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Suprapubic catheter insertion using an ultrasound-guided technique and literature review

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Suprapubic catheter (SPC) insertion is a common method of bladder drainage in contemporary urological practice. The procedure involves insertion of a sharp trocar into the bladder percutaneously, usually by palpation, percussion or cystoscopy for guidance. Although generally considered a safe procedure, the risk of bowel injury is estimated at up to 2.4% with a mortality rate of 1.8%. Recently published British Association of Urological Surgeons (BAUS) guidelines have recommended that ultrasonography (US) may be helpful to identify bowel loops and recommends its usage whenever possible. The present paper describes the use of US for SPC insertion and discusses the implications of this advice. This paper is designed to support and supplement practical techniques learnt on a course and in clinical practice.

What's known on the subject? and What does the study add?

The conventional 'blind' technique for suprapubic catheter (SPC) insertion relies on adequate filling of the bladder to displace bowel away from the site of needle puncture. However, in a small percentage of patients this fails to happen, which can occasionally lead to life-threatening bowel injury. Recently published British Association of Urological Surgeons (BAUS) guidelines have recommended that ultrasonography (US) may be helpful to identify bowel loops and recommends its usage whenever possible.

This paper describes the technique of US-guided needle puncture and SPC insertion to reduce the likelihood of bowel injury. The paper addresses training, equipment and logistical issues associated with this advice. We have reviewed the available publications on the outcomes from this technique and also present our experience.

KEYWORDS

suprapubic catheter, ultrasonographic guidance, British Association of Urological Surgeons (BAUS), National Patient safety agency (NPSA)

INTRODUCTION

The indications for suprapubic catheter (SPC) insertion include urinary retention after urethral trauma and in patients needing long-term catheterisation for bladder dysfunction in neurological conditions, e.g. multiple sclerosis, spinal cord injury etc.

In most cases, the distended bladder pushes the peritoneal reflection superiorly and prevents bowel loops passing between the anterior abdominal wall and the bladder, therefore allowing safe insertion of a SPC 'blindly'. However, one study reported the incidence of bowel injury from 'blind' SPC insertion to be as high as 2.4% with resultant mortality in 1.8% [1]. Obesity, abdominal adhesions from previous surgery and inadequate bladder distension further increases the risk of bowel injury during 'blind' SPC insertion. Cystoscopic-guided or open surgical insertions are alternative methods of SPC insertion. However, cystoscopic guidance does not completely exclude bowel injury. Open surgical SPC insertions need a general anaesthetic and have a higher morbidity. Image-guided suprapubic catheterisation offers a safer, less invasive method obviating the need for a general anaesthetic.

The present paper describes the use of ultrasonography (US) for SPC insertion and the implications of this advice. This paper is designed to support and supplement practical techniques learnt on a course and in clinical practice.

US GUIDANCE FOR SPC INSERTION

I. OBJECTIVES, TYPES OF PROBES AND US MACHINES

The objectives of US guidance for SPC insertion are to assess bladder filling, identify interposed bowel at risk of injury and guide the needle puncture at the optimum site (Figs 1–3).

Clinical US uses sound frequencies higher than the human ear can detect (20 000 Hz) mostly in the range of 2.5–15 MHz. The higher frequency probes, such as a linear 15 MHz probe, will have limited penetration, higher resolution, and enable better visualisation of shallower structures, e.g. subcutaneous vessels. Lower frequency probes (3.5–6 MHz) have greater depth

penetration and are more useful for abdominal scanning and procedures such as SPC insertion.

Although there is a large variation in cost and complexity, any US machine with an abdominal probe can be used to aid SPC insertion. The smaller units are eminently suitable and are easier for non-specialists to become familiar with. An appreciation of the US probe and beam geometry is essential. The effective width of the US beam is affected by probe construction, depth and focussing and for a 3.5 MHz probe this commonly ranges between 3 to 5 mm.

II. TECHNIQUES FOR US SCANNING IN SPC INSERTION

We describe two techniques of US scanning of the bladder for SPC insertion.

a. Transverse scanning

Here the probe is placed transversely (Fig. 4). The needle is positioned midway along the length of the probe, with slight angulation of the probe towards the needle; the needle appears as a bright spot. Ensuring the needle follows the chosen path, it may be advanced whilst rocking the probe to-and-fro to show the needle. The disadvantage is that the tip of the needle can be difficult to identify and the needle may be advanced too far. Suction applied to a syringe attached to the puncture needle will yield urine after bladder wall penetration.

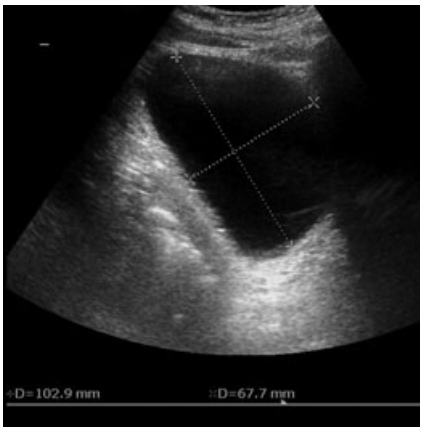
b. Longitudinal scanning

Here the probe is placed sagitally (Fig. 5).The needle is advanced from the end of the probe keeping the beam in line with the needle at all times. The needle tip and intended track are visible at all times as the needle traverses the tissues. The disadvantages of this method are that there is often not enough space for the probe and the needle on the suprapubic skin and there is a tendency to angle the needle towards the probe. Care should be taken that the probe is angled (rather than the needle) to allow visualisation of the needle.

III. TIMING OF US SCANNING

US scanning can be performed before or during SPC insertion:

FIG. 1. Assess bladder filling.



a. Preliminary scan only

During the initial US assessment, an optimal site is selected and marked. The needle direction and depth are memorised and the puncture is performed without moving the patient and without real-time image guidance. This method has been found to be satisfactory with a well-filled bladder and easy access. Alternatively, a sonographer or radiologist marks the best site, before a third party performs the puncture, usually on return to the ward. This method carries potential risk for a change in position of the bowel or loss of bladder contents and is therefore not advisable.

b. Real-time US during bladder puncture

Continuous imaging of the needle as it traverses the tissues allows an optimal track to be selected and followed. Needle guides are available for most probes but can be expensive, may not always be usable and are not infallible. Free-hand imaging requires a more practice, but should be achievable for most operators.

STEPS IN US-GUIDED SPC INSERTION

I. PREPARATION AND INFORMED CONSENT FOR THE PROCEDURE

Before starting the procedure, a review of the need for suprapubic catheterisation is recommended. Contraindications include anticoagulation, bleeding tendency, bladder malignancy and urinary sepsis. A history of previous abdominal surgery, bladder

FIG. 2. Identify interposed bowel at risk of injury.

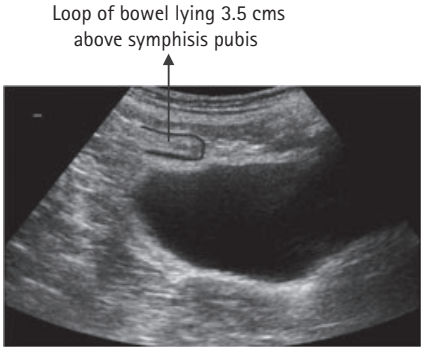


FIG. 3. Guide the needle puncture at the optimum site. Here there is a 3-cm window for SPC puncture.

FIG. 4. Transverse scanning.

FIG. 5. Longitudinal scanning.

TABLE 1 Tips for successful puncture

Tips for successful puncture
• Keep the needle in line with the beam.
• The needle should be oriented exactly in the plane of the probe for longitudinal scanning.
• Holding the probe with a palmar grip allows the gloved fingers to make contact with the patients skin and reduce probe skidding. The 'palmar grip' steadies the probe on the patient's skin.
• Some puncture needles are etched to aid US detection.
• Micro-puncture needles are safer than large trocars and allow repositioning if the initial puncture is not ideal.
• A 21-G needle can be used to infiltrate local anaesthetic down to bladder then disconnected and left *in situ* as a finder needle to guide a larger needle.
• Vibrating the needle in a short 'in-and-out' or 'side-to-side' motion causes deflection of the adjacent soft tissues and makes the trajectory of the needle more discernible within the otherwise stationary field.

FIG. 6. CT-guided SPC insertion.

instability or neurological disease increases the risk of interposed bowel loops or a small volume bladder. Preliminary review of the previous US, CT and MRI and reports is always advised and may identify patients at increased risk of bowel injury who would benefit from a CT-guided procedure or surgical approach.

