Percutaneous ultrasound-guided renal biopsy in supine antero-lateral position: A new approach for obese and non-obese patients

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Abstract

Background. Percutaneous ultrasound (US)-guided renal biopsy is the gold standard in the evaluation of renal diseases, but some patients, such as the obese, may not be eligible for this procedure. Aim of this study was to determine the feasibility, efficacy and safety of US-guided percutaneous renal biopsy in supine antero-lateral position (SALP) in high-risk patients (BMI > 30 and/or respiratory difficulty), as well as to compare the overall outcome of SALP with that of traditional prone position (PP) in low-risk patients (BMI ≤ 30/no respiratory difficulty).

Methods. One hundred and ten consecutive patients scheduled for native kidney biopsy were recruited. Ninety low-risk patients were randomized following a permuted block randomization list to receive either US-guided renal biopsy in PP (Group 1) or SALP (Group 2), whereas 20 high-risk patients received US-guided renal biopsy in SALP (Group 3) and were our observational cohort study. Comfort compliance and breathing difficulty in each group were evaluated by the Visual Analogue Scale (VAS). Bleeding complications were evaluated through US renal scanning.

Results. Mean operating time was 7 min. Comfort compliance and breathing difficulty were significantly better for SALP in both low- and high-risk patients; there were no significant differences in pain after biopsy among the three groups. Bleeding complications were slightly higher in Group 1. Diagnostic yield was similar in all groups.

Conclusions. SALP is reliable, minimally invasive, easy, highly successful, timesaving and almost free from severe side-effects. A better VAS score for breathing difficulty and comfort compliance characterizes this procedure, making it particularly suitable for obese patients.

Keywords: biopsy complications; obesity; ultrasound percutaneous renal biopsy

Introduction

Renal biopsy plays an essential role in the management of patients with haematuria, proteinuria and renal failure, as it provides valuable diagnostic and prognostic information on renal diseases [1]. The ‘standard’ technique involves percutaneous ultrasound (US)-guided puncture of the lower renal pole under local anesthesia and with the patient in prone position (PP). PP is considered to provide the most rationale approach to a retroperitoneal organ, as it is supposed to bring the kidney closer to the posterior abdominal wall.

The experience gained over the last decades [2–4] has shown this technique to be safe and effective in most but not all patients, with the obese, whose proportion is rapidly growing in developed countries, being those at highest risk for bleeding complications and technical failures [5,6]. As a matter of fact, a large body mass can be associated with poorer US visualization of the kidney as well as severe respiratory difficulties.

To overcome these drawbacks, a number of technical refinements have been proposed over the years, including computerized tomography (CT) guidance, laparoscopic renal biopsy and transjugular (TJ) biopsy [6–11]. CT-guidance, while providing adequate kidney visualization, does not prevent the respiratory difficulties associated with the PP and yet may not be feasible in those patients who are too large or too heavy for the scanner. Laparoscopic renal biopsy, although safe and effective, requires general anesthesia and lengthy recovery times [7,8]. Finally, despite the theoretical advantage of lowering the risk of capsular perforation, TJ renal biopsy is more invasive than percutaneous biopsy and yet is associated with a lower diagnostic yield due to the need to traverse the medulla first in order to reach the more distal cortex [9–11].

The possibility of expanding an easy procedure such as percutaneous US-guided renal biopsy also to patients obese or with respiratory problems would therefore be particularly attractive.
It has recently been shown [12] that percutaneous access to renal calices and pelvis can easily, safely and effectively be obtained with the patients in SALP using US-guidance and local anesthesia, i.e. the same setting as in renal biopsy, and that such an approach prevents respiratory problems, particularly in obese patients. On the basis of this experience, we performed a study aiming to determine feasibility, efficacy and safety of SALP renal biopsy in obese patients (high risk: BMI > 30 and/or breathing difficulty), as well as to compare the overall outcome of SALP with that of the traditional PP in non-obese patients (low-risk: BMI ≤ 30 and no breathing difficulty).

Material and methods

Study design

Before starting the study, in a 6-month period (January–June 2005), an experienced nephrologist (LG) learned and set up the new technical approach under the supervision of an experienced urologist (LC) trained to perform latero-oblique percutaneous nephrostomy [12]. During this period, 25 SALP ultrasound-guided renal biopsies were performed.

On the basis of this acquired experience, we started a prospective and comparative single center study. The protocol was approved by the local ethical committee, and all patients giving their written informed consent were included in the study.

