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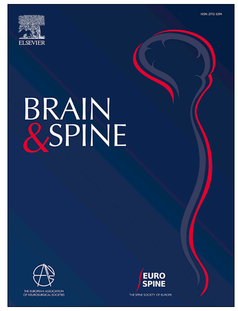

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When bigger is not the whole story: decompressive craniectomy size, intracranial pressure, and surgical phenotyping

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Dear Editor,

We read with great interest the article by Vreeburg and colleagues[1] evaluating the comparative effectiveness of decompressive craniectomy size in traumatic brain injury using CENTER-TBI data. The authors should be congratulated for addressing an important and surprisingly unresolved question in neurotrauma surgery: whether the anatomical size of a decompressive craniectomy translates into better physiological control and, ultimately, improved clinical outcome. The main finding is clinically relevant: in this large real-world cohort, larger decompressive craniectomy size was not associated with more favorable 12-month functional outcome. This result challenges a simplistic "larger is better" paradigm and rightly highlights the heterogeneity of decompressive craniectomy indications in contemporary practice, including primary procedures during mass lesion evacuation and secondary procedures for refractory intracranial hypertension[2] .

However, we believe that one aspect deserves further emphasis. The absence of an association between craniectomy size and long-term functional outcome should not be interpreted as evidence that size is physiologically irrelevant for intracranial pressure control. Outcome and pressure physiology are related but not interchangeable endpoints. Functional outcome after traumatic brain injury is determined by multiple factors, including primary injury severity, extracranial insults, timing of intervention, systemic complications, rehabilitation, and withdrawal-of-life-sustaining-treatment practices. A negative association with GOSE therefore does not necessarily imply absence of a decompressive effect on ICP.

Indeed, the authors report that in conventional random-effects linear regression, larger decompressive craniectomy size was associated with a greater postoperative ICP decrease. This signal was not confirmed in the instrumental variable analysis. Given the limited availability of preoperative ICP data, this should probably be interpreted as uncertainty rather than evidence of physiological equivalence. This distinction is important because ICP control is the primary physiological rationale for decompressive craniectomy, particularly when the procedure is performed as a treatment for refractory intracranial hypertension. In other words, the study robustly suggests that craniectomy size alone was not associated with better long-term functional outcome, but it does not definitively establish that size is indifferent for ICP control.

A related issue is the temporal dimension of intracranial hypertension. The reported pre–post ICP comparison captures an early pressure change around surgery, but it does not fully describe the duration, intensity, or cumulative burden of intracranial hypertension before decompression. This may matter biologically. A given craniectomy size may have different physiological and clinical implications if performed early during evolving swelling, during mass lesion evacuation, or after prolonged refractory intracranial hypertension. Future studies should therefore consider not only

ICP values before and after surgery, but also ICP dose, timing from ICP rise to decompression, and the trajectory of intracranial hypertension. A second issue is that bone flap size may be an incomplete surrogate for the true decompressive intervention. The effective decompressive capacity of the operation is likely determined by the interaction between several surgical and biological variables: bone removal area, temporal basal decompression, medial margin-to-midline distance, dural opening, expansile duraplasty, brain swelling phenotype, and the pressure–volume relationship of the injured brain. A large bone window with a restrictive dural opening may not provide the same physiological decompression as a smaller but anatomically well-targeted craniectomy with wide dural opening and adequate expansile duraplasty. Conversely, two craniectomies with similar surface area may differ substantially in their ability to accommodate temporal swelling, reduce uncal displacement, or prevent secondary herniation.

This is particularly relevant because dural management is often underreported in decompressive craniectomy studies. Whether the dura was widely opened, left open, closed loosely, augmented with expansile duraplasty, or reconstructed using a specific substitute may substantially modify the relationship between measured bone size and actual ICP response. Without these details, the anatomical surface area of the craniectomy risks becoming a proxy for decompression rather than a true measure of decompressive efficacy.

The work by Vreeburg et al. therefore raises an important methodological point for future studies. Rather than asking only whether "larger" craniectomies are better, the field may need to move toward a more integrated measure of effective decompressive capacity. Such a measure could incorporate bone flap area, skull-adjusted size, temporal base decompression, distance to midline, dural opening and duraplasty characteristics, postoperative transcalvarial expansion, and ICP burden before and after surgery. This would better capture the physiological intent of decompressive craniectomy than surface area alone.

In this context, the clinically relevant question may not be whether larger craniectomies are universally superior, but whether the decompression performed is anatomically, temporally, and physiologically sufficient for the specific swelling phenotype being treated. The study by Vreeburg and colleagues is valuable precisely because it shows the limits of using size alone as a treatment descriptor. Its findings should encourage more granular surgical phenotyping rather than a premature conclusion that size does not matter.

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Declaration of interests

☒ The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

☐ The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: