REV SEN
rev-sen.ec

Handheld portable ultrasound as an affordable alternative in resource-limited countries. A single-center observational study.

Cristina Chediak [1,2,3], Adela Marisol Angüisaca Vela [1], Mayra Oñate [1], María Belén Larco Vargas [1], Meri Magoli Orna [1], Juan Cristóbal Santacruz Mancheno [1].

1. Nephrology Service, Calderón General Teaching Hospital, Ministry of Public Health, Quito, Ecuador.
2. Nephrology Service, Vozandes Quito, Ecuador.
3. Department of Nephrology, Hospital Metropolitano de Quito, Ecuador.
4. Menydial Kidney Clinic, Quito, Ecuador.

Abstract

Introduction: Percutaneous native kidney biopsy (PNKB) is crucial for diagnosing renal pathology. In resource-limited environments, handheld ultrasound devices may offer a cost-effective alternative for procedural guidance. We aimed to compare the safety and diagnostic yield of PNKB performed with handheld versus high-end ultrasound systems.

Methods: Retrospective cohort study at Calderón General Teaching Hospital (2021–2023), including adult patients undergoing ultrasound-guided PNKB. Procedures were categorized by device: handheld (Butterfly iQ with iPhone) versus high-end (Philips Sparq). We collected data on demographics, biopsy indications, number of passes, glomerular yield, histological diagnosis, and complications. Diagnostic adequacy and safety outcomes were compared using chi-square and t tests.

Results: A total of 57 PNKBs were analyzed (22 handheld; 35 high-end). Patients were 56% female, with a mean age of 33.8 ± 12.7 years. The average number of glomeruli obtained per core was 15.7 ± 8.1. Overall, 82.5% of procedures were complication-free; 17.5% had minor complications (pain ≥12 h, hematoma, or macroscopic hematuria); and no significant complications occurred. Complication-free rates were similar between groups (handheld: 72.7% vs. high-end: 88.6%; p = 0.39). Diagnostic adequacy was achieved in 85.7% of biopsies, with no significant difference between handheld (81.8%) and high-end (88.2%; p = 0.50).

Conclusion: Handheld ultrasound-guided PNKB demonstrates safety and diagnostic yield comparable to those of high-end systems, offering a low-cost, effective alternative in resource-limited settings. Wider adoption may enhance access to renal biopsy without compromising quality or safety.

Received: July 8, 2025.
Accepted: October 10, 2025.
Published: October 16, 2025.
Editor: Dr. Franklin Mora.

How to cite:
Chediak C, Angüisaca A, Oñate M, Larco M, Orna M, Santacruz J. Handheld portable ultrasound as an accessible alternative in resource-limited countries. A single-center observational study. REV SEN 2025; 14(1):30-38.

DOI: http://doi.org/10.56867/121
Sociedad Ecuatoriana de Nefrología, Diálisis y Trasplantes.

ISSN-L: 2953-6448

* Corresponding author

Email: Juan Cristobal Santacruz Mancheno < geovas40@hotmail.com >/Address: Calle Vozandes N39-130 and Av. América, Ankara Building, 2nd floor. Tel: 02-3317070, CP 170521, Quito, Ecuador.

Keywords:

Ultrasound Portable, Percutaneous renal biopsy, Resources limited, Profitability Diagnostic, Safety.

Percutaneous renal biopsy (PRB) is an indispensable diagnostic tool in nephrology and is essential for histopathological classification, prognosis, and therapeutic planning for various glomerular and tubulointerstitial kidney diseases [1]. Traditionally, this procedure has been guided by high-end ultrasound (HEUS), which enables precise visualization of the renal parenchyma, thereby improving diagnostic performance and reducing complication rates [2]. However, access to these devices can be limited in healthcare facilities with scarce resources, especially in low- and middle-income countries, where technological availability is uneven.

