Imaging features of colovesical fistulae on MRI

¹Y Z TANG, MRCS, FRCR, ¹T C BOOTH, MRCP, FRCR, ²D SWALLOW, MA, MRCS, ¹K SHAHABUDDIN, MRCP, FRCR, ²M THOMAS, MBBS, MRCS, ²D HANBURY, FRCS, ¹S CHANG, FRCR and ¹C KING, MRCP, FRCR

¹Radiology Department, Lister Hospital, Stevenage, UK, and ²Urology Department, Lister Hospital, Stevenage, UK

Objectives: MRI is routinely used in the investigation of colovesical fistulae at our institute. Several papers have alluded to its usefulness in achieving the diagnosis; however, there is a paucity of literature on its imaging findings. Our objective was to quantify the MRI characteristics of these fistulae.

Methods: We selected all cases over a 4-year period with a final clinical diagnosis of colovesical fistula which had been investigated with MRI. The MRI scans were reviewed in a consensus fashion by two consultant urologists. Their MRI features were quantified.

Results: There were 40 cases of colovesical fistulae. On MRI, the fistula morphology consistently fell into three patterns. The most common pattern (71%) demonstrated an intervening abscess between the bowel wall and bladder wall. The second pattern (15%) had a visible track between the affected bowel and bladder. The third pattern (13%) was a complete loss of fat plane between the affected bladder and bowel wall. MRI correctly determined the underlying aetiology in 63% of cases.

Conclusions: MRI is a useful imaging modality in the diagnosis of colovesical fistulae. The fistulae appear to have three characteristic morphological patterns that may aid future diagnoses of colovesical fistulae. To the authors' knowledge, this is the first publication of the MRI findings in colovesical fistulae.

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Colovesical fistulae are uncommon complications of a wide range of pathologies, but they are most frequently secondary to sigmoid diverticulitis. While faecaluria is pathognomonic and pneumaturia is suggestive, patients often present with non-specific symptoms, which delay diagnosis. In these cases further investigations are needed to make the diagnosis. A wide range of investigations including cystoscopy, colonoscopy, cystography and cross-sectional imaging have been used to diagnose colovesical fistulae. Currently there is no single optimal test and the investigations employed by individual centres vary. Often, the patient will undergo a combination of diagnostic tests, with an average of four investigations performed before surgical treatment [1].

We use MRI as the primary imaging investigation in suspected colovesical fistulae. MRI is ideal for demonstrating fistulae because of the inherent contrast of the fistula's fluid contents and its wall. MRI is able to demonstrate fistula morphology and anatomical location, which guides surgical management [2, 3]. While the sensitivity of MRI in the diagnosis of colovesical fistulae has been addressed previously [2, 3], the MRI signs have not been systematically assessed. The aim of this observational study was to determine the MRI signs present in patients with an established diagnosis of colovesical fistula.

Methods and patients

Patient selection

The hospital ethics committee confirmed formal approval was not required [4].

A retrospective search was performed on our radiology information system (RIS) for all pelvic MRI reports containing the word "fistula" between 1 January 2007 and 1 January 2011. These were reviewed to identify patients in whom a colovesical fistula was suspected. Correlation was then made with the patients' clinical notes to establish how the clinical diagnosis was made. Clinical diagnosis of a colovesical fistula was established with cystoscopy or surgery, or on clinical follow-up.

A robust database, recording all colovesical fistulae cases between January 2007 and December 2009, was kept by the urologists. It was not maintained beyond this date. This database was reviewed to confirm we had not missed any cases not found by our RIS search for this period.

Image analysis

Two consultant urologists, with 16 (CK) and 3 (SC) years of experience, reviewed the anonymised MRI in a consensus fashion. We divided the imaging findings according to site. In the bowel, the presence of diverticulosis within the region of the fistula, lesions with malignant characteristics and focal wall thickening was recorded. In the bladder, focal wall thickening, the

Address correspondence to: Dr Yen Zhi Tang, Lister Hospital, Coreys Mill Lane, Stevenage SG1 4AB, UK. E-mail: yenzhitang@doctors.net.uk

Table 1. Imaging protocol at first hospital site

Parameters	T ₂ weighted TSE sequence (axial)	T ₂ weighted TSE sequence (sagittal)	T ₂ weighted TSE sequence (coronal)	T ₁ weighted TSE sequence (axial)
Time (ms)				
Repetition	4000	5970	4660	599
Echo	125	127	125	13
Matrix	384×193	448×234	384×227	512×245
Field of view (mm)	300	300	300	400
Section thickness (mm)	3	4	5	6

