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Success and safety of same-day kidney biopsy in children and adolescents

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Abstract Renal biopsy is crucial for the diagnosis, management, and monitoring of many kidney diseases. Although percutaneous renal biopsy is considered a routine safe procedure in children, the optimal length of in-hospital observation following the procedure is not yet known. We prospectively studied two comparable groups of children to compare the success and safety of performing native renal biopsy as an outpatient procedure versus keeping the children hospitalized post biopsy. Doppler ultrasonography of the biopsied kidney was performed approximately 2 weeks after the procedure. For 40 children the biopsy was performed on a same-day basis (study group) and another 15 children were kept for overnight observation (control group). All biopsies yielded adequate tissue for histopathological diagnosis. There was no difference between the two groups in the amount of reported pain and analgesics used after the procedure. Only 1 child in the study group was readmitted 5 days after the biopsy for 48 h, but no major complications were detected. The incidence of post-biopsy intra- or perirenal hematoma detection by sonography was not statistically different between the two groups (39% study group, 43% control group). Follow-up imaging studies were performed on 10 of the 20 children who had an early post-biopsy hematoma and all were completely normal. Patients and their families appreciated being discharged home the same day. In addition, total charges for hospitalization were significantly less for the study group than the control group. We conclude that in selected patients, same-day discharge after renal biopsy may be performed safely without an increased risk of complications.

Key words Kidney biopsy · Renal hematoma

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Introduction

Kidney biopsy (Bx) has a central role in establishing renal diagnoses and aiding in therapeutic decisions. For decades it has been considered a safe procedure in children [1–9]. However, the optimum period of bed rest and in-hospital observation is controversial, as is the issue of whether or not kidney Bx should be performed on an outpatient basis [10]. It is not known if strict overnight bed rest in the hospital after a kidney Bx decreases the risk of complications such as peri- and intrarenal hematoma formation and macroscopic hematuria. A study of adults concluded that a minimum of 12 h of observation post Bx was required, and 24 h was optimal in order to identify complications [11]. Another recent retrospective study of adults found that a stable hematocrit 6 h post Bx was a predictor for a low risk of bleeding complications at 24 h, and these findings may support the performance of renal Bx in the outpatient setting [12]. It has been reported that children have a lower incidence of post-Bx complications than adults [8]. Indeed, several recent pediatric studies support the performance of renal Bx in the outpatient setting provided certain precautions were observed [13–17]. However, these reports were mainly based on retrospective analysis and did not include post-Bx ultrasonography (US) to detect complications such as hematoma, arteriovenous fistula, and aneurysm, all of which may be asymptomatic. It is unknown whether such complications develop more frequently in children dismissed on the Bx day than in those hospitalized overnight.

In the present study we prospectively analyzed the success and safety of same-day native kidney Bx in children. The findings in the study group were compared with a control group that fulfilled the same clinical criteria but were kept overnight in the hospital due to logistic factors.

Patients and methods

Parents and guardians of children scheduled for percutaneous renal Bx at our institution between November 1995 and June 1999

were given the option to participate in this study provided they met the following eligibility criteria: Bx of a native kidney, presence of two kidneys, age 5–20 years, no history of bleeding diathesis or collagen vascular disease, normal pre-Bx laboratory test results, including complete blood count (CBC), prothrombin time (PT), and partial thromboplastin time (PTT), lack of azotemia, use of short-acting sedation, stable home environment within 1 h drive of our hospital, home telephone, and the ability to understand and accept all instructions, including supine bed rest at home overnight. All patients were instructed not to take any nonsteroidal anti-inflamatory drugs for 10 days prior to the scheduled Bx. Patients were discharged home on the day of Bx after 4–6 h of supine bed rest provided they met the following discharge criteria; fully alert and tolerating oral intake, normal and stable vital signs, not more than mild pain at the Bx site, and two consecutive voided urine samples without macroscopic hematuria. Patients who met all of the above criteria but either lived more than a 1 h drive from the hospital or the family preferred an overnight hospital stay served as controls. All patients enrolled, study and controls, were scheduled for Doppler US of the biopsied kidney within 1 month after the Bx, to be interpreted, when possible, by the same pediatric radiologist (K.M.G.). If the initial post-Bx sonogram was abnormal, follow-up US was recommended.