In this context, handheld portable ultrasound scanner (held) ultrasound (EG-P) devices have emerged as promising alternatives. These devices, based on low-cost, highly portable ultrasound technology, have shown encouraging results in various clinical settings, from pulmonary assessment to the identification of abdominal or cardiac abnormalities [2-4]. Their application in interventional procedures, such as bi-orespiratory surgery (BRS), has sparked growing interest because of their potential to democratize access to advanced diagnostic techniques without compromising safety or efficacy.

Recent studies have shown that handheld ultrasound systems can provide adequate image quality for guiding procedures such as paracentesis, thoracentesis, and even renal punctures, provided that they are used by trained personnel [5, 6]. However, evidence regarding their specific utility in performing native renal biopsies remains limited and poorly systematized, particularly in settings where their implementation would have a greater impact.

This study aims to compare the safety and diagnostic performance of biorespiratory biopsies guided by handheld ultrasound and high-end ultrasound systems in a secondary-level hospital in Ecuador. This comparison could have relevant implications for nephrology practice in resource-limited countries, where the incorporation of accessible, efficient tools is urgently needed to close gaps in the timely diagnosis of kidney diseases [7].

Materials and methods

Studio design

This was an observational, cross-sectional study. The source is retrospective.

Scenery

This study was conducted in the nephrology department of the Calderón General Teaching Hospital, a Ministry of Public Health facility in Quito, Ecuador. The study period was from January 1, 2021, to December 31, 2023.

Participants

Historical records of adult patients aged 18 years or older who underwent conventional renal biopsy were included. No records were excluded. The group that underwent the procedure guided by handheld ultrasound was compared with the group guided by conventional ultrasound (control group).

Variables

The sociodemographic variables included age, sex, comorbidities, indication for renal biopsy, number of punctures, percentage of adequate sample, glomerular count, and histological diagnosis. The objective variables were the presence of complications —pain for more than 12 hours, hematuria for more than 24 hours, and hematomas.

Data sources/measurements

BRP indications

They were established according to the recommendations contained in the usual clinical guidelines and included the following: 1) nephrotic syndrome (NS): proteinuria ≥ 3.5 g/24 h with hypoalbuminemia; 2) prolonged acute renal failure of unknown origin (> 3 weeks); 3) persistent urinary abnormalities: the presence of microhematuria in the urinary sediment maintained over time (more than 3 determinations) with other causes of microhematuria excluded (lithiasis, infection, etc.); 4) proteinuria > 1 g/24 with suspected glomerular etiology; and 5) lupus with proteinuria ≥ 500 mg/24 hours.

Biopsy procedure and postbiopsy monitoring

Before the procedure, the following methods were performed: 1) laboratory tests, including complete blood count, coagulation studies, urea and creatinine, elemental and microscopic urine analysis, blood group and Rh factor; and 2) renal ultrasound.

BRP was performed in patients without absolute contraindications, with standard or correctable coagulation tests, blood pressures below 160/90 mmHg, hematocrit values equal to or greater than 30, and without the use of antiplatelet or anticoagulant drugs (the withdrawal of these medications was carried out according to usual recommendations).

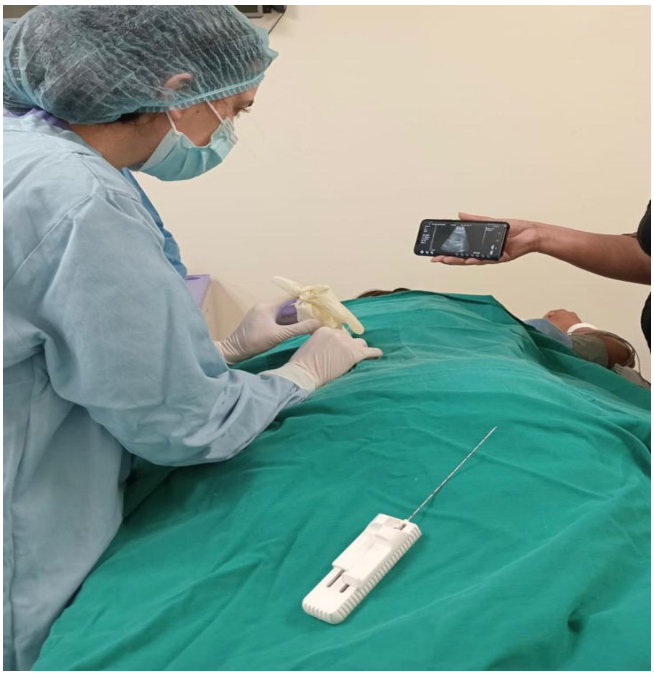
All percutaneous renal biopsies were performed by nephrologists with the patient in the prone position, guided by real-time ultrasound, accessing the lower pole of the left kidney. In cases of anatomical difficulties on that side, a percutaneous renal biopsy was performed on the lower pole of the right kidney. The procedure was performed using 16- or 18-gauge semiautomatic needles, 10-15 cm in length, to obtain two renal tissue cores via a maximum of 4 punctures.

