Anorectal malformations: Role of MRI in preoperative evaluation

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Abstract

Purpose: To evaluate the spectrum of magnetic resonance imaging (MRI) findings in pediatric patients with anorectal malformation (ARM) and compare the accuracy of MRI and distal cologram (DC) findings using surgery as reference standard. **Materials and Methods:** Thirty pediatric patients of age less than 14 years (19 boys and 11 girls) with ARM underwent preoperative MRI. MRI images were evaluated for the level of rectal pouch in relation to the pelvic floor, fistula, and development of sphincter muscle complex (SMC). Associated spinal and other anomalies in lumbar region and pelvis were also evaluated.DC was done in 26 patients who underwent colostomy. Ultrasound of abdomen and pelvis was also done for associated anomalies. **Results:** Overall accuracy of MRI and DC to detect the exact level of rectal pouch including cloacal malformation was 93.33% and 76.9% respectively. MRI and DC could correctly identify presence or absence of fistula in 76.6% and 76.9% cases respectively. MRI and DC correctly identified the anatomy of fistula in 76% and 65% cases respectively. On MRI, correlation of development of levator ani and puborectalis with the level of rectal pouch as found on surgery was significant ($P = 0.008$; 0.024 respectively). Subjective assessment of sphincter muscle development on MRI correlated well with the surgical assessment [$P = 0.019$ and 0.016 for puborectalis and external anal sphincter (EAS) respectively]. Lumbosacral spine anomalies were present in 33.3% of patients and were most common in high type of ARM. Vesicoureteric reflux and renal agenesis were the most common renal and urinary tract anomalies and were present in 40% of cases. **Conclusion:** MRI allows reliable preoperative evaluation of ARM and should be considered as a complementary imaging modality for preoperative imaging in ARM.

Key words: Anorectal malformation; distal cologram; MRI

Introduction

Anorectal malformations (ARM) comprise a wide spectrum of diseases, which can involve the distal anus and rectum as well as the urinary and genital tracts. Incidence is approximately 1:5,000 live births with a slight male predominance.[1] ARM since long has been classified by the Wingspread classification of 1984 based on puborectalis (PR) sling. More recent Krickenbeck classification, which is based mainly on the presence or absence of fistulas, their type and location, as well as the position of the rectal pouch is widely accepted today.[2,3]

ARM is commonly associated with other developmental anomalies. Most common association is with genitourinary system, while vertebral, spinal, skeletal, cardiovascular, and gastrointestinal anomalies as well as syndromic associations are also observed. This is important because the overall prognosis and the quality of life is guided by the severity of the associated anomaly.Once the diagnosis

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of the specific defect is established, the functional prognosis can be rapidly predicted, which is vital to avoid raising false expectations in the parents. Factors such as the status of the spine, sacrum, and perineal musculature influence the prognosis. Patients with a hypo-developed sacrum and sphincter muscle complex (SMC) are much more likely to be incontinent.

The most commonly used operative procedures for treatment of ARMs are posterior sagittal anorectoplasty (PSARP) and laparoscopicor laparotomic anorectoplasty (LAARP). These operative procedures require specific anatomical information for which clinical examination is not enough. Imaging plays a key role in establishing and evaluating the real position of the rectal pouch; the presence or absence of rectourogenital fistulas and their location; the grade of development of SMC.

Accurate assessment of ARM has long been considered difficult. Invertography was the earliest imaging technique used but its estimation of rectal pouch is highly inaccurate.[4] Ultrasonography (US) is a good diagnostic modality for imaging pelvic structures, distal rectal pouch, and internal fistulas but does not show the SMC directly. It has been advocated as a screening method for associated spinal and genitourinary anomalies.[3] Limited studies have been done on infracoccygealtransperineal US but its role is still not established.[5] Voiding cystourethrography (VCUG) has also been used in patients with urinary tract abnormalities at US or clinical suspicion of rectourinary fistulas (meconium in urine) and identification of vesicoureteric reflux (VUR).High-pressure distal colostography is currently considered the most efficient imaging technique for demonstrating level of rectal pouch and fistulas; however, no information regarding development of muscles of continence and associated anomalies can be obtained.[6] Computed tomography (CT) allows direct visualization of SMC but is poor in soft tissue characterization. High dose of ionizing radiation limits its use in children.

