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INTERVENTIONAL RADIOLOGY

Transrectal and transvaginal catheter drainages and aspirations for management of pelvic fluid collections: technique, technical success rates, and outcomes in 150 patients

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Abstract

Purpose To evaluate outcomes of image-guided transrectal/transvaginal (TR/TV) drainage for symptomatic pelvic fluid collections (SPFCs).

Materials and methods Single-center retrospective study of 150 consecutive patients (36 males, 114 females, average age 41 years) who underwent attempted TR/TV drainages of SPFCs during an 11-year, 5-month period. All patients presented with pain and had SPFCs with rectal or vaginal contact on preceding diagnostic CT. Routine technique included Foley catheter insertion, image-guidance with ultrasound and fluoroscopy, 18 g/20 cm Chiba needles, and Seldinger technique for catheter insertion. No anoscope or speculum was used. SPFCs causes were classified by etiology including postoperative—70 (47%); gynecologic—49 (33%); and gastrointestinal—31 (21%). Resolutions of the SPFCs without the need for surgical intervention, collection recurrence, and complications were assessed. Surgical management after attempted TR/TV drainage was considered a failure.

Results Technical success was achieved in 172/180 procedures [TR 128/134 (95%); TV 44/46 (96%)]. TR/TV drainage successfully managed SPFCs in 141/150 patients (94% success rate) and 145/150 patients (97%) did not require surgical intervention; 4 patients with failed TR/TV drainage attempts were managed conservatively. In 5 patients requiring surgery, 4 were after technically successful TR/TV and 1 was after a failed TR attempt. Complications occurred in 4 (3%) patients: 2 bladder punctures (both resolved with medical management), 1 propagation of sepsis, and 1 hemorrhagic return from TR drainage that prompted surgical exploration.

Conclusion Transrectal and transvaginal drainage had high technical success rates and were successful in managing the majority (141/150; 94%) of patients with pelvic fluid collections.

Keywords Image-guided percutaneous drainage · Transrectal drainage · Transvaginal drainage · Abscess drainage · Pelvic abscesses · Intraabdominal abscesses

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Introduction

Image-guided percutaneous drainage of pelvic fluid collections is a safe and highly effective procedure performed by radiologists and serves as the standard of care for the majority of pelvic fluid collections with indications for drainage [1–3]. Transrectal and transvaginal drainage techniques are two options that have been used in clinical practice for more than 30 years [4, 5]. Upper pelvic collections located above the innominate line usually offer a safe anterior transabdominal wall pathway for catheter insertion. However, a transabdominal approach often cannot safely be used for lower pelvic collections below the innominate line ['true pelvis'] because of the interposed bowel between the skin and the collection. Lower pelvic fluid collections not accessible by a transabdominal approach require specific access routes for safe catheter insertion ("advanced techniques/approaches") including transrectal, transvaginal, transgluteal, or transperineal approaches. Transrectal, transvaginal, and transgluteal approaches are the three most common techniques [6]. Transrectal and transvaginal compared to transgluteal techniques have differences in terms of image-guidance, materials, and expertise that may influence their selection for drainage of lower pelvic fluid collections. These three main advanced techniques have different reported rates of success, although the success rates are similar in larger series [6]. The purpose of this study is to evaluate outcomes of image-guided transrectal and transvaginal drainage for management of pelvic fluid collections.

Materials and methods

This was an institutional review board-approved retrospective study that included patients with pelvic fluid collections managed with a transrectal or transvaginal catheter drainage or one-step needle aspiration at a single institution during an 11-year, 5-month period. Inclusion criteria allowed enrollment of patients in whom transrectal or transvaginal drainage had been attempted for management of pelvic fluid collections. Even patients in whom transrectal or transvaginal drainage was attempted but failed were also included in the overall cohort population. All collections were diagnosed based on preceding CT examinations of the abdomen and pelvis. Indications for transrectal or transvaginal drainage were fluid collection in contact with the rectum or vaginal wall and a low deep-seated position in the pelvis below the innominate line without a safe transabdominal approach.

Nearly all (178/180; 99%) procedures were performed with combined transorificial ultrasound and fluoroscopy. One patient too critically ill to go to the fluoroscopic suite was performed at bedside under transrectal ultrasound guidance [2/180 (1%) procedures; 1/150 (0.7%) patient]. Procedural/conscious sedation was used for most [139/150 (93%)] patients; monitored anesthesia care and general anesthesia were used in select patients ($n = 4$ patients each), local anesthesia in 1 patient, spinal anesthesia in 1 patient, and 1 patient did not have proper documentation of their anesthesia method. All procedures in this study were performed by one of two radiologists with 15 years experience and with 27 years experience (HBD). If the patient did not have an indwelling Foley catheter, one was inserted for the procedure to serve as a landmark during ultrasound localization and was subsequently removed after the procedure. When a collection abutted both the rectum and vagina in female patients, the approach was dictated by the clinical suspicion for an infected collection (abscess) versus the few collections presumed to be sterile, e.g., symptomatic ovarian cyst for which nonoperative intervention was desired; in this situation, a transrectal approach was used for collections presumed to be infected, and a transvaginal approach was used for collections presumed to be sterile. Transrectal or transvaginal needle access and catheter insertion were performed without local anesthesia. Catheter drainages, as opposed to one-step needle aspirations, were preferred; however, at the discretion of the performing radiologist, when the operator felt the collection was adequately drained using needle aspiration, no catheter was inserted. Local anesthesia was used only for suture placement to secure successfully placed catheters at the perianal or vulvar skin. The ipsilateral decubitus position was used for unilateral pelvic collections. If the collection was lateralized to one side, the ipsilateral side of the collection was down so the fluid collection was dependent; supine positioning was used for midline collections. In transrectal drainages, progressive digital anal dilatation preceded digital rectal examination and introduction of the endocavitary ultrasound probe with the needle-guide attachment. In transvaginal drainages, the transvaginal ultrasound probe with the needle-guide was inserted directly into the vagina after digital vaginal examination. Once a safe pathway from the rectum or vagina was identified through ultrasound, an 18-gauge, 20-cm Chiba needle was used for access. As mentioned, the Foley balloon served as a sonographic landmark to distinguish the cannulated urinary bladder from the pelvic fluid collection. No anoscope or vaginal speculum was used in any procedure. Once initial needle access was achieved by endocavitary ultrasound guidance, the guidewire and catheter exchange was performed using fluoroscopic guidance. Drainage catheters were inserted using Seldinger technique. A 0.035″ stiff guidewire was coiled within the collection cavity followed by sequential dilation and placement of a self-retaining pigtail drainage catheter under fluoroscopic guidance. The catheters were brought anteriorly between the thighs for patient comfort and follow-up irrigation. An external fixation device or a perianal/vulvar suture was used

