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Reversible hyposmia caused by intracranial tumour

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Abstract
Two patients with hyposmia caused by an intracranial tumour recovered olfactory functions after craniotomy. The first case was a 68-year-old male with a tumour metastasized from the lung to the right frontal lobe. The second case was a 75-year-old male with meningioma of the right frontal lobe. Results of T & T olfactometry and venous olfaction tests also indicated suspected central hyposmia. Magnetic resonance imaging (MRI) indicated compression of the frontal lobe by intracranial tumour. Pressure on the olfactory centre located in the frontal lobe produced hyposmia. Decompression of the frontal lobe by craniotomy improved the sense of smell. Therefore, some cases of olfactory disturbance caused by intracranial tumour may be reversible if they are the result of simple compression of the olfactory centre.

Key words: Smell; Olfactory pathways; Brain neoplasms

Introduction

Olfactory dysfunction originates not only from peripheral, but also from intra-cranial changes. Brain tumours produce a location-related disturbance. When a brain tumour occupies the olfactory area of the brain, olfaction is disturbed. However, if the damage is reversible, olfactory disturbance will be resolved after craniotomy. We present two cases of hyposmia that were resolved after craniotomy.

Methods

Two methods of olfactory testing were used. T and T olfactometry (Takagi, 1989) was used for measuring the detection and recognition thresholds. When the maximum concentration of the odorant could not be detected, we called it 'off the scale'. The venous olfaction test was also used. Ten mg in two mls of the original solution of thiamine propyldisulphide (Alinamin, Takeda Pharmaceutical Company, Osaka, Japan) was injected into the median vein of the arm at a constant rate for 20 sec, the time taken for the recognition of a latent garlic smell was measured from the start of the injection and its duration was also measured (Furukawa *et al.*, 1988). When no odour could be detected, the venous olfaction was said to be 'off the scale'.

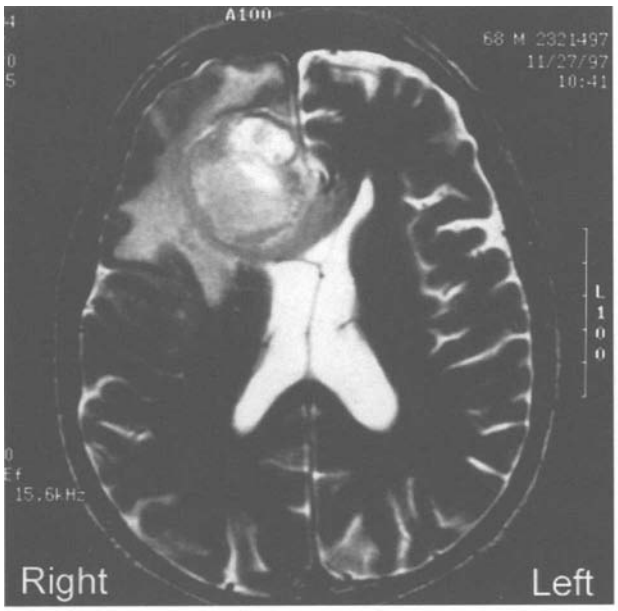

FIG. 1
T_2-weighted axial MRI of *Case 1*. A metastatic tumour from a lung occupies the right frontal lobe.

Case reports

Case 1

A 68-year-old male in-patient from our neurosurgical department with lung cancer metastasized to the right frontal lobe (Figure 1) had his olfactory function tested before craniotomy. The patient did not complain of olfactory loss. Both sides of the olfactory clefts and middle nasal meatus were open and there were no unusual otolaryngological findings. The average recognition thresh-

TABLE I
SCORES OF T & T AND VENOUS OLFACTION TEST (V) PRE- AND POST-CRANIOTOMY

	T & T Det	T & T Rec	V latency	V duration
Case 1				
Pre-	0	2	off	off
Post-	0	0.8	15	10
Case 2				
Pre-	0.2(R), 0.6(L)	1.8(R), 2.6(L)	off	off
Post-	0(R), 0(L)	1.4(R), 1.4(L)	8	42

'Det' and 'Rec' means detection and recognition thresholds respectively. 'Off the scale' T & T is defined as 6. For the odorant B, 'off the scale' is defined as 5. T and T thresholds of five odours are averaged. Right (R) and left (L) thresholds were measured in *Case 2*. The unit of venous olfaction score is second. 'Off' indicates off the scale.

