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Research Article

Percutaneous Endoluminal Forceps Biopsy in Cholangiocellular Carcinoma – A Perspective Approach to Timeliness of Diagnostic Confirmation Using Two Scenarios

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1. Abstract

1.1. Aim: To assess the benefits of performing endoluminal forceps biopsy during initial drainage compared to postponed biopsy using two patient management scenarios.

1.2. Methods: Since 2006, 101 consecutive patients with malignant biliary stenosis due to cholangiocellular carcinoma have been followed up. All patients underwent a percutaneous biliary drainage (PBD) procedure and endoluminal forceps biopsy to obtain histological verification of stenosis. The cumulative success rate, complication rate, time needed to obtain diagnosis, and procedural costs were studied in two scenarios. In the first scenario, 59 patients underwent percutaneous drainage first and after 1–40 (median 7) days, had a postponed biopsy using multi-use 7.5F biopsy forceps. In the second scenario, 42 patients underwent percutaneous drainage and successive biopsy in a single, combined procedure using 5.2F disposable biopsy forceps.

1.3. Results: Interventions with a single-procedure PBD biopsy were not associated with a higher rate of complications. The cumulative success rates of endoluminal biopsy in both scenarios were 81% and 76%, respectively. The average time needed to obtain a conclusive biopsy specimen from the time of initial drainage were 47 days and 10 days ($p = 0.002$). Patients undergoing endoluminal biopsy with the 5.2F forceps benefited from 2,1 fewer percutaneous interventions on average ($p< 0.001$) and procedural expenses per patient were on average 1.84 times lower ($p< 0.001$).

1.4. Conclusion: Percutaneous forceps biopsy is a safe procedure even when performed during initial drainage. Its success rate is comparable to that of the postponed biopsy procedure, meanwhile malignancy is determined significantly sooner and healthcare expenses are significantly lower.

2. Key words: Forceps biopsy; Biliary biopsy; Percutaneous drainage; Biliary malignancy; Cost analysis

3. Abbreviations: PBD:Percutaneous Biliary Drainage; ERCP:Endoscopic Retrograde Cholangiography**;** F: French**;** PTBD:Percutaneous Transhepatic Biliary Drainage

4. Core Tip

Percutanous endoluminal forceps biopsy for histological proof of cholangiocellular carcinoma performed during initial drainage with 5.2 F forceps compared to postponed biopsy with 7.5 F forceps benefited from shorter time to definitive diagnosis, lower number of interventions, and heathcare savings. At the same time there was no significant difference in sentitivity and complication rates in both study groups.

5. Introduction

In more than half of all cases of patients with suspected biliary malignancy undergoing percutaneous biliary drainage (PBD), histopathological confirmation is not available at the time of the initial drainage. Non-invasive imaging techniques can precisely determine the level of obstruction, but are unable to provide a definitive histological diagnosis[1]. Early confirmation of malignancy may be important for the influence and direction of patient care, especially in the pursuit of oncological therapy. Thus, the earliest reasonably possible determination regarding malignancy is important because of potential implications for patient plan of care.

Brush cytology and endoluminal forceps biopsy can be used during PBD for diagnostic analysis of malignancy. However, brush cytology used during PBD has low sensitivity (generally reaching 30-40%), is highly dependent on the experience of the pathologist involved, and results in a significant number of atypical or inconclusive findings [2,3], while the sensitivity of forceps biopsy ranges from 40% to 90% [4-7]. Thus, endoluminal forceps biopsy is a preferred modality for obtaining specimens for histopathological analysis. However, the optimal timing for biopsy is not yet clear, as it can be performed several days after the initial drainage procedure, after normalization of hyperbilirubinemia and predilatation of the trans hepatic tract, or performed at the time of the initial drainage procedure.

