Kidney Biopsy Adequacy and Complications in Children – Does Technique Matter?

Chen Pettit

Royal Prince Alfred Hospital

Roshana Kanagaratnam

University of New South Wales

Finbarr Coughlan

Children's Hospital at Westmead

Nicole Graf

Children's Hospital at Westmead

Deirdre Hahn

Children's Hospital at Westmead

Anne M. Durkan (✉ anne.durkan@health.nsw.gov.au)

Children's Hospital at Westmead <https://orcid.org/0000-0002-5721-2114>

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Abstract

Background

Kidney biopsy is part of the diagnostic workup of many children with renal disease. Traditionally a perpendicular approach to the biopsy has been used but more recently some proceduralists have favoured a tangential approach. It is not clear if one technique is superior with regards to tissue adequacy or complication rates. In our centre interventional radiologists (IR) use general anaesthetic and a tangential approach whereas paediatric nephrologists (PN) use sedation and a perpendicular approach.

Methods

We examined consecutive kidney biopsies performed between January 2008 and December 2017 for adequacy (sufficient tissue for light and electron microscopy and immunofluorescence) and examined the electronic medical records for data regarding technique and complications.

Results

IR performed 72 (29.4%) of the 245 native kidney biopsies, obtaining more total glomeruli (median 39 *vs* 16, $p<0.001$) and more glomeruli per tissue core (median 13.2 *vs* 8.0, $p<0.001$) than PN. No differences in specimen adequacy were observed between the two groups (79.2% IR *vs* 80.9% PN, $p=0.75$) and a diagnosis could be made in 98.6% and 93.6% respectively ($p=0.1$). A statistically lower rate of peri-nephric haematoma (27.8% *vs* 41.6%, $p=0.04$) was detected in the IR group, but there were no significant differences in other complications. One patient required a blood transfusion (PN) and another required surgical intervention for a perinephric haematoma (IR).

Conclusion

IR obtained larger samples and number of glomeruli, but the overall adequacy for native kidney biopsies was good using both perpendicular and tangential techniques, with similar low rates of significant complications.

What Is Known

- Kidney biopsy is integral to the diagnostic work-up of many children with kidney disease
- Kidney biopsy is a safe procedure with well-established complications in a minority of children

What is new?

- The biopsy yield using a tangential technique is superior to the perpendicular technique

- Biopsy adequacy rates are high using both techniques and provided a diagnosis in over 95%

Introduction

Percutaneous kidney biopsy (PKB) is integral to the current standard of care in the diagnosis of many renal diseases in children [1]. Different techniques for obtaining kidney tissue have evolved, with no universally accepted best method. Traditionally a perpendicular approach has been taken but more recently a tangential approach has been favoured by some, with improved yield in the adult setting [2–5]. Increasingly, interventional radiologists are performing kidney biopsies on children, however, direct comparison between radiologist and nephrologist obtained biopsies is lacking in the paediatric setting. Several studies have compared biopsy adequacy and complication rates between nephrologists and radiologists in adult populations with discrepant results, with some studies finding no difference between the operators whereas others found that nephrologists obtained smaller samples with fewer glomeruli [6–9].

A major problem in assessing native kidney biopsy adequacy is the heterogeneity of definition used in the published literature. Given the importance of a pathological diagnosis in many kidney diseases, samples would, at the very least, be expected to be examined under all available modalities - light microscopy, immunofluorescence and electron microscopy. There is no uniformly accepted minimum number for glomeruli or other components of the biopsy sample[10]. For diseases such as membranous glomerulonephritis, a single glomerulus may be sufficient for diagnosis but for other diseases, such as focal and segmental glomerulosclerosis, many glomeruli may be required to detect the diagnostic histopathological lesion [11].

Although PKB is a relatively safe procedure, it has well recognised potential complications including haematuria and perinephric haematoma [12–15]. Intra-renal bleeding may require blood transfusion or more rarely intervention such as angiography, embolization or nephrectomy[16]. Arteriovenous (AV) fistula is also reported after renal biopsy[17; 18].

The aims of this study were i) to evaluate the overall adequacy and complication rates of native kidney biopsy in children at our institution and ii) to compare the adequacy and safety profile between interventional radiologists (IR), who use a tangential approach, and paediatric nephrologists (PN), who use a perpendicular approach.