Biopsies were performed by a nephrology fellow supervised by an attending nephrologist. In the absence of a fellow or if attempts by the fellow failed to yield renal tissue, the procedure was performed by an attending nephrologist. The goal was to obtain two or three cores of kidney tissue from the left lower pole after sonographic localization of the kidney. Short-acting deep intravenous sedation administered by a sedation team nurse was achieved using midazolam and either meperidine or fentanyl, as preferred by the nephrologist. In a few children pentobarbital was added as well. Cardiorespiratory status and oxygen saturation were monitored closely during sedation in accordance with hospital regulations. Three types of needles were used at the discretion of the nephrologist, including: 14-gauge modified Franklin-Vim-Silverman (Baxter Healthcare, Deerfield, Ill., USA), 14-gauge Tru-Cut (Travenol Laboratories, Deerfield, Ill., USA), and 15-gauge Medi·tech ASAP Automated Core Biopsy System (Boston Scientific, Watertown, Mass., USA). The number of passes made per Bx was recorded. At the end of the procedure direct pressure was applied to the Bx site for 5–10 min, after which the patient was turned to the supine position for strict bed rest. Vital signs were checked serially and IV fluids (D5 1/4 normal saline) were administered at 1.5 times maintenance requirement, and discontinued once the patient was fully alert and tolerating oral fluids. Blood tests were not routinely performed post Bx. After 4–6 h of supine bed rest and at least two voided urine samples without gross hematuria, the patients were then either discharged home (study group) or remained hospitalized (control group). Both groups were given instructions for supine bed rest overnight, with bathroom privileges as long as macroscopic hematuria was absent.

A questionnaire was mailed to each subject's family with a return stamped envelope. Patients and parents were asked questions regarding the level of pain the patient endured following the Bx (1–10 scale) and the use of analgesics. Those in the study group were asked if another Bx was required whether they would want to be hospitalized overnight or discharged home the same day. In addition, all charges for each subject's hospitalization were tallied and the two groups were compared. Our Institutional Review Board approved the study. Informed consent was obtained from the parents or guardians as well as assent by the patients when applicable.

Statistical analysis was performed by chi-squared test, Fisher's two-sided exact test, and Student's two-tailed *t*-test, as appropriate. Data are presented as mean±SD and $P<0.05$ was considered significant.

Results

Fifty-five renal Bxs were performed over 4 years on 52 children who enrolled in this study. Forty children were discharged home on the day of the Bx (study group) and 15 were hospitalized overnight (control group). Characteristics of the two groups are compared in Table 1. There were no differences between the groups with regard to age and gender. By definition, pre-Bx laboratory tests, including CBC, PT, PTT, serum creatinine, and blood urea nitrogen, had to be normal for participation in the study (data not shown). There were no significant differences between the two groups regarding the number of Bxs preformed by a fellow, attending nephrologist, or both. Nor was there a difference in the percentage of Bxs performed with a particular type of needle. The average number of passes per Bx was similar in the two groups, as was the mean number of glomeruli yielded per Bx. All 55 Bxs yielded adequate tissue for a histopathological diagnosis.

None of the patients had significant complications or side effects from sedation and all were alert shortly after

Table 1 Comparison of baseline pre-biopsy (Bx) epidemiological data, procedural data, and post-Bx ultrasonography results in the control group (hospitalized overnight post renal Bx) and the study group (discharged home on the same day as kidney Bx)

		Same-day discharge $n=40$[a]	Overnight hospitalization $n=15$[a]
Males		25 (62.5%)	7 (46.7%)
Age (years)		12.4±4.2	11.7±4.0
Bx performed by	Attending	9 (22.5%)	3 (20%)
	Fellow	25 (62.5%)	10 (66.7%)
	Fellow then attending	6 (15%)	2 (13.3%)
Bx needle	Franklin-Vim-Silverman	12 (30%)	2 (13.3%)
	Tru-Cut	9 (22.5%)	5 (33.3%)
	Automated	16 (40%)	8 (53.3%)
	Tru-Cut + Franklin-Vim-Silverman	2 (5%)	–
	Tru-Cut and automated	1 (2.5%)	–
Passes (no.)		4.7±1.8	4.1±1.6
Glomeruli (no.)		24.0±14.3	19.9±10.0
Post-Bx ultrasonography (days post Bx)		14.6±5.5 ($n=36$)	16.1±4.7 ($n=14$)
Hematoma (on early sonogram)		14 (38.9%) ($n=36$)	6 (42.9%) ($n=14$)

