Section: Radio Diagnosis

Original Research Article

STUDY OF APPLICATION OF DIFFUSION TENSOR IMAGING IN DECIDING SURGICAL MANAGEMENT OF BRAIN TUMOURS IN ANDHRA PRADESH

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Abstract

Background: The diffusion tensor imaging (DM) technique is one of the non-invasive neuroimaging tools for visualising white matter tracts and pre-identifying tumour locations. This technique also measures the interaction between the tumour and surrounding areas of the brain, especially functional areas of the brain. **Materials and Methods:** 30 patients over 18 years old with brain tumours underwent conventional MRI, supplanted by DTI. Neurological deficits affected by motor and sensory dysfunction, speech, and vision were studied and analysed. **Result:** The majority of tumours were observed on right side 17 (54%) and located mainly in frontal lobe 14 (46.6%). High-grade glioma was 15 (50%) followed by low-grade 10 (33.3%) and 5 (16.6%) metastasis. The pre-operative highest deficit was motor weakness 15 (50%) followed by cognitive defect 12 (40%). In D I – 16 (53.3%) were displaced, only 10 (33.3%) invaded, and 4 (13.3%) were disrupted post-surgery. The highest defect was cognitive deficit, with 14 (46.6%) followed by memory impairment and 5 (16.6%). Total resection in displacement tracts was 16 (53.3%), and 14 (46.6%) were infiltration disruptions of tracts. **Conclusion:** The present pragmatic study has concluded that DTI and tactography are important tools for neurosurgeons to decide the surgical approach to tumour resection.

INTRODUCTION

Pre-operative planning in brain surgery plays a significant role in the successful outcome of surgery, which eventually improves the patient's quality of life. Furthermore, pre-operative planning in neurosurgery maximises tumour resection while preserving the brain's neurological functions.[1] Diffusion tensor imaging (DTI) is one of the non-invasive neuro-imaging tools for visualising white matter tracts and pre-identifying tumour locations. This technique can also measure the interaction between the tumour and surrounding areas of the brain, especially in the eloquent brain area.[2]
Previously DTI (diffusion tensor imaging) was utilised in brain tumour patients, mainly to classify the tissue characteristics and understand the effects if tumour growth on the microstructural integrity of the surrounding brain tissue,[3] Besides, DTI was also used for navigating the anatomy of the tumour, giving essential routes for neurosurgery, and deciding the surgical approaches. Intensive research on DTI in tumour surgery has been carried out mainly on the evaluation of brain tumour resection and when incorporated with other modalities, i.e., when combined with functional magnetic resonance imaging (FMRI).[4] Hence, an attempt was made to incorporate MRI, and tumours of the brain were evaluated because no single technique has become the ultimate technique for understanding radiological assessment for brain tumour resection surgery.

MATERIALS AND METHODS

30 (thirty) patients regularly visited Siddhartha Medical College, beside YSR Health University Vijayawada, NTR district Andhra Pradesh-520008 were studied.
Inclusive Criteria
Patients over 18 years of age and patients or guardians given written consent for treatment were selected for study.
Exclusion Criteria
Patients who had previously undergone surgery, patients with contraindications to MRI, and patients who were inoperable were excluded from the study.
Method: All patients underwent conventional MRI supplanted by diffusion tensor imaging on a Philips Ingenia 1.5T scanner. Every patient was examined,

and neurological deficits were observed and recorded, i.e., abnormalities of sensory and motor functions, speech, and vision. After evaluating the radiological diagnosis of the lesion, we collaborated with the neurosurgical team to find out the best surgical approach and management for the space-occupying lesion. Later, these patients were evaluated using diffusion tensor imaging and fibre tractography, complementary to conventional MRI. We evaluated relevant white matter fibre tracts in supra and infra tentorial compartments. Anatomical locations and orientations of fibre tracts and their density or clustering compared to the contralateral side were also noted.

