeneous, including patients with primary biliary malignancy, metastatic disease, postoperative strictures, inflammatory mimics, intraductal tumor progression, and one desmoplastic pancreatic/peribiliary mass with prior non-diagnostic core biopsies. Sensitivity, specificity, and predictive values were not calculated because the study was not designed as a diagnostic accuracy trial and final diagnoses were based on a composite reference standard rather than uniform surgical pathology. One malignant diagnosis required multidisciplinary adjudication because of dysplasia and a dense desmoplastic inflammatory reaction on PEFB. Two patients continued follow-up outside the institution. Finally, forceps biopsy has intrinsic limitations, including small sample size, crush artifact, and lack of direct visual targeting compared with cholangioscopy-guided biopsy. Emerging techniques such as percutaneous cholangioscopy-guided biopsy and endobiliary

cryobiopsy may improve targeting or sample quality but require additional equipment, expertise, and validation.^{18,19}

CONCLUSION

Fluoroscopy-guided PEFB may provide clinically actionable tissue in selected patients with complex biliary obstruction when conventional image-guided or endoscopic tissue acquisition is unavailable, unsuitable, or non-diagnostic. Its most defensible role is as a complementary problem-solving technique in patients who already require percutaneous biliary access or who lack a safe extraluminal biopsy target.

Data Availability

The data underlying this article cannot be shared publicly because of patient privacy and institutional restrictions. De-identified data may be made available from the corresponding author upon reasonable request and subject to institutional approval.

Ethics

Ethics Committee Approval: This study was approved by the Hacettepe University Health Sciences Research Ethics Committee (approval number: SBA 26/195, decision no.: 2026/05-24, date: 03.03.2026).

Informed Consent: The requirement for study-specific informed consent was waived owing to the retrospective archive-review design. Written procedural consent had been obtained for all clinically indicated biliary interventions.

Footnotes

Author Contributions

Concept Design – A.U., E.Ü.; Data Collection or Processing – A.U.; Analysis or Interpretation – A.U.; Literature Review – A.U.; Writing, Reviewing and Editing – A.U., E.Ü.

Declaration of Interests: The authors declare no conflict of interest.

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