
Neuroimaging Highlight

Editor: David Pelz

Decompressive Craniectomy in Traumatic Brain Injury: The Edge Effect

Submitted by: F.A. Zeiler, P.J. McDonald

Can J Neurol Sci. 2012; 39: 652-653

A 25-year-old male presented with history of blunt trauma to the head with decreased level of consciousness and computed tomography (CT) evidence of a left acute subdural hematoma with 2.2 cm of midline shift, and no intra-parenchymal lesions. The patient underwent a left decompressive craniectomy with evacuation of the subdural hematoma. No venous injury was noticed intra-operatively. Post-operatively the patient remained difficult to rouse, off all sedatives, five days later.

Magnetic resonance imaging (MRI) including diffusion weighted imaging (DWI) was conducted to assess the degree of ischemic insult to the brain. Diffusion weighted imaging demonstrated hyperintense signal throughout the left hemisphere (Figure 1). The cortex was herniated 3.25cm through the craniectomy site. The highest intensity noted on DWI was

focused around the edges of the craniectomy at the superior and inferior margins of the bony decompression (Figure 1). This was confirmed to indicate true restricted diffusion on apparent diffusion coefficient (ADC), negating the likelihood of T2 weighted shine through (Figure 2). Fluid-attenuated inversion recovery (FLAIR) and gradient echo (GRE) sequencing failed to demonstrate hemorrhage in these areas.

Craniectomy for diffuse cerebral edema in the setting of trauma is a controversial topic in the treatment of medically refractory elevated intracranial pressures. Randomized prospective trials to date have demonstrated inconclusive mixed results in terms of clinical outcome¹⁻³. The findings above suggest an ischemic “edge effect” that has been described sparingly in the literature⁴. Some of the MRI findings (left

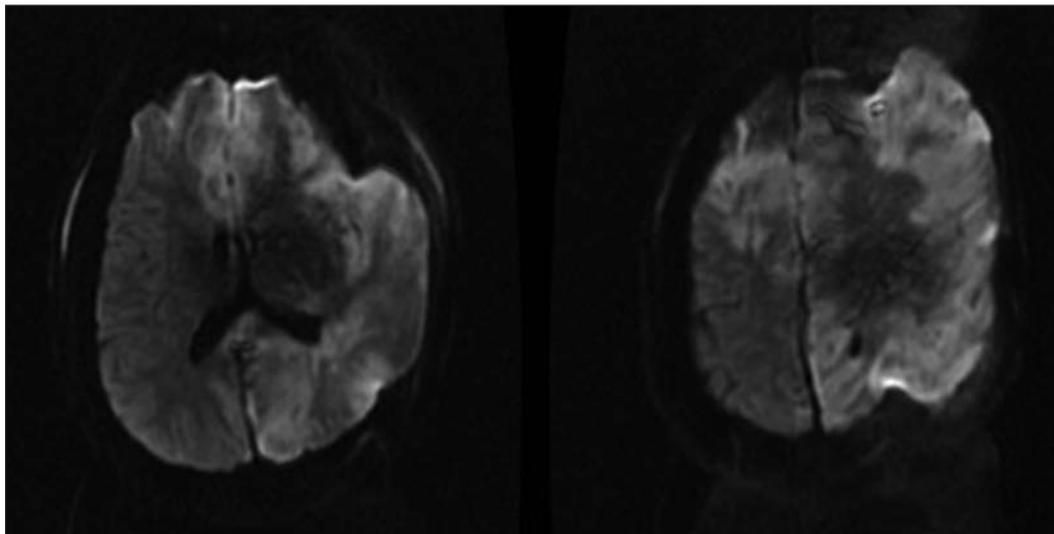


Figure 1: DWI at inferior (left) and superior (right) of craniectomy site demonstrating hyperintensity at bony edges, suggestive of restricted diffusion, and ischemia.

From the Section of Neurosurgery, Department of Surgery, University of Manitoba, Winnipeg, Manitoba, Canada.

RECEIVED MARCH 19, 2007. FINAL REVISIONS SUBMITTED JUNE 11, 2007.

Correspondence to: Frederick A Zeiler, Section of Neurosurgery, University of Manitoba, Health Sciences Center, GB-1 820 Sherbrook Street, Winnipeg, Manitoba, R3A 1R9, Canada. Email: umzeiler@cc.umanitoba.ca.

