

## RESEARCH ARTICLE

# Role of Magnetic Resonance Imaging in the Diagnosis and Management of Pelvic Floor Dysfunction

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## ABSTRACT

**Aim:** To study the effect of age and parity in pelvic floor anatomy in women with pelvic floor dysfunction and the changes in pelvic floor anatomy after a course of pelvic floor exercises.

**Design:** A prospective study at Government Kilpauk Medical College (KMC), Chennai.

**Materials and methods:** Patients with pelvic floor dysfunction are subjected to clinical examination and magnetic resonance imaging (MRI). The changes in anatomy are analyzed in terms of levator hiatus dimension and descent of the pelvic organs. Substratified analysis is done and mean diameters in each degree of prolapse are identified (Chi-square tests using cross tables). Patients with cystocele, rectocele, or enterocele are also compared in both clinical examination and MRI and the degree of correlation is measured (inter-rater kappa). The changes in pelvic floor anatomy in terms of H line, M line, and levator plate angle with respect to age and parity are studied. In patients with lower degrees of prolapse, the changes in anatomy in terms of H line, M line, and levator plate angle are studied after a course of pelvic floor exercises (*post hoc* tests and paired t-tests). The area under curve of receiver-operating curve in each degree of prolapse is seen and the critical cut-off value of the various anatomical parameters above which a patient develops a prolapse is calculated.

**Results:** Ninety patients with symptoms of pelvic floor dysfunction were studied with clinical examination and MRI. Levator hiatus width cut off at rest above 5 cm and at straining above 5.8 cm develops clinical first-degree prolapse. Levator plate angle of more than 44.4° develops a clinical first-degree prolapse. With increasing age there is an increase in mean values of levator hiatus width at straining, levator plate angle, and descent of various organs. With increasing parity, there is an increase in mean values of levator hiatus width at rest and straining and increase in descent at straining.

**Conclusion:** Magnetic resonance imaging should be considered as a pretreatment planning tool when the physical findings are equivocal.

**Keywords:** Cystocele, Dynamic magnetic resonance imaging, Pelvic floor dysfunction, Prolapse.

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## INTRODUCTION AND LITERATURE REVIEW

On an average, about 30 to 50% of women develop pelvic organ prolapse in their lifetime.<sup>1</sup> Pelvic floor dysfunction affects 300,000 to 400,000 persons annually worldwide.<sup>1</sup> It is a common condition which can cause significant impact on the quality of life. The prevalence appears to increase with increasing life expectancy.<sup>2</sup> Many of these people require surgery and almost 30% of them require repeat surgery.<sup>3</sup> This indicates that the current diagnostic modalities and surgical management is far from satisfactory. Hence, there is a need for a promising tool for pretreatment evaluation for patients with pelvic floor dysfunction.

Internationally, the hospital admission for uterine prolapse is 20.4%, surgery for prolapse is done is 16.2%.<sup>4</sup> The average incidence of prolapse uterus in the United States is about 11.4%, Italy 5.5%, Egypt 56%, California 1.9%, Pakistan 19.1%, and Iran 53.6%. It has been calculated that about 60,000 women from Nepal have uterine prolapse and of them 18,600 are in need of surgical intervention.<sup>5</sup>

The incidence of uterine prolapse in North India is 7.6%. The incidence in Eastern India is estimated to be around 20%. In South India, mainly in the state of Tamil Nadu, the incidence of uterine prolapse is estimated to be 0.7% and in the state of Karnataka the incidence of uterine prolapse is 3.4%.<sup>5</sup>

Pelvic floor dysfunction can manifest as mass descending per vaginam, difficulty in urination, difficulty in defecation, or chronic pelvic pain. The diagnosis, classification, grading, and management were previously done based on clinical examination and certain radiographic imaging modalities like cystourethrography, cystocolpoproctography, evacuation proctography, and peritoneography.

