Magnetic Resonance Imaging in Anorectal Malformations

AA Shah[1] MR Kothari[2] N Bhattacharjee[3] AJ Shah[4] AV Shah[5]

Magnetic Resonance Imaging (MRI) is a relatively new diagnostic tool in the management of Anorectal Malformation (ARM) and this investigative modality in evaluation of patients with ARM is unique due to its exquisite soft tissue imaging ability in all three planes. It is noninvasive in nature. Both, pre and postoperative patients have been studied by imaging the pelvis and lumbosacral spine in the sagittal, transverse and coronal planes in the present study. MRI provided detailed information on the type of malformation, extent of the pelvic musculature and the skeletal status particularly of the lumbosacral spine in preoperative evaluation. This can be very helpful to study the relationship between the pulled through bowel and the muscle complex in patients with incontinence before one considers redo surgery. The cost factor may be a little prohibitive; however, the information obtained is worthwhile in selected patients with ARM. MRI performed on neonates at the time of first presentation may provide all the informations necessary and other investigations like invertogram, intravenous pyelogram and lopogram etc. with their own major drawbacks can be avoided.

This paper deals in depth regarding our experience with MRI in the management of ARM in 20 cases.

Key Words : MRI, Anorectal malformations.

Anorectal anomalies have a reported incidence of 1 in 1000 to 1 in 9630 live births.[1,2] In India, 13,223 babies with ARM are born annually, with around 1 in 1862 live births.[3] The international classification subdivides ARM into high, intermediate, low and miscellaneous deformities with emphasis on the sex of the child. The classification is

Paper presented at 26th Annual Conference of IAPS at Chandigarh
Department of Pediatric Surgery
KM School of Post Graduate Medicine & Research, VS Hospital, Ahmedabad-380 006.
1 Resident
2 Senior Resident
3&4 Assoc Professors
5 Professor
Correspondence:
Amar A Shah
57, Pritamnagar Society, Nr. Govt. Ladies Hostel, Nr. Gujarat College, Ellisbridge, Ahmedabad-380006.
E-Mail : arpita@adl.vsnl.net.in

based on where the rectum terminates in relation to the levator ani muscle. Approximately 50% of patients with ARM have associated lesions, the commoner are genitourinary and skeletal anomalies.[1,2] These lesions necessitate a variety of radiological investigations. The particular role of MRI in the evaluation of preoperative newborns or infants with ARM prior to definitive surgery and the postoperative cases with continuing problems has been studied and we thought it worthwhile to share our experience regarding the usefulness of MRI as compared to other radiological options available today.

Evolution of MRI as the latest diagnostic tool dates back to 1940, when Prof Bolch of Stanford and Prof Purcell of Harvard University first elucidated the principle of Nuclear Magnetic Resonance, and were awarded the Nobel Prize in Physics in 1952 for the same.[4] By the 1970s the principle of nuclear magnetic resonance was utilized to generate cross sectional images, and by the 1980s, clinical trials with MRI were underway.

Wangensteen and Rice (1930) first described the use of plain radiographs (Invertogram) to differentiate high from low variety of ARM.[5] Stephens in 1953,[6,7] developed the concept of identification of the gas bubble with respect to the bony pelvis to differentiate high from low lesions. He also demonstrated the relationship of the levator sling to the P-C plane and the 1 point.

Donaldson et al[8] (1989) suggested the use of ultrasound to accurately demonstrate the distance from the skin to the blind rectal pouch. A distance more than 1 cm would be suggestive of a high anomaly.

Materials and Methods

Twenty children with ARM admitted to the Pediatric Surgery Department of VS General Hospital, attached to KM School of Post Graduate Medicine & Research underwent MRI in this study. There were 11 boys and 9 girls and their age group ranged from 5 days to $3\frac{1}{2}$ years (Table1). Based on clinical features, operative findings and radiological investigations, 9 cases were classified as high, 10 as intermediate and 1 as a cloacal malformation. Ten studies were done preoperatively and 10 were done postoperatively (Table 2).

Table-I
Variety Of Anorectal Malformations

	High	Intermediate	Cloaca	Total
Male	6	5	–	11
Female	3	5	1	9
Total	9	10	1	20

Table-II
Variety Of Anorectal Malformations

	High	Intermediate	Cloaca	Total
Preoperative	6	6	1	10
Postoperative	3	4	–	10
Total	9	10	1	20

The patients were anesthetized with ketamine and diazepam. With a 0.5 T Super conducting system, 5 mm thick sections were obtained in transaxial, coronal and sagittal planes which included lumbar spine, kidneys and pelvis. The patients were studied in supine position with body coil field of view and to facilitate identification of the anatomical landmarks, a red rubber catheter was placed in the pulled through intestine and when necessary, the urethra, vagina or common channel of the cloaca were

catheterized. For better visualization of the rectum and fistula in preoperative cases, the distal loop of colon was filled with water through the distal end of the colostomy and the opening of the colostomy was blocked by the inflated balloon of a Foley catheter. In 2 cases paraffin was injected down the distal loop, which gave a bright echo due to its fat content and made identification easy.

Assessment of MRI Pictures

Absence of rectal pouch at the P-C plane was considered a high anomaly. Presence of rectal pouch at the P-C plane but not at the ischial plane (I-Plane) was considered as intermediate, and the presence of rectal pouch in both P-C plane and I plane was considered a low anomaly.

On preoperative imaging, the location of the fistula was noted. The size of the rectum was estimated on all studies. On postoperative imaging the relationship of the pulled through rectum to the puborectalis, sphincter muscle complex and external sphincter was carefully noted. Postoperative cases were also scrutinized for diverticula in the rectum and presence of mesenteric fat along the pulled through rectum.

The development of the puborectalis muscle was estimated by measuring the width of the muscle at the P-C plane. A puborectalis muscle thickness measurement of 2.5 mm was taken as the lower limit of normal for children less than 2 years of age.[9] Patients with measurements above these were considered to have a well developed puborectalis whereas those with measurements between 1.5mm and 2.5 mm were considered to have a fairly developed muscle. Patients with thickness below 1.5 mm were considered to have poorly developed muscle. Associated anomalies were looked for in the vertebral column, spinal cord, genitourinary system and presacral region.

The clinical assessment of external sphincter development in preoperative cases were done on the basis of appearance of the natal cleft and contraction of the anal area on stimulation with a low voltage muscle stimulator. Patients with flat bottom and no contraction on stimulation were considered to have a poorly developed external sphincter, while those with deep cleft and good contraction were considered to have a well developed external sphincter.

Operative assessment of the musculature was done by subjective assessment of thickness of muscle and strength of contraction on stimulation.

The assessment of fecal continence was done according to Kelly's criteria and the results were graded as good/fair/poor (Table 3).

Table-III

Variety of ARM	Development of R sphincter complex (M.R.I)			Development of ext. sphincter (M.R.I.)			Assessment of muscle continence (PER OPERATIVE)			Assessment of continence (CLINICAL)		
	good	fair	poor	good	fail	poor	good	fair	poor	good	fair	poor
High	1	5	3	3	3	3	3	2	–	2	3	2
Interme diate	8	2	–	8	2	–	7	3	–	6	2	–
Low	–	1	–	–	1	–	–	1	–	–	1	–

Results and Discussion

In all patients it was possible to see the levator ani (puborectails and sphincter muscle complex) and external sphincter in all three planes clearly (Fig 1). Among pre-operative patients MRI allowed precise delineation of the fistulous connection of the bowel with the urinary tract in 5 patients (Fig 2).

In patients with cloacal malformation, bowel communication to the common channel could also be visualized, but in such cases the relationship of the pelvic organs to each other is highly variable and it is difficult by MRI to depict their arrangement in three dimensions. Hence conventional dye injection studies and endoscopy score over MRI.

