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Non-contrast MRI and surgical concordance in fistula-in-ano

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Fistula-in-ano is an abnormal connection between the anal canal or rectum and the perianal skin, often resulting from infection in the anal glands. While clinical examination provides some insights, MR fistulogram is essential for detailed assessment and reducing recurrence rates after surgery.

Objective – to compare and correlate the pre-operative non-contrast MR fistulogram findings with surgical findings, focusing on concordance rates for fistula type, craniocaudal extent of tracts, number and clock position of internal and external openings, and presence of complicating features like secondary tracts, supralevator extension, presence and location of abscesses.

Materials and methods. We retrospectively analysed 236 patients with fistula-in-ano who underwent both MR fistulogram and subsequent surgery within a span of 1 month over one year. MRI scans were reviewed by an experienced radiologist blinded to surgical findings. Parameters assessed included fistula type (Parks, St. James, simple vs. complex), number and clock position of internal and external openings, craniocaudal level of internal openings, puborectalis involvement, secondary tracts, presence of secondary tracts, and location of abscess, if any. Concordance between MRI and surgical findings was evaluated using percentage agreement and weighted kappa coefficients.

Results. Our study cohort had a mean age of 41.7 years, with the majority being men (89 %) and cryptoglandular etiology (93.6 %). Transsphincteric fistula was the most common type (64 %). Complex fistulas were seen in 63.6 %. Secondary tracts, abscesses, or multiple tracts were seen in 45 %, 30.5 %, and 11 %, respectively. There was almost perfect agreement between MRI and surgical findings in identifying fistula type, clock position of internal and external openings, secondary tracts, and location of abscesses ($\kappa = 0.98$, 0.93, 0.94, 0.88 and 0.98, respectively), substantial agreement for the craniocaudal level of internal opening ($\kappa = 0.72$), and only moderate agreement for the number of internal and external openings ($\kappa = 0.56$ and 0.51, respectively).

Conclusions. Non-contrast MR fistulogram, with its excellent soft tissue resolution, accurately depicts the type of fistula-in-ano, localises the internal and external openings, and identifies the presence of any complicating features with almost perfect agreement between MRI and surgical findings.

Keywords
fistula-in-ano, perianal fistula, cryptoglandular fistula, MR fistulogram, complex fistula, Parks classification, St. James University Hospital classification.

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Fistula-in-ano is a pathological communication between two epithelialized surfaces, specifically the anal canal or rectum with the perianal skin, and the fistulous tract itself lined by granulation tissue [2, 21]. The prevalence of fistula-in-ano is estimated to be approximately 0.01 % in the general population, with a higher incidence in young adults and a greater occurrence in males than females [5]. The anal glands, located within the intersphincteric space, open into the anal crypts at the level of the dentate line [8]. Infection or obstruction of these glands is believed to be the primary etiological factor in the development of most cryptoglandular fistulas [10]. Once an infection establishes itself within the anal gland, it can spread through the path of least resistance, either forming an abscess or piercing through the surrounding tissues to create a fistula [22]. This process is influenced by various immunological, microbiological, and host factors. Rarely, secondary causes such as Crohn's disease, tuberculosis, pelvic infections, trauma, diverticulitis, anorectal cancer, or radiation therapy can also lead to fistula formation [12]. The most frequent clinical manifestation of fistula-in-ano involves perianal discharge accompanied by pain, swelling, and inflammation in the affected region [5]. Parks classification categorizes fistula into four main types based on its relationship to the anal sphincter: intersphincteric, transsphincteric, suprasphincteric, and extrasphincteric [13]. The St. James University Hospital classification system further categorizes fistula based on anatomical landmarks, secondary extensions, and abscess formation, and it is more useful for describing the level of complexity of fistula-in-ano [12]. The precise preoperative assessment of fistula characteristics, including the location of the internal opening, the course and extent of the fistulous tract, and the presence of any associated abscesses or secondary extensions, is paramount for effective surgical management and prevention of fistula recurrence [17]. Clinical examination, including digital rectal examination and probing of the external opening may provide some anatomical detail about the fistula; however, it is often incomplete due to significant patient discomfort and may necessitate examination under anaesthesia (EUA) for better assessment. Imaging is frequently necessary to fully delineate the anatomy and associated complications of fistula-in-ano, with the exception of low uncomplicated fistulas [9, 18]. Magnetic resonance imaging (MRI)/MR fistulogram has emerged as the preferred non-invasive modality for evaluating complex perianal fistulas due to its superior soft-tissue resolution, multiplanar capabilities, and ability to detect subtle inflammatory changes and fluid collections as well as delineate complex fistula anatomy [5, 18]. Despite advancements in medical understanding and surgical techniques, the management of fistula-in-ano remains a formidable challenge, primarily because of the complex anal sphincter anatomy and the need to preserve sphincter function in order to prevent postoperative faecal incontinence [14]. MRI aids in assessing prognosis, particularly concerning the post-operative faecal incontinence by assessing the length of sphincter involved and monitoring treatment progress, including resolution or recurrence of the fistula [6].

