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Preliminary single-operator experience with ultrasound-guided liver core needle biopsy performed by a supervised general surgery resident

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ABSTRACT

Objective: Ultrasound-guided core needle biopsy (CNB) is essential for diagnosing liver tumors not amenable to resection, but the outcomes of resident-performed CNB are poorly defined. We evaluated the diagnostic performance and safety of liver CNB performed by a single ultrasound-certified general surgery resident under specialist supervision.

Material and Methods: In this retrospective single-center case series, 65 consecutive patients underwent ultrasound-guided liver CNB between July 2022 and January 2025. All procedures constituted the resident's entire initial experience with liver CNB. Diagnostic success was defined as obtaining sufficient tissue for definitive histopathological diagnosis. Predictors of diagnostic success were assessed using univariate analyses and logistic regression. Learning-curve effects were evaluated by comparing early and late tertiles of chronologically ordered cases and by modelling case number as a continuous predictor. The impact of lesion size was examined by subgroup analysis comparing <4 cm and ≥4 cm lesions and by treating the maximal lesion diameter as a continuous variable.

Results: Adequate tissue was obtained in 58/65 biopsies (89.2%), with malignancy confirmed in 49 patients (75.4%) and benign lesions in 9 patients (13.8%). Diagnostic success was 85.7% in the early tertile and 95.5% in the late tertile (p=0.345). Logistic regression showed a non-significant trend toward a higher diagnostic yield over time. Neither lesion size (categorized as <4 cm versus ≥4 cm) nor maximal diameter (analyzed as a continuous variable) was significantly associated with diagnostic success. No immediate or clinically overt delayed complications were observed during 24 hours of in-hospital monitoring.

Conclusion: This preliminary single-operator experience suggests that, under close supervision, an appropriately trained general surgery resident can perform ultrasound-guided liver CNB with a high diagnostic yield and a low observed complication rate. These hypothesis-generating findings support further multi-operator and comparative studies of resident-performed liver CNB.

Keywords: Biopsy, needle, ultrasonography, interventional, liver neoplasms/diagnosis, residents, medical, safety, diagnostic yield

INTRODUCTION

Core needle biopsy (CNB) under ultrasound (US) or computed tomography (CT) guidance is a key diagnostic tool for patients with advanced, multifocal, or suspicious liver tumours that are not suitable for surgical resection. Under these conditions, CNB is the preferred method for obtaining tissue samples from primary or metastatic liver masses that do not meet the criteria for non-invasive diagnosis, allowing further treatment, e.g., the Liver Imaging Reporting and Data System for hepatocellular carcinoma (HCC) diagnosis. Histopathological examination of biopsy specimens is crucial for guiding oncological treatment (1).

The diagnostic accuracy of CNB varies depending on tumour characteristics. While its specificity and positive predictive value for HCC nodules smaller than 2 cm are excellent (100%), sensitivity ranges between 66% and 93%, depending on tumour size, operator experience, pathologist expertise, and needle size (1,2). In cases of advanced pancreatic ductal adenocarcinoma, CNB of liver metastases has been reported to achieve a sensitivity of 97% (3). If a lesion remains suspicious despite a negative initial biopsy, a repeat biopsy may be necessary. However, this carries inherent risks, including bleeding, track seeding, and sampling error, particularly when tumour location complicates access (3).

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US- or CT-guided percutaneous liver biopsy is one of the procedures that should be performed during the general surgery residency training program (4). Developing proficiency in US-guided CNB is particularly important for surgical residents specializing in hepatopancreatobiliary (HPB) surgery. Mastering this minimally invasive technique not only enhances diagnostic accuracy and patient safety but also broadens the surgeon's skill set, preparing trainees to independently manage complex liver pathologies and participate actively in multidisciplinary oncological care.

However, no published studies specifically evaluate the safety and effectiveness of CNB for liver tumours when performed by general surgery residents. Most available literature focuses on the procedure's efficacy and complication rates when conducted by experienced radiologists or hepatologists. While CNB is well-established as a reliable diagnostic tool, its outcomes when performed by surgical trainees remain largely unexamined.

This study aims to analyze the effectiveness and safety of CNB performed by a single general surgery resident for suspicious liver tumors. By addressing this gap, our findings may improve understanding of procedural outcomes when trainees perform CNB under supervision.

MATERIAL and METHODS

We conducted a retrospective analysis of electronic medical records of 65 consecutive patients who underwent US-guided CNB between July 2022 and January 2025. All procedures were performed by a single operator. The operator was a general surgery resident who held a diagnostic ultrasonography certification from the Polish Ultrasound Society. This credential formally attests to competency in diagnostic US examinations but does not, by itself, certify interventional skills. Importantly, this series included all US-guided liver core-needle biopsies performed by the resident during the study period. No prior liver CNB procedures performed by this operator were excluded; therefore, the 65 consecutive cases reported here represent the entire initial learning curve for resident-performed US-guided liver CNB in our unit.

Inclusion criteria:

1. Informed patient consent for the procedure,
2. Age >18 years,
3. Unresectable single or multiple liver mass,
4. High clinical suspicion of malignancy,
5. Prior oncological consultation confirming the patient's eligibility for treatment,
6. Absence of contraindications for CNB.

Exclusion criteria:

1. Prior histopathological confirmation of malignancy,
2. Contraindications for CNB [e.g., severe coagulopathy international normalized ratio (INR) >1.5, platelet count <50,000/mm^3, uncontrolled infections, inability to cooperate during the procedure],
3. Patients disqualified from further oncological treatment due to general condition.

All procedures were performed under hospital conditions and were preceded by a review of the medical history, including imaging diagnostics of underlying disease; assessment of anticoagulant or antiplatelet therapy, which may require temporary discontinuation; blood tests, including a coagulation profile (INR, prothrombin time, activated partial thromboplastin time, platelet count); and liver function tests. US assessment was performed to determine lesion location, size, vascularity, and accessibility.

Patients were placed in the supine or left lateral decubitus position, with the right arm elevated above the head, to optimize access to the liver. All procedures were performed using a sterile technique and real-time US guidance to ensure accuracy and minimize complications.

The procedure began with skin disinfection using an alcohol-based antiseptic, followed by local infiltration with 1% lidocaine. A 3-5-mL dose was injected subcutaneously at the planned needle entry site, and an additional 3-5-mL dose was injected into deeper layers, including the pericapsular region of the liver.

Under real-time US guidance with a convex probe (3.5-7.5 MHz) equipped with an in-line needle guide, a 16G tru-cut biopsy needle was introduced percutaneouslyusing a subcostal or intercostal approach depending on lesion location. A coaxial technique was used when feasible to minimize the risk of bleeding. The needle trajectory was carefully planned to avoid major blood vessels and bile ducts. Once the needle was in position, the automated spring-loaded biopsy device was activated to obtain a core tissue sample measuring approximately 20 mm in length. Depending on the lesion characteristics, one to three passes were performed to optimize the diagnostic yield while minimizing procedural risk (Figure 1).

Following tissue acquisition, US was used to assess for immediate complications, such as hematoma formation or active bleeding. The biopsy needle was then withdrawn, and manual compression was applied to the puncture site for haemostasis. The patient was placed in the supine position for 2 hours and observed in hospital for 24 hours after CNB. Vital signs were monitored at 15-minute intervals for the first hour, followed by 30-minute intervals for the next two hours. The puncture site was periodically examined for signs of bleeding or bile leakage.