Post-operative evaluation: gross total tumour resection was 100% macroscopic removal of tumour mass, stereotactic biopsy without tumour debulking. The estimation of the extent of tumour removal was primarily the responsibility of the local neurosurgeons but was also validated by surgical MRI scan review whenever possible. The extent of resection was defined as gross total resection (GTR) (no residual enhancement), beside total resection (NTR) (thin rim of enhancement in resection only), or subtotal resection (STR) residual nodular enhancement based on immediate post-operative MRI findings.

Clinical examinations of patients were done pre-operatively and post-operatively at the end of the 1st and 3rd weeks.

Cortical discrimination testing: Two-point discrimination, sterognosis, and lesions of the cerebral cortex cause a diminution of all sensory modalities on the contralateral side of the body. Visual field testing, integrity of optic pathways, and evaluation of speech and language Aphasia, dysphasia, Wernicks aphasia, Brocas aphasia, and conduction aphasia were carried out.

The duration of the study was from September 2022 to September 2023.

Statistical analysis: Various clinical manifestations of displacement, infiltration, or disruptions of tracts associated with the grade of tumours and resection of tumours were classified by percentage. The statistical analysis was carried out in SPSS software. The ratio of males and females was 2:1.

RESULTS

[Table 1] Clinical manifestations of patients

a) Side of tumour – 17 (56%) right, 10 (33.3%) left, 3 (10%) Bilateral (corpus callosum)
b) Site of the tumour – 14 (46.6%) frontal lobe, 5 (16.6%) parietal lobe, 5 (16.6%) temporal lobe, 8 (26.6%) more than one lobe
c) Grades of tumour – 10 (33.3%) low grade glioma, 15 (50%) high grade glioma, 5 (76.6%) metastasis
d) Pre-operative manifestation – 15 (50%) had motor weakness, 3 (10%) language disorder, 2 (6.6%) urine incontinence, 10 (33.3%) seizure, 4 (13.3%) memory impairment, 12 (40%) cognitive defect.
e) DTI (Diffusion tumour imaging) – 16 (53.3%) displaced only, 10 (33.3%) invaded, 4 (13.3%) disrupted
f) Post-operative clinical examination – 3 (10%) power deterioration – 4 (13%) power improvement, 3 (10%) language function deterioration, 1 (3.3%) language function impairment, 2 (6.6%) seizure (post-operative), 5 (16.6%) memory impairment, 14 (46.6%) cognitive defect.

[Table 2] (A) Displacement and infiltration / disruption of tracts associated with grade of tumour – 5 (31.2%) high grade glioma, 7 (43.7%) low grade glioma, 4 (25%) metastasis.

(B) In infiltration / disruption of tracts – 10 (71.4%) high grade glioma, 3 (21.4%) low grade glioma, 1 (7.1%) metastasis

[Table 3] Displacement and infiltration / disruption tracts associated with resection of tumour

A) Displacement of tracts – 10 (0.5%) had total resection, 6 (37.5%) had subtotal resection

B) Infiltration – 4 (28.5%) had total resection, 10 (71.4%) had subtotal resection.

