Magnetic Resonance Imaging of Fistula-in-ano

Peter J. Lunniss, F.R.C.S., Peter G. Barker, F.R.C.R.,*
Abdul H. Sultan, M.R.C.O.G.,* Peter Armstrong, F.R.C.R.,
Rodney H. Reznek, F.R.C.R.,* Clive I. Bartram, F.R.C.R.,*
Karen S. Cottam, D.C.R.,† Robin K. Phillips, F.R.C.S.

*From the Departments of Surgery and *Radiology, St. Bartholomew's and St. Mark's Hospitals, and †The London Clinic Scanning Services, London, United Kingdom*

PURPOSE: Successful management of anal fistulas depends upon accurate assessment of the primary tract and any secondary extensions. Preoperative imaging has, to date, been disappointing. METHODS: A prospective study of 35 patients with a clinical diagnosis of fistula-in-ano was performed comparing magnetic resonance imaging with the independently documented operative findings. Magnetic resonance imaging was also compared with anal endosonography in 20 patients. RESULTS: Magnetic resonance imaging is accurate and demonstrates pathology missed at surgery by experienced coloproctologists. Magnetic resonance imaging is superior to anal endosonography. CONCLUSIONS: Magnetic resonance imaging is advocated as the method of choice when imaging is required for anal fistulas. [Key words: Magnetic resonance imaging; Fistula-in-ano]

Lunniss PJ, Barker PG, Sultan AH, Armstrong P, Reznek RH, Bartram CI, Cottam KS, Phillips RK. Magnetic resonance imaging of fistula-in-ano. Dis Colon Rectum 1994;37:708–718.

Successful fistula surgery depends upon accurate assessment. Recurrence occurs because of errors in assessing and dealing with the internal openings, the primary tract, or any secondary extensions and abscesses,[1] particularly supralevator sepsis.[2] Although most fistulas are simple and easy to treat,[3] some pose greater problems. Fear of causing incontinence and lack of confidence in fistula assessment prompt most referrals from other surgeons.

Technology has added little to careful examination under anesthesia by an experienced coloproctologist, until we began to evaluate magnetic resonance imaging (MRI),[4] which we now consider to be the best method for imaging anal fistulas, and perhaps more accurate than the surgeon's assessment at operation.

METHOD

All patients with a clinical diagnosis of fistula-in-ano and awaiting surgery between August 1991 and August 1992 were invited into the study. The only selection was for logistic reasons, *e.g.*, practicality of scheduling a scan. Fully informed written consent was obtained in all cases. The machine used was an IGE MR Max 0.5 Tesla scanner (General Electric, Milwaukee, WI) at The London Clinic Scanning Services. Patients were scanned in a comfortable supine position with a small enema tip placed within the anal canal to separate the mucosal walls. T1-weighted spin echo (TR 500 μs, TE25 μs) and short tau inversion recovery (STIR) (TR 2000 μs, TI 100 μs, TE 25 μs) sequences were used. T1-weighted images provide excellent resolution of the anatomy of the pelvic musculature and surrounding tissues; the STIR images were used to highlight the presence of pus and granulation tissue without the need for any contrast media. Fourteen images were obtained in both coronal and axial planes, with section thickness of 5 mm and 2 mm separation. Average scanning time was 45 minutes for all four sets of images. The technique involves no ionizing radiation.

The interpretations of the scans were documented on a standard fistula operation sheet (Fig. 1) and classified according to Parks[2] classification. At subsequent surgery, the operating consultant surgeon was asked to record his operative impression of the fistula on a similar sheet, unaware of the scan findings. The two sets of recorded results were then compared.

Twenty unselected patients also underwent preoperative anal endosonography (AES), which was performed on the day before surgery. AES was

Abdul Sultan is supported by the Joint Research Board at St. Bartholomew's Hospital.
Read in part at the meeting of The American Society of Colon and Rectal Surgeons, Chicago, Illinois, May 2 to 7, 1993, and the Surgical Research Society, London, United Kingdom, January 7 and 8, 1993.
Address reprint requests to Mr. Phillips: St. Mark's Hospital, City Road, London EC1V 2PS, United Kingdom.

