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Original Research Article

Evaluation of unenhanced three-dimensional endoanal ultrasound scan in preoperative assessment of perianal sepsis

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ABSTRACT

Background: Perianal sepsis which includes perianal fistula and abscess is a common clinical condition that requires thorough preoperative evaluation to decrease the recurrence rate and to plan relevant surgery according to the anatomy of the fistula. MRI and 3D EAUS are two important preoperative investigations that delineate the anatomy of simple and complex fistula tracts. Due to lower cost and easier use 3D EAUS is a safe and reliable first-line investigation in evaluating perianal abscess.
Methods: This is a retrospective and prospective analysis of patients with perianal sepsis who underwent pre-operative unenhanced 3D-EAUS in the departments of Colorectal surgery, Gastrointestinal surgery, and General surgery in our hospital. A B-K medical 2052 transducer was used for the study and the surgical assessment was done by multiple surgeons from multiple departments.
Results: A total of 255 patients were assessed. The accuracy for primary fistula tracts and internal opening was 83.53% and 88.62% respectively. The kappa coefficient of correlation was k=0.70 (substantial agreement) for the fistula tract and k=0.81 (near perfect agreement) for the internal opening. The sensitivity, and specificity of primary tracts and internal openings were calculated. Transphincteric fistulas were 57% in our study.
Conclusions: Unenhanced 3D EAUS is a reliable first-line investigation in preoperative evaluation of perianal fistula and abscess. Transphincteric fistula is the most common type of fistula. There is a high chance of correlation for the primary tract if a non-colorectal specialist performs the fistula surgery after 3D-EAUS without blinding.

Keywords: Endoanal ultrasound, Perianal fistula, Intersphincteric fistula, Correlation

INTRODUCTION

Perianal sepsis which includes perianal fistula and abscess are common conditions surgeons encounter in their day-to-day clinical practice.[1-3] Recurrence and incontinence are the two important surgical complications in fistula surgery. After the introduction of MRI and Three-dimensional- Endoanal ultrasound (3D-EAUS), much information regarding the anatomy of the perianal fistula and abscess can be obtained preoperatively. 3D-EAUS is a safe and highly reliable technique in the preoperative assessment of perianal fistula and abscess.[1,2] Due to its comparable accuracy with MRI, easier use, and lower cost, 3D-EAUS can even be considered as the first-line diagnostic tool in the evaluation of perianal sepsis.[2-4] Hydrogen peroxide (H2O2) enhancement can better delineate the fistula tract in 3D-EAUS but that does not significantly improve the diagnostic accuracy compared to unenhanced 3D-EAUS.[2] There were reported complications though rare like air embolism, proctitis and abdominal pain with H2O2 instillation into the fistula tract.[2,5-7] Our study aims to evaluate the accuracy of unenhanced 3D-EAUS in the diagnosis of perianal fistula and abscess in comparison to the intraoperative surgical findings.

METHODS

This is a retrospective and prospective analysis of a cohort of 255 patients with perianal fistula and abscess (perianal sepsis) who underwent pre-operative 3D-EAUS from September 2018 to December 2020 in the departments of Colorectal surgery, Gastrointestinal (GI) surgery, and General surgery in Apollo hospitals, jubilee hills, Hyderabad. The study period was from May 2020 to April 2021. These patients were preoperatively evaluated with clinical history, digital rectal examination followed by 3D-EAUS without hydrogen peroxide enhancement, and subsequently underwent surgery. The patients with perianal sepsis who underwent 3D-EAUS before surgery and with complete records like the 3D-EAUS reports, imaging and discharge summary were included in the study. Incomplete 3D-EAUS reports, imaging and records with incomplete information were excluded. Our hospital records like discharge summary and 3D-EAUS reports were examined and information like patients demographics, previous anal fistula or abscess drainage surgery, medical comorbidities, number of surgeries in colorectal, gastrointestinal, and general surgery departments, the time interval between the 3D-EAUS scan and surgery, anatomical features of the fistula on 3D-EAUS examination and during surgery, and the type of surgical procedure performed were prospectively recorded and retrospectively extracted from the hospital records. The institutional ethics committee exempted the study from ethics approval as the study was retrospective and patient details have not been disclosed in any form in the article.

Ultrasound technique

All the 3D-EAUS were done either by a colorectal surgery consultant or a senior colorectal surgical fellow. The examination was performed with a BK Medical Ultrasound probe type 2052 (B-K Medical, Herlev, Denmark) with a 360-degree rotating head and work frequency ranging from 6-16 MHz. The transducer was covered with a glove filled with ultrasound gel. After lubrication, this transducer was introduced into the anal canal with the patient in left lateral position. 3D images were obtained by an inbuilt function in the ultrasound system. Fistula tracts and abscesses were visualized as hypoechoic tracts and collections respectively while hyperechoic areas denote air in the tract/cavity. Specific features like the site of the internal opening, the level of the fistula tract, the relation of tracts to anal sphincters, and site of abscess cavities were obtained. All the endoanal scan reports and hospital records were assessed and re-examined. The ultrasound machine with the BK Medical 2052 transducer is shown in (Figure 1).

Surgical evaluation

Patients were placed in a lithotomy position and after thorough examination under anesthesia appropriate surgery was carried out by a team of colorectal surgeons, GI, and general surgeons in their concerned departments. The primary opening was located by using a conventional fistula probe, methylene blue dye, and hydrogen peroxide where required. The site of the internal opening, the type of fistula tracts, and fluid collections/abscesses were identified and recorded. Appropriate surgeries like Incision and drainage, Seton placement, Fistulotomy, and Fistulectomy with or without sphincter repair were performed. The old cases' surgical findings were retrospectively extracted from hospital records and the new cases' findings were prospectively recorded.

Figure 1: Ultrasound machine with BK 2052 3D Endoanal transducer.

Statistical analysis

The collected data was tabulated and analyzed using Microsoft Word & Excel (Microsoft Word & Excel 2010©, Microsoft, Redmond, USA), and statistical analysis was performed using a web-based open-source software, OpenEpi, version 3.01.[8] Values are expressed as means±standard deviation (SD) and range. The Odds ratio, Sensitivity, Specificity, Positive predictive value, Negative predictive value, and accuracy were calculated. The p value was calculated using a two-sided Fisher's exact test. We considered $p<0.05$ with a confidence interval (CI) of 95% as statistically significant. The concordance rate and Cohen's kappa coefficient *(*extent of agreement between frequencies of two sets of data collected on two different occasions.*)* were calculated. The Kappa coefficient varies between 0 and 1, considering: k=0, no agreement; k<0.2, slight agreement; k=0.21-0.40, fair agreement; k=0.41-0.60, moderate agreement; k=0.61-0.80, substantial agreement; k=0.81-0.99, near perfect agreement; and k=1, perfect agreement.[9]

RESULTS

A total of 646 3D-Endoanal ultrasound scans were performed over a period of 27 months in our hospital out

of which 255 scanned patients had preoperative scanning for perianal fistula and abscess and got operated on in our hospital. These 255 3d-endoanal scan findings were correlated with the intraoperative surgical findings in our study. Out of 255 cases, males were 207 (81.18%) with a mean age of 43.81±13.04 years, and females were 48 (18.82%) with a mean age of 36.3±12.8 years giving a M:F ratio of 4.31:1. Out of 255 cases, 213 (83.53%) correlated for fistula tract/abscess alone, 226 (88.62%) correlated for internal opening alone, and 198 (77.64%) correlated for both fistula tract/abscess and internal opening.

There was a complete noncorrelation for fistula tract/abscess alone in 42 (16.47%), for internal opening alone in 29 (11.38%), and for both fistula tract/abscess and internal opening in 14 (5.5%). There was a partial correlation in 43 (16.86%) for either fistula tract/abscess or internal opening in our study. The kappa coefficient for concordance between 3D-EAUS and intraoperative findings for the fistula tract and abscess was k=0.7 (substantial agreement) and for the internal opening was k=0.81 (almost perfect agreement) in our study. The results of 3D-EAUS findings and intraoperative findings are given in (Table 1).

Table 1: The results of 3D-EAUS and intraoperative findings.

