

**Role of MRI in Preoperative and Postoperative Evaluation of Anorectal Malformation**

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**Abstract:**

**Background:** Anorectal malformations (ARMs) are among the most common congenital defects seen in pediatric surgery, with an estimated incidence of 1 in 2000 to 1 in 5000 live births. Identification of malformation type and level is essential for the postnatal care of children with ARM.

**Objectives:** To assess the role of MRI in preoperative and postoperative evaluation of anorectal malformation.

**Patients and methods:** This cross-sectional study was performed in the diagnostic radiology department at Qena University Hospital. It was performed on 30 cases of anorectal malformation patients; and all of them were subjected to MRI for preoperative or postoperative evaluation.

**Results:** A total of 30 anorectal malformation patients were included in this study, 19 patients presented by anterior ectopic anus(63.3%) and 11 patients presented by imperforated anus (36.7%). The study detected anatomical malformation pre-operative and detected degree of correction of this malformation and the postoperative complication.

**Conclusion:** MRI provided elaborate anatomical details which were well correlated with the operative findings. MRI is the single imaging modality which can answer all these aspects of ARM accurately in a single sitting and without use of any ionizing radiation to child.

**Keywords:** Magnetic resonance imaging (MRI); Anorectal malformation; Preoperative; Postoperative.

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## Introduction

Boys and girls can develop anorectal malformations, a broad range of illnesses that affect the distal rectum and anus in addition to the urinary and genital tracts. Incidence is about 1:5,000 live births. Defects can range in severity from very minor and easily managed with an excellent functional prognosis to complex, challenging to manage, frequently associated with other anomalies, and poor functional prognosis (Levitt and Peña, 2007).

ARM has been classified by Krickbeck's 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. This classification is widely accepted today (Alamo et al., 2013). Accurately identifying the level and type of malformation as well as the existence and kind of fistula is essential for the postnatal care of children with ARM. A primary perineal anoplasty may occasionally be performed on patients who have an imperforate anus with a rectoperineal or recto-vestibular fistula. A diverting colostomy is performed within the first few days of life for most other malformation types. This is followed by definitive surgical repair (posterior sagittal anorectoplasty [PSARP]) with or without laparoscopy depending on the height of the rectum) later in infancy (Lawal, 2019).

Recently, laparoscopically assisted anorectal pull-through (LAARP) has completely replaced posterior sagittal anorectoplasty procedure in some countries. It is a safe approach for high ARMs with good continence and correctable side effects (Gurusamy et al., 2017).

Fetal MRI has a great role for ARM patients; it helps in providing enough parental information and vest proper postnatal and antenatal management. With the development of quicker imaging sequences and more sophisticated imaging methods, MRI is being used more frequently to assist in the planning of definitive surgical correction. MRI is increasingly used to help ARM patients assess postoperative complications after the initial corrective surgery (Podberesky et al., 2013).

The aim of the current work is to evaluate the role of MRI in assessment of anorectal malformation preoperative and postoperative.

## Patients and Methods

A cross-sectional study was done to assess the MRI role in anorectal malformation among patients attending diagnostic radiology department at Qena University Hospital. The patients were selected by simple random sample. The following formula was

used to determine suitable sample size: 
$$\frac{z^2 xp(1-p)}{1 + \left(\frac{z^2 xp(1-p)}{e^2 N}\right)}$$

N= population size, Z= Z-score, e=margin of error, p=standard of deviation. The level of confidence is 95%. The estimated sample size was 30. About 30 cases of anorectal malformation patients presented to general surgery outpatient clinic (pediatric unit) and referred to diagnostic radiology department.

The study was accepted by the ethical committee of the Qena Faculty of Medicine. Ethical Approval code: (SVU-MED-RAD028-1-22-2-334)

**Inclusion criteria:** Patients With anorectal Malformation at any age group and accepted to participate in the study.

**Exclusion criteria:** Patients with any contraindications to MRI as: those with pacemakers or cochlear implant.

## Data collection

Data were collected during April 2022 to October 2023. All participants subjected to the following:

1-Full history taking (personal history and surgical history)

2-Imaging: Magnetic Resonance Imaging (MRI).

## MRI examination protocol: Sequences: -

•Thin cuts  $\leq$  4mm.

•**T1 weighted (T1W):** multiplaner- **Sagittal T2 weighted (T2 W)** used to understand the axis of anus. In mid sagittal T32 W, the anorectal angle is measured.

•**Coronal T2 weighted (T2 W)** is necessary to verify findings on the axial images and to assist in ascertaining the location of the bowel in relation to the muscles.

•**Axial T2 weighted (T2W)** may be helpful for differentiating associated anomalies of the lower genitourinary tract.

•**Coronal oblique T2 Weighted:** it is an optional sequence, used when further clarification of the sphincter–bowel relation is necessary.

•**Coronal STIR:** used in young infants with thin fat planes where routine T2-weighted images were not sufficient and evaluate fluid collection or inflammation in surgical bed.

**Technique:** After preparation of the patients by liquid diet 12 hours prior to scan and enema on morning of scan, the patients take the sedation and lie on MRI table in supine position, adjust the device and start examination the optional sequence is the coronal oblique T2 angulated in line with the anal canal when further clarification of the sphincter–bowel relation is necessary.

**Use MRI to analyze four parameters**

1) striated muscle complex sphincter thickness symmetry or asymmetry.

2) the outlines and regularity of the sphincter to rule out perirectal fibrosis.

3) Position of pull through rectum whether in central or midline as regard to pelvic floor.

4) presence or absence of mega rectum.

The analysis of these structures is done at the level of ischial ramus and level midway between pubococcygeal line and ischial ramus line.

**Statistical analysis**

Data were collected, coded, revised, and entered the Statistical Package for Social Science (IBM SPSS) version 26. Qualitative data were presented as numbers and percentages. Quantitative data were presented as means  $\pm$  standard deviation, median, and range. P value < 0.05 was significant.

**Results**

A total of 30 anorectal malformation patients were included in this cross-sectional study. The patient underwent evaluation by MRI at radiology department pre-operative and post operative. The demographic features of the patients and pre-operative MRI finding were represented in (Table.1). The postoperative MRI findings of the cases were demonstrated in (Table.2).

Regarding the age, the range from 3 days to 10 years. Most of cases were females (80%) and male represent about (20%). Regarding types of anorectal malformation, most of cases of low type (90%). Regarding pre-operative MRI finding, most cases of imperforate anus were low type (rectal pouch below PC line). Most of cases of imperforate anus showed dilated rectal pouch, and all cases of anterior ectopic anus showed obtuse anorectal angle (n=19) (63%), (Table.1).

Regarding post operative of MRI finding, half of cases showed poor developed sphincter and most of the cases had obtuse anorectal angle (73.3%) which indicate under correction, and about (76.7%) of cases showed para central position of pulled through bowel. Regarding post operative complication, 63.3% of cases presented postoperative by stool incontinence, (Table.2).

Regarding associated anomalies, spinal anomalies recorded in 2 cases in form of tethered cord, renal anomalies (ectopic kidney) recorded at 1 case and agenesis of distal vagina recorded at 1 case, (Table.1).

**Table 1. Patient demographic and pre-operative MRI finding**

Parameters		Number	Percentage %
<b>Gender</b>	Male	6	20%
	Female	24	80%
<b>Age (years)</b>	<b>Mean <math>\pm</math>SD</b>	4.1782 $\pm$ 3.217	
	<b>Median (range)</b>	4.250 (0.0082 (3 days-10years))	
<b>anorectal malformation type</b>	Low	27	90%
	High	3	10%
<b>Anorectal angle (n=19)</b>	Obtuse angle	19	63.3%
<b>Rectal pouch location (n=11)</b>	Above the Pubococcygeal line	2	18.2%
	Below the Pubococcygeal line	9	81.8%
<b>Rectal pouch caliber (n=11)</b>	Average	1	9%
	Dilated	10	91%
<b>Associated</b>	Non	24	80.0%

<b>anomalies</b>	Ectopic kidney	1	3.3%
	Hydronephrosis	1	3.3%
	distal vagina agenesis	1	3.3%
	Tethered cord	2	6.7%
	VSD	1	3.3%

(Table.1) showed that, among the studied patients, 90% had a low ARM type, 10% had a high type. Among the 19 cases with ectopic anus measures 100% had an increased angle. Among the participants, 20% had associated anomalies.

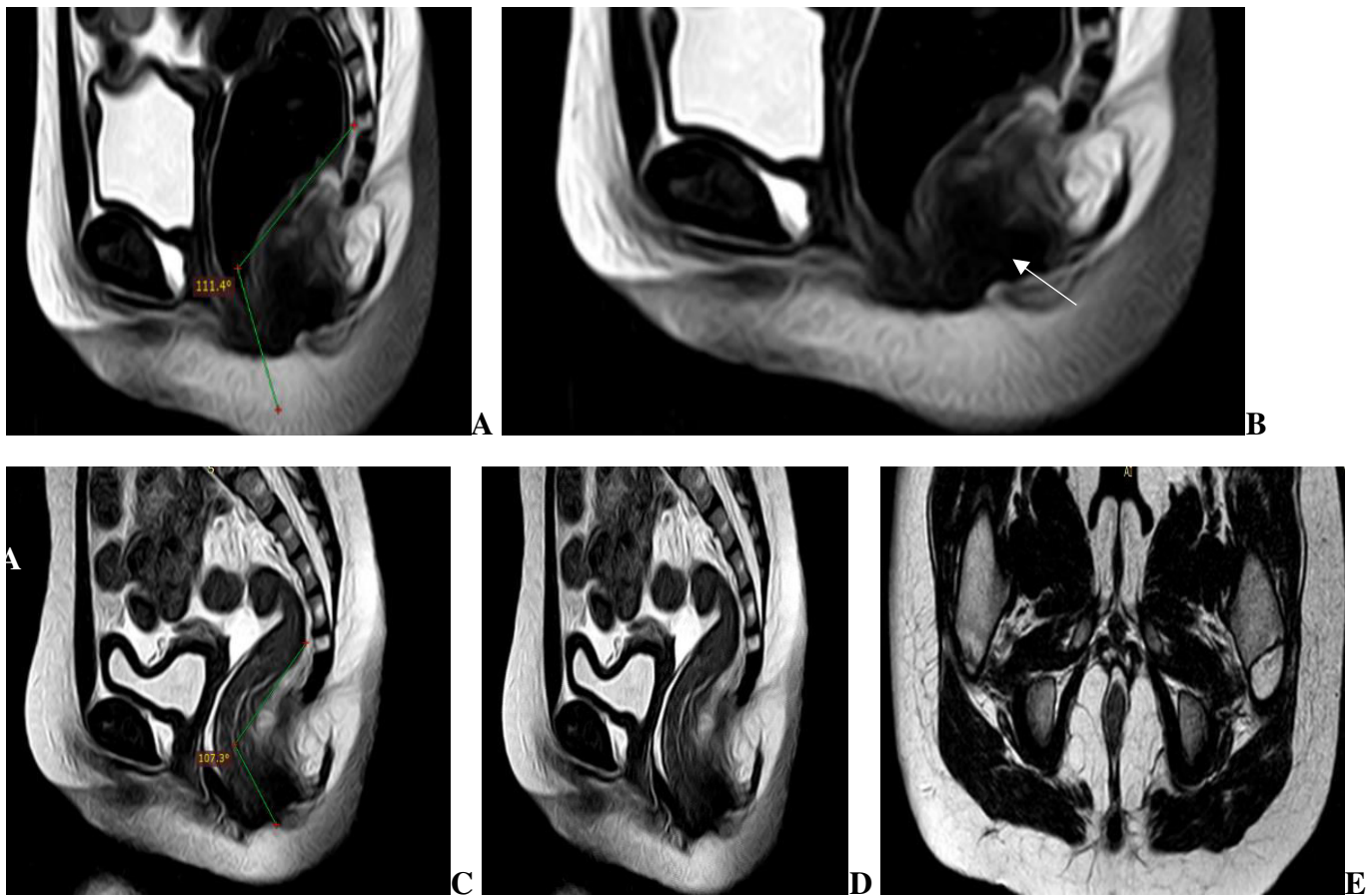
**Table 2. Postoperative MRI findings among anorectal malformation patients(n=30)**

<b>Parameters</b>		<b>Number</b>	<b>Percentage %</b>
<b>Post-operative complications</b>	Stool incontinence	19	63.3%
	Constipation	1	3.3%
<b>External anal sphincter thickness</b>	Asymmetric Thin	15	50 %
	Symmetric average thickness	7	23.3%
	Asymmetric, average thickness	8	26.7%
<b>Position of pulled bowel</b>	Central	7	23.3%
	Para-central	23	76.7%
<b>Diameter of neorectum</b>	Average diameter	9	30%
	dilated	20	66.7%
	Collapsed	1	3.3%
<b>Mesenteric fat around pulled bowel</b>	Yes	2	6.7%
	No	28	93.3%
<b>Sphincter development</b>	Good	7	23.3%
	Fair	8	26.7%
	Poor	15	50 %
<b>Anorectal angle</b>	Obtuse angle	22	73.3%
	Normal	8	26.7%

(Table.2) showed that, among the patients with postoperative MRI evaluation, 96.6% had stools incontinence postoperatively. As regards the external anal sphincter development, 23.3% had a well-developed sphincter. Regarding the position of the pulled bowel, it was paracentral in most patients

(76.7%). Only 6.7% of patients had mesenteric fat around the pulled bowel.

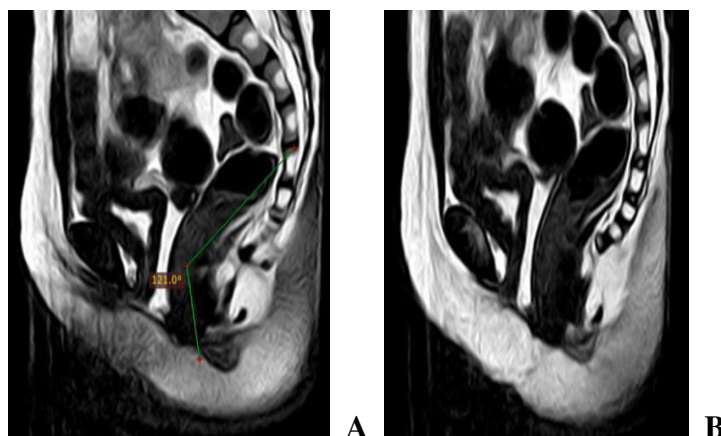
**Case I:** A female patient 7 years old presented by constipation, clinical examination revealed anterior ectopic anus. The patient underwent surgical repair. Post operative MRI for postoperative evaluation (**Fig.1A-E**)

