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A Technique for MRI-Guided Transrectal Deep Pelvic Abscess Drainage

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Abstract

This report introduces a technique for transrectal drainage of deep pelvic abscesses performed under interactive MR-image guidance. A new method for tri-orthogonal image plane MR guidance was developed and used to interactively monitor the puncture needle on continuously updated sets of adjustable 3-plane images. The merits and limitations of the technique are highlighted and the patient population that is likely to benefit from this approach is suggested.

Introduction

Transrectal access is an alternative route for draining deep pelvic abscesses when establishing a safe percutaneous trajectory is technically challenging. Although the technique has been described under both ultrasound[1, 2] and CT[3] guidance; the former is more commonly used due to its cost and time effectiveness and its ability to image along the needle path. Ultrasound guidance, however, entails the insertion of an endorectal imaging probe coupled with the biopsy device, which can be difficult to tolerate in certain patient populations. Additionally, ultrasound imaging can be compromised by the presence of large amounts of air within the abscess cavity. CT guidance is restricted to the axial (x-y) plane requiring significant mental triangulation by the interventionist while introducing the needle/catheter along the cranio-caudal (z) plane direction. Additionally, in the younger age groups, CT guidance entails unnecessary radiation exposure to the pelvis.

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In this report, we introduce the first use of interventional MRI technology to guide transrectal drainage of a deep pelvic abscess, highlight the merits and limitations of the technique, and suggest the patient population that is likely to benefit from this approach.

Material and Methods

IRB approval was obtained. A written informed consent was obtained from the patient. The study was HIPAA compliant.

A 62-year-old male patient with pre-sacral abscess secondary to anastomotic leakage following resection of invasive rectal adenocarcinoma was referred for abscess drainage. The procedure was performed entirely on a high-field(1.5T), open-configuration (bore diameter = 70cm, bore length = 125cm) interventional MRI scanner (Magnetom Espree, Siemens Medical Solutions, Erlangen, Germany) equipped with an electronically shielded in-room high-resolution LCD monitor. Mild IV conscious sedation was administered (0.25mg Midazolam HCl, 1mg/ml, Bedford Laboratories, Bedford, OH, USA and 50 mcg Fentanyl Citrate, 0.05 mg/ml, Hospira Inc, Lake Forest, IL, USA). No local anesthesia was administered. The patient was placed on the MRI table in the supine lithotomy position and was introduced feet-first into the short-bore (125 cm) gantry. A 20-cm, 18-gauge MRI-compatible needle (E-Z-EM, Westbury, NY) was placed inside the manufacturer's plastic sheath. The latter was cut to expose the needle tip. The needle tip was then retracted within this plastic sheath, the sheath was lubricated with sterile gel, and the needle/sheath combination was advanced through the rectum aiming at the fluid component of the abscess under real-time MR "fluoroscopic" guidance using the in-room monitor.

A new method for tri-orthogonal image plane MR guidance was developed and used to interactively monitor the puncture needle on continuously updated sets of adjustable sagittal, coronal, and axial True-FISP images (TR/TE=4.35ms/2.18ms, FOV=250x250mm, matrix=192x192, Slice thickness= 5mm, FA=60°, NSA=3, BW=554 Hz/Px, Tacq=3.11s/slice). The 3-orthogonal planes could be acquired relative to the needle axis, relative to the target abscess itself, or in any 3 arbitrary planes relative to each other and to patient's body (Figure 1). The reconstruction and display program was modified to simultaneously project the 3 planes immediately as they were acquired. The interventionist first places the localizing planes along the "ideal" trajectory in his/her judgment (Figure 1). He/she then introduces the needle under interactive 3-plane imaging. Typically, the needle is initially seen on only one or two out of the three planes. He/she would then use the in-room monitor and controller to co-localize the missing plane(s) on the plane(s) where the needle is already visualized. This process can be repeated whenever the needle is deflected out-of-plane on any of the 3 planes.

Once the tip of the puncture needle was identified within the fluid component of the abscess (Figure 2; see also supplementary video), the stylet was removed and 10ml of pus was aspirated and sent for bacteriological culture. A 0.035-inch standard Rosen guidewire was advanced under MRI guidance through the needle into the collection. The needle was then removed over the wire and an 8F-pigtail catheter (Skater, Angiotech, Gainesville, FL) was advanced into the abscess. The pigtail was formed, the strings were locked, and the tip

location within the abscess was confirmed on sagittal and axial True-FISP(TR/TE=4.58/2.29, FOV=280x280mm, matrix=320x320, Slice thickness=5mm, FA=65°, NSA=1, BW=558 Hz/Px, Tacq=39.4s) (Figure 3) and TSE-T2(TR/TE=4840/67, FOV=360x360mm, matrix=205x256, Slice thickness=4mm, FA=150°, NSA=2, fat saturation pulse, BW=150 Hz/Px, Turbo Factor =13, Tacq=2:30min) images.

Results

The MR interventional setup, including the patient's access and the guidance process, was simple and favorable. The interventionist and the assistant had ready access to the perineum at the center of the short-bore scanner and were able to interactively guide and monitor the needle progress on the in-room monitor placed at the same side of the magnet's bore. They were also able to either operate the scanner from the in-room monitor's console or to communicate operating instructions to the technologist at the main console.