One hundred and ten consecutive patients scheduled for renal biopsy of native kidney, from July 2005 to February 2007, were enlisted. Indications for biopsy included unexplained proteinuria, haematuria or acute renal failure in the context of various underlying disorders. Patients were asked to abstain from aspirin or NSAIDs for at least 7 days before biopsy; administration of heparin was stopped the day before biopsy. Standard coagulation parameters (prothrombin time, partial thromboplastin time and fibrinogen) were measured on the day of biopsy; also bleeding time (Ivy) was measured just before the biopsy to rule out platelet dysfunction due to intrinsic causes (e.g. von Willebrand’s disease or prolonged bleeding time secondary to uraemia).

The patients were classified as low-risk (90 patients; prospective and randomized study) if their body mass index (BMI) was ≤30 and had no respiratory difficulty, and high risk if their BMI was >30 and/or had respiratory difficulty (20 patients; observational cohort study). Ninety low-risk patients were randomized following a permuted block randomization list to receive their US-guided renal biopsy in the standard PP (Group 1; No 45) or the new SALP (Group 2; No 45), whereas all high-risk patients received their US-guided renal biopsy in the new SALP (Group 3; No 20).

The day before biopsy all patients were placed in SALP for 5 min and then in PP for another 5 min, and asked to score, using the 10-cm scale-bar marking method (so-called Visual Analogue Scale—VAS), their compliance and difficulty in the two positions in terms of comfort and breathing, respectively. For comfort compliance, the higher the score the better the compliance, whereas for breathing difficulty and pain, the lower the score the lower the difficulty and pain, respectively.

The day of biopsy execution all patients received, 30 min before biopsy, bleeding prophylaxis with 1-deamino-8-D-arginine vasopressin (DDVAP), 0.4 µg/kg body weight, intravenously and antibiotic prophylaxis with cefotaxime, 1 g intravenously, as previously reported [4].

Twenty-four hours post-biopsy all patients were asked to rescore their comfort compliance and breathing difficulty to the assigned position during biopsy execution, as well as to score the strength and duration of subjective pain using the VAS method.

Post-biopsy bleeding complications were evaluated using US renal scanning at 30 min, 6 h, 1 day and 1 month after the procedure, and categorized as either minor or major. Minor complications included gross haematuria and/or subcapsular perinephric haematoma (∼5 cm²) that spontaneously resolved without the need for further intervention [4]. Major complications were defined as those requiring an intervention, either transfusion of blood products or an invasive procedure (angiography), and those that led to acute renal obstruction or failure, septicemia or death [4]. The size of post-biopsy haematomas (surface area) was defined as the product of the longest and the shortest diameters on the two-dimensional sonographic pictures [4].

Demographic, clinical and relevant laboratory data were abstracted from the patient hospital records and entered into a dedicated database. The number of glomeruli seen by light microscopy, immunofluorescence and electron microscopy was recorded from pathology reports, as was the diagnosis.

Technique

Figure 1 (panels A and B) shows one of the obese patients who underwent renal biopsy in the SALP position. The SALP was obtained by placing towels under the ipsilateral shoulder and gluteus to elevate the flank by ~30° (Figure 1C–D). The ipsilateral arm was placed over the thorax while the contralateral was abducted and used for intravenous perfusion. The ipsilateral leg was slightly flexed over a pillow whereas the contralateral was flexed and abducted so that its lateral aspect was lying on the table. This position provides full exposure of Petit’s triangle (lattissimus dorsi muscle—12th rib—iliac bone) (Figure 2A) thus providing enough space to perform US scanning and to easily oriente the US-guided puncture toward the inferior renal pole (Figure 2B and C). In this position the posterior face of the kidney is expected to be almost parallel to the operating table while the ipsilateral colon is expected to fall antero-medially, sufficiently far from the puncture paths (Figure 3).

After shaving and draping the flank, the kidney was US-scanned to determine the ideal puncture path (Figure 2). The identification of the lower kidney pole by US scanning was easy and the quality of image resolution was similar to the PP position (Figure 2B). The entire path was then anesthetized with 10 ml of 2% lidocaine solution. A 16-gauge one-piece disposable automatic needle (Monopty™, Bard, USA) was guided to the capsule in the lower pole of the kidney using an ESAOTE MEGAS GPX ultrasonograph.
Fig. 1. A and B show one of those obese patients who underwent renal biopsy in the SALP position. SALP was obtained by placing towels under the ipsilateral shoulder and gluteus to elevate the flank by 30° (C). The ipsilateral arm was placed over the thorax while the contralateral was abducted and used for intravenous perfusion (D).