Two types of ultrasound equipment were used throughout the study. In the initial phase, a Philips Sparq ultrasound scanner (high-end, EG-A) was used (Figure 1). In contrast, in later stages, a portable ultrasound scanner (Butterfly IQ, EG-P) connected to an iPhone was used. The change in device type was due to logistical considerations and technological availability at different points in the study.

The BRPs were processed in the Synlab laboratory for study via optical microscopy and immunofluorescence.

Following the procedure, patients remained hospitalized for 24 hours in the supine position under strict bed rest, with vital signs and urine output monitored. Twenty-four hours after the biopsy, a complete blood count and bedside ultrasound were performed. Patients with favorable progression were discharged.

Figure 1. Renal biopsy performed with handheld portable ultrasound.



Biases

The surveys were administered in a standardized manner by the principal investigator via a preestablished guide approved in the research protocol. The data were independently reviewed by two researchers and recorded in duplicate. Only records with complete agreement were included. Clear definitions of the inclusion and exclusion criteria, as well as obtaining a recent clinical history, helped minimize selection and information bias.

Study size

The sample was selected via convenience sampling to recruit adult patients who had undergone a renal biopsy during the study period, meeting the inclusion criteria.

Quantitative variables

The results for ordinal variables are presented as frequencies and percentages. The results for the scale variables are presented as averages. Scale variables were not converted into quantitative variables.

Statistical analysis

Medical records were reviewed to collect data on the patients' demographic and clinical characteristics, the details of the procedure (biopsied kidney, number of punctures), the representativeness of the sample, the histopathological diagnosis, and the complications associated with the biopsy.

The complications associated with BRP were classified as follows: 1) Major: When blood transfusion and/or surgery were performed, nephrectomy, arteriography, embolization, or death were needed. 2) Minor: a decrease in hemoglobin >1 g/L without the need for blood transfusion or other endovascular or surgical techniques.

To compare qualitative variables between groups, the chi-square test was used. To analyze differences in the means of quantitative variables between groups, Student's t-test for independent samples was used. Statistical analysis was performed via Microsoft Excel 2013 and SPSS 15.

Results

Participants

There were 22 patients in the portable ultrasound group (ECO-P), and 35 patients underwent high-end ultrasound (ECO-AG).

Characteristics of the study population

In both groups, age was similarly distributed, with a mean age of approximately 30 years. In the high-end ultrasound group, there was a greater proportion of men (27.3%) than in the low-end ultrasound group (54.3%) (P = 0.045). The most common comorbidity and indication was the presence of systemic lupus erythematosus (Table 1).

Characteristics of renal biopsy samples and histology

In both groups, the left kidney was the preferred biopsy site, with more than 95% of samples obtained from that kidney. The number of punctures performed in both groups was 2, with adequate sampling rates of 81.8% in the ECO-P group and 88.2% in the ECO-AG group (P=0.50). The histological results are presented in Table 2. Lupus nephritis was the most common diagnosis in both groups, followed by membranous nephropathy and immunoglobulin A nephropathy. The histologically inadequate sample rate was 4.5% in the ECO-P group and 2.9% in the ECO-AG group, with no statistically significant difference.