Patients with low anomaly are expected to achieve good continence because they uniformly have good development of the skeletal muscle mass. But among the intermediate and high varieties the muscle mass is variable and this plays an important role in achieving continence. It can be seen from the results, that as the level of anomaly changes from intermediate to high the muscle mass becomes scantier. The effect can be seen on the degree of continence achieved by the patients with high anorectal malformations which is definitely lower than patients with intermediate malformations are, which is a universal experience.

References[11-24] are also available regarding other studies like anal endosonography, electro-myography of the external anal sphincter and manometry of the internal anal sphincter along with MRI (Fig 3). A dilated rectum requiring tapering was not found in any of the patients. Most patients in the study with high and intermediate malformations show good to fair development of the levator ani and external sphincter. In high anomaly, external sphincter development is better than development of puborectalis or sphincter muscle complex. With proper placement of rectum many of them should be able to achieve acceptable continence, thus emphasizing that even patients with high malformations can have good external sphincter with good prospects of continence (Fig 4). MRI thus if done preoperatively on neonates can provide all the required information in a single study.[25]

Patients with rectovestibular fistula although classified as having an intermediate anomaly almost always have good muscle development and they are always continent. This fact is very well brought out in our study. All five patients with rectovestibular fistula show presence of good musculature on MRI with achievement of good continence. Our feeling is that the majority of female patients with ARM who come with a perineal opening may not be subjected to MRI. Certain anomalies associated with ARM like tethered cord, lipoma of cord, absence of abnormal kidneys, hydronephrosis, presacral mass etc. can be diagnosed with MRI without the need of any additional study.[26] MRI plays an important role in the diagnosis and further management of incontinent postoperative patients. Eccentric placement of rectum, poorly developed muscles, dilated rectum, diverticulum, mesenteric fat etc (Fig 5 & 6) may be the contributing factors for incontinence. Thus a direct approach like that of PSARP[27] which uses the available musculature by precise identificaiton of the muscles and proper placement of the rectum within them is preferable over other methods of abdominoperineal pull through.

Mesenteric fat when pulled through the rectum (Fig 7) may interfere with the action of the muscles of continence. Resection of this fat and approximation of the muscles to the bowel wall may make the patient continent.[28]