Fig. 2. Left renal US scanning through Petit’s triangle (latissimus dorsi muscle—12th rib—iliac bone) (A) and US image of the puncture path (B and C).

and fired into the renal parenchyma (Figure 2). All biopsies were performed by the same nephrologist (LG).

Statistical analysis
The results of the quantitative variables were expressed as mean ± SD and compared by ANOVA and paired Student’s t-test, as appropriate. All tests were two-tailed. Statistical significance was set at $P < 0.05$. The Statview software package, SAS Inc. Co (5.0 version), was used for all analyses.

Results
There were no significant differences in baseline demographic and clinical data among Groups 1, 2 and 3; patients in Groups 1 and 2 also matched in height and weight whereas patients in Group 3 obviously had greater weight and BMI (Table 1).

The procedure was easy, safe and effective in all patients and mean operating time was 7 min (range 5–9) in all groups (Table 2). There were no cases of inadequate
Fig. 3. CT scan of the left kidney (white arrow) showing in a 30° SALP position (white triangle) the descending colon (white asterisk) that moves antero-medially, thus away from any possible puncture path.

sampling and no statistically significant differences were found in the mean number of glomeruli/cores among the groups (Table 2). A precise definition of renal disease was achieved in all cases.

Post-biopsy bleeding complications occurred in 13 patients (11.82%), and were minor in all but one in Group 1 who presented an artero-venous fistula that required chemoembolization (Table 2).

The SALP provided significantly better comfort compliance and significantly lower breathing difficulty than the PP in both low- and high-risk patients, whereas there was no difference in post-biopsy pain and diagnostic yield among the three groups (Table 3). Interestingly, pre- and post-biopsy comfort compliance and breathing difficulty scores were exactly the same in all patients suggesting that patient compliance was related to the position rather than to the procedure itself.

Discussion

The present study demonstrates that percutaneous US-guided renal biopsy in SALP is feasible, safe and effective in high-risk patients and that it provides significantly better comfort compliance and significantly lower breathing difficulty than the standard PP in both low- and high-risk patients. Moreover, it does not impact on post-biopsy pain, diagnostic yield and bleeding complications.

In our experience the percentage of complications was very low (<15%) and comparable to those reported in the literature [2,13,14]. Remarkably, we recorded almost exclusively minor complications following percutaneous renal biopsy, regardless of the approach adopted.

According to our findings, changing patients from PP to SALP apart from improving comfort compliance and respiratory difficulty, seems to eliminate those safety and technical problems that have often led to the high-risk obese patient being scheduled for ‘alternative’ biopsy procedures. Safety issues are basically related to bleeding complications, whose higher incidence in the obese patients after percutaneous US-guided biopsy has been attributed to poorer US visualization of the kidney rather than to the obesity itself [9,11]. In the present study, the rate of bleeding complications was lower, though the difference was not statistically significant, in high-risk obese subjects biopsied in SALP (Group 3) than in low-risk patients biopsied in PP (Group 1). A clear and detailed US visualization of the

Table 1. Demographic and clinical features of the three groups of patients

<table>
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<th>Group 1</th>
<th>Group 2</th>
<th>Group 3</th>
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<tbody>
<tr>
<td>No of patients</td>
<td>45</td>
<td>45</td>
<td>20</td>
</tr>
<tr>
<td>BMI (mean)</td>
<td>23.9 ± 3.0</td>
<td>25.2 ± 2.3</td>
<td>36.5 ± 6.3*</td>
</tr>
<tr>
<td>Age (years) (mean)</td>
<td>45.1 ± 7.9</td>
<td>44.8 ± 16.1</td>
<td>48.8 ± 13.9</td>
</tr>
<tr>
<td>Haemoglobin (g/dl) (mean)</td>
<td>12.9 ± 2.6</td>
<td>13.1 ± 2.2</td>
<td>12.9 ± 2.9</td>
</tr>
<tr>
<td>Haematocrit (%) (mean)</td>
<td>38.9 ± 6.5</td>
<td>38.1 ± 5.5</td>
<td>37.8 ± 7.6</td>
</tr>
<tr>
<td>Ivy Test (second) (mean)</td>
<td>189.9 ± 87.4</td>
<td>188.1 ± 70.9</td>
<td>176.8 ± 78.1</td>
</tr>
<tr>
<td>Systolic blood pressure (mean)</td>
<td>129.9 ± 16.6</td>
<td>130.9 ± 19.6</td>
<td>127.9 ± 16.1</td>
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<tr>
<td>Diastolic blood pressure (mean)</td>
<td>84.3 ± 10.2</td>
<td>83.2 ± 10.2</td>
<td>81.8 ± 11.8</td>
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*P < 0.001 G3 versus G1 and G2 by ANOVA.