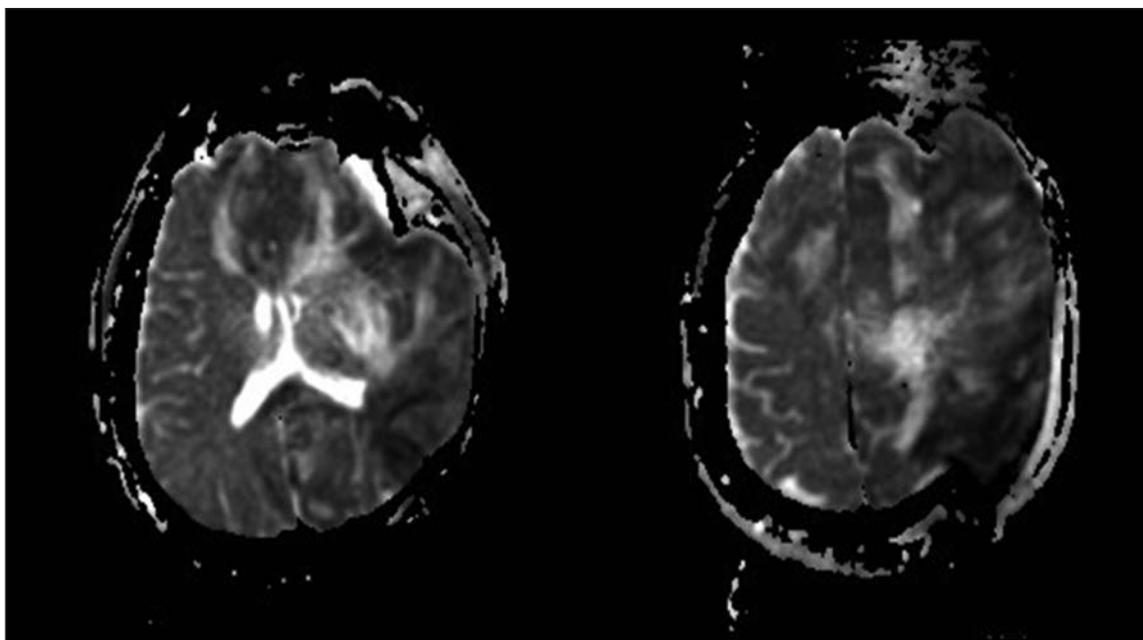


Figure 2: ADC maps demonstrating cerebral hypo-intensity at the craniectomy edges, confirming restricted diffusion at bony margins described in Figure 1.

occipital and lateral cortical restricted diffusion) cannot be explained in their entirety due to cortical compression at the craniectomy edge, and may relate to cortical compression from the subdural hematoma pre-operatively.

Complications associated with craniectomy in this setting include the theoretical risk of axonal stretch and ischemia (thought to be venous in nature) associated with the herniating brain at the bony margins of the craniectomy⁴. Currently we know that there is improvement in partial brain tissue oxygenation (PbtO₂)^{5,6}, cerebral microdialysis⁶, and pressure reactivity indices⁶ through invasive monitoring post-craniectomy for trauma. This has yet been correlated to improved clinical outcome.

We have a poor understanding of the physiological effects on herniated brain at the edges of a craniectomy site. We know that small movements in axonal position, as in diffuse axonal injury, can lead to devastating neurological consequences. The toll that extensive axonal stretch post-craniectomy has on the neurologic outcome is unknown. In addition, the degree of ischemia at the craniectomy edge has yet to be well described. Despite DWI evidence here of focal restricted diffusion at the craniectomy site edges, it is not known what physiological changes are taking place. Furthermore, this entity has yet to be correlated to clinical outcome.

With increasing availability of the MRI capabilities of tractography and functional blood oxygen level dependent (BOLD) sequencing, hopefully in the near future further light will be shed on the significance of the “edge effect”.

REFERENCES

1. Taylor A, Butt W, Rosenfeld J, et al. A randomized trial of very early decompressive craniectomy in children with traumatic brain injury and sustained intracranial hypertension. *Child's Nerv Syst.* 2001;17:154-62.
2. Cooper DJ, Rosenfeld JV, Murray L, et al. Decompressive craniectomy in diffuse traumatic brain injury. *N Engl J Med.* 2011;346(16):1493-502.
3. Hutchinson PJ, Corteen E, Czosnyka M, et al. Decompressive craniectomy in traumatic brain injury: the randomized multicenter RESCUEicp study (www.RESCUEicp.com). *Acta Neurochir.* 2006;96:17-20.
4. Honeybul S, Ho KM. Long-Term complications of decompressive craniectomy for head injury. *J Neurotrauma.* 2011;28(6): 929-35.
5. Weiner GM, Lacey MR, Mackenzie L, et al. Decompressive craniectomy for elevated intracranial pressure and its effect on the cumulative ischemic burden and therapeutic intensity levels after severe traumatic brain injury. *Neurosurgery.* 2010;66(6): 1111-9.
6. Ho CL, Wang CM, Lee KK, et al. Cerebral oxygenation, vascular reactivity, and neurochemistry following decompressive craniectomy for severe traumatic brain injury. *J Neurosurg.* 2008;108:943-9.