Furthermore, the size of the biopsy forceps must be considered due to potential risks for the patient. Using a routine 7.5F biopsy forceps with an 8-9F sheath during initial drainage requires insertion of instruments with an outer diameter of 10-11F, thereby creating a potential risk of liver laceration and bleeding [8]. This could be avoided by using a smaller size biopsy forceps (5.2F) and thereby collecting a proportionately smaller biopsy specimen. The reduced size of the biopsy forceps influences their precise mechanical construction, and thus are more commonly available only as single-use (i.e. disposable) devices.

This is a combined analysis of retrospective and prospective nature, in which we compared the sensitivity of definitive diagnosis obtained from endoluminal forceps biopsy between multi-use 7.5F biopsy forceps performed at a postponed interval and disposable 5.2F biopsy forceps performed subsequent to percutaneous biliary drainage.

6. Material and Methods

6.1. Study design

The study was a comparative combined retrospective and prospective study consisting of consecutive patients referred to our department between January 2006 and September 2017 for biliary tract stenosis requiring intervention and histological evaluation of the stenosis. Included were patients with cholangiocellular carcinoma infiltrating liver hilum which were not able to undergo curative surgery and duodenobilliary drainage via ERCP was unsuccessful or failed. All patients underwent a percutaneous biliary drainage procedure and endoluminal forceps biopsy for further histological analysis. Patients were included in the study if they were confirmed to have cholangiocellular carcinoma (confirmed via endoluminal or percutaneous biopsy, imaging methods follow up or autopsy – **Table 1**) and were excluded if they were confirmed to have biliary stenosis of other causes, including other malignant biliary lesions, such as pancreatic or hepatocellular carcinoma and benign lesions. Written consent was obtained from all patients and the study was approved by the Institutional Review Board.

The primary objective of the study was to assess and compare the success of an endoluminal biopsy in confirmation of malignant pathology along with their respective complication rates according to the endoluminal biopsy technique employed for sampling. Patient management was stratified into two different scenarios (A or B) based on the timeframe in which a biopsy was performed, i.e., postponed or periprocedural biopsy. The frequency of complications was also evaluated between the groups. A secondary objective was a rough cost comparison between the two patient management scenarios to assess if there may be any appreciable cost difference between the costs of sampling.

Table 1 Basic characteristics

Endoluminal biopsy 7.5F	48	81,4%	7	16.7%	
Endoluminal biopsy 5.2F	2	3.4%	25	59.5%	
Imaging follow-up	5	8,5%	9	21.4%	
Percutaneous CT-guided biopsy	3	5.1%	0	0.0%	
Autopsy	1	1.7%	1	2.4%	
	Average (SD)	**Median (min–max)**	**Average (SD)**	**Median (min–max)**	***P value***
Time from initial drainage to biopsy (days)	10 (10)	7 (1-40)	0	0 (0)	
Total number of procedures	2,7 (1,0)	2 (2-7)	1,3 (0,9)	1 (1-5)	**<0,001**

In scenario A (n = 59), patients who underwent an initial PBD drainage were biopsied between 1–40 days after the initial drainage procedure using a 9F sheath and 7.5F biopsy forceps. Patients in scenario B (n = 42) underwent a concurrent biopsy using a 5.2F biopsy forceps at the time of the initial drainage procedure. Patients who underwent percutaneous biliary drainage before 2014 were evaluated retrospectively, while patients who underwent the procedure after 2014 were assessed prospectively.

Prior to 2014, the procedural standard in our department was to obtain biopsy after the initial drainage procedure, as in scenario A. From 2014 onward, the possibility to perform an endoluminal forceps biopsy during initial drainage was established, as in scenario B. Therefore after 2014, patients were preferentially managed under scenario B if the patient and clinician agreed to the biopsy and if the external-internal drainage was possible. Biopsy collection was only delayed if the initial external-internal drainage was not successful or if the biopsy was not initially demanded (e.g. patient was referred from another hospital).

