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Original contribution

# Fine-needle aspiration of the liver: a 10-year single institution retrospective review☆,☆☆,★,★★

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**Summary** Fine-needle aspiration (FNA) of liver masses is a minimally invasive means of evaluation, with diagnostic accuracy over 85%. Given that most of the recent literature on sampling hepatic tumors was published by radiologists and gastroenterologists, we herein conduct a 10-year retrospective review of a single institution's cytopathology experience with the diagnosis of liver lesions. Electronic record review of the cytopathology files (CoPathPlus; Cerner Corp) was conducted for the 10-year interval January 2007 through December 2016. All cytology specimens designated as "liver" and "FNA" were included. Associated concurrent and subsequent surgical pathology and cytopathology cases were identified. All FNA cases were organized into four diagnostic categories: positive for malignancy, atypical, negative for malignancy, and non-diagnostic. There were 713 hepatic FNAs that were categorized as follows: positive for malignancy 467 (65.5%), atypical 49 (6.9%), negative 171 (24.0%) and non-diagnostic 26 (3.6%). Metastatic tumors (95.7%) were more common that primary (4.3%). The top two metastatic primary sites were pancreas (30.1%) and colon (12.7%). A total of 166 (23.2%) cases had concurrent core needle biopsies (CNB). 111 (66.9%) were concordant with the FNA diagnosis. Of the 55 discordant cases, 43 (25.9%) had diagnostic material only on CNB and 12 (7.2%) had diagnostic material only on FNA. The sensitivity, specificity, positive predictive value, negative predictive value, and diagnostic accuracy were 93.4%, 96.7%, 98.2%, 84.3%, and 89.3% respectively. Irrespective of endoscopic versus percutaneous approach, hepatic FNA is a sensitive and specific means of identifying metastatic and primary malignancies of the liver.


## 1. Introduction

The evaluation of hepatic lesions by fine-needle aspiration (FNA) cytology was first described in the medical literature in 1975 as a percutaneous methodology [1]. Over the last four decades, the practice of hepatic FNA has evolved to include both imaging guidance, by either ultrasound (US)

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or computed tomography (CT), and alternative routes of access, including both transjugular and endoscopic approaches. With myriad methodologies for accessing and aspirating focal hepatic lesions, it benefits practicing pathologists to be familiar with the benign and malignant lesions most frequently encountered in the setting of FNA. Many authors have evaluated procedural factors affecting diagnostic yield, including endoscopist experience, on-site adequacy assessment by cytopathologists, the gauge and style of utilized aspiration needles, and the number of needle passes within a lesion [2-5]. In the last decade, few authors have published on the diagnostic performance of hepatic FNA. To date, in the English-language literature, none have published comprehensive reviews on their institutional experience with hepatic FNA from the perspective of the cytopathologist. Herein, we have conducted a comprehensive 10-year retrospective review of the Cleveland Clinic's experience with hepatic FNA, focusing on both diagnostic performance and the frequency with which various diagnostic entities present as hepatic lesions.

## 2. Materials and methods

### 2.1. Case selection

This study was approved by the Cleveland Clinic Institutional Review Board. The Cleveland Clinic cytopathology database (CoPathPlus; Cerner Corp) was searched over a 10-year interval, from January 2007 through December 2016, for all cases in which the anatomic site was listed as "liver" and the specimen collection methodology was "FNA." All cytopathology cases were organized into one of four diagnostic categories: positive for malignancy, atypical, negative for malignancy, and non-diagnostic. A simultaneous review of the electronic surgical pathology database (CoPathPlus; Cerner Corp) was conducted for associated concurrent core needle biopsy (CNB) material and relevant subsequent surgical pathology or cytopathology cases. The medical record (Epic, Epic Systems Corp) was also reviewed to gather pertinent medical history and clinical follow-up information. Through synthesis of aforementioned data, the ultimate etiology of each liver lesion initially sampled by FNA was classified into one of three categories: malignant, benign, or uncertain. Patient data was collected and managed in a single Microsoft Excel spreadsheet.

