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ORIGINAL ARTICLES

Diagnostic accuracy of Magnetic Resonance Imaging (MRI) in Evaluation of Pituitary Adenoma

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Abstract:

Objectives: *To assess the diagnostic accuracy of Magnetic Resonance Imaging in evaluation of pituitary adenoma.* ***Methodology:*** *This cross sectional observational study was done for a period of two years from July 2017 to June 2019 in the department of Radiology and Imaging, Dhaka Medical College Hospital (DMCH) with non-random purposive sampling of 36 patients suspected of having pituitary adenoma. Patients having no contraindication for MRI were imaged with 1.5 Tesla open MRI machine without and with contrast in the supine position with a slice thickness of 5-6 mm. Biopsy reports were compared with MR Diagnosis. The diagnostic value of MRI in the diagnosis of pituitary adenoma was determined by calculating sensitivity, specificity, accuracy, positive predictive value and negative predictive values.* ***Results:*** *In the study, sensitivity, specificity, positive predictive value, negative predictive value & accuracy of MRI in detecting pituitary adenoma were 96.66%, 83.33%, 96.66%, 83.33% & 94.44% respectively.*

Conclusion: *MRI is a non-invasive, ideal and reliable imaging modality for evaluating anterior cruciate ligament injury.*

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Introduction:

The pituitary gland is an important gland of the body as it controls most of the endocrine functions of the body by means of the hypothalamus-pituitary axis. It regulates many body processes including growth, reproduction and various metabolic activities[1]. This small, pea-sized gland in the sella turcica is divided into two parts: anterior lobe and posterior lobe[2].

Tumours of the pituitary gland are almost always benign and slow growing. Pituitary adenomas constitute approximately 10% to 25% of all intracranial neoplasms and represent the most common sellar pathology[3].

On the basis of size, pituitary adenomas can be classified as microadenomas (measuring less than 10 mm in diameter) and macroadenomas (measuring more than 10 mm in diameter). Tumors larger than 4 cm are referred to as giant adenomas[4].

Pituitary tumours can produce sign and symptoms due to excessive hormone production, local effects of the tumour or by inadequate hormone production by the remaining pituitary gland. The most characteristic presenting features of pituitary adenomas include inappropriate pituitary hormone secretion and visual field deficits. An expanding mass may give rise to signs and symptoms of mass effects, particularly raised intracranial pressure and headache is the most common manifestation. Small lesions confined to the pituitary gland may be asymptomatic[5]. As the tumor grows it extends up in front of' the pituitary stalks to press on inferior aspect of optic chiasma, leading to gradual

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bi-temporal hemianopia by stretching of decussating fibers of optic chiasma[5]. Macroadenoma often expands the bony sella and extends into the suprasellar cistern giving a "figure of eight" or "snowman" like appearance, the waist of the mass being the rigid dura of the diaphragm sellae. Very large pituitary tumours may cause obstruction of CSF, resulting in hydrocephalus and expansion of the lateral ventricles[6]. Inferiorly, macroadenoma can extend into the sphenoid sinus, and posteriorly, they extend into the dorsum sella. Laterally they can invade the cavernous sinus and temporal lobe. The most reliable sign of cavernous sinus invasion is complete encasement of the internal carotid artery or presence of tumor between the lateral wall of the cavernous sinus and the carotid artery[7]. Seizure may occur if lesion extends into temporal lobe. Acute hemorrhagic infarction of a pituitary adenoma is referred to as pituitary apoplexy which clinically presents as acute onset of headache, vomiting, visual loss, and depression of consciousness or seizure[5].

The most common functioning pituitary adenoma is prolactin secreting adenoma which constitute about 30% of all pituitary adenomas, which clinically present as secondary amenorrhea, galactorrhea, infertility in women and loss of libido, impotence in men. The cardinal symptoms of GH-producing adenomas are acromegaly in adults or gigantism in children. Elevated glucocorticoid levels (ACTH-producing adenomas) are noted in about 5-10% of pituitary adenomas. Over production leads to the stigmata of Cushing's disease. In less than 1%, TSH-producing adenomas occur and produce hyperthyroidism. Pan-hypo-pituitarism or varying degrees of loss of any of the six hormones may occur[8].