Parameters	3D-EAUS	Intraoperative findings
Fistula/abscess[a]	**N (%)**	**N (%)**
Normal	1 (0.4)	3 (1.17)
Superficial	3 (1.17)	3 (1.17)
Intersphincteric	106 (41.56)	93 (36.48)
Transsphincteric	136 (53.33)	147 (57.64)
Suprasphincteric	2 (0.8)	2 (0.8)
Extrasphincteric	7 (2.74)	7 (2.74)
Total	255 (100)	255 (100)
Internal openings[b]		
Anterior 11'-1'	84 (32.95)	86 (33.73)
Left lateral 2'-4'	4 (1.57)	8 (3.13)
Posterior 5'-7'	134 (52.55)	132 (51.76)
Right Lateral 8'-10'	3 (1.17)	2 (0.8)
Couldn't identify	30 (11.76)	27 (10.58)
Total	255 (100)	255(100)

[a]Agreement=83.53% (213/255), kappa=0.7, [b]Agreement= 88.62% (226/255), kappa=0.81

The percentages of correlation between 3d-EAUS with surgical findings are given in (Table 2). The Sensitivity, Specificity, Positive predictive value (PPV), Negative predictive value (NPV), and accuracy of unenhanced 3D-EAUS for Intersphincteric, Transphincteric fistula/abscess and anterior, posterior quadrant internal openings are given in (Table 3). The factors studied affecting the correlation of the fistula tract and the internal opening are given in (Table 4). 91 (35.7%) cases had a prior history of fistula surgery or abscess drainage and 164 (64.3%) cases were fresh cases. 71 (39.88%) are recurrent cases and 107 (61.12%) are first cases in the colorectal specialty. The mean duration between the 3D EAUS scan to surgery was 10 days (0-362 days). 70% (N=178) of the cases were operated by colorectal surgeons specialized in perianal surgery with almost 40% (N=71) of them being recurrent. The remaining 30% were operated by other departments.

Table 2: Shows the agreement between 3D-EAUS and surgical findings.

Surgical assessment features (number of patients)	Agreement of 3D-EAUS with surgical findings (N)	Percent agreement
Fistula tract/abscess		
Normal (3)	0	0
Superficial (3)	1	33.33
Intersphincteric (93)	81	87.1
Transphincteric (147)	124	84.35
Suprasphincteric (2)	1	50
Extrasphincteric (7)	6	85.7
Total (255)	213	83.53
Internal opening		
Anterior (86)	77	89.53
Left lateral (8)	3	37.5
Posterior (132)	127	96.21
Right lateral (2)	1	50
Couldn't identify (27)	18	66.66
Total (255)	226	86.62

DISCUSSION

3D EAUS is the first line investigation preferred for fistula in ano.[1-4,10-18] Almost all the studies including our study used BK medical endoanal transducers 1850, 2050, and 2052 except one study that used an Olympus type RU-75M-R1 transducer.[13]

In our study, we never used hydrogen peroxide for enhancement of fistula tracts as there was no significant difference between the two and it was time-consuming with known though uncommon side effects.[2,15] Though most of the studies including our study compared 3D-EAUS findings with surgical findings (gold standard), there were only a few studies that compared 3D EAUS findings with endoanal MRI and with MRI followed by surgery findings[1-4,10-15,17,18] Many studies questioned the reliability of surgical findings as a reference gold standard for comparison as few fistula tracts and internal openings identified in 3D-EAUS and MRI were missed during surgery which later presented with recurrence.[1,10,13-15] In our study, an anterior extra sphincteric abscess diagnosed by 3D EAUS was missed during surgery which later presented with fulminant necrotizing fasciitis of the perineum and scrotum. Considering these errors, a combination of surgery and MRI is more reliable as a gold standard than surgery

alone. Nevertheless, in our retrospective study, we compared our 3D-EAUS findings to the surgical findings of various surgery departments. Our study sample size was 255 but most of the study's sample size was less than 150 [2-4, 10-15, 18]. 57-88% of the patients were males with M: F ratio ranging from as low as 1.3:1 to as high as 6.9:1.[1,13] Our study's M: F ratio was 4.31: 1 and the mean age was about 40-45 years. Though it was thought that the most common type of fistula was intersphincteric fistula accounting for 50-80% of total cases, most of the recent studies performed on 3D EAUS and MR fistulogram including our study revealed transphincteric fistula as the most common type with incidence ranging from 50-90% followed by intersphincteric fistula with 5-45% incidence.[1-4,10-19] The unenhanced 3D EAUS images of normal anatomy, intersphincteric, and transphincteric fistula are given in (Figure 2-4) respectively.

