Safety and Efficacy Performance of Coaxial 18G vs 20G Needles for Pediatric Percutaneous Liver Biopsy: A Retrospective Cohort Study

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Article

Safety and Efficacy Performance of Coaxial 18G vs 20G Needles for Pediatric Percutaneous Liver Biopsy: A Retrospective Cohort Study

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Abstract

liver biopsy is a cornerstone in the diagnostic and therapeutic management of pediatric liver diseases, yet data on the optimal needle gauge for coaxial techniques in children remain scarce. Smaller-gauge needles may enhance safety but could potentially compromise diagnostic yield. **Objectives:** To compare the safety, diagnostic adequacy, and clinical impact of ultrasound-guided percutaneous liver biopsies performed with semi-automated coaxial 18-G versus 20-G needles in pediatric patients. **Patients and Methods:** This retrospective cohort study included all consecutive patients aged ≤19 years who underwent percutaneous liver biopsy at a tertiary university-affiliated medical center between 2006 and 2012. Demographics, biopsy technique (needle gauge, number of cores, tract embolization), diagnostic yield, and procedure-related complications were analyzed. Technical adequacy was defined by diagnostic pathology, ≥7 portal tracts, or direct impact on patient management. Complications were classified according to the Society of Interventional Radiology guidelines. **Results:** A total of 320 biopsies were performed in 260 patients (44.6% females, mean age 7.4±6 years). Indications included post-liver transplantation (28.4%) and unexplained liver enzyme elevation (22.5%). Biopsies were performed with 18G (46.3%) or 20G (53.7%) needles, obtaining a median of three cores. Technical success was achieved in 100% of cases, with biopsy results influencing clinical management in 39.7%. The overall complication rate was 5.3% (3.4% minor, 1.9% major), with no procedure-related mortality. Complication rates did not differ significantly between 18G and 20G needles (p=0.41). **Conclusions:** Ultrasound-guided coaxial percutaneous liver biopsy in children demonstrates high diagnostic yield and low complication rates. The use of a 20G needle is as safe and effective as an 18G needle, supporting its routine use across all pediatric age groups.

Keywords: liver biopsy; Coaxial needle gauge; Ultrasound-guided biopsy; Diagnostic yield; complications

Introduction

Histopathological evaluation of the liver is crucial for the diagnosis, management, and appropriate investigation of a wide range of malignant and benign liver diseases in pediatric patients. Percutaneous liver biopsy has become the standard technique for obtaining liver tissue for histological examination [1–3]. The success of this procedure is determined not only by the acquisition of sufficient tissue for histological diagnosis but also, and perhaps more importantly, by its safety profile. Early studies of pediatric percutaneous liver biopsies indicated a higher rate of complications in very young children and immunocompromised patients, such as those post-transplant and oncology patients [2,4,5]. Furthermore, the use of ultrasound guidance has been

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demonstrated to enhance the safety profile of liver biopsies [1,6–8]. Studies employing needles ranging from 15G to 20G have reported 0% and 9.2% complication rates. [1–4,6,9–14] No previous studies have compared the efficacy and safety of biopsies performed with different needle gauges. [15–21].

The coaxial biopsy technique entails the insertion of a biopsy needle through a larger, outer guiding needle. This method reduces the frequency of repeated punctures of the liver capsule. Hatfield [9] conducted a comparative study on coaxial versus non-coaxial liver and kidney biopsies in adults, revealing no significant difference in complication rates between the two techniques, although differences in diagnostic efficacy were not reported. The coaxial approach offers potential advantages, such as decreased capsule punctures, the ability to obtain multiple samples in a shorter time frame due to the pre-established pathway, and the option to embolize the needle tract with hemostatic agents (e.g., Gelfoam particles, as utilized in our center). A potential drawback is the requirement for a larger outer needle or the use of a smaller biopsy needle, which may compromise tissue yield. Additionally, the coaxial technique samples only a single area, potentially increasing sampling bias.

The objective of our study was to evaluate the safety and efficacy of semi-automated coaxial liver biopsies conducted with 18G and 20G inner biopsy needles in pediatric patients up to 19 years of age. Currently, there is a paucity of data regarding the use of smaller-gauge needles in this demographic. We posited that employing a smaller-gauge coaxial needle (20G) for pediatric liver biopsy would enhance safety without compromising diagnostic accuracy when compared to larger or non-coaxial needles. The outcomes of this study may aid our Interventional Radiology Unit in formulating definitive guidelines for liver biopsies in pediatric and potentially adult population.

Patients and Methods

Study Population

The cohort comprised all consecutive patients who met the following inclusion criteria: age ≤19 years and having undergone percutaneous liver biopsy at a tertiary university-affiliated medical center between June 1, 2006, and April 30, 2012.