[a] Four patients from the study group and 1 patient from the control group had their initial post-Bx sonogram performed more than 31 days after the procedure. It was normal in all

Table 2 Comparison of renal histopathology between study and control groups

Kidney Bx result	Study group *n*=40	Control *n*=15	Significance*
Focal segmental glomerulosclerosis, focal global sclerosis and focal segmental hypercellularity	11 (27.5%)	5 (33.3%)	NS
Minimal change disease	8 (20%)	1 (6.7%)	NS
IgA nephropathy and Henoch-Shonlein purpura	9 (22.5%)	6 (40%)	NS
Alport disease and thin basement membrane disease	3 (7.5%)	1 (6.7%)	NS
Normal	4 (10%)	1 (6.7%)	NS
Membranoproliferative glomerulonephritis-I	2 (5%)	–	NS
Membranous nephropathy	1 (2.5%)	1 (6.7%)	NS
Interstitial nephritis	1 (2.5%)	–	NS
Mesangioproliferative glomerulonephritis	1 (2.5%)	–	NS

**NS* not significant, $P>0.05$

Table 3 Renal histopathology based on presence of post-Bx hematoma on early post-Bx ultrasonography

Kidney Bx result	Normal post-Bx ultrasonography *n*=30	Post-Bx hematoma *n*=20	Percent hematomas per diagnosis	Significance*
Focal segmental glomerulosclerosis, focal global sclerosis and focal segmental hypercellularity	9 (30%)	5 (25%)	35.7%	NS
Minimal change disease	7 (23.3%)	2 (10%)	22.2%	NS
IgA nephropathy and Henoch-Shonlein purpura	9 (30%)	6 (30%)	40%	NS
Alport disease and thin basement membrane disease	1 (3.3%)	2 (10%)	66.7%	NS
Normal	1 (3.3%)	3 (15%)	75.0%	NS
Membranoproliferative glomerulonephritis-I	–	2 (10%)	100%	NS
Membranous nephropathy	2 (6.7%)	–	0%	NS
Interstitial nephritis	1 (3.3%)	–	0%	NS

**NS* not significant, $P>0.05$

the procedure. No child in either group developed significant post-Bx macroscopic hematuria and there were no major complications. None of the children complained of excessive abdominal or flank pain after the Bx, except for 1 child in the study group. This 16.8-year-old male underwent renal Bx due to new-onset nephrotic syndrome. The Bx, performed by a nephrology fellow, required five passes by an automated needle. He was discharged home 6 h post Bx with complaints of only minimal pain at the Bx site, which completely resolved. Five days after the Bx, he developed flank pain at the Bx site accompanied by fever (39.2°C) and was admitted. The admission hemoglobin level (14.9 g/dl) was similar to that measured pre Bx (15.4 g/dl) and the creatinine level remained unchanged (0.7 mg/dl). Urinalysis was negative for cells and bacteria. Urine and blood cultures were negative. An abdominal computed tomographic (CT) scan detected a mild/moderate perinephric hematoma adjacent to the biopsied kidney. The patient was treated with bed rest and empiric antibiotics. He was afebrile throughout the hospitalization and was discharged after 2 days. Urinary tract Doppler US performed 9 days after the CT scan found nearly complete resolution of the hematoma.

In the study group, 36 of 40 (90%) children returned for the scheduled Doppler US within 31 days of the Bx (Table 1). The corresponding figure in the control group was 14 of 15 (93%) children. This early imaging study was performed 14.6±5.5 days after the Bx for those in the study group and 16.1±4.7 days post Bx for those in the control group. Of the other 5 children 4 (3 study, 1 control), subsequently had US 67±26 days after the Bx, and a child in the study group had US 271 days after the Bx. All of these 5 later imaging studies were normal. For those who had early post-Bx renal US, 14 of the 36 (39%) children in the study group and 6 of 14 children (43%) in the control group were found to have an asymptomatic subcapsular, intra- or perirenal hematoma. Of the 20 children in both groups who had an asymptomatic early post-Bx renal hematoma, 9 had follow-up Doppler US 4.8±1.7 months after the Bx and all were completely normal. Another child who had a hematoma had a repeat renal Bx after 2 years and US of the previously biopsied kidney was normal. None of the patients had an intrarenal arteriovenous fistula or aneurysm detected either by early or late US.

