In the following article, Kim et al. attempted to understand the factors that influence outcomes in the resection of the medial frontal lobes. As the authors indicate in their introduction, since Penfield and Welch, neurosurgeons treating epilepsy have noted this interesting phenomenon of temporary postoperative deficits in motor and possibly speech function associated with resection of the medial frontal cortex immediately anterior to the central gyrus. The term “supplementary motor area,” or SMA, has been used to describe this region. They detail their experience in treating 43 adults with a variety of pathological lesions of the medial frontal lobe as a means of controlling pharmaco-resistant epilepsy. They found that transient new neurological deficits occurred in approximately half of their patients and that these deficits affected a mixture of motor, sensory, and speech functions. Only 3 (7%) of the 43 patients had what they considered to be permanent deficits, and all deficits involved motor loss: 1 case involving the upper extremity; 1 case, the lower extremity; and 1 case, the upper and lower extremities. While this series adds a significant number of patients to the literature on this important topic, it does not yet give neurosurgeons what they would like to know regarding surgery in this brain region. What has been difficult to determine is which patients are more likely to experience these deficits and, even more importantly, which patients are at higher risk for permanent deficits. Kim et al. found that, in general terms, patients who demonstrated temporary deficits had resections that were farther posterior (true SMA) and more inferior, including the cingulate gyrus. The authors performed a multivariate analysis and found that resection of the cingulate gyrus was the only factor that was predictive of a new deficit. There were no predictors of which patients would have permanent deficits, possibly because the risk was so low (7%).

Nevertheless, these data should be helpful to surgeons who are planning to resect medial frontal cortex, both for the treatment of pharmaco-resistant epilepsy and for the resection of cortical brain tumors. Like the findings of Kim et al., the review by Rostomily et al. indicated that permanent deficits are exceedingly rare. Similarly, Tate et al. described a large series of patients who had undergone resection of lesions from the cingulate gyrus. Once again, permanent deficits were exceedingly rare, and temporary deficits were more likely to occur if SMA tissue was also resected, which implies that although resection of the cingulate gyrus is a factor, it is not the only explanation for new deficits. The take-home message from this series of cases is that patients and families should be informed in advance about the possibility of new, probably transient deficits when this region of the brain is approached, and a 50% likelihood seems reasonable.

What the report by Kim et al. does not do is help us to understand whether there was something different about the injury in cases in which permanent deficits developed. For example, could there have been a vascular injury that caused damage to primary motor cortex (for example, a pericallosal arterial branch or a venous infarction), or is there something intrinsically different about the SMA in a small subset of patients? Presumably, with enough experience and with the addition of tools such as functional MRI and fiber tract imaging, these questions will eventually be answered. Until then, surgeons must give patients as much advance information as possible and continue to wait expectantly each time an SMA syndrome occurs to see if the deficits resolve.

Disclosure

The author reports no conflict of interest.

References


Editorial

Supplementary motor resections

NICHOLAS M. BARBARO, M.D.

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In the following article, Kim et al. attempted to understand the factors that influence outcomes in the resection of the medial frontal lobes. As the authors indicate in their introduction, since Penfield and Welch, neurosurgeons treating epilepsy have noted this interesting phenomenon of temporary postoperative deficits in motor and possibly speech function associated with resection of the medial frontal cortex immediately anterior to the central gyrus. The term “supplementary motor area,” or SMA, has been used to describe this region. They detail their experience in treating 43 adults with a variety of pathological lesions of the medial frontal lobe as a means of controlling pharmaco-resistant epilepsy. They found that transient new neurological deficits occurred in approximately half of their patients and that these deficits affected a mixture of motor, sensory, and speech functions. Only 3 (7%) of the 43 patients had what they considered to be permanent deficits, and all deficits involved motor loss: 1 case involving the upper extremity; 1 case, the lower extremity; and 1 case, the upper and lower extremities. While this series adds a significant number of patients to the literature on this important topic, it does not yet give neurosurgeons what they would like to know regarding surgery in this brain region. What has been difficult to determine is which patients are more likely to experience these deficits and, even more importantly, which patients are at higher risk for permanent deficits. Kim et al. found that, in general terms, patients who demonstrated temporary deficits had resections that were farther posterior (true SMA) and more inferior, including the cingulate gyrus. The authors performed a multivariate analysis and found that resection of the cingulate gyrus was the only factor that was predictive of a new deficit. There were no predictors of which patients would have permanent deficits, possibly because the risk was so low (7%).

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References


See the corresponding article in this issue, pp 7–14.
Response

YOU NG- HOO N K I M, M.D.,1,2 AND CHUN K E E CH U NG, M.D., PH.D.1,3

1Department of Neurosurgery, Seoul National University College of Medicine; 2Department of Neurosurgery, Seoul National University Hospital, Seoul; and 3Department of Neurosurgery, Seoul National University Bundang Hospital, Seongnam-si, Gyeonggi-do, Korea

In commenting on our article “Risk factor analysis of the development of new neurological deficits following supplementary motor area resection,” Professor Barbaro summarized the significant points and limitations of our study. Although he acknowledged that our data would be helpful to neurosurgeons who plan to resect medial frontal cortex, he raised several important issues concerning cingulate gyrus resection, which was the most significant factor leading to transient, but not permanent, neurological deficits in our study. We offer the following comments to his editorial.