Few studies have been done to evaluate ARM with magnetic resonance imaging (MRI) but MRI has no defined status in the imaging protocol of ARM. Recent advances in MRI technology allow fast and high-resolution imaging and visualization of small pediatric pelvic structures in good detail. An attempt should be made to reassess its role in evaluation of the level of rectal pouch and type of ARM, fistulas, SMC development, and the possibility to determine associated anomalies, especially of spinal cord, spine and the urogenital system in a single examination.

The present study was attempted to further clarify the utility of MRI in ARM and its role in imaging protocol.

Materials and Methods

A cross-sectional observational study was conducted after approval of institutional review board and ethics committee. Informed consent was obtained from the parents. Study was done for a period of 1.5 years from October 2013 to March 2015. Thirty pediatric patients of age less than 14 years (19 boys and 11 girls) with suspected ARM on clinical evaluation underwent MRI. Patients who had been previously undergone reparative surgery for ARM or had any contraindications to MRI or sedation were excluded. Distal cologram (DC) was done in 26/30 patients who underwent colostomy. Colostomy was not done in four female patients with anovestibular fistula with no colonic outflow obstruction. US was done for urogenital anomalies in all the 30 patients. MRI interpretation was done prior to DC to prevent any bias.

Magnetic resonance imaging scanning method and parameters

MRI was done with a 1.5-T magnet (PhilipsAchieva). The patients were placed in a supine position with the pelvis positioned within the phased array body coil. The patients were administered adequate sedation. No contrast instillation was done through the perineal orifices. Multiplanar T1-weighted and T2-weighted images were obtained in all patients [Table 1]. Fat suppression was used in young infants with thin fat planes where routine T2-weighted images were not sufficient.

The imaging protocol was modified in view of patient's individual requirements wherever needed. Approximate scan time was 8–10 min.

Image interpretation

Images were evaluated for: (1) level of rectal pouch in relation to pelvic floor (2) presence or absence and type of fistula (3) subjective developmental state of SMC and

Table 1: Magnetic resonance imaging (MRI) protocol

Sequence	Slice width (mm)	TR/TE (ms)	Flip angle (°)	FOV (mm)	Imaging plane	Anatomical region
T2W TSE	3	4500/120	90	300	Coronal	Pelvis, spine (from D10), kidneys
T2W TSE	3	4500/125	90	150	Sagittal	Pelvis , lumbosacral spine
T2W TSE	3	4500/120	90	200	Axial	Pelvis, lumbosacral spine
T1W TSE	3	760/15	90	200	Axial	Pelvis, lumbosacral spine
T2WTSE SPAIR*	4	2500/70	90	150	Sagittal	Pelvis , lumbosacral spine

*Fat suppression was done wherever T2W images were not adequate, mostly in young infants, TSE: Turbo spin echo, FOV: Field of view, TR: Repetition time, TE: Echo time levator ani (4) length and width of PR muscle (5) length and width of external anal sphincter (EAS) (6) lumbosacral spine and spinal cord anomalies (7) renal and urinary tract anomalies (8) genital tract anomalies. T2-weighted images in both axial and sagittal planes were used in correlation for detection of fistula. The distinction between bowel and fistula was made according to presence or absence of layered bowel wall respectively. Normal bowel was identified by the T2 hyperintense mucosa, while the wall of fistula was homogenous with no central hyperintense mucosa [Figure. 1]. The development of levator ani, PR, and EAS were assessed subjectively as good, fair, and poor. A well-developed levator ani was seen clearly as a sling-like structure on coronal images supporting the rectal ampulla. PR muscle was seen as a triangular muscular structure on axial images surrounding the rectum with apex posteriorly. EAS was seen as a posterior curved band like structure on sagittal images, with fibers extending in parasagittal images and as an oval structure symmetrically surrounding rectum/anal canal on axial images. Deviation from the normal well-defined appearance was evaluated as "fair" and when the muscle fibers were poorly visualized, they were graded as "poor."Thickness and length of the PR and EAS were also objectively measured and following indices were calculated.Pubococcygeal (PC) distance was distance from inferior border of pubic symphysis to sacrococcygeal joint. "I" distance was half of the distance between the inner border of ischial tuberosities. Total width of PR and EAS was considered the sum of both left and right muscle width of rectum or anal canal. Both were measured along 3 o'clock and 9 o'clock at mid-level of anal canal.

Relative width of PR (RWPR) = (Total width of PR)/(half of "I" distance).