Methods

Ethical approval was granted by the Human Research Ethics Committee (HREC) of the Sydney Children's Hospitals Network (HREC approval: LNR/17/SCHN/474). A medical record coding search was carried out to identify all kidney biopsies performed at the Children's Hospital at Westmead, Sydney between 1 January 2008 and 31 Dec 2017. Only children aged 18 years or less at the time of the biopsy were included. Kidney tumour, transplant allograft and back-table biopsies performed during transplant

surgeries were excluded. Children needed at least 3 years follow up to allow for evidence of disease progression in those with normal or non-diagnostic biopsies.

Biopsy technique.

Biopsies were performed by one of two interventional radiologists, one of five consultant paediatric nephrologists or one of ten nephrology trainees. IR performed biopsies in operating theatres, usually on scheduled lists, on children undergoing general anaesthesia. Generally these children were deemed unsuitable for sedation due to their age or co-morbidities or they were undergoing general anaesthesia for another procedure simultaneously. PN performed biopsies on lightly-sedated children, using oral morphine and midazolam with inhaled nitrous oxide if required, in a procedure room in the ultrasound department. Real-time ultrasound guidance was used for all biopsies, with IR performing their own ultrasound and PN being assisted by an ultrasonographer. An 18-gauge biopsy needle was used in all cases. PN used a Bard Max Core biopsy gun (Bard Biopsy, Tempe, Arizona, USA) with a fixed penetrating depth of 22mm. One interventional radiologist used a semi-automated Bard Mission biopsy gun in a coaxial system with an adjustable throw of 10mm or 20mm. The other used a Biopince Full Core biopsy gun (Argon Medical Devices, Athens, Texas, USA) with adjustable throws of 13mm, 23mm, and 33mm. PN used a perpendicular entry to the kidney, whereas IR used a tangential approach of approximately 45°. The biopsy sample was examined immediately by a pathologist using a dissecting microscope to determine if sufficient tissue had been obtained. At the end of the procedure an ultrasound scan was performed. The post-procedure urine of all children was examined to assess for haematuria for at least 6 hours. Children were discharged after 6 hours of bedrest if they were haemodynamically stable and had no persistent macroscopic haematuria, if there was no other indication for hospital admission.

Data collection

Demographic and clinical data were manually retrieved from the electronic medical record for each patient, along with the designation of the biopsy operator, details of the procedure and follow up. All available post-procedure ultrasound reports were examined to assess for the presence of arterio-venous fistulae but a late post-procedure ultrasound was not part of routine follow up.

Biopsy yield (the number of cores, glomeruli, and arteries obtained) were identified from the histopathology report. Biopsies were examined by at least one of three histopathologists, with consensus opinions given in many cases. In the event of missing data on the report, the slides were reviewed (by NG or FC).

Definitions

Adequate native biopsy – sample large enough to be successfully processed for light microscopy (LM), immunofluorescence (IF), and electron microscopy (EM), with at least one whole glomerulus examined in each modality.

Perinephric haematoma – any perinephric fluid collection seen on ultrasound within 48 hours of biopsy.

De novo macroscopic haematuria – any new onset of macroscopic haematuria within 48 hours of biopsy.

Statistical analysis

Results are expressed as percentages and median values for categorical and continuous variables, respectively. Differences of categorical data were tested using Pearson's chi-squared test or Fisher's exact test. Differences of continuous variables were detected using the Mann–Whitney U Test after the normality test.

All analyses were performed on IBM SPSS Statistics 24 (IBM Corp, released 2016, IBM SPSS Statistics for Windows, Version 24.0. Armonk, NY: IBM Corp). A p value < 0.05 was considered to be statistically significant and all p values are two-tailed.

Results

A total of 482 consecutive biopsies were performed during the study period; 237 renal mass, transplant and back-table biopsies were excluded. Of the 245 biopsies included, 72(29%) were done by IR, and 173 were done by PN. Subject characteristics are presented in Table 1.