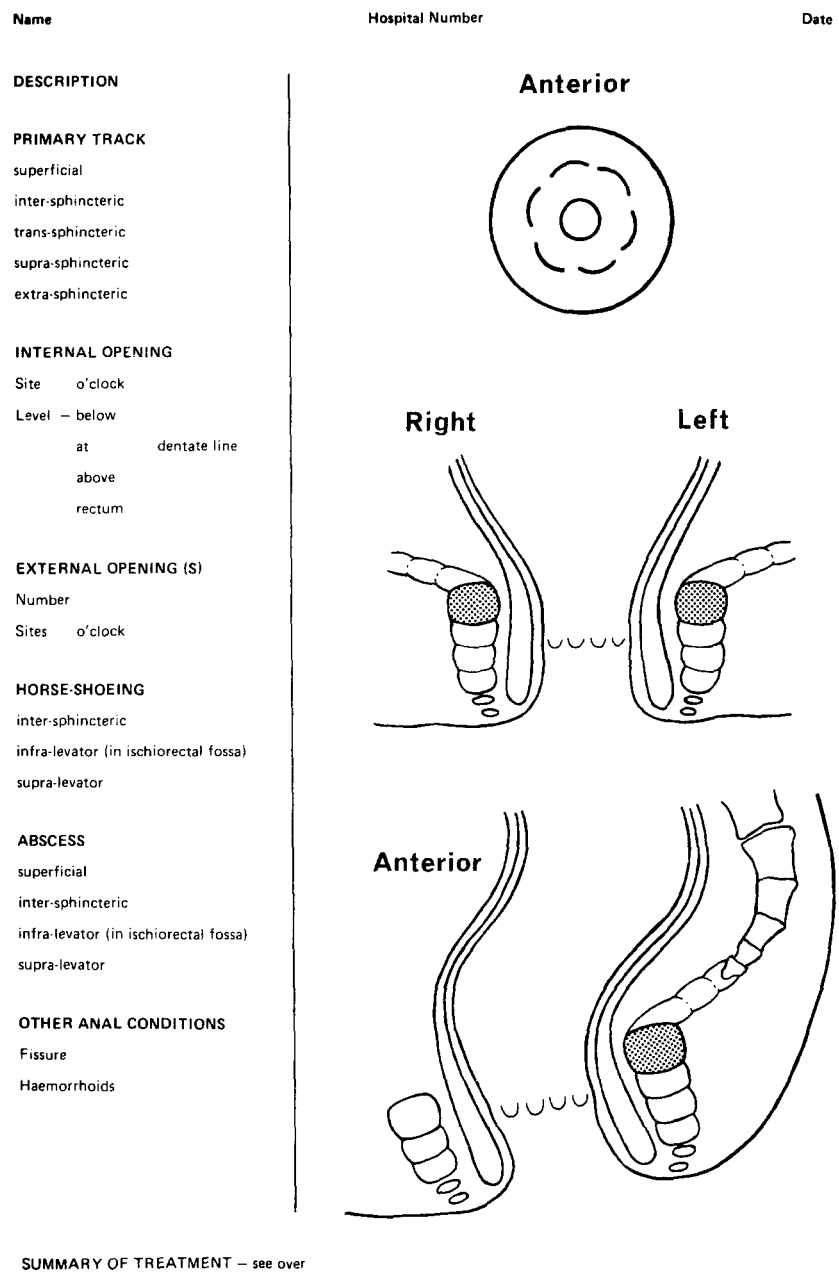

Figure 1. St. Mark's Hospital Fistula Operation Sheet, designed by Mr. James P. S. Thomson.

performed and reported by one experienced ultrasonologist (AHS) using a Bruel and Kjær (Nærum, Denmark) ultrasound scanner with a 7-MHz rotating endoprobe. This technique has been described previously[5] and the interpretation of images validated.[6] The ultrasonologist was unaware of the previously documented MRI findings and did not have access to the MRI images. The interpretations of MRI and AES scans were compared with the definitive operative findings, vindicated by complete wound healing.

RESULTS

Magnetic Resonance Imaging *vs.* Surgery

Thirty-six patients entered the main study, one of whom could not tolerate scanning because of claustrophobia, which left 35 patients for analysis.

There were 26 males and 9 females, with a mean age of 41 (range, 24–67) years. Five patients had inflammatory bowel disease and 20 patients had undergone previous unsuccessful surgery. The average time interval between MRI scan and surgery was 29 (range, 1–136) days.

Of the 35 patients scanned, 27 were thought to have true fistulas, *i.e.*, a tract crossing some part of the sphincter complex (Fig. 2). Of the remaining eight patients, the MRI scans showed five to have blind-ending sinuses running outside the sphincters (and were classified as sinuses), scar tissue alone in one patient, an isolated collection within the right levator muscles in another patient, and in one patient no abnormal findings could be seen.

Twenty-five of the 27 fistulas seen on scanning were confirmed at operation. Of the two patients in whom true fistulas were not identified at surgery but in whom fistulas had been demonstrated by MRI (both classified as transsphincteric), the wound in one remains unhealed 12 months later (Patient a, Fig. 2). The other patient (Patient b, Fig. 2; Fig. 3) was thought at operation to have no active pathology and no procedure other than examination under anesthesia was performed. However, this patient presented to the local hospital one month later with acute anorectal sepsis which was drained; subsequent fistula surgery confirmed the MRI findings to have been correct.

Figure 3. Coronal section (STIR sequence) showing part of the fistula tract (arrow) running alongside the external anal sphincter in a patient in whom no pathology was identified at initial operation.

Surgery revealed fistulas in two patients in whom no active pathology had been identified by MRI. One patient, thought on scanning to have just scar-

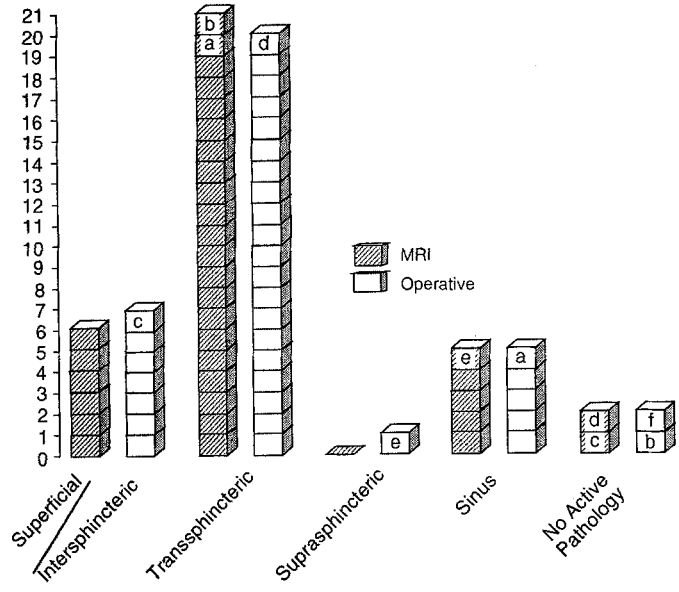

Figure 2. Chart showing the classification of primary pathology in the 35 patients as documented on MRI scan interpretations (left-hand shaded boxes) and the subsequent operative findings (right-hand open boxes). Therefore, each patient is represented by two boxes. The letters represent the MRI and operative findings from the same patient that were discordant. Thus: a, MRI transsphincteric fistula, operative sinus; b, MRI transsphincteric fistula, operative no pathology; c, MRI no pathology, operative intersphincteric fistula; d, MRI no pathology, operative transsphincteric fistula; e, MRI sinus, operative suprasphincteric fistula; and f, MRI an isolated collection (therefore, neither fistula nor sinus), operative no pathology.

ring from previous surgery, was found to have a skin-lined low intersphincteric fistula which contained neither pus nor granulation tissue (Patient c, Fig. 2). The other patient had a short pinhole-sized anovaginal fistula, also epithelialized (Patient d, Fig. 2). There was agreement between scan interpretations and operative findings with respect to the course of the primary tract in 30 of the 35 patients. Besides the four discrepant cases described above, there was one other patient (Patient e, Fig. 2) in whom MRI had shown a tract originating in the supralevator pararectal space and passing distally through the right levator plate and ischiorectal space to terminate at a perineal external opening. This was therefore not classified as a fistula. At operation there was a tract, classified as suprasphincteric, that entered into a loculated postrectal dermoid cyst, a feature that was visible on the MRI scans but which was identified only in retrospect. This tract had no internal opening and so the scan interpretation, although prospectively missing the dermoid cyst, must otherwise be considered to be correct.

Secondary extensions and abscesses were seen in 21 of the 35 patients at MRI (Fig. 4). No extensions or abscesses were found at operation that had not been identified at MRI. There was agreement between scan and operative findings in regard to the origin of supralevator sepsis, either from craniad extension of an intersphincteric tract or a blind extension of sepsis passing up from the ischiorectal space through the levators in all nine patients in whom supralevator sepsis was found at surgery. An isolated collection of fluid within the right levator muscle posteriorly was identified in one patient on MRI in whom no abnormality was found at examination under anesthesia (Patient f, Figs. 2 and 4; Fig. 5). This patient presented three months later with an acute ischiorectal abscess which, on surgical drainage, was found to extend to the site of pathology demonstrated by MRI. Neither MRI nor three examinations under anesthesia has yet revealed an enteric communication.

The presence of a "horseshoe" extension was identified by MRI in eight of nine patients affected. In seven of these nine patients, the scan and operative findings were in exact concordance. One patient with a posterior horseshoe extension in the ischiorectal space was incorrectly thought on scanning to have two separate tracts running around

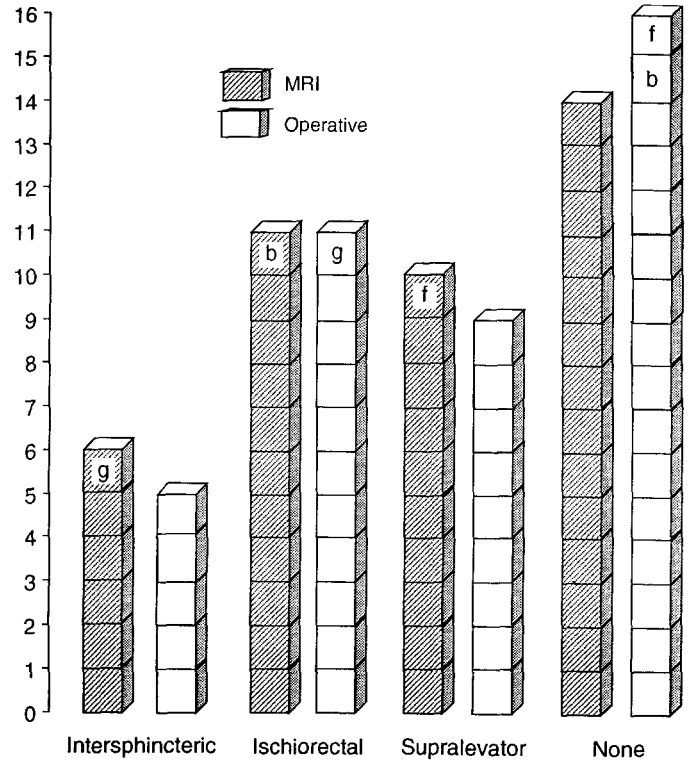

Figure 4. Chart showing the number and site of secondary extensions or abscesses identified by MRI (left-hand shaded boxes) and at surgery. Discordant findings occurred in three patients (b, g, and f) and are explained in the text.