Radiological diagnosis for lesions arising in the sella and parasellar region remains challenging due to complex anatomy of this region[8]. For pituitary gland abnormality, plain radiograph is not a sensitive indicator in detecting size of the sella and it is poor at depicting soft tissues. Thus the plain radiographs have been replaced by CT scan and MRI[1]. CT scan may be useful when supplementary information concerning bony structures or calcification is required[5]. With CT there is radiation exposure and difficulty in identifying smaller lesion. Hence CT scan is replaced by Magnetic Resonance Imaging[1].

At present, MR imaging is the modality of choice in the imaging of pituitary lesion[9]. MR imaging has better soft tissue resolution and produces no artifacts from surrounding bony structures. In addition MR imaging allows for direct imaging in all three planes and lack of ionizing radiation.

Diffusion weighted imaging (DWI) and apparent diffusion co-efficient (ADC) maps can give information regarding the consistency (soft/hard) of pituitary macroadenomas and tumor components of pituitary microadenoma. Soft adenoma appears hyperintense on DWI and shows low ADC value and hard adenoma appears hypointense on DWI and shows high ADC value. On MR spectroscopy pituitary adenoma may show a choline peak. Primary role of MR spectroscopy is to differentiate various type of pituitary lesion[10].

Correct diagnosis prior to any intervention is essential as the treatment of choice will be different. MRI is now the mainstay in the imaging of pituitary lesions because of high soft tissue contrast, multiplanar capability, tissue characterization ability, absence of bone artifacts and not having the hazards of radiation. Early detection of tumor before involvement of parasellar structure especially cavernous sinus is very much crucial and beneficial for the patient, when resection is easier. The present study is thus intended to assess the accuracy of Magnetic Resonance Imaging in the evaluation of pituitary adenoma.

Methodology:

This cross sectional observational study was done for a period of two years from July 2017 to June 2019. All clinically suspected pituitary adenoma patients referred to department of Radiology and Imaging, Dhaka Medical College Hospital (DMCH) for a MRI scan from outpatient and inpatient departments of neurosurgery and medicine of Dhaka Medical College Hospital (DMCH) were included in the study. Non-random purposive sampling was done with a sample size of 36. Patients who did not have surgery, patients implanted with non-paramagnetic medical device or patients unfit for surgery were excluded from the study.

Operational definition:

Pituitary macroadenomas[11] are well defined mass with a size of more than 10 mm in diameter which

are Iso-intense to grey matter in T1W & T2W images. Signal characteristics vary depending on the presence of hemorrhage, cystic change or necrosis. Post contrast images shows in-homogeneous moderate to bright enhancement with or without one or more accessory findings like a) Shape - Figure of eight (in coronal section) if upward extension. b) Displacement of optic chiasma upwards. c) Compression on the third ventricle with resulting hydrocephalus. d) Lateral extension may cause invasion of cavernous sinus. MRI variables were size & location of the tumor, signal intensity in both T1WI, T2W1 and DWI, Contrast enhancement pattern, Involvement of adjacent structures, Optic chiasma compression, Compression of third ventricle, Cavernous sinus involvement and Sphenoid sinus involvement.

Study procedure:
Prior to commencement of this study the research protocol was approved by ethical committee of Dhaka Medical College, Dhaka. Subjects were briefed about the objective of the study, risk and benefits and confidentiality. Written informed consent was obtained from the patients and MRI scan of brain was performed in all cases.

