ISSN:0975-3583,0976-2833 VOL12,ISSUE05,2021

ORIGINAL ARTICLE

Role OfMultiparametric Magnetic Resonance Imaging In Predicting Pituitary Macroadenoma Consistency

Mai Hassan Dawood[1], Inas Mohamed Elfiki[2], FatenFawzy Mohamed[3],Ali Mahmoud Hassanin[4].

[1,2,3,4]Department of diagnostic radiology, Faculty of Medicine, Zagazig University, Sharkia, Egypt.

Email: Maihdawood@gmail.com[1],Inas-rad@hotmail.com[2],Fatenfawzy25@hotmail.com[3], Dr_alih2000@hotmail.com[4]

Abstract

Background:Assessmentof pituitary macroadenomaconsistency before surgical resection is crucial for neurosurgeonsto choose the surgical procedure. So, we sought to evaluatethe multiparametric MRI role as a noninvasive method in predicting pituitary macroadenoma consistency

PatientsandMethods: AtZagazig University Hospitals, a multiparametric MRI was scheduled fortwenty-four patients with pituitary macroadenoma. We determined the tumor consistency both macroscopically by neurosurgeons and microscopically by histopathologists.

Results: The consistency of the pituitary macroadenoma and the T2 weighted image (T2 WI) signal intensities were found to have a significant association as well as DWI & the corresponding ADC values, while we found no correlation between the post contrast T1 weighted image patterns of enhancement and the tumor consistency.

Conclusions: As part of the usual pre-operativemacroadenoma consistency check, T2 WI, DWIand the corresponding ADC value were shown to be able to detect macroadenomas consistency with high accuracy.

Keywords:ADC, Diffusion-weighted magnetic resonance imaging DW MRI, Multiparametric MRI, Pituitary macroadenoma, T2 weighted image.

Introduction

Pituitary macroadenoma is one of the most commonsellar space-occupying lesions. It isconsidered a benign tumor of the pituitary gland.Surgical resection is indicated for sellar decompression of masses causing visual field defects, pressure on the central nervous system and problems with pituitary function [1].

Pituitary macro-adenomas were categorized into soft, moderate and hard types according to histopathology and surgical viewpoint of tumor consistency [2].

Choosing the appropriate method relies partially on an inner characteristic of the tumors; its integrity. Neurosurgeons decided that trans-sphenoidal endoscopic suctioning is convenient if the tumor has a delicate texture,while trans-craniotomy is more ideal in removing the intermediate &ones that are more firm. Therefore, pre-operative tumor integrity testing can assistin determining the perfect operational approaches and therapies that will not only improve the chance of full tumor elimination but decrease their reappearancetoo [3].

The goal of our research is to determine the role of multiparametric MRIas a noninvasive method in predicting the consistency of a pituitary macroadenomaand determining the appropriate a resection strategy, whether recent minimally invasive endoscopic transsphenoidal approach or transcranial approach.

1. Patientsand Methods

1.1. Patients:

A total number of 24 patients were scheduled for MRI at the Radio-diagnosis department, ZagazigUniversityHospital. They were referred by neurosurgeons for suspicion of having pituitary macroadenoma.

2.2.1. Inclusion criteria:

Patients withpituitary macroadenomas that had been diagnosed by multiparametricMRI and proved later by histopathologists.

2.1.2. Patient exclusion criteria:

Patients with obstacles for MRI (cardiac pacemakers, insulin pump drives, imbedded hearing aids, and intra-cranial metallic clips are all examples of implanted electric and electronic equipment). Patients with previously operated macroadenoma with residual lesions were excluded as well as patients with invasive macroadenoma.

We explained our study to the patients then we took an informed approval from them.The study was authorized by the Zagazig University Faculty of Medicine's ethical research committee. The study was conducted in accordance with the World Medical Association's Code of Ethics (Declaration of Helsinki) for human studies.