Nearly 50-65% of the fistula in ano open internally into the posterior quadrant of the anal canal, a finding which was consistent with our study with more than 50% of fistulas opening internally into the posterior anal quadrant from 5' to 7' o clock both in 3D EAUS and on surgical evaluation.[2,14,17,18] The accuracy of 3D EAUS in diagnosing primary fistula tracts was around 80-90% a finding consistent with our study.[2,11,12,14-18]

Table 3: Sensitivity, specificity, positive predictive value, negative predictive value, and accuracy for intersphincteric and transphincteric fistula/abscess and anterior and posterior quadrant internal openings of 3D-EAUS in comparison to intraoperative findings.

Tracts/IO	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)
Intersphincteric	87.1	84.57	76.42	91.95	87.33
Transphincteric	84.35	88.89	91.18	80.67	86.27
Anterior 11'-1'	89.53	95.86	91.67	94.74	93.73
Posterior 5'-7'	96.21	94.31	94.78	95.87	95.29

IO-Internal opening

Table 4: Factors studied affecting correlation.

Factor	Odds ratio for correlation (95% CI)	Odds ratio for noncorrelation (95% CI)	P value
Fistula/abscess			
Male gender	0.84 (0.35-2.02)	1.2 (0.5-2.87)	0.8848
female gender	1.2 (0.5-2.87)	0.84 (0.35-2.02)	0.8848
<5 days interval	1.383 (0.69-2.78)	0.722 (0.36-1.45)	0.4598
Fresh cases	0.59 (0.28-1.23)	1.7 (0.8-3.55)	0.2163
Recurrent cases	1.7 (0.8-3.55)	0.59 (0.28-1.23)	0.2163
Colorectal Specialist	0.33 (0.13-0.82)	3 (1.2-7.45)	0.0177
Other specialists	3 (1.2-7.45)	0.33 (0.13-0.82)	0.0177
Nondiabetics	1.078 (0.48-2.42)	0.92 (0.41-2.08)	0.999
Nonhypertensives	2.33 (1.13-4.77)	0.43 (0.21-0.87)	0.0373
Non-DM + HTN	1.52 (0.57-4.03)	0.65 (0.24-1.74)	0.5422
Internal opening			
Male gender	0.66 (0.22-1.99)	1.51 (0.5-4.56)	0.6529
Female gender	1.51 (0.5-4.56)	0.66 (0.22-1.99)	0.653
<5 days correlation	0.45 (0.16-1.24)	2.2 (0.8-6)	0.1675
Fresh cases	0.43 (0.17-1.1)	2.31 (0.9-6)	0.106
Colorectal Specialist	0.86 (0.366-2.05)	1.15 (0.48-2.73)	0.9299
Other specialists	1.15 (0.48-2.73)	0.86 (0.366-2.05)	0.9299
Non diabetic	1.91 (0.81-4.5)	0.52 (0.22-1.22)	0.2113
Non Hypertension	2.05 (0.89-4.72)	0.48 (0.21-1.11)	0.1442
Non-DM + HTN	0.27 (0.03-2.1)	3.64 (0.47-27.88)	0.312

Among fistulas, transphincteric fistula has accuracy from 85-100% compared to intersphincteric fistulas which range from 75-95%.[1,11,12,17,18] Our studies accuracy for intersphincteric and transphincteric fistula was around 87% (87.33% vs. 86.27%). The accuracy for diagnosing internal openings was higher than the primary tract and ranged from 85-95%.[2,11,12,14-18] Among internal openings, the accuracy of posterior quadrant internal openings was 96.2% a finding similar to our study (95.3%).[18] In our study, the kappa (k) coefficient for the correlation of primary fistula tract and internal opening was 0.70 (substantial agreement) and 0.81 (near perfect agreement) respectively which was low compared to the findings of Brillantino et al which were 0.93 & 0.97 for primary tract and internal opening respectively.[1] In other studies kappa coefficient for primary tract and internal opening ranged

from substantial agreement to perfect agreement.[3,10-12] The lowest k value for the primary fistula tract was k=0.318 (fair agreement) seen in a study done by Almeida et al and the transducer used by them was Olympus type RU 75M-R1.[13]