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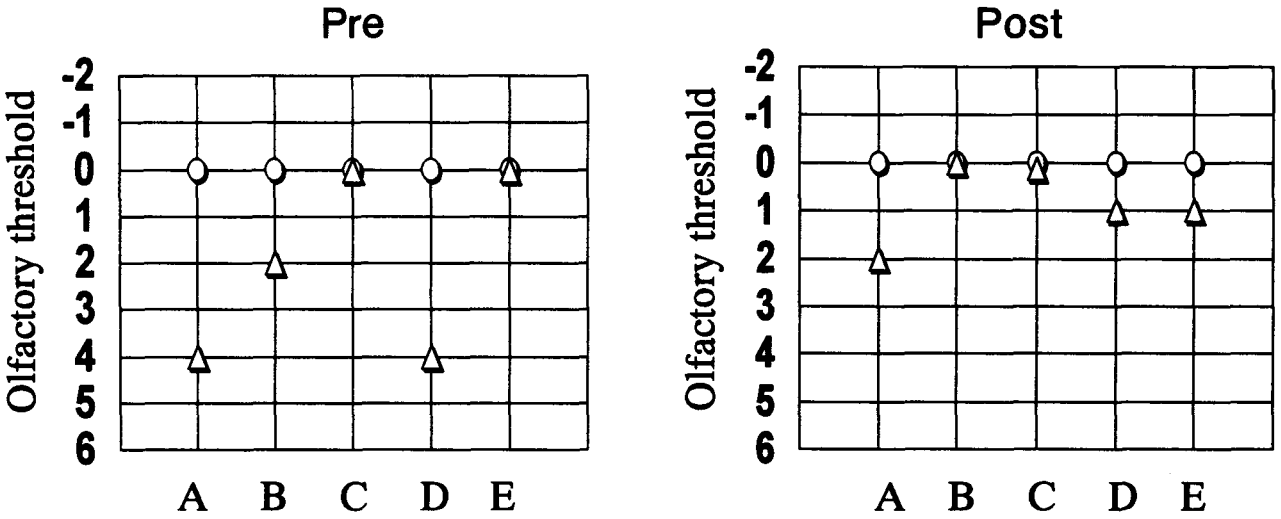

FIG. 2

Results of T & T olfactometry of pre- and post-craniotomy of *Case 1*. Detection threshold (○) and recognition threshold (△) of five types of odorants are plotted. Odorants are β-Phenyl ethyl alcohol (A), Methyl cyclopentenolone (B), Isovaleric acid (C), γ-Undecalactone (D) and skatole (E).

old improved after craniotomy, but the detection threshold did not improve (Figure 2, Table I). Venous olfaction also improved after craniotomy (Table I). The right frontal lobe had been compressed by a tumour. The right olfactory sulcus was not recognizable in a pre-operation magnetic resonance image (MRI). However, it was recognizable in a post-craniotomy MRI (Figure 3).

Case 2

A 75-year-old male in-patient in our neurosurgical department with meningioma of the right frontal lobe (Figure 4) consulted us for left-sided olfactory loss discovered by the neurosurgeon. The patient himself was not aware of the olfactory loss. Both sides of the olfactory clefts and middle nasal meatus were open and there were no unusual otolaryngological findings.