ISSN:0975-3583,0976-2833 VOL12,ISSUE05,2021

2.1.3. Patients' preparations

Full history taking and clinical analysiswas made,then we asked all patients to get rid of any metallic subjects as well as they were asked about any contraindication to MRI examination (except that made of Titanium).

1.2. ***Imaging and image study: (pre-surgery MRI)****:*

Using1.5 TPhilipsMRI equipment with configuration that is closed,the patients were placed in supine position; their headswere rested on a vacuum pillow, and the head coils were used.

The following MRI protocols were used on wholly patients:

Conventional MRI as follows; Pre-contrast administration axial, coronal, and sagittal cuts of T1-WIs using the following parameters TR 400–550 m/s, TE 15 m/s, Field of view 250, matrix 256 x 256, slices thickness 3 mm, inter-slice gaps 1 mm, and coronal cuts of T2-weighted turbo-spin-echo (T2 TSE) by the next parameters TR 3500–4800 m/s, TE 110 m/s, Field of view 250, matrix 256 x 256, slice thickening 3 mm, inter-slice gaps 1 mm, then post-contrast administration axial, coronal and sagittal cuts of T1-WIs after IVGd-DTPA (gadopentetatedimeglumine)injection0.10 mm/kg body weight (00.20 ml/kg) were done.

Before administration of the contrast material, breath-hold DWI was done in axial and coronal planes, with one shot spin-echo echo-planner sequence (TR/TE: 2000/33–55, matrix size 128 x 128, section thickning 5 mm, inter-slice gap 1 mm, Field of view 38 cm, b values 00 and 1000 s/ mm²).

ADC maps were generated automatically, and ADC values were obtained by employing a circumferential ROI (8–50 mm2) in the solid centre regions of macro-adenomas to estimate ADC values.

1.3. Surgery:

Using the transsphenoidal approach, all macroadenoma patients underwent excisional surgery. At surgery, neurosurgeons , who didn`t know the pre-operative MRIdata, assessedthe neoplasm consistency and divided it into three categories: soft (suction-removable); medoerate, and firm (not suctioned).

1.4. Diagnosis histopathologically:

After surgical resection, our pathological outcome was secured.

1.5. Statistical Analysis:

Microsoft excel was used to gather, code, enter and analyse the data. The data was then analyzed using the Statistical Package for the Social Sciences (SPSS version 23.0)programme.

Variances between quantitative paired groups were evaluated by paired t-test for significance; P-value was set at <0.05 for significant outcomes&<0.001 for high significant outcomes.

2. Results

In the current study, we include twenty-fourpatients; formed of 10 males and 14 females, their ages ranging around 29- 42 years old, with a mean34.38 years of age.

Table (1):This table shows consistency of macroadenoma by histopathology versus T2 weighted image signal intensity:

There is a statistically significant association between macroadenoma consistency and their T2WI signal intensity where p-value = 0.01, as shown in (Table 1). Low signal T2 intensity points primarily to the hard, fibrous tumor.

T2 WI	Soft (*n*=12)		Intermediate (n=3)		Hard (n=9)		χ^2	P
	N	%	N	%	N	%		
▪ Isointense	3	25%	0	0%	0	0%	9.06	0.01*
▪ Hypointense	2	16.7%	0	0%	9	100%		
▪ Hyperintense	7	58.3%	3	100%	0	0%		

χ2: Chi square test *: Significant result (P<0.05).

Table (2): This table shows consistency of macroadenoma by histopathology versus pattern of enhancement: There is no significant association between consistency of pituitary macroadenomas and their enhancement pattern where P value = 1. As shown in (Table 2). P value is considered significant statistically when (P < 0.05)

ISSN:0975-3583,0976-2833 VOL12,ISSUE05,2021

Pattern of enhancement	Soft (n=12)		Intermediate (n=3)		Hard (n=9)		$\chi 2$	P
	N	%	N	%	N	%		
▪ Homogenous	7	58.3%	0	0%	7	77.7 %		
▪ Heterogeneous	5	41.7%	3	100%	2	22.2 %	0	1 NS

$\chi 2$: Chi square test NS: Nonsignificant (P>0.05)

Table (3): This table shows consistency of macroadenoma byhistopathology versus DWI & ADC: There is highly statistically significant associations between tumor consistency and DWI& ADC map signal intensity as well as mean ADC values where P value < 0.001 as shown in (Table 3).