Table 1. Baseline characteristics of the biopsied patient groups .

Category	ECO-P n=22	ECO-AG n=35	*P*
Age	39.2(14.0)	30.5 (10.7)	0.097
Sex-Male	6 (27.3%)	19 (54.3%)	0.045
Comorbidities			
Hypertension	1 (4.5%)	11 (32.4%)	0.098
Diabetes mellitus	0	1 (2.9%)	
Coronary artery disease	0	1 (2.9%)	
Hypothyroidism	2 (9.1%)	1 (2.9%)	
Thrombocytopenic purpura	0	4 (11.8%)	
Other autoimmune diseases	1 (4.5%)	1 (2.9%)	
Liver disease	1 (4.5%)	1 (2.9%)	
Neoplasms	1 (4.5%)	0	
Lupus	12 (54.5%)	10 (28.6%)	0.05
Indication for renal biopsy			
Nephrotic syndrome	7 (31.8%)	18 (51.4%)	0.269
Nonnephrotic proteinuria	1 (4.5%)	1 (2.9%)	
Hematuria	2 (9.1%)	0	
Nonnephrotic proteinuria and hematuria	0	1 (2.9%)	
Acute kidney injury	0	2 (5.7%)	
Nephritic syndrome	1 (4.5%)	2 (5.7%)	
Lupus with active urinary sediment	11 (50%)	11 (31.4%)	

Table 2. Sampling characteristics and histological results.

Category	ECO-P n=22 (%)	ECO-AG n=35 (%)	*P*
Kidney: Left (%)	21 (95.5%)	34 (97.1%)	0.736
Number of punctures (n)	2.3 (0.55%)	2.2 (0.47%)	0.329
Adequate sample (%)	18 (81.8%)	30 (88.2%)	0.50
Glomeruli (n)	15.4 (7.4%)	16.0 (8.6%)	0.264
Histological diagnosis			
Membranous	8 (36.4%)	7 (20%)	0.087
Focal and segmental	0	1 (2.9%)	
IgA	2 (9.1%)	2 (5.7%)	
Membranoproliferative	0	2 (5.7%)	
Minimal changes	0	1 (2.9%)	
Lupus	11 (50%)	12 (34.3%)	
Amyloidosis	0	1 (2.9%)	
diabetic CKD	0	1 (2.9%)	
Other	0	7 (20%)	
Inadequate sample	1 (4.5%)	1 (2.9%)	

CKD: Chronic kidney disease. IgA: Immunoglobulin A. ECO-P: Portable ultrasound. ECO-AG: High-end ultrasound.

Table 3. Complications of the procedure.

Category	ECO-P n=22 (%)	ECO-AG n=35 (%)	*P*
None	16 (72.7%)	31 (88.6%)	0.39
Pain > 12 Hours	2 (9.1%)	2 (5.7%)	
Hematuria > 24 h	1 (4.5%)	1 (2.9%)	
Hematoma	3 (13.6%)	1 (2.9%)	

No complications such as transfusions, urinary tract infection, puncture site infection, arteriovenous fistula, liver puncture, pancreatic puncture, spleen puncture, or need for invasive procedures were recorded. ECO-P: Portable ultrasound. ECO-AG: High-end ultrasound.

Complications of the procedure

There were no differences in complications between patients who underwent the procedure with portable ultrasound and those who underwent it with high-gamut ultrasound. There were 6 (27.3%) complications in the portable ultrasound group and 4 (12.9%) in the high-gamut ultrasound group (P = 0.126) (Table 3).

Discussion

Advances in the miniaturization, portability, and accessibility of ultrasound equipment are rapidly transforming this tool into an immediate diagnostic modality increasingly integrated into everyday medical practice. In clinical nephrology, bedside ultrasound with portable devices has demonstrated significant benefits for both nephrologists and their patients. Its use helps reduce care fragmentation, minimizes discomfort associated with patient transfer, shortens diagnostic times, and facilitates the performance of interventional procedures in non-conventional settings [8, 9].

In this context, the present study aimed to evaluate the safety and diagnostic cost-effectiveness of percutaneous renal biopsy guided by portable ultrasound in a single institution.

Our findings suggest that handheld portable ultrasound systems for percutaneous renal biopsies are a safe and effective alternative to high-end ultrasound systems, especially in technologically limited settings. The absence of significant complications and the similar diagnostic yields between the two groups reinforce the feasibility of using portable devices in secondary and tertiary hospital settings.

The diagnostic yield of 85.7% in our study falls within the range reported in the literature (80–95%) for image-guided biopsy of renal parenchyma (BRP) under optimal conditions [10–12]. Despite the less sophisticated technology of ultrasound-guided biopsy, adequate visualization of the renal parenchyma and an acceptable rate of representative sampling were achieved, consistent with previous findings validating the use of portable ultrasound in other image-guided procedures.

The number of glomeruli obtained in both groups in our study was consistent with that reported in the literature. Previous studies have shown that real-time ultrasound guidance allows the extraction of 11.6-21.6 glomeruli per biopsy [13]. In particular, one study found that nephrologists, on average, obtain 16-18 glomeruli, whereas interventional radiologists obtain 15-21.

The complication rate in our cohort was low, with only minor adverse events reported in both groups, and no statistically significant differences were observed between them. Compared to previously reported rates, the significant complication rate in our study was lower than the previously described range (0.5% to 6%), while the minor complication rate was similar [15-17].

A systematic review of 87 studies, including 118,604 renal biopsies from native kidneys, reported the following complication rates: pain at the puncture site (4.3%), macroscopic hematuria (3.5%), hematoma (11%), need for transfusion (1.6%), need for intervention to control bleeding (0.3%), nephrectomy (0.01%), and mortality (0.06%) [18].

On the other hand, a second study that analyzed 52,138 percutaneous renal biopsies reported a severe bleeding rate of 5%, a transfusion requirement of 5%, a need for angiographic intervention of 0.4%, a nephrectomy rate of 0.1%, and an overall mortality rate of 1% [19].

The rates of minor complications observed in these cohorts align with those reported in our analysis, further supporting the procedure's safety. Importantly, in our study, no patients required transfusion, surgical intervention, or radiological procedures, which affirms the safety of percutaneous renal biopsy regardless of the ultrasound machine used.

Although this study was not designed to prove superiority, it provides evidence supporting the noninferiority of portable ultrasound in terms of safety and diagnostic performance. This finding could have important implications in resource-limited countries, where investing in portable technologies might improve access to essential diagnostic procedures, such as renal biopsy, helping to reduce disparities in renal care. The main limitations of this study include its retrospective design, small sample size, and the fact that all procedures were carried out by trained nephrologists, which may not be applicable in other settings without specialized training. Future prospective studies with larger, multicenter samples could provide more substantial evidence regarding the use of portable ultrasound in renal biopsies and other nephrological procedures.

Conclusion

Handheld portable ultrasound scanners represent a practical, safe, and potentially cost-effective tool, comparable to high-end ultrasound-guided renal biopsy procedures, with relevant implications for expanding access to histopathological diagnoses in nephrology.

Abbreviations

BRP: Percutaneous renal biopsy.
ECO-P: portable ultrasound.
ECO-AG: high-end ultrasound.

Supplementary information

The supplementary materials have not been included.

Acknowledgments

We thank the medical, nursing, and administrative staff, as well as the patients of the Calderón General Teaching Hospital, where the study was conducted.