The procedure was well tolerated by the patient who did not indicate any level of discomfort at any stage. The ability to perform an image-guided puncture through the rectal wall without inserting an imaging probe or a needle attachment device into the rectum contributed significantly to the procedure tolerability. Setting-up and utilizing the 3-orthogonal plane image guidance was straightforward and time effective. The 18G puncture needle was clearly visible with minimal artifactual widening throughout the guidance process (Figure 2; see also supplementary video). Superb visualization of the target abscess and its surrounding anatomy was achieved and facilitated with unparalleled tissue detail and clarity, when compared to similar procedures using other image guidance modalities. The presence of a large amount of air leaking into the abscess did not create any image artifacts as would have been encountered on ultrasound. Retrieval of pus was achieved in 4.5 minutes (measured from the time the puncture needle was inserted into the rectum). Handling and visualizing the non-MR-compatible guidewire within the magnetic field were challenging due to significant torque and artifact. This was not, however, technically prohibitive since we only performed a brief confirmation scan of the final guidewire location. Securing the pigtail catheter in its final position was achieved in 41 minutes (measured from the time the puncture needle was inserted into the rectum). The total magnet time including the pre-procedural diagnostic MRI study, administration of sedation and institution of patient monitoring, sterile draping, placing and securing the drainage catheter, and performing the post-procedural imaging was 108 minutes.

Discussion

This report introduces a technique for draining deep pelvic abscesses via the transrectal route under direct MRI guidance. It capitalizes on employing emerging interventional MRI technology to help a subset of patients with restricted percutaneous access and limited utility of alternative imaging guidance techniques.

The use of ultrasound to guide transrectal pelvic abscess drainage is simple and cost-effective. However, ultrasound guidance entails the introduction of a relatively sizeable endorectal probe, a biopsy guide, and a puncture needle. This can create significant

discomfort in certain patients such as in immediate post-operative individuals, in patients with proctitis, and in the pediatric age group. Additionally, the presence of a large amount of air within the abscess cavity creates significant back shadowing artifacts that preclude adequate delineation of anatomical details on ultrasound [4].

The MRI-guided transrectal drainage technique described here was used to drain a pre-sacral abscess in a patient with a dehiscence rectal anastomosis resulting in bowel air communicating freely with the abscess cavity. The ability to perform this drainage while introducing only a thin plastic sheath harboring an 18G needle into the rectum, to continuously monitor the needle in three planes, and to exploit the unequalled soft tissue contrast and resolution of MR imaging appeared well suited for this particular setting. The patient did report a complete lack of intraprocedural discomfort despite his immediate post-operative status and the presence of pelvic infection. The three-plane, high-contrast, high-resolution, artifact-free imaging assured safe and accurate guidance and guarded against complications resulting from unexpected post-operative anatomy. The development of the tri-orthogonal imaging plane guidance [5] represented a significant departure from the single-plane (or multiple parallel-plane) guidance of earlier MR interventions [6, 7] and helped significantly shorten the guidance duration. The guidance time could have been further shortened by reducing the number of signal averagings (NSA) utilized and thereby increasing the temporal frame rate of the guidance images. This would, however, occur at the expense of the signal-to-noise ratio (SNR). In our opinion, the 3 signal averages we utilized allowed us a sufficiently fast frame rate (3.11s) while providing an excellent SNR to allow safe navigation of the interventional device. Conceivably, with more widespread use of the technique, various interventionists may elect to modify these parameters to achieve their own comfortable balance between speed and image quality.

The described technique is limited by the narrow selection of available MR-compatible devices, particularly FDA-approved devices in the US market. The duration of this procedure could be further shortened to equal that of the puncture needle insertion, should the currently available singlestick catheters be offered with MR-compatible stylets. A need also exists for reliable MR-safe guidewires. In this context, safety primarily entails guidewires that do not heat in response to the time-varying magnetic field gradients. In addition, they should be reliably visualized under MR guidance. Suboptimal visualization of a 0.035-inch guidewire included in an MR-compatible drainage kit has been reported[8]. Recent reports describe preclinical testing of glass-fiber[9] and polymer-based[10] MR-safe guidewires.

In summary, we have described a new technique for performing transrectal drainage of deep pelvic abscesses under continuous interactive tri-orthogonal MR image guidance. The technique is best suited for circumstances when it is desirable to avoid the discomfort associated with inserting a relatively sizeable ultrasound probe, biopsy guide, and puncture needle into the rectum, such as in post-operative patients, patients with proctitis, and in the pediatric population. It is also suitable for abscesses with large air contents precluding adequate visualization with ultrasound. This report also emphasizes a current need for more MRI-compatible devices particularly guidewires and singlestick catheters.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

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Fig. 1.

Pre-procedural sagittal (a) and axial (b) True-FISP images (TR/TE = 4.35ms/2.18ms, FOV= 250x250mm, matrix= 192x192, Slice thickness= 5mm, FA=60, NSA= 3) showing the typical set-up for tri-orthogonal image plane guidance. The desired trajectory is planned so that the fluid component of the pre-sacral abscess (arrowheads) cavity resides along the sagittal (1), oblique coronal (2), and axial (3) planes of guidance. The trajectory can subsequently be modified to any combination of 3 planes during needle navigation in a time-efficient manner.

Fig. 2.

The puncture needle (arrowheads) has been advanced through the rectum under real-time MR “fluoroscopy” utilizing True-FISP images. The needle tip (arrows) is seen within the fluid component of the abscess cavity. The ability to observe a continuous update of the needle tip location on simultaneously displayed 3 planes allows a fast and confident puncture of the abscess cavity.

Fig. 3.
The final confirmation sagittal (a) and axial (b) True-FISP images of the drainage catheter in place. The catheter shaft (arrowheads) is seen extending through the rectum and within the air component of the abscess cavity. The pigtail end (arrows) has been locked in the dependent portion of the fluid component.