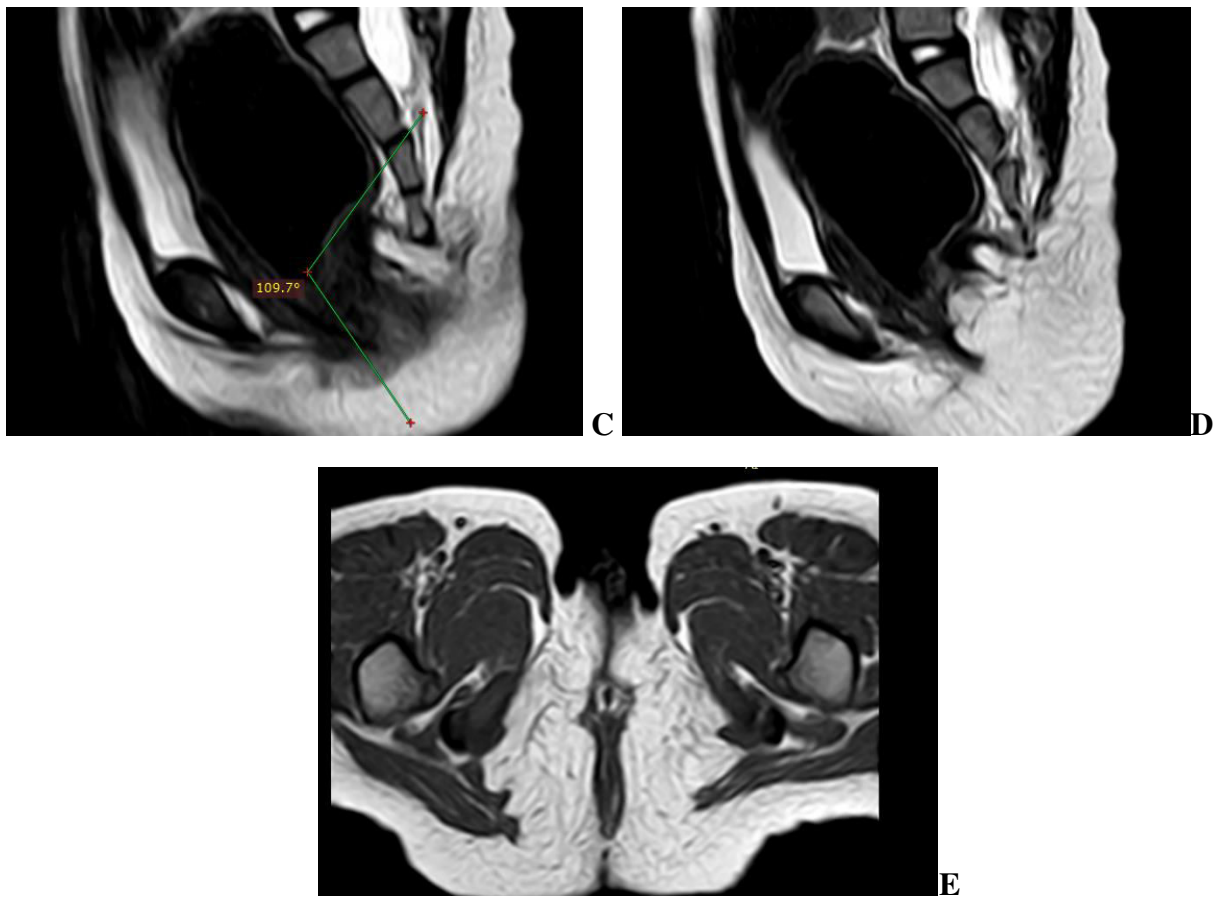


**Fig.1.Pre-Operative Pelvic MRI, T2WI (Mid sagittal plane) A:** show increased anorectal angle+/-111.5° indicated anterior ectopic anus. **B:** show anterior displacement of distal anal canal in front of muscle (arrow) and mild dilation of the rectum. **Post-Operative Pelvic MRI, T2WI (Mid sagittal plane) C:** show mild increase of anorectal angle+/-107°. **D:** collapsed rectum. **E:** T2WI (coronal plane) shows asymmetrical thickness of sphincter muscle (fair developed sphincter).