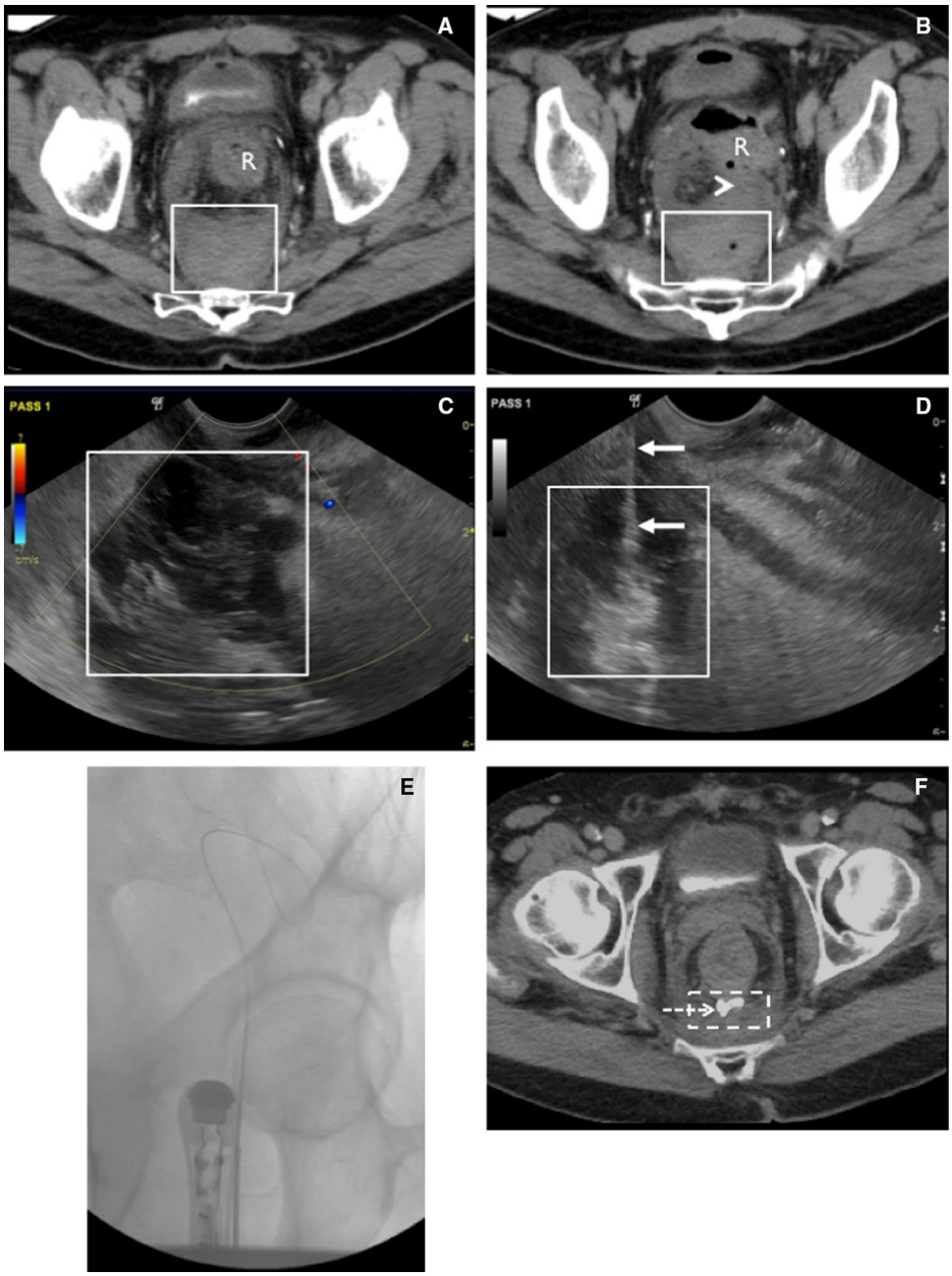

Fig. 1 Transrectal drainage using ultrasound and fluoroscopic guidance. 54-year-old male postoperative from low anterior resection for rectal cancer presenting with abdominal pain, fever, and leukocytosis. Consecutive axial CT images (**a**, **b**) demonstrate a dependent pelvic fluid collection (boxes) in communication with the rectal anastomosis (rectum = R) with the communicated tract depicted by an arrowhead (**b**). The pelvic collection (boxes) was localized with transrectal ultrasound (**c**, **d**) and accessed using an 18-g Chiba needle (**d**; arrows). After performing needle access under ultrasound guidance, the guidewire was inserted under fluoroscopic guidance (**e**). Subsequently, a 10.2 F drainage catheter was inserted over the guidewire, and the guidewire was removed (not pictured). At follow-up CT (**d**), the collection is resolved (dashed box demonstrates the area of the previously noted pelvic fluid collection and the dashed arrow shows the looped pigtail tip of the drainage catheters)

to secure the drainage catheters in place. A radiology resident or attending flushed drains with outputs < 20 cc/24 h with 3–5 cc of 0.9% normal saline daily to ensure patency. Catheters with outputs > 20 cc/24 h were irrigated with 0.9% normal saline daily in volumes comparable to 24-h output. When frank pus was returned during the initial fluid return of the access needle or drainage catheter, ¼ strength Dakin's solution was utilized for irrigation [7]. Exemplary cases for transrectal and transvaginal drainages are demonstrated in Figs. 1 and 2, respectively, and Fig. 3 provides an illustrative diagram of the two drainage techniques.

150 patients met inclusion criteria with 36 males and 114 females with an overall average mean age of 42 years (range 3–75 years). Patients were grouped by drainage technique (transrectal or transvaginal approach), and three etiology-based categories, namely, (i) postoperative complications (70/150 patients; 47%); (ii) gastrointestinal (31/150 patients; 21%); and (iii) gynecologic (49/150 patients; 33%): the gastrointestinal and gynecologic categories were reserved for patients who had not undergone surgical intervention prior to the development of a pelvic fluid collection. Mean follow-up was 133 days (range 2–1410 days).

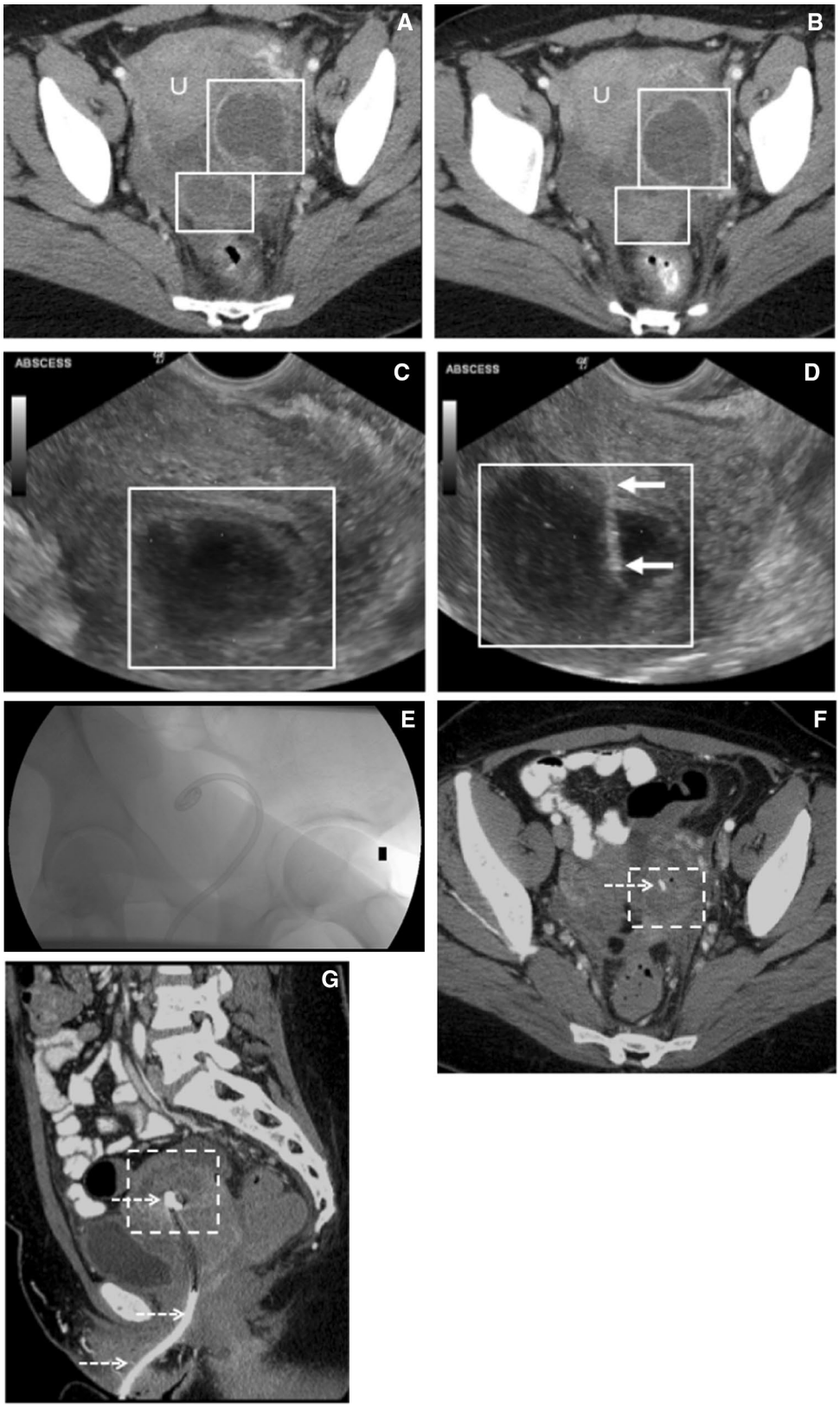

Fig. 2 Transvaginal drainage using ultrasound and fluoroscopic guidance. 23-year-old female with a history of pelvic inflammatory disease and prior tuboovarian abscesses presenting with pelvic pain, fever, and leukocytosis. Consecutive axial CT images (**a**, **b**) demonstrate a multiloculated rim-enhancing pelvic fluid collection (boxes), the dominant collection in the left adnexal region, causing mass effect on the uterus (U). The pelvic collection (boxes) was localized with transvaginal ultrasound (**c**, **d**) and accessed with an 18-g Chiba needle (**d**; arrows). After performing needle access under ultrasound guidance, the guidewire was inserted under fluoroscopic guidance (not pictured). Subsequently, a 10.2 F drainage catheter (**e**) was inserted over the guidewire, and the guidewire was removed. Follow-up CT axial image (**f**) and sagittal reconstruction (**g**) demonstrated decreased size of a persistent small pelvic fluid collection (dashed boxes) with the drainage catheter (dashed arrows) positioned in the collection's caudal aspect. The sagittal reconstruction (**g**) delineates the transvaginal course of the drainage catheter (dashed arrow)

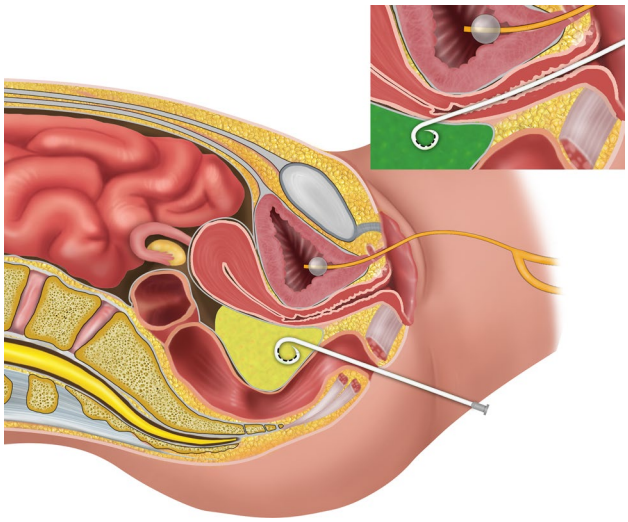

Fig. 3 Illustrative diagram of transrectal (main illustration) and transvaginal drainages (top right box illustration) managing a pelvic fluid collection. A Foley catheter is depicted in the bladder, which serves as a useful sonographic landmark during ultrasound-guided access. Modified and reproduced with permission from Ref. [16]

The primary aim was assessing outcomes of attempted transrectal or transvaginal drainages. Outcome was dichotomized into successes and failures. Successes were defined for transrectal or transvaginal drainages that adequately resolved patients' pelvic fluid collections. Failures were defined as those that needed surgical drainage or management after the attempted transrectal or transvaginal drainages. Interval surgeries were excluded and not considered failures, e.g., patients with perforated appendicitis and abscesses where patients later underwent interval appendectomy after initial transrectal catheter management. Technical failures are also noted, and their outcomes were assessed. Additional recorded factors included etiologies of the pelvic collection, whether a patient underwent a single vs. multiple procedures, mean volume drained at the initial procedure, complications, recurrences of fluid collections, and if patients had additional percutaneous drainage procedures by a transabdominal percutaneous approach. The mean volumes between the transrectal and transvaginal drainages along with the three subgroups were assessed using Student *t* test. A p value of < 0.05 was considered statistically significant.

Results

There were 180 attempted transrectal and transvaginal drainages in 150 patients with an overall technical success rate of 172/180 (95%). The overall cohorts grouped by transrectal or transvaginal drainage approach along with the three different subgroups are summarized in Tables 1 and 2, respectively. Accounting for patients who had preceding or subsequent transabdominal percutaneous drains along with multiple transrectal and transvaginal drainage procedures, 95 patients (63%; 95/150) required only a single transrectal or transvaginal drainage for successful management. In the 8 patients with technical failure of the initial transrectal or transvaginal drainage procedure, 3 had eventual successful percutaneous or transrectal or transvaginal drainage; in the remaining 5 patients, 4 that were aborted without subsequent successful attempts were managed conservatively with antibiotics, and without the need for surgical intervention; and 1 patient with perforated diverticulitis required surgical intervention. In the patients with perforated diverticulitis requiring surgery, they had preceding placement of two transabdominal drains but had ongoing sepsis and persistence of a low pelvic fluid collection. The attempted transrectal drainage was not technically successful, and the patient underwent surgical drainage along with sigmoidectomy. There were 4 patients who had technically successful transrectal or transvaginal drainages, but needed eventual surgical drainage or intervention (Tables 1 and 2). In these 4 patients, 2 had tuboovarian abscesses and underwent hysterectomy and oophorectomy 2 and 10 days after initial transvaginal drainage (catheter placement and aspiration, $n = 1$ each) after persistent sepsis; 1 patient with a suspected tuboovarian abscess clinically and by imaging had frank blood returned at transvaginal catheter drainage (described subsequently with other complications), and 1 patient with perforated appendicitis and abscess refused attempted transrectal drainage until several days in their admission—the patient condition clinically worsened 9 days after transrectal drain placement when a CT examination demonstrated a small bowel obstruction with ischemic changes (pneumatosis) in the ileum. Overall, 141 patients (94%; 141/150) were successfully managed through percutaneous interventions alone, and 145 patients (97%; 145/150) did not require surgical intervention.