Unilateral T and T olfactometry showed bilateral hyposmia (Figure 5). Left olfaction was inferior to the right. Differences between recognition and detection thresholds pre-craniotomy showed abnormal patterns. Post-craniotomy, all T & T olfactometry thresholds, except the odorant C (isovaleric acid), improved. Venous olfaction also improved after craniotomy (Table I). The pre-craniotomy coronal MRI shows that the frontal lobe was compressed. The right olfactory sulcus was not recognizable in a pre-operation MRI, but it was recognizable in a post-operation MRI (Figure 6).

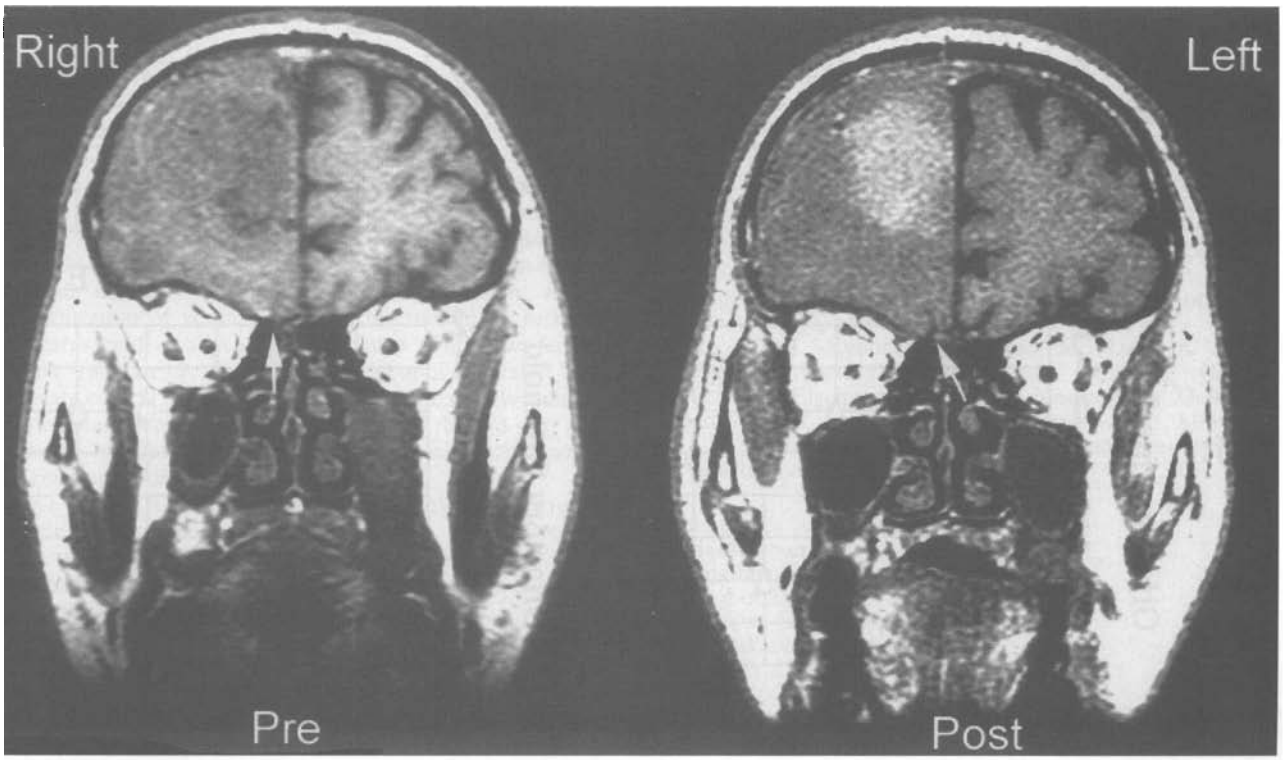

FIG. 3

Coronal sections of T_1-weighted MRIs of *Case 1*. The right olfactory sulcus (arrow) is unclear in the pre-craniotomy, but in the MRI of post-craniotomy, the olfactory sulcus (arrow) was clearly identified.