Variable	Soft		Intermediate		Hard		Total	X^2	P
	N	%	N	%	N	%			
▪ DWI &ADC results	10	41.6%	5	20.8%	9	37.5%	24	24	<0.001**
▪ Histo-pathology	12	50%	3	12.5%	9	37.5%	24		

$\chi 2$: Chi-square test **: Highly significant result (p<0.01)

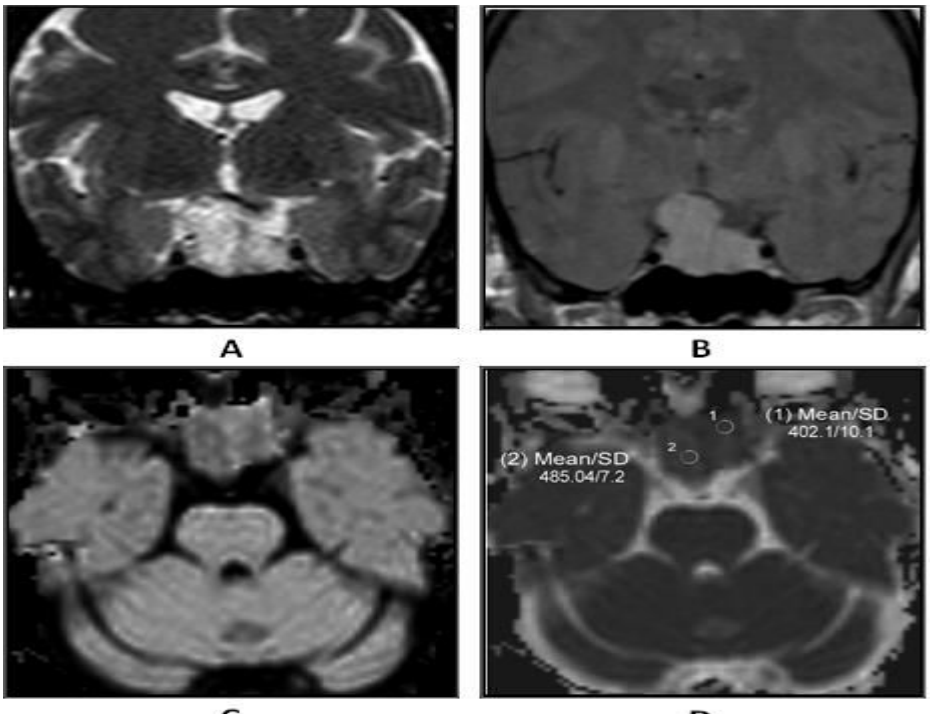

Figure (1): A 30-year-old woman complained of a headache, visual blurring, and repeated vomiting. A-Coronal cut of T2-WI exposedhyperintensesellar , suprasellar&parasellarmass. B- Coronal cut of T1-WI Post contrastexposed intense uniform enhancing pattern of the detected lesion. C- Axial cut of DWI-MRIexposed hyper-intensity of the detected lesion (Diffusion restriction). D- ADC map sequenceexposed hypo-intensity of the detected lesion withvalue of ADC of 0.44 x 10^{-3} mm^2 /s. Surgery and histopathology determined that the tumor was of the soft kind.