TSE, turbo spin echo.

presence of a track in the bladder wall (which we defined as any area of fluid signal within the bladder wall not necessarily involving the full thickness), intraluminal air with no recent instrumentation and intravesical debris were recorded. Between the affected bowel and bladder wall one of the following features was documented for each fistula: an intervening abscess, a fistula track or loss of the fat plane between the affected bowel and bladder. Only one of these patterns was assigned to each case. Ancillary signs such as free fluid, lymph node enlargement and fat stranding were also recorded. If an underlying aetiology for the colovesical fistula was demonstrated on MRI, the urologists documented this and stated what the aetiology was. The original radiology report was not consulted in the study.

Images were acquired at two hospital sites. The first site used a 1.5T Siemens Avanto scanner (Siemens, Munich, Germany) with a pelvic phased-array coil. The second site used a 1.5T Signa Excite HD scanner (General Electric, Milwaukee, WI). The details of the MRI sequences are listed in Tables 1 and 2.

Results

40 patients satisfied the search criteria with both a radiological and a clinical diagnosis of a colovesical fistula. 24 patients were male and 16 were female. The mean age was 67 years (range 35–85 years). On correlation with the clinical notes, 14 patients had surgical confirmation of a colovesical fistula. A further 11 patients had a cystoscopy which supported the diagnosis of a colovesical fistula. The remaining 15 patients were diagnosed with a colovesical fistula on clinical history and examination alone. Of these 15 patients, 2 had manageable symptoms and 6 had significant comorbidities preventing surgery. The remaining seven patients were lost to follow-up.

Seven patients were identified from the RIS search in which a colovesical fistula was suspected, but with “no fistula evident” or “no colovesical fistula” reported. These patients were also negative for a fistula on clinical follow-up. Five of the seven patients had a cystoscopy in which no fistula was seen. One patient was asymptomatic for a colovesical fistula and the remaining patient’s presenting pneumaturia resolved spontaneously shortly after the MRI.

Review of the urology database revealed no additional cases, which suggests our RIS search was thorough. 31 patients were scanned at the first hospital site and 9 patients were scanned at the second hospital site.

The characteristics and imaging findings of the colovesical fistulae are summarised in Table 3. All cases were sigmoid colovesical fistulae, except for one fistula which was rectovesical. The fistula tract morphology consistently fell into three patterns (Figures 1–3). There was an intervening abscess between the affected bowel and bladder wall in 71% of cases. A track was seen between the affected bladder and bowel wall with no associated abscess in 15% of cases. A complete loss of fat plane between the affected bladder and bowel wall was seen in 13% of cases. The different fistula tract patterns did not coexist. The presence of gas or debris in the bladder was a helpful ancillary sign, particularly when a bladder defect was not seen.

The aetiology of the fistulae is listed in Table 4. Correlation was made between the fistula morphology and aetiology. Of the 31 fistulae due to diverticular disease, 24 had an intervening abscess, 4 had a fistulous track and 3 demonstrated loss of the fat plane between the affected bladder and bowel. The fistulae due to a rectosigmoid adenocarcinoma all demonstrated an intervening abscess. There were three fistulae due to Crohn’s disease, and each demonstrated one of the three morphological patterns. The fistula due to radiotherapy demonstrated a fistula track.

Table 2. Imaging protocol at second hospital site

Parameters	T ₂ weighted FSE sequence with fat suppression (axial)	T ₂ weighted FSE sequence with fat suppression (coronal)	T ₂ weighted FSE sequence with fat suppression (sagittal)	T ₁ weighted FSE sequence pre- and post-gadolinium (axial)
Time (ms)				
Repetition	5000	4000	4100	700
Echo	100	100	100	13
Matrix	512×224	512×224	512×224	384×224
Field of view (mm)	260	260	260	260
Section thickness (mm)	3	3	3	6

FSE, fast spin echo.

Table 3. Sensitivity and specificity of imaging findings of the colovesical fistulae

MRI findings	n	Sensitivity (%)	Specificity (%)
Imaging findings in the bowel			
Diverticulosis within the region of the fistula	34	83	97
Focal wall thickening	28	68	100
Lesions with malignant characteristics	1	2	100
Imaging findings in the bladder			
Focal wall thickening	33	83	100
Track visible in wall	27	68	100
Air in bladder	31	78	100
Debris in bladder	9	23	100
Fistula morphology			
Intervening abscess	29	71	100
Fistula track	6	15	100
Loss of fat plane	5	13	63
Ancillary signs			
Free fluid	4	10	100
Adjacent lymph node enlargement ^a	2	5	100
Fat stranding	21	53	100

^aIliac and mesenteric lymph nodes.