Imaging technique and procedure:
Patients having no contraindication for MRI were assured that the examination is not painful. MR imaging was obtained with 1.5 Tesla open MRI machine (ECHELON OVAL- HITACHI) in the supine position. Scanning protocol included a series of T1 & T2 weighted images in axial, sagittal, coronal planes, FLAIR images in axial plane and DW images in axial plane. Non-ionic contrast media named Diascan (Gadodiamide INN 287 mg/ml or 0.5 mmol/ml) was given at a dose of 0.1 to 0.2 ml/kg body weight as bolus intravenous injection and post contrast T1 weighted images in sagittal, coronal and axial planes were taken immediately. Slice thickness was 5-6 mm.

Histopathology technique:
Biopsy material was collected after surgical intervention and sent to pathology in 10% formalin for ultimate histopathology report. Collected reports were then compared with diagnosis of MRI.

Data analysis:
Statistical analysis of recorded collected data was performed using the statistical package for social science (SPSS-23.0). Results were presented in tables, figures, diagrams. Continuous parameters were expressed as mean ± SD and categorical parameters as frequency and percentage. The diagnostic value of MRI in the diagnosis of pituitary macroadenoma was determined by calculating sensitivity, specificity, accuracy, positive predictive value and negative predictive value and comparison of the radiological diagnosis with histopathological diagnosis was calculated by using appropriate formula.

Results:
This cross-sectional study was conducted in the department of Radiology and Imaging of Dhaka Medical College, Dhaka to evaluate the diagnostic accuracy of MRI in detection of pituitary adenoma enrolling 36 patients of 21 to 80 years of age range during the period of July 2017 to June 2019. The results of the study were set out in tables and figures as follows:

Table I
Showing distribution of the patients by age (n=36).

Age (Years)	Frequency (n)	Percentage (%)
21 - 40	25	69.46
41 - 60	08	22.22
> 60	03	8.32
Mean ± SD	38.2 ± 8.32	
Range (min-max)	21-72 years	

Gender distribution of the patients showed that among 36 patients, 16(44%) were male and 20(56%) were female with a male to female ratio was 1:1.2.

The most common presenting clinical finding of the patients with pituitary tumor was headache 29(80.55%) followed by visual disturbance 21(58.33%), Vomiting 12(33.33%), Secondary amenorrhea 05 (13.88%) Galactorrhoea 04 (11.11%), Polyuria, polydipsia 03 (8.33%), Convulsion and acromegaly 02 (5.5 %) each respectively.

Table II
Showing distribution of the patients by MRI diagnosis (n = 36).

MRI diagnosis	Frequency	Percentage
Pituitary macroadenoma	30	83.33
Menigioma	04	11.11
Craniopharyngioma	02	5.56
Total	36	100

Table III
Showing MRI features of pituitary macro-adenoma according to size of the tumor (n=30).

Size of the tumor (in mm)	Frequency	Percentage
11-30	14	46.66
31-50	16	53.33

The smallest macro adenoma measured 12 mm and the largest about 48 mm in maximum dimension.

Among 30 patients of pituitary macroadenoma, purely sellar macroadenoma was seen in 01(3.33%) case, sellar and supra-sellar extension was in 19(63.33%) cases and 10(33.33%) cases having para-sellar extension.

Table IV
Showing MRI features of pituitary macro-adenoma according to signal intensity and contrast enhancement(n= 30).

MRI Signal Intensity		Frequency	Percentage
T1WI	Hypointense	05	16.66
	Hyperintense	01	3.33
	Iso intense	24	80
	Mixed intense	00	00
T2WI	Hypointense	00	00
	Hyperintense	10	33.33
	Iso intense	19	63.33
	Mixed intense	01	3.33
DWI	Restricted	09	30
	Not restricted	21	70
Contrast enhancement	Homogeneous	21	70
	Heterogeneous	09	30

Table V
MRI features of pituitary macroadenoma according to involvement of adjacent structures (n=30)

Involvement of adjacent structures	Frequency	Percentage
Optic chiasma compression	18	60
Third ventricle compression	05	16.66
Cavernous sinus invasion	10	33.33
Sphenoid sinus invasion	02	6.66

Table VI
Showing distribution of the patients by histopathological diagnosis (n = 36).