There were no significant differences between the two groups regarding the histopathological results of the Bxs (Table 2). Stratified based on histological diagnosis, the frequency of detecting a post-Bx hematoma by early US (<31 days) is presented in Table 3. Although the frequency of hematoma was high for certain diagnoses, there were no statistically significant differences.

Pre-Bx laboratory results, performer of the Bx (fellow vs. attending), type of Bx needle used, and other parameters are compared based on whether or not a post-Bx renal hematoma was detected (Table 4). Only those children who had the post-Bx US within 31 days of the Bx

Table 4 Comparison of baseline pre-renal Bx laboratory results and procedural data in those with and without a post-Bx intra- or perirenal hematoma

	(–) Hematoma n=30[a]	(+) Hematoma n=20[b]
Male	18 (60%)	10 (50%)
Age (years)	11.6±4.6	12.6±3.1
Hemoglobin (g/dl)	13.7±1.3	13.9±1.1
Platelet ($\times 10^3$/mm^3)	306±80	292±71
Prothrombin time (s)	12.5±0.7	13.3±2.0*
Partial thromboplastin time (s)	31.6±7.3	29.7±5.8
Blood urea nitrogen (mg/dl)	15.3±6.3	13.2±4.4
Serum creatinine (mg/dl)	0.7±0.3	0.7±0.2
Biopsy needle		
Franklin-Vim-Silverman	6 (20%)	7 (35%)
Tru-Cut	11 (36.7%)	2 (10%)
Automated	13 (43.3%)	9 (45%)
Tru-Cut + Franklin-Vim-Silverman	–	1 (5%)
Tru-Cut + Automated	–	1 (5%)
Passes (no.)	4.3±1.6	4.9±2.0
Glomeruli (no.)	21.8±12.8	24.6±14.9
Biopsy performed by		
Attending	8 (26.7%)	4 (20%)
Fellow	19 (63.3%)	11 (55%)
Attending + Fellow	3 (10%)	5 (25%)
Ultrasound no.1 (≤31 days)	16.2±5.9	12.9±3.6**

*P=0.06; **P=0.03

[a] Five additional children had an initial normal post-Bx ultrasonography but these imaging studies were performed >31 days after the Bx and their data are not included in this table

[b] Of the 20 children with an early post-Bx renal hematoma, 10 had repeat ultrasonography and it was normal in all

were included in this analysis. Of the 50 children in both groups who had an early post-Bx US, 20 (40%) were found to have a hematoma. For the 30 children in both the control and study groups who did not have a hematoma, US was performed 16.2±5.8 days after the Bx compared with 12.9±3.6 days in those who did have a hematoma (P=0.03). There were no significant differences between the two groups, hematoma versus normal early post-Bx US, regarding age, hemoglobin, platelet count, PTT, serum creatinine, number of passes per Bx, and total number of glomeruli counted by the pathologist per Bx specimen. Although individual results were in the normal range, the mean PT tended to be longer in those who had a hematoma (13.3±2.0 vs. 12.5±0.7 s, P=0.06). The frequency of detecting an early hematoma for each of the needles was: modified Franklin-Vim-Silverman 7 of 13 (54%), automated Medi·tech needle 9 of 22 (41%), and Tru-Cut 2 of 13 (15%). There was a trend for the modified Franklin-Vim-Silverman needle to be associated with a higher (P=0.19) and the Tru-Cut needle with a lower (P=0.09) frequency of post-Bx hematoma compared with the other two types of needles. There was no significant difference in the incidence of detecting a hematoma when a nephrology attending or fellow performed the Bx [attending 4/12 (33%) vs. fellow 11/30 (37%)]. However, if two different types of Bx needles were used during a single procedure, or if an attending needed to perform the Bx after unsuccessful attempts by the fellow, the detection of a renal hematoma increased to 2 of 2 (100%) and 5 of 8 (63%), respectively, although these small numbers did not reach statistical significance.