### 2.2. Fine-needle aspiration cytology specimen acquisition

At our institution, at the time of FNA biopsy for sample procurement, a portion of the specimen is placed onto a glass slide. The remainder of the specimen is carefully dropped into a vial of Cytolyt (Hologic, Marlborough, MA). Two smears are prepared from the sample on the slide: one is immediately placed in alcohol for fixation and subsequently stained with Papanicolaou staining; the other is thoroughly air dried and stained using the Romanowsky method. The Romanowsky-stained slide is used to assess for adequacy of the specimen at the time of sample procurement. PreservCyt (Hologic, Marlborough, MA) fluid is added to the Cytolyt sample and it is centrifuged to create a cytology cell pellet. Portions of the cell pellet are utilized to generate both a ThinPrep slide and a Cellient cell block. The remainder of the cell pellet, stored in PreservCyt, is used for subsequent needs including molecular testing. Our institution has previously validated next generation sequencing (NSG) methodology for cytology cell pellet specimens, demonstrating NGS success rates of 96%, equivalent to those generated with formalin-fixed paraffin-embedded surgical pathology and cytopathology tissues [6,7]. At the Cleveland Clinic, cell pellets derived from cytology specimens are prioritized over surgical pathology specimens for molecular testing.

### 2.3. Statistical analysis

Statistical analysis was performed using MedCalc (MedCalc Software BVBA, Version 16.4.3) and Microsoft Excel (Microsoft Office Professional Plus 2010, Version 14.0.6023.1000).

## 3. Results

### 3.1. Diagnostic performance of hepatic FNA

During the 10-year interval, there were a total of 713 liver FNA specimens. Three hundred seventy-seven specimens were collected from males (52.9%) and 336 from females (47.1%). Ages ranged from 13 to 90 years (average and median ages, 63 years). One hundred seventy cases (24%) were obtained via EUS-FNA and 543 (76%) were percutaneous image-guided FNAs. In 358 (50.2%) of our 713 cases, focal liver lesions were identified in patients with a known history of extra-hepatic malignancy. Of these 713 cases, cytopathologic interpretations were as follows: 467 (65.5%) positive for malignancy, 49 (6.9%) atypical, 171 (24.0%) negative for malignancy, and 26 (3.6%) non-diagnostic.

Through synthesis of index, concurrent, and subsequent pathology material paired with pertinent clinical information, ultimate etiologies of the identified liver lesions were as follows: 527 (73.9%) malignant, 154 (21.6%) benign, and 32 (4.5%) uncertain. When excluding cases of uncertain etiology (32/713, 4.5%), the sensitivity and specificity of hepatic FNA for detecting malignancy were 93.4% and 96.7%, respectively. The positive and negative predictive values were 98.2% and 84.3%. Overall diagnostic accuracy was 89.3%. When considering only the two definitively diagnostic cytopathologic interpretations, positive for malignancy and negative for malignancy, diagnostic accuracy increased to 95.3%.

Comparison of the diagnostic performance of EUS-FNA versus percutaneous image-guided FNA revealed no statistically significant difference in sensitivity ($p = .33$), specificity ($p = .23$), or diagnostic accuracy ($p = .06$).

One hundred and sixty-six (23.2%) of the 713 identified cytology specimens had concurrent CNB. Of those, 112 (67.5%) were consistent with the FNA interpretation, 42 (25.3%) contained definitively diagnostic material lacking in the FNA, and 12 (7.2%) were non-diagnostic while the FNA contained diagnostic material. In total, 687 (96.4%) of 713 FNA specimens contained cellular material sufficient for diagnostic interpretation while 154 (92.8%) of 166 concurrent CNB met this standard.

## 3.2. Hepatic FNA findings per diagnostic category

### 3.2.1. Cases with a positive cytologic interpretation

Within the cohort of FNA specimens interpreted as positive, diagnoses included adenocarcinoma (290, 62.1%), carcinoma (58, 12.4%), neuroendocrine tumor (36, 7.7%), melanoma (35, 7.5%), squamous cell carcinoma (16, 3.4%), spindle cell neoplasm (12, 2.6%), hepatocellular carcinoma (5, 1.1%), hematopoietic neoplasm (4, 0.9%), Merkel cell carcinoma (2, 0.4%) and malignant neoplasm not otherwise specified (9, 1.9%). A total of 77 (16.5%) of the 467 positive FNA specimens had concurrent CNB: 65 (84.4%) had diagnostic material in interpretive agreement with the FNA cytologic diagnosis and 12 (15.6%) were non-diagnostic while the paired FNA did contain diagnostic material. For all positive interpretations at FNA where the primary site of tumor was known (438/467, 93.8%), metastatic disease (419/438, 95.7%) far exceeded primary hepatic malignancies (19/438, 4.3%).