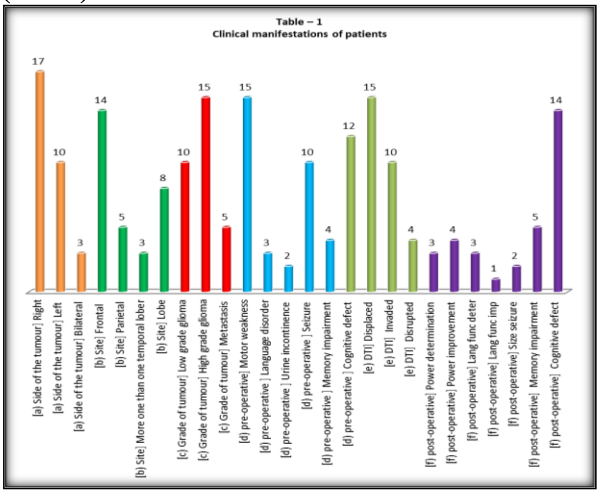

Figure 1: Clinical manifestations of patients

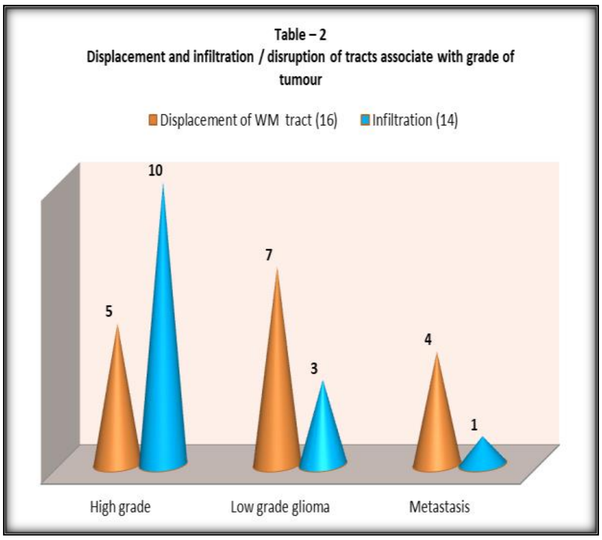

Figure 2: Displacement and infiltration / disruption of tracts associate with grade of tumour

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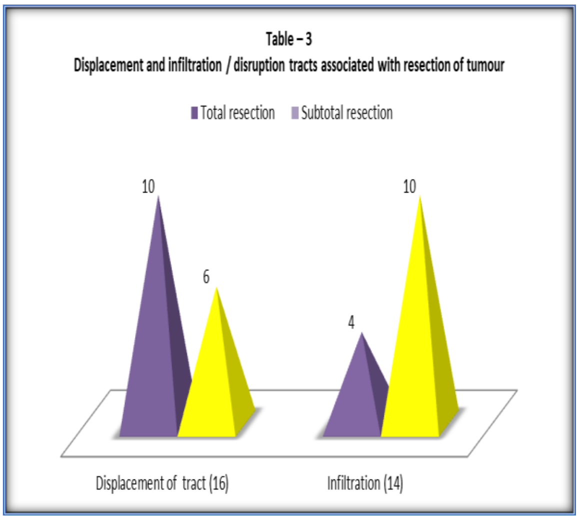

Figure 3: Displacement and infiltration / disruption tracts associated with resection of tumour

Perception of caregiver burden found in the present study was mild in 24%, moderate in 31% and severe in 45% shown in [Figure 1]. While comparing the level of burden perceived in psychiatric ill patients, burden experienced in substance abuse disorder was more with 56% followed by schizophrenia 52% and dementia 48% shown in [Table 2].

Perception of caregiver burden in relation to sociodemopraghicdata, female experienced severe burden in comparsion to male this difference was statistically significant($p<0.05$). caregivers aged between 21-40 years experienced severe burden than other age groups,this was statistically significant($p<0.05$). Participants belonging to Lower socioeconomic status experienced severe burden which was statistically significant($p=0.05$). Care duration of less than 5 years given by caregivers experienced severe burden and it was statistically significant [Table 3].

Table 1: Clinical manifestations of patients

Manifestation	**No. of Patients (30)**	**Percentage (%)**
a) Side of the tumour		
Right	17	56
Left	10	33.3
Bilateral (corpus callosum mass)	3	10
b) Site		
Frontal	14	46.6
Parietal	5	16.6
More one than one temporal lobe	3	10
Lobe	8	26.6
c) Grade of tumour		
Low grade glioma	10	33.3
High grade glioma	15	50
Metastasis	5	16.6
d) pre-operative		
Motor weakness	15	50
Language disorder	3	10
Urine incontinence	2	6.6
Seizure	10	33.3
Memory impairment	4	13.3
Cognitive defect	12	40
e) DTI		
Displaced	15	53.3
Invaded	10	33.3
Disrupted	4	13.3
f) post-operative Neurological examination		
Power determination	3	10
Power improvement	4	13
Language function determination	3	10
Language function important	1	3.3
Size seizure (post operative)	2	6.6
Memory impairment	5	16.6
Cognitive defect	14	46.6

DTI = Diffusion tensor imaging.