**Case II:** A female patient 7 years old presented by constipation, clinical examination revealed anterior ectopic anus. The patient

underwent surgical repair. Patient presented by stool incontinence post operative (**Fig.2A-E**)

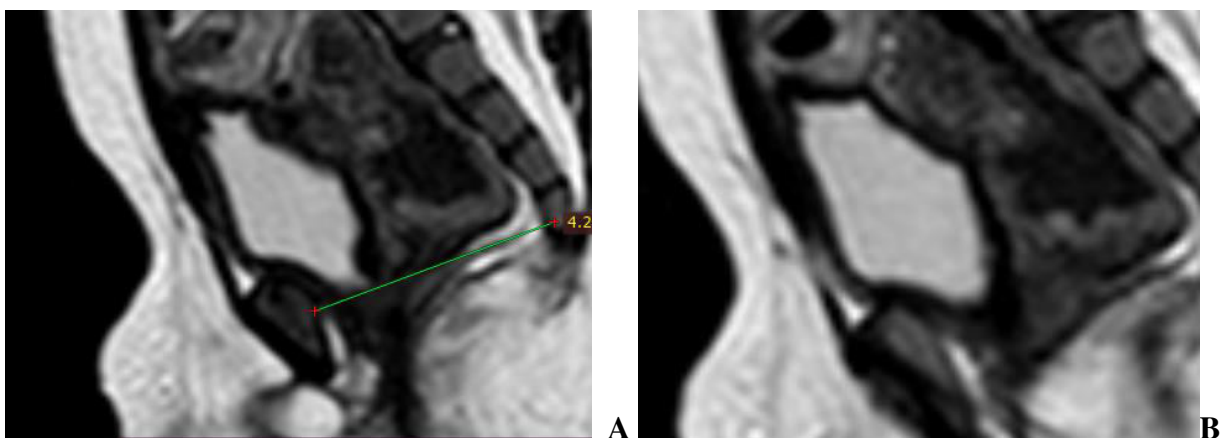


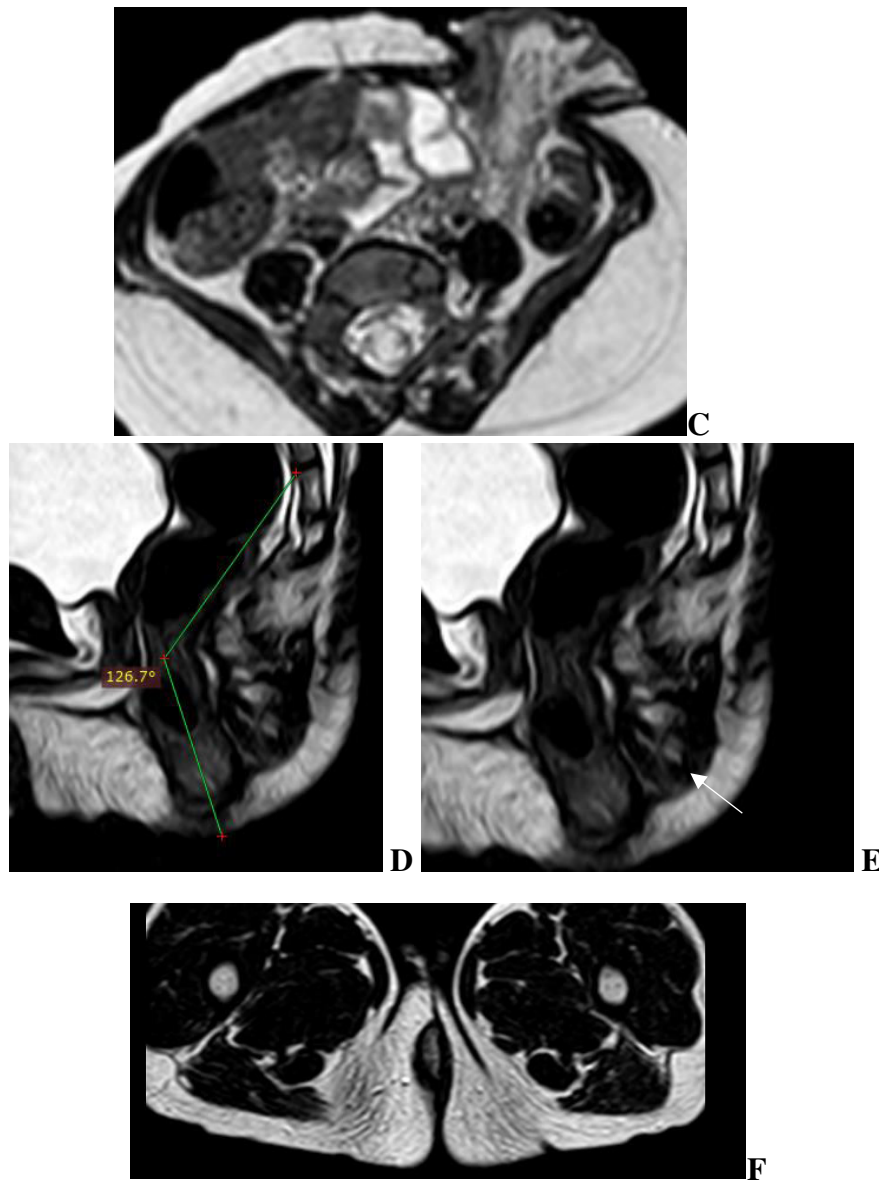


**Fig.2. Pre-Operative Pelvic MRI, T2WI (Mid sagittal plane) A:** show increased anorectal angle $\pm$ 121.5° indicated anterior ectopic anus. **B:** show anterior displacement of distal anal canal in front of muscle (arrow). **Post-Operative Pelvic MRI, T2WI (Mid sagittal plane) C:** show mild increase of anorectal angle $\pm$ 109.7°. **D:** dilated rectum. **E: T1WI (coronal plane)** shows asymmetrical thickness and thinning of sphincter muscle (poorly developed sphincter).

**Case III:** male patient presented at age of 6 months with imperforate anus with left sided

colostomy, then presented at age of 11 months for post-operative evaluation, (**Fig.3A-F**).





**Fig.3. Pre-Operative Pelvic MRI, T2WI A:** rectal pouch above PC line. **B:** average rectal diameter. **C:** left sided colostomy. **Post-Operative Pelvic MRI, T2WI (Mid sagittal plane) D:** show increase of anorectal angle  $\pm 126.7^\circ$ . **D:** average diameter of rectum. **E:** **T1WI (axial plane)** shows asymmetrical thickness and thinning of sphincter muscle (poorly developed sphincter).