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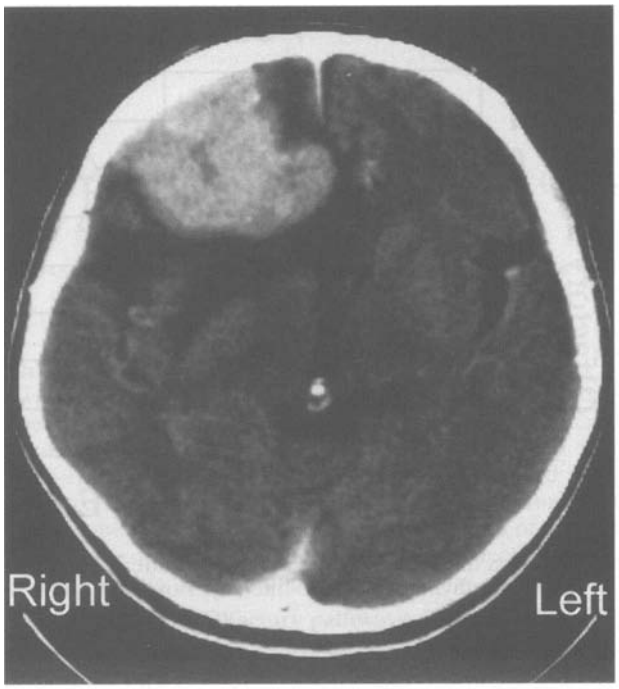

FIG. 4
Axial CT of *Case 2* after contrast injection. A meningioma occupies the right frontal lobe.

Discussion

It is not well known if hyposmia caused by a brain tumour is reversible. The patients in the cases we experienced did recover olfactory functions. These results lead us to suspect that the depression of olfactory activity was only due to compression of the olfactory area of the brain. The olfactory sulcus was unclear in MRI before craniotomy. This sign is thought to be caused by swelling of the frontal lobe. Similar MRI findings are often seen in anosmia caused by head trauma (Iida *et al.*, 1994); recovery in those cases is difficult. Although the olfactory sulcus is not the olfactory centre, swelling of the olfactory sulcus has a relationship to olfactory disturbance. Because the olfactory sulcus is close to the olfactory cortex and covers the bulb, changes in the olfactory sulcus are reflected in damage to these olfactory centres. In our cases, olfactory disturbances was resolved satisfactorily. We think the following two reasons can explain this recovery; 1) The damage to the olfactory centre was caused only by pressure from the intracranial tumour and the tumour did not invade the olfactory cortex, 2) The damage to the olfactory centre was slight and reversible.

The location of the olfactory centre is thought to be in the piriform cortex, orbitofrontal cortex and inferior medial frontal lobe, (Takagi, 1980; Zatorre *et al.*, 1992; Koizuka *et al.*, 1994). MRIs of our two cases, with compressed orbitofrontal cortex and inferior medial frontal lobe, indicated hyposmia. The olfactory bulb also seemed to be compressed by the intracranial tumour.