IR performed biopsies on younger (median age 4.4 vs 12.1 years, $p < 0.001$) and smaller (BMI 17.2 vs 19.1 kg/m², $p < 0.001$) children than PN, however the obesity rate (16.7% vs 10.9%, $p=0.237$) was not significantly different. The eGFR was not statistically different between the two groups. The most common indications for kidney biopsy were non-nephrotic range proteinuria (49%), impaired renal function (30.2%), nephrotic range proteinuria (19.6%) and macroscopic haematuria (usually in association with either proteinuria or impaired renal function) (29.4%). Some children had more than one indication. IR performed more biopsies on children with nephrotic syndrome (31.9% vs 14.5%, $p=0.002$) as these were usually non-urgent and could be performed on a routine operating list.

Biopsy yield

IR obtained a median of 3 (range 2-5) kidney cores compared to 2 (range 1-5) by PN. They also had more glomeruli per core (median 13.2 vs 8.0, $p < 0.001$). Overall IR obtained more total glomeruli (median 39 vs 16, $p < 0.001$), as shown in Table 2. IR obtained 15 to 80 (interquartile range of 31) glomeruli and PN obtained 0 to 60 (interquartile range of 11) glomeruli (Figure 1).

Biopsy adequacy

The overall adequacy rate of native biopsy was 80.4%, with no significant difference between IR and PN (79.2% IR vs 80.9% PN, $p=0.75$). Using an alternative definition of “being able to make a diagnosis”, the overall adequacy increased to 95.1%, again with no significant difference between IR and PN (98.6% vs 93.6%, $p=0.10$). A diagnosis is particularly important in those children who develop progressive renal impairment and the potential need of a kidney transplant, as families need to be counselled about the risk of disease recurrence. We therefore analysed more thoroughly the data of the children with non-diagnostic abnormalities. The results of these 12 children are shown in table 4, along with the data of those who had normal biopsies. Two thirds of those with non-diagnostic abnormalities presented with advanced renal impairment and accordingly, five had non-reversible histopathological changes of end stage renal failure. Of these five, one was subsequently found to be ANCA positive and one had a genetic form of FSGS. One child underwent a second biopsy and was diagnosed with Alport’s syndrome, having not had sufficient tissue for EM on the first biopsy. The primary diagnosis in six who progressed to renal replacement therapy remained elusive.

Comparing trainee (107) and consultant nephrologist biopsies (48); there was no significant difference in adequacy, yield or complication rate. In 18 cases it was unclear what grade of physician had performed the biopsy.

Post-biopsy diagnosis

The most common post-biopsy renal diagnoses were minimal change disease (19.2%), lupus nephritis (18.0%) and IgA vasculitis/IgA nephropathy (17.1%), as shown in table 3.

Post-procedural complications

Post-procedural complications are presented in Table 4. The overall rate of perinephric haematoma formation was 37.6%; (27.8% IR and 41.6% PN $p=0.04$).

The overall rates of *de novo* macroscopic haematuria and unplanned overnight admission were 16.7% and 17.3%, respectively. There were no significant differences between the two groups.

One case in the IR group required an emergency angiogram with wire manipulation and platelets transfusion because of a large perinephric haematoma. This patient returned approximately one week later with a urinary tract infection. Another case in the IR group was found to have an intrarenal haemorrhage four days post biopsy and developed fever with rigors two days later, but urine culture was negative. The haemorrhage resolved spontaneously. Blood transfusion was required in one case in the PN group in association with *de novo* macroscopic haematuria. No AV fistulae were detected during the period of study.

Discussion

This study shows that in 80% of cases of native kidney biopsy an adequate sample was obtained based on the availability of tissue for LM, IF and EM. In 95% of biopsies a diagnosis was possible. Obtaining adequate tissue is crucial to maximising the diagnostic accuracy and usefulness of the procedure. A major issue for native biopsies is the lack of a universally accepted definition of adequacy and this has resulted in different definitions being used in the published literature, making comparison between studies difficult. Our primary definition, of sufficient tissue to be examined by all three modalities, may not be adequate for some conditions such as focal segmental glomerulosclerosis, where a large sample size ideally from the cortico-medullary region is preferred. Some studies have defined adequate as ≥ 10 glomeruli, and assessing both transplant and native kidney specimens, have demonstrated adequacy rates of 93-98%, [19; 20]. Using this same definition, 84% of our biopsies were adequate. One major difference between our study and the previous studies is the number of operators. Our hospital is a tertiary training centre and the majority of our biopsies were done by trainee nephrologists, perhaps resulting in more variability than in a centre where one person performs all the procedures, though it should be noted that we did not find a difference in adequacy rates based on the grade of the operator.