The families of 15 of 40 (38%) study patients and 8 of 15 (53%) control patients returned the questionnaire. There was no significant difference between the two groups in the level of pain (1–10 scale) on the night following the Bx (4.0±2.1 study group vs. 5.0±1.6 control group). In the study group, 9 of 15 (60%) used oral analgesics during the first 24 h after the Bx and 5 of 15 (33%) used analgesics during the subsequent week. Similarly, in the control group, 4 of 8 (50%) used analgesics during the first 24 h after the procedure and 2 of 8 (25%) used analgesics during the following week. Of the 15 families of study patients who responded, 13 (87%) stated that if another renal Bx was required they would again want it as an outpatient procedure. The most frequent comment by parents regarding the advantages of same-day discharge was that their child was able to rest comfortably in his/her own bed at home. Parents of the 2 children in the study group who responded that they would prefer to remain overnight in the hospital for a future Bx believed that additional in-hospital recovery time was needed, although neither patient had any clinically significant or overt complications.

Hospital accounting records were reviewed for patients in both groups. Total charges were significantly lower for the study group than the control group (U.S. $3,414±399 vs. U.S. $4,018±196, P=0.0001). Similarly, the charges for hospital observation plus physician attendance fees were lower for the study group (U.S. $513±50 vs. U.S. $884±57, P<0.0001).

Discussion

The frequency of serious complications from a renal Bx in children is very low and it is considered a safe procedure [1–9]. Major complications such as death, nephrectomy, and need for transfusion are very uncommon [1–3, 7, 9, 18]. Post-Bx intrarenal arteriovenous fistula formation may occur more frequently, but is often a transient phenomenon and resolves spontaneously [19, 20]. Transient increased hematuria and mild localized pain at the Bx site commonly occur and are considered minor complications, usually of no clinical significance. Severe flank pain may indicate the presence of an intra- or perirenal hematoma and US is a good imaging study for assessment [21]. Although the incidence of clinically significant post-Bx hematoma is very low, the frequency of asymptomatic hematoma is higher and has been reported to be 55%–85% as determined by CT scan in adults [21–23] and 10.9%–26% by US in children [7, 8, 24]. Similarly, Feneberg et al. [9] reported an overall post-renal Bx hematoma rate in children of 34% as detected by US. Although the detection of an asymptomatic post-

Bx renal hematoma may be considered a minor complication, it may be an expected finding considering the trauma incurred by the kidney. The difference in resolution of the imaging study utilized or other technical or age-related factors may affect the frequency of detecting a post-Bx hematoma [8, 9].

Dodge et al. [1] reviewed data from various investigators regarding percutaneous renal Bx in children and reported a mortality rate of 0.12% in 4,000 Bxs. They also reported post-renal Bx incidences of 0.8% for transfusion, 0.1% for nephrectomy, and 0.4% for (symptomatic) perirenal hematoma. A review of complications of percutaneous renal Bx in 135 children by Karafin et al. [2] in 1970 reported that macroscopic hematuria occurred transiently in 22%, transfusion was required in 1.4%, and symptomatic perirenal hematoma occurred in 0.9%. Analysis of a large series of 890 children by Carajaval et al. [3] revealed an incidence of 4.8% for serious post-Bx complications and 17.3% for minor complications. In another report by Diaz-Buxo and Donadio [18] on 1,000 consecutive renal Bxs in adults and children, the majority performed using the modified Franklin-Vim-Silverman needle, 1 patient died (0.1%) and 14 (1.4%) had a symptomatic perirenal hematoma. A statistically higher frequency of complications occurred in those with decreased renal function (serum creatinine >1.2 mg/dl) and in younger patients (<40 years old). In contrast, Alon and Perry [8] compared the frequency of post-renal Bx hematoma in three prior reports of adults as detected by CT scan with that observed in children detected by US 48 h after the Bx and found a significant difference (65.6% for adults and 10.9% for children, $P<0.001$). Although death following renal Bx in children has been reported to occur rarely in the past [1, 18, 25], it is now less likely, probably secondary to modern Bx and imaging equipment. In a review of reports published between 1971 and 1976, of >1,700 percutaneous Bxs of children, no deaths occurred [26]. However, in 1990, Al Rasheed et al. [25] retrospectively analyzed 120 consecutive renal Bxs performed on children using a Tru-Cut needle and reported the following incidences: death – 0.8%, arteriovenous fistula – 1.7%, blood transfusion – 4.2%. Symptomatic perirenal hematoma was detected in 1.7% by US 24 h after the Bx and asymptomatic hematoma in 14.2%. Bohlin et al. [7] reported no serious complications following 119 consecutive renal Bxs performed on children using an automated needle who had US after 24 h of in-hospital bed rest. The incidence of post-Bx hematoma was 26%.