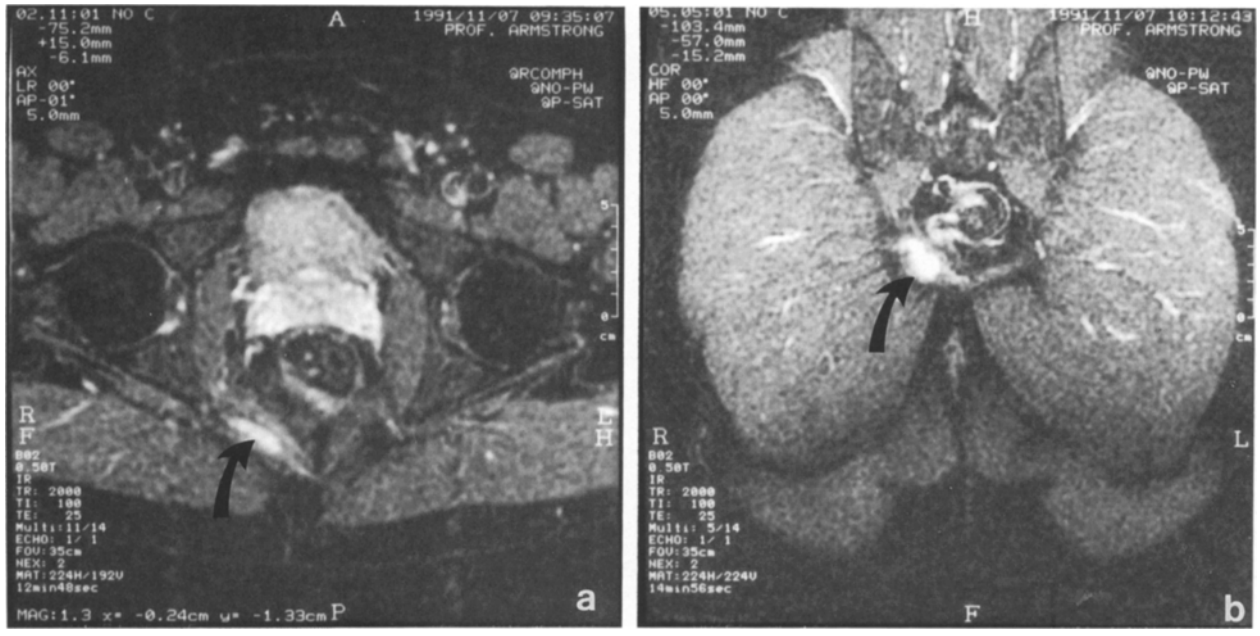

Figure 5. Axial (a) and coronal (b) sections (STIR sequences) of a fluid collection (arrows) within the right levator ani muscle of a patient in whom the initial operative findings were unremarkable.

the posterior aspect of the sphincter complex, but with no communication between them. In another patient, a horseshoe extension was identified on scanning to run in the intersphincteric space, with a half-horseshoe in the ischiorectal fossa, but at initial operation only the component running outside the sphincter was identified (Patient g, Fig. 4). Failure of healing led to further surgery six months later, at which time the intersphincteric horseshoe extension was identified and drained, resulting in healing.

The mucosa and internal anal sphincter are not separately identifiable on the MRI sequences used, and therefore the presence of an internal opening has to be inferred by the site of pathology within the intersphincteric space. Nevertheless, the position of the internal opening was correctly identified by MRI in 21 of 26 patients in whom an opening was identified at operation. We could not infer the site of the internal openings in the two patients in whom no abnormality was seen at MRI but in whom tracts were demonstrated at surgery. Interpretations of scans placed one opening intra-anally but above the dentate line and another below the dentate line, when in fact these openings were found at surgery to be at the level of the crypts. MRI scanning does not show the dentate line as a discernible structure, but its position can be inferred approximately on coronal sections. Although of little clinical significance, the position of the external skin openings was correctly identified by MRI in all cases except the one patient with the skin-lined tract.

Magnetic Resonance Imaging *vs.* Anal Endosonograpy

Of the 20 patients in the study comparing MRI and AES with the definitive surgical findings, operative assessment revealed 12 transsphincteric primary tracts, 5 intersphincteric primary tracts, and 3 blind-ending sinuses lying outside the external anal sphincter. The numbers of each in which there was agreement or disagreement with the AES and MRI interpretations are shown in Figure 6.

In 3 of 12 patients in whom transsphincteric tracts were identified at surgery, AES showed no tracts in two patients (Patients h and i, Fig. 6; Fig. 7) and a superficial fistula in the third. This last patient (Patient d, Fig. 6), with the epithelialized pinhole anovaginal fistula, was the only one of the 12 in whom there was discordance between MRI and surgery, MRI having revealed no abnormality. Of the five patients with primary tracts identified at surgery as intersphincteric, AES interpretations were similar in three (Fig. 8). In one patient (Patient j, Fig. 6), no abnormality was identified and in the other patient (Patient k, Fig. 6), the primary tract was classified as transsphincteric. MRI identified four intersphincteric tracts correctly; the fifth

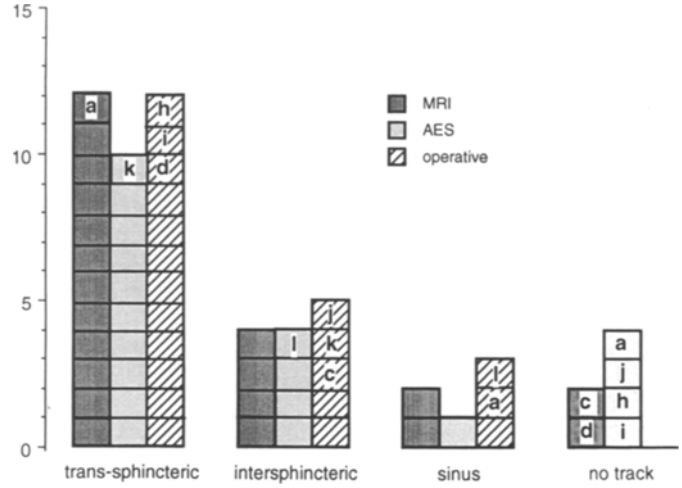

Figure 6. Chart showing the correlation between MRI and AES with operative assessment of the primary tract in 20 patients investigated by both techniques. The lettered boxes represent those cases in which there was a discrepancy between either of the scan interpretations and operative findings (thus, "h" operative transsphincteric, AES no tract, and so on) and are discussed in the text. The difference between MRI and AES does not reach statistical significance.

patient (Patient c, Fig. 6) had the low skin-lined intersphincteric tract.