Relative length of PR (RLPR) =(Length of PR)/(PC distance).

Relative width of EAS (RWEAS) = (Total width of EAS)/(half of "I" distance).

Relative length of EAS (RLEAS) = (Length of EAS)/(PC distance).

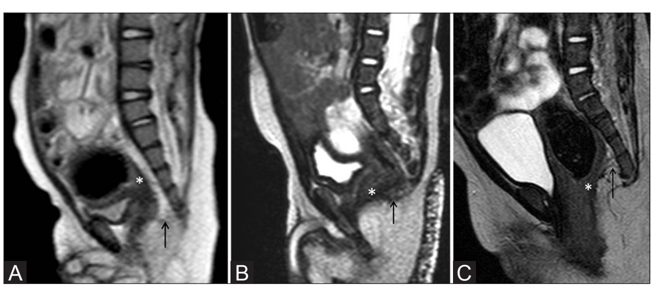

Figure 1 (A-C): Level of rectal pouch (*) as identified by hyperintense mucosa lying above, at or below pelvic floor (arrow) on T2-weighted sagittal image. (A) High type. (B) Intermediate type. (C) Low type. Also note that rectum is opening into the vestibule in (C) (rectovestibular fistula)

The MRI findings were correlated with the preoperative observations. At surgery, the level of rectal pouch in relation to the pelvic floor was ascertained. Anatomy of any fistula present was noted as per Krickenbeck classification. The development of SMC was graded according to subjective assessment of muscle thickness by the pediatric surgeon preoperatively as good, fair, or poor.

Statistical analysis

The sensitivity, specificity, and accuracy of MRI in defining the level of rectal pouch, fistula detection, and development of SMC were calculated. The sensitivity, specificity, and accuracy of DC in defining the level of rectal pouch and fistula detection were also obtained. Chi-square test was used to calculate the significance of MRI findings.

Results

There were 19 male and 11 female patients. Most of the patients (27/30) underwent MRI at <3 years of age. Age distribution was <6months (N = 16), 6 months to 3 years (N = 11), 3–7 years (N = 1) and 7–14 years (N = 2).There were 18/19 males with no anal opening and 1/19 male with ectopic anus with rectal atresia.Four perineal openings were present in a female with H-type fistula.

Surgery confirmed that among 19 males, level of rectal pouch was above, at and below the pelvic floor in nine, four, and six patients respectively. Among 11 females, level of rectal pouch was above, at and below the pelvic floor in one, zero, and eight patients respectively, while two were cloaca.The results of MRI and DC with respect to level of rectal pouch are summarized in Table 2. Overall accuracy of MRI and DC to detect the exact level of rectal pouch including cloacal malformation was 93.33% and 76.9% respectively. DC could not define the level of rectal pouch in two patients due to lack of bony landmarks consequent to anomalies like pubic diastasis and partial sacral agenesis. Other causes of inaccuracy were over distension or under distension of rectal pouch. MRI misinterpreted the level in two patients due to inadequate visualization of bowel mucosa and poor image quality.

On surgery, 21 (70.00%) cases had fistula including 10 males and 11 females. Fistula was absent in nine patients; all

Table 2: Level of rectal pouch in relation to pelvic floor as assessed on surgery

Level of rectal pouch	Surgery	Correctly diagnosed on MRI	Correctly diagnosed on DC
Above pelvic floor	9	8	8
At pelvic floor	5	5	3
Below pelvic floor	14	13	7 (out of 10)
Cloaca	2	2	2
Total	30	28	20

MRI: Magnetic resonance imaging, DC: Distal cologram male, with imperforate anus. The results of MRI and DC in detecting presence or absence of a fistula are given in Table 3. MRI and DC could correctly identify presence or absence of fistula in 76.6% and 76.9% cases respectively. The sensitivity and specificity of MRI and DC in detecting presence of fistula were 76.19%and 77.78% and 70.59% and 88.89% respectively.

Type of fistula was categorized as per Krickenbeck classification [Figures 2–5]. The accuracy of MRI and DC in correct diagnosis of anatomical type of fistula was calculated as given in Table 4. MRI and DC correctly identified the anatomy of fistula in 76% and 65% cases respectively. DC was more specific than MRI in detecting presence of fistula but less accurate in anatomical characterization [Figures 6–8].