### 3.2.2. Cases with an atypical cytologic interpretation

Of the 49 FNA cases interpreted as atypical, 11 cases (22.4%) were atypical suspicious for malignancy, 31 cases (63.3%) cited rare or limited atypical cells of concern, 4 cases (8.2%) cited confounding abundant inflammation affecting interpretation, and 3 cases (6.1%) had no additional qualifiers within the report. Thirty-eight (77.6%) of these atypical cases had subsequent follow-up (surgical pathology or cytopathology). Twenty-five (65.8%) were found to be malignant, 9 (23.7%) were benign, and 4 (10.5%) were persistently atypical. Malignant diagnoses included adenocarcinoma (11, 44%), cholangiocarcinoma (5, 20%), carcinoma (4, 16%), hepatocellular carcinoma (1, 4%), squamous cell carcinoma (1, 4%), neuroendocrine tumor (1, 4%), gastrointestinal neuroectodermal tumor (1, 4%) and malignancy not otherwise specified (1, 4%). Benign diagnoses included benign hepatic parenchyma (4, 45%), cirrhosis (3, 33%), adenoma with high-grade dysplasia (1, 11%), inflammation and fibrosis (1, 11%).

### 3.2.3. Cases with a negative cytologic interpretation

Of the 171 FNA cases interpreted as negative, 87 (50.9%) specimens specified the presence of benign hepatic elements within the aspiration sample, 29 (17.0%) contained abundant acute and/or chronic inflammation, 26 (15.2%) were cyst contents, and 5 (2.9%) were exclusively fibrous tissue. Sixty-one (35.7%) of the 171 negative FNA specimens had concurrent CNB, 54 (31.6%) cases had subsequent surgical pathology or cytopathology follow-up, and 56 (32.7%) lacked any pathologic follow-up. Of the 115 cases with additional pathologic material, 27 (23.5%) were found to be malignant, 85 (73.9%) were benign, and 3 (2.6%) were persistently atypical. Malignant diagnoses included adenocarcinoma (13, 48.2%), carcinoma (4, 14.8%), cholangiocarcinoma (4, 14.8%), hepatocellular carcinoma (2, 7.4%), neuroendocrine tumor (1, 3.7%), melanoma (1, 3.7%), squamous cell carcinoma (1, 3.7%), and angiosarcoma primary to the liver (1, 3.7%).

### 3.2.4. Cases with a non-diagnostic interpretation

Of the 26 non-diagnostic FNA specimens, 8 (30.8%) had concurrent CNB, 7 (26.9%) had subsequent surgical pathology follow-up, and 11 (42.3%) lacked any pathologic follow-up. In total, 8 (53.3%) of the 15 cases with additional pathologic material were found to be malignant, 4 (26.7%) were benign, and 3 (20%) were non-diagnostic. Malignant diagnoses included adenocarcinoma (5, 62.5%), hepatocellular carcinoma (1, 12.5%), leiomyosarcoma (1, 12.5%), and cholangiocarcinoma (1, 12.5%).

## 3.3. Ultimate etiology of identified focal liver lesions

For all interpretive FNA categories, a total of 527 (527/713, 73.9%) definitively malignant pathologic diagnoses were ultimately rendered. Of these, 492 cases (93.4%) were initially interpreted as atypical (25/492, 5.1%) or positive for malignancy (467/492, 94.9%) on hepatic FNA cytology. The primary sites of origin for each neoplasm identified within the liver, as well as the tumor subtypes, are listed in order of decreasing frequency in Table 1.

For all interpretive FNA categories, a total of 154 (154/713, 21.6%) definitively benign hepatic lesion etiologies were ultimately identified (Table 2), with 9 (9/49, 18.4%) in the atypical FNA cohort, 141 (141/171, 82.5%) in the negative for malignancy FNA cohort, and 4 (4/26, 15.4%) in the non-diagnostic FNA cohort. "Benign hepatic parenchyma" was the most common final pathologic diagnosis within this cohort (46/154, 29.9%). Thirty-three (71.7%) of these 46 cases were without concurrent or subsequent tissue collection for pathologic examination. Of the 33 cases, 10 (30.3%) patients were lost to follow-up at our institution within 4 months of hepatic FNA (average, 2.3 months).