ISSN:0975-3583,0976-2833 VOL12,ISSUE05,2021

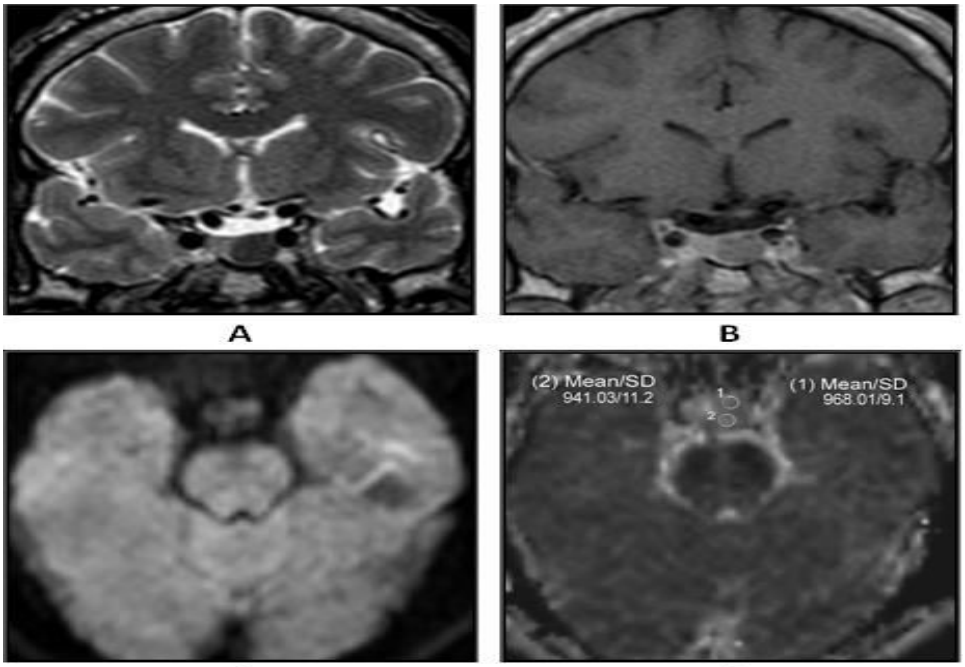

Figure (2): The patient is a 40-year-old man presented byheadache. A- Coronal cut of T2-WI exposed hypo-intense expanding sellar mass. B_ Coronal cut of T1-WI Post contrast exposed mild uniform enhancing pattern of the detected lesion. C_ Axial cut of DWI-MRIexposed hypo-intense signal of the detected lesion (No diffusion restriction). D_ ADC map sequence exposed hyper-intense signal of the detected lesion with value of ADC of 0.95 x 10^{-3} mm^2 /s. Surgery and histopathology determined that the tumor was of the hard kind.

3. Discussion

Macroadenomas of the pituitary are known as the most prevalentsellar pathology, and they are in generalconsidered as nonthreateningreplication of the anterior lobe cells of the pituitary gland. Regarding size, adenomas more thanten(10) mm in diameterarestated tobemacro-adenomas, while lesions less than ten (10) mm are classified to be micro-adenomas [1,4].

There are two surgical approaches to resect those pituitary macro-adenoma masses, named endoscopic trans-sphenoid surgery and trans-cranial open surgery, but the selection of the surgerysomewhatreliesonmacroadenomasconsistency. Macroadenomas with soft consistency is easy to be curetted by means of suctioning through the trans-sphenoidal endoscopic approach, whilethe harder onesneed the trans-cranial approach[3].

The transsphenoidal endoscopic procedure is non-disturbing;it affordsimmediate access to the tumour while preservingthe residual typical pituitary cells, healing and fewererrors of field of sightowing to that the chiasmaand the optic nervesare only manipulated to a certain extent. However, the restriction of the macroadenomaconsistency,asasoft mass can be aspirated, while a more extensive procedure (transcraniotomy approach) is needed for the fibrous pituitary macroadenomas with hard consistency [5].

The percentage of collagen is the main determinant of the texture of the tumor, as soft macroadenomas arerich in cells with few collagen contents while the hard one showsfew cells, excessive fibrous stroma, and high content of collagen [6].