In the 172/180 successful transrectal or transvaginal procedures, a drainage catheter was left in place for post-procedure irrigation drainage by gravity 144 times (84%; 144/172 procedures). 28 of the procedures (16%; 28/172 procedures) were aspiration only with no in-dwelling drain placement. Catheters ranged in size from 8.5-F to 24-F although the vast majority (95%: 137/144 catheter drainages) of catheters were 10.2 F. Attempted procedure was not completed, being aborted due to pain or patient tolerance. However, one transrectal procedure was prematurely terminated at an aspiration, when catheter placement was desired; the same patient later underwent transrectal catheter placement when their sedation was increased from conscious sedation to monitored anesthesia care. Mean volume drained for transrectal patients was 96 ml compared to 139 ml for transvaginal patients ($p = 0.08$). Mean volume drained for postoperative, gastrointestinal, and

Table 1 Procedural outcomes, complications, and additional factors of the 150 patients with pelvic fluid collections in the study cohorts grouped by transrectal, transvaginal, and combined approaches

	Transrectal drainage	Transvaginal drainage	Transrectal and transvaginal drainage	Overall cohort
Number, sex	107 patients, 36 males, 71 females	37 patients, 0 males, 37 females	6 patients, 0 males, 6 females	150 patients, 36 (24%) males, 114 (76%) females
Total number of attempted procedures, technical success rate	127 attempted procedures 123/127 (96%) successful Note: 1 additional failure represented in combined column	39 attempted procedures 39/39 (100%) successful Note: 2 transvaginal drainage attempt failures are represented in combined column)	14 attempted procedures 11/14 (71%) successful In two patients, a transvaginal approach was unsuccessfully attempted but a transrectal approach was subsequently successful. In one patient, both approaches failed	Transrectal: 128 successful procedures/134 attempts (95%) Transvaginal: 44 successful procedures/46 attempts (96%) Overall: 172 successful procedures /180 attempts (95%)
Etiology	Postoperative = 52 Gynecologic = 25 Gastrointestinal = 30	Postoperative = 16 Gynecologic = 17 Gastrointestinal = 4	Postoperative = 1 Gynecologic = 5 Gastrointestinal = 0	Postoperative = 69 Gynecologic = 47 Gastrointestinal = 34
Technical failures (# of patients/consequence)	6 patients with initial technical failure 3 were managed conservatively with antibiotics and did not require surgical intervention. 1 patient had re-attempted transrectal drainage that was successful 1 patient had transabdominal drains successfully placed during same procedure after transrectal attempt failed 1 patient required surgical drainage and sigmoidectomy (diverticulitis with abscess)	None	2 patients with initial technical failure 1 patient failed transvaginal approach but a transrectal approach was successfully performed during the same procedure. 1 patient failed both transvaginal and transrectal attempts. Collection managed conservatively with antibiotics and did not require surgical intervention	8 patients 4 were managed conservatively with antibiotics and did not require surgical intervention 2 patients had subsequent successful transrectal drainage 1 had collection access with transabdominal drain 1 patient require surgical drainage
Indwelling drainage catheter vs one-step aspiration (successful procedures)	104 catheter drainages Most (101/104; 97%) catheters = 10.2 F, range 8.5–24.0 F 18 aspirations	31 catheter drainages Most (27/31; 87%) catheters = 10.2 F, range 8.5–20.0 F 8 aspirations	9 catheter drainages All catheters = 10.2 F 2 aspirations	144 catheter drainages 28 aspirations
Single vs multiple procedures (number of patients)	82 with a single intervention 27 with multiple	31 with a single intervention 6 with multiple	3 with a single intervention 3 with multiple	114 patients with a single intervention 36 with multiple
Mean volume drained	96 ml	139 ml	79 ml	107 ml

Table 1 (continued)