In the event that an operator was unsuccessful in passing through a stenosis in a patient assigned to scenario B (n = 5), a 6F external drain was inserted for a short period of time (median 2 days) and the biopsy was postponed. The patient was then assessed under patient management scenario A. The constitution of patients associated with a particular scenario (A or B) and the procedural details are described in Appendix A. Demographic parameters, definitive confirmation of malignancy, and histopathological diagnosis are shown in **Table 1**.

Statistical analysis standard statistics were used in the descriptive analysis of patients. Categorical values were described by absolute and relative frequencies. For the statistical analyses of success rate between the two procedural scenarios, Fischer's exact test and the Mann-Whitney test were applied. Due to the retrospective nature of results obtained between 2006 and 2013 and the prospective aspect of data obtained after 2014 for scenario A, both sets of results were compared for statistically significant differences.

Comparison of costs was performed by assessing costs from the health-care provider's perspective. When comparing material and procedural costs, only patients who underwent the initial drainage procedure in the last 5 years of the study (2012-2017) were included. In the event of an unsuccessful biopsy, neither the cost of the imaging study nor the cost of the follow-up intervention other than endobiliary biopsy were included. Because of the comprehensive treatment protocol in patients with biliary stenosis and significant differences in patient management, hospitalization was not included in the cost of the procedure.

The level of statistical significance in all analyses was set at $\alpha = 0.05$. All alternative hypotheses were two-sided. Analyses were performed using IBM SPSS Statistics 23 (IBM Corporation, Armonk, NY, USA).

7. Results

Between January 2006 and September 2017, 294 endoluminal forceps biopsies were performed on 207 individual patients with biliary tree stricture in our department. If the patient was proven to have malignant biliary stenosis due to cholangiocellular carcinoma not suitable for curative surgical treatment, then was enrolled in the study. Our population included 101 consecutive patients, and 152 endoluminal forceps biopsies were performed in this population (**Figure 4**). Excluded from the analysis were patients with benign biliary stenosis (n = 28), pancreatic carcinoma (n = 42), liver metastasis (n = 9), hepatocellular carcinoma (n = 13), and patients with other tumours or otherwise unknown malignancy (n = 14), for a total of 106 patients excluded. Patients treated according to scenario A (n = 59) underwent a postponed biopsy while patients treated according to scenario B (n = 42) underwent biopsy following drainage.

7.1. Diagnostic performance between scenario A and B

In total, the confirmation of malignancy with endoluminal biopsy was successful in 81% and 76% of patients in scenarios

A (n = 59) and B (n = 42), respectively, a difference that was not shown to be statistically significant (p = 0,56). Table 2 details the percentages of successful sampling by endoluminal forceps. The sensitivity of biopsy using the 7.5F biopsy forceps was 47.5% (48/101 biopsies) in scenario A, while usage of the 5.2F biopsy forceps in scenario B yielded a sensitivity of 59.5% (25/42 biopsies). This difference was also not significant (p = 0.19). Patients in scenario A from the year 2014 (n = 16) and between the years 2006 – 2013 (n = 43) did not differ significantly in any of the evaluated parameters: biopsy sensitivity (81.8% vs. 80%, p = 0.85), number of biopsies for diagnostic confirmation per patient (1.73 vs. 1.67 p = 0.76) and diagnostic confirmation on first biopsy (53% vs. 45%, p = 0.6). Based on these figures, the prospective and retrospective results of the overall study period (2006–2017) for both groups of scenario A were included in the study and further analysed.

The mean time from initial drainage to biopsy in scenario A was 11 days with a median of 7 days (range of 1–40 days). Fewer interventional procedures to obtain a conclusive biopsy specimen were found to be needed in scenario B than scenario A, with the number of procedures at 1.4 ± 0.9 and 2.6 ± 1.0, respectively (p < 0.001). Scenario B was also found to have a significantly shorter time to obtain a conclusive biopsy from the time of initial drainage, with a median time of 0 days compared to the 20 days for scenario A (p = 0.006). Thus, patients undergoing endoluminal biopsy with the 5.2F forceps benefited from fewer percutaneous interventions as well as reduced time to diagnosis by approximately 20 days.