Three patients were thought at operation to have blind sinuses outside the sphincters. AES correctly identified one of these as a sinus, but rather than lying superficially in the ischiorectal fossa (as found at operation), the sinus was thought on AES to extend cephalad through the levator ani to terminate as a supralevator collection. The sonographic appearances in one patient (Patient l, Fig. 6) were reported as showing an intersphincteric tract, and in the third patient, no abnormality was recorded. This last patient (Patient a, Fig. 6) represented the only discordant interpretation between MRI and operative findings, in whom MRI had shown a transsphincteric tract and in whom the wound has yet to heal after lay open, suggesting that the operative assessment may have been incorrect. Although the overall concordance between MRI and surgery (85 percent) was higher than between AES and surgery (65 percent) with respect to classification of the primary tract, this did not reach statistical significance ($P = 0.27$, Fisher's exact test).

In the assessment of secondary tracts and extensions, there was 100 percent concordance beween MRI and surgery with respect to both the presence and site of the extensions, either in the ischiorectal fossa or in the supralevator space. AES correctly identified three of the four supralevator and two of the four ischiorectal extensions identified at surgery. Furthermore, AES interpretations included the presence of four supralevator and two ischiorectal extensions in six patients which were not identified at surgery, and in whom subsequent healing has been uneventful. In this series, the positive predictive value of AES in identifying supralevator extensions was 42.9 percent and ischiorectal extensions 50 percent. MRI was statistically more accurate than AES in the determination of secondary extensions ($P = 0.0083$, Fisher's exact test).

Internal openings were found at operation in 16 of the 20 patients. A low transsphincteric tract in one patient terminated blindly in the intersphincteric space. The interpretations of MRI scans were in agreement with the operative findings in all cases, except for the patient in whom a transsphincteric tract opening in the posterior midline of the anal canal was seen on MRI but in whom a sinus was found at operation, and the two patients in whom MRI had failed to reveal tracts. AES failed to show six internal openings that were demonstrated at surgery. The difference between MRI and AES in the correct determination of internal openings did not reach statistical significance ($P = 0.45$, Fisher's exact test).

Four horseshoe extensions were found at operation. AES correctly identified two of these, but also suggested the presence of horseshoe extensions in the intersphincteric plane in two patients in whom no such characteristic was identified at