After explaining the procedure, associated benefits and the risks informed consent is obtained from the patient in keeping with recent BAUS guidelines [2].

Antibiotic prophylaxis, sedation and analgesia should be given before starting the procedure. Familiarisation with the US machine to be used is important and it is recommended that the manufacturer's handbook be studied before use. If not previously used, it is worthwhile taking 20–30 min to switch on and apply the probe to oneself or a willing colleague. Most US machines including basic units have depth, gain and focussing controls. Optimising the image may be easier with the probe applied over the liver to avoid reflections from bowel. Firstly, adjust the depth control so that the organ being scanned fills the screen. If this is set too deep, the area of interest will be too small and compressed into the top half of the image. If too superficial, the structures of interest will not be viewed in their entirety and important collateral structures may not be seen. The gain control affects the brightness of the image and may be adjusted by a single knob or a group of slide controls, sometimes split into near gain and far gain. Next adjust the focal depth to the area of most interest, so that the effective beam width is reduced and the resolution is optimised.

II. ORIENTATION OF THE PROBE

The position of the operator, the patient and the screen can be varied but it is helpful if the screen can be viewed comfortably whilst the bladder puncture is performed. The image on the screen should correspond with the position of the patient and any movement of the probe should produce a logical and corresponding movement on the screen. Touch one end of the probe or move the probe on the patient and rotate the probe 180 ° if necessary to correct the orientation. There may be a palpable ridge on the end of the probe, which corresponds to a marker on the display. Tips for successful puncture have been described in Table 1.

III. IDENTIFYING THE BLADDER AND PUNCTURE SITE WITH US

With the patient lying supine, the suprapubic area is scanned to evaluate bladder filling and the anatomy. The bladder should be adequately distended for optimal visualisation. In patients who are not in urinary retention, this can be effectively achieved by filling the bladder with the aid of a cystoscope. An alternate option is by instillation of warmed saline through a urethral catheter into the bladder.

In most cases, the echo-free or echo-poor bladder contents can be identified in the midline deep to the anterior abdominal wall. Patients with an indwelling urethral catheter will often have some air within the bladder, appearing as a very bright echo in the nearest part of the bladder. This may occasionally be large enough to totally obscure the bladder, in which case CT guidance may be necessary (Fig. 6). The pubic bone should be located both by feel and by US. Loops of colon are identified by their intraluminal gas showing as a bright echo sometimes changing shape with peristalsis. Small bowel may not contain gas and appears as a compressible circular or linear low echo. Moving the probe along the length of the bowel will aid evaluation. Marking the pubic bone, the peritoneal reflection and the ideal puncture site with a skin marker is helpful, at the same time

noting whether the probe is angled cephalad, caudal or perpendicular as this angle should be reproduced at the time of actual puncture.

After skin preparation, a sterile aperture drape should be applied to the marked area. A long sterile plastic sheath is used to cover the gelled probe and sterile gel applied to the skin.

IV. BLADDER PUNCTURE UNDER US GUIDANCE

With adequate bladder distension, intervening bowel having been excluded, the site of puncture is usually between 2 and 4 cm above the symphysis pubis. Angulation downwards may result in the catheter impinging on the trigone causing discomfort. Having identified the puncture site, local anaesthetic should be injected into skin and deeper tissues in the chosen path down to and into the bladder wall using a spinal needle or the puncture needle itself for deeper administration under US guidance.

V. SPC INSERTION

This description assumes the use of one of the Seldinger type SPC insertion kits available commercially, which include a needle, guidewire, peel apart sheath with introducer and Foley type catheter.

The Seldinger technique is the safest way to insert a SPC. Once a needle has been placed into the bladder (Fig. 7), a J-guide wire is advanced and the needle removed (Fig. 8), ensuring that the wire is not inadvertently withdrawn. Enlargement of the skin incision can be made if necessary and the peel-away sheath inserted over the wire with a gentle screwing action. Excessive force should not be necessary and increases the risk of wire kinking and bladder injury. Make sure that the sheath follows the line of the wire at all times and the wire remains free running. Resistance followed by a 'give' will be felt as the sheath passes through the bladder wall. Avoid deeper insertion. Keeping the wire and sheath in place, momentarily withdraw the introducer to allow flow of urine and confirm that the sheath tip lies within the bladder. Swiftly, remove the introducer and insert the catheter to its hub. Inflate the balloon and peel apart the sheath. Confirmation of satisfactory position using US is advisable before and after balloon inflation to avoid inadvertent insertion of the catheter tip into the urethra or a diverticulum (Fig. 9).