## 3.4. Probabilities of malignancy for hepatic FNA diagnostic categories

Based on ultimate discerned etiology (.ie., malignant, benign, or uncertain) and excluding focal intrahepatic lesions of ultimately uncertain etiology, probabilities of malignancy

**Table 1** Final pathologic diagnoses for all hepatic masses initially investigated by hepatic FNA with ultimately malignant etiologies

| Tumor types by primary site of origin (%) | Number of cases |
|---|---|
| Pancreas | 159 (30.1%) |
| Adenocarcinoma | 137 (86%) |
| Neuroendocrine tumor | 15 (10%) |
| Carcinoma | 7 (4%) |
| Colorectum | 67 (12.7%) |
| Adenocarcinoma | *62 (93%)* |
| Squamous cell carcinoma | 3 (5%) |
| Gastrointestinal stromal tumor | 1 (1%) |
| Spindle cell neoplasm, NOS | 1 (1%) |
| Liver | 45 (8.5%) |
| Cholangiocarcinoma | 29 (64%) |
| Hepatocellular | 14 (31%) |
| Melanoma | 1 (2.5%) |
| Angiosarcoma | 1 (2.5%) |
| Unknown | 36 (6.8%) |
| Adenocarcinoma | 12 (33%) |
| Carcinoma | 12 (33%) |
| Neuroendocrine tumor | 7 (20%) |
| Malignant, NOS | 5 (14%) |
| Lung | 33 (6.2%) |
| Carcinoma | 13 (40%) |
| Neuroendocrine tumor | 9 (27%) |
| Adenocarcinoma | 8 (24%) |
| Squamous cell carcinoma | 3 (9%) |
| Esophageal | 33 (6.2%) |
| Adenocarcinoma | 26 (79%) |
| Squamous cell carcinoma | 3 (9%) |
| Neuroendocrine tumor | 2 (6%) |
| Carcinoma | 2 (6%) |
| Breast | 30 (5.7%) |
| Adenocarcinoma | 28 (93%) |
| Carcinoma | 1 (3.5%) |
| Angiosarcoma | 1 (3.5%) |
| Eye – choroid | 22 (4.2%) |
| Melanoma | 22 (100%) |
| Skin | 15 (2.8%) |
| Melanoma | 12 (80%) |
| Merkel cell carcinoma | 2 (13%) |
| Carcinoma | 1 (7%) |
| Stomach | 12 (2.3%) |
| Adenocarcinoma | 9 (75%) |
| Gastrointestinal stromal tumor | 3 (25%) |
| Extrahepatic bile duct | 11 (2.1%) |
| Adenocarcinoma | 11 (100%) |
| Kidney | 9 (1.7%) |
| Carcinoma | 7 (78%) |
| Adenocarcinoma | 1 (11%) |
| Leiomyosarcoma | 1 (11%) |
| Head & Neck | 9 (1.7%) |
| Squamous cell carcinoma | 6 (67%) |
| Carcinoma | 2 (22%) |
| Spindle cell neoplasm, NOS | 1 (11%) |
| Small Bowel | 9 (1.7%) |
| Neuroendocrine tumor | 5 (56%) |
| Carcinoma | 2 (22%) |
| Gastrointestinal neuroectodermal tumor | 1 (11%) |
| Adenocarcinoma | 1 (11%) |
| Bladder | 8 (1.5%) |
| Urothelial | 6 (75%) |
| Squamous cell carcinoma | 1 (12.5%) |
| Melanoma | 1 (12.5%) |
| Prostate | 5 (1.0%) |
| Adenocarcinoma | 4 (80%) |
| Carcinoma | 1 (20%) |
| Hematopoietic | 4 (0.8%) |
| Non-Hodgkin B-cell lymphoma | 2 (50%) |
| DLBCL | 1 (25%) |
| Plasma cell neoplasm | 1 (25%) |
| Uterine cervix | 4 (0.8%) |
| Squamous cell carcinoma | 2 (50%) |
| Carcinoma | 1 (25%) |
| Adenocarcinoma | 1 (25%) |
| Uterine corpus | 3 (0.6%) |
| Adenocarcinoma | 1 (33.3%) |
| Carcinoma | 1 (33.3%) |
| Carcinosarcoma | 1 (33.3%) |
| Eye – uvea | 3 (0.6%) |
| Melanoma | 3 (100%) |
| Intra-abdominal | 3 (0.6%) |
| Solitary fibrous tumor | 1 (33.3%) |
| Leiomyosarcoma | 1 (33.3%) |
| DSRCT | 1 (33.3%) |
| Ovary | 2 (0.4%) |
| Adenocarcinoma | 1 (50%) |
| Carcinoma | 1 (50%) |
| Adrenal | 2 (0.4%) |
| Carcinoma | 2 (100%) |
| Retroperitoneal | 2 (0.4%) |
| Liposarcoma | 1 (50%) |
| Leiomyosarcoma | 1 (50%) |
| Thymus | 1 (0.2%) |
| Carcinoma | 1 (100%) |