The largest paediatric dataset is from a survey across 11 UK paediatric nephrology centres, demonstrating a combined adequacy rate of 97.5% in native and transplant cases using adequacy criteria defined as “ ≥ 10 glomeruli OR histopathologist able to make a clear diagnosis on limited number of glomeruli using all modalities”[13]. This broad definition would include many that we considered to be inadequate and makes a direct comparison difficult.

When comparing the IR and PN biopsies, there were inevitable differences in the baseline characteristics of the two groups, as IR tended to perform biopsies on younger children who required general anaesthesia or those for whom sedation was inappropriate. Blood pressure was lower in IR group, however it was difficult to separate the effects of younger age and general anaesthetic. The rates of hypertension were similar. The differences in platelet count and creatinine levels can be largely explained by physiology. PN were more likely to perform urgent biopsies in acutely unwell children, which could also have contributed to these baseline differences [21].

Interventional radiologists obtained larger kidney samples, as observed in more glomeruli per core of tissue. The tangential approach used may contribute to this, as the needle will pass through a wider area. This approach has been validated in both adult and paediatric studies to achieve high sampling adequacy (95- 99%), with low complication rates, yet in general, nephrologists are taught to do a perpendicular approach, as they are taught by colleagues who only know this method [2–5]. IR also took more cores of tissue and it could be argued that two cores in most cases would have been sufficient, or that the number of cores be tailored to the anticipated histological diagnosis such that more tissue is obtained when FSGS is a differential diagnosis.

The finding of a normal biopsy can be concerning as it may imply that insufficient tissue was obtained to see any abnormalities. We found that in the majority of these cases, the indication for biopsy was mild

proteinuria and over the minimum 3 year follow up period, none of those with normal biopsies had disease progression. On the other hand, those with non-diagnostic abnormalities often presented late, with evidence of severe renal impairment. These biopsies had fewer glomeruli and this may be due to loss of identifiable glomeruli secondary to marked sclerosis and atrophy.

The published rates of *de novo* post-biopsy macroscopic haematuria vary between 1.5% and 20.3% and transfusion requirement between 0.1% and 0.88% [12–14]. Our overall rate of *de novo* haematuria (17.1%) and transfusion rate (0.4%) are within the ranges suggested by these studies. Only children with a normal coagulation profile and platelet count $> 80,000 \times 10^9/L$ were eligible for biopsy. This practice excluded children whose risks outweighed potential benefits. Post-biopsy bleeding has been associated with uraemia, coagulation disorders, low platelet level and high blood pressure[19; 22]. Although bleeding is well-recognised in association with uraemia[23; 24], the pathophysiology is not completely understood, but is likely to involve platelet dysfunction and abnormal platelet-endothelial interactions[25; 26]. The increased risk of bleeding in those with higher pre-biopsy urea levels in this study was despite the routine administration of desmopressin in those with urea $> 35 \text{ mmol/L}$.

Ultrasonographers documented the presence of perinephric haematomas for nephrologists, whereas radiologists made their own documentations and there was perhaps a bias to not reporting smaller haematomas that were deemed insignificant. The exact dimensional measurements were often omitted, but we postulate that large symptomatic haematomas were rare given that only one case required angiographic intervention. Our rate of perinephric haematoma was comparable to that of a Norwegian paediatric cohort [12]. One previous paediatric study identified male gender and low weight-for-height as risk factors for perinephric haematoma, however we did not find similar associations[14].

No post-procedural AV fistulae were detected throughout the period studied. Other studies reported rates of 0.1–8.3%, with a large number resolving spontaneously[17; 23]. Given that surveillance for AV fistula is not routine in our practice, it is possible that an asymptomatic AV fistula may have been undetected.

Kidney biopsy is generally a day procedure at our institution and this practice is supported by the low numbers of unplanned overnight hospital admissions. Other groups have similarly found kidney biopsy to be a safe day-case procedure, with improved cost effectiveness and enhanced patient satisfaction[27].