	Transrectal drainage	Transvaginal drainage	Transrectal and transvaginal drainage	Overall cohort
Complications	3 patients 1 inadvertent transabdominal catheterization of urinary bladder (concurrent transrectal game was appropriately placed) 1 frank blood returned out of catheter, immediately went to surgery. An ovarian collection by imaging and clinically was thought to be tubo-ovarian abscess but was ruptured hemorrhagic cyst confirmed at surgery 1 propagation of septicemia	1 patient Inadvertent bladder puncture with access needle. Recognized during procedure. Needle removed with no further clinical consequence	None	4 patients 2 bladder punctures 1 catheter return of hemorrhage prompting surgical exploration 1 propagation of septicemia
Recurrence of fluid collection	None	3, all resolved with repeated drainage	1, resolved with repeated drainage	4, all resolved with repeated drainage
Failure despite technically successful drainage requiring surgical drainage or intervention	2 patients	2 patients	None	4 patients
Preceding, concurrent, or subsequent placement of transabdominal drains (TAD)	TAD placed before transrectal drainage = 5 patients TAD concurrent placement during transrectal placement = 9 patients TAD placed after transrectal procedure = 10 patients	TAD placed before transvaginal drainage = 2 patients TAD concurrent placement during transvaginal placement = 2 patients TAD placed after transvaginal procedure = 4 patients	TAD placed before transrectal/transvaginal drainage = 1 patient TAD concurrent placement during transrectal/transvaginal placement = 1 patient TAD placed after transrectal/transvaginal procedure = 1 patient	TAD placed before transrectal/transvaginal drainage = 8 patients TAD concurrent placement during transrectal/transvaginal placement = 12 patients TAD placed after transrectal/transvaginal procedure = 15 patients
Mortality	None	1 patient Diffuse metastases and sepsis; death unrelated procedure. Pelvic fluid collection was successfully drained.	None	1 patient (0.7%); death unrelated to procedure

Table 2 Procedural outcomes, complications, and additional factors of the 150 patients with pelvic fluid collections in the study cohorts grouped by the three subgroups: postoperative, gastrointestinal, and gynecologic

	Postoperative	Gastrointestinal	Gynecologic	
Number, sex	70 patients, 28 males and 42 females	31 patients, 8 males, 23 females	49 patients, 0 males, 49 females	150 patients, 36 (24%) males, 114 (76%) females
Type of procedure	70 transrectal, 17 transvaginal	28 transrectal, 3 transvaginal	36 transrectal, 26 transvaginal	134 attempted transrectal 46 attempted transvaginal
Total number of attempted procedures, technical success rate	87 attempted procedures 83/87 (95%) successful	32 attempted procedures 30/32 (94%) successful	61 attempted procedures 59/61 (95%) successful	172 successful procedures /180 attempts (95%)
Etiology	Bowel resection for malignancy—21 Gynecologic surgery for benign indication—20 Bowel resection for benign indications—15 Laparotomy for trauma—9 Gynecologic surgery for malignant indication—4 Vascular surgery—1	Diverticulitis abscess—16 Ruptured appendicitis abscess—12 Crohn disease-related abscess—2 Blunt trauma managed nonoperatively—1	Tuboovarian abscess—37 Benign ovarian cyst—5 Tumor abscess—5 [17] Endometriomas (thought to be tuboovarian abscesses on imaging)—2	Multiple, see individual column distributions
Technical failures (# of patients/consequence)	4 patients with initial failure 2 patients collections managed conservatively with antibiotics and did not require surgical intervention 1 patient had re-attempted transrectal drainage that was successful 1 patient had transabdominal drains successfully placed during same procedure after transrectal attempt failed	2 patients with initial failure 1 patient with perforated diverticulitis required surgical drainage and sigmoidectomy (with abscess) 1 patient with perforated appendicitis was managed conservative with antibiotics, improved clinically, and later underwent interval appendectomy	2 patients with initial failure 1 patient failed transvaginal approach but a transrectal approach was successfully performed during the same procedure 1 patient failed both transvaginal and transrectal attempts. Collection managed conservatively with antibiotics and did not require surgical intervention	8 patients 4 were managed conservatively with antibiotics and did not require surgical intervention 2 patients had subsequent successful transrectal drainage 1 had collection access with transabdominal drain 1 patient require surgical drainage
Indwelling drainage catheter versus one-step aspiration (successful procedures)	71 catheter drainages Most (65/71; 92%) catheters = 10.2 F, range 8.5–24.0 F 12 aspirations	22 catheter drainages All catheters = 10.2 F 8 aspirations	51 catheter drainages Most catheters (50/51; 98%=10.2 F), range = 8.5–10.2 F 8 aspirations	144 catheter drainages 28 aspirations
Single vs multiple procedures (number of patients)	52 with a single intervention 18 with multiple	23 with a single intervention 8 with multiple	29 with a single intervention 10 with multiple	114 patients with a single intervention 36 with multiple
Mean volume drained	101 ml	97 ml	119 ml	107 ml
Recurrence of fluid collection	2 (both resolved with repeat drainage)		0 2 (both resolved with repeat drainage)	4, all resolved with repeated drainage

Table 2 (continued)