## Discussion

Anorectal malformations (ARMs) are a complex group of congenital anomalies involving the distal rectum and anus (**Levitt and Peña, 2007**). The classification of ARMs is mainly based on the position of the rectal pouch relative to the puborectal sling and the presence or absence of fistulas (**Holschneider et al., 2005**).

Few studies have been conducted to analyze ARM using MRI. The Recent developments in MRI technology enable for high-resolution imaging and visualization of tiny pediatric pelvic structures. An attempt should be made to reevaluate its function in determining the degree of rectal pouch and type of ARM, fistulas, SMC development, and the likelihood of determining related anomalies, particularly of the spinal cord, spine, and urogenital system, in a single examination (**Ghasi et al., 2018**).

The current study aimed to evaluate role of MRI in assessment of anorectal malformation preoperative and postoperative. The mean age of the study population was 4.2 years, with a very wide range, from 3 days to 10 years. In the study of **Farghaly et al., 2018**, their cases ranged in age from 1-18 years. The cases of the **Bhuyan et al., 2015**, ranged from 4 months to 16 years.

most of the cases were females (80%) compared to only 6 cases (20%) were males. This female predominance was comparable to the study of **Augustine et al., (2017)**, where females accounted for 54% of the cases. However, according to **Farghaly et al., (2018)**, most of the cases were males (13 out of 17).