There are a number of limitations to this single centre study and the results may not be generalisable to all paediatric centres. We cannot separate the effects of the tangential approach, operator guided ultrasound and general anaesthetic in contributing to larger IR samples. Given the number of paediatric nephrology proceduralists (fifteen) it was unclear whether there were any significant outliers given that individual operator adequacy and complication rates were not assessed.

Conclusion

In summary, our analysis found that both PN and IR obtained adequate kidney biopsy samples in the large majority of cases. IR had larger biopsy yield than nephrologists, possibly due to the radiologists'

tangential approach, though patient immobility with general anaesthesia and self-directed real time ultrasound may also have contributed. The two groups had comparable safety profiles. Kidney biopsy was shown to be an important component of the diagnostic process for children with kidney disease.

List Of Abbreviations

AKI – acute kidney injury

AV –arterio-venous

BMI – body mass index

eGFR – estimated glomerular filtration rate

EM – electron microscopy

FSGS –focal segmental glomerulosclerosis

GN - glomerulonephritis

HREC – human research ethics committee

IF - immunofluorescence

IGAV – immunoglobulin A vasculitis

IR – interventional radiologist

LM – light microscopy

PKB – percutaneous kidney biopsy

PN – paediatric nephrologist

Declarations

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Competing interests

No author declares any financial or non-financial competing interest

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Conflict of Interest: Nil declared by any author

Availability of data, material and software code: The raw data and codes are freely available to anyone requesting it from the corresponding author.

Author contributions: AD conceived and supervised the project and also edited the manuscript, RS and CP collected the data, CP drafted the manuscript, FC and NG reviewed the biopsy samples and clarified any queries, DH and all authors revised the manuscript.

Ethics Approval: LNR/17/SCHN/474 (approval letter attached separately)

Consent to participate and publication: Not applicable (waiver of consent was granted by the ethics committee).

References

1. Hogan JJ, Mocanu M, Berns JS (2016) The native kidney biopsy: update and evidence for best practice. *Clin J Am Soc Nephrol* 11:354–362
2. Patel MD, Phillips CJ, Young SW, Kriegshauser JS, Chen F, Eversman WG, Silva AC, Lorans R (2010) US-guided Renal Transplant Biopsy: Efficacy of a Cortical Tangential Approach. *Radiology* 256:290–296
3. Liu B, O'Dell M, Flores M, Limback J, Kendall M, Pepe J, Burt JR, Contreras F, Lewis AR, Ward TJ (2016) CT-guided Native Medical Renal Biopsy: Cortical Tangential versus Non-Tangential Approaches—A Comparison of Efficacy and Safety. *Radiology* 283:293–299
4. Cakmakci E, Caliskan KC, Turkoglu OK, Cakmakci S, Ozcelik G, Yilmaz E, Turk S, Ozagari A, Ucan B (2014) A modified technique for real time ultrasound guided pediatric percutaneous renal biopsy: the angled tangential approach. *Quantitative imaging in medicine and surgery* 4:190
5. Caliskan K, Ozcelik G, Cakmakci E, Ulusay S, Celebi A, Turk S, Ozagari A, Karpat Z (2014) Real time ultrasound guided pediatric percutaneous renal biopsy: The traditional method versus angled tangential approach. *JBR-BTR* 97:206–210
6. Sekulic M, Crary GS (2017) Kidney Biopsy Yield. *Am J Surg Pathol* 41:961–972
7. Gupta RK, Balogun RA (2005) Native renal biopsies: complications and glomerular yield between radiologists and nephrologists. *J Nephrol* 18:553–558
8. Chung S, Koh ES, Kim SJ, Yoon HE, Park CW, Chang YS, Shin SJ (2014) Safety and tissue yield for percutaneous native kidney biopsy according to practitioner and ultrasound technique. *BMC Nephrol* 15:96
9. Ferguson C, Winters S, Jackson S, McToal M, Low G (2018) A retrospective analysis of complication and adequacy rates of ultrasound-guided native and transplant non-focal renal biopsies. *Abdominal*

