Decompressive laparotomy for