Irrespective of the patient management scenario (A or B), if endoluminal biopsy attempts failed twice, the patient was referred to percutaneous core-cut biopsy, open surgical techniques, or biopsy under endoscopic guidance based on the decision of the multidisciplinary tumour board. However, endoluminal techniques followed in parallel. Malignant aetiology of biliary stenosis was confirmed by autopsy in 2 patients (2%), by biopsy under CT guidance in 3 patients (3%), and in 14 patients (14%) by radiological follow-up with clear progression of malignancy involving bile ducts after 6 months or longer.

7.2. Procedural complications and mortality

Intervention which utilized the successive PBD/biopsy procedure was not associated with a higher rate of complications, and no complications requiring emergency surgery or blood transfusion such as life-threatening biliary bleeding were observed during the study period. Complications not related to endobiliary sampling, such as bilioma formation, pain, and sensation at the point of drain insertion did not differ between the scenarios and were reported as very rare in scenario B (2/42 patients [4.7%]).

Major deterioration in patient status within 30 days after biopsy was observed in 5 patients (8%) and 3 patients (7%) in scenarios A and B, respectively (p = 0.81), mainly due to hepatorenal failure. There was no significant difference in 30-day mortality - 2/42 patients [4.8%] (scenario B) vs. 1/59 patients [1.7%] (scenario A), p = 0.37.

8. Cost Comparison

A brief cost comparison between the two-step (scenario A) and single-step (scenario B) biopsy method over the period of 2012–2017 (cost comparison period) is shown in Table 3 and Figure 3. No significant difference was found in either the overall biopsy sensitivity during this time interval (77% vs. 76%, p = 0.88) or in the cost of material per patient ($1450 USD vs. $1235 USD, p = 0.2) between the scenarios. However, both service costs and total periprocedural costs per patient were found to be significantly lower in a single-step procedure over the two-step procedure, with service costs in scenario A averaging $1209 USD versus scenario B at $656 (p < 0.001), and total periprocedural costs per patient averaging $2658 USD in scenario A and $1891 USD in scenario B (p = 0.01). Scenario B additionally benefited from a shorter hospitalization period associated with bile duct biopsy procedures (scenario A 35 days, scenario B 21 days, p = 0.006).

From an overall perspective, the combined costs of materials and services were significantly lower for the single-step approach than for the two-step approach, but the material cost alone did not trend toward any statistically significant difference (mean difference $52.70 USD). The average cost of a short hospitalization (2–3 days) in patients undergoing percutaneous biopsy without any diagnostic or therapeutic workup was $3881 USD.

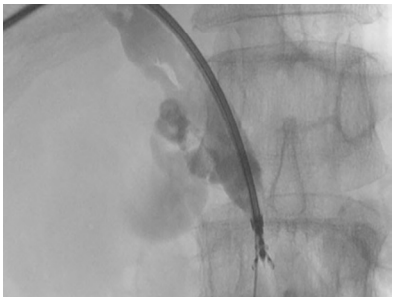

Figure 1: Endoluminal biopsy 10 days after initial drainage procedure (7.5F multi-use biopsy forceps, 9F sheath).

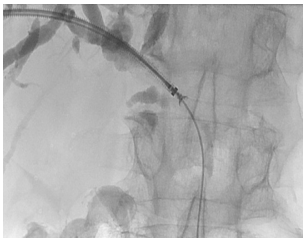

Figure 2 Endoluminal biopsy (5.2F disposable biopsy forceps, 7F sheath).