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Imaging is mainly useful in persons in whom the physical clinical examination findings are inconclusive or equivocal. Jennifer Hubert et al have done a study to find out when magnetic resonance imaging (MRI) should be considered in a female pelvis.<sup>6</sup>

Yan Mee Law and Julia R. Fielding made a review on the anatomy and various causes of pelvic floor weaknesses in women and also role of MRI in pelvic floor dysfunction. A few other studies have also been attempted worldwide to evaluate the role for newer dynamic modalities in the diagnosis and pretreatment planning of pelvic floor dysfunction.<sup>7</sup>

The need of the hour is a noninvasive modality that helps in better understanding of the complex anatomic changes for better management, i.e., for the improvement of symptoms as well as to prevent recurrence and the role of the conservative management – to know how better the anatomic changes improve. Hence, this study was intended to know the anatomical changes in various types of pelvic floor dysfunction and the role of conservative management (pelvic floor exercises) in various dysfunction using dynamic MRI of the pelvic floor.

Appearance of urinary incontinence can occur following repair of a large prolapse if the preoperative evaluation is not performed properly after reducing the prolapse.<sup>8</sup> Clinical examination is found to be insufficient and inadequate and in disagreement with surgical findings, mainly for posterior vaginal wall pelvic organ prolapse. Studies show that the clinical examination for prolapse correlated with surgical findings in only 59% of women.<sup>9</sup> Studies show that even though patients present with symptoms suggestive of isolated pelvic floor compartment dysfunction, most of these patients have concomitant defects in other compartments as well.<sup>9</sup>

Therefore, this study is intended to search for a better tool for universal grading and classification as well as to be a one-time reading with no interobserver variation and also noninvasive.

A study comparing chain cystourethrography with dynamic MRI showed that on pelvic straining the measurements of bladder neck descent, angle of the urethra, and the posterior urethrovesical angle were not significantly different. In the diagnosis of cystocele, MRI had a high degree of correlation to lateral cystourethrography with a Spearman correlation coefficient of 0.95.

Radiologically, the level of the pelvic floor is determined by the pubococcygeal line. In normal persons, the levator plate must be parallel to the pubococcygeal line. There are two main reference lines used, which are H line and M line. These lines are used in various types

of pelvic floor dysfunction and the organ prolapse can be identified and staged. The H line is measured as the distance from the inferior pubic symphysis to the posterior anorectal region on a midsagittal image and it indicates the anteroposterior width of the levator hiatus. The M line is drawn perpendicular from the pubococcygeal line to the most distal aspect of the H line and it indicates the descent of the hiatus from the pubococcygeal line. The normal values in normal individuals are: H line – 5 cm and M line – 2 cm.

The presence of pelvic organ prolapse causes sloping of levator plate and increases in H line and M line. These indicate the widening and descent of the levator hiatus. Even though these are useful indicators in quantifying the pelvic organ prolapse, little is described in literature about quantifying severity using this. Hence, this study is attempted to study the various anatomic changes in different degrees of prolapse using MRI.

## MATERIALS AND METHODS

### Study Design

Prospective observational study. Ethical committee clearance was obtained.

### Inclusion Criteria

Patients attending the gynecology outpatient department (OPD) at the Government Kilpauk Medical College with any one of the following were included:

- First- and second-degree uterovaginal prolapse
- Cystocele
- Rectocele
- Enterocele
- Defecatory incontinence
- Third-degree prolapse.

### Exclusion Criteria

- Age under 18 years
- Those with proclivita
- Pelvic masses
- Currently under treatment for malignancy
- Previous radiation to the pelvis
- Any autoimmune disorder
- Women who are currently pregnant
- Pregnant in the past year
- Abnormal uterine bleeding.

### Place of Study

Gynecology OPD in Kilpauk Medical College.

*Period of study:* September 2013 to September 2014

*Sample Size:* Calculated by the formula (Table 1).