So, assessing macroadenoma texture preoperatively is critical for neurosurgeons to determine which surgical procedure to proceed; whether the endoscopic trans-sphenoid orthe open trans-cranial method, which will ensure the likelihood of full tumor eradicationand avoid their reappearance[7].

We matched our radiological findings to our histological data to investigate the MRI role in detecting pituitary adenomas consistency.

Our research discovered a significant link between the pituitary macroadenomas consistency and the T2-WI signals of the three clusters we looked at. On T2WI, soft masses had hyper-intense signal (7), iso-intense signal (3), and hypo-intense signal (2 cases) compared to grey matter, while the intermediate group had hyperintense signals relative to grey matter (3 cases). In comparison to grey matter, the hard group showed a hypointense signal (9 cases).

Our findings matched those of Smith et al. and Wei et al., who observed that a lower signal intensity on T2 WI connects with augmented content of collagen and thus a fibrous firm consistency [8,9].

ISSN:0975-3583,0976-2833 VOL12,ISSUE05,2021

Unlike Pierallini et al., who found an inverse relationship between signalsat T2WI and the proportion of the collagen content of macroadenomas, we found no such relationship while Boxerman et al..reportedanon-significantlinkage betweentumoral T2-weighted signal intensity and surgical result;this could be due toseveralelements affecting T2-weighted image signals such astumoral cellularity content, nucleus:cytoplasmic percentage, the free water amount in the extra-cellular areaandthetumoral content of fibrous tissue and microcysts [10,11].

We discovered no significant correlation between consistency and post-contrast enhancement pattern in different histological subtypes of macroadenoma; the enhancement pattern of the soft group was homogeneous in (7) cases and heterogeneous in (5) cases, while all intermediate (3) cases displayed heterogeneous pattern. (7) cases of hard macroadenomademonstrateda homogenous enhancingpattern, while another (2) cases demonstrated a heterogeneous pattern of enhancement.

The uniform pattern of enhancement is inversely connected with the soft components of the neoplasmthat have a high percentage of fibrosis and peri-vascular fibrosis, according toRomano et al.[12].

We observed no association between our study and this one in terms of the style and consistency of post-contrast enhancement; we identified different patterns of enhancement in each group.

Illuminating the statistical analysis of our DWI & ADC findings with histopathological findings; which exhibited that soft macroadenomas were verified to be 12 cases by histopathology from which DWI & ADC spotted 10 cases only, there were five intermediate macroadenomas by DWI & ADC which were proved to be 3 cases only by histopathology and 9 hard macroadenomas were found by both DWI & ADC and histopathology, we reported a shining major association between pituitary macroadenoma consistency and DWI& ADC map signal intensity as well as mean ADC values where P-value (< 0.001).

Our study was in agreement with the study described by Mohamed and Abouhashem**.**Consideringanundeviatingrelationship between ADC and neoplasm consistency from the soft to the firm side, soft neoplasmsexhibit smallADC values, and the tough ones exhibitlargeADC values [13].

Our results have been found unchanging with Pierallini et al. andAlashwah et al.,who found there isamajorconnection between the neoplasm consistency and ADC values with the recommendation of using DW MR images toafforddetails about the tumorconsistency [10, 2].

We were in conflict with the results ofthe study of**Suzuki et al.,**where cases at their study were restricted to soft and moderate textures, without encountered cases of hard macroadenoma, and the moderate consistencymean ADC `s value was found faintlylesserthan soft ADC`s values, however the between-group ADCs were non-considerablydissimilar [14].

These disparities between the findings can be related to consumingaltered DWI techniques and limited sample size in their study, which was restricted to soft and intermediate consistencies.

4. Conclusion

Our findings reveal that T2-WI signal intensity and pituitary macroadenoma consistency have a significant relationship, but DWI and ADC signal intensity and adenoma consistency have a highly significant relationship. Finally, T2 WI and DWI with the corresponding ADC value may be a simple and effective strategy for forecasting pituitary macroadenoma consistency.