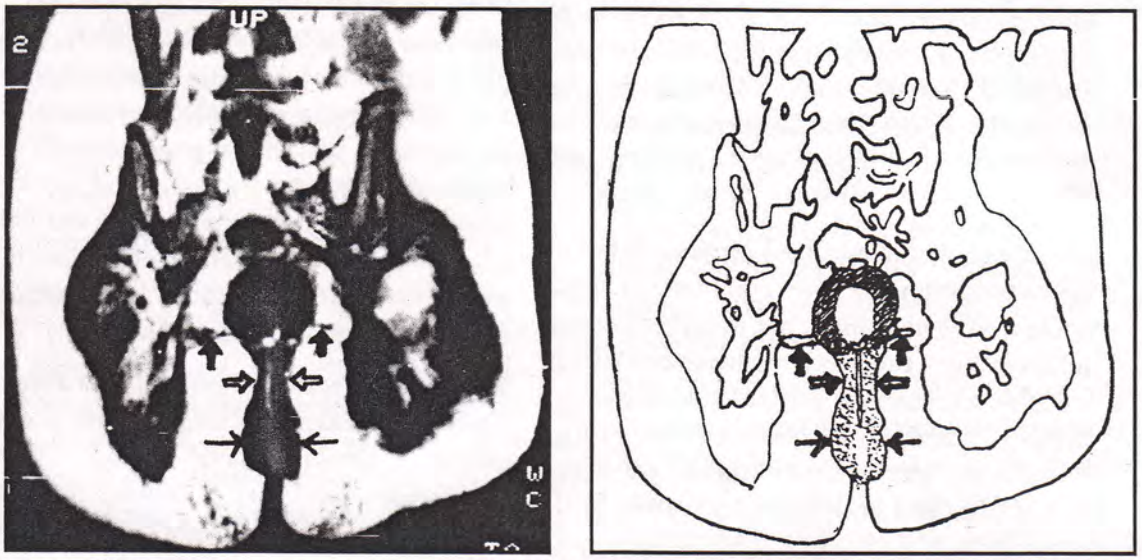

Fig 1 : MRI coronal view showing Levator sling (thick arrow), muscle complex (hollow arrow) and external sphincter (thin arrow)

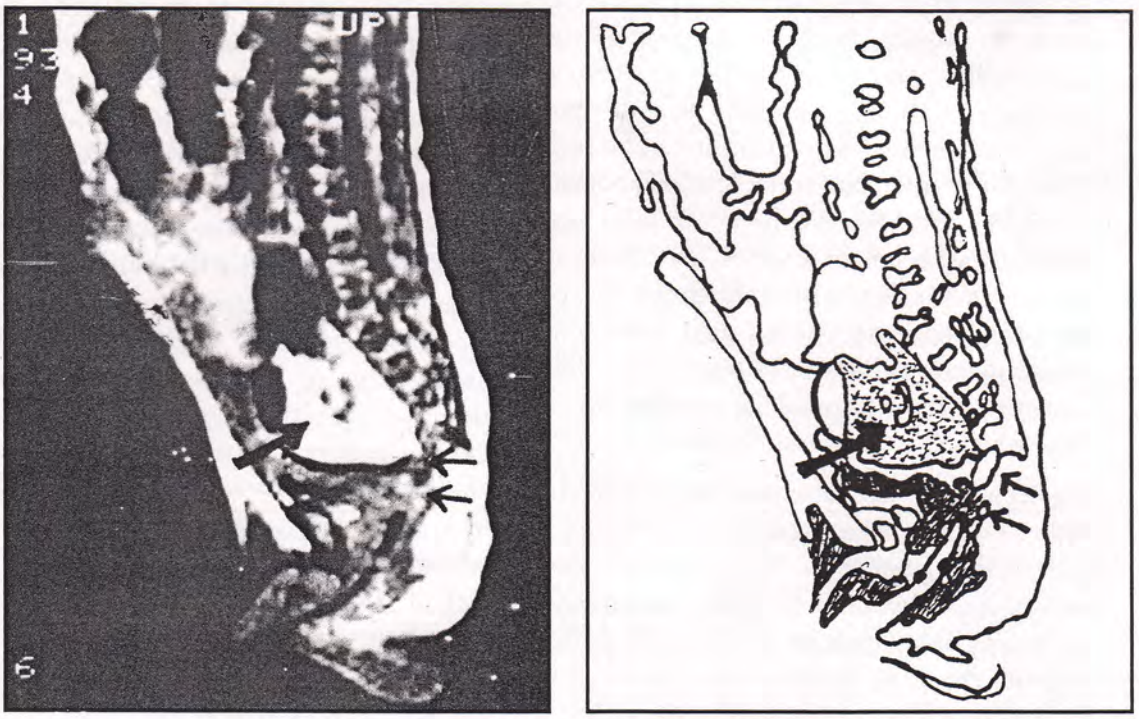

Fig 2 : Preoperative MRI in a neonate with high anomaly showing the bright image of the rectum filled with liquid paraffin (thick arrow) with a rectoprostatic fistula (thin arrows).

Fig 3 : Preoperative MRI showing a rectoprostatic fistula (thick arrows) with a well-developed external sphincter (thin arrows) and parasagittal fibers (hollow arrow).

Fig 4 : Postoperative picture in a continent child showing a centrally placed rectum and well-developed striated muscle complex (thin arrows).