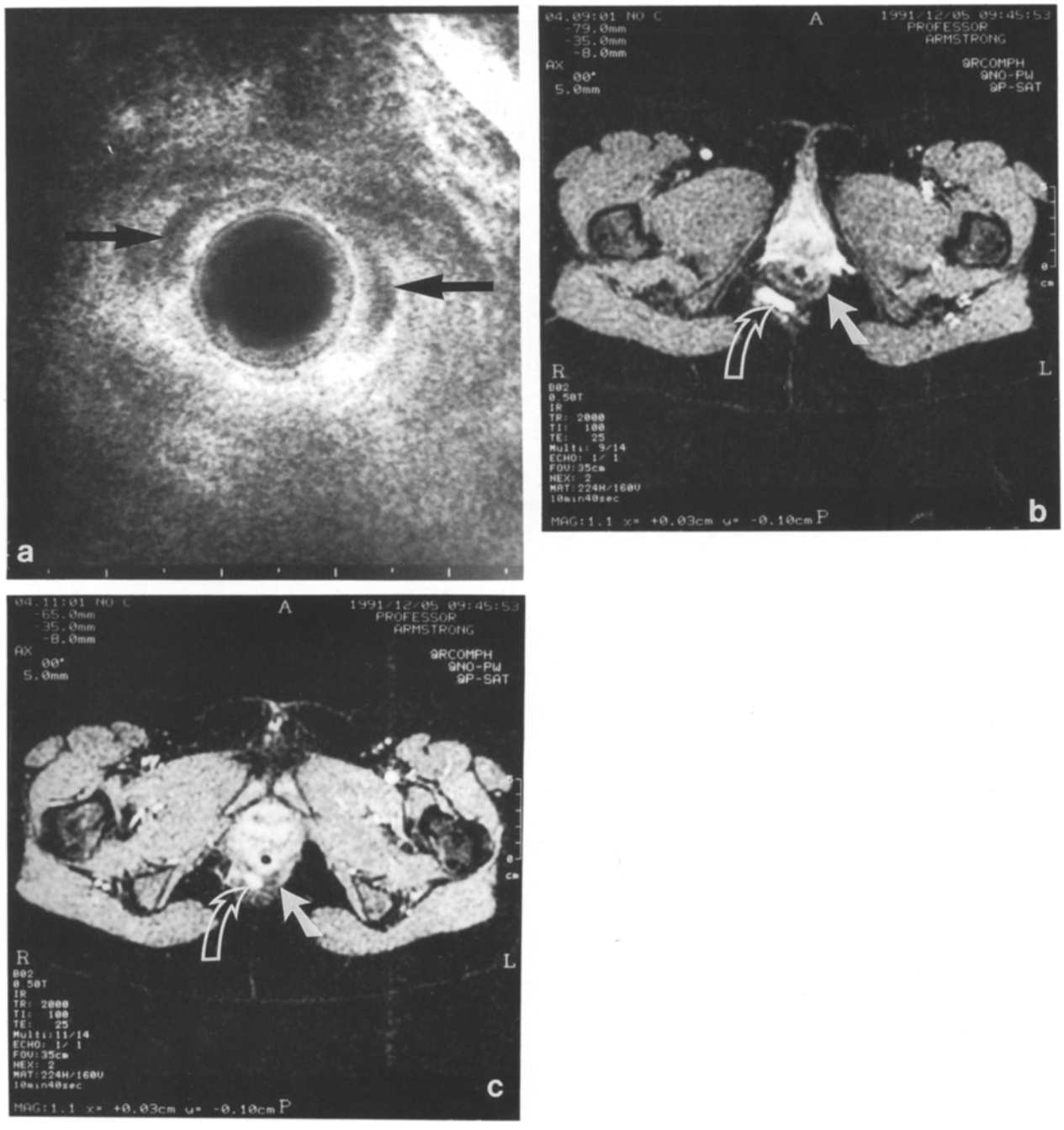

Figure 7. Sonographic image (a) of the sphincter in a patient in whom previous surgery has led to extensive internal sphincter disruption and scarring of the external sphincter (arrows indicate remnants of internal sphincter). A fistula tract is difficult to identify in this situation. Axial STIR MRI images (b and c) of the same patient, however, show a tract (open arrow) running outside the external sphincter (closed arrow) in (b) which at a higher level (c) is seen in the intersphincteric space. Findings at operation confirmed the MRI assessment of a transsphincteric fistula. Anterior is at the top of parts a to c.

operation. MRI was correct in identification of the presence or absence of horseshoe extensions in all cases.

AES was unable to demonstrate external openings in 17 of 19 patients with perineal skin openings, whereas MRI correctly identified the site of such openings in all cases, except for the patient with the skin-lined intersphincteric tract.

DISCUSSION

In our group of 35 patients, concordance rates between scan and operative findings were 85.7

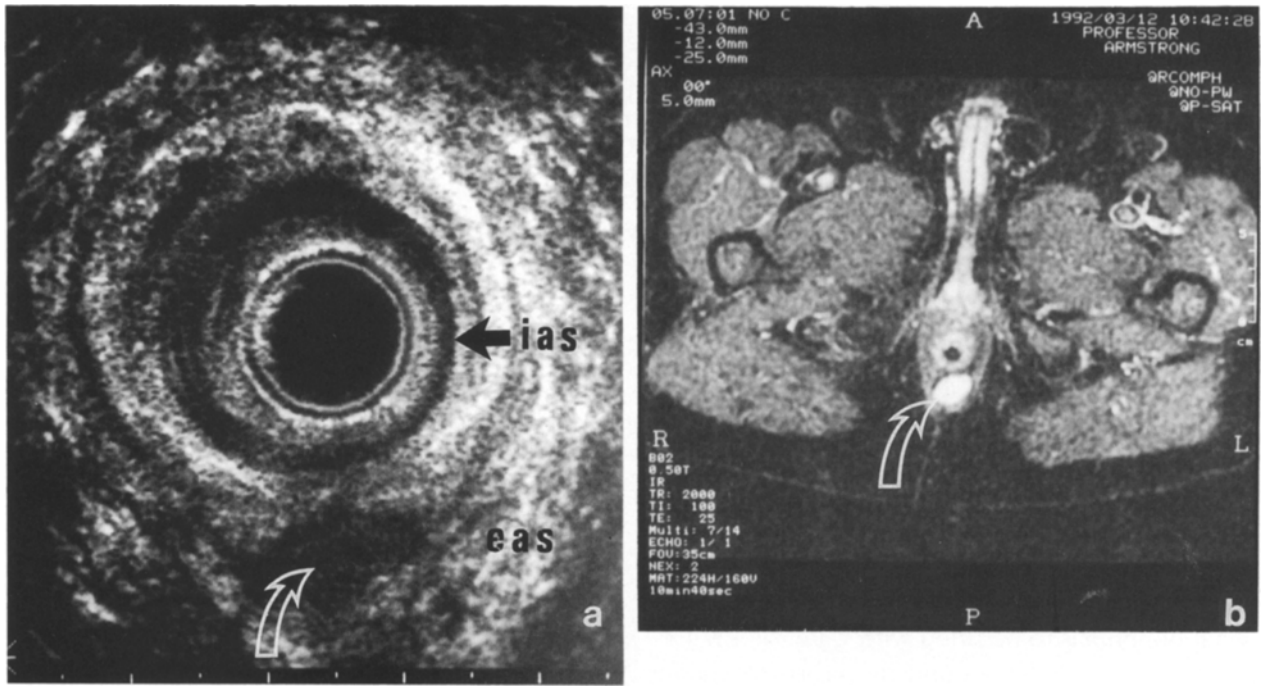

Figure 8. Anal endosonograph (a) and an axial MRI STIR image (b) of the same patient, both revealing a posterior intersphincteric abscess (open arrow) within an intersphincteric primary tract. ias = internal anal sphincter; eas = external anal sphincter.

percent for the presence and course of the primary tract, 91.4 percent for the presence and site of any secondary extensions or abscesses, 94.3 percent for the presence and plane of horseshoeing, and 80 percent for the position of internal openings. In only five cases was there disagreement between the operative findings and the preoperative scan interpretations of the primary tract. In two of these patients, where scans demonstrated transsphincteric tracts but no such pathology was identified at surgery, the subsequent clinical course has indicated that the MRI scan interpretation was correct. MRI failed to identify tracts in two patients, but both were epithelialized and therefore did not contain high signal tissue on the sequences used. The final patient had a correctly diagnosed sinus outside the sphincter complex but the associated postrectal dermoid cyst was only picked up in retrospect.

Surgery did not reveal any extensions that had not been identified by scanning. MRI identified abscesses or extensions missed at surgery in three patients, the subsequent clinical course indicating that the MRI interpretations had indeed been correct. In two patients recurrent acute sepsis led to the identification and vindication of the MRI findings; in the third, failure of healing led to the eventual identification and treatment of a missed horseshoe extension (previously demonstrated on MRI).

The sequences used for the scans in this study were unable to identify as separate structures the internal anal sphincter, anal mucosa, and any granulation tissue within those structures. Thus, internal openings could only be inferred by the site of pathology within the intersphincteric space. The interpretations of MRI scans failed to identify 3 of the 26 internal openings demonstrated at surgery; in another two patients, openings were thought to lie intra-anally but not at the dentate line. However, the operative findings demonstrated openings at the cryptal level in both cases. In no patients in this study were rectal openings found at either scan or surgery.

Preoperative assessment of anorectal abscesses and fistulas has been attempted previously with a variety of techniques. Reports concerning the usefulness[7, 8] and accuracy[9, 10] of contrast fistulography vary, but in a critical review by Kuijpers and Schulpen[9] of 25 fistulograms reviewed retrospectively, the presence of an anal or rectal internal opening was correctly identified in only 24 percent of patients and the presence of high extensions was detected radiologically in only 56 percent of the cases with that complication. The correct determination of both internal openings and exten-

sions occurred in only 16 percent of patients. Furthermore, false positive information suggesting high internal openings and extensions was evident in 12 percent of cases, which, if acted upon, could have led to serious iatrogenic complications. The procedure exposes the patient to ionizing radiation, is uncomfortable, and carries the risk of dissemination of sepsis.[11] However, Weisman *et al.*[10] did find fistulography to be useful because it revealed clinically unsuspected pathology or directly altered surgical management in 48 percent of their 27 patients. In assessing the level of fistulas, accuracy is improved by placing radiopaque markers at either end of the anal canal.[12]

Patients with perianal complications of Crohn's disease have been assessed by a combination of flexible and rigid nonoptical echoprobes and flexible echoendoscopy.[11, 13] Above the sphincters, the rectal lumen has to be filled with water or a water-filled balloon placed around the probe to enable transmission of ultrasound waves. Transrectal ultrasonography has been shown to be superior to computerized tomography (CT) in determining the presence of fistulas and abscesses in these patients.[14] The exact site of pathology in relation to the levator muscles on axial CT sections can only be determined indirectly through the relations of the abnormality to the piriformis and coccygeus muscles since the levators are not well identified on computerized tomographic scanning.[15] Further disadvantages of CT are radiation exposure, the need for contrast media, and the relatively poor resolution of the sphincter musculature. Computerized tomographic imaging in the coronal plane is rarely possible[15] and coupled with the numerous diagnostic pitfalls in scan interpretation,[16] computerized tomographic scanning is less than optimal in accurately assessing perianal fistulous disease.

Early studies employing MRI to assess perianal Crohn's fistulas involved small numbers of patients and few comparisons were made with the operative findings. Instead, they were made with CT, sonography, fistulography, or barium studies.[17] Even so, the potential advantages occasioned by the lack of ionizing radiation, the multiplanar imaging capabilities and the high soft tissue contrast resolution were apparent.[17, 18] The value of MRI in perianal Crohn's disease has recently been demonstrated prospectively where clinical examination missed nearly half of the patients noted on MRI scanning (confirmed at surgery) to have abscesses deep in the ischiorectal fossa.[19]

Initial results of anal endosonography using a 7-MHz rotating endoprobe covered by a hard sonolucent plastic cone in the evaluation of intersphincteric and transsphincteric tracts were promising,[20] but this mode of sonography is unable to assess pathology outside the sphincters because of the limited focal range of the probe and lack of acoustic coupling when the probe is in the rectum. Unfortunately, it is pathology outside the sphincters that is often the most important to be able to image. In determining intrasphincteric pathology, ultrasound has been shown to be no more accurate than careful digital examination under anesthesia.[21] Digital examination by an experienced operator can however misdiagnose intersphincteric and extrasphincteric tracts as well as miss supralevator extensions,[21] and not all surgeons have an "experienced digit."

MRI agreed more frequently with the operative findings than AES in determining the primary tract and situation of the internal opening, although the difference between the two imaging methods did not reach statistical significance.

Although differences in the sonographic appearances of sepsis and scarring in the sphincter complex have been described,[5] these differences are subtle and may confuse accurate AES assessment of fistulas in patients who have undergone previous surgery. Another problem with AES is the effect of sepsis on the sonographic appearances of adjacent structures; thus, acoustic shadowing from the intersphincteric region may, for example, simulate transsphincteric extension.

It is in the imaging of extensions that MRI is significantly more useful than AES. Although the differentiation of fistulas into simple and complex types depends on definition, in the series comparing the two techniques, 10 of 20 patients had fistulas in which there were secondary ramifications away from the primary tract.

The positive predictive value of AES in the assessment of secondary extensions is confirmatory evidence that the technique as used in this study is of insufficient accuracy to provide much benefit over clinical examination. The lack of definition in imaging the ischiorectal fossae is because of the limited focal range of the probe. Probes of greater focal distance should overcome this problem at the expense of lower power of resolution of the sphincter itself. Failure to image external openings is also attributable to insufficient focal range, although an ability to demonstrate these would confer no clinical benefit. Recognition of supralevator

sepsis can be difficult when acoustic coupling of the probe is limited to the anal canal, and may be overcome by using a rectal balloon attachment.