NOTE. Total: 527 cases.

for each diagnostic category of cytopathologic interpretation are as follows: positive, 100%; atypical, 74%; negative, 16% (Table 3). Within the non-diagnostic interpretive category, only 12 cases had subsequent clinical follow-up that included procurement of diagnostic pathologic material. For these 12 cases, the probability of malignancy was 67% (8/12 cases).

## 4. Discussion

While malignant tumors primary to the liver are relatively less frequent in the United States (US) than in other parts of the world [8,9], the liver is one of the most common sites of tumor metastasis in the human body. This is secondary to its rich dual blood supply paired with the predilection for malignancies to metastasize via hematogenous routes. When

**Table 2** The final pathologic diagnosis for all hepatic FNA specimens ultimately determined to be benign

| Final diagnosis | No. of cases |
|---|---|
| Benign hepatic parenchyma | 46 |
| Cyst | 29 |
| Abscess | 17 |
| Fibrosis | 14 |
| Cirrhosis | 12 |
| Hemangioma | 7 |
| Bile duct proliferation | 6 |
| Inflammation | 6 |
| Steatosis | 4 |
| Steatohepatitis | 3 |
| Granulomatous inflammation | 3 |
| Benign lymphoid sample | 2 |
| Focal nodular hyperplasia | 2 |
| Hepatic adenoma | 2 |
| Regenerative nodule | 1 |
| *Sum* | *154* |

patients present with newly identified liver lesions, especially in the setting of a known history of malignancy, discerning the etiology is of paramount importance for appropriate clinical management, staging, and prognostication.

The utilization of FNA in sampling focal liver lesions has been in practice for multiple decades, with demonstrated diagnostic sensitivities exceeding 80% and specificities nearing 100% in multiple series [10-18]. When compared head-to-head with CNB, FNA is superior in its diagnostic capabilities in multiple reported studies, especially in in the setting of metastatic disease involving the liver [10-15]. When utilizing the two diagnostic methodologies in concert, maximal diagnostic performance can be achieved [12,14]. In more recent years, new methodologies of targeted hepatic sampling have evolved from percutaneous and transjugular approaches to the inclusion of endoscopic ultrasound (EUS)-based procedures [19,20].

To date, while many authors have published on the diagnostic performance of hepatic FNA at their respective institutions [10-18], none have focused on cytopathologic diagnoses paired with ultimate pathologic and clinical outcomes in their patient population.

Herein, we have described the largest single-institution retrospective review of hepatic FNA to date in the English-language literature. With sensitivity, specificity, and diagnostic accuracy well within the expected range of performance [10-18], our analysis also includes careful detailing of the most commonly encountered benign and malignant diagnostic entities seen at needle sampling of focal intrahepatic lesions. Important to note is that, at our institution, the diagnosis and management of suspected primary intrahepatic neoplasms is largely based on radiographic findings, with utilization of the Liver Imaging Reporting and Data Systems (LI-RADS) standardized interpretations, reporting, and management guidelines paired with CNB when necessary [21]. Radiographic means of diagnosing hepatocellular carcinoma have been shown to be robustly sensitive and specific [22]. Generally, hepatic FNA is reserved for instances of suspected metastatic disease involving liver [23,24] and, in more rare situations, when radiographic findings are non-specific or when CNB is contraindicated for clinical reasons (i.e. coagulopathy).