Table 2: Displacement and infiltration / disruption of tracts associate with grade of tumour

Details	**Displacement of WM tract (16)**		**Infiltration**	**Disruption of tract (14)**
	No	%		
High grade	5	31.2	10	71.4
Low grade glioma	7	43.7	3	21.4
Metastasis	4	25	1	7.1

WM = white matter

Table 3: Displacement and infiltration / disruption tracts associated with resection of tumour

Details	**Displacement of tract (16)**		**Infiltration**	**Disruption of tract (14)**
	No	%		
Total resection	10	62.5	4	28.5
Subtotal resection	6	37.5	10	71.4

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DISCUSSION

Present study of application of DTI in deciding surgical management of brain tumours in the Andhra Pradesh population. The majority of tumours were observed on the right side, 17 (56%) and located mainly in the frontal lobe, 14 (46.6%). High-grade glioma was 15 (50%) followed by low-grade, 10 (33.3%), and 5 (16.6%) metastases. In pre-operative care, the highest deficit was motor weakness, with 15 (50%) followed by 12 (40%). In DTI, 16 (53.3%) were displaced only, 10 (33.3%) invaded, and 4 (13.3%) were disrupted. The post-surgically highest deficit was cognitive defect, 14 (46.6%), followed by memory impairment [Table 1]. In displacement and infiltration/disruption of tracts associated with grade of tumour, 16 (53.3%) were displacement of white matter tracts, and 14 (46.6%) had infiltration/disruption of tracts [Table 2]. Displacement and infiltration disruption of tracts associated with resection of the tumour in the displacement of tracts, 10 (62.5%) were total resections and 6 (37.5%) were subtotal resections. In infiltration or disruption of tracts, 4 (28.5%) had total resection and 10 (71.4%) had subtotal resection [Table 3]. These findings are more or less in agreement with previous studies.[5-7]

Diffusion tensor imaging (DTI) is a relatively new MR imaging technique that is sensitive to the directional movement of water molecules included in tissue barriers. In white matter, there is a greater movement of water parallel to a tract or fascicule compared to a cross section. The white matter tissue providing a barrier to the movement of water molecules is believed to be primary myelinated axons, encoding the diffusion gradients at least in six directions.[8]

DTI has been used to identify the location of eloquent white matter in brain tumour patients by providing important preoperative spatial relocationships. DTI has been used to characterise the impact of tumours on white matter, including displacement, invasion, and distinction of tracts and fascicules.[9] The pathophysiological factors associated with brain tumours could hinder the detection of eloquent white matter. The presence of vasogenic oedema commonly associated with tumours is known to increase mean diffusivity and decrease fractional anisotrophy.[10] Tumour infiltration and associated tissue destruction can dramatically decrease fractional anisotrophy. Consequently, oedema and infiltration of neoplastic cells could hinder the detection of functional white cells in the vicinity of a tumour. The impact of DTI in achieving increased or decreased tumour cytoreduction due to the functional information afforded by the technique and the subsequent impact on tumour reoccurrence or survival remain to be elucidated as well.[11] However, larger series are necessary to definitively show the benefits of preoperative DTI on surgical outcomes.

CONCLUSION

Diffusion tensor imaging is a technique that generates a new form of contrast that provides the capability of identifying important white matter fibre bundles in brain tumour patients. When combined with morphological imaging and f MRI, DTI can significantly increase the estimation of the proximity of functional brain systems to brain tumour borders, which is quite useful to neurosurgeons, but this study demands newer techniques to optimise the management if combined with preoperative mapping by DTI-FT and f MRI to minimise postsurgical neurological deformities.

Limitations: Owing to the tertiary location of the research centre, the small number of patients, and the lack of the latest techniques, we have limited findings and results.

The present study was approved by the Ethical Committee of Siddhartha Medical College, beside YSR Health University Vijayawada, NTR district Andhra Pradesh-520008.

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