In 1998, Davis et al. [13] reviewed 137 consecutive native renal Bxs of children and reported a major complication rate of 3.0% and a minor complication rate of 15.3%. The frequency of post-Bx hematomas as detected by either CT scan or US was 10.9%. The incidence of post-Bx hematoma was higher when performed using an automated needle compared with those performed using a non-automated needle (20.3% as detected by CT scan or US vs. 3.3% as assessed by US, respectively, $P<0.01$). Nonetheless, the authors suggested that there were practical advantages of the automated renal Bx needle over a non-automated needle, including fewer passes required to obtain a tissue core, faster procedures, and a reduced risk of bleeding complications and non-renal organ perforation. The authors suggested that outpatient renal Bxs could be performed safely in non-hypertensive, adequately sedated patients without vasculitic diseases using an automated needle with real-time direct visualization of the kidney followed by monitoring of patients for a minimum of 10 h post Bx.

Overnight hospital stay after a percutaneous renal Bx for bed rest and observation has been the routine practice of pediatric nephrologists. A survey by Gauthier et al. [27] in 1993 found that only 2 of 25 pediatric nephrologists in the New York metropolitan area and in Philadelphia performed renal Bx as an ambulatory procedure. Similarly, only 2 of 13 pediatric nephrology departments in England reported in 1995 that they performed day-care renal Bxs, yet 1 of these centers reported performing renal Bxs in children as day cases for more than 6 years, without any serious complications [28]. Although the performance of renal Bx as an outpatient procedure is controversial [10], there have been several, albeit retrospective, reports in support of this [14–16]. Chesney et al. [14] reported a complication rate of 11.4% after outpatient percutaneous renal Bx in children, compared with 17.5% in inpatients. Ogborn and Grimm [16] reported a complication rate of 8.7% and White and Poole [15] a rate of only 2.6% in retrospective studies on the performance of renal Bx in children on an outpatient basis.

Our prospective study supports the notion that in selected pediatric patients kidney Bx can be performed safely as an outpatient procedure. The incidence of asymptomatic post-Bx intra- or perirenal hematoma was similar in the two groups (39% study group vs. 43% control group). One may speculate why the overall incidence of post-renal Bx hematoma of 40% in our patients was higher than in previously reported studies, such as those by Alon and Perry (10.4%) [8] and Al Rasheed et al. (14.3%) [25]. One possibility is better imaging equipment with higher resolution. Indeed, in studies using CT scan rather than US, the frequency of post-Bx hematoma detection was 55%–85% [22, 23, 29]. Nonetheless, Feneberg et al. [9] reported a post-Bx hematoma rate as detected by US of 34%, similar to our findings. Another factor is the type of Bx needle used. All of the Bxs in the study of Alon and Perry [8], as well as that of Al Rasheed et al. [25], were performed with a Tru-Cut needle. In our study, the incidence of hematoma following Bx with a Tru-Cut needle was 15.4% (Table 4), similar to other reports [8, 9, 25]. Indeed, this type of needle was found to be least traumatic, with the lowest frequency of post-Bx hematoma compared with the two other types of needles [modified Franklin-Vim-Silverman (54%) and automated spring-loaded needle (22%)] (Table 4). The relatively lower hematoma frequency following a renal Bx performed by Tru-Cut compared with an automated needle has been reported by others [9, 14].

In contrast, use of the Tru-Cut needle has been reported to have a greater risk of bleeding complications compared with the spring-loaded automated needle after Bx of transplanted kidneys [30]. We found that neither disease entity nor Bx performance by an attending or a fellow predicted post-Bx hematoma formation (Tables 3, 4). However, the above discussion may be of limited relevance as suggested by the fact that all 15 late renal US studies performed on children in our study were completely normal. These include all 5 children who had only a late US evaluation and all 10 children who had a normal follow-up sonogram after early post-Bx US found a hematoma. All of the follow-up sonograms found complete resolution of the hematomas without any evidence of long-term complications. These findings indicate excellent long-term outcome, independent of the presence or absence of an early post-Bx hematoma.