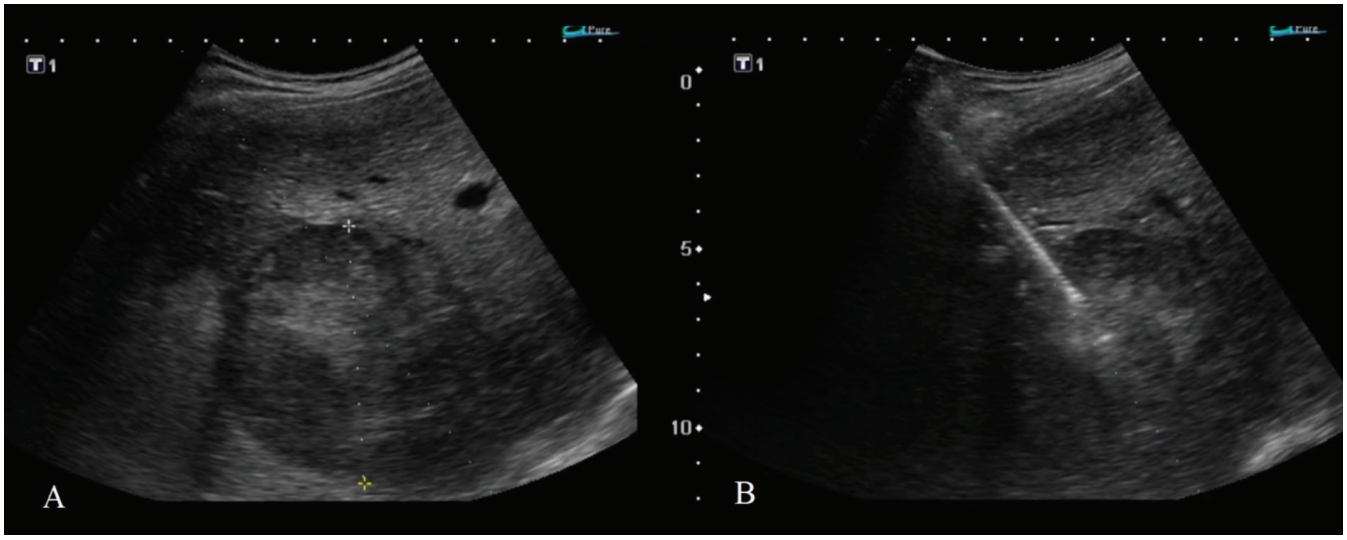

Figure 1. Ultrasound-guided core needle biopsy of the tumour (70 mm in diameter) of the right lobe of the liver. A) The measurement of the tumour. B) Core needle biopsy of the lesion.

Patients were advised to avoid strenuous activity and heavy lifting for the next 48 hours. Pain was managed with metamizolum (1250-2500 mg). Patients were discharged after 24 hours if no complications occurred and were instructed to seek medical attention if they experienced severe pain, hypotension, tachycardia, or symptoms suggesting biliary injury or infection. A follow-up outpatient visit within 7-10 days was scheduled.

This monitoring protocol aimed to detect both early and delayed post-biopsy complications, including events that might occur beyond the usual 4-6-hour observation window recommended for day-case procedures.

Statistical Analysis

Initially, univariate analyses were performed using Spearman's rank correlation for continuous variables and the chi-square test for categorical variables. Subsequently, a simplified logistic regression model was developed based on variables that showed statistical significance ($p<0.05$) in the initial analyses. The primary outcome was successful diagnostic biopsy, defined as obtaining adequate tissue for definitive histopathological diagnosis.

Variables analyzed included patient age, sex, number and location of lesions, lesion size, biopsy access route, number of needle passes, tumor marker concentrations (CA19-9, CA15-3, CA125, CEA, AFP), and procedure-related complications.

Assessment of Learning Curve and Lesion Size

To explore potential learning-curve effects, all 65 procedures were ordered chronologically by biopsy date and assigned case numbers (1-65). The series was then divided into three tertiles of approximately equal size by case number. For descriptive comparison of early and late performance, the first tertile (cases 1-21) and the third tertile (cases 44-65) were used to represent the early and late phases of the operator's experience. Diagnostic success rates between these two phases were compared using Fisher's exact test. In addition, a logistic regression model was fitted with diagnostic success (yes/no) as the dependent variable and case number as a continuous predictor to assess the learning curve across the entire series. Odds ratios (ORs) were reported per 10 additional procedures.

To evaluate the impact of lesion size on diagnostic yield, the maximal lesion diameter was calculated for each patient as the largest value among the three recorded orthogonal dimensions. Summary statistics (mean, median, interquartile range) were obtained for this maximal diameter. For subgroup analysis, lesions were classified by maximum diameter as <4 cm or ≥4 cm, and diagnostic success rates were compared between the two categories using Fisher's exact test. Furthermore, a logistic regression model was constructed with diagnostic success as the outcome and either lesion size category (<4 vs. ≥4 cm) or maximal diameter as a continuous predictor. For the continuous model, ORs were expressed per 10-mm increase in maximal lesion diameter. A two-sided p-value of<0.05 was considered statistically significant.

Ethical approval for this retrospective study was obtained from the Institutional Ethics Committee of Medical University of Lodz (number: RNN/230/25/KE, number: 09.09.2025). Given the retrospective design and analysis of anonymized data, informed consent was not required for participation in the study.