FIG. 7. Needle puncture under US guidance.

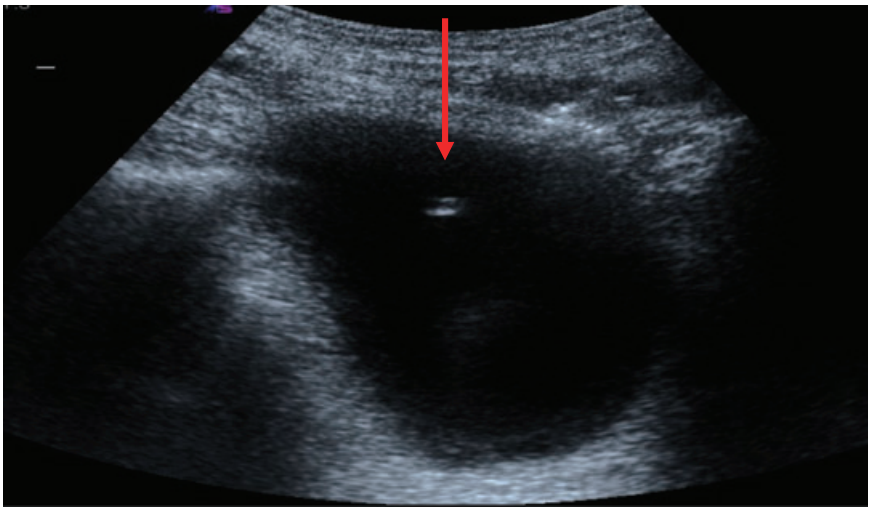
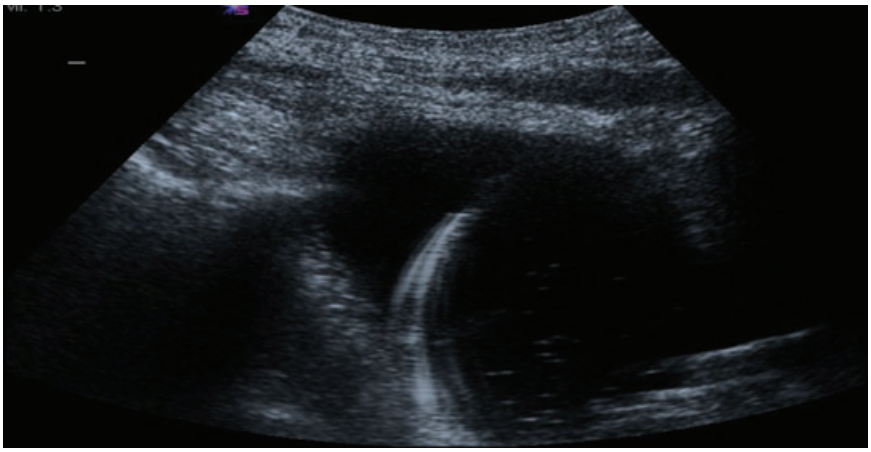


FIG. 8. Guidewire position confirmed on US.



The patient should be monitored for a minimum of 24 h after the procedure and CT performed if there is any cause for concern.

Alternatives to US guidance are CT, MRI and fluoroscopic guidance [3,4]. CT and MRI provide the greatest degree of certainty of bowel position (Fig. 10). A preliminary scan with bladder distension may be reassuring in the days before catheter insertion.

DISCUSSION

The National Patient Safety Agency (NPSA) has received several reports of bowel injury after SPC insertions and has advised that US is to be used by all staff inserting these catheters. This has been further supported by recently published BAUS guidelines, which recommend the use of US guidance for SPC insertion whenever possible [2]. The implications of this advice are substantial in terms of training, availability of machines, transfer of patients to centres with these in place and cooperative working between interventional radiologists and urologists.

US guidance for needle access and visceral biopsies is common practise by radiologists.

FIG. 9. Foley's catheter within the bladder.