Lumbosacral spine anomaly was present in 9/30 (33.3%) patients, and included partial sacral agenesis (*N* = 5), block vertebra (*N* = 3), hemivertebra (*N* = 1). Spinal cord anomalies were seen in two patients including lipomyelomeningocele with tethered cord and presacral lipoma in one patient [Figure 9] and filar lipoma with tethered cord in another.It was found that 50% of spinal anomalies were present in high type, 33.33% in intermediate type and 16% in low type. Renal and urinary tract anomalies were present in 12 patients (40% of cases) [Figure 10A and B]. The most common anomaly was vesicoureteral reflux (VUR) 6/30 (20%) followed by renal agenesis 5/30 (16.67%). Others were hydronephrosis (*N* = 3), atrophic kidney (*N* = 2), and horseshoe kidney (*N* = 1). Renal and urinary tract anomalies were most common in high type of ARM (88.9% of anomalies), followed by intermediate (40%) andlow type (7%). Genital anomaly was present in 3/30 (10%) patients, including both cloacal anomalies. One of the cloacal anomalies had associated hydrocolpos and other had bicornuate uterus. Hydrocolpos was also present in another patient of low type of ARM.

The development of levator ani and PR were assessed subjectively on MRI as good, fair, and poor and compared with the level of ARM as found on surgery.It was found that

Table 3: Presence of fistula as assessed in surgery

Fistula	Surgery	Correctly detected on MRI	Correctly detected on DC
Present	21	16	12
Absent	9	7	8
Total	30	23	20

MRI: Magnetic resonance imaging, DC: Distal cologram

Table 4: Fistula characterization as per Krickenbeck classification on surgery and number of correct diagnosis on magnetic resonance imaging and distal cologram

Krickenbeck classification	Surgery	MRI	DC
Rectoperineal	1	1	-
Bulbar recto-urethral	2	2	1
Prostatic recto-urethral	6	4	3
Bladder neck fistula	4	2	2
Vestibular fistula	4	3	1
Cloacal malformation	2	2	0
No fistula	9	7	9
H-type	1	1	0
Rectovaginal	1	1	1
Anal stenosis	0	0	0
Total	30	23/30 (76%)	17/26 (65%)

MRI: Magnetic resonance imaging, DC: Distal cologram

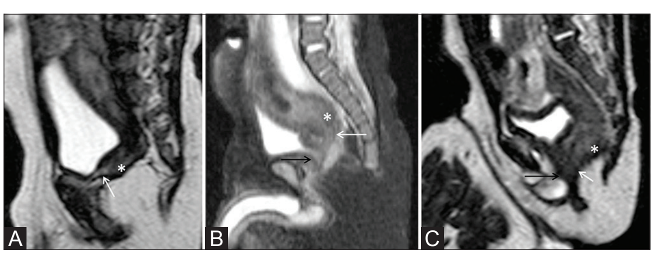

Figure 2: Fistula (white arrow) with urinary tract (black arrow) can be distinguished from the rectum (*) by absence of T2 hyperintense mucosa. (A) Bladder neck fistula. (B) Prostatic rectourethral. (C) Bulbar rectourethral