Several studies have shown that MRI accurately detects the primary tract and presence of abscesses, with reasonably high sensitivity and specificity [9, 20]. However, we did not come across any large population study in English literature with a head-to-head comparison between surgical findings and MRI, taking into consideration several MRI findings in patients with fistula-in-ano. Through this study, we aim to provide additional insight into the reliability of non-contrast MRI for accurate depiction of the number, clock position, and distance from the anal verge of the internal and external openings, secondary tracts, and presence and location of abscesses with respect to the anal sphincter and levator ani muscle.

Objective. Through this large-volume retrospective observational study, we aim to compare and correlate the preoperative non-contrast MR fistulogram findings with surgical findings, focusing on concordance rates for fistula type, craniocaudal extent of tracts, number and clock position of internal and external openings, and presence of complicating features like secondary tracts, supralevator extension, and presence and location of abscesses.

Materials and methods

We retrospectively reviewed all consecutive MRI scans done in the department of Radiology in our institution over the course of one year for patients with clinically apparent perianal fistulous disease who underwent surgery for the same within 1 month after the MRI scan (n = 236). Their demographic, clinical, and surgical details were obtained from electronic medical records (EMR) by the abdominal radiology fellow; MRI scans were reviewed on our PACS (Picture Archiving and Communication System) database by an experienced abdominal radiologist who was blinded to the operative findings. Patients who either did not undergo surgery after the MRI or those who underwent surgery more than a month after the MRI and had no fistula on imaging were excluded from analysis.

The MRI scans were performed on either a Philips 1.5-Tesla Ingenia S or a PHILIPS 3-Tesla Ingenia Elition X scanner using body or phased-array coils, without the use of intravenous paramagnetic contrast agents or instillation contrast into the fistulous tracts. No patient preparation was required prior to the scan. T2-weighted high-resolution MRI sequences, with and without fat suppression, using small field of view in sagittal, oblique axial, and oblique coronal planes with respect to the anal canal axis were used to document the MRI findings in a structured proforma. The detailed list of our MR fistulogram protocol is in Table 1.

Operative/surgical findings were considered as the gold standard to assess the accuracy of the following MRI parameters: 1. Fistula Type: Classified using both the Parks classification [13] and

Table 1. **MR fistulogram sequences**

MRI sequences	Slice thickness, mm		Slice gap, mm		TR/TE, ms		Flip angle, degree		Field of view, cm	
	1.5T	3T	1.5T	3T	1.5T	3T	1.5T	3T	1.5T	3T
T2 STIR axial	4	3.7	0	0.4	5300/75	5100/80	90	90	22 × 22	23 × 23
T2 STIR coronal	4	3.5	0	0.4	2200/60	5000/80	90	90	20 × 20	25 × 25
T2 STIR sagittal	4	4	0	0.4	2200/60	4700/80	90	90	20 × 20	25 × 25
3D T2 FS axial	2	1.2	0	0	1300/200	1500/152	90	90	34 × 34	28 × 28
DWI axial	4	4	0	0.8	4000/105	4900/79	90	90	26 × 26	24 × 24
T2 TSE axial	4	3.7	0	0.4	3600/100	4600/100	90	90	20 × 20	23 × 23
T2 TSE coronal	4	3.5	0.5	0.4	5300/100	4600/100	90	90	20 × 20	25 × 25
T2 TSE sagittal	4	3	0	0.3	3100/110	3600/100	90	90	20 × 20	25 × 25
T1 3D mDIXON	2	2.5	0	0	5900/0	4900/0	10	10	35 × 35	32 × 32