The aetiology of the colovesical fistulae on MRI was compared with the aetiology derived clinically. In two cases, the underlying aetiology was clinically unknown. MRI correctly diagnosed the aetiology in 24 of the remaining 38 cases (63%). An aetiology was not seen on MRI in 11 cases, and the clinical and radiological diagnoses were discordant in 3 cases. The correct aetiologies in these cases were diverticular disease (which had been falsely ascribed to Crohn's disease on MRI), Crohn's disease (which had been falsely ascribed to diverticular disease) and ulcerative colitis (UC; which had been ascribed to diverticular disease). The fistula with UC was due to two pathologies: UC and diverticular disease. Although MRI correctly identified the diverticular disease, evidence of UC was not seen.

Discussion

Colovesical fistulae complicate a wide range of pathologies including diverticular disease, inflammatory

bowel disease, colon cancer, bladder cancer and radiotherapy. Pneumaturia and faecaluria have a reported frequency of 71% and 51%, respectively [3]. Pneumaturia is not specific as it is also seen in gas-producing organisms in the urinary tract, particularly in diabetics, and can be a subjective symptom. Faecaluria is pathognomonic, but a late sign, and presents when the fistula tract diameter has become quite large. The remaining cases present with non-specific symptoms such as recurrent urinary tract infections (UTIs), dysuria or haematuria. It may take months before the condition is recognised, and therefore a high index of suspicion is needed.

A range of investigations can be used to diagnose enterovesical fistulae, but usually a combination is used for a confident diagnosis. The poppy seed test, in which poppy seeds are ingested and their presence in the patient's urine tested, is the most sensitive test, with a sensitivity of 94.6–100% [3, 5]. While sensitive and cost-effective, there is no information on the aetiology or site of the fistula. Endoscopic options are cystoscopy and colonoscopy, which have the added benefit of taking a biopsy sample for histopathology. Cystoscopy is often performed, but has a quoted sensitivity of 10–44% [3, 6]. Cystoscopy can directly visualise the orifice of the fistula, or indirectly localise it by identifying oedema, erythema or ulceration of the affected bladder wall. Faecal material may also be seen coming through the fistula. Colonoscopy had a sensitivity of 8.5% in one series but is unable to detect enterovesical fistulae involving small bowel [3].

Barium enemas and cystography were the main radiological tests until a decade ago. They have been superseded by cross-sectional imaging. CT and MRI offer the benefit of determining the underlying aetiology, fistula morphology and the tract's anatomical location. Crucially, both CT and MRI may demonstrate pericolic abscesses and bladder or colonic malignancy, which influences the patient's management (in particular the surgery performed). A primary anastomosis will not be performed in the presence of an abscess. Similarly, alternative surgery as well as additional investigations will be performed in the presence of malignancy.

Figure 1. Sagittal T_2 weighted image of a track between the dome of the bladder and sigmoid colon.

Figure 2. Coronal T_2 weighted image of an intervening abscess (arrow) between the affected bladder and sigmoid colon.

Colovesical fistulae can be demonstrated on CT in 61–80% of cases [3, 5, 7]. CT findings of a colovesical fistula are intravesical air with no known prior instrumentation, focal bladder and bowel wall thickening, presence of contrast in the bladder after contrast was administered orally or per rectum, and a paravesical mass. Only occasionally is the actual fistulous tract identified on CT [8, 9].

MRI is ideal for visualising fistulae because of its intrinsic soft tissue contrast and, like CT, multiplanar image acquisition. It is well established in the diagnosis

Figure 3. Sagittal T_2 weighted image demonstrates complete loss of the fat plane between the bladder dome and sigmoid colon (arrow). There is also focal disruption of the low T_2 signal bladder muscularis. Dependent debris is seen along the posterior wall of the bladder.