The optimal timing to detect the maximum incidence of post-Bx hematoma by US has yet to be determined. We performed the post-Bx US 2 weeks after the Bx, compared with other studies which imaged the kidney 6–8 h [9], 24 h [7], and 48 h [8] after the procedure. Interestingly, in our study the sonograms that detected a hematoma were performed 3.7 days earlier than those not detecting a hematoma (Table 4). One may speculate that the later the US is performed after the Bx, the higher the chance of a normal result. Indeed, follow-up US found complete resolution of the hematoma after 4–5 months.

It is routine to perform coagulation studies prior to a renal Bx. Children in our study who were found to have a post-Bx hematoma tended to have a longer PT than those without a hematoma (Table 4). This finding, although interesting, is only a statistical observation and likely is not clinically important, since the pre-Bx PT values were normal in all of the children. It is our routine to measure bleeding time only in those with uremia or a history of a bleeding disorder, collagen vascular disease, or renal transplantation [31]. Bleeding time has been reported not to be a predictor of post-renal Bx hematoma formation [7].

In conclusion, percutaneous renal Bx performed as an outpatient procedure on selected patients is a successful and safe procedure, without apparent clinically significant complications and is appreciated by the patients and their families. In addition to a reduction in professional and hospital charges, as has been reported by others [14], the stress and anxiety for patients and their families, as well as the utilization of hospital resources, is minimized. There was no difference between the control and study patients regarding the amount of subjective pain or in the use of analgesics following the Bx. Of those who had a same-day procedure, a majority responded that they would prefer being discharged home on the same day if another Bx was required. Even when an asymptomatic intra- or perirenal hematoma is detected within 1 month of Bx, there seems to be no long-term complications. For Bxs which are technically more difficult, closer observation is advised because of an increased risk of complications such as intra- or perirenal hematoma formation.

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LITERATURE ABSTRACT

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ACE inhibition improves glomerular size selectivity in patients with idiopathic membranous nephropathy and persistent nephrotic syndrome

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Patients with idiopathic membranous nephropathy (IMN) and persistent nephrotic-range proteinuria are at risk for progression to end-stage renal failure. Whether angiotensin-converting enzyme (ACE) inhibitors are also renoprotective in these patients remains elusive. In 14 patients with IMN (patients) and persistent proteinuria (protein > 3 g/24 h for >6 months), we studied mean arterial pressure (MAP), urinary protein excretion, glomerular filtration rate (GFR), renal plasma flow (RPF), and albumin and neutral dextran fractional clearance after 2 months washout from previous antihypertensive treatment (basal), after 2 months of enalapril (2.5 to 20 mg/d) therapy (posttreatment), and 2 months after enalapril withdrawal (recovery). MAP, proteinuria, and GFR were also measured at the same time points in 6 patients with IMN and persistent overt proteinuria maintained on conventional treatment throughout the study period (controls). Basal MAP, proteinuria, and GFR were similar in the two study groups. However, in patients at the end of the treatment period, MAP (posttreatment, 99.6 +/– 11.2 versus basal, 103.3 +/– 12.1 mm Hg; $P < 0.05$), proteinuria (posttreatment protein, 5.0 +/– 2.9 versus basal, 7.1 +/– 4.9 g/24 h; $P < 0.05$), albumin fractional clearance (posttreatment median, 1.7 x 10(-3); range, 0.2 to 22.7 x 10(–3) versus basal median, 4.1 x 10(–3); range, 0.4 to 22. 1 x 10(–3); $P < 0.05$), and fractional clearance of largest neutral dextrans (radii from 62 to 66 A) were significantly less than basal values. At recovery, MAP significantly increased to 106.6 +/– 11.7 mm Hg ($P < 0.001$ versus enalapril), but all other parameters remained less than basal values. GFR and RPF were similar at each evaluation. Changes in proteinuria after treatment withdrawal positively correlated ($r = 0.72$; $P < 0.01$) with baseline GFR. Theoretical analysis of dextran-sieving data indicated that ACE inhibitor treatment significantly improved glomerular membrane size-selective dysfunction. This effect persisted more than 2 months after treatment withdrawal. No patient had symptomatic hypotension, acute renal function deterioration, or hyperkalemia during enalapril treatment. Thus, in patients with IMN and long-term nephrotic syndrome, ACE inhibitor treatment, but not conventional therapy, improves glomerular barrier size selectivity. The antiproteinuric effect of ACE inhibition is long lasting, especially in patients with more severe renal insufficiency. This is the premise of a long-term renoprotective effect that may limit the need for treatment with more toxic drugs.