Histopathological diagnosis	Frequency	Percentage
Macroadenoma	30	83.33
Other tumor of sellar region	06	16.67
Total	36	100

Among the 06 cases of other tumors of sellar region 03(8.33%) cases were histopathologically diagnosed as meningioma and 03(8.33%) cases were craniopharyngioma.

Table VII
Showing MRI diagnosis compared with histopathological diagnosis of pituitary macroadenoma (n = 36)

MRI diagnosis	Histopathological diagnosis		Total	p value
	Positive	Negative		
Test positive	29 (TP)	01 (FP)	30 (TP +FP)	
Test negative	01 (FN)	05 (TN)	06 (FN + TN)	<.001
	30	06	36	
Total	(TP +FN)	(FP+TN)	(TP+FP+TN+FN)	

*chi square test (TP: True positive, FP: False positive, TN: True negative, FN: False negative)

Table VIII

Showing Validity test results of MRI scan in the diagnosis of pituitary macroadenoma (n = 36)

Validity test parameters	Percentage (%)
Sensitivity	96.66%
Specificity	83.33%
Positive predictive value	96.66%
Negative predictive value	83.33%
Accuracy	94.44%

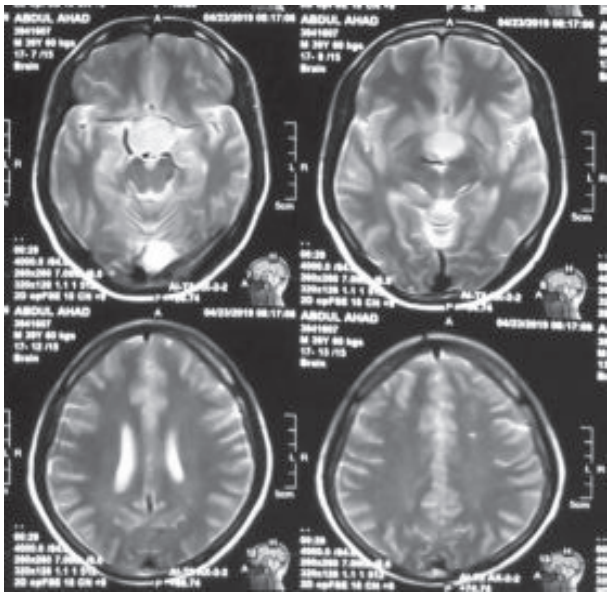

Fig.-1: *Non contrast axial T2WI showing iso-intense supra-sellar pituitary macroadenoma*

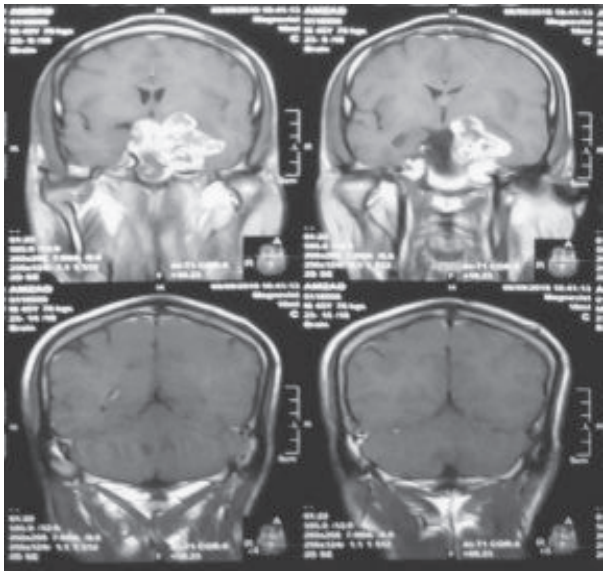

Fig.-2: *Evidence of compression on optic chiasma & third ventricle and involvement of cavernous sinus in a case of pituitary macroadenoma as shown by contrast enhanced MR images*

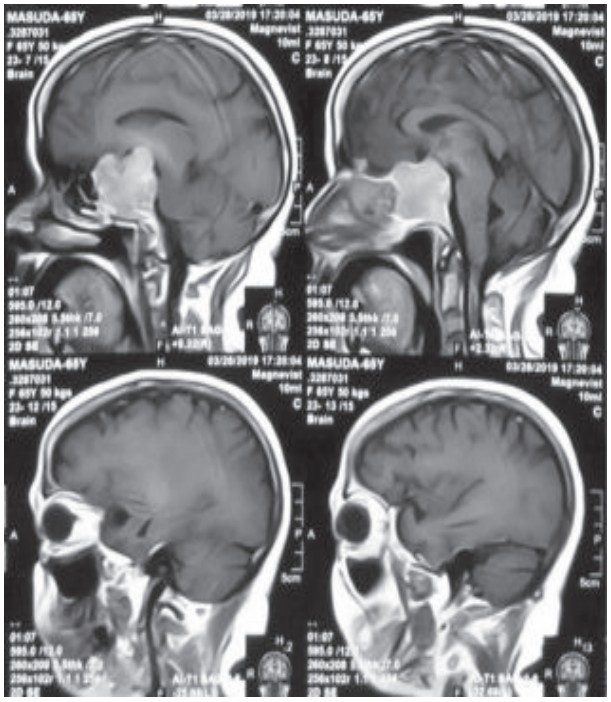

Fig.-3: *Contrast enhanced sagittal MR scans showing heterogeneous contrast enhancement of pituitary macroadenoma*

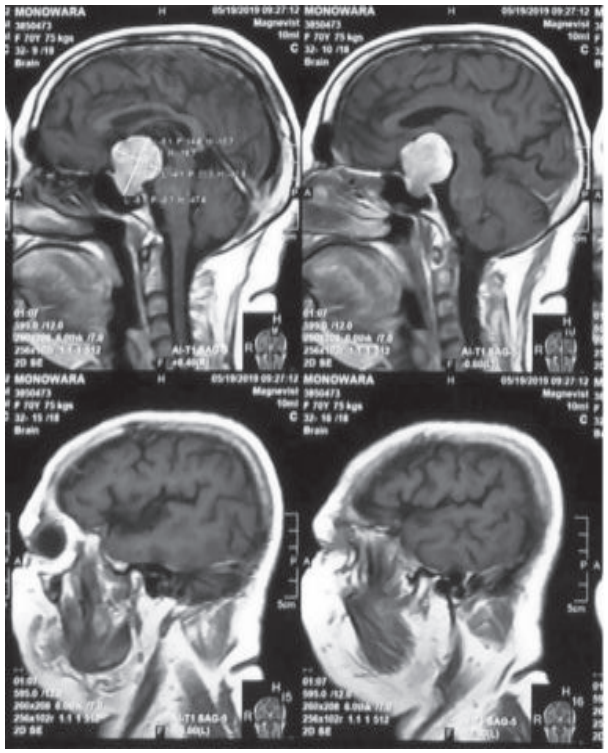

Fig.-4: *Contrast MR with sagittal images showing heterogeneous contrast enhancement of Supra-sellar pituitary macro-adenoma*