Table 4. Aetiology of the colovesical fistulae

Fistula aetiology	n	%
Diverticular disease ^a	31	78
Radiotherapy	1	3
Crohn's disease	3	8
Rectosigmoid adenocarcinoma	3	8
Unknown	2	5

^aOne of the fistulae due to diverticular disease had active ulcerative colitis, which also contributed to the fistula formation.

and visualisation of perianal fistulae [10]. MRI has also been used to detect intestinal fistulae in patients with inflammatory bowel conditions [11]. Its use in colovesical fistulae is less well established. In one retrospective series, MRI had a sensitivity and specificity of 100% in diagnosing the presence of a colovesical fistula. It also correctly diagnosed its aetiology in all 18 cases [2]. In another small series, colovesical fistulae were correctly diagnosed on MRI in three of five patients [3].

In our practice, if the clinical history is suggestive of a colovesical fistula, an MRI is the first imaging modality requested. If the symptoms are non-specific, such as those suggesting recurrent UTIs, the patient will initially have full urological workup, followed by a range of basic radiological studies including kidneys, ureters and bladder (KUB) X-ray, KUB ultrasound, urinary flow studies and often cystoscopy [12].

Compared with the study by Ravichandran et al [2], our sensitivity and specificity for detecting colovesical fistulae on MRI was the same at 100%. However, our sensitivity for identifying the aetiology was significantly less, at 63%. This may be because the reading radiologists only commented on an underlying aetiology if they were absolutely confident. Colonic adenocarcinoma can be hard to differentiate from diverticulitis in patients with colovesical fistulae. We therefore perform routine endoscopic evaluation. Diverticular disease was the aetiology in 78% of patients. This is comparable with the literature, which quotes 52–75% of colovesical fistulae are due to diverticular disease [1, 13]. The remaining cases were due to Crohn's disease, rectosigmoid adenocarcinoma and radiotherapy.

Nine cases of colovesical fistulae had post-gadolinium, fat-suppressed sequences. On analysis of the sequences for the individual MRI signs documented in Table 3, we found that these signs were readily seen on the unenhanced T_1 and T_2 weighted sequences. It is noteworthy that abscesses were readily identified on the unenhanced sequences. The post-gadolinium sequences therefore did not provide any further information or signs. The natural contrast between the fluid or air within the fistula and its wall appear sufficient for diagnosis. Indeed, the post-gadolinium, fat-suppressed sequence was often confusing because of extensive inflammatory enhancement around the fistula.

In contrast, Semelka et al found that in pelvic fistulae early post-gadolinium images showed enhancement of the tract walls and central signal void within the fluid of the fistula. However, only two patients in the series had colovesical/enterovesical fistulae [14].

Anecdotally, short-tau inversion-recovery (STIR) sequences are employed by some centres in the assessment of pelvic fistulae. However, its use in colovesical fistulae has not been established in the literature. The MRI studies of colovesical fistulae described by other authors do not appear to include a STIR sequence [2, 14].

Our MRI findings overlap with previously reported CT findings (in particular, the presence of an abscess, intravesical air, bladder or bowel wall thickening). The advantage of MRI is in characterising the morphology and location of the fistula tract, which is more readily seen. As documented by Outwater and Schiebler [15], a focal disruption of the bladder muscularis on T_2 weighted sequences, representing the fistula penetrating the bladder wall, is a characteristic finding on MRI. This was found in 68% of cases in our study. The equivalent defect in the bowel wall is not as easily seen. Our results show the morphology of the fistula on MRI consistently falls into the three patterns described above. The most common morphology in diverticular disease was an intervening abscess. It was difficult to draw conclusions on the morphological pattern in fistulae from other causes owing to their small number.

A limitation of our retrospective and observational study was that only 14 patients had surgical confirmation of a colovesical fistula, which some would consider to be the gold standard. The remainder were managed conservatively owing to comorbidities or manageable symptoms. Some were eventually discharged from our care, and therefore lost to follow-up. Larger, prospective studies are required to further determine MRI's sensitivity and specificity in the diagnosis of colovesical fistulae.

Conclusion

To our knowledge, this is the largest study of colovesical fistulae imaged with MRI scans, and the first study to document the MRI imaging findings and their frequency. We have found that MRI is accurate in the diagnosis of colovesical fistulae and may help to define the underlying cause. Although there are non-radiological tests that are more sensitive, MRI provides important information regarding the fistula's anatomical location and aetiology. This determines the surgical approach and overall patient management. We have also shown that post-contrast sequences are unnecessary in colovesical fistula imaging, which may benefit the hospital and patient. Our findings demonstrate the utility of MRI as a

first-line imaging investigation in suspected colovesical fistula. However, endoscopy remains important to exclude malignancy as an underlying cause.

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