Cortical Localization and Monitoring During Excision of Frontoparietal Tumours

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Abstract : Cortical sensory potentials were evoked intraoperatively under general anaesthesia by median nerve stimulation in 13 out of 14 patients with frontoparietal tumour. In 13 patients,the central sulcus could be identified by phasereversal of cortical somatosensory evoked potential (CSEP) across the central fissure. CSEP recordings were obtained before and after excision of the tumour and in three patients evoked responses were also monitored throughout selected portions of the operative procedure. A representative case has been presented to illustrate how observations made with this method have been used to facilitate intraoperative management of the patient in an effort to limit postoperative morbidity.

Key Words : Brain neoplasms, evoked potentials, somatosensory, sensory motor performance.

INTRODUCTION

It is well known that the pre and postcentral gyri cannot be identified with certainty by intraoperative inspection alone, even in an undisturbed hemisphere. Mass lesions with associated oedema often displace brain tissue and further obscure identification. In cases with lesions adjacent to the sensorimotor area, recognition of the pre and postcentral gyri is essential for an aggressive neurosurgical attack without producing a functional deficit.Therefore, precise identification of the central sulcus is important as an aid to definition of these critical areas.

Our goals in this study have been:

1) To identify the sensorimotor cortex (SMC),

2) To identify the relationship between the SMC and tumours in the midportion of the cerebral hemisphere intraoperatively under general anaesthesia,

3) To see if the pre and postcentral gyri can be identified with certainty without the help of CSEP,

4) To see if there is any correlation of the pre and postoperative neurological status with CSEP records before and after excision of the tumour,

5) In some instances to monitor evoked responses in the SMC during the removal of nearby lesions.

PATIENTS AND METHODS

Fourteen patients were investigated in this study. The pre and early postoperative (as soon as the patient awakened) neurological status, CSEPs before and after excision and the localization of the mass lesion are summarized in Table I. The distribution of patients according to pathologies is given in Table II. Out of our 14 patients 8 were male and 6 were female. Ages ranged between 13 and 67. In 6 patients the tumour was on the left and in 8 on the right.

TECHNICAL ASPECTS

Nicolet Compact Four/CA 2000 equipment was employed. Median nerve stimulation was delivered through bar electrodes located 2cm apart and positioned across the median nerve on the wrist. A stimulus pulse of 0.2 msec duration at 4.8/sec and 1060 mA was delivered. Each pulse induced a mild thumb twitch confirming that an effective stimulus had been delivered. Negative cortical recording

Table I: Localization of the tumour, pre- and postoperative neurological examination (NE), CSEP before (CSEPB) and after (CSEPA) excision

Localization	Preop.NE	CSEPB	CSEPA	Postop.NE
under MC	normal	low MCP	no MCP	hemiplegic
front MC	normal	SMCP equal	same	no change
under MC	UE paresis	low MCP	same	no change
front MC	normal	SMCP equal	low MCP	hemiparesis
under MC	hemiparesis (HP)	low MCP	no MCP	UE plegic LE paresis
front MC	normal	SMCP equal	low MCP	UE paresis
under MC	mild HP	SMCP equal	same	no change
under SC	mild HP & hemihypoaesthesia	SMCP equal (HH)	low SMCP	moderate HP & HH
behind SC	normal	SMCP equal	same	no change
under SMC	severe HP & HH	very low SMCP	same	no change
behind SC	normal	SMCP equal	low SCP	HH
under SC	HH	low SCP	same	no change
central	hemiplegic & astereognosia	no SMCP	same	no change
behind SC	normal	SMCP equal	same	no change

Abbreviations:

MC : Motor cortex
SC : Sensory cortex
MCP : Motor cortex potential
SCP : Sensorial cortex potential
SMCP : Sensory and motor cortical potentials
UE : Upper extremity
LE : Lower extremity

Table II: The distribution of the patients according to their pathologies

Pathology	Number of cases
Menengioma	3
Astrocytoma	6
Metastatic tumour	3
Oligodendroglioma	1
Cavernoma	1

electrodes consisted of flat platinium discs, 1cm in diameter. CSEPs were recorded monopolarly. All recordings were obtained directly from the exposed cortex. The electrodes were applied to different parts of the exposed cortex until a highamplitude phasereversal of the early components was obtained indicating the central sulcus (12).

Amplification bandpass was set between 5 Hz and 1.5 kHz. The time analysed was 50 msec after stimulus onset. Usually 100 to 200 CSEPs were averaged. A positive needle electrode was applied to the ipsi or contralateral ear lobe. The grounding electrode was positioned 1012.5 cm above the wrist. The primary cortical waves were in the 18 to 25 msec poststimulus latency range with phasereversals of the early components indicating the central sulcus (2,9). On the most active site the process was repeated to seek a phasereversal at the same cortical site to confirm that the evoked potential was not being recorded from a remote locus (5).

After identifying the central sulcus by CSEP, we saw that the surgeons had located the SMC correctly in 3 patients,partially correctly (either motor or sensorial cortex was identified) in 6 and incorrectly in 4 patients. As a result in 77 percent of the patients the SMC was displaced.

The latencies were similar before and after excision.The recording period for CSEP usually lasted for 30 to 45 minutes.

Case 6: This 60 year old man had suffered left hand seizures for 1 month before admission. He had no obvious neurological deficit. MRscan (Figures 1 and 2) revealed a superficial glioma near the right

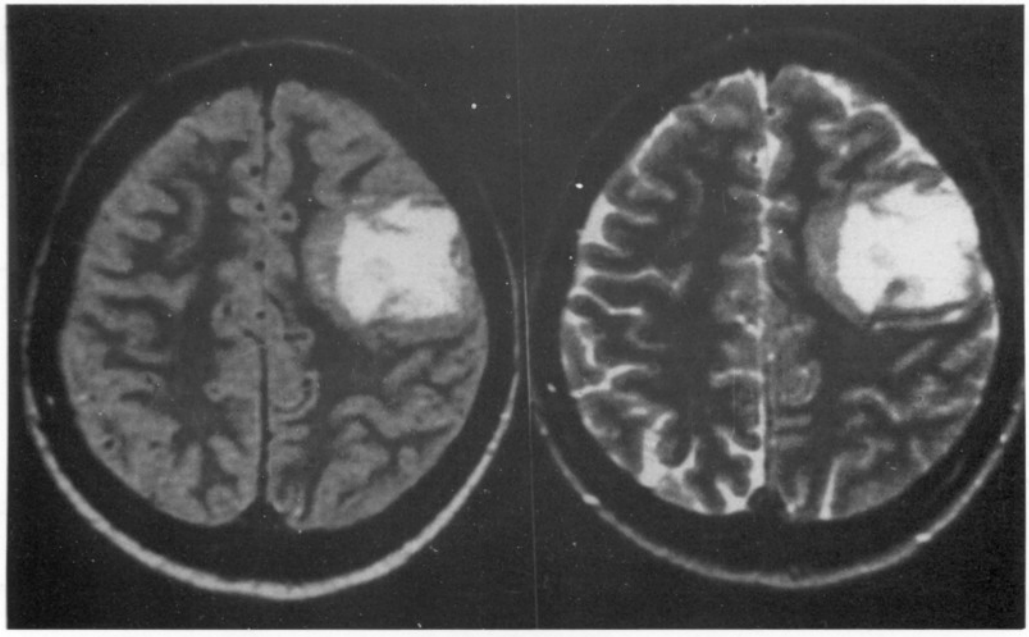

Fig. 1 : MRI : Right central tumour (axial section)