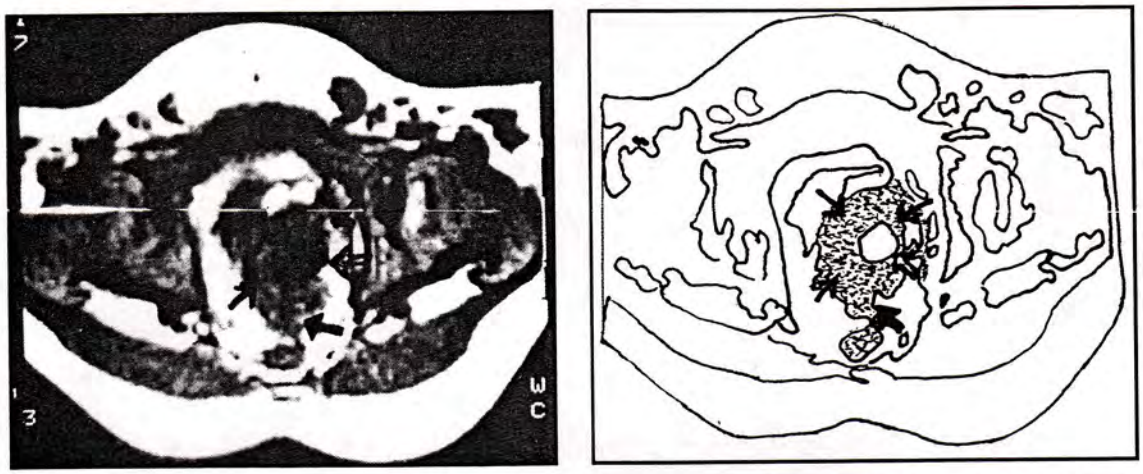

Fig 5 : Postoperative picture, showing a dilated rectum (thin arrows) displaced laterally and anteriorly (hollow arrow) with poor development of puborectalis (thick arrow).

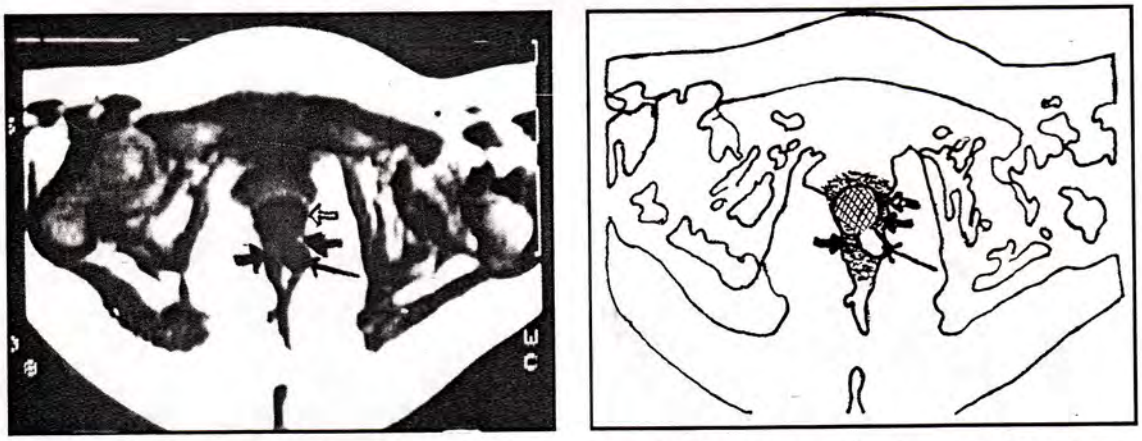

Fig 6 : MRI in a patient operated for ARM with postoperative incontinence showing a displaced rectum (thin arrow) with an anterior diverticulum (hollow arrow). Thick arrows show the muscle complex.