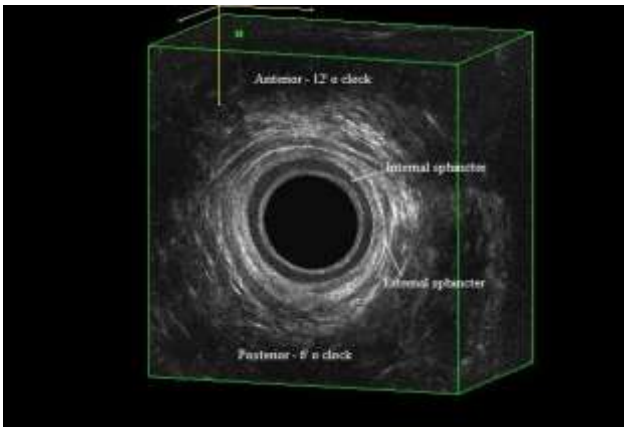

Figure 2: 3D Endoanal ultrasound scan image of a normal anal canal.

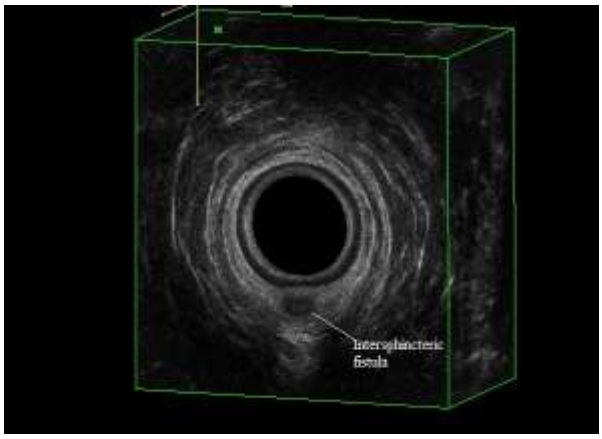

Figure 3: Unenhanced 3D Endoanal ultrasound scan image of posterior intersphincteric fistula.

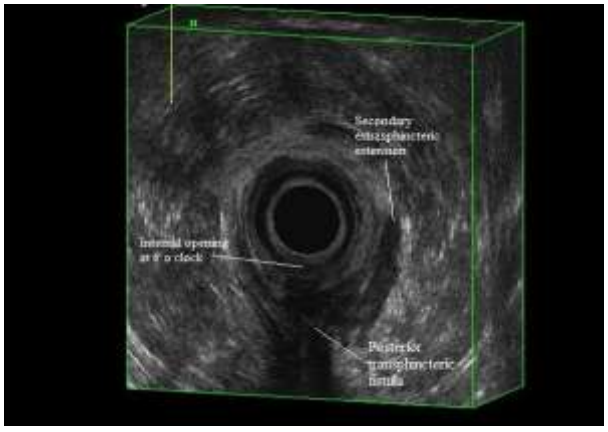

Figure 4: Unenhanced 3D Endoanal ultrasound scan image of posterior transphincteric fistula with an internal opening at 6' o clock and a secondary tract from 6' to 3' o clock.

