Right-left discrimination

To the Editor: The recent case review by Cohen et al. (Cohen FL, Mendelsohn D, Bernstein M: Wrong-side craniotomy: analysis of 35 cases and systems for prevention. Clinical article. J Neurosurg 113:461–473, September, 2010) and the accompanying editorial (Cima RR: Editorial. Wrong-site craniotomy. J Neurosurg 113:458–460, September, 2010) provide the profession with an in-depth review of wrong-side craniotomy cases reported in the academic and gray literature. The authors supported this analysis with a survey of state medical licensing bodies inquiring of the frequency of such events and the actions taken against licensees in the event of wrong-sided brain surgery. This work provides more factual case detail than has been available previously in other reports, with the exception of the case report from Bernstein. The authors assist the profession greatly by providing their interpretation of the factors contributing to this type of error.

Given the efforts by the National Patient Safety Agency, the Joint Commission, Accreditation Canada and others to eliminate site errors and side error in particular, it is both curious and disturbing that such errors continue to occur. It is with this in mind that I wish to draw the readership’s attention to psychological foundations that may underpin the human error that contributes to side errors. I am indebted to Dr. John Senders for his insights on this topic. I will not address issues of documentation accuracy regarding the side of surgical booking requests.

The error that the paper and this letter address is side error, meaning right-left, as it is in this dimension that we, bilaterally symmetrical humans, have unique challenges. Orientation difficulties and error are not seen in the non-symmetrical dimensions—superior-inferior or posterior-anterior.

The terms left and right are derived from the fact that some 90% of the population use the hand of the same side of their body for writing and other manual tasks. This has implications for most activities of daily living including how we work in the operating theater. Operating theaters are designed and set up to facilitate the right-handed worker. There are also implications in the language we use to describe handedness: right hand, meaning correct, and its opposite “sinister” hand, meaning the other side.

In the general population approximately 9% of people have considerable difficulty in distinguishing right from left. A similar prevalence was found in medical students. Such an individual could have a 50% chance of misidentifying the correct operative side if acting alone and in the absence of other clues to clarify sidedness. If other members of the team or the patient are similarly challenged in correctly identifying left from right, there is a real probability that side recognition and identification errors could occur and would not be caught by current checking methods. Fortunately, the chance that all team members and the patient have side discrimination problems is small so that preoperative briefings and “time-outs” are usually effective in recognizing side-identification errors before they reach the patient.

Right-left blindness is not associated with right or left handedness. Affected individuals are generally aware of this difficulty and over time develop compensatory mechanisms. Techniques used among students include relating side to physical activity, a unilateral body, dress or accessory feature, or by word association. In medicine, mechanisms can include establishing spatial congruence (with the patient) and using fixed reference (allocentric) frame(s) for orientation. Such mechanisms are dependent on attention and situational awareness and can fail in the face of fatigue, stress, illness, clinical urgency, unfamiliar environments, and new team members.

Whether right or left handed, all individuals can be subject to problems of orientation and spatial congruence. Much of perception and activity is viewed from one’s personal (egocentric) positional reference scheme (worldview) where locations are encoded relative to a body axis. When the surgeon and the patient share differing worldviews, and they always do, side misidentification can occur without recognition by either party.

Maintaining their respective egocentric worldviews, both patient and surgeon can contribute to side errors through their use of language and by mirroring. By using terms that do not specify the patient’s worldview, the patient and the surgeon can both “accurately” misinterpret. If a the surgeon points to his or her own body part while asking a patient to confirm the side of a proposed operation, most patients will involuntarily mirror the movement, identifying the incorrect side and thereby setting the stage for the failure of subsequent body-side checks.

Not all people can easily and accurately deal with the transformations required in neurosurgery practice. The examples given in Cases 15 and 33 represent the challenge faced in transforming image space to patient space. Not only can errors occur in labeling and hanging images, but data transformations can occur during transfer between CT or MR imaging machines and image guidance systems. To address these errors, image guidance systems have functions for correcting data orientation errors. These processes assume that the surgeon can properly identify right and left. The placement of a fiducial, within the imaged volume and on the side of the patient bearing the lesion, is a useful check and an example of using the fiducial in an allocentric reference frame.

The most common transformation needed in neurosurgery is changing from the supine or sitting position in the preoperative area to the prone position required for an operation. In this situation it may be difficult or impossible for the surgeon to establish spatial congruence...
with the patient prior to final positioning, the result being that the operative side can be identified and marked incorrectly. The only way to address this is for the surgeon to assume a patient-centric worldview for the purposes of identification and side marking.

Whatever tools and checks are put in place, it is probable that intrinsic differences in humans, in particular problems with right-left discrimination and establishing spatial congruence, will remain as key risk factors for side error. The only way to address this is for the surgical team members to interact as a highly functional and resilient team. Checklists, time-outs, and playbooks help structure communication amongst team members but it is the team working together that will mitigate the risk to patient when human factors, fatigue, efficiency tradeoffs, technical failures, and other factors conspire to put the patient at risk.

