Prediction of Recovery from Supplementary Motor Area Syndrome after Brain Tumor Surgery: Pre-Operative Diffusion Tensor Tractography Analysis and Post-operative Neurological Clinical Course

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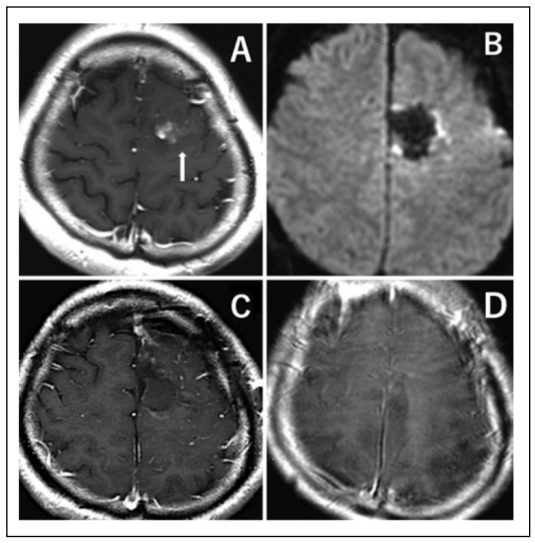
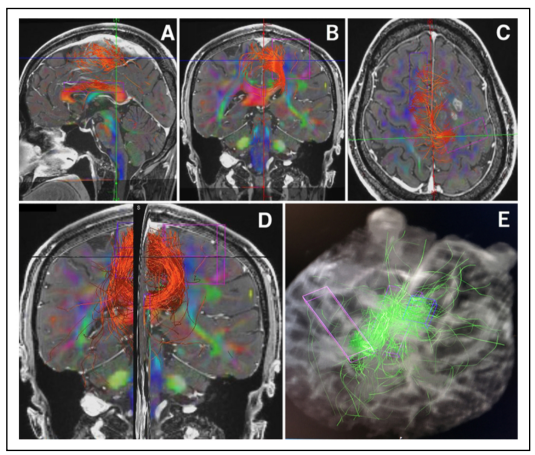
Introduction

Previous studies suggest a correlation of interhemispheric sensorimotor networks with recovery from supplementary motor area (SMA) syndrome. In the present study, we examined the hypothesis that interhemispheric connectivity of the primary motor cortex in one hemisphere with the contralateral SMA may be important in the recovery from SMA syndrome. Further, we hypothesized that motor cortical fiber connectivity with the SMA is related to the severity of SMA syndrome.

Methods

Patients referred to the authors' institute were retrospectively analyzed for this study. All patients with tumors involving the unilateral SMA region, without involvement of the primary motor area, and diagnosed with SMA syndrome in the postoperative period were eligible for inclusion. Preoperative diffusion tensor imaging tractography (DTT) was used to examine the number of ber tracts (NFidx) connecting the contralateral SMA to the ipsilateral primary motor area via the corpus callosum. All tumors were resected without corticospinal tract injury by "Avalanche Probing Technique" (Yamaguchi F, JNS2017). Complete neurological examination had been performed in all patients in the pre- and postoperative periods. All patients were divided into two groups: those who recovered from SMA syndrome within 7 days (early recovery group) and those who recovered later than 8 days (late recovery group). Differences between the two groups were assessed using the Student t-





Results

Eleven patients (10 men, 1 woman) were included in the study. All patients showed transient postoperative motor deficits because of SMA syndrome. Tractography data revealed NFidx from the contralateral SMA to the ipsilateral primary motor area via the corpus callosum. The mean tumor volume (early 27.87 vs late 50.91 cm3, p = 0.028) and mean NFidx (early 8923.16 vs late 4726.4, p = 0.002) were significantly different between the two groups. Fisher exact test showed a significant difference in the days of recovery from SMA syndrome between patients with an NFidx > 8000 and those with an NFidx < 8000.idx <8000.

Case No.	1	2	3	4	5	6	7	8	9	10	11
Age in yrs	66	61	49	68	41	58	62	60	66	76	64
Sex	M	F	M	M	M	M	M	M	M	M	M
Hemisphere	Lt	Rt	Lt	Rt	Lt	Lt	Rt	Rt	Lt	Rt	Lt
Tumor location	Pre-SMA	Pre-SMA	SMA proper	SMA proper	Pre-SMA	Pre-SMA	Pre-SMA	SMA proper	SMA proper	SMA proper	SMA proper
Clinical features	Rt motor sei-zures	Lt motor sei-zures	Rt motor sei-zures	Lt motor sei-zures	Motor apha-sia	Rt motor sei-zures	Lt motor sei-zures	Lt motor sei-zures	Motor apha-sia	Lt motor sei-zures	Rt motor sei-zures
Preop evaluation											
Aphasia	No	No	No	No	Yes	No	No	No	Yes	No	No
Facial motor deficit	No	No	No	No	No	No	No	No	No	No	No
UE motor deficit	No	No	No	No	No	No	No	No	No	No	No
LE motor deficit	No	Yes	No	No	No	No	No	No	No	No	No
Preop tumor vol (cm^3)	17.5	52.2	34.2	38.5	24.8	77	35.7	25.9	55.7	44.8	15.4
Pathological diagnosis	GBM	GBM	LGG	Metas-tasis (lung)	GBM	Malg	LGG	LGG	GBM	GBM	Metas-tasis (lung)
Postop neurological course	Transient motor deficit	Transient motor deficit	Transient motor deficit	Transient motor deficit	Transient mo-tor deficit, transient aphasia	Transient motor deficit	Transient motor deficit	Transient motor deficit	Transient motor deficit	Transient motor deficit	Transient motor deficit
Days of recovery from SMAS	7	30	7	7	15	15	5	5	9	8	5
NFidx	7252	3449	8825	8879	5188	5857	8474	11,767	2374	6764	8342

GBM = glioblastoma multiforme; LE = lower extremity; LGG = low-grade glioma; Malg = malignant lymphoma; SMAS = SMA syndrome; UE = upper extremity.
In all cases, the postoperative tumor volume was 0 cm^3, resection percentage was 100%, and SMA resection was total.

Parameter	All	Early	Late	p Value
No. of patients	11	6	5	
Mean age in yrs (SD)	61.0 (9.423)	61.5 (6.745)	60.4 (12.818)	0.858
No. of males (%)	10 (90.9)	6 (100)	4 (80.0)	0.421
No. in rt hemisphere (%)	5 (45.4)	3 (50.0)	2 (40.0)	0.482
No. tumors in pre-SMA (%)	5 (45.4)	2 (33.3)	3 (60.0)	0.327
Mean preop tumor vol in cm^3 (SD)	38.34 (18.31)	27.87 (9.811)	50.91 (18.870)	0.028*
Mean NFidx (SD)	7051.9 (2712.6)	8923.16 (1512.04)	4726.4 (1789.46)	0.002*

* $p < 0.05$.

NFidx/Recovery	Early	Late	Total
>8000	5	0	5
<8000	1	5	6
Total	6	5	11

Significant difference in the days of recovery from SMA syndrome between patients with an NFidx > 8000 and those with an NFidx < 8000 (p = 0.0152, Fisher exact test).

Conclusions

Diffusion tensor imaging tractography may be useful for predicting the speed of recovery from SMA syndrome. To the authors' knowledge, this is the first DTT study to identify interhemispheric connectivity of the SMA in patients with brain tumors.

Learning Objectives

These findings will be useful for future prediction of recovery from SMA syndrome, and suggest a relationship between cortical fiber connections of the SMA and the degree of deficit in SMA syndrome.

References

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