St. James University Hospital classification [12] systems 2. Internal Openings: Number and clock position, and craniocaudal level (low anal canal, mid anal canal, high anal canal or rectum) 3. External openings: Number and clock position. Additional MRI parameters assessed were: 4. Puborectalis sling involvement 5. Secondary tracts/extensions 6. The presence and location of fluid collections 7. Involvement of adjacent organs (urinary bladder, urethra, external genitalia, etc.). There was missing data in a few patients, as their surgical notes did not include information regarding some of the fistula parameters that we were trying to assess. The concordance rate in such instances was calculated by including only those patients with paired data available. We also documented the presence of any other compelling evidence of co-existing inflammatory bowel disease from the patient's EMR or other available imaging from PACS and any evidence of tuberculosis from the histopathological examination of the excised fistulous tract, when available. In patients with two or more fistulous tracts, the highest grade of St. James classification applicable to the patient was assigned; the rest of the details of each fistulous tract were documented separately. In cases where the internal opening was not visually apparent in the anal mucosa, its location was inferred based on the clock position and craniocaudal level where the fistulous tract penetrated the internal sphincter. Clock positions of the internal and external openings from MRI and surgery were considered concordant when they matched or were within one clock hour of each other. Every attempt was made to document the same details assessed during the surgery; however, in the event of one or more missing details in the operative notes, the same parameter was excluded from analysis. When internal openings were not visible during the surgery, hydrogen peroxide was injected into the tract via the external opening to assist in identification. For the purpose of our study, the craniocaudal level of internal opening was categorized as low anal canal when the opening was seen at or below the inferior edge of the internal sphincter. The rest of the upper anal canal was arbitrarily divided into equal upper and mid thirds in order to be able to compare MRI and clinical findings. Clinically, the level of internal opening was documented as 'low' when it was at or below the dentate line. Above the level of the dentate line, the anal canal was arbitrarily divided into equal upper and mid thirds – equated to 'high' and 'mid' anal canal on MRI. Patients were also broadly grouped into simple and complex fistulas in this study, the latter characterized by the presence of one or more of the following features: high transsphincteric tract, involvement of puborectalis, supralevator extension or rectal involvement, associated fluid collections, multiple fistulous tracts, involvement of > 30 % of the anal sphincter complex, coexisting tuberculosis, or Crohn's disease.

Statistical Analysis: Continuous and categorical data were described in terms of mean, frequencies (number of cases), and relative frequencies (percentages), as appropriate. MRI accuracy in predicting fistula type, number, clock position, and the craniocaudal level of internal opening was expressed as percentage concordance with surgical findings and also measured using the weighted kappa coefficient (κ) with a 95 % confidence interval (CI). The degree of agreement was classified as slight agreement

Table 2. **Demographics and clinico-radiological profile (n = 236)**

Indicator	Value
Age, years (mean (min–max))	41.7 (7–78)
Male	211 (89 %)
Female	25 (11 %)
Etiology of fistula	
Cryptoglandular	221 (93.6 %)
Crohn's disease	5 (2.1 %)
Tuberculosis*	4 (1.7 %)
Trauma	4 (1.7 %)
Immunosuppression (bone marrow transplant)	2 (0.8 %)
Recurrent fistula	56 (23.7 %)
Single fistula	211 (89.4 %)
Multiple fistula	25 (10.6 %)
2 tracts	23
3 tracts	1
4 tracts	1
Secondary tracts (information is available for 186 patients)	84 (45.2 %)
Abscess	72 (30.5 %)
Ischioanal fossa	36
Intersphincteric	25
Supralevator	11

* Confirmed on histopathology of the excised fistulous tracts.

($0.01 \le \kappa \le 0.20$), fair ($0.21 \le \kappa \le 0.40$), moderate ($0.41 \le \kappa \le 0.60$), substantial ($0.61 \le \kappa \le 0.80$), or almost perfect ($\kappa \ge 0.81$). All the analyses were performed using the statistical package IBM SPSS 23.0 (SPSS, USA).