Disadvantages of Conventional Investigations : (Invertogram, Distal Loopogram, Micturating Cystourethrogram etc.)

a) Increased radiation exposure

b) Frequent procedure related complications

c) Erroneous results due to technical errors, or due to the child crying or straining

d) No information regarding development of muscles of continence is obtained

e) No assessment regarding postoperative incontinence

f) Associated anomalies cannot be detected accurately e.g. tethered cord, intraspinal lipoma, presacral mass etc.

g) Physical and mental stress of undergoing multiple investigations for the patients and parents.

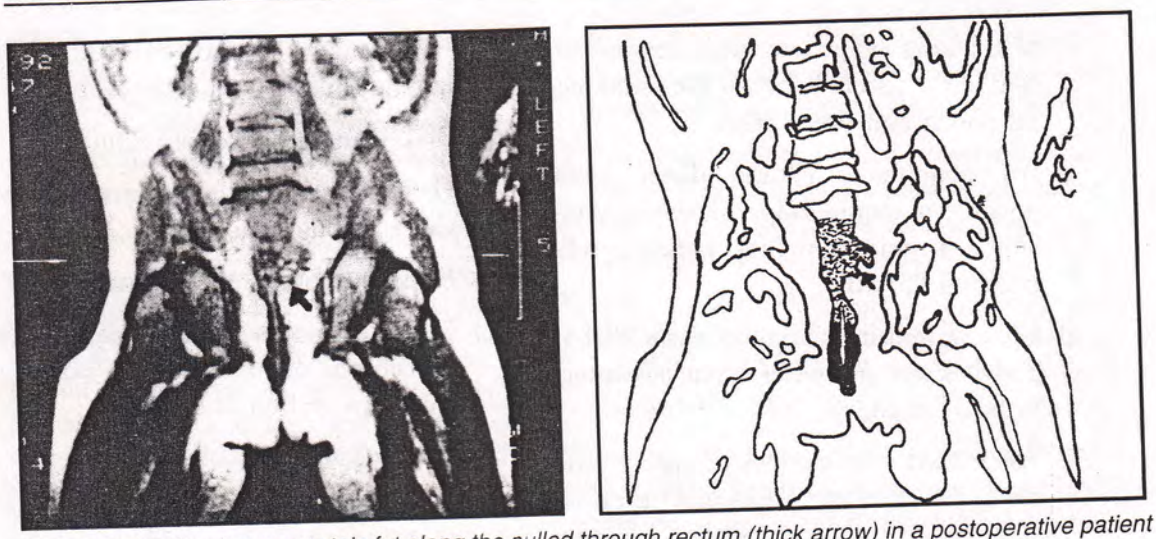

Fig 7 : MRI showing mesenteic fat along the pulled through rectum (thick arrow) in a postoperative patient with incontinence.

