Predictive Value of Conventional MRI Sequences on Operative Findings and Histopathology of Meningiomas - A Prospective Study

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Introduction

This study was undertaken to correlate MRI signals with operative consistency, vascularity, surgical plane & histopathology of meningiomas.

Methods

Patients with meningioma underwent T1, T2, FLAIR & contrast MRI, and those planned for excision were enrolled for the study. Clinico-demographic details, signal intensity of tumor in various sequences, & contrast enhancement were prospectively noted, and studied in relation to intra-operative tumor consistency, vascularity, dissection plane, Simpson's grade, and histopathology. SPSS21 was used for univariate & multivariate analysis.

Results

Of the total 70 patients (44 females, 26 males), 18 had skull base, 15 had convexity, 10 had parasagittal, 11 had falcine, and 7 had tentorial meningiomas. Majority (67) had tumors which were hypo to isointense in T1. While 14 had hypointense signal in T2, only 8

T1 Tumor Intensity Vs Operative Findings

T1 Tumor Intensity		Marked Hypointense	Mild Hypointense	Isointense	Mild Hyperintense
Total Number		7	20	40	3
Tumor Consistency	Soft	2 (29%)	9 (45%)	12 (30%)	-
	Mixed	4 (57%)	5 (25%)	16 (40%)	3 (100%)
	Hard	1 (14%)	6 (30%)	12 (30%)	-
Vascularity	Mild	-	4 (20%)	10 (25%)	1 (33%)
	Moderate	4 (57%)	7 (35%)	21 (53%)	1 (33%)
	High	3 (43%)	9 (45%)	9 (23%)	1 (33%)
Surgical Plane	Extrapial	6 (86%)	14 (70%)	31 (78%)	1 (33%)
	Mixed	1 (14%)	3 (15%)	5 (13%)	1 (33%)
	Subpial	-	3 (15%)	4 (10%)	1 (33%)
Histopathology	Meningothelial	4 (57%)	9 (45%)	25 (63%)	3 (100%)
	Transitional	1 (14%)	6 (30%)	7 (18%)	-
	Fibroblastic/ Psammomatous	-	2 (10%)	7 (18%)	-
	Others	2 (29%)	3 (15%)	1 (3%)	-

T2 Tumor Intensity Vs Operative Findings

T2 Tumor Intensity		Marked Hypointense	Mild Hypointense	Isointense	Mild Hyperintense	Marked Hyperintense
Total Number		2	12	19	30	7
Tumor Consistency	Soft	-	3 (25%)	9 (47%)	9 (30%)	2 (29%)
	Mixed	-	5 (42%)	6 (32%)	13 (43%)	4 (57%)
	Hard	2 (100%)	4 (33%)	4 (21%)	8 (27%)	1 (14%)
Vascularity	Mild	1 (50%)	5 (42%)	3 (16%)	6 (20%)	-
	Moderate	1 (50%)	4 (33%)	9 (47%)	17 (57%)	2 (29%)
	High	-	3 (25%)	7 (37%)	7 (23%)	5 (71%)
Surgical Plane	Extrapial	-	9 (75%)	16 (84%)	21 (70%)	6 (86%)
	Mixed	2 (100%)	2 (17%)	1 (5%)	4 (13%)	1 (14%)
	Subpial	-	1 (8%)	2 (11%)	5 (17%)	-
Histopathology	Meningothelial	-	6 (50%)	12 (63%)	19 (63%)	4 (57%)
	Transitional	-	2 (17%)	5 (26%)	7 (23%)	-
	Fibroblastic/ Psammomatous	2 (100%)	4 (33%)	2 (11%)	1 (3%)	-
	Others	-	-	-	3 (10%)	3 (43%)

FLAIR Tumor Intensity Vs Operative Findings

FLAIR Tumor Intensity		Hypointense	Isointense	Hyperintense
Total Number		8	27	35
Tumor Consistency	Soft	1 (13%)	7 (26%)	15 (43%)
	Mixed	2 (25%)	11 (41%)	15 (43%)
	Hard	5 (63%)	9 (33%)	5 (14%)
Vascularity	Mild	5 (63%)	6 (22%)	4 (11%)
	Moderate	3 (38%)	11 (41%)	19 (54%)
	High	-	10 (37%)	12 (34%)
Surgical Plane	Extrapial	3 (38%)	21 (78%)	28 (80%)
	Mixed	3 (38%)	3 (11%)	4 (11%)
	Subpial	2 (25%	3 (11%)	3 (9%)
Histopathology	Meningothelial	4 (50%)	18 (67%)	19 (54%)
	Transitional	-	6 (22%)	8 (23%)
	Fibroblastic/ Psammomatous	4 (50%)	3 (11%)	2 (6%)
	Others	-	-	6 (17%)