Results and discussion

A total of 423 MR fistulograms were performed in our Radiology department over 1 year for evaluation of perianal fistula. After excluding patients with duplicated imaging (n = 19), those who did not undergo surgery in our institute (n = 127), underwent surgery more than a month after MRI (n = 14), or had no fistula or alternate diagnosis on MRI (n = 27), a total of 236 patients were included in our final analysis with a mean age of 41.7 years and the majority being males (211, 89 %), which is consistent with available literature [15, 20, 22]. The demographic and clinico-radiological profile of these patients is given in Table 2.

The overwhelming majority of our study patients were thought to have cryptoglandular perianal fistula; etiology was attributable to tuberculosis or Crohn's disease (Fig. 1) in less than 4 % of subjects, consistent with previous reports [16]. Despite the majority of our patients having cryptoglandular fistulas (93.6 %), more than half had complex fistulas (63.6 %) (Fig. 2). This is somewhat higher than the reported prevalence of complex fistulas in other studies [4, 9, 22] which can be explained by the referral bias in a tertiary care setting like our institution, which tends to attract a higher proportion of complex cases. Approximately a quarter of our patients (23.7 %) had a history of prior fistula surgery and were presenting with recurrent perianal disease.

The most common type of fistula seen on both MRI and surgery was transsphincteric followed by intersphincteric types, and St James Grade III followed by Grade IV fistula (Table 3). Although intersphincteric fistula is the most frequently encountered in clinical practice, [12] transsphincteric fistula remains the predominant type identified on MRI, reflecting the inherent selection bias in all imaging-based studies, especially in a tertiary referral care centre [2, 14].

Abscess associated with perianal fistula was seen in 72 patients (30.5 %), half of whom were in the ischioanal fossa. Puborectalis muscle involvement was observed in 54 patients (22.8 %). Ten patients had fistulous tracts extending into adjacent organs, including the urethra (n = 1), penile shaft (n = 2), scrotum (n = 4), prostate (n = 1), vagina (n = 1), and inguinal region (n = 1).

Identification of fistula location and associated complications before surgery is crucial for appropriate surgical management and to minimize recurrence [11]. In our study, MRI accurately depicted the primary fistulous tract (both Parks type & St. James grade), clock position of internal and external openings, and presence of secondary tracts and abscesses with almost perfect agreement (κ ranging from 0.88 to 0.98) between MRI and surgical findings (Tables 3, 4). There was substantial statistical agreement ($\kappa = 0.72$) between MRI and surgical findings for the craniocaudal level of internal opening as well. Despite a reasonably high concordance (> 70 %) between MRI and surgery in identifying the number of internal and external openings, there was only moderate statistical agreement ($\kappa = 0.51–0.56$). This could be explained by the fact that one cannot always visualise the sinus opening itself on the skin or mucosa despite accurately localising the fistulous tract on MRI due to inflammation and swelling. In some long-term fistulas, the internal opening may be cicatrized, making its identification very challenging on MRI [19]. Moreover, when an internal opening is not directly visualised on MRI, its location may

