I am conscious : Mr ASL says so

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EDITORIAL

I am conscious

Mr ASL says so

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I am the only one to know that I am conscious. I can nevertheless interact with others using verbal communication or motor responses to let them know that I am. What would happen if, to some extent, I would know this, but I would be unable to express it? How would my surroundings know? Here is the challenge facing clinicians involved in the care of patients recovering from coma: differentiating reflex from voluntary activity, or, in other words, detecting consciousness in noncommunicative patients.

Behavioral assessment is the primary method to detect signs of consciousness and, hence, to determine diagnosis. However, a recent study has shown a misdiagnosis rate of 41% in patients who were clinically diagnosed as being in a vegetative state.[1] Detection of consciousness is confounded by numerous factors including fluctuations in arousal level, sensory and motor impairments, medication side effects, and the possibility of aphasia.[2] Because misdiagnosis can lead to serious consequences, especially related to pain treatment and end-of-life decisions,[3] additional tools have to be used to characterize more completely and accurately remaining brain functioning linked to consciousness.

Functional neuroimaging techniques are well equipped to identify covert cognitive processes in patients who are otherwise incapable of intelligible or sustained behavioral expression and offer information complementary to bedside examination findings. In this issue of *Neurology*®, Liu et al.[4] used arterial spin labeling (ASL) to compare cerebral blood flow (CBF) patterns in 4 minimally conscious state (MCS) patients compared with 10 normal controls in the resting awake state. ASL is an MRI technique differing from the blood oxygen level–dependent (BOLD) signal in the sense that it measures changes in the capillary bed of the regions of interest and not the oxygenation of nearby veins. It is, therefore, a more direct way to assess CBF. ASL is less popular than BOLD imaging, because it has a lower signal/noise ratio and spatial resolution. It nevertheless allows a more reliable interpretation of residual brain activity in patients with severe neurovascular lesions. It also offers improved detection of changes in functional brain states without being invasive, which is not the case with similar neuroimaging techniques (e.g., injection of PET radioactive tracer or gadolinium-based MRI contrast agents). Because previous studies used BOLD signals to assess residual brain functioning in patients recovering from coma, one could argue that it may be difficult to compare results obtained with both techniques. Liu et al.[4] show us instead that ASL leads to findings similar to those in previous BOLD imaging studies, namely global metabolic depression (of 50%) in gray matter in MCS subjects compared with controls[5] and decreased CBF in frontal areas.[6] This study may be the first to demonstrate that the ASL technique could be reliable for investigation of residual brain activity in disorders of consciousness.

Not only the imaging technique but also the paradigms used are crucial in the detection of voluntary brain activity. Several studies using active paradigms identified complex cognitive processes[7–9] in patients presenting with behavioral patterns seemingly of unconsciousness. Active paradigms require cognitive control (top-down processing) because the participant has to understand the instruction and actively/voluntarily respond. These paradigms are therefore useful for detection of conscious brain activity in patients with severe brain injuries. The downside of active paradigms is that a response is obtained only in a minority of patients considered to be in the MCS[7,10]; hence, these paradigms cannot be considered to be highly sensitive for detecting signs of consciousness. This fact stresses the importance of maximizing the use and reliability of simpler/passive paradigms to identify conscious cognition. In this study, Liu et al.[4] investigated the preservation of CBF in the resting awake state. A number of neuroimaging studies recently assessed brain activity at rest to investigate the so-called "default network." This network is defined as a set of areas, encompassing the posterior cingulate/precuneus, anterior cingulate/mesiofrontal cortex, and temporo-

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parietal junctions, showing more activity at rest than during attention-demanding tasks, with fluctuations according to a patient's consciousness level.[6,11] Liu et al.[4] observed decreased CBF, particularly in medial prefrontal and midfrontal areas, in parallel to relative preservation of posterior portions of the default mode network in MCS patients compared with controls. Even if further validation will be needed before the resting state is considered to be a reliable diagnostic tool, these results support the existence of a relationship between the functional status of the default network and alterations of consciousness.

If the current results can be replicated, ASL could be used in conjunction with BOLD signals to better characterize residual brain activity in patients recovering from coma and, hence, to identify conscious processing. Nevertheless, further investigations are required to confirm the results in larger numbers of subjects. Moreover, it could be interesting to investigate whether ASL can provide valuable information on the efficiency of drug treatment because perfusion changes due to a pharmacologic agent can be monitored over time. In this context, ASL would be useful not only for increasing the accuracy of the diagnosis but also for improving the quality of the treatment in patients recovering from coma.

AUTHOR CONTRIBUTIONS

Dr. Schnakers: drafting/revising the manuscript. Dr. Laureys: drafting/revising the manuscript, study supervision, and obtaining funding. Dr. Majerus: Drafting/revising the manuscript and study supervision.

DISCLOSURE

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