28 had marked tumor interface in MRI, while 33 and 9 had regular and irregular border respectively. 19 had no edema, while 33 and 18 had focal and lobar edema respectively.

Significant MRI predictive factors on operative findings

Operative & Post-op Finding	MRI Characteristic	Positive Predictive Value	Specificity	Univariate p value	Multivariate p value
Operative tumor hardness	FLAIR hypointensity	5/8 (63%)	94%	0.03	NS
	Inhomogen. enhancement	10/21 (48%)	78%	0.01	NS
Low vascularity	FLAIR hypointensity	5/8 (63%)	95%	0.01	NS
Subpial/mixed plane of cleavage	Recurrent tumors	5/7 (71%)	96%	0.01	NS
	Skull base location	7/18 (39%)	77%	0.04	0.04
	FLAIR hypointensity	5/8 (63%)	94%	0.02	0.02
	Irregular border	6/9 (67%)	94%	0.01	NS
Incomp. excision	Skull base location	6/18 (33%)	77%	0.01	0.01
Fibroblastic/ psammomatous	T2 hypointensity	6/14 (43%)	87%	0.001	NS
	FLAIR hypointensity	4/8 (50%)	93%	0.01	NS

Tumor Interface Vs Surgical Plane

Tumor Brain Interface	Total	Surgical Plane		
		> 2/3 Extra-pial	Mixed	> 2/3 Sub-pial
Marked Interspace > 50%	28	22 (79%)	4 (14%)	2 (7%)
Regular Border > 50%	33	27 (82%)	4 (12%)	2 (6%)
Irregular Border > 50%	9	3 (33%)	2 (22%)	4 (44%)
Total	70	52 (74%)	10 (14%)	8 (11%)

Inhomogeneous enhancement (p=0.01) & FLAIR hypointensity (p=0.03) had significant association with tumor hardness. FLAIR hypointensity (p=0.01) had significant association with low vascularity. Skull base location (p=0.04), FLAIR hypointensity (p=0.02), irregular border (p=0.01), and recurrence (p=0.01) had significant association with subpial or mixed plane of cleavage. Only skull base location (p=0.01) had significant impact on extent of excision.

Contrast Enhancement Vs Tumor Consistency

Contrast Enhancement	Total	Tumor Consistency		
		Soft	Mixed	Hard
Marked Homogenous	24	11 (46%)	9 (38%)	4 (17%)
Marked Inhomogenous	15	3 (20%)	5 (33%)	7 (47%)
Moderate Homogenous	25	8 (32%)	12 (48%)	5 (20%)
Moderate Inhomogenous	6	1 (17%)	2 (33%)	3 (50%)
Total	70	23 (33%)	28 (40%)	19 (27%)

T2 hypointensity (p=0.001) and FLAIR hypointensity (p=0.01) had significant association with Fibroblastic or Psammomatous meningioma. In multivariate analysis, FLAIR hypointensity (p=0.02) and skullbase location (p=0.04) had significant independent association with suboptimal surgical plane, while skull base location (p=0.01) had significant association with extent of excision. Among MRI sequences, FLAIR hypointensity had significant specificity of 94% to predict suboptimal surgical plane.

Conclusion

FLAIR hypointensity of meningioma in MRI appears to have significant independent association with suboptimal surgical plane with high specificity.

Learning Objectives

Participants should be able to: 1) Describe the importance of MRI sequences in preoperative planning of meningiomas, 2) Identify tumors which are likely to have hard consistency, high vascularity, and suboptimal surgical plane, influencing extent of excision.

Reference

Alvernia JE, Sindou MP. Preoperative neuroimaging findings as a predictor of the surgical plane of cleavage: prospective study of 100 consecutive cases of intracranial meningioma. J Neurosurg 2004;100:422-30