RESULTS

The analysis included 65 patients, comprising 37 men and 28 women. Single focal lesions were identified in 25 patients, while

40 patients had multiple lesions. Biopsies were performed on the left lobe of the liver in 21 cases and on the right lobe in 44 cases. The subcostal approach was used in 63 cases, while the intercostal approach was required in 2 cases. Accurate tissue collection was achieved with 1, 2, and 3 needle passes in 25, 35, and 5 patients, respectively. No patient experienced any early or late complications associated with the procedure (Table 1).

Diagnostic success, defined as obtaining sufficient tissue for definitive histopathological evaluation (including both malignant and benign diagnoses), was achieved in 58 of 65 patients (89.2%). Among these successful biopsies, 49 (75.4%) revealed malignancy, while 9 (13.8%) identified benign conditions, including regenerative nodules, focal steatosis, adenoma, or atypical hemangioma. Primary liver cancer (HCC) was diagnosed in 8 cases (12.3%), and metastatic disease in the remaining cases: Adenocarcinoma of the pancreas and colon [33 pts, 50.8%), neuroendocrine tumours (NET and GNET) in 3 cases (4.6%)], non-small-cell renal cancer in 2 cases [(3.1%), gastrointestinal stromal tumour in 1 case (1.5%)], melanoma in 1 case (1.5%), and small-cell lung cancer in 1 case (1.5%). Seven biopsies (10.8%) were non-diagnostic and required a repeat procedure (Table 2).

Table 1. Patients characteristic

Sex	Male	37	56.92%
	Female	28	43.08%
Age (years)	Mean	68.7	
	Median	73	
	Range	52-84	
Number of lesions	Single	25	38.50%
	Multiple	40	61.50%
Location of CNB	Left lobe	21	32.30%
	Right lobe	44	67.70%
Access	Subcostal	63	96.90%
	Intercostal	2	3.10%
Diameter of CNB lesion (mm)	Mean	53.2	
	Median	43	
	Range	11-150	
Number of needle passes	One	26	40%
	Two	34	52.30%
	Three	5	7.70%
Proper tissue collection	Yes	58	89.2%
	No	7	10.8%
Cancer diagnosis	Positive	49	75.40%
	Negative	16	24.60%
Complications	Yes	0	0%
	No	65	100%

CNB: Core needle biopsy.

Initial statistical analysis identified that performing CNB in patients with multiple liver lesions was a significant factor associated with diagnostic success of US-guided CNB (Spearman's rho =0.34, p=0.006; chi-square test, p=0.021). The regression analysis confirmed that the presence of multiple liver lesions was an independent predictor of diagnostic success [OR =10.36; 95% confidence interval (CI): 1.10-97.62; p=0.041]. This indicates that patients with multiple liver lesions had significantly higher odds of obtaining a definitive histopathological diagnosis than patients with single lesions (Figure 2).

Learning-curve Analysis

When cases were analysed according to chronological tertiles, the first tertile (early phase, cases 1-21) and the third tertile (late phase, cases 44-65) included 21 and 22 procedures, respectively. Diagnostic success rates were 85.7% (18/21) in the early phase and 95.5% (21/22) in the late phase; the difference was not statistically significant (p=0.345). In a logistic regression model including all 65 procedures, case number, treated as a continuous variable, was not significantly associated with diagnostic success. The OR per 10 additional procedures was 1.43 (95% CI 0.90-2.29; p=0.134), indicating a trend toward higher diagnostic yield over time that did not reach statistical significance, rather than reflecting a clear-cut learning-curve effect.

Table 2. Histopathological findings

Histopathological findings	Patients	Percentage
Malignant	49	75.4%
Adencarcioma	33	50.8%
HCC	8	12.3%
NET	2	3.1%
Non-small cell renal cancer	2	3.1%
GIST	1	1.5%
GNET	1	1.5%
Melanoma	1	1.5%
SCLC	1	1.5%
Non-malignant	9	13.8%
Regenerative nodules	3	4.6%
Adenoma	3	4.6%
Focal steatosis	2	3.1%
Atypical haemangioma	1	1.5%
Non-diagnostic	7	10.8%
Necrotic tissue	3	4.6%
Non-diagnostic material	2	3.1%
Proper liver structure	2	3.1%

HCC: Hepatocellular carcinoma, SCLC: Small cell lung cancer, GIST: Gastrointestinal stromal tumor, GNET: Gastrointestinal neuroectodermal tumor.

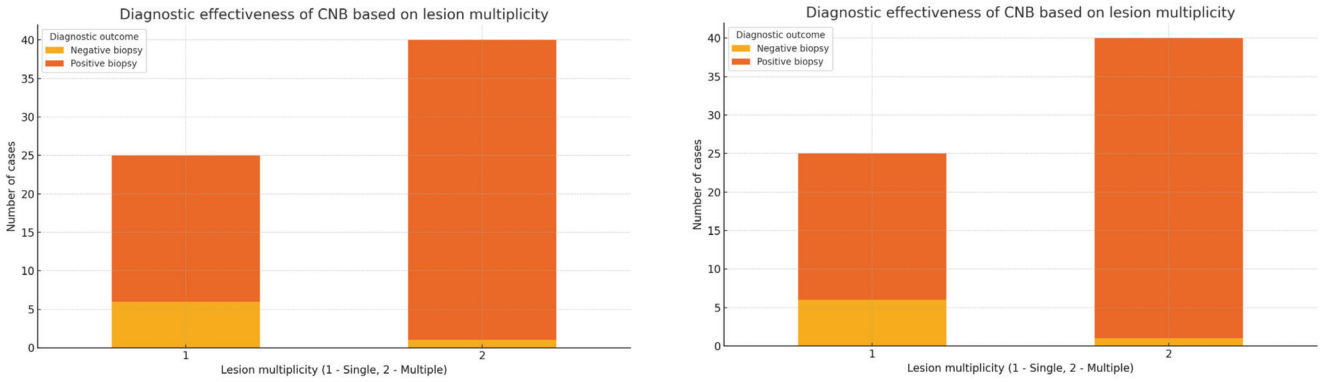

Figure 2. Diagnostic yield of ultrasound-guided core needle biopsy stratified by lesion multiplicity. The bar chart compares positive (diagnostic) and negative (non-diagnostic) biopsy outcomes between patients with single (n=25) and multiple (n=40) liver lesions. Multiplicity significantly predicted diagnostic success (OR=10.36, 95% CI:1.10-97.62, p=0.041).

OR: Odds ratio, CI: Confidence interval

Subgroup Analysis by Lesion Size

The mean maximal diameter of the lesions was 53.5 mm, with a median of 43 mm and an interquartile range of 30-76 mm. Lesions <4 were observed in 28 cases, whereas lesions ≥4 were observed in 37 cases. Diagnostic success was 89.3% (25/28) for lesions <4 cm and 89.2% (33/37) for lesions 64 cm (p=1.000). In a logistic regression model with lesion size category as the predictor, lesions ≥4 cm were not significantly associated with diagnostic success compared with lesions <4 cm (OR 0.65; 95% CI 0.11-3.88; p=0.638).

When maximal lesion diameter was analysed as a continuous variable, no significant association with diagnostic yield was observed. The OR for diagnostic success per 10-mm increase in maximal diameter was 0.97 (95% CI, 0.75-1.24; p=0.779), suggesting that lesion size did not have a measurable effect on biopsy performance in this cohort.

DISCUSSION

The findings of this study provide valuable insights into the safety and effectiveness of US-guided CNB for liver tumors performed by a general surgery resident under supervision. Our results demonstrate that CNB is a highly effective diagnostic tool, achieving a malignancy confirmation rate of 75.4%, with no observed early or late complications. This study contributes to the existing literature by highlighting the feasibility of CNB within surgical training programs, an area that has been largely unexamined.

Notably, the present series documents the resident's initial experience with US-guided liver CNB in its entirety. No earlier liver biopsies performed by the operator were omitted; the 65 consecutive procedures therefore constitute a complete learning curve rather than a selected segment of more advanced practice. Within this context, the absence of a statistically significant improvement in diagnostic yield between the earliest and latest tertiles and the only non-significant trend toward higher success in the logistic regression analysis suggest that acceptable performance can be achieved early when residents trained in diagnostic US are introduced to CNB in a structured, closely supervised training environment.

The 75.4% malignancy-confirmation rate observed in our study aligns with previously reported sensitivities for CNB, which typically range from 66% to 97%, depending on lesion size, operator experience, and histopathological evaluation criteria (4,5). Notably, our study population included a diverse range of malignancies, with metastatic adenocarcinoma being the most common histopathological diagnosis (50.8%), followed by HCC (12.3%). This distribution is consistent with known epidemiological patterns of liver tumors, in which secondary liver malignancies outnumber primary hepatic neoplasms (5).