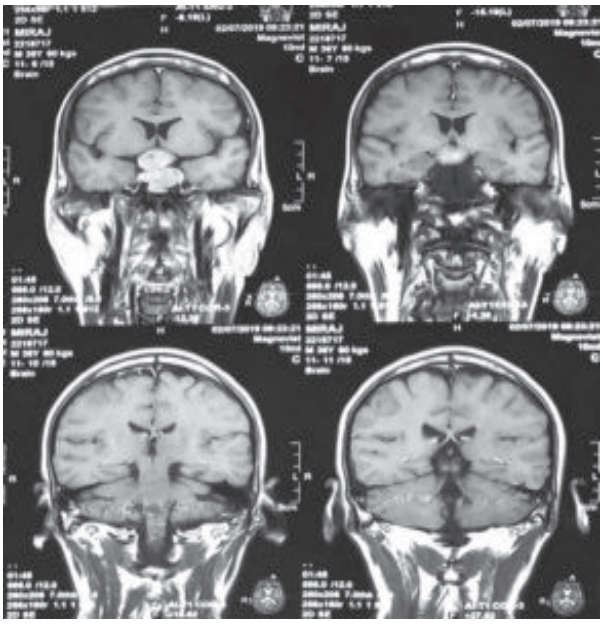

Fig.- 5: *Contrast enhanced T1W coronal MR images of pituitary macroadenoma with evidence of compression on optic chiasma and third ventricle and cavernous sinus involvement*

Discussion:

The present cross-sectional study was conducted in the department of Radiology and Imaging of Dhaka Medical College, Dhaka, between the periods of July 2017 to June 2019. The study was conducted to assess the diagnostic accuracy of MRI in the evaluation of pituitary adenoma. A total of 36 patients were included in this study after fulfillment of inclusion and exclusion criteria who referred to Radiology and Imaging department of Dhaka Medical College for MRI scan.

The age range of the patient was 21 to 72 years. The mean ± SD of age was 38.2 ± 8.32. The maximum number of the patients 25(69.46%) was between 21-40 years. Out of all 36 patients, 16(44%) were male and 20(56%) were female. Male to female ratio was 1:1.2. This study is more or less similar to the findings by Hui et al.[12] who showed majority of the patients (58%) belonged to the age group of 20-49 years with a mean age of presentation of 34.6 years. There was a female predominance with a male-to-female ratio of 1:1.17. In another study, Batra et al.[13] reported that majority of the patients (42%) was in the age group of 21 to 40 years. Females predominated in the study constituting 60% of the total population with a male to female ratio of 1:1.5.

Analysis of clinical features revealed that headache and visual disturbance were the common presentations constituting 29(80.55%) and 21(58.33%) of cases respectively, followed by vomiting which was observed in 12(33.33%) patients. This is more or less consistent with the study of Pereira et al.[14] who showed headache and visual disturbance were common presenting complains and noted in 63% and 58% patients, respectively. In another study, Gupta et al.[6] found headache was present in 75% and decreased vision in 43% of patients. Visual disturbance was more in this study which could be explained by patients' negligence, denying of mild symptoms and delayed seeking to medical advice until the macroadenoma enlarges and affect the optic pathway. In this study headache was little more possibly due to involvement of sellar and juxtasellar structures by majority of macroadenoma cases.

This cross-sectional study was carried out by 1.5-T MRI with 5-6mm slice thickness. Out of 36 patients, 30 cases were diagnosed as pituitary macroadenoma, 4 cases were meningioma and 2 cases were craniopharyngioma.

In this study, pituitary macroadenomas ranged in size from 1-3 cm in 14(46.66%) cases and 16(53.33%) of them were between 3-5 cm in size. A study done by Pereira at al.[14] who showed that 41.5% of macroadenoma ranged in size from 1-3 cm and 58.5% of them were between 3-5 cm.Thus showing similar result and closely resemble our study.

Regarding the location, 1 case of macroadenoma was entirely intra-sellar with no supra or para-sellar extension, 19 cases (63.33%) of macroadenoma had sellar and supra-sellar extension and 10 cases (33.33%) having para-sellar extension. This is in consistent with the study of Ironside[5] who showed that the common location of pituitary macroadenomas are sellar and supra-sellar and additional para-sellar extension in giant macroadenoma. In another study, Hui et al.[12] reported that most of the patients involved both sellar and supra-sellar regions consisting of 74%, 22% of patients involved only parasellar region and 4% of patients involved only sellar area which was more or less similar to this study.