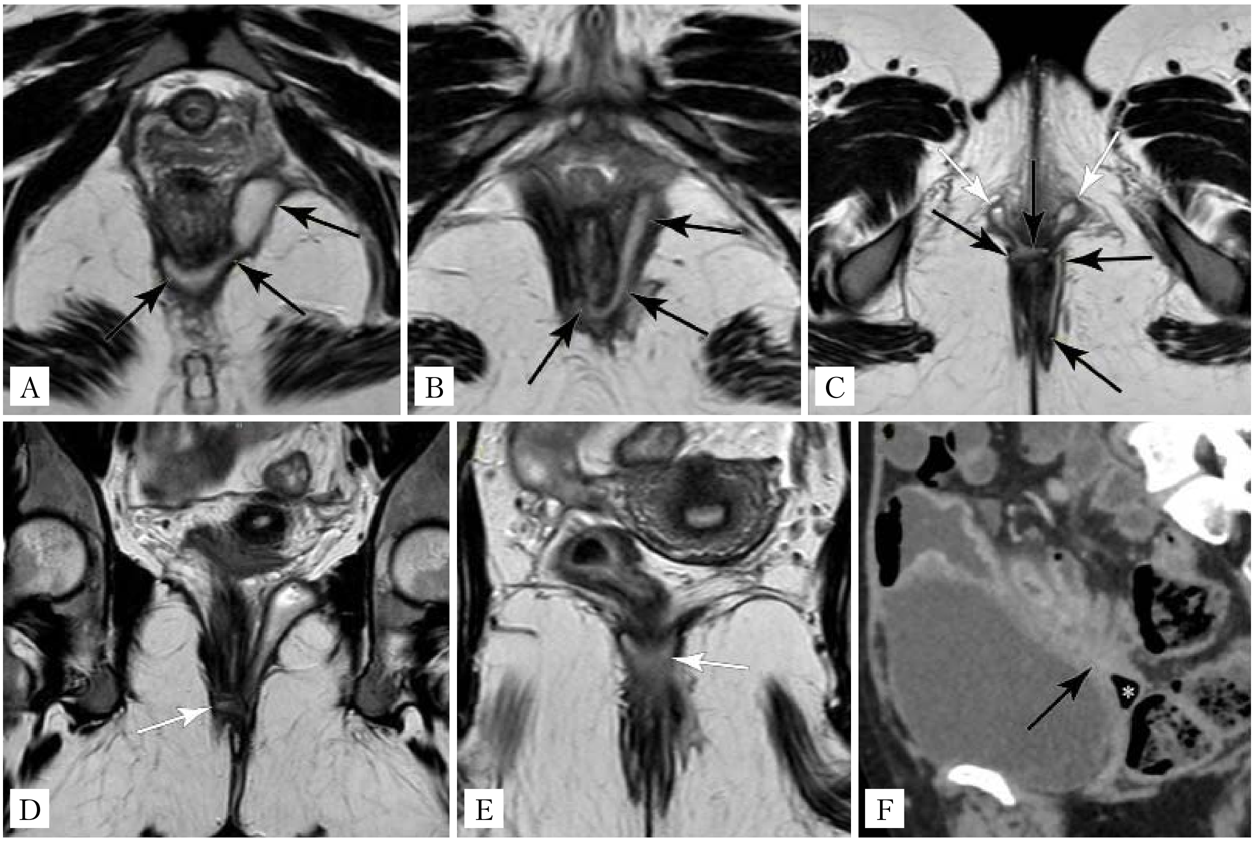

Figure 1. **21-year-old woman with fistulizing Crohn's disease and complex branching high trans-sphincteric fistula. T2w axial MR images above the level of puborectalis (A), upper anal canal (B) and lower anal canal (C) demonstrating a nearly circumferential fluid tract/collection (black arrows) encircling the outer aspect of the anal sphincter complex and involving external sphincter muscle fibers, extending from the 1 to 8 o'clock position (A, B) at the upper anal canal and puborectalis level and from the 10 to 6 o'clock position at the lower anal canal level (C). Few blind-ending branching tracts are seen at 11 and 1 o' clock positions (white arrows in C). Craniocaudal extent of the tract and the external opening in the left gluteal region are well depicted in the T2w coronal image (D). The horseshoe-like extensions of the tract around the anal canal are depicted in the coronal T2w images at the level of the low anal canal (white arrow in D) and upper anal canal (white arrow in E). Sagittal CT image (F) of the same woman showing small bowel involvement by Crohn's disease with thickened and clumped ileal loops in the pelvis and ileovaginal fistula (black arrow) resulting in air in the vaginal lumen (*). She underwent EUA with drainage of collection and seton insertion and received antibiotics followed by Biologics**