Previous studies have suggested that factors such as tumor size, number of needle passes, and lesion vascularity influence biopsy yield (6). In our study, the presence of multiple liver lesions likely increased diagnostic yield by increasing overall tumor burden and facilitating the selection and acquisition of representative tissue samples during biopsy.

One of the most striking findings of this study is the complete absence of complications, including bleeding, bile leakage, or tumor seeding. Previous reports have documented CNB-related complication rates between 0.1% and 4% (7,8). The favorable safety profile observed in this study may be attributed to several factors:

- Real-time US guidance, which allows precise needle placement while avoiding major blood vessels.
- Standardized procedural protocol, including the use of a coaxial technique where feasible, minimizing the risk of bleeding.

- Immediate post-procedure monitoring, ensuring early detection of potential adverse events.

The lack of complications also suggests that CNB can be safely performed by surgical residents under appropriate supervision. However, given the small study size, it is essential to interpret this finding cautiously, as rare complications may not have been captured.

Most studies evaluating CNB outcomes have focused on procedures performed by radiologists or hepatologists, with little data on performance by general surgeons or trainees. Our results suggest that, with adequate training, general surgery residents can achieve comparable diagnostic accuracy and safety outcomes. This finding supports the integration of CNB training into general surgery residency programs, particularly for those specializing in HPB surgery.

A systematic review by Rockey et al. (9) reported that CNB performed by radiologists had a sensitivity of 90-95% for HCC, with complication rates below 1%. Similarly, Matsubara et al. (10) found that CNB of pancreatic tumors and metastatic liver tumors demonstrated diagnostic accuracy exceeding 90% when performed by experienced specialists. Our malignancy detection rate is slightly lower than these values, potentially reflecting differences in operator experience and lesion characteristics. Nonetheless, our findings highlight that residents can achieve a high diagnostic yield when working under structured supervision.

These findings reinforce the importance of structured CNB training in surgical residency programs. In many institutions, liver biopsy remains a predominantly radiologist-led procedure, limiting exposure for general surgeons (11). However, as minimally invasive techniques become increasingly relevant in HPB surgery, it is crucial for surgeons to be proficient in interventional techniques such as CNB.

Our institutional policy of 24-hour in-hospital observation after CNB, although more conservative than the 4–6-hour monitoring commonly used for day-case biopsies, may be viewed as both a strength and a limitation. On the one hand, extended observation increased the likelihood of identifying delayed post-biopsy events that might otherwise present after discharge and necessitate readmission. On the other hand, it reduces the direct comparability of our safety outcomes with outpatient protocols and prevents extrapolation of our findings to centres using shorter monitoring periods.

No comparator group of procedures performed by radiologists or hepatologists was included. Our study does not aim to demonstrate equivalence or non-inferiority of resident-performed CNB and should be regarded as hypothesis-generating rather than definitive.

Key training recommendations include:

- Simulation-based learning: Before performing CNB on patients, residents may benefit from practicing with US-guided biopsy simulation models to enhance hand-eye coordination.
- Supervised practice: Residents should initially perform CNB under close supervision, gradually increasing their independence as they gain proficiency.
- Standardized competency assessments should employ objective performance metrics, such as diagnostic accuracy, patient safety, and procedural confidence, to evaluate trainees.
- By implementing these strategies, surgical training programs can ensure that residents acquire the necessary skills to safely and effectively perform CNB.

Future Directions

Further research should focus on:

- Multi-center studies to validate our findings in larger, more diverse patient populations.
- Comparative studies evaluating CNB performance between residents and experienced specialists.
- Long-term outcome analysis to assess rare complications, such as tumor seeding.
- Implementation of standardized training curricula for CNB in surgical education.

Study Limitations

This retrospective single-center study is based on 65 procedures performed by a single diagnostic US–certified general surgery resident under specialist supervision, which limits the generalizability of the findings to other residents, institutions, and training programs. The sample size is too small to reliably detect rare complications or modest predictors of diagnostic success; with zero events, the upper bound of the 95% confidence interval for the true complication rate is still approximately 4.6%. All patients underwent 24-hour in-hospital observation according to local policy; this may have improved detection of delayed events but reduces comparability with outpatient 4-6-hour monitoring protocols and cannot exclude complications arising beyond this period. In addition, no comparator group (e.g. radiologists or hepatologists) was included, and lesion size data were missing for a minority of patients, limiting more detailed subgroup analyses.