Funding: No funding was received for this study.

Data Availability Statement: The data presented in this study are available on request from thecorresponding author.

Conflicts of Interest: The authors declare no conflict of interest.

References

1.**Przybylowski CJ, Dallapiazza RF, Williams BJ,Pomeraniec IJ, Xu Z, Payne SC, et al.,**: Primary versus revision transsphenoidal resection for nonfunctioning pituitary macroadenomas: matched cohort study. J Neurosurg**(2017)**; 126(3): 889-896.

2. **Alashwah MA, Moharram MA, and Allakany AS:** Role of diffusion weighted magnetic resonance imaging DW-MRI in choice of the surgical approach for pituitary macroadenoma resection. Egypt. J. Radiol. Nucl.Med. **(2017)**; 48(4): 983-989.

3. **Sol YL, Lee SK, Choi HS, Lee YH, Kim J and Kim SH.:** Evaluation of MRI criteria for cavernous sinus invasion in pituitary macroadenoma. J Neuroimaging**(2014)**; 24(5): 498-503.

4. **Pal A, Leaver L, and Wass J.:** Pituitary adenomas. BMJ **(2019);** 365: l2091.

5. **Ji-Hu Y, Guo-Dong H, Tao J,Hai-Dong W, Yu-Fei L, Jian G, et al.,:** Endoscopic endonasal surgery treatment strategies for invasive pituitary adenoma: analysis of four approaches. World Neurosurg.**(2018)**; 115: 5-13.

6. **Fang N, Wu Z, Jiang C, Wang X, Kang D, Li L, et al.,:** Prediction of the consistency of pituitary adenomas based on multiphoton microscopy. J PHYS D APPL PHYS **(2019)**; 52(18): 185401.

ISSN:0975-3583,0976-2833 VOL12,ISSUE05,2021

7.**Yamamoto J, Kakeda S, Shimajiri S, Takahashi M, Watanabe K, Kai Y, et al.,:**Tumor consistency of pituitary macroadenomas: predictive analysis on the basis of imaging features with contrast-enhanced 3D FIESTA at 3T. AJNR **(2014)**; 35(2): 297-303.

8. **Smith KA., Leever JD., and Chamoun RB.,:** Prediction of consistency of pituitary adenomas by magnetic resonance imaging. J Neurol Surg B Skull Base**(2015)**; 76(05): 340-343

9.**Wei L., Lin SA., Fan K., et al.,:** Relationship between pituitary adenoma texture and collagen content revealed by comparative study of MRI and pathology analysis. Int J Clin Exp Med **(2015)**; 8(8): 12898.

10. **Pierallini A, Caramia F, Falcone C, Tinelli E, Paonessa A, Ciddio AB, et al.,:** Pituitary macroadenomas: pre-operative evaluation of consistency with diffusion-weighted MR imaging-initial experience. Radiology **(2006)**; 239(1): 223-231.

11.**Boxerman JL., Rogg JM., Donahue JE., et al.,:** Pre-operative MRI evaluation of pituitary macroadenoma: imaging features predictive of successful transsphenoidal surgery. AJR Am J Roentgenol **(2010)**; 195(3): 720-728.

12.**Romano A., Coppola V., Lombardi M., et al.,:** Predictive role of dynamic contrast enhanced T1-weighted MR sequences in pre-surgical evaluation of macroadenomas consistency. Pituitary **(2017)**; 20(2): 201-209.

13. **Mohamed FF and Abouhashem S:** Diagnostic value of apparent diffusion coefficient (ADC) in assessment of pituitary macroadenoma consistency. Egypt. J. Radiol. Nucl.Med.**(2013)**; 44(3): 617-624.

14.**Suzuki C, Maeda M, Hori K, Kozuka Y, Sakuma H, Taki W, et al.,:** Apparent diffusion coefficient of pituitary macroadenoma evaluated with linescan diffusion-weighted imaging. J Neuroradiol**(2007)**; 34(4): 228-235.