10. Walker PD, Cavallo T, Bonsib SM (2004) Practice guidelines for the renal biopsy. *Mod Pathol* 17:1555
11. Fogo AB (2003) Approach to renal biopsy. *Am J Kidney Dis* 42:826–836
12. Tøndel C, Vikse BE, Bostad L, Svarstad E (2012) Safety and complications of percutaneous kidney biopsies in 715 children and 8573 adults in Norway 1988–2010. *Clin J Am Soc Nephrol* 7:1591–1597
13. Hussain F, Mallik M, Marks SD, Watson AR, on behalf of the British Association of Paediatric N (2010) Renal biopsies in children: current practice and audit of outcomes. *Nephrology Dialysis Transplantation* 25:485–489
14. Rianthavorn P, Kerr SJ, Chiengthong K (2014) Safety of paediatric percutaneous native kidney biopsy and factors predicting bleeding complications. *Nephrology* 19:143–148
15. Simckes AM, Blowey DL, Gyves KM, Alon US (2000) Success and safety of same-day kidney biopsy in children and adolescents. *Pediatric Nephrology* 14:946–952
16. Manno C, Strippoli GFM, Arnesano L, Bonifati C, Campobasso N, Gesualdo L, Schena FP (2004) Predictors of bleeding complications in percutaneous ultrasound-guided renal biopsy. *Kidney Int* 66:1570–1577
17. Oates A, Ahuja S, Lee MM, Phelps AS, Mackenzie JD, Courtier JL (2017) Pediatric renal transplant biopsy with ultrasound guidance: the ‘core’ essentials. *Pediatr Radiol* 47:1572–1579
18. Wickre CG, Golper TA (1982) Complications of percutaneous needle biopsy of the kidney. *Am J Nephrol* 2:173–178
19. Levart TK, Kenig A, Ponikvar JB, Ferluga D, Čavić MA, Kenda R (2001) Real-time ultrasound-guided renal biopsy with a biopsy gun in children: safety and efficacy. *Acta Paediatr* 90:1394–1397
20. Ding J-J, Lin S-H, Huang J-L, Wu T-W, Hsia S-H, Lin J-J, Chou Y-C, Tseng M-H (2020) Risk factors for complications of percutaneous ultrasound-guided renal biopsy in children. *Pediatric Nephrology* 35:271–278
21. Alkandari O, Eddington KA, Hyder A, Gauvin F, Ducruet T, Gottesman R, Phan V, Zappitelli M (2011) Acute kidney injury is an independent risk factor for pediatric intensive care unit mortality, longer length of stay and prolonged mechanical ventilation in critically ill children: a two-center retrospective cohort study. *Crit Care* 15:R146
22. Muñoz AT, Valdez-Ortiz R, González-Parra C, Espinoza-Dávila E, Morales-Buenrostro LE, Correa-Rotter R (2011) Percutaneous renal biopsy of native kidneys: efficiency, safety and risk factors associated with major complications. *Archives of medical science: AMS* 7:823
23. Riccabona M, Schwinger W, Ring E (1998) Arteriovenous fistula after renal biopsy in children. *J Ultrasound Med* 17:505–508
24. Mezzano D, Tagle R, Panes O, Pérez M, Downey P, Muñoz B, Aranda E, Bajra P, Thambo S, González F (1996) Hemostatic disorder of uremia: the platelet defect, main determinant of the prolonged

bleeding time, is correlated with indices of activation of coagulation and fibrinolysis. *Thromb Haemost* 75:312–321

25. Weigert AL, Schafer AI (1998) Uremic bleeding: pathogenesis and therapy. *Am J Med Sci* 316:94–104

26. Sohal AS, Gangji AS, Crowther MA, Treleaven D (2006) Uremic bleeding: pathophysiology and clinical risk factors. *Thromb Res* 118:417–422

27. Hussain F, Watson AR, Hayes J, Evans J (2003) Standards for renal biopsies: comparison of inpatient and day care procedures. *Pediatric Nephrology* 18:53–56

Tables

Table 1 — Subject characteristics at the time of biopsy. Data are presented as median value or percentage.

	Radiology	Nephrology	P value
	n = 72	n = 173	
Age (years)	4.4	12.1	< 0.001
Male	54.2%	54.3%	0.981
<u>Anthropometric</u>			
Height (cm)	103	151	< 0.001
Weight (kg)	18.3	43.9	< 0.001
BMI (kg/m ²)	17.2	19.1	< 0.001
Obesity (%)	16.7%	10.9%	0.237
<u>Blood pressure</u>			
Systolic (mmHg)	107	112	0.004
Diastolic (mmHg)	62	69	0.001
<u>Blood count</u>			
Haemoglobin (g/L)	122	120	0.674
Platelet count (× 10 ⁹ /L)	353	275	0.006
<u>Renal function</u>			
Urea (mmol/L)	5.7	6.0	0.474
Creatinine (μmol/L)	41	61	< 0.001
eGFR (ml/min/1.73 m ²)	110	124	0.875
<u>Indication for biopsy*</u>			
	n=72 (%)	n=173 (%)	
Non-nephrotic Proteinuria	28 (38.9)	92 (53.2)	0.042
Raised creatinine or AKI	22 (30.6)	52 (30.1)	0.938
Nephrotic range proteinuria	23 (31.9)	25 (14.5)	0.002

Haematuria	18 (25.0)	54 (31.2)	0.331
Other	0 (0.0)	1 (0.6)	0.518

***Some children had more than one indication**

Obesity defined as BMI $\geq$ 30

BMI = body mass index, eGFR= estimated glomerular filtration rate calculated using Schwartz formula,

AKI=acute kidney injury

Table 2 – Biopsy yield – median number of passes, cores and glomeruli by radiologist and nephrologists.

	Radiology	Nephrology	P value
n=72	n=173		
Passes	3	2	< 0.001
Cores	3	2	< 0.001
Glomeruli per core	13.2	8	< 0.001
Glomeruli	39	16	< 0.001

Table 3- Post biopsy diagnosis

	Radiology	Nephrology
	n= 72 (%)	n= 173 (%)
Minimal change disease	19 (26.4)	28 (16.2)
IgAV/IgA nephropathy	12 (16.7)	30 (17.3)
Lupus nephritis	2 (2.8)	42 (24.3)
FSGS	9 (12.5)	9 (5.2)
Other GN	7 (9.7)	24 (13.9)
Alport's syndrome	4 (5.6)	7 (4.0)
Nephronophthisis	4 (5.6)	6 (3.5)
Normal	2(2.8)	8 (4.6)
Non-diagnostic	1 (1.4)	11 (6.4)
Other	12 (16.7)	8 (4.6)

IgAV- Immunoglobulin A vasculitis (previously Henoch-Schönlein Purpura), FSGS – Focal segmental glomerulosclerosis, GN –glomerulonephritis

Table 4. Normal and non-diagnostic biopsy characteristics.

	Normal biopsy (n=10)	Non-diagnostic biopsy (n=12)
Operator		
PN	8	11
Indication		
Proteinuria	6	1
Haematuria	3	1
eGFR <40ml/min/1.73m ²	0	8*
eGFR 60-90ml/min/1.73m ²	1	2
Follow up biopsy to assess treatment	1	0
Adequacy		
Light microscopy	10	12
Immunofluorescence	10	8^
Electron microscopy	9	10
No of glomeruli (median and range)	18 (12-70)	6 (2-27)
Disease progression	0	9
Repeat biopsy	0	1 – Alport's diagnosed on EM

*5 had “end stage kidney disease” on biopsy, 1 was subsequently found to be ANCA positive and another had a homozygous mutation in *PLCE-1*. ^There was a technical failure in the laboratory on one biopsy

Table 5— Complications — Numbers of individual complications are given with percentage in brackets.

	Radiology	Nephrology	P value
	n = 72	n = 173	
Perinephric haematoma	20 (27.8%)	72 (41.6%)	0.042
De novo macroscopic haematuria	12 (16.7%)	30 (17.3%)	0.898
Unplanned overnight admission	13 (18.1%)	26 (15%)	0.555
Transfusion	0 (0.0%)	1 (0.6%)	1.00
Biopsy-related infection	2 (2.8%)	0 (0.0%)	0.086
Arteriovenous fistula	0 (0.0%)	0 (0.0%)	-

Table 6 — Median number of cores, passes and glomeruli by nephrology consultants and nephrology trainees

	Consultants	Trainees	P value
	n=48	n=107	
Passes	2	2	0.635
Cores	2	2	0.857
Glomeruli per core	8	8	0.655
Glomeruli	16.5	17	0.767

Figures

Figure 1

The total number of glomeruli obtained by interventional radiologists and nephrologists. The IR group obtained a median number of 39 glomeruli and the PN group obtained a median number of 16