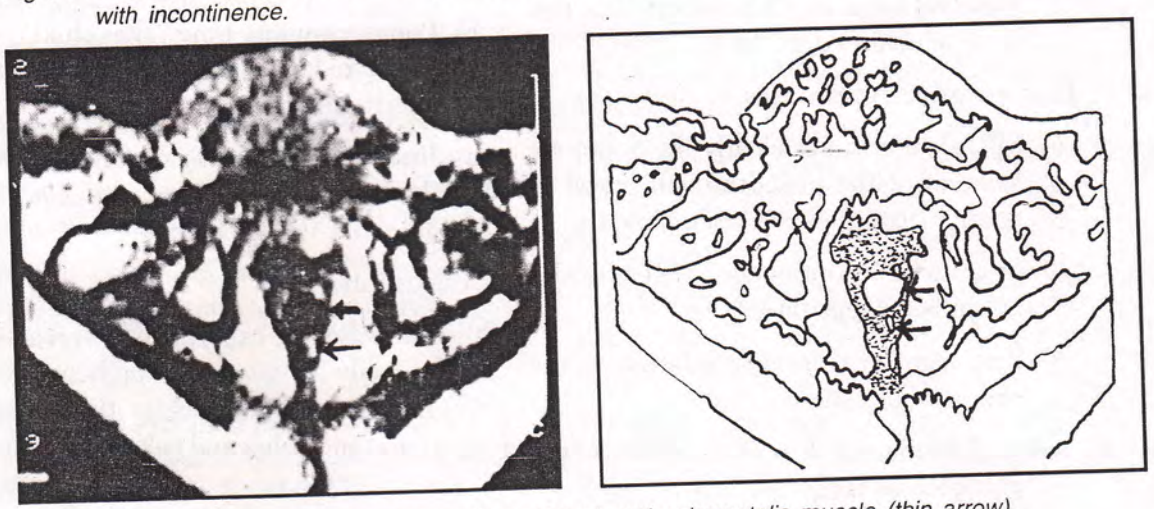

Fig 8 : MRI, axial view showing rectum (thick arrow) and puborectalis muscle (thin arrow).

Advantages of MRI

Preoperative advantages

a) MRI determines the level of rectal pouch more accurately than conventional radiographic imaging.

b) MRI provides exact information regarding the development of the pelvic musculature, which is essential to plan the pullthrough procedure.

c) Axial MRI sections display the puborectalis mass distinctly from the rectum (Fig 8). The coronal and sagittal planes can demonstrate the iliococcygeus and ischiococcygeus parts of the muscles as they course towards the rectum and anococcygeal ligament.

d) MRI findings of well or poorly developed puborectalis correlated well with findings at surgery in all patients.

c) MRI allows a clear and exact demonstration of the fistula between the blind rectal pouch and the urethra.

f) An abnormally ectatic distal rectal pouch that requires tapering can be seen, which is important for patients who undergo PSARP.

g) Lack of ionizing radiation with MRI in pediatric age group is a strong advantage over CT scan.

h) Associated anomalies e.g. renal anomalies, spinal anomalies such as tethered cord, intraspinal lipoma, presacral mass, sacral hemivertebrae can be demonstrated on MRI.

Postoperative Advantages

a) MRI demonstrates clearly the anatomic location of the pulledthrough bowel in relation to the puborectalis sling.

b) in cases of incontinence, MRI provides information regarding:

i) Placement of rectum in relation to the puborectalis sling e.g.

* Placement of rectum outside the puborectalis sling

* Asymmetric location of rectum within the sling

* Diverticulisation of rectum

* Mesenteric fat inclusions along with the pulledthrough rectum.

ii) Hypoplasticity of the sphincters

c) MRI is of immense help in planning redo procedures of patients with postoperative constipation and soiling.

Disadvantages of MRI

a) High cost (approximately Rs. 3,500/- to Rs.5,000/- at our centers)

b) Long scanning time, the child needs heavy sedation and the presence of an anesthesiologist.

c) Intensive monitoring during the procedure is not possible and so it is not suitable in a very sick child.

Conclusion

MRI in ARM is expensive, however, in a single study it gives comprehensive and accurate information about the anomaly, associated anomalies and pelvic musculature.

References

1 Hasses W. Associated Malformation with anal and rectal atresia. Prog Pediatr Surg 1976; 9 : 99.

2 Tunnel WP, Austin JC, Barnes PD. Neuroradiologic evaluation of sacral abnormalities in imperforate anus complex. J Pediatr Surg 1987; 22 : 58-61.

3 Chatterjee SK. Anorectal Malformations : A Surgical Experience. Delhi, Oxford University Press, Oxford, 1991.

4 Sato Y, Pringle KC, Bergman RA. Congenital Anorectal Anomalies, MR, Imaging. Radiology 1988; 168 :157-162.

5 Wangensteen OH, Rice CO. Imperforate Anus : A method of determining the surgical approach. Ann Surg 1930; 92 : 77.

6 Stephens F. D. : Congenital imperforate rectum, rectourethral and rectovaginal fistulae. Aust NZ J Surg 1953; 22 : 161.