A kappa value k=0.45, moderate agreement for the primary tract was seen in a study done by West et al who compared the 3D EAUS findings with endoanal MRI.[14] The overall sensitivity of 3D EAUS inferred by Brillantino et al for the primary fistula tract was above 98%.[1,3] This is high when compared to the current and other studies. The sensitivity for transphincteric and intersphincteric fistula tract ranged from 80-96% which was consistent with our study, 84.35%, and 87.1% respectively.[11,16] The sensitivity of 3D EAUS for internal opening overall ranged from 95-98% which was consistent with the sensitivity of posterior quadrant internal opening (96.21%) of our study.[1,3,11,12,16] The specificity of primary fistula tracts was 84.6% and 88.9% for intersphincteric and transphincteric tracts respectively in our study which was in the range of 83-96% seen in various studies.[1,3,12,16] In contrast to the low specificity for internal opening seen by Garcés-Albir et al and Li et al which was 66% and 61% respectively, our study's specificity for anterior and posterior quadrant internal openings was 95.86% and 94.31% respectively.[12,16] From (Table 3) we can observe that the Sensitivity, Specificity, PPV, NPV, and accuracy for intersphincteric and transphincteric fistula/abscess was more than 80% except for the PPV for intersphincteric fistula/abscess (76.42%). The Sensitivity, Specificity, PPV, NPV, and accuracy of 3D-EAUS for anterior and posterior quadrant internal openings were more than 90% except for the sensitivity of anterior quadrant internal openings (89.53%). In our study, based on the patient's history we have studied the possible factors affecting the correlation like gender, the gap between the 3D-EAUS scan and performing surgery, recurrent and fresh fistula, colorectal specialist vs other specialties, and medical comorbidities like diabetes mellitus and hypertension for both fistula tract/abscess and internal opening presented as odds ratio in (Table 4).

The only significant factors that affected the correlation in our study were colorectal specialists vs. other specialties and hypertension for fistula tract/abscess but not for internal openings. If the fistula surgery was performed by a non-colorectal specialist then the chance of correlation of 3D-EAUS findings to intraoperative findings was 3 times (odds ratio-3; 1.2-7.45, 95% CI, p=0.0177) higher than colorectal surgeons. This might be because the non-colorectal specialties have followed the 3D-EAUS reports before surgery whereas the colorectal specialties have their intraoperative findings irrespective of the 3D-EAUS reports. Surprisingly in our study, the odds of correlation for a normotensive patient is 2.33 times (odds ratio-2.33; 1.13-4.77, 95% CI, p=0.0373) higher than for a hypertensive patient which was difficult to explain. The mean duration between 3D EAUS and surgery was 10 days in our study and was recorded only in a few studies which was between 1-3 weeks ranging from 0-91 days.[2,11,14]

There was no significant difference in correlation with the increase in the time interval between the 3D-EAUS scan and surgery. 35.7% of our cases had a prior history

of fistula/abscess surgery and as inferred by Emile et al and West et al, there was no statistically significant difference in accuracy or sensitivity between fresh cases and recurrent cases which was also seen in our study.[11,14] 15% of transphincteric fistulas diagnosed intraoperatively were diagnosed as intersphincteric fistula in 3D-EAUS. Nearly 21% of the fistulas described as intersphincteric fistula by 3D EAUS were transphincteric on surgical evaluation. Most of these intersphincteric fistula in 3D EAUS were low transphincteric fistula during surgery. Nearly 10% of the fistulas diagnosed as intersphincteric during surgery were diagnosed as transphincteric fistulas on 3D EAUS. This shows that 3D EAUS relatively under-estimated transphincteric fistulas and over-estimated intersphincteric fistulas in our study which contradicts the findings of Brillantino et al, Nagendranth et al, and Almeida et al where there was overestimation of external sphincter involvement of the intersphincteric fistulas on 3D-EAUS.[1,10,13]

Limitations

Our study's limitation was its retrospective design and hence considered a diagnostic accuracy study rather than an outcome study similar to other retrospective studies.[11,13,14] Taking surgical findings of multiple surgeons and departments as the gold standard for reference without blinding was also a limitation. Our study results were based on the common practical scenario where a specialist colorectal surgeon or a radiologist does the 3D-EAUS scan and multiple surgeons with variable experience perform the necessary surgery after going through the 3D-EAUS scan reports.

CONCLUSION

From this study, we conclude that unenhanced 3D-EAUS is a good initial investigation for diagnosing fistula in ano and abscesses with high sensitivity, specificity, and accuracy. It has a substantial agreement for the fistula tract and an almost perfect agreement for identifying the internal opening. There is a significantly high chance of correlation for the fistula primary tract if a non-colorectal specialist performs the fistula surgery after 3D-EAUS without blinding. Hypertensive patients have significant odds of noncorrelation for the primary fistula tract for unknown reasons. Other factors like gender, interval between the scan and surgery, recurrent fistulas, and medical comorbidities do not have a significant effect on the correlation of either primary fistula tract or internal opening.

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