**Table 1:** Sample size for frequency in a population

Population size (for finite population correction factor or fpc)(N)	2000
Hypothesized % frequency of outcome factor in the population (p)	5% ± 5
Confidence limits as % of 100 (absolute ± %)(d)	5%
Design effect (for cluster surveys-DEFF)	1
<i>Sample size(n) for various confidence levels</i>	
Confidence level (%)	Sample size
95%	71
<i>Equation</i>	
Sample size $n = [DEFF * Np(1-p)] / [(d^2 / Z_{1-\alpha/2}^2 * (N-1) + p * (1-p))]$	

**METHODS OF COLLECTION OF DATA AND STUDY**

Women with complaints of mass descending per vaginum, urinary difficulty, defecation difficulty, or chronic pelvic pain (>6 months) attending gynecology OPD at KMC after getting informed consent for the study were evaluated by

- Questionnaire
- General examination
- Pelvic examination
- Basic investigations
- Dynamic T2 MRI of pelvic floor.

The evaluation with MRI is done with the patient in supine position, without injecting any contrast agent, and within 15 minutes. A multicoil array and a rapid half-Fourier T2-weighted imaging sequence were used to get sagittal images when the patient is at rest and during pelvic strain, followed by axial images. The H line, M line, and levator plate angle were measured by the radiologist. Also the presence of cystocele, rectocele, and enterocele are recorded and if present the type of cystocele is identified in MRI and in clinical examination.

The patients who were identified to be with pelvic floor dysfunction of lower grade (first- and second-degree prolapse) are subjected to pelvic floor exercises and followed up after a period of 6 months. Repeat MRI was taken and the anatomical changes in terms of H line, M line, and levator plate angle are recorded.

**METHOD OF ANALYSIS**

Patients presenting to gynecology OPD with symptoms of pelvic floor dysfunction (already mentioned) are subjected to clinical examination and MRI. The changes in pelvic floor anatomy in each type of dysfunction is analyzed in terms of H line (at rest and straining), M line (at rest and straining), and levator plate angle values. That is, the changes in levator hiatus dimension and descent of the pelvic organs in various degrees of prolapse are studied.

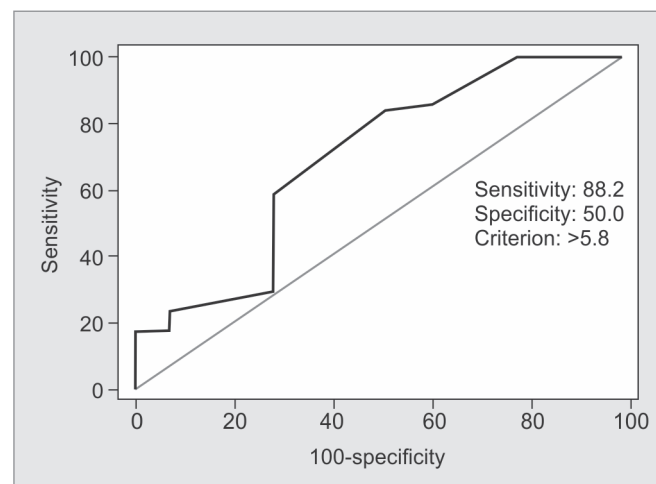
Substratified analysis is done and mean diameters in each degree of prolapse is identified (Chi-square tests using cross tables). The patients who are diagnosed to have cystocele (if present along with the type), rectocele, or enterocele are also compared in both clinical examination and MRI and the degree of correlation is measured (inter-rater kappa). The changes in pelvic floor anatomy in terms of H line, M line, and levator plate angle with respect to age and parity are studied. In patients with first- and second-degree prolapse, the changes in anatomy in terms of H line, M line, and levator plate angle are studied after a course of pelvic floor exercises (*post hoc* tests and paired t-tests).

The area under curve of receiver-operating curve (ROC) in each degree of prolapse is seen and the critical cut-off value of the various anatomical parameters above which a patient develops a prolapse is calculated.

**DISCUSSION**

In this study, the following are thus evident:

- With the area under curve interpretation of ROC with respect to clinical examination, with a sensitivity of around 90%, it is found that levator hiatus width cut off at rest above 5 cm and at straining above 5.8 cm develop a first-degree prolapse clinically (Graph 1).
- M line straining with a sensitivity of 100% shows cut off more than 4.8 cm to develop a clinical prolapse.
- Similarly from ROC of various other MRI parameters, it is found that with almost 100% sensitivity with respect to clinical examination a levator plate angle of more than 44.4° develops a clinical first-degree prolapse.
- From ROC of second-degree prolapse, it is inferred that the cut-off value of levator hiatus width at rest >5.2 cm, at straining >6.6 cm, descent >2.3 cm at rest and >4.8 cm at straining with specificity around 100%.
- The cut-off value for levator plate angle is >49° with sensitivity around 96% in clinical second-degree prolapse.



**Graph 1:** H line straining

**Table 2:** Effect of age on pelvic floor anatomy

	Age		Standard	
	group	n	Mean	Deviation
H line (at rest)	1	12	5.325	.2832
	2	5	5.160	.0894
H line (straining)	1	12	6.28	.811
M line (at rest)	2	5	6.40	.784
	1	12	2.175	.3621
M line (straining)	2	5	2.320	.2864
	1	12	3.71	.825
Levator plate angle (in degrees)	2	5	4.14	1.043
	1	12	47.33	.987
	2	5	48.48	.589

- Five patients with first-degree prolapse who were not diagnosed clinically were picked up by MRI.
- In seven patients with equivocal findings with regard to type of cystocele in clinical examination, MRI could identify the fascial defect and hence, the type of cystocele and thus helped in site-specific repair of cystourethrocele.
- Magnetic resonance imaging has also helped to differentiate high rectoceles and enteroceles.
- Effect of age and parity on pelvic floor anatomy – With increasing age there is an increase in mean values of levator hiatus width at straining and increase in descent of various organs. More so, there is also a statistically significant increase in the levator plate angle with increasing age (Table 2).
- With increasing parity, there is an increase in mean values of levator hiatus width at rest and straining and increase in descent at straining. Also, there is an increase in levator plate angle with increasing parity though not statistically significant (Table 3).

Few significant values that are to be noted from statistical analysis are as follows:

- Mean levator hiatus width at rest when the patient shows no clinical evidence of prolapse – 5.09 cm.
- Mean width of the hiatus at rest when there is clinically *first degree of prolapse* – 5.28 cm.
- Mean width of the hiatus at rest when there is clinically *second degree of prolapse* – 5.41 cm.
- Mean width of the hiatus at rest when there is clinically *third degree of prolapse* – 9.36 cm.
- The mean levator hiatus width at straining when the patient shows no evidence of clinical prolapse – 5.771 cm.
- The mean width of the hiatus at straining when there is clinically first degree of prolapse – 6.318 cm.
- The mean width of the hiatus at straining when there is clinically second degree of prolapse – 7.486 cm.
- The mean width of the hiatus at straining when there is clinically third degree of prolapse – 9.973 cm.

**Table 3:** Effect of parity on pelvic floor anatomy

	Parity		Standard	
	n	Mean	Deviation	
H line(at rest)	2	6	5.217	.1722
	3	10	5.300	.3018
	4	1	5.400	
	Total	17	5.276	.2513
H line (straining)	2	6	5.93	.273
	3	10	6.54	.942
	4	1	6.40	
	Total	17	6.32	.780
M line (at rest)	2	6	2.167	.1211
	3	10	2.240	.4402
	4	1	2.300	
	Total	17	2.218	.3395
M line (straining)	2	6	3.32	.454
	3	10	4.13	.998
	4	1	4.00	
	Total	17	3.84	.884
Levator plate angle (in degrees)	2	6	47.42	1.303
	3	10	47.79	.921
	4	1	48.00	
Total	17	47.67	1.023	

- The average descent of pelvic organs at rest in centimeters in first degree of prolapse – 2.218 cm.
- The average descent of pelvic organs at rest in centimeters in second clinical degree prolapse – 2.476 cm.
- The average descent of pelvic organs at rest in centimeters in third clinical degree prolapse – 4.690 cm.
- The average descent of pelvic organs at straining in centimeters in first clinical degree prolapse – 3.835 cm.
- The average descent of pelvic organs at straining in centimeters in second clinical degree prolapse – 5.834 cm.
- The average descent of pelvic organs at straining in centimeters in third clinical degree prolapse – 7.807 cm.
- The mean levator plate angle values in women without clinical evidence of prolapse – 46.971° (Table 4).
- The mean levator plate angle values in women with clinical first degree of prolapse – 47.671°.
- The mean levator plate angle values in women with clinical second degree of prolapse – 50.21°.
- The mean levator plate angle values in women with clinical third degree of prolapse – 56.497°.