AES may be considerably cheaper than MRI, but the information it provides appears to be limited to the sphincter, where it is pre-eminent in defining sphincter integrity. Extrasphincteric tracts were not visualized accurately with the equipment used, and there is a fundamental problem that ultrasound may not differentiate some inflammatory tissue from scar tissue. MRI suffers from none of these drawbacks and has the added advantage of multiplanar imaging. This enables fistula anatomy to be imaged in a way that is directly related to surgical planes and exploration.

Therefore, MRI, though much more expensive than AES, has substantial advantages in planning fistula surgery and is recommended for difficult cases, particularly when there is recurrent fistula formation following previous surgical intervention.

CONCLUSIONS

Using operative findings by an experienced coloproctologist as the gold standard, our study has demonstrated the high degree of accuracy of MRI in demonstrating the topography of anal fistulas. We have also shown that in four of seven patients classified as discordant, failure of healing was related to pathology missed at surgery but which had been documented on the scan interpretations. We believe, therefore, that MRI scanning now challenges the operative findings as the gold standard.

Finally, the accuracy of MRI in demonstrating fistula pathology also means that we now have a way of monitoring fistula healing by nonsurgical methods.

ACKNOWLEDGMENTS

The authors thank the surgeons of St. Mark's Hospital for allowing their patients into this study, and Dr. Janet Husband and Mrs. Tiba Seear for their most generous support of this project by allowing patients to be scanned in their MRI unit at The London Clinic.

REFERENCES

1. Seow-Choen F, Phillips RK. Insights gained from the management of problematical anal fistulae at St. Mark's Hospital, 1:984–88. Br J Surg 1991;78: 539–41.
2. Parks AG, Gordon PH, Hardcastle JD. A classification of fistula-in-ano. Br J Surg 1976;63:1–12.
3. Shouler PJ, Grimley RP, Keighley MR, Alexander-Williams J. Fistula-in-ano is usually easy to manage surgically. Int J Colorectal Dis 1986;1:113–5.
4. Lunniss PJ, Armstrong P, Barker PG, Reznek RH, Phillips RK. Magnetic resonance imaging (MRI) of anal fistulae. Lancet 1992;340:394–6.
5. Law PJ, Bartram CI. Anal endosonography: technique and normal anatomy. Gastrointest Radiol 1989; 14:349–53.
6. Sultan AH, Nicholls RJ, Kamm MA, Hudson CN, Beynon J, Bartram CI. Anal endosonography and correlation with *in vitro* and *in vivo* anatomy. Br J Surg 1993;80:508–11.
7. Ani AN, Lagundoye SB. Radiological evaluation of anal fistulae: a prospective study of fistulograms. Clin Radiol 1979;30:21–4.
8. Sainio P, Husa A. Fistula-in-ano. Clinical features and long-term results of surgery in 199 adults. Acta Chir Scand 1985;151:169–76.
9. Kuijpers HC, Schulpen T. Fistulography for fistula-in-ano. Is it useful? Dis Colon Rectum 1985;28: 103–4.
10. Weisman RI, Orsay CP, Pearl RK, Abcarian H. The role of fistulography in fistula-in-ano: report of five cases. Dis Colon Rectum 1991;34:181–4.
11. Tio TL, Mulder CJ, Wijers OB, Sars PR, Tytgat GN. Endosonography of peri-anal and peri-colorectal fistula and/or abscess in Crohn's disease. Gastrointest Endosc 1990;36:331–6.
12. Pommeri F, Pittarello F, Dodi G, Pianon P, Muzzio PC. Diagnosi radiologica delle fistole anali con reperi radiopachi. Radiol Med 1988;75:632–7.
13. Mulder CJ, Tio TL, Tytgat GN. Transrectal ultrasonography in the assessment of periano-rectal fistula and/or abscess in Crohn's disease. Gastroenterology 1988;94:A313.
14. Schratter-Sehn AU, Lochs H, Vogelsang H, Schurawitzki H, Herold C, Schratter M. Comparison of transrectal ultrasonography and computed tomography in the diagnosis of periano-rectal fistulas in patients with Crohn's disease. Gastroenterology 1992;102:A691.
15. Guillaumin E, Jeffrey RB, Shea WJ, Asling CW, Goldberg HI. Perirectal inflammatory disease: CT findings. Radiology 1986;161:153–7.
16. Yousem DM, Fishman EK, Jones B. Crohn's disease: perirectal and perianal findings at CT. Radiology 1988;167:331–4.
17. Koelbel G, Schmiedl U, Majer MC, *et al.* Diagnosis of fistulae and sinus tracts in patients with Crohn disease: value of MR imaging. AJR 1989;152: 999–1003.
18. Heiken JP, Lee JK. MR Imaging of the pelvis. Radiology 1988;166:11–6.
19. Skalej M, Bongers H, Aicher H, Weinlich M, Starlin-

ger M, Jenss H. Value of MR-tomography in perianal Crohn's disease—a prospective study. Gastroenterology 1992;102:A697.
20. Law PJ, Talbot RW, Bartram CI, Northover JM. Anal endosonography in the evaluation of perianal sepsis and fistula in ano. Br J Surg 1989;76:752–5.
21. Choen S, Burnett S, Bartram CI, Nicholls RJ. Comparison between anal endosonography and digital examination in the evaluation of anal fistulae. Br J Surg 1991;78:445–7.