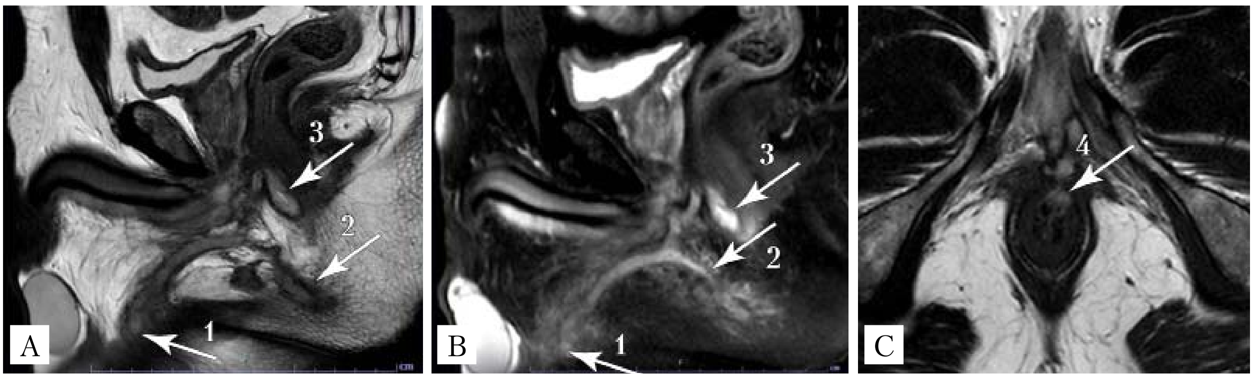

Figure 2. 36-year-old man with a complex branching anterior fistula-in-ano. T2w (A) and T2 Fat suppressed (B) sagittal MRI depicting the long anterior tract leading to the external opening in the scrotum (1), its branches in the perineum (2), and an anterior intersphincteric abscess (3). T2w axial MRI (C) depicts the defect in the internal sphincter with a potential internal opening at the 12 o' clock position (4) of the upper anal canal. Examination under anaesthesia showed a high anterior intersphincteric fistula with an external opening at the 1 o' clock position at the base of the scrotum, an internal opening at the 12 o' clock position 3 cm above the anal verge, and an intersphincteric abscess, which was drained along with partial fistulectomy and seton insertion

Table 3. **MR and surgical classification of perianal fistula**

Indicator	MRI	Surgery	Concordance	κ (95 % CI)
Parks (n = 264)				
Intersphincteric	70 (26.5 %)	67 (25.3 %)	98.9 %	0.97 (0.95–1)
Transsphincteric	169 (64 %)	172 (65.1 %)		
Suprasphincteric	13 (4.9 %)	13 (4.9 %)		
Extrasphincteric	12 (4.5 %)	12 (4.5 %)		
St James (n = 236)				
Grade I	43 (18.2 %)	41 (17.3 %)	98.7 %	0.98 (0.96–1)
Grade II	16 (6.8 %)	15 (6.3 %)		
Grade III	83 (35.1 %)	85 (36 %)		
Grade IV	69 (29.2 %)	70 (29.6 %)		
Grade V	25 (10.5 %)	25 (10.5 %)		
Simple	86 (36.4 %)	83 (35.1 %)	98.7 %	0.98 (0.96–1)
Complex	150 (63.6 %)	153 (64.8 %)		

Table 4. **Concordance/agreement between MRI and surgical findings**

Index	Patients with surgical and MRI details available	Concordance	κ (95 % CI)
Number of external openings	232	166 (71.6 %)	0.51 (0.4–0.62)
Clock position of external opening	205	173 (84.4 %)	0.94 (0.91–0.97)
Number of internal openings	226	171 (75.7 %)	0.56 (0.45–0.66)
Clock position of internal opening	187	156 (83.4 %)	0.93 (0.88–0.96)
Level of internal openings	169	139 (82.2 %)	0.72 (0.63–0.81)
Secondary tracts	186	175 (94 %)	0.88 (0.81–0.94)
Abscess	236	233 (98.7 %)	0.98 (096–1)

be inferred based on where the tract is seen involving the internal sphincter (as explained in the Methodology section); this is an indirect and less reliable way of assessment compared to the real-time visualisation of the internal or external openings during surgical exploration and taking advantage of hydrogen peroxide injection into the tract to assist in the identification of the internal opening.

We acknowledge the limitations in our study, including its retrospective nature, which may have resulted in missing data. In our institute we do not routinely administer I. V. Gadolinium for MRI, which arguably may have the advantage of identifying some secondary tracts and tiny abscesses that may be missed on non-contrast MR fistulogram [1, 3, 7].

Advantages of our study include a large sample size with a high proportion of complex fistulae and head-to-head comparison between multiple findings documented both on MR fistulogram and surgical notes. We identified the MRI parameters that are highly reliable or concordant with surgery and listed some parameters that are less reliably depicted on MRI. Specifically, the ability of MRI to visualize soft tissues and delineate the course of fistulas and associated extensions makes it a valuable tool for surgical planning. For example, identifying supralevator extensions preoperatively is crucial, as these can be easily missed during EUA [10].

Our head-to-head comparison between MR fistulogram and surgical findings helps highlight the reliability of preoperative MRI in depicting the morphology of complex fistulas. Most importantly, there was complete concordance between MRI features and surgical findings in terms of classifying the type of sphincter involvement, detecting abscesses, and identifying supralevator extension.