Authors' contributions

Cristina Chediak: Conceptualization, data curation, research, visualization, original draft writing.
Adela Anguisaca: Conceptualization, data curation, research, visualization, writing - original draft.
Mayra Oñate: Conceptualization, data curation, formal analysis, project management, software, validation, visualization, writing–review and editing.
Belén Larco: Conceptualization, formal analysis, methodology, project management, resources, software, supervision, validation, writing, review and editing.
Meri Orna: Conceptualization, data curation, research, visualization, original draft writing.
Juan Santacruz: Conceptualization, formal analysis, methodology, project management, resources, software, supervision, validation, writing, review and editing.
All the authors read and approved the final version of the manuscript.

Financing

The study was self-funded by the authors.

Availability of data or materials
Not applicable.

Statements

Ethics committee approval and consent to participate
The Bioethics Committee approved the study for Health Research of the Calderón General Teaching Hospital of the Ministry of Public Health, Quito, Ecuador.

Consent for publication
This does not apply when specific patient images, radiographs, or photographs are not published.

Conflicts of interest
The authors declare that they have no conflicts of interest.

Author information
Not declared.

References

1. Schnuelle P. Renal Biopsy for Diagnosis in Kidney Disease: Indication, Technique, and Safety. J Clin Med. 2023 Oct 9;12(19):6424. doi: 10.3390/jcm12196424. PMID: 37835066; PMCID: PMC10573674.
https://doi.org/10.3390/jcm12196424
PMid:37835066 PMCid:PMC10573674

2. Lo Cricchio, A., Storelli, A., Bertoletti, I. et al. Accuracy of lung ultrasound performed with handheld ultrasound device in internal medicine: an observational study. J Ultrasound 27, 825-830 (2024). https://doi.org/10.1007/s40477-024-00941-5
https://doi.org/10.1007/s40477-024-00941-5
PMid:39097546 PMCid:PMC11496455

3.Dayıoğlu M, Gürsel G, Özercan S, Aydın EM, Nadastepe Ö. Performance of handheld ultrasound devices in diagnosis of pulmonary hypertension and right heart dysfunction in ICU patients. Echocardiography. 2024 Jan;41(1):e15721. doi: 10.1111/echo.15721. Epub 2023 Dec 1. PMID: 38041481.

4. Shokoohi H, Boniface KS, Zaragoza M, Pourmand A, Earls JP. Point-of-care ultrasound leads to diagnostic shifts in patients with undifferentiated hypotension. Am J Emerg Med. 2017 Dec;35(12):1984.e3-1984.e7. doi: 10.1016/j.ajem.2017.08.054. Epub 2017 Aug 26. PMID: 28851498.

5. Pietersen PI, Madsen KR, Graumann O, Konge L, Nielsen BU, Laursen CB. Lung ultrasound training: a systematic review of published literature in clinical lung ultrasound training. Crit Ultrasound J. 2018 Sep 3;10(1):23. doi: 10.1186/s13089-018-0103-6. PMID: 30175392; PMCID: PMC6119680.

6. Segura-Grau A, Salcedo-Joven I, Montes-Belloso E, Cinza-Sanjurjo S, Segura-Fragoso A, Segura-Grau E. Usefulness of handheld ultrasound devices in the assessment of abdominal pathology and comparison with high-end ultrasound devices. Ultrasound J. 2025 Aug 5;17(1):38. doi: 10.1186/s13089-025-00433-5. PMID: 40762871; PMCID: PMC12325146.

7. Nelson BP, Melnick ER, Li J. "Portable ultrasound for remote environments, part I: feasibility of field deployment." J Emerg Med. 2011;40(2):190-197.
https://doi.org/10.1016/j.jemermed.2009.09.006
PMid:20097500

8. Narula J, Chandrashekhar Y, Braunwald E. Time to add a fifth pillar to bedside physical examination: inspection, palpation, percussion, auscultation, and insonation. JAMA Cardiol. 2018;3(4):346-350.
https://doi.org/10.1001/jamacardio.2018.0001
PMid:29490335

9. Moore CL, Copel JA. Point-of-care ultrasonography. N Engl J Med. 2011;364(8):749-757.
https://doi.org/10.1056/NEJMra0909487
PMid:21345104