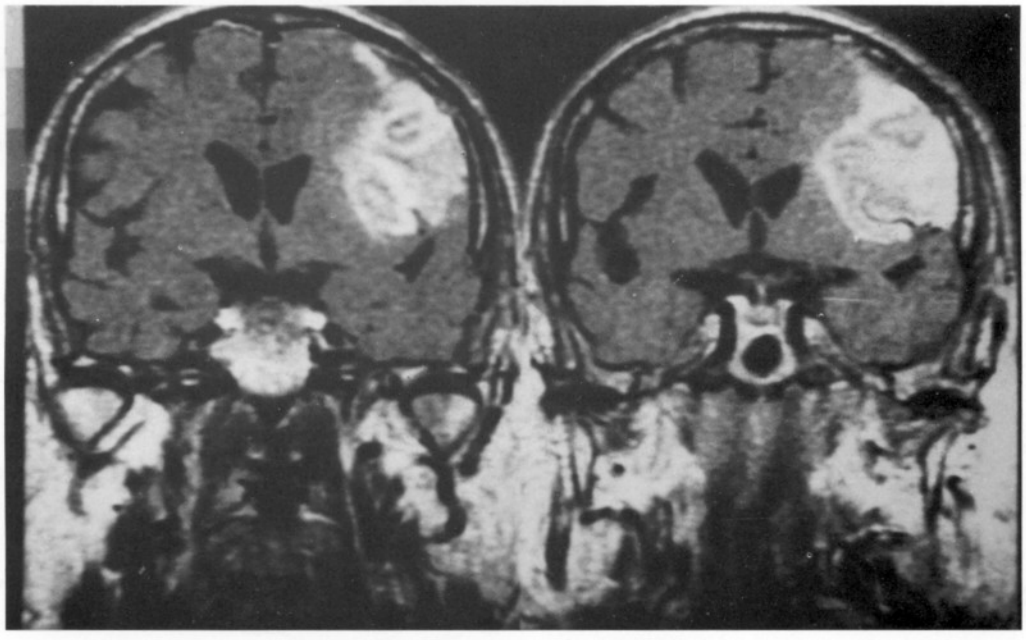

Fig. 2 : MIR : Right central tumour (coronal section)

precentral gyrus. After identifying the central sulcus by the use of CSEP, we also used cortical stimulation under special anaesthetic conditions to confirm, that we had identified the precentral gyrus by CSEP. The stimulus was applied to the gyrus anterior at the site of the most active evoked response and administered with bipolar silvertippedelectrodes spaced 0.5 cm apart. 0.3 to 1 msec pulses were delivered at a rate of 50/sec for 5 to 10 seconds at 5 to 10 mA. General anaesthesia was induced by preoperative atropine, fentanyl citrate and nitrous oxide which was reduced to 20% to 40% during test intervals. Succinylcholine was administered to provide relaxation for intubation and again after the recordings were completed. Spontaneous movements were occasionally seen under these circumstances. We did not elicit a motor response by stimulating what appeared to be sensory cortex under general anaesthesia.

During resection of the tumour, the CSEP from the precentral gyrus was monitored. When there was a nearly 50% decrease in amplitude of the CSEP recorded from the precentral gyrus, the traction was reduced, but the amplitude remained low. In the early postoperative period the patient had a left upper extremity paresis. While the CSEP recordings before excision were similar in amplitude recorded both from the sensory and motor cortex, after excision the amplitude of the motor cortex potential decreased (Figures 3 and 4).

Figures 5 and 6 show the intraoperative recordings.