MRI is highly effective in classifying sphincter involvement, detecting abscesses, and identifying supralevator extensions in anal fistulas. Studies have shown that MRI has a high sensitivity and specificity for identifying these features, often outperforming physical examination under anaesthesia.

Conclusions

Non-contrast MR fistulogram, with its excellent soft tissue resolution, accurately depicts the type of fistula-in-ano, the clock position of internal and external openings, the presence of any complicating features including secondary tracts, and the presence and location of abscesses with almost perfect agreement between MRI and surgical findings.

Declaration of interests

The authors declare no conflicts of interest.

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Ethics approval and written informed consent statements

Ethical approval was waived by the Ethics Committee of Asian Institute of Gastroenterology, AIG Hospitals in view of the retrospective nature of the study and all the procedures being performed were part of the routine care.

Patient Informed Consent: Not applicable; patient informed consent was waived as this is a retrospective study.

Authors contributions

S. Naidu: data collection and interpretation, statistical analysis, drafting the article; T. Putta: conception and design, data interpretation, critical revision of the article.

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Відповідність між МРТ без контрастування та результатами інтраопераційної оцінки при норицях прямої кишки

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Нориця прямої кишки – це аномальне сполучення між анальним каналом або прямою кишкою та шкірою періанальної ділянки, яке здебільшого виникає внаслідок інфікування анальних залоз. Клінічне обстеження дає певну інформацію, але магнітно-резонансна фістулографія є необхідною для детальної візуалізації та зменшення частоти післяопераційних рецидивів.

Мета — оцінити відповідність між результатами доопераційної магнітно-резонансної фістулографії без контрастування та оцінкою інстраопераційно з урахуванням типу нориці, внутрішнього та зовнішнього отворів, краніокаудального рівня внутрішніх отворів, наявності вторинних ходів і локалізації вторинних абсцесів.

Матеріали та методи. Ретроспективно проаналізовано дані 236 пацієнтів із норицями, яким було виконано магнітно-резонансну фістулографію та подальше хірургічне лікування з інтервалом від 1 міс до 1 року. Магнітно-резонансні фістулограми були розглянуті досвідченим радіологом, який не був поінформований щодо результатів хірургічного лікування. Оцінювали такі параметри: тип нориці (за класифікаціями Паркса, лікарні Сент-Джеймса – проста чи складна), кількість і розташування внутрішніх та зовнішніх отворів, краніокаудальний рівень внутрішніх отворів та залучення лобково-прямокишкового м'яза, а також (за наявності) вторинні ходи й локалізацію абсцесів. Відповідність між результатами МРТ та оцінкою інстраопераційно визначали за допомогою відсотка узгодженості та коефіцієнта κ.

Результати. Середній вік пацієнтів дослідної групи становив 41,7 року, більшість із них були чоловіками (89 %), етіологія – криптогенною (93,6 %). Найпоширенішим типом нориці була транссфінктерна нориця (64 %). Складні нориці спостерігалися у 63,6 % пацієнтів, вторинні нориці, абсцеси або множинні нориці – у 45 %, 30,5 % та 11 % відповідно. Установлено майже повну відповідність між результатами магнітно-резонансної фістулографії та оцінкою інтраопераційно щодо визначення типу нориці, розташування внутрішнього та зовнішнього отворів за умовним циферблатом, наявності вторинних ходів і локалізації абсцесів (k 0,98, 0,93, 0,94, 0,88 та 0,98 відповідно), значну відповідність для краніокаудального рівня внутрішнього отвору (κ = 0,72) та помірну відповідність – щодо кількості внутрішніх та зовнішніх отворів (κ = 0,56 та 0,51 відповідно).

Висновки. Магнітно-резонансна фістулографія без контрастування забезпечує відмінну роздільну здатність м'яких тканин, точно відображує тип нориці прямої кишки, локалізацію внутрішніх та зовнішніх отворів, а також дає змогу визначити наявність будь-яких ускладнень із майже повною відповідністю між даними МРТ та результатами оцінки інтраопераційно.

Ключові слова: нориця прямої кишки, періанальна нориця, криптогландулярна нориця, магнітно-резонансна фістулографія, складна нориця, класифікація Паркса, класифікація Лікарні Святого Джеймса.

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