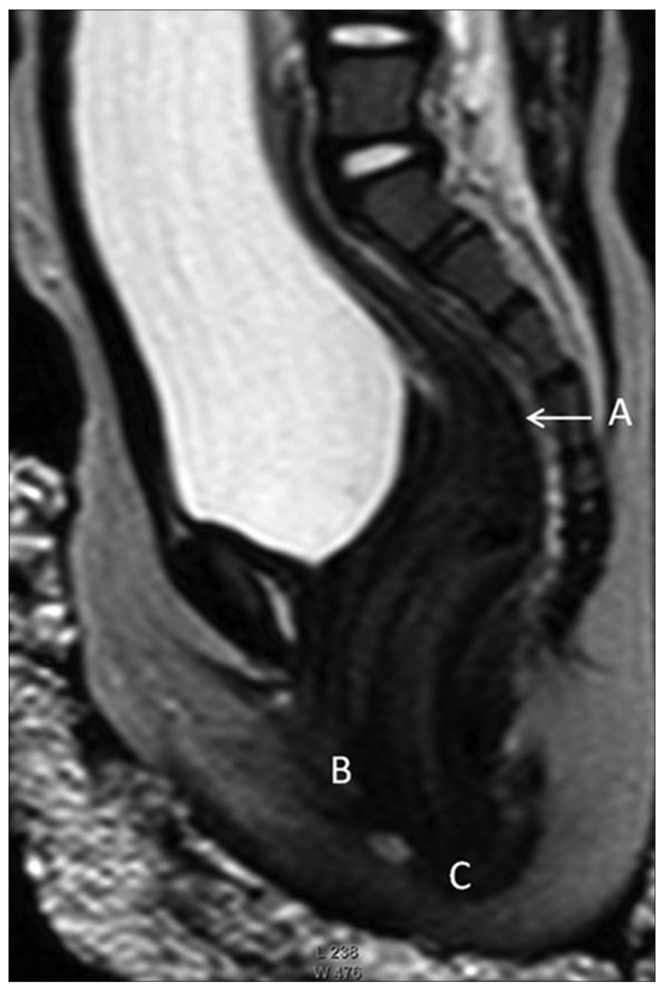

Figure 3: H-type fistula is seen extending from the rectum at point A to the vestibule at point B. Anal opening is located at point C

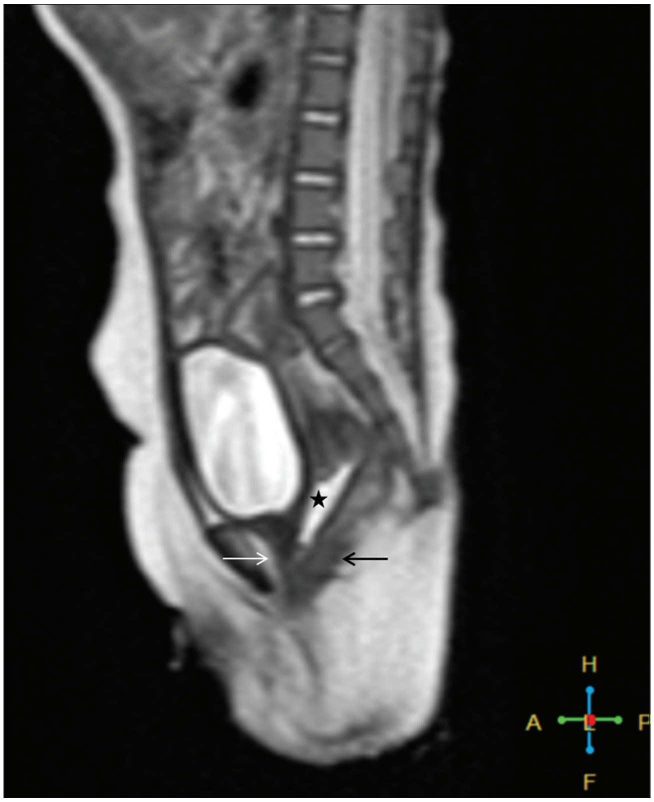

Figure 4: Cloacal anomaly. The urethra (white arrow), vagina with hydrocolpos (*) and rectum (black arrow) are seen to open into a short common channel

Figure 5: Blind ending rectal pouch (*) with no fistula is seen having a clear fat interface with the urinary tract (white arrow) and atretic anal canal (black arrow)

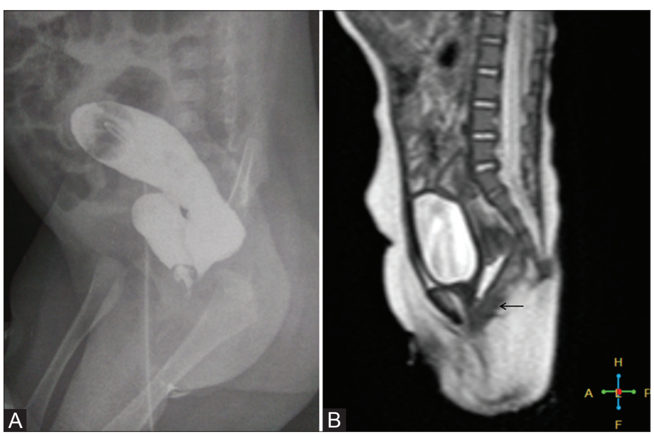

Figure 6 (A and B): 2-month-old female with single perineal opening at birth. (A) Distal cologram (DC) shows rectovaginal fistula. (B) T2-weighted sagittal MRI image shows convergence of rectal pouch, vagina and urethra (arrow), clearly depicting cloacal anatomy