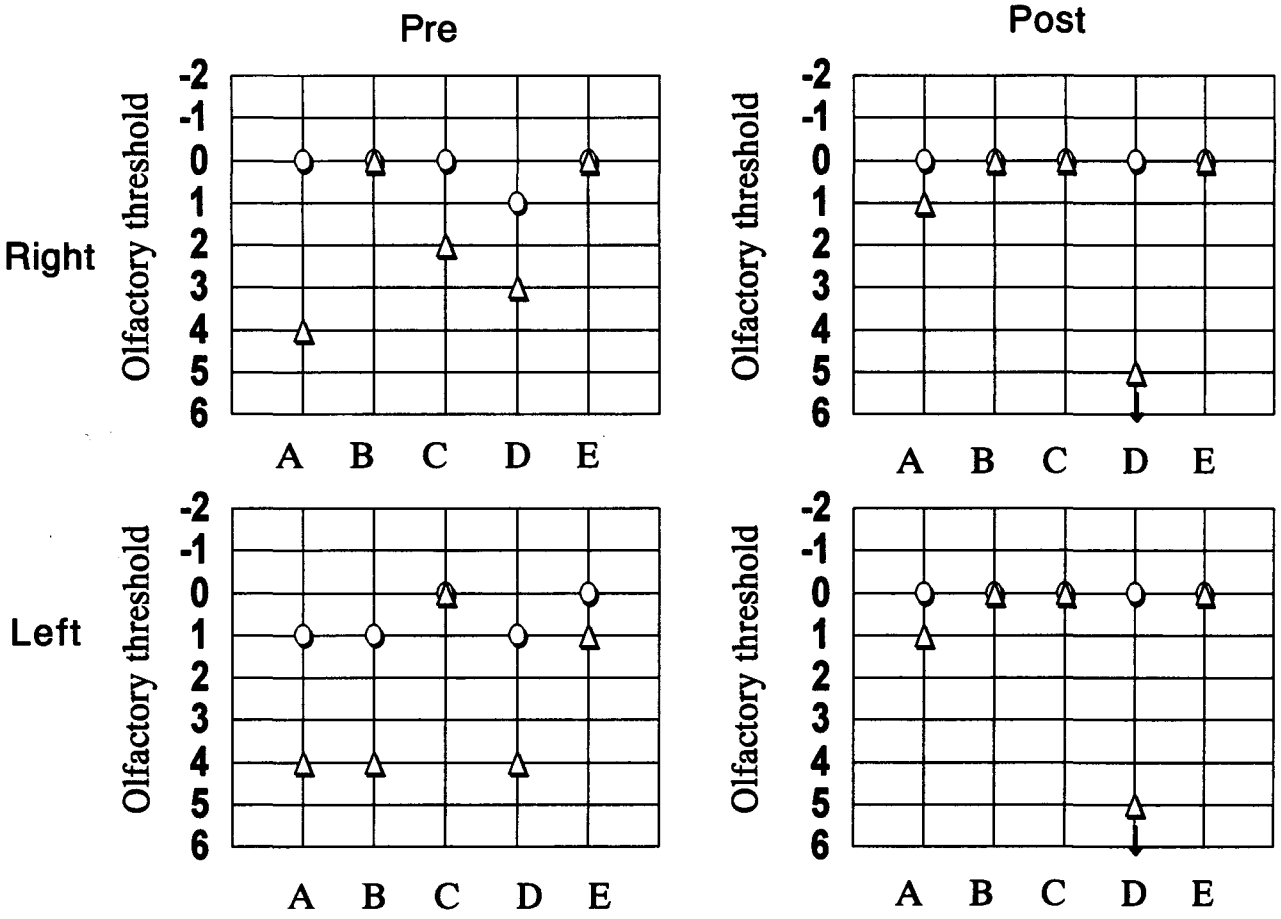

FIG. 5
Results of T & T olfactometry of *Case 2*. The gap between the detection threshold (○) and recognition threshold (△) post-craniotomy is smaller than pre-craniotomy. See Fig. 2 for details of odorants A to E. Arrows indicate 'off the scale'.

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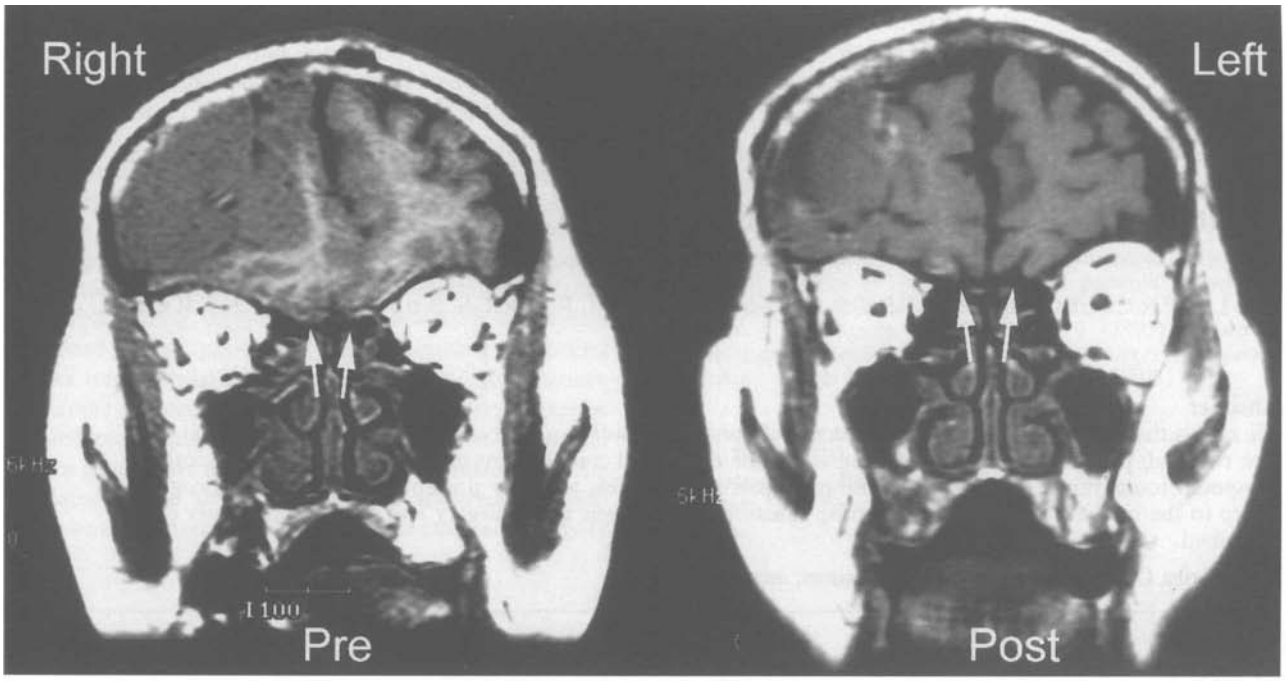

FIG. 6

Coronal sections of T_1-weighted MRIs of *Case 2*. Bilateral olfactory sulcuses (arrows) unclear in the pre-craniotomy MRI were clear in the post-craniotomy MRI.

Takeuchi *et al.* (1993) reported that a ruptured dermoid cyst located in the frontal cortex presented olfactory delusion and the symptoms disappeared after removal of the cyst by craniotomy. In Takeuchi's case, the patient did not complain of hyposmia. The change in olfactory thresholds pre- and post-surgery is not known because olfactometry was not performed. Therefore, we thought that it would be impossible to detect hyposmia. But the fact that olfactory symptoms disappeared after craniotomy indicates that the damage to the cortex was reversible.

Olfactory disturbance is generally categorized in three types; 1) respiratory; 2) olfactory mucosal, and 3) olfactory central disturbance. A difference of up to 1.0 between recognition threshold and detection thresholds (r-d gap) is normal, but over 2.0 points is abnormal and indicates a central olfactory disturbance (Morita, 1987; Kimura *et al.*, 1993). Venous olfaction testing accurately reflects not only the level of olfactory disturbance, but also indicates whether olfactory epithelium or the cortex is the focus. The duration of venous olfaction test within 15 seconds indicates central olfactory disturbance (Furukawa *et al.*, 1988). In *Case 1*, the results of venous olfaction still indicate central hyposmia, but in *Case 2* the results indicate normal function. Therefore, recovery of the r-d gap and venous olfaction indicate improvement of hyposmia originating in the olfactory centre.

We should realize that some cases of hyposmia caused by an intracranial mass are reversible. Therefore, in patients with an intracranial tumour combined with hyposmia, careful craniotomy is recommended to avoid side-effects to the olfactory sense.

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