10. Helvacı Ö, Korucu B, Gonul İİ, Arınsoy T, Guz G, Derici U. Kidney biopsy in elderly individuals: diagnostic adequacy and yield. Int Urol Nephrol. 2021 Jan;53(1):105-109. doi: 10.1007/s11255-020-02640-6. Epub 2020 Sep 17. PMID: 32940813.
https://doi.org/10.1007/s11255-020-02640-6
PMid:32940813

11. Chung S, Koh ES, Kim SJ, Yoon HE, Park CW, Chang YS, Shin SJ. Safety and tissue yield for percutaneous native kidney biopsy according to practitioner and ultrasound technique. BMC Nephrol. 2014 Jun 23;15:96. doi: 10.1186/1471-2369-15-96. PMID: 24957046; PMCID: PMC4071327.
https://doi.org/10.1186/1471-2369-15-96
PMid:24957046 PMCid:PMC4071327

12. Maya ID, Maddela P, Barker J, Allon M. Percutaneous renal biopsy: comparison of blind and real-time ultrasound-guided technique. Semin Dial. 2007;20(4):355-358.
https://doi.org/10.1111/j.1525-139X.2007.00295.x
PMid:17635829

13. Tang S, Li JH, Lui SL, Chan TM, Cheng IK, Lai KN. Free-hand, ultrasound-guided percutaneous renal biopsy: experience from a single operator. Eur J Radiol. 2002;41:65-69. doi: 10.1016/s0720-048x(01)00439-9.
https://doi.org/10.1016/S0720-048X(01)00439-9
PMid:11750155

14. Gupta RK, Balogun RA. Native renal biopsies: complications and glomerular yield betweenradiologists and nephrologists. J Nephrol. 2005;18:553-558. PMID: 16299681.

15. Koirala A, Jefferson JA. How Safe Is a Native Kidney Biopsy? Clin J Am Soc Nephrol. 2020 Nov 6;15(11):1541-1542. doi: 10.2215/CJN.14890920. Epub 2020 Oct 15. PMID: 33060161; PMCID: PMC7646248.
https://doi.org/10.2215/CJN.14890920
PMid:33060161 PMCid:PMC7646248

16. Kajawo S, Ekrikpo U, Moloi MW, Noubiap JJ, Osman MA, Okpechi-Samuel US, Kengne AP, Bello AK, Okpechi IG. A Systematic Review of Complications Associated With Percutaneous Native Kidney Biopsies in Adults in Low- and Middle-Income Countries. Kidney Int Rep. 2020 Nov 3;6(1):78-90. doi: 10.1016/j.ekir.2020.10.019. PMID: 33426387; PMCID: PMC7783578.
https://doi.org/10.1016/j.ekir.2020.10.019
PMid:33426387 PMCid:PMC7783578

17. Corapi KM, Chen JL, Balk EM, Gordon CE. Bleeding complications of native kidney biopsy: a systematic review and meta-analysis. Am J Kidney Dis. 2012;60(1):62-73.
https://doi.org/10.1053/j.ajkd.2012.02.330
PMid:22537423

18. Emilio D Poggio 1, Robyn L McClelland 2, Kristina N Blank . Systematic Review and Meta-Analysis of Native Kidney Biopsy Complications. Clin J Am Soc Nephrol. 2020 Nov 6;15(11):1595-1602.
https://doi.org/10.2215/CJN.04710420
PMid:33060160 PMCid:PMC7646247

19. Halimi J-M, Longuet H, Barbet C, Bisson A, Herbert J, Buchler M, Grammatico-Guillon L, Fauchier L: Major bleeding and risk of death after percutaneous native kidney biopsies: A French nationwide cohort study. Clin J Am Soc Nephrol 15: 1587-1594, 2020
https://doi.org/10.2215/CJN.14721219
PMid:33060158 PMCid:PMC7646233

DOI : Digital Object Identifier. **PMID** : PubMed Identifier.

Editor's Note

REV SEN remains neutral with respect to jurisdictional claims regarding published maps and institutional affiliations.