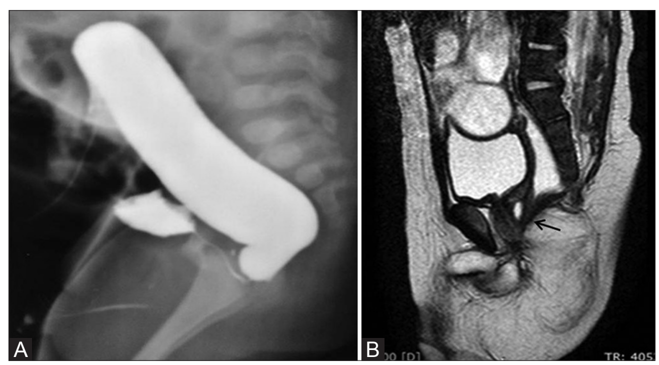

Figure 7 (A and B): 18-month-old male child. (A) Distal cologram (DC) shows high rectourethral fistula. (B) T-weighted sagittal MRI image clearly depicting anatomy as hypointense fistulous tract (arrow) leading from the rectal pouch to the lower prostatic part of urethra

higher the ARM, poorer the levator ani and PR development as seen on MRI. The association was statistically significant with *P*-value of 0.008 and 0.023 respectively. A correlation was made between appearances of levator ani, PR, and EAS on MRI [Figure 11 A and B] and overall assessment of SMC on surgery subjectively as good, fair, and poor. The correlation was found to be significant for each with *P*-values of 0.003, 0.019, and 0.016 respectively [Table 5]. Therefore, MRI can accurately predict development of SMC in ARM.

MRI was also used to determine the development of PR and EAS using objective indices. Relative width of PR and EAS were compared with the development of SMC on surgery and the results were not statistically significant ($P = 0.3394$; 0.1297 respectively).

Discussion

The study was done to evaluate pediatric patients of ARM with MRI. There was male preponderance; M:F ratio being

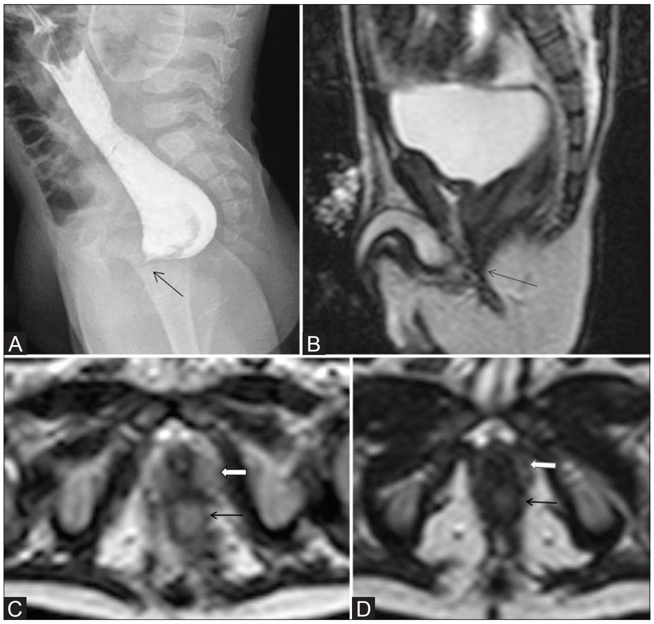

Figure 8 (A-D): 10-month-old child. (A) Distal cologram (DC) shows anterior beaking (arrow) in the rectal pouch suspicious of fistula, although no further opacification was achieved due to reflux from the colostomy site. (B) T2-weighted MRI image shows hypointense tract (arrow) from the rectal pouch to the urethra. (C) Axial T2-weighted image shows the rectal pouch (black arrow) close to the prostate (white arrow). Note the central hyperintense mucosa allowing differentiation from fistula. (D) Axial image caudal to it leaves no doubt to the anatomy as the hypointense fistula (black arrow), lacking a central bright mucosa as seen in the rectal pouch, is directly visualised entering the prostatic parenchyma (white arrow) to join the prostatic urethra

Table 5: Comparative study of subjective assessment of muscle development on magnetic resonance imaging with the sphincter muscle complex assessment on surgery

MRI appearance	SMC as assessed on surgery			Total	*P*
	Poor	Fair	Good		
Levator ani					
Poor	4	3	0	7	0.003
Fair	4	3	2	9	
Good	1	2	11	14	
PR					
Poor	5	5	0	10	0.019
Fair	4	2	4	10	
Good	0	1	9	10	
EAS					
Poor	6	4	1	11	0.016
Fair	3	4	7	14	
Good	0	0	5	5	
Total	9	8	13	30	

EAS: External anal sphincter

1.72:1 (19/11 patients), which is in concordance with the incidence data in literature.[3]

The most common presenting complaint was nonpassage of meconium at birth (63.33%), and was seen in 94.73% of males. Second most common complaint was leakage of feces in urine. In females, the presenting complaint was much more variable.