Within our patient cohort, important generalizations that can be drawn from this study include: metastatic malignancies far outnumber primary intrahepatic neoplasms, pancreas is the most common primary site of metastatic disease to the liver (Figure, A-C), and adenocarcinoma involving liver far outweighs other tumor types. In addition, our study highlights the comparable diagnostic performance of hepatic FNA via both EUS and percutaneous methodologies. In contrast, other authors have found that EUS has higher diagnostic yields. [5,19,25]. Likely, diagnostic performance relies heavily on comfort of the clinician with the procedure as well as the availability of an on-site pathologist for sample adequacy assessment.

Beyond statistical trends, the rare neoplasms highlighted within this study are also of educational value. Particularly, the identification of intrahepatic metastatic and primary tumors with spindle cell components: gastrointestinal neuroectodermal tumor (Figure, G-I), solitary fibrous tumor, leiomyosarcoma, gastrointestinal stromal tumor, angiosarcoma, melanoma (Figure, D-F), hemangioma, and fibrosis. In the rare instance when collected lesional tissue at the time of hepatic FNA demonstrates a spindle cell cytomorphology, recognition of differential diagnoses and knowledge of the ancillary studies available is of importance.

**Table 3** Correlation of initial hepatic FNA cytologic interpretation and ultimate etiology of hepatic lesion with associated probabilities of malignancy for each diagnostic cohort

| Diagnosis in cytology | Liver lesion ultimate etiologies | | | Total | Probability of malignancy |
|---|---|---|---|---|---|
| | Malignant | Benign | Uncertain | | |
| Positive for malignancy | 467 (100%) | 0 (0%) | 0 (0%) | 467 (65.5%) | 100% |
| Atypical | 25 (51%) | 9 (18%) | 15 (31%) | 49 (6.9%) | 74% |
| Negative for malignancy | 27 (16%) | 141 (82%) | 3 (2%) | 171 (24.0%) | 16% |
| Non-diagnostic | 8 (31%) | 4 (15%) | 14 (54%) | 26 (3.6%) | 67% |
| | | | *Total* | *713* | |