Procedure

As previously described, experienced interventional radiologists conducted all biopsies under ultrasound guidance. [1,6] Written informed consent was obtained from the parents before each procedure, and coagulation parameters (platelet count and INR) were corrected when necessary. All biopsies were performed under general anesthesia. A subxiphoid anterior approach (segment 4) was preferred, although the exact entry site was at the operator's discretion. Local anesthesia with 1% lidocaine and a ~2 mm skin incision was utilized. Biopsies were performed using semi-automated coaxial core-needle systems: outer needles 17G or 19G, with corresponding inner biopsy needles of 18G or 20G, from various manufacturers. When blood was observed within the outer coaxial needle, or when INR >1.5 or platelets <100,000/μL, the needle tract was prophylactically embolized using Gelfoam particles, as described by Amaral.[4]. Outpatients were routinely monitored for 24 hours post-procedure.

Data Collection

The study was conducted in accordance with the Helsinki Declaration and approved by the local Institutional Review Board. Retrospective data were extracted from the patients' angiography logs, electronic medical records, and gastroenterology clinic archives. The variables collected included demographics (age, date of biopsy), technical details (needle gauge, number of cores, and tract embolization), pathology (diagnostic yield and number of portal tracts), and clinical outcomes (indication, complications, and impact on management). A biopsy was deemed technically adequate

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if a diagnostic pathology report was obtained and/or ≥7 portal tracts were present, and/or no repeat biopsy was required owing to insufficient material, and/or the result directly influenced patient management. Complications were categorized as minor or major in accordance with the Society of Interventional Radiology guidelines for percutaneous image-guided biopsies.[15] Major complications included those necessitating blood transfusion, ICU admission, surgery, prolonged hospitalization (>48 hours), permanent damage, or death.

Statistical Analysis

Descriptive statistics were used for the analysis. Continuous variables are presented as mean ± standard deviation (SD) or median with interquartile range (IQR). Categorical variables were expressed as frequencies and percentages. Chi-square tests were employed to compare categorical data, and Chi-square tests were used to calculate the p-value between major and minor complications. Complication and success rates were reported with 95% confidence intervals. Sample size calculation was not conducted, as all eligible biopsies over six years were included in the study. A 95% confidence interval was used. Statistical significance was set at $p < 0.05$. All statistical analyses were performed using SPSS version 25.0 (SPSS Inc., Chicago, IL)

Results

Cohort Description

A total of 320 percutaneous liver biopsies were performed in 260 pediatric patients between January 2006 and April 2012. Table 1 presents the distribution of the number of biopsies per patient. Most patients (85.8%, n=223) underwent a single biopsy, while the remainder underwent 2–6 biopsies. Notably, three patients who underwent five or more biopsies were liver transplant recipients. The cohort comprised 116 females (44.6%) and 144 males (55.4%). The age of participants ranged from 18 days to 18 years and 11 months, with a mean age of 7.4±6 years and a median age of 5.9 years (IQR: 1.9–12.6 years). The mean age at the time of the first biopsy was 7.3±6.1 years. No discernible temporal trends were observed in the annual number of biopsies.

Table 1. Number of biopsies per patient.

No of biosies	Frequency	Percent
1	223	85.8
2	23	8.8
3	9	3.5
4	2	0.8
5	2	0.8
6	1	0.4
Total	260	100.0

Indications

Table 2 details the indications for biopsies, encompassing a total of 320 cases. The most prevalent indication for biopsy was post-liver transplantation (n=91, 28.4%), followed by unexplained elevation of liver enzymes (n=72, 22.5%). Additional indications included inflammatory bowel disease, chronic kidney disease, diabetes, immunodeficiency, hematologic/oncologic disorders, and pre- or post-transplantation monitoring.

All biopsies were performed coaxially using inner needles of either 18G or 20G: 148 (46.3%) with 18G, 172 (53.7%) with 20G.

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Table 2. Biopsy Indications.

Biopsy Indications		
	Frequency	Percent
Post Liver Transplant	92	28.7
Liver Disorder NOS	72	22.4
Neonatal Cholestasis	29	9.0
Infectious (HCV, HBV, CMV)	23	7.2
Post BMT	21	6.5
Fulminant Hepatic Failure	17	5.3
Autoimmune Hepatitis (suspected or proven in previous biopsy)	17	5.3
Portal Hypertension	4	1.2
Metabolic Disease	3	.9
Desferal Treatment for Thalasemia	3	.9
Familial Mediteranian Fever (FMF)	3	.9
Fever of Unknown Origin (FUO)	2	.6
Total Parenteral Nutrition (TPN)	2	.6
Other	33	10.3
Total	321	100.0

Other: includes children with elevated liver enzymes, and other underlying disease such as: inflammatory bowel disease, chronic kidney failure, diabetes, immune deficiency, hemato-oncologic disease. NOS – not otherwise specified. HCV – hepatitis C virus. HBV – hepatitis B virus. CMV – cytomegalovirus. BMT – bone marrow transplantation.

Core Numbers and Tract Embolization

The number of cores obtained ranged from 2 to 7, with a median value of 3. Gelfoam tract embolization was employed in 51.9% of cases, predominantly in 18G biopsies (90% compared to 20% for 20G biopsies).

Diagnostic Yield

All biopsies satisfied the criteria for technical adequacy, achieving a 100% success rate in each case. Four repeat biopsies were conducted: two due to suspected sampling error despite adequate material, one owing to early non-diagnostic sampling in an infant with biliary atresia, and one with unclear documentation. No statistically significant differences in repeat rates were observed between the 18G and 20G groups.

Clinical Impact

Biopsy results influenced clinical management in 39.7% of cases, most frequently in the context of autoimmune hepatitis, infectious workup, neonatal cholestasis, and post-transplant assessment. Table 3 describes the impact of pathologic biopsy results on patient management, by Indication.

Table 3. Pathologic Result's Effect on Patient Management, per Indication.

Indication	Effect			Total
	yes	no	unknown	
Autoimmune Hepatitis (suspected or proven in previous biopsy)	11(64.7%)	4(23.5%)	2(11.8%)	17
Infectious (HCV, HBV, CMV)	14(60.9%)	8(34.8%)	1(4.3%)	23
Neonatal Cholestasis	16(55.2%)	12(41.4%)	1(3.4%)	29
Post Liver Transplant	47(51.6%)	43(47.3%)	1(1.1%)	91
Fulminant Hepatic Failure	5(29.4%)	12(70.6%)	0	17

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Liver Disorder NOS	19(26.4%)	48(66.7%)	5(6.9%)	72
Post BMT	2(9.5%)	1(4.8%)	18(85.7%)	21
Fever of Unknown Origin (FUO)	1(50%)	1(50%)	0	2
Portal Hypertension	0	3(75%)	1(25%)	4
Familial Mediteranian Fever (FMF)	0	3(100%)	0	3
Metabolic Disease	1(33.3%)	1(33.3%)	1(33.3%)	3
Desferal Treatment for Thalasemia	0	0	3(100%)	3
Total Parenteral Nutrition (TPN)	2(100%)	0	0	2
Other	9(27.3%)	21(63.6%)	3(9.1%)	33
Total	127(39.7%)	157(49.1%)	36(11.2%)	320

Other: includes children with elevated liver enzymes, and other underlying diseases such as: inflammatory bowel disease, chronic kidney failure, diabetes, immune deficiency, hemato-oncologic diseases. NOS - not otherwise specified. HCV - hepatitis C Virus. HBV - Hepatitis B Virus. CMV - Cytomegalovirus. BMT - bone marrow transplantation.

Complications

The overall complication rate was 5.3% (95% CI: 2.85–7.75%), comprising 3.4% minor and 1.9% major complications. No procedure-related mortality was reported. One patient required surgical intervention due to a biliary leak following concomitant cholecystostomy, and three patients required blood transfusion, with only one directly attributable to biopsy-related hemorrhage. Comparing the two needle gauges, the 20G needle shows a slightly higher percentage of both minor (4.0% vs. 2.7%) and major (2.9% vs. 0.7%) complications compared to the 18G needle, based on the provided raw counts and percentages. However, as previously analyzed using the Chi-square test, these differences were not statistically significant for either major or minor complications at a 0.05 significance level. The complication rates did not differ significantly between the 18G and 20G groups (p=0.29 and 0.71 respectively) (Table 4). No significant associations were identified between complications and variables such as age, indication, core number, or tracheostomy.

Table 4. Complication Rate by Needle Gauge.

	Complications			Total
	none	minor	major	
18-G	143(96.6%)	4(2.7%)	1(0.7%)	148
20-G	160(93%)	7(4.0%)	5(2.9%)	172
Total	302(94.4%)	11(3.4%)	6(1.9%)	320

The p-value for the difference in general (minor and major) complication rate, between 18G and 20G is 029 and 0.71(non-significant). The 95% confidence interval for the general complication rate in the total sample is 2.85%-7.75%

Discussion

Our study did not reveal any statistically significant differences in safety or efficacy between the use of 20-G and 18-G coaxial needles for percutaneous liver biopsies in pediatric patients. Technical success was achieved in all biopsy procedures. In four instances where a repeat biopsy was necessary, two were attributed to suspected sampling errors rather than insufficient material, while in the remaining two cases, the medical records did not specify whether the nondiagnostic result of the initial biopsy was due to technical issues (such as insufficient tissue) or other factors (e.g., early biopsy with limited pathological findings). The overall complication rate was 5.3%, with 1.9% of patients classified as having major complications. Comparing the two needle gauges, the 20G needle shows a slightly higher percentage of both minor (4.0% vs. 2.7%) and major (2.9% vs. 0.7%) complications compared to the 18G needle. No statistically significant differences were observed between the 20G