On the evaluation of imaging characteristics, pituitary macroadenomas are usually isointense to grey matter on both T1WI and T2WI. In this

study, within 30 cases of macroadenoma, 24(80%) were iso-intense and 5(16.66%) were hypo-intense and 1(3.33%) was hyper-intense on T1WI. Similar result was shown by Batra et al.[13]. They showed that 75% macroadenomas were iso-intense and 17% were hyper intense on T1WI. High signal intensity on T1WI could be due to the presence of hemorrhage accompanying pituitary adenoma.

On T2WI, 19(63.33%) macroadenoma were iso-intense, 10(33.33%) were hyper-intense and 01(3.33%) was mixed intensity. More or less similar result was found by Pereira et al.[14]. They showed 60% macroadenoma were iso-intense and 40% were hyper-intense on T2WI. The presence of cystic or necrotic areas could result in variable signal intensity on T2WI. In another study, Hui et al.[12] showed that majority of the macroadenomas were iso-intense to gray matter (85.71%), followed by hypo-intense (14.29%) on T1WI, and all the cases were T2 hyper-intense.

In 05 cases (16.66%), there was focal hypo-intensity on TIWI which were hyper-intense on T2WI and nonenhancing after contrast. The signal intensity changes are characteristic of cystic degeneration within the tumor as suggested by Mourad and Khalaf[15] who showed about 17.5% of macroadenomas reveal the cystic component, which is similar to our study result.

Regarding the pattern of contrast enhancement, the present study showed contrast enhancement in all cases of pituitary macroadenoma, homogeneous enhancement was in 21(70%) cases and heterogeneous enhancement was in 09(30%) cases. A study by Hui et al.[12] showed that homogeneous enhancement was seen nearly in 71.43% of macroadenomas. In another study, Mourad and Khalaf[15] showed 82.5% of macroadenoma exhibit homogeneous moderate enhancement. Heterogeneous enhancement may occur due to presence of cystic or necrotic areas within pituitary macroadenoma.

In this study, optic chiasma compression was noted in 18 cases (60%), compression of third ventricle with resultant hydrocephalus was in 05 cases (16.66%), cavernous sinus invasion was in 10 cases (33.33%) and sphenoid sinus invasion was in 02 cases (6.66%) which is more or less similar to the study of Pereira et al.[14]. They showed optic chiasma compression in 58.5% cases, third ventricle compression with resultant hydrocephalus in 9.4% cases and cavernous sinus invasion in 68% cases. In another study, Batra et al.[13] reported optic chiasma compression in 62% cases, cavernous sinus invasion in 35% cases and sphenoid sinus invasion in 7% cases. So present study finding closely resembled the mentioned studies.[13,14]

Out of 36 cases, 30 were diagnosed as pituitary macroadenoma by MRI and among them 29 were confirmed by histopathological evaluation. They were true positive and another 1 case was false positive. Out of 06 cases of other than pituitary macroadenoma which were confirmed by MRI, 1 was confirmed as pituitary macroadenoma and 05 were other than macroadenoma by histopathology diagnosis. They were false negative and true negative respectively. The sensitivity of MRI in diagnosing macroadenoma was 96.66%, specificity was 83.33%, positive predictive value was 96.66%, negative predictive value was 83.33% and accuracy was 94.44%. The sensitivity, specificity, positive predictive value, negative predictive value and accuracy of MRI were 88.2%, 83.3%, 88.2%, 83.3%, and 86.2% respectively in the study of Batra et al.[13]. In another study, Hui et al.[12] showed sensitivity, specificity and accuracy of 95.24%, 93.33% and 94.12% respectively which are almost similar to our study.

Conclusion:

It can be concluded that magnetic resonance imaging (MRI) scan is accurate imaging modality for the diagnosis of pituitary adenoma.

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