Technical note

Functionally tailored transcortical approach of deep-seated lesions: An alternative to the transulcal approach? A technical case report

Abord transcortical guidé par cartographie fonctionnelle des lésions profondes : une alternative à l’abord transulcal ?

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ABSTRACT

It is commonly believed that sulci offer a natural path to reach deep-seated lesions. However, it has also been argued that this approach carries a risk of damaging the vessels during the opening of the sulcus. We therefore were prompted to test the possibility of finding a transcortical path identified as non-functional by intraoperative brain mapping. A successful resection is presented of a left posterior isthmus clear cell ependymoma through a selected corridor based on functional mapping in an awake patient. MRI performed at 12 months showed no tumour recurrence. Pre- and postoperative extensive testing confirmed an improvement of the patient’s cognitive functions. Therefore, we were able to demonstrate the feasibility of a functionally tailored transcortical approach as an alternative to the transulcal approach for deep-seated lesions. This concept should be validated in a larger patient series.

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RÉSUMÉ


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1. Clinical presentation

A 28-year-old patient was referred to our department for management of a left posterior isthmus [1] lesion (Fig. 1) revealed by a generalized seizure, following a few days of headaches of increasing intensity. The patient reported a recent onset of a slight language disorder, mainly phonemic paraphasia, and to a lesser degree, word searching. He also noted difficulties in maintaining attention particularly when participating in multiple discussions. Later, he complained of a behavioural disorder, i.e. emotional hypersensitivity and irritability. No neurological deficit or oedema of the optic disk was observed in this left-handed patient.

The patient underwent an extensive cognitive testing by a speech therapist (Table 1). This examination showed minimal language impairment, with a slight deficit in the picture naming test (DO 80 scored at 75/80) and difficulty in understanding or repeating long texts during the Boston Diagnostic Aphasia Examination (BDAE). A motor dysgraphia was also observed. Literal and Categorial word fluency were −0.4 SD and −1.5 SD respectively under average. As regards executive functions, the Frontal Assessment Battery (FAB) score was subnormal (16/18). Flexibility, inhibition

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and visuo-spatial planning were clearly impaired. Overall the speed of information processing was low in all tasks. Working memory was reduced (a score of 4 in forward and backward digit span), but episodic memory was preserved.

Functional MRI during language tasks located activations mainly on the right hemisphere in this left-handed patient, and also an activation in the left posterior superior temporal gyrus. DTI tracking showed that the cortico-thalamic fibres and the pyramidal tracts were displaced medially and anteriorly by the tumour, and that the arcuate fasciculus was arching posteriorly around the tumour (Fig. 2).

The patient was operated on 4 weeks after radiological diagnosis. Surgery lasted 12 hours and a complete resection was achieved, as confirmed by the absence of enhancement on T1 weighted sequence with gadolinium injection. Immediately after surgery, the patient had no motor deficit, but noted right sided paraesthesia; he was able to speak and to name pictures. Conduction aphasia occurred during the following 48 hours, which resolved progressively. Extensive cognitive testing was carried-out again 3 months after surgery, confirming improvements in almost every aspect. The DO 80 scored at 79/80. BDAE remained unchanged, except that patient recovered from motor dysgraphia. Literal and categorical word fluency improved (1 SD and −1 SD respectively above and under average). As regards executive functions, the FAB score normalized (18/18). Flexibility and inhibition were no longer impaired although the patient still had difficulties in visuo-spatial planning. Working memory was also improved (score at 5 in forward digit span). The patient resumed his professional activity (banking administration) and the MRI was clear at 12 months follow-up (Figs. 3 and 4).

Histological slides were reviewed independently by three pathologists, and diagnosis of “anaplastic ependymoma with clear cells” was finally established.

2. Technique

We used an asleep/awake/asleep protocol. The opening was initially performed under sedation with propofol and after cortical mapping with the patient awake. Then the patient was sedated again and intubated for the resection.

Electrical stimulation was generated by a nimbus stimulator (Hemodia® France). Pulses were biphasic, lasted 1 min, and repeated at a frequency of 60 Hz. We used an intensity of 1 mA. The ventral premotor cortex, inducing a speech arrest during counting, was first identified. Primary motor and sensory area of the hands were also located. During picture naming testing, two sites were identified (Fig. 5): one at the posterior end of the superior temporal sulcus (tag 1), inducing amnesia, and another one at the inferior part of the supramarginal gyrus (tag 2), inducing dysarthria. We thus defined a small cortical “non eloquent” window, limited inferiorly

Table 1
Pre- and postoperative results of cognitive testing.
Résultats des tests cognitifs pré- et postopératoires.

<table>
<thead>
<tr>
<th></th>
<th>Preoperative</th>
<th>Postoperative</th>
</tr>
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<tbody>
<tr>
<td><strong>Language</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Literal and categorical word fluency [4]</td>
<td>Literal word fluency −0.4 SD</td>
<td>Literal word fluency +1 SD</td>
</tr>
<tr>
<td></td>
<td>Category word fluency −1.5 SD</td>
<td>Category word fluency −1 SD</td>
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<tr>
<td><strong>Executive functions</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FAB [5]</td>
<td>16/18</td>
<td>18/18</td>
</tr>
<tr>
<td>Inhibition: Stroop colour-word test SCWT [4,6]</td>
<td>Impaired</td>
<td>Improved</td>
</tr>
<tr>
<td>Planning: Rey figure (copy) [7]</td>
<td></td>
<td>Unchanged</td>
</tr>
<tr>
<td><strong>Working memory</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Verbal: Digit Span [8]</td>
<td>4 forward</td>
<td>5 forward</td>
</tr>
<tr>
<td></td>
<td>4 backward</td>
<td>4 backward</td>
</tr>
<tr>
<td><strong>Episodic memory</strong></td>
<td></td>
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<tr>
<td>Verbal: Grober and Buschke [9]</td>
<td>Preserved</td>
<td>Preserved</td>
</tr>
</tbody>
</table>

BDAE: Boston Diagnostic Aphasia Examination; FAB: Frontal Assessment Battery.
BDAE : échelle d’évaluation de l’aphasie « Boston Diagnostic Aphasia Examination »; FAB : batterie rapide d’évaluation frontale.
Fig. 2. Preoperative DTI tracking. The pyramidal tract is displaced medially and anteriorly by the tumour, and the arcuate fasciculus is arching posteriorly around the tumour.

La tractographie des séquences en tenseur de diffusion montre que les fibres cortico-thalamiques et le faisceau pyramidal sont déplacés médialement et antérieurement et que le faisceau arqué s’enroule autour du pôle postérieur de la tumeur.

Fig. 3. Postoperative MRI (left: axial T1 with gadolinium; right: coronal T2) at 12 months of postoperative follow-up. There only remains a porencephalic postoperative cavity, with no contrast enhanced nodules.

IRM postopératoire (gauche : axiale T1 avec Gadolinium, droite : coronale T2) un an après la chirurgie. On visualise une cavité porencéphalique postopératoire, sans prise de contraste.

Fig. 4. Postoperative DTI tracking. The arcuate fasciculus has been spared by the transcortical approach, thanks to intraoperative functional mapping.
Tractographie postopératoire des séquences en tenseur de diffusion. Grâce à la cartographie fonctionnelle peropératoire, le faisceau arqué aura été respecté.

and anteriorly by Labbé’s vein, posteriorly by site 1 and superiorly by site 2. We also extended the corticectomy 5 mm anteriorly to Labbé’s vein, but the stimulation of underlying white matter generated speech delays and word searching and this corridor was finally not used further during resection (tag 3). Finally, we removed white matter located under our cortical window while continuously testing picture naming, until phonological disturbances were encountered posteriorly (tag not shown in the depth).

Resection was then pursued under general anaesthesia, using of standard micro-neurosurgical techniques.

3. Discussion

The concept of a transulcal approach arose from a generalization of the micro-neurosurgical principles initiated by Yasargil for aneurysmal clipping [10]. In this latter case, opening of the sylvian fissure combined with opening of the basal cistern and subsequent cerebrospinal fluid drainage allows optimal brain relaxation and good exposure with no brain insult from excessive use of retraction. This transulcal approach is also considered to be the safest way to reach a deep-seated lesion, minimizing brain trauma [11]. However, in the present case, the sulcal approach would have consisted in a wide opening of the sylvian fissure, including its most distal part, in its retro-insular portion. This could not have been performed without any risk of damaging the inferior part of the supramarginal gyrus and superior part of the superior tempo-
Considering the size of the corticectomy at the end of the resection, a smaller bone and dural exposure could have been an option. However, this would have implied performing a negative mapping as recently proposed by some authors [12]. Also, this method raises the issue of selecting the maximal stimulus intensity defining a negative mapping and we preferred to perform the standard positive mapping [13].

In conclusion, reaching deep-seated lesions through a functionally tailored parenchymatous corridor could be a reliable alternative to the commonly used transsulcal approach. This hypothesis needs to be tested further in a large series of cases.

Disclosure of interest

The authors declare that they have no conflicts of interest concerning this article.

References