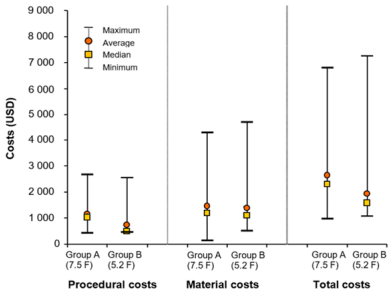

Figure 3 Comparison of costs for services, materials, and total cost per care episode according to the method of biopsy in patients having the first procedure in the years 2012–2017

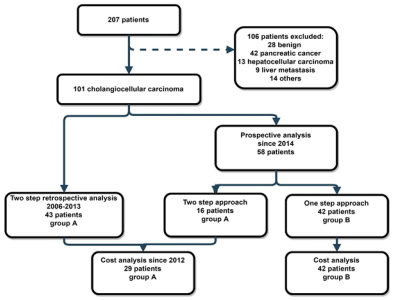

Figure 4. Graph showing selection of enrolled patients

9. Discussion

Percutaneous endobiliary biopsy plays a role for a potential surgical candidate as well as for non-operable patients prior to palliative treatment such as chemotherapy, radiotherapy, or metal stent insertion. Transluminal sampling of malignant lesions of bile ducts using forceps has been a well-established technique for more than 35 years [9]. Since 1980, the technology has evolved from fluoroscopy through percutaneous endoscopy to endomicroscopy. The miniaturisation of tools over time offered further possibilities for visualisation and manipulation within the endoluminal tracts [10,11].

Despite the evolution of diagnostic techniques, the basic underlying principle has remained unaffected—safety and efficiency are prioritised. However, speedy and timely diagnostics are another important attribute that should be taken into account. Therefore, in the case of biliary tract intervention, it is worth questioning whether catheter-induced chronic biliary inflammation in long-term percutaneous biliary drainage may compromise histopathological evaluation of biopted tissues.

In our hospital, the institutional approach is to firstly perform PBD when a patient was considered to have a high level of bile duct stenosis (i.e., reaching the hilum) and biopsy through PBD is also performed in patients when endoscopic drainage procedures were not successful.

In our series, the overall sensitivity for confirmed diagnosis by endoluminal forceps biopsy was nearly 80% (76%–81%), meaning that one-fifth of the patients could not be histologically verified by more than three attempts of forceps biopsy. Moreover, two patients needed to undergo more than four procedures of endoluminal sampling to prove malignancy. In cases which present with complications, alternative endoluminal sampling procedures which preserve precision should be considered. Cholangioscopy could be such an alternative, as it is a safe and effective procedure when performed by an experienced interventional specialist [10].

The sensitivity of endoluminal biopsy at 47.5% using 7.5F biopsy forceps and 59.5% with 5.2F biopsy forceps lies at the lower level of values described in literature. Ierardi analysed 40 patients undergoing percutaneous biopsy with 7F pliers and achieved a sensitivity of 85%[12]. However, half of the patients reported as benign underwent biopsy in a delayed procedure with very short follow-up (3 months) to establish a definitive diagnosis.

A larger cohort of 80 patients treated in the years 1992–1999 was described by Rossi et al. [6]. All presented patients had biliary stenosis of uncertain nature without clear tumorous mass on pre procedural imaging. These authors compared cytological brushing and forceps biopsy using 5F flexible forceps under endoscopic guidance using 5 mm cholangioscope. At a sensitivity of 92.1%, these results favour forceps biopsy, although the use of a cholangioscope required track dilatation through the insertion of an 18F sheath during the procedure.

The largest study focused on predictive factors of percutaneous biopsy was conducted by Jung et al.[13]. Overall sensitivity with 5.4F forceps was 78.4%, with significantly higher values in the subgroup of patients with cholangiocarcinoma. Seventy-five percent of those patients underwent biopsy during the initial drainage, while the remaining patients underwent biopsy shortly after the initial procedure (with an average waiting time of 4 days).

Patel achieves sensitivity of more than 93% using the so-called "cross and push" technique with 5.2F biopsy forceps (14). This technique is known since 2015 and therefore was limitedly used in our study population. However, the use of this technique could potentially contribute to the higher cost-effectiveness of using 5.2 F bioptic forceps if applicable in all patients.