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and 18G needles, nor was any association identified between complications and other parameters, such as age, biopsy indication, or the number of cores obtained. These rates are comparable to those reported in the literature for larger diameter and non-coaxial needles. In Hatfield's study [9], the complication rate for both coaxial and non-coaxial needles (18G and 20G) was 3.2%, with 0.8% classified as major complications. No statistically significant difference was found between the coaxial and non-coaxial techniques. In that study, 5% of all liver and kidney biopsies were performed using 20G needles; however, the complication rates for 20G liver biopsies were not reported.

Scheimann et al. [3] examined liver biopsies using non-coaxial needles ranging from 15G to 18G, reporting an overall complication rate of 6.83%, including 2.4% major complications. No statistically significant differences were observed between the different needle types. However, they noted an increased incidence of bleeding complications in children under five years of age when using ASAP spring-loaded needles (non-coaxial). The small cohort size and potential selection bias may have influenced their results. Additionally, some biopsies were performed on specific lesions, in contrast to our study, which exclusively included general liver biopsies. As indicated, we did not identify any statistically significant association between patient age and the complication rates. Two studies by Nabili et al. [1,6] assessed the safety and efficacy of ultrasound-guided biopsies and concluded that sonographic guidance significantly enhanced biopsy performance. Their adequacy criteria included a core length of >15 mm and >10 portal tracts in the specimen. In 421 biopsies conducted using non-coaxial 18G needles with a single pass in 80% of cases, they reported a 100% technical success rate and no bleeding or other major complications. However, the report did not specify the definition of a complication. As detailed in the results section, within our cohort of 320 biopsies, only one case of severe bleeding was directly attributable to the biopsy. Sornsakrin et al. [10] investigated biopsies in a subgroup of pediatric liver transplant recipients, reporting an overall complication rate of 5%, including 1.7% major complications. The needle gauge was not specified in their reports. This complication rate is comparable to ours, possibly because liver transplantation was the most common indication in our study. However, no statistically significant association was identified between complication rates and indications such as liver transplantation or bone marrow transplantation (both higher-risk populations).

Hoffer et al. [2] concentrated on a subgroup of pediatric oncology patients, including those who had undergone bone marrow transplantation. Of the 22 percutaneous liver biopsies, 21 were coaxial (21 with 17G and one with 14G). Tract embolization was performed in all patients. They reported a 100% technical success rate, with three of 22 cases experiencing bleeding complications, including one major complication that necessitated the transfusion of blood products. Amaral et al. [4] examined the complication rates of biopsies performed on children under one year of age. The majority of these biopsies utilized non-coaxial 18G needles, with only seven out of 65 biopsies employing coaxial 17G needles. Tract embolization was performed in all cases. The overall complication rate was 9.2%, with major complications occurring in 4.6% of cases, suggesting higher complication rates in infants. In our study, 49 infants under one year of age were included; 16 underwent biopsy with a 20-G coaxial needle (needle gauge data were unavailable for 20 cases). The overall complication rate in this cohort was 4 (8.2%), with two (4.1%) major complications. In summary, a review of the literature indicates that the overall complication rate for pediatric percutaneous liver biopsies ranges from 0% to 9.2%. The results of our study are consistent with the reported range.

The limitations of our study primarily stem from its retrospective design, which resulted in some missing data, as detailed in the Results section. The inclusion of these missing data might have slightly altered the findings. Additionally, the retrospective nature of the study constrains our ability to evaluate minor complications and the rationale for post-procedure ultrasound surveillance. It is not always feasible to ascertain the timing of complication onset following a biopsy, a factor that may influence guideline recommendations for post-biopsy monitoring. This issue has been previously examined, and guidelines from the American Gastroenterological Association [5] and Society of Interventional Radiology [22] are available. Our institutional guidelines were more stringent. Our

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study exclusively included general liver biopsies, excluding those from patients with focal lesions. The primary endpoint was to assess the pathological diagnosis and its impact on clinical management.

In conclusion, we found that the use of a 20G coaxial needle is as safe and technically effective as the use of a larger (18G) needle. Therefore, we recommend using a smaller needle gauge across all pediatric age groups.

Author Contributions: Both authors designed, collected the data, made statistical analysis, made bibliographical review and wrote the manuscript.

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Data Availability Statement: The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

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Conflicts of Interest: Authors declared no conflict of interest and no funding.

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