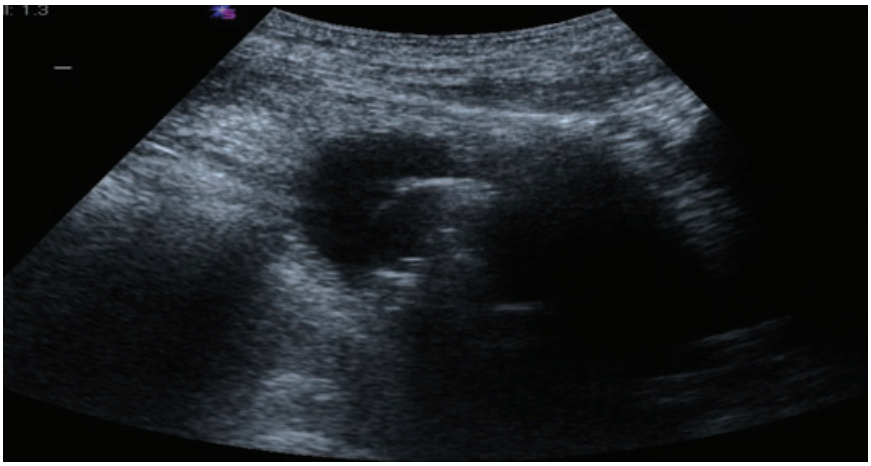
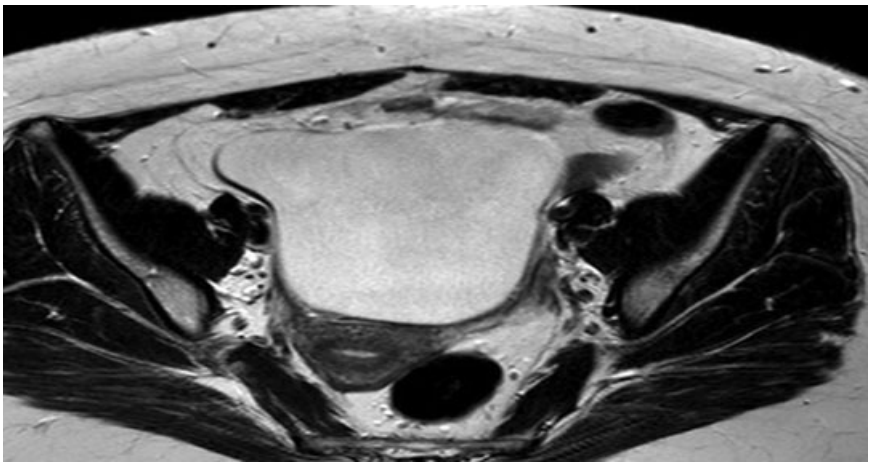


FIG. 10. MRI of bladder showing small-bowel loops lying in front of bladder.



The use of US by clinical staff for diagnosis, confirmation of pleural effusions and needle guidance is increasing as well. Although urologists do not routinely use US for SPC insertion, they are familiar with it while performing prostate biopsies. The authors therefore feel that the skill required for US-guided SPC insertion should be achievable by most urologists.

Each hospital in the UK should have clear guidelines and policies concerning their insertion, a named lead for training and a training plan. US machines should be available for use and staff trained in their use.

WHAT IS THE EVIDENCE IN FAVOUR OF IMAGE GUIDANCE?

The evidence in favour of image-guided SPC insertions is sparse. Aguilera *et al.* [5] performed real-time US-guided SPC insertions in 17 patients with acute urinary retention, with no complications. Evidence from central venous catheter insertions is that US guidance not only reduces the complication rate but improves first-time success rate and as a result reduces the risk of infection [6,7]. Our own unpublished experience of 25 US-guided cases supports the view that unguided bladder puncture is difficult to justify and that these skills should be acquired by all operators.

TRAINING

Attendance at a BAUS-affiliated US-skills course for urologists and certificate of competency in performing US certified by a consultant radiologist before undertaking this technique is recommended. All clinicians should maintain a logbook of cases performed with level of supervision documented to demonstrate competency. The authors would recommend formal assessment of the technique with the use of validated assessment tools, e.g. procedure-based assessment's tools used in the Intercollegiate Surgical Curriculum Programme website before being certified to perform this technique independently.

In conclusion, US-guided SPC insertion has the potential to reduce the incidence of bowel injury. The technique necessitates some training for most operators and will pose training, equipment and logistical issues for medical institutions.

CONFLICT OF INTEREST

None declared.

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Abbreviations: **SPC**, suprapubic catheter; **US**, ultrasonography/ultrasound; **NPSA**, National Patient Safety Agency.