Figure 9: Currarino's triad comprising anorectal malformation, partial sacral agenesis with presacral mass (*). Spinal cord is tethered (black arrow) to the presacral lipoma

This study revealed high type ARM as the most common type in males which is in concordance with previous literature.[3,7] Most commonly seen ARM variant in females was low type (72.72%). This is consistent with the study by Hashmi MA *et al*.[8] where analysis of 130 female patients of ARM over 10 years revealed a prevalence of low type lesions in 72% patients.

DC was done in 26 out of 30 cases because four patients were passing feces through the ectopic anal/vestibular/normal opening and in them colostomy was not done. The overall accuracy of DC in determining level of rectal pouch was 76.9%.

Overall accuracy of MRI in determining the level of rectal pouch was 93.33%. It is similar to one of the studies by Nievelstein *et al*.[9] in year 2002, where MRI could correctly depict the levels in 96% cases. The accuracy of DC in determining level of ARM is limited byim proper distension and difficult visualization of bony landmarks in patients with lumbosacral anomalies and scoliosis. On the other hand, the rectal wall and mucosa as well as pelvic floor is directly visualized on MRI and hence, the assessment of rectal pouch level is more accurate.

Rectovestibular fistula was the most common fistula in females and rectourethral was most common in males. Hashmi *et al*.[8] and Peña[7] also report the same.

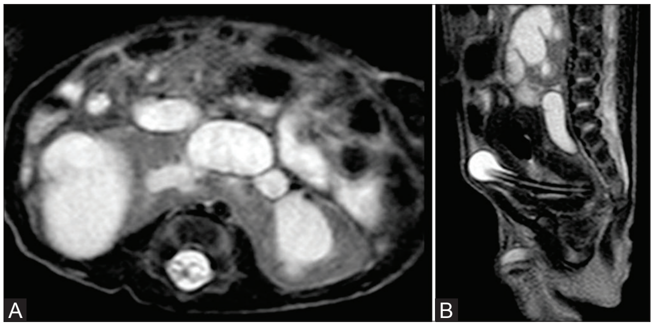

Figure 10 (A and B): Complex urinary anomaly. (A) Horseshoe kidney is seen with hydroureteronephrosis. (B) Large thick walled neurogenic bladder with Foley's catheter in situ is seen in the sagittal image

In the present study, it was found that fistula was present in 70% of cases. Nievelstein *et al.*[10] in year 2002 observed fistula on MRI in 62.5% patients. The present study reveals that MRI is 76.19% sensitive and 77.78% specific in fistula detection. MRI and DC correctly identified the fistula anatomy in 76% and 65% cases respectively. Similar results were reported by Thomeer *et al.*[11] in year 2015 found that MRI and DC could correctly predict anatomy of fistula in 88% and 61% cases respectively.

The present study shows that MRI is more sensitive but less specific in fistula detection when compared with DC. This may be attributed to the fact that in DC, contrast is instilled with an augmented pressure to identify a fistula which increases the specificity of this investigation in detecting fistulas. However, the anatomical type of fistula is more accurately depicted by MRI than DC due to direct visualization of pelvic structures.

Lumbosacral spine and spinal cord anomalies have been reported in 41% to 60% of cases with ARM on MRI.[5,7,10,12,13] In the present study, frequency of associated lumbosacral spine anomalies were 33.33% and majority of them were present in high type (50%). Genitourinary anomalies were commonly associated, most frequent being VUR followed by renal agenesis. Previous literature also showed similar results.[13-18]

Development of SMC plays important role in restoration of the bowel function after surgical correction of ARM. Few studies have been done to assess the PR and EAS on MRI. The developmental state of SMC has been positively correlated in different types of ARM.[19,20] Patients with low anomaly are expected to have good development of skeletal muscle mass.