Table 2. Objective outcome measures in the three groups of patients

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<th>Group 1</th>
<th>Group 2</th>
<th>Group 3</th>
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<tbody>
<tr>
<td>No of patients</td>
<td>45</td>
<td>45</td>
<td>20</td>
</tr>
<tr>
<td>Procedure time (min) (mean)</td>
<td>6.8 ± 0.6</td>
<td>7.0 ± 0.5</td>
<td>6.8 ± 0.8</td>
</tr>
<tr>
<td>Number of passes</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>(median, min and max)</td>
<td>1–4</td>
<td>1–3</td>
<td>1–3</td>
</tr>
<tr>
<td>Number of cores</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>(median, min and max)</td>
<td>1–2</td>
<td>1–2</td>
<td>1–2</td>
</tr>
<tr>
<td>Number of glomeruli/core</td>
<td>15.64 ± 5.80</td>
<td>15.04 ± 6.83</td>
<td>12.72 ± 4.37</td>
</tr>
<tr>
<td>Post-biopsy complications</td>
<td>Minor (no. of patients and %)</td>
<td>6/13.3</td>
<td>4/8.9</td>
</tr>
<tr>
<td>Major (no. of patients and %)</td>
<td>1/2.2</td>
<td>0/0</td>
<td>0/0</td>
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kidney probably remains the most important factor limiting the occurrence of bleeding complications. On the other hand, the PP likely causes higher pressure levels onto intra-abdominal organs, including the kidney, compared to SALP. We hypothesize that the increase of the intra-abdominal pressure exerted onto the kidney capsule perforated by the biopsy needle might favor bleeding complications in PP.

The possibility of safely submitting even high-risk obese patients to percutaneous US-guided renal biopsy in the routine nephrological setting simply by adopting SALP should avoid the recourse to laparoscopic renal biopsy, which is invasive, requires general anesthesia and can be associated with significant morbidity and even mortality [7,8]. Also, TJ renal biopsy is more invasive than percutaneous US-guided renal biopsy and should therefore be offered to patients with increased bleeding risk due to coagulopathy and platelet dysfunction rather than to patients with simple obesity.

The present study demonstrated the expected advantages of SALP over PP in terms of patient’s comfort compliance and breathing difficulty even in the ‘standard’ low-risk patient.

Furthermore, the bleeding complication rate was lower among low-risk patients, though not statistically significant, for patients biopsied in the SALP (Group 2) than for those biopsied in PP (Group 1), which would further support the hypothesis that bleeding complications are possibly related to variations of the abdominal pressure onto the kidney capsule, regardless of variations in patient body mass.

Another safety issue, which has probably led to performing percutaneous renal biopsy in prone rather than the supine position, is the fear of puncturing the bowel. Recent radiological studies have demonstrated that this fear is unjustified and that the kidney may safely be punctured in SALP [13,15–19]. One of these studies [15], based on retrospective evaluation of CT scans in prone and supine position [15], showed that, at the opposite, the risk of colonic injury is higher for PP than for SALP, since in the former position the colon is usually pushed against the posterolateral surface of the kidney while in the SALP it falls antero-medially, thus at some distance from the puncture path.

In conclusion, percutaneous renal biopsy can easily, safely and effectively be carried out in SALP in a standard nephrological setting, comprising local anesthesia and US-guided kidney puncture. In comparison with the traditional PP, the SALP provides significantly higher patient compliance, along with a similar diagnostic yield, and a slightly lower bleeding complications rate. SALP is particularly advantageous in patients with respiratory difficulty and or obesity, thus enabling percutaneous US-guided renal biopsy to be carried out on patients who would otherwise have been submitted to more complex and invasive procedures.

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Conflict of interest statement. None declared.

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