Professor Barbaro was concerned that our analysis demonstrated a risk for transient deficits only, not permanent ones, and underestimated temporary postoperative neurological deficits such as supplementary motor area (SMA) syndrome. Several previous reports, as well as our study, have shown that permanent deficits are exceedingly rare after medial frontal resections (Table 1). This was discussed in his editorial. Our study primarily focused on the risk factors for developing SMA syndrome and their significance. The fact that injury to the primary motor cortex and its associated fiber tracts could lead to the development of permanent neurological deficits is not an innovative idea; therefore, it was not a focus of our study. Moreover, there was no vascular or cortical injury to the primary motor cortex during SMA resection in the 3 patients who demonstrated permanent deficits in our study.

The overall incidence rate of SMA syndrome is variable, ranging from 23% to 100% according to a recent series (Table 1). We were interested in why some patients suffered from transient neurological deficits, while others did not. According to Professor Barbaro, resection of the cingulate gyrus was not the explanation for new deficits, because temporary deficits were more likely to occur if SMA tissue was resected. However, in our study, only 39% of patients who had undergone resection of the SMA only without cingulate gyrus resection actually experienced SMA syndrome, whereas 80% with cingulate gyrus resection did experience it. Therefore, we believed that cingulate gyrus resection could invoke SMA syndrome in patients who underwent SMA resection. The characteristics of SMA syndrome after SMA resection in previous series are thoroughly reviewed in Table 1. The variability in incidence and several proposed risk factors of SMA syndrome could be identified.

In conclusion, although permanent deficits are more important than transient ones after cortical resection, even transient motor weakness and language deficits can cause considerable embarrassment to patients. Therefore, risk factors for and surgical interventions that can cause SMA syndrome are important considerations for surgeons, as they try to avoid this neurological syndrome.

<table>
<thead>
<tr>
<th>Authors &amp; Year</th>
<th>No. of Patients</th>
<th>Pathology (no. of patients)</th>
<th>% w/ SMA Syndrome</th>
<th>% Permanent Deficits</th>
<th>Possible Risk Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laplane et al., 1977</td>
<td>3</td>
<td>ND</td>
<td>100</td>
<td>ND</td>
<td>ND</td>
</tr>
<tr>
<td>Rostomily et al., 1991</td>
<td>6</td>
<td>tumor (6)</td>
<td>100</td>
<td>0</td>
<td>ND</td>
</tr>
<tr>
<td>Bleasel et al., 1996</td>
<td>10</td>
<td>tumor (3); CD (2); other (5)</td>
<td>60</td>
<td>ND</td>
<td>ND</td>
</tr>
<tr>
<td>Zentner et al., 1996</td>
<td>28</td>
<td>tumor (19); nontumor (9)</td>
<td>89</td>
<td>0</td>
<td>AP extent</td>
</tr>
<tr>
<td>Bannur &amp; Rajshekhar, 2000</td>
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<td>tumor (6)</td>
<td>100</td>
<td>0</td>
<td>ND</td>
</tr>
<tr>
<td>Duffau et al., 2001</td>
<td>1</td>
<td>tumor (1)</td>
<td>100</td>
<td>0</td>
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<td>tumor (22); CD (1)</td>
<td>65</td>
<td>ND</td>
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<td>100</td>
<td>0</td>
<td>AP extent</td>
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<tr>
<td>Nelson et al., 2002</td>
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<td>0</td>
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<tr>
<td>Peraud et al., 2002</td>
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<td>83</td>
<td>29</td>
<td>distance from precentral gyrus</td>
</tr>
<tr>
<td>Russell et al., 2003</td>
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<td>26</td>
<td>8</td>
<td>ND</td>
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<td>Kainnik et al., 2004</td>
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<td>tumor (12)</td>
<td>100</td>
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<td>ND</td>
</tr>
<tr>
<td>Yamane et al., 2004</td>
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<td>83</td>
<td>0</td>
<td>ND</td>
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<td>Ulu et al., 2008</td>
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<td>tumor (9); nontumor (3)</td>
<td>50</td>
<td>ND</td>
<td>AP extent</td>
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<td>Rosenberg et al., 2010</td>
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<td>tumor (24); CD (1); other (1)</td>
<td>23</td>
<td>ND</td>
<td>ND</td>
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<tr>
<td>Kasasbeh et al., 2012</td>
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<td>nonlesion (39)</td>
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<td>present study</td>
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<td>7</td>
<td>cingulate gyrus resection</td>
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</table>

* AP = anteroposterior; CD = cortical dysplasia; fMRI = functional MRI; ND = not described.

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