**Table 4:** Changes in pelvic floor anatomy in various degrees of prolapse

		F	Sig.
H line (at rest)	Between Groups	2415.241	.000
H line (straining)	Between Groups	393.905	.000
M line (at rest)	Between Groups	475.740	.000
M line (straining)	Between Groups	325.376	.000
Levator Plate Angle (in degrees)	Between Groups	204.467	.000

Comparative study with reference to previous studies on this topic:

- In *Open Journal of Obstetrics and Gynaecology*, Fernando G. de Almeida, Larissa v. Rodríguez, Rhlomoraz et al observed pelvic floor abnormalities in 46 patients, which did not show any abnormalities on the static images, the finding of which is similar to this study.
- Mohamed N. El-Gharib et al found that there was great association between parity status and the high incidence of pelvic floor dysfunction as pelvic floor dysfunction in their study was found in patients with more than two normal vaginal deliveries.<sup>10</sup> In this study, maximum incidence of pelvic floor dysfunction is seen in patients with three vaginal deliveries. Higher the parity, higher the degree of prolapse.
- Summers et al measured levator plate angle in women with normal support as 44.3°. During Valsalva, women with prolapse have a modest (9.1°) though statistically greater levator plate angle compared with controls. In this study also, there is a statistically significant increase in levator plate angle in various degrees of prolapse.
- Though many studies have been conducted in this aspect, studies in South Indian population with respect to anatomic changes were very few. Thus, this article has attempted to do this study on South Indian population.

## CONCLUSION

Thus, it is evident that MRI should be considered as a pretreatment planning tool when the physical findings are equivocal. Magnetic resonance imaging is not indicated for all patients with pelvic floor dysfunction. Preferably, MRI is to be done for patients with pelvic floor dysfunction who have equivocal or insignificant clinical findings, the cut-off value above which a patient will have clinical prolapse having been calculated, early diagnosis can be made based on the anatomic changes, and conservative management in terms of pelvic floor exercises may be considered to prevent greater degrees of prolapse and, thenceforth, its surgical management.

Magnetic resonance imaging has proved to be superior and significant for differentiating high rectoceles and enteroceles and also for typing cystoceles. Rest of the changes do not show statistically significant difference from clinical examination. Magnetic resonance imaging has helped in improving the knowledge about regional normal anatomy. Thus, it does have a role in preoperative planning to do site-specific repairs and thus prevent recurrence.

Magnetic resonance imaging also helps in a universal classification (quantitative) with little interobserver

**Table 5:** Effect of pelvic floor exercises in pelvic floor anatomy

		<i>Paired Differences</i>	
		<i>95% Confidence Interval of the Difference</i>	
		<i>Lower</i>	<i>Upper</i>
Pair 1	H line (at rest) - H line after treatment at rest	-.002	.013
Pair 2	H line (straining) - H line straining	-.0696	.0524
Pair 3	M line (at rest) - M line(at rest)	.0878	.1604
Pair 4	M line(straining) - M line (straining)	.3511	.6524
Pair 5	Levator plate angle (in degrees) - levator plate	.9899	1.5610

variations as the case with existing classification methods and it is superior to fluoroscopy in terms of its noninvasiveness, no ionization, and the ability to do thorough evaluation of pelvic organs dynamically in no time based on its high-quality soft tissue imaging.

The pelvic floor exercises do not seem to cause a statistically significant reduction in levator hiatus width but they have caused a significant decrease in descent of the organ (measured in terms of M line) (Table 5). Few of the patients who did not show any abnormality in static images showed changes in straining, thus the benefit of dynamic MRI.

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