A non-significant difference in biopsy sensitivity was observed with 5.2F disposable forceps (47.5 % vs 59.5 %), despite the fact that a smaller instrument size could potentially negatively affect the results. On the other hand, Lim et al. found a higher quality

of samples obtained by disposable forceps, and found that the higher purchase price of reusable forceps with the cost of reprocessing exceeded the price of disposable ones [15].

Bourguignon et al. calculated, from the Western European perspective, the cost of reusable forceps as 1.5 to 2.3 times lower than the disposable ones [16]. However, it must be considered that reusable forceps may expose patients to cross-contamination or transmission of infection[15-17]. Furthermore, all of the above studies limit the cost analysis to less costly gastrointestinal endoscopy techniques, as opposed to the costly percutaneous drainage procedures analysed in our study. In these studies, neither sensitivity differences in diagnosis nor the cost of other procedures leading to the diagnosis were calculated.

The higher material costs in connection to the utilization of disposable 5.2F biopsy forceps are fully offset by the fewer number of interventions (i.e., lower service costs), and generate savings of more than $750 USD per patient. The greatest benefit for patients lies in the significantly shorter time to diagnosis of malignancy.

Patients in scenario B also benefited from shorter hospitalisation periods associated with bile duct biopsy procedures than patients in scenario A (21 days vs. 35 days, respectively), but this result should be taken with reservations due to many possible side factors (e.g. comorbidities, complications, patient desired to go home, etc.). Total periprocedural hospitalization costs were also not included in the analysis for the same reason.

If the costs of hospitalisation had been included in the analysis, a different situation could be expected. However, the complex diagnostic and therapeutic processes involving mostly acute and elderly patients with malignancy comprising the bile ducts result in extremely different initial hospitalisation costs (USD $3500–$15000 in our hospital). As a result, inclusion of these procedures (e.g. ERCP, surgery, US and CT examination) into the analysis would prevent proper assessment of biliary sampling costs. All economic results are limited to a distinct/specific European region; therefore, generalisations should be made with caution.

Complications associated with endobiliary sampling by forceps include creation of false passages leading to potential bile leakage, cholangitis, pancreatitis, and hemobilia - all of which are reported at very low levels not exceeding 3% [6,18]. Reported complications notwithstanding, mild hemobilia immediately post-procedure is rarely reported despite being quite common because it usually resolves quickly. Greater morbidity is attributed to the drainage procedure rather than the forceps biopsy; Tapping et al. reported no increase in morbidity or mortality due to biopsy or cytological sampling [19]. None of our patients required blood transfusions in our series.

The complication rate of PTBD from previous studies ranges between 8 and 42% (20) and the 30-day mortality rate ranges between 2 and 19.8% [19,21]. The overall complication rate (11,9%) and mortality rate (1,7% and 4,8%) of the present study is comparable to these.

Between 2006 and 2013, all patients referred to our department were managed according to scenario A (postponed biopsy). In 2014, it became procedural standard in our department to biopsy at the same time as initial drainage, and thus patients were preferentially managed as per scenario B if the patient and clinician agreed to the two-step procedure, unless some circumstance occurred in which prevented periprocedural biopsy. Therefore, from the year 2014, delayed endoluminal forceps biopsy as per scenario A was performed only in cases where initial external-internal drainage was not successful, or in the event that a biopsy was not initially demanded. Patients under these situations were consequently moved into scenario A (n = 16), and all results from 2014 were prospective (42 patients in scenario B). In addition, in an attempt to reduce statistical bias by combining retrospective and prospective data, the retrospective results from scenario A in 2006-2013 were compared to the prospective results obtained from scenario A after 2014 (Figure 4).

In an ideal scenario, in the two-step biopsy procedure, a biopsy specimen would be obtained after an approximate period of 1 week, allowing for puncture track maturation. Our histopathologist required a 1 to 2 weeks analysis period per specimen, and repeat specimens in the event of inconclusive sampling were obtained after a minimum waiting period of 7 days- a time limitation that was set by the need for time in between samples. This shed more light on the importance of high sensitivity in endoluminal sampling, because any unsuccessful attempt leads to prolongation of the period of hospitalisation and postponement of definitive diagnosis.