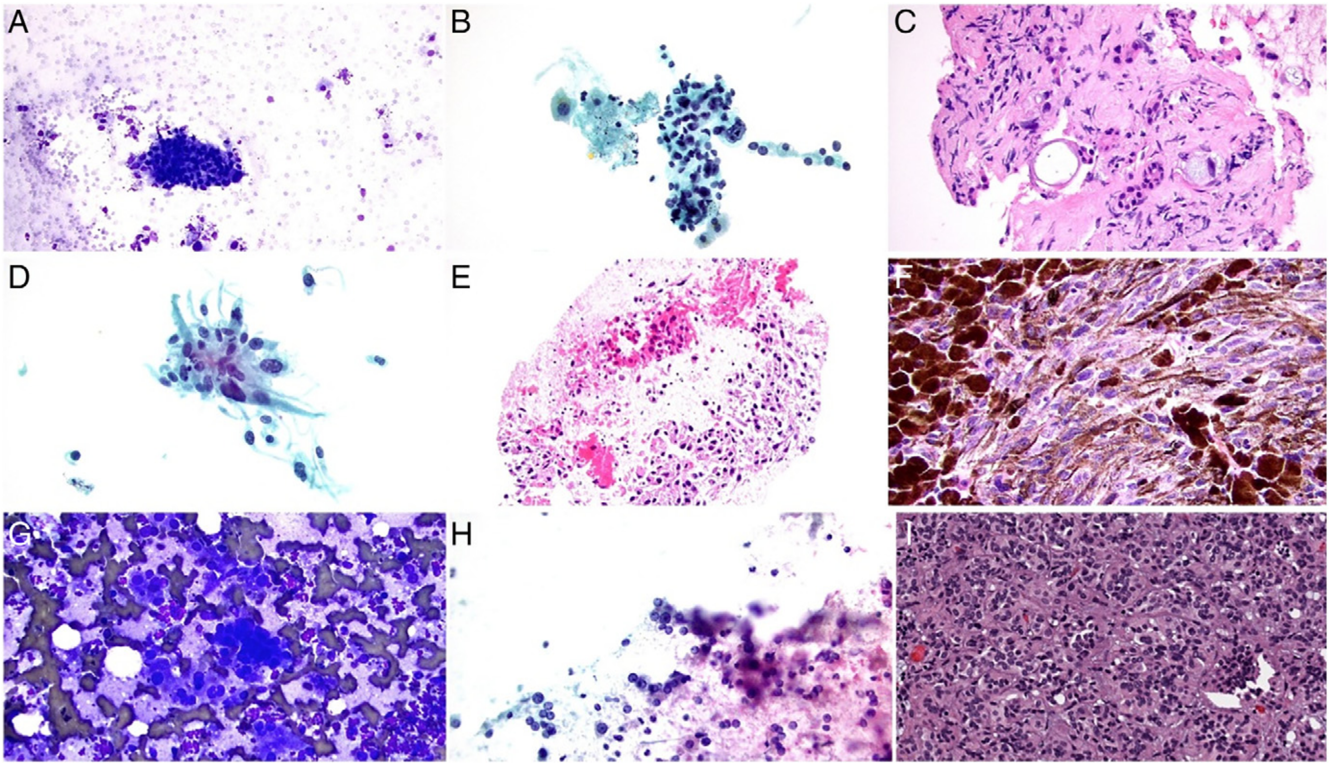


**Figure** Liver mass cytology and concordant surgical pathology material from three examples cases: carcinoma, melanoma, and gastrointestinal neuroectodermal tumor. A, Metastatic pancreatic adenocarcinoma involving liver (Diff-Quik, original magnification ×200). B, Metastatic pancreatic adenocarcinoma involving liver (ThinPrep original magnification ×400). C, Metastatic pancreatic adenocarcinoma involving liver (hematoxylin & eosin [H&E], original magnification ×200). Metastatic malignant melanoma of the choroid involving liver (ThinPrep, original magnification ×400). E, Metastatic malignant melanoma of the choroid involving liver on cell block (H&E, original magnification ×200). F, Malignant melanoma of the choroid (H&E, original magnification ×400). G, Metastatic gastrointestinal neuroectodermal tumor involving liver (Diff-Quik original magnification ×400). H, Metastatic gastrointestinal neuroectodermal tumor involving liver (ThinPrep original magnification ×400). I, Gastrointestinal neuroectodermal tumor of the small bowel (H&E original magnification ×200).

Limitations of this study include that all cytopathology and subsequent surgical pathology material was classified into diagnostic categories based on details within the final pathology report. For our calculated probabilities of malignancy, it is important to consider other factors that may have contributed to which cases were followed closely: lesions particularly worrisome based on radiographic and clinical findings were likely followed more closely than those lesions with less concerning clinicoradiographic features. This phenomenon may skew our data to reflect definitive diagnoses for the more "malignant" subset of our case population. Many of the focal intrahepatic lesions of ultimately "uncertain" etiology may represent suspected benign lesions not carefully followed-up within our medical system. On the other hand, the high probability of malignancy within our non-diagnostic FNA cohort may represent the fact that only those lesions of great clinicoradiographic concern were closely followed to ensure diagnostic tissue was ultimately obtained.

As the access to and assortment of hepatic sampling methodologies continues to broaden, so, too, will the usefulness of hepatic FNA in a variety of clinical settings. While many authors have published on the utility of hepatic FNA in the investigation of both common and rare primary [26-30] and metastatic malignancies [10,27,31], studies conducted in more recent years have revealed roles for hepatic FNA in the clinical management of patients post-liver transplant [32] and in the setting of intrahepatic biliary atresias and strictures [33,34]. The ever-expanding horizon of hepatic FNA clinical utility demands pathologists' familiarity with the practice. The first building block in this endeavor is comfort with the most common clinical scenario: focal intrahepatic masses evaluated by needle sampling. We offer this study as a framework upon which pathologists' understanding of hepatic FNA and its associated spectrum of benign and malignant diagnostic possibilities may be constructed. At our institution, hepatic FNA via both EUS and percutaneous image-guided methodologies will continue to be the go-to means of evaluating focal intrahepatic masses, especially in the setting of clinical concern for metastatic malignancy. Cytopathologists will continue to be integral in the clinical management of this subset of patients, through both provided diagnoses as well as the appropriate triaging and management of collected material for necessary molecular [6,7,35] and other ancillary testing [36,37].

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