In our study, the subjective appearance of levator ani, PR, and EAS on MRI relative to the SMC assessment on surgery were statistically significant ($P < 0.05$). Objective measurement of the SMC on MRI was however, not found to correlate well with the preoperative assessment. The diagnostic criteria for the poor developmental state of muscles were defined by Shah *et al.*[19] as RWPR <0.18 and RWEAS <0.15. In the present study, these cut-off values

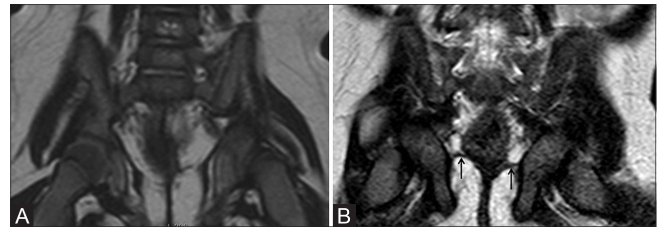

Figure 11 (A and B): Muscle development. (A) Levator ani is graded as poor development on subjective assessment. (B) Levator ani is graded as good development on subjective assessment

were not found to be significant with *P*-values of 0.339 and 0.129 respectively [Table 6].

The refinements in surgical management of ARM call for a more precise preoperative local anatomical evaluation.[11,21] The benefits over single stage over staged repair have long been advocated as better continence and easier dissection in neonate due to virgin anatomical planes. The poor social acceptance of colostomy is also an issue.The hazards of single stage repair are mainly due to intraoperative injury to urinary tract because of lack of anatomical knowledge otherwise provided by DC.[22] MRI has the potential to circumvent this problem in a noninvasive manner and equip the surgeon for a single stage repair.

Postoperatively, MRI can play a role in the evaluation of patients with persistent fecal incontinence. MRI is undoubtedly the optimal imaging modality for assessing these patients who are underconsideration for reoperation. Axial images are generally best for assessing thesiting of the pulled-through rectum and also for evaluating the puborectalis and EAS.[23] Anterior misplacement of the neorectum in the externalanal sphincter, and lateral misplacement of the neorectum in the puborectalis muscle, are the most common errors observed.[24]

Many technical innovations have been used in the recent past to extract more information from MRI. Jarboe *et al.* in 2012 reported a Combined 3D rotational fluoroscopic-MRI cloacagram procedure by instilling contrast through catheters placed into mucous fistula, cloacal channel, bladder, vagina, rectum in complex pelvic malformations.[25] Recent studies have successfully attempted 3D MRI reconstruction, 3D MRI genitography, and MRI-guided LAARP.[21]

There were many limitations in our study. There was limited number of participants. We did not perform gadolinium contrast installation through the colostomy or fistula site for the MRI. We did not follow-up these patients after surgery and did not study the difference in postoperative outcome of these patients with those in which MRI was not done. A study with greater number of participants with long-term follow-up of postoperative outcome would better validate the role of MRI in these patients.

Table 6: Range of the relative values for muscle development

	RLPR	RWPR	RLEAS	RWEAS
Poor	0-0.4	0-0.13	0	0-0.29
Fair	0.49-0.55	0-0.37	0-0.27	0.16-0.21
Good	0.31-0.63	0-0.48	0.31-0.56	0.17-0.32

RLPR: Relative length of puborectalis, RWPR: Relative width of puborectalis, RLEAS: Relative length of external anal sphincter, RWEAS: Relative width of external anal sphincter

Conclusion

The preoperative imaging evaluation of ARM presently involves DC, fistulogram, voiding cystourethrogram, ultrasound of the kidneys or bladder and spine, and MR imaging of the spine with DC being the current gold standard for precise anatomy of distal rectum. The present study has shown that MRI provides accurate answers for most of the preoperative questions and scores over DC at many fronts. MRI can accurately evaluate the level of rectal pouch by direct identification of pelvic floor and also the rectum by its hyperintense mucosa, thereby eliminating indirect assessment on DC by hypothetical radiographic lines. Pelvic musculature including LA, PR, and EAS can be directly assessed. Fistula can also be directly visualized without the limitations of variation in pressure by rectal distension. There is added advantage of simultaneous depiction of associated spinal and genitourinary anomalies. MRI can accurately evaluate multiple facets of the clinical problem in a single investigation. With advances in MRI technology and newer innovations in MRI technique, it is expected to assume a more important role in the preoperative evaluation of ARM.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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