Most of the cases (90%) had low ARM, while 3 cases (10%) had high ARM. In the study of **Bhuyan et al., (2015)**, all of the cases had either high (24 cases) or intermediate type ARM (2 cases).

Regarding preoperative MRI finding, all cases of anterior ectopic anus (19 of 30)

revealed obtuse anorectal angle. In the study to **Amr Abdelhamid et al.**, 9 out of 9 cases of anterior ectopic anus revealed obtuse anorectal angle. The rectal pouch was seen in 11 of the studied cases who diagnosed as imperforate anus. Among them, 9 cases showed rectal pouch below the PC line (81.8%) while the other 2 cases showed above PC line pouch. The caliber of the pouch was dilated in the majority of cases (91%).

Regarding the postoperative complications, 19 cases (63.3%) had stool incontinence and 1 case (3.3%) had constipation. In the study of **Farghaly et al., (2018)**, 11 out of 17 cases had severe stool incontinence.

Among the post operative cases, 20 cases of stool incontinence showed dilated rectum. In the study of **Farghaly et al., (2018)**, MRI examination of 3 cases of those complaining of fecal incontinence revealed distended recto-sigmoid with fecal matter.

Among the postoperative cases, regarding external anal sphincter development, 7 cases were well- developed (23.3%) and 15 were poorly developed (50%). In the study of **Farghaly et al., (2018)**, 4 of the 17 patients had adequately developed sphincter muscle complex (levator ani and external anal sphincter), two patients had fair sphincter muscle development, 5 cases had poor sphincter muscle development and 3 cases had asymmetrical muscle complex on both sides. 3 cases had poor muscles at levator ani muscle level and fairly developed external anal sphincter. According to the study of **Bhuyan et al., (2015)**, among their 26 cases, 2 demonstrated good degree of development of the pelvic floor muscles; other 11 of them had fair number of muscles, and the rest 13 had significantly thinned out or poorly developed muscles.

According to postoperative MRI finding, only two out of the 30 cases (6.7%)



had mesenteric fat around the pulled bowel. According to the study of **Farghaly et al., (2018)**, 10 out of their 17 cases had mesenteric fat around the pulled bowel. In the study of **Bhuyan et al., (2015)**, a little more than half of the cases had mesenteric fat around the pulled bowel. Regarding the sphincter development, only 3 cases showed good sphincter development (27.3%), while 4 had fairly developed sphincter (36.4%) and the remaining 4 cases (36.4%) showed poorly developed sphincters.

According to postoperative MRI finding, Regarding the anorectal angle, it was increased in the majority of cases (73.3%), average in 8 out of 30 cases (26.7%). In the study done by **Farghaly et al., (2018)**, the anorectal angle ( $>100^\circ$ ) was also increased in the majority of cases (10 out of the 17 cases).

Regarding the associated anomalies of the studied cases, we found anomalies in 20% of the cases (6 cases). Among them, tethered cord was seen in 2 cases, ectopic kidney in other 1 case, hydronephrosis in the 1 case, vaginal agenesis in 1 case and last case was reported as VSD. On the other hand, in the study of **Farghaly et al., (2018)**, the incidence of urogenital anomalies was about 65%, 4 patients of them had urinary anomalies, in which crossed fused ectopia and single kidney were the most commonly encountered renal anomalies represented 35% of the patients in the study and 5 of them had genital anomalies (about 30% of cases) in the form of 4 cases of undescended testis in males and one female case had mullarian duct anomaly (uterus didelphys) this case had a cloacal malformation.

### Conclusion

MRI provided elaborate anatomical details which were well correlated with findings at surgery. MRI is the single imaging modality which can answer all these aspects of ARM accurately in a single sitting and without use of any

ionizing radiation to child. Therefore, we suggest MRI as the only needed imaging investigation and can be a better alternative to traditional imaging in ARM cases which requires imaging investigations before definitive surgery, and it provides guidance to the suitable way of surgical repair.

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