In scenario B, endobiliary forceps biopsy during the initial drainage determined cholangiocellular carcinoma histologically in 59.5% of patients. The patient management was delayed only by the time of mentioned histopathological analysis, which should be consistent with the recovery time of a patient undergoing percutaneous procedure and relief of jaundice.

In summary, endoluminal biopsies using 5.2F disposable forcepses during initial drainage procedures generate savings from the health-care provider's perspective in all situations. Delay in obtaining histopathological proof of malignant biliary stenosis affects medical care. In particular, it extends hospitalization time, reduces the catheter-free period, and shortens the period of chemotherapy treatment. By comparison, performing repeated endoluminal biopsies or other sampling techniques to obtain histology verifications may affect quality of life and the cost of

treatment.

10. Conclusion

Percutaneous forceps biopsy during initial drainage is a safe procedure, provides high accuracy in diagnosing cholangiocellular carcinoma, and has a success rate comparable to that of a postponed biopsy. Contrary to the general concept that reusable instruments are cost-effective, our study may indicate that a single-step procedure with disposable forceps may significantly reduce costs. The overall benefit for both patients and physicians lies in the substantially shorter time needed to establish histopathological diagnosis as well as lower number of procedures. Our results suggest that this approach could be considered as a new standard in the future for the assessment of indefinite biliary stenosis in patients undergoing percutaneous transhepatic drainage.

11. Appendix A

11.1. Study scenarios and endoluminal sampling techniques

In study scenario A, 59 patients underwent biopsy 1–40 days after the biliary drainage procedure. The procedure was performed under local anesthesia and analgosedation (intravenous administration of Fentanyl (Janssen-Cilag GmbH, Neuss, Germany); Midazolam (Midazolam Torrex, Chiesi Pharma GmbH, Austria) as well as subcutaneous administration of Trimecain hydrochloride (Mesocain, Zentiva (Sanofi-Aventis), Czech Republic). Throughout the procedure, oxygen saturation, heart rate, respiratory rate and blood pressure were monitored.

For initial drainage, a 21G Chiba needle was used to puncture the bile duct (AccusStick II Introducer system, Boston Scientific, Marlborough, MA, USA or Aprima Acces Set NPAS-104, Cook Inc., Bloomington, IN, USA). Iodine contrast agent was used for visualization. The bile duct, which tends to be optimal for further procedures, was chosen for biliary drainage. A 0.018" guidewire and 5F coaxial introducer were used to access the biliary duct. The cannulations of stricture and subsequent drainage procedure were performed using 0.035" guidewires and 5F manipulation catheters.

If the operator could not pass through the stenosis, a 6F external drain was inserted for a short period of time 5/59 [8.4%] of patients). When biliary stenosis was successfully overcome, an 8F external–internal drain (in 91.6% of patients) was used to maintain drainage to the duodenum. On subsequent intervention, the external–internal drain was extracted, a 9F sheath was introduced, and a 7.5F multi-use biopsy forceps (GBF-2.5-160-S, Cook Inc., Bloomington, IN, USA) was used to take biopsy specimens under fluoroscopic guidance, Figure 1. In total, 101 forceps biopsies were performed in this study scenario.

In scenario B, 42 patients underwent percutaneous drainage and biopsy in a single procedure using a 7F sheath and 5.2F biopsy forceps (Transluminal Biliary Biopsy Forceps Set, BBFS-100, Cook Inc., Bloomington, IN, USA). The initial drainage procedure as described in scenario A was followed by insertion of a 7F sheath above the stenosis. The biopsy forceps were then inserted through the sheath into the stricture, Figure 2. Three to seven specimens were then acquired. Two patients underwent both types of biopsy procedures with 7.5 and 5.2F biopsy forceps during subsequent procedures due to need of additional intervention on undrained branches.

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