	Postoperative	Gastrointestinal	Gynecologic	
Complications	None	2 patients 1 inadvertent transabdominal catheterization of urinary bladder (concurrent transrectal game was appropriately placed) 1 propagation of septicemia	2 patients 1 inadvertent bladder puncture with access needle that was recognized during procedure. Needle removed with no further clinical consequence 1 frank blood returned out of catheter, immediately went to surgery. An ovarian collection by imaging and clinically was thought to be tubo-ovarian abscess but was ruptured hemorrhagic cyst confirmed at surgery	4 patients 2 bladder punctures 1 catheter return of hemorrhage prompting surgical exploration 1 propagation of septicemia
Failure despite technically successful drainage requiring surgical drainage or intervention	None	1 patient	3 patients	4 patients
Preceding, concurrent, or subsequent placement of transabdominal drains (TAD)	TAD placed before transrectal/transvaginal drainage = 5 patients TAD concurrent placement during transrectal/transvaginal placement = 4 patients TAD placed after transrectal/transvaginal procedure = 7 patients	TAD placed before transrectal/transvaginal drainage = 2 patients TAD concurrent placement during transrectal/transvaginal placement = 3 patients TAD placed after transrectal/transvaginal procedure = 5 patients	TAD placed before transrectal/transvaginal drainage = 1 patient TAD concurrent placement during transrectal/transvaginal placement = 5 patients TAD placed after transrectal/transvaginal procedure = 3 patients	TAD placed before transrectal/transvaginal drainage = 8 patients TAD concurrent placement during transrectal/transvaginal placement = 12 patients TAD placed after transrectal/transvaginal procedure = 15 patients
Mortality	None	None	1 patient Diffuse metastases and sepsis; death unrelated procedure. Pelvic fluid collection was successfully drained	1 patient (0.7%); death unrelated to procedure

The latter two categories were patients without prior surgical intervention causing the pelvic fluid collection

gynecological subgroups were 101 ml, 97 ml, and 119 ml, respectively; none of which were significantly different ($p > 0.4$ in all comparisons). An identifiable organism was cultured in 114 (76%; 114/150) patients. The most commonly isolated microorganism was *Escherichia coli* (41%; 47/114 patients with identifiable microorganisms). There were complications in 4 patients (3%; 4/150) including 2 bladder punctures and 1 septic reaction, all 3 without significant morbidity. The remaining 1 patient, who developed a complication, was taken directly for surgical aspiration after a transrectal aspiration returned frank blood. On imaging and clinical presentation, the collection was thought to be a tuboovarian abscess but was diagnosed as a ruptured hemorrhagic ovarian cyst at surgery. Two patients (1%) had abscess–fistula complexes [7, 8] that were diagnosed at a subsequent sinogram after initial transrectal drainage; these were related to their pelvic fluid collection etiologies and not to the transrectal procedures.

Discussion

The present study demonstrated a high technical success rate [172/180 (96%)] and favorable outcomes of patients with low pelvic fluid collections managed with transrectal or transvaginal drainage. The success rate of 94% (141/150) patients managed with transrectal or transvaginal drainage is comparable to previously reported advanced techniques (transrectal, transvaginal, transgluteal, and transperineal access) which have success rates ranging from 75 to 96% in larger series (50 or more patients) [6, 9, 10]. Drainage of pelvic fluid collections via the transrectal and transvaginal approaches has been used for several decades as demonstrated by Graham and Sanders in 1982 [4] and Mauro et al. in 1984 [5], respectively. This study further demonstrates that these approaches can be used to treat pelvic fluid collections of various etiologies allowing many patients a high likelihood of recovery (94% success rate; 97% nonoperative rate) without the need for surgery and with low complication rates. This present study's 94% success rate with transvaginal and transrectal drainages meets the standards and thresholds established by the American College of Radiology and the Society of Interventional Radiology suggested curative and partial success rates of 85% for percutaneous drainage [2]. Complications in the present study were rare [3%; 4/150] and generally uneventful with the exception of the 1 patient who went to surgical exploration after hemorrhagic return of a pelvic fluid collection thought to be a tuboovarian abscess clinically and by imaging, but was a ruptured hemorrhagic ovarian cyst at surgical exploration.

The present study represents one of the largest studies employing advanced techniques for pelvic abscesses with attempted transrectal or transvaginal procedures in 150 patients. Akıncı et al. [10] presented a cohort of 163 patients with 185 deep pelvic abscesses drained primarily (58%) with transabdominal approach [107/185 (58%) abscesses unclear in how many patients]; it is unclear from that study's methods what constituted a deep pelvic abscess in their series—if the transabdominal approaches were for pelvic abscesses that extended or resided above the innominate line. In the Akıncı et al.'s [10] study cohort, the remaining approaches using a transrectal, transvaginal, or transgluteal approach (78/185 [42% abscesses; unclear in how many patients). In that series, the success rate was 93% for advanced techniques and 94% for advanced techniques and transabdominal approaches.

A more comparable cohort to the present study using only an advanced pelvic fluid collection drainage technique was reported by Harisinghani et al. [11] who used transgluteal drainage in 140 patients with a 96% (134/140 patients) success rate without the need for surgery compared to the 94% (141/150 patients) success rate in the present series using transrectal or transvaginal drainage [along with 97% nonoperative rate (145/150 patients); discrepancy accounted for by 4 patients that drainage was unsuccessful but conservative management was successful]. In the present series, 1 patient (1%) experienced substantial pain-related events during a transrectal or transvaginal procedure, which is comparable to Harisinghani et al. [11], who reported 4 patients with procedural-related pain events (3%; 4/140 patients) along with 27 patients (19/140 patients) with immediate post-procedural pain. The current study did not assess immediate post-procedural pain but subjectively/anecdotally, this was not an issue that was experienced. Although the current study did not report cases with transgluteal drainage, our clinical experience is that transgluteal access and drainage is more painful, leading to transrectal and transvaginal approaches being strongly favored in our practice. Harisinghani et al. [11] reported a 2% complication rate (2%; 3/140) where 3 patients underwent arteriography with 2 patients undergoing arterial embolization. In contrast, the most serious complications in this series was the hemorrhagic return of transvaginal catheter placement prompting a surgical exploration representing faulty diagnosis (tuboovarian abscess was suspected when it was a symptomatic hemorrhagic ovarian cyst) along with 2 bladder punctures that were managed conservatively. Hovsepian et al. [12] evaluated post-procedure pain in both transrectal and transvaginal drainages, a study involving 22 men and 40 women. They found that indwelling catheter transrectal approach was well-tolerated in both men and women with an average pain score of 1.6 ± 1.5 compared to the transvaginal approach with a significantly less well tolerated with an average pain score of 4.8 ± 3.9; other advanced techniques