Side errors are amongst rare tragedies that require a different approach to learning and mitigation compared with other complications. As Cranston has said with respect to an intrathecal vincristine injection and death:

In the course of reviewing our own mistake, we also sought information across the country about other, similar, tragedies... there have been at least three other child deaths.... Each was fully investigated in the institution where it occurred, both internally and by provincial coroners... the details of these errors have not been comprehensively shared .... We were not able to learn from our mistakes, nor did we have the opportunity to learn from those of our colleagues.12

Cohen and colleagues are to be congratulated for bringing this analysis to the attention of the profession. The Journal of Neurosurgery is thanked for its courage in publishing this work as it is only through such reports that rare events such as side errors can be better understood and prevented.

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Disclosure

The author reports no conflicts of interest concerning the materials or methods used in this study or the findings specified in this paper.

References


RESPONSE: There are multiple perspectives and facets to any situation that involves human behavior, precisely because we are such complex organisms. Dr. Cochrane’s letter nicely illustrates some of the many underlying reasons why humans may confuse left and right. We thank Dr. Cochrane for a complementary insight on why wrong-site surgeries continue to occur.

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Interhemispheric hygroma

To THE EDITOR: We read with great interest the article by Kaen et al.1 (Kaen A, Jimenez-Roldan L, Alday R, et al: Interhemispheric hygroma after decompressive craniectomy: does it predict posttraumatic hydrocephalus? Clinical article. J Neurosurg 113:1287–1293, December, 2010), in which the authors reviewed the records of 73 patients with severe head injuries who underwent decompressive craniectomy (DC), either with evacuation of mass lesions (66 patients, 90%) or without. The authors...
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reported that 36 patients developed subdural hygromas, that 17 (47%) of these patients exhibited interhemispheric hygromas (IHHs), and that hydrocephalus was observed in 15 (88%) of the 17 patients with IHHs. Statistical analysis revealed that the presence of IHHs was a predictive radiological sign of hydrocephalus development with 94% sensitivity and 96% specificity. We completely agree with the authors and wish to provide further comment. Aarabi et al.\(^2\) recently reported that, in 54 patients with severe head injuries who underwent DC with evacuation of mass lesions, 15 patients developed subdural hygromas, that 10 (67%) of these patients exhibited IHHs, and that hydrocephalus was observed in 4 of the 15 patients with subdural hygromas. These data are in accord with the results of Kaen et al. In contrast, Aarabi et al.\(^1\) previously reported that, of 50 patients with severe head injuries who underwent DC without removal of clots or contusion for diffuse brain swelling, 25 patients developed subdural hygromas, which were rarely interhemispheric. Thus, the studies by Kaen et al.\(^3\) and Aarabi et al.\(^1,2\) suggest that the high incidence of IHH might be the result of DC with evacuation of mass lesions. Therefore, we hypothesize that the volume of the evacuated mass may be correlated with the occurrence of IHHs. As such, DC with evacuation of large mass lesions may generate a greater suction effect and the interhemispheric space is more likely to expand. If this hypothesis is correct, careful attention should be paid to the occurrence of IHHs, especially when DC with evacuation of large mass lesions is performed. Further investigation into the correlation of the volume of evacuated mass lesions with occurrence of IHHs may provide additional insight into the mechanism of IHHs after DC.

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**Response:** We appreciate Dr. Takeuchi and his co-workers’ interest in our study and the opportunity to respond to their comments. We agree that the evacuation of contusions or large mass lesions could be related to the development of IHH and posttraumatic hydrocephalus. However, in our work we found no statistically significant difference in the frequency of appearance of hydrocephalus between patients who needed brain resection for cerebral contusions as well as DC and those in whom just a DC was performed \((p = 0.20)\). Furthermore, we found no statistically significant intergroup differences in the frequency of IHH or hydrocephalus when we separated our patients into the following subgroups: patients who have more than 25 cm\(^3\) of contusion and needed surgery; patients who only had subdural hematomas; patients with subdural hematomas and contusion; and finally patients with small contusions.

The lack of a relationship between contusion resection and the development of hydrocephalus is surprising, but not new.\(^2\) Recently De Bonis et al.\(^1\) hypothesized that a medial craniotomy may have a potentially pathogenetic role in the development of posttraumatic hydrocephalus (venous blood flow theory). Nonetheless, this hypothesis does not explain why the resolution of hydrocephalus after bone flap replacement was observed only in some patients. Probably, there are several factors related to the pathogenesis of IHH and posttraumatic hydrocephalus, and they work together in the development of ventricular enlargement. Further studies are necessary to understand these questions, the real relationship between decompressive craniectomy and posttraumatic hydrocephalus, and how these factors modify prognosis.

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