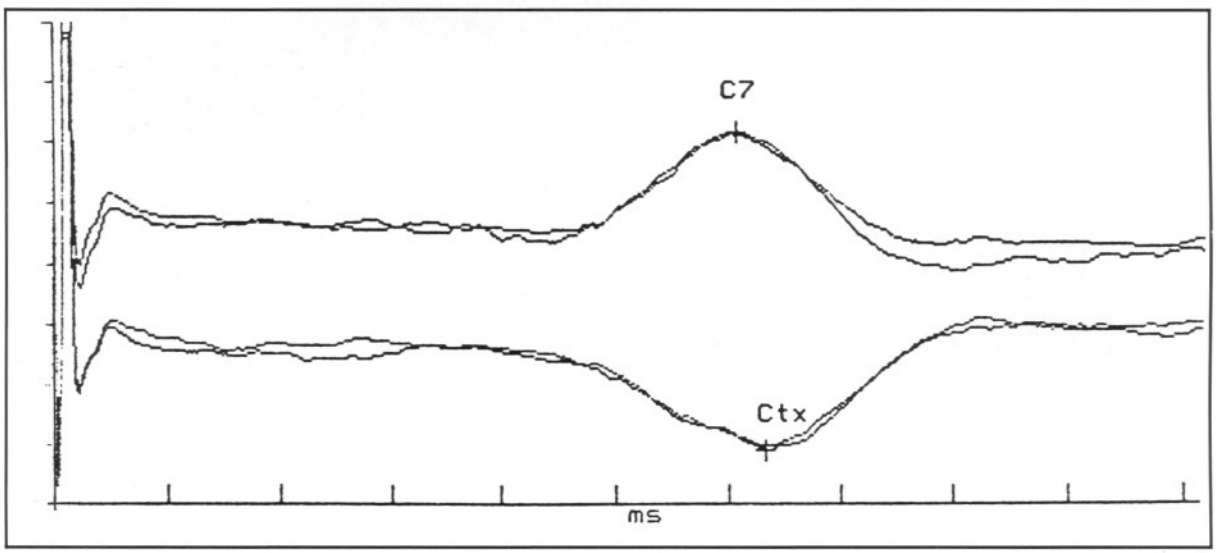

Fig. 3 : CSFP : Before excision (C7: the peak point of the potential recorded from the postcentral gyrus. Ct: the peak point of the potential recorded from the precentral gyrus)