including transgluteal and transperineal approaches were not evaluated.

Saokar et al. [13] presented a larger cohort of transvaginal catheter drainages or aspiration compared to the number of patients and procedures with a transvaginal approach in the present series. In their series, 67 patients underwent a total of 85 transvaginal procedures including 45 aspirations and 40 catheter drainages compared to the transvaginal approaches in this series, performed in 43 patients with 44 successful transvaginal procedures including 10 aspirations and 34 catheter drainages. The outcomes of the present series are favorable compared to the Saokar et al. cohort [13], with a transvaginal procedure success rate of 93% (present series; 40/43 patients) compared to 75% (Saokar et al. [13] cohort; 50/67 patients). Similar to the present series where 2 patients with tuboovarian abscesses and 1 patient with a symptomatic ovarian cysts (thought clinically and by imaging to be a tuboovarian abscess) comprising the majority of patients requiring surgery (3 of 4 with technically successful drainages and 3 of 5 of the overall cohort), patients that required surgery in the Saokar et al. [13] cohort primarily composed of patients with tuboovarian abscesses (5 patients) and symptomatic ovarian cysts (10 patients) accounting for 15 of 17 patients (of 67 patients) that required surgery after transvaginal drainage.

Some authors have advocated that the transgluteal technique has advantages over transrectal and transvaginal techniques for long-term catheter management, however the basis for this critique is not clear [11]; catheter securement was not an issue in the present series. The previously described largest transvaginal drainage cohort, Saokar et al. [13], described lack of catheter securement with sutures leading to a risk of catheter dislodgement as a limitation to the technique; however, in this series, we sutured the catheter to the vulvar skin and catheter dislodgement was not an issue. The main issue with choice of technique for access of deep pelvic fluid collections not accessible with a transabdominal approach is institutional practice and expertise. Transgluteal drainage may preferentially use CT-guidance (authors' experience) whereas transrectal or transvaginal drainage can be accomplished with ultrasound and fluoroscopic guidance or ultrasound guidance alone in aspiration cases or select catheter drainages. A prior survey of academic and private practice habits of image-guided drainage showed that academic centers were significantly more likely to use transrectal or transvaginal drainage approaches whereas private practices were significantly more likely to use a transgluteal approach [14]. The study authors surmised that this reflected a lack of experience for private practice radiologists for transrectal or transvaginal drainage approaches or, alternatively, that the transgluteal approach may be a faster technique.

There are several limitations to this study. The single center and retrospective design are inherent weaknesses. Our institution strongly favors transrectal and transvaginal approaches over the transgluteal approach creating operator bias for technique selection. The study investigator's preference is to use combined ultrasound and fluoroscopic guidance for transrectal and transvaginal drainage procedures. Other reports and operators have been successful using only ultrasound guidance [13]. The use of two modalities may create logistical constraints for some practices and fluoroscopy introduces radiation exposure. In the present study, Foley catheters were routinely inserted to serve as a sonographic landmark to avoid bladder puncture. However, its presence did not prevent the two bladder injuries. Bladder catheterization has its own inherent risks, and it is not known from this study if its routine insertion reduced the rate of bladder injury. There were 18 transrectal one-step aspirations in the present series. The use of transrectal aspiration alone may contaminate reliable cultures from the aspirated fluid and introduce new organisms into the pelvic fluid collection, worsening or propagating infection. It is unclear from the present study if transrectal aspirations alone can serve as an alternative to catheter drainages; however, there were no fluid collection recurrences in any of the 18 transrectal one-step aspirations. Pain ratings were not systematically acquired from patients, making it difficult to substantiate the claim that the transrectal or transvaginal approaches offer an advantage over the transgluteal approach. The transperineal approach is not commonly used at our institution, although the largest series, according to our literature search, has 32 patients [6, 15]. An ideal study design would have a balance between different advanced drainage techniques, including transrectal, transvaginal, transgluteal, and transperineal. Ideally, these techniques would be assessed by a number of radiologists from different institutions with preferences for different techniques, such as ultrasound guidance alone, combined ultrasound and fluoroscopic guidance, and routine use of Foley catheters.

In conclusion, the ultrasound and fluoroscopic-guided drainages of symptomatic low pelvic fluid collections by transrectal or transvaginal approaches represent safe and effective techniques. These techniques were able to effectively manage the majority (94%; 141/150 patients) of pelvic fluid collections in the present series.

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Compliance with ethical standards

Conflict of interest The authors have no potential conflicts of interest to disclose.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Informed consent Informed consent was waived by the institutional research committee for this HIPAA compliant retrospective study.

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