CONCLUSION

In this preliminary single-center, single-operator case series, US-guided liver CNB performed by a supervised, diagnostic US-trained general surgery resident was associated with a high diagnostic yield and no clinically overt complications during a 24-hour in-hospital observation period. These results

suggest that within a structured and closely supervised training pathway, selected general surgery residents can safely and effectively perform US-guided liver CNB. However, the findings are hypothesis-generating rather than definitive, and larger multi-operator and multicenter studies, including comparative analyses involving imaging specialists and outpatient monitoring protocols, are needed to confirm and extend these observations.

Ethics

Ethics Committee Approval: Ethical approval for this retrospective study was obtained from the Institutional Ethics Committee of Medical University of Lodz (number: RNN/230/25/KE, number: 09.09.2025).

Informed Consent: Informed consent was not required for participation in the study.

Footnotes

Author Contributions

Surgical and Medical Practices - W.C.; Concept - W.C., J.S., A.K., A.P.; Design - A.D.; Data Collection or Processing - A.S., W.C., A.D., P.H., K.K.; Analysis or Interpretation - W.C., J.S., A.K., A.P.; Literature Search - W.C., T.K., K.S.; Writing - A.S., W.C., A.D., J.S., P.L., K.S.

Conflict of Interest: No conflict of interest was declared by the authors.

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REFERENCES

1. *European Association for the Study of the Liver. EASL clinical practice guidelines on the management of hepatocellular carcinoma. J Hepatol. 2025;82:315-74.*
2. *Wang L, Wang J, Zhang X, Li J, Wei X, Cheng J, et al. Diagnostic value of preoperative needle biopsy for tumor grading assessment in hepatocellular carcinoma. PLoS One. 2015;10:e0144216.*
3. *Kadri Aribas B, Dingil G, Ungul U, Sahin G, Nil Unlu D, Dogan K, et al. Accuracy and safety of percutaneous US-guided needle biopsies in liver metastasis and hemangiomas. Minerva Gastroenterol Dietol. 2010;56:377-82.*
4. *Program specjalizacji w dziedzinie chirurgii ogólnej (moduł podstawowy i moduł specjalistyczny) dla lekarzy nieposiadających odpowiedniej specjalizacji I lub II stopnia lub tytułu specjalisty w odpowiedniej dziedzinie medycyny. Warszawa 2023.*
5. *Heimbach JK, Kulik LM, Finn RS, Sirlin CB, Abecassis MM, Roberts LR, et al. AASLD guidelines for the treatment of hepatocellular carcinoma. Hepatology. 2018;67:358-80.*
6. *Takano Y, Noda J, Yamawaki M, Azami T, Kobayashi T, Niiya F, et al. Comparative study of an ultrasound-guided percutaneous biopsy and endoscopic ultrasound-guided fine-needle aspiration for liver tumors. Intern Med. 2021;60:1657-64.*
7. *Siegel RL, Miller KD, Wagle NS, Jemal A. Cancer statistics, 2023. CA Cancer J Clin. 2023;73:17-48.*
8. *Di Tommaso L, Spadaccini M, Donadon M, Personeni N, Elamin A, Aghemo A, et al. Role of liver biopsy in hepatocellular carcinoma. World J Gastroenterol. 2019;25:6041-52.*
9. *Rockey DC, Caldwell SH, Goodman ZD, Nelson RC, Smith AD; American Association for the Study of Liver Diseases. Liver biopsy. Hepatology. 2009;49:1017-44.*
10. *Matsubara J, Okusaka T, Morizane C, Ikeda M, Ueno H. Ultrasound-guided percutaneous pancreatic tumor biopsy in pancreatic cancer: a comparison with metastatic liver tumor biopsy, including sensitivity, specificity, and complications. J Gastroenterol. 2008;43:225-32.*
11. *Tzortzis D, Revenas K, Deladetsima I, Antoniou E, Tzortzis G. Percutaneous US-guided liver biopsy in focal lesions using a semiautomatic device allowing to perform multiple biopsies in a single-pass. Minerva Gastroenterol Dietol. 2012;58:1-8.*