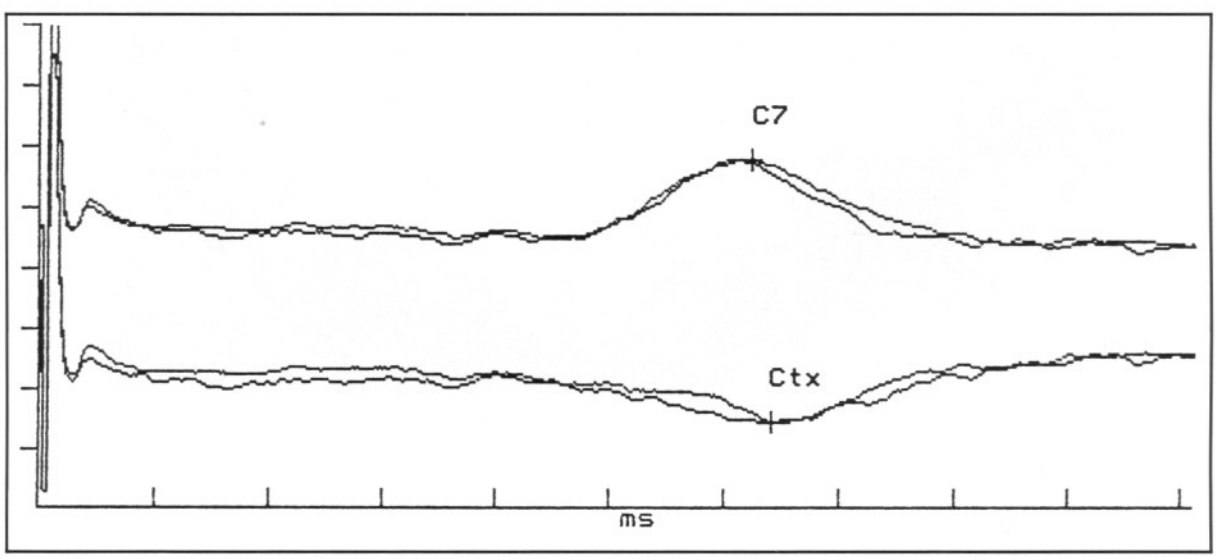

Fig. 4 : CSEP: After excision

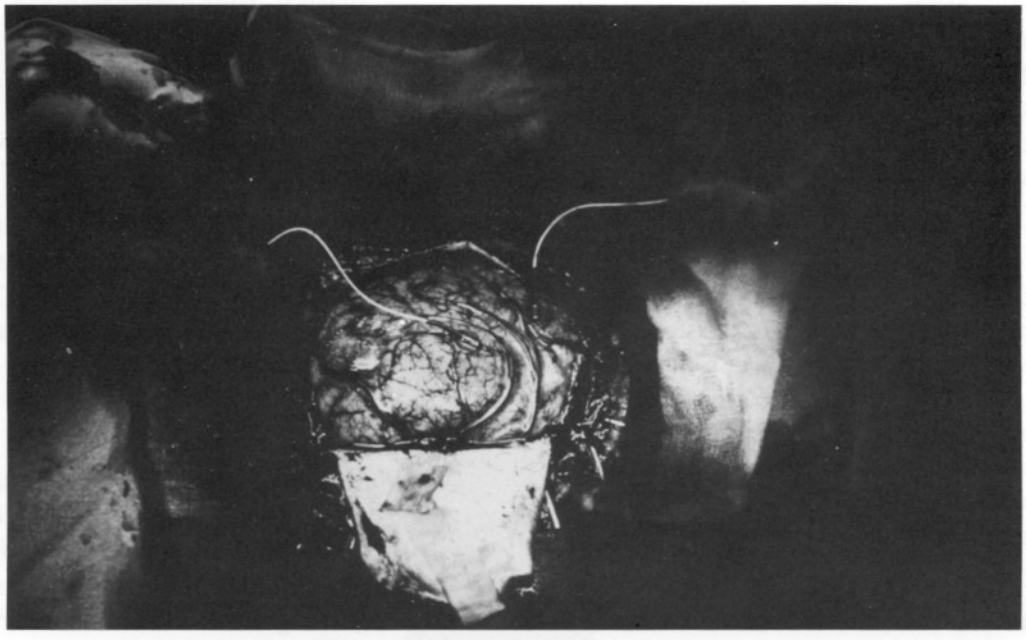

Fig. 5. Intraoperative recording before excision

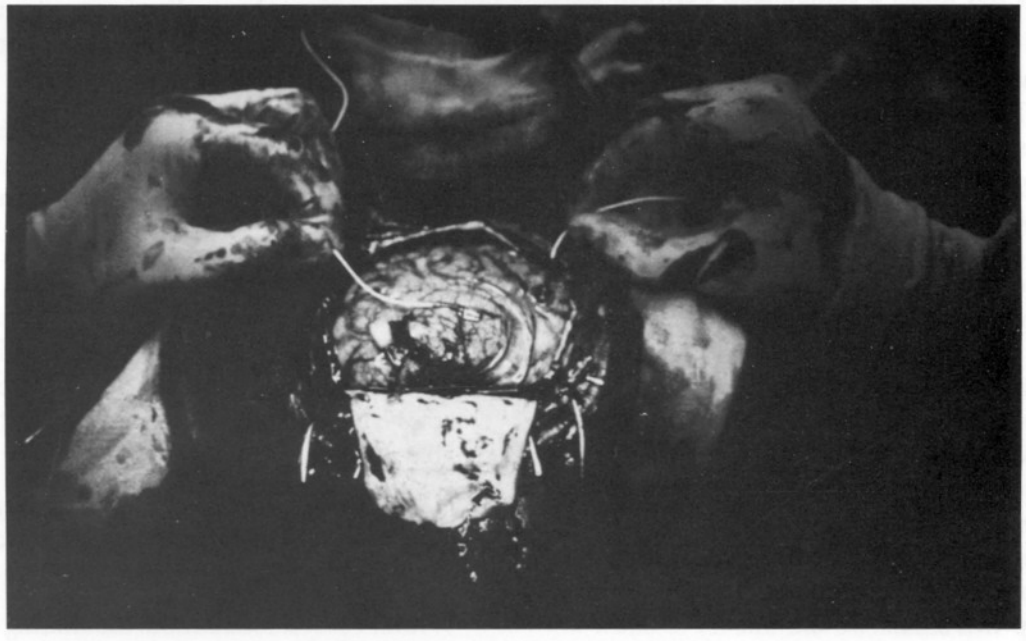

Fig. 6 : Intraoperative recording after excision

DISCUSSION

Since the introduction of CT scan and MRI, early diagnosis of cerebral lesions is now possible. Among the major postoperative sequelae, motor disturbance is one of the greatest problems, particularly in surgery for lesions adjacent to the sensorimotor area. Therefore, in such lesions recognition of the pre- and postcentral gyri is essential to perform neurosurgery without producing a functional deficit.The central sulcus cannot be adequately determined only from the shape of the cranium because the actual sulcus is often displaced by mass effect (1,6).

On the other hand, from recent neurophysiological studies of surgical candidates with intractable epilepsy, the central sulcus can be identified using CSEP (3,8). Few reports have been published so far on intraoperative identification of the central sulcus for brain tumours (1,4,6,11).

CSEPs by median nerve stimulation were examined in 13 out of 14 cases. In all the CSEP was obtained with typical phasereversal across the central sulcus (2,5,9,10). In the remaining hemiplegic patient, CSEP was not detected. Out of 13 patients, one with severe hemiparesis had very low amplitude potential that could only be recorded after 200 stimuli were applied. This was the only patient that 200 cortical potentials were averaged while in the others 100 to 150 were enough. Our findings corresponded with those of Aiba (1).

As the kind and level of anaesthesia, intensity and number of stimuli, length of the arm and other variables change the amplitude and latency of the CSEP we did not make a comparison between patients (7,10).

In patients who had moderate paresis approximately 50% loweramplitude potentials were recorded in the precentral gyrus when compared with the postcentral gyrus. On the other hand, in the patient with hemihypoaesthesia it was vice versa. Only in the first case, probably as the electrode was not properly applied over the precentral gyrus was the amplitude low although the patient was neurologically normal. In one case, while paresis and hypoaesthesia increased postoperatively the amplitudes recorded from the pre and postcentral gyri decreased. In the two patients who became plegic postoperatively, we were unable to record any potential from motor the cortex after excision. These findings show that, while neurological deficit increases, amplitude of the CSEP's decreases. As our patient group was small, we did not try to show a numerical correlation between amplitude and neurological deficit.