7 Stephens FD. Malformations of the anus. Aust NZ J Surg 1953; 23 : 9.

8 Donaldson JS, Black CT, Reynonlds M. Ultrasound of the distal pouch in infants with imperforate anus J Pediatr Surg 1989; 24:465-468.

9 Taccone A, Martuccillo G, Fondelli P. CT of anorectal malformation—a post operative evaluation. Pediat Radiol 1989; 19 : 375-378.

10 Iukata R, Iwai N, Yanagihara J, et al. A comparison of anal endoscopy with electromyography and neonates in high and intermediate anorectal anomalies. J Pediatr Surg 1997; 36 : 837-842.

11 Doolin EJ, Black CT, Donaldson JS. Rectal Manometry, Computed Tomography and Functional Results of Anal Atresia Surgery. J Pediatr Surg 1993; 28 : 195-198.

12 Scharil AF, Kiesewetter WB. Imperforate Anus : Anorectosigmoid Pressure Studies as a quantitative evaluation of postoperative incontinence. J Pediatr Surg 1969; 4 : 694-704.

13 Arain T, Faverdin C, Devroede G, Manometric assesment of continence after surgery for imperforate anus. J Pediatr Surg 1976; 11 : 157-166.

14 Willital GH. Advances in the diagnosis of anal and rectal atresia by ultrasonic echoscan. J Pediatr Surg 1971; 6 : 454-457.

15 Schuster SR, Tiele RL. An analysis of ultrasound scanning as a guide in determining of "high" and "low" imperforate anus. J Pediatr Surg 1979; 14 : 798-800.

16 Ikawa H, Yokoyama J, Sauboumatsu T. The use of computerized tomography to evaluate anorectal anomalies. J Pediatr Surg 1985; 20 : 644-660.

17 Kohoda E, Fujikoa M, Ikawa H. Congenital anorectal anomaly, CT Evaluation. Radiology 1985; 157 : 349-352.

18 De-Augustin JC, Alami H, Lassaletta L. Nuclear Magnetic Resonance of anorectal malformations in persistent postoperative fecal incontinence. Cir Pediatr 1991; 5 : 129-134.

19 Panuel M, Guys JM, Devred P. Magnetic Resonance Imaging of high anorectal malformations. A preliminary study apropos of 15 cases. Chir-Pediatr 1988; 29 : 243-246.

20 Vade A, Reyes H, Vilbur A. The anorectal sphinter after rectal pullthrough surgery for anorectal anomalies. MRI evaluation. Pediatr Radiol 1989; 19 : 179-183.

21 Taccone A, Martucceillo G, Dodergo P. New Concepts in preoperative imaging of anorectal malformation. Pediatr Radiol 1992; 22 : 196-199.

22 DeVeries PA, Pena A. Posterior sagittal anorectoplasty. J Pediatr Surg 1982; 17 : 638-643.

23 Pringle KC, Sato Y, Sopor RT. Magnetic resonance imaging as an adjunct to planning and anorectal pullthrough. J Pediatr Surg 1987; 22 : 571-575.

24 Osborn AG, Handrik ER, Kanal E. Introduction to magnetic resonance imaging, a basic primar. Radiology 1980; 177-185.

25 Sachs TM, Applebaum H, Touran T. Use of MRI in evaluation of anorectal anomalies. J Pediatr Surg 1990; 25 : 817.

26 Peng HC, Chen HC, Wu JJ. Evaluation of anorectal malformations using magnetic resonance imaging : Chung-Hue-I.-Hsuch-FSA-Chih 1991; 48 : 190-196.

27 DeVries PA, Cox KL. Surgery of anorectal anomalies. Surg Clin North Am 1985; 65 : 1130-1167.

28 Pena A. Atlas of Surgical Management of anorectal malformations. Springerverlag, 1990.