We observed no latency differences before and after excision of the tumour, also no increase of amplitude due to decompression of the lesion or any marked improvement in the early postoperative period.

In three monitored cases; Two had no change in their amplitudes intraoperatively and no worsening of the neurological status postoperatively. One who showed decreased of the amplitude recorded from the motor cortex, had postoperative monoparesis in the upper extremity. On the other hand 5 out of 10 patients, who had not been monitored, worsened postoperatively.

Motor responses to cortical stimulation were more difficult to elicit and more timeconsuming than CSEP, as others have noted (3,6,8,13,14,15). Therefore only in one patient was cortical stimulation used to define the precentral gyrus.

CONCLUSIONS

While pursuing our goals, several observations modified our intraoperative management of the patients we studied and our appreciation of patterns of responsivity of the human cerebral cortex that can be elicited under general anaesthesia. Our observations are as follows:

1) CSEPs readily elicited intraoperatively under general anaesthesia by median nerve stimulation for identification of the central sulcus in 13 out of 14 patients with frontoparietal mass lesions.

2) As the sensorimotor cortex had been displaced by mass lesions, it was identified at sites unexpectedly remote from a mass lesion, adjacent to a mass lesion, draped over or lying beneath a mass lesion.

3) In 77% of our patients, the central sulcus was identified in a location other than that had been guessed before CSEP recordings. Therefore, localization of the pre and postcentral gyri by CSEP is a more reliable method.

4) As the neurological deficit increased the amplitude of the CSEP decreased. In plegic patients no potential could be recorded.

5) After cortical localization, monitoring the CSEP is essential and useful during removal of nearby lesions or manipulation of blood vessels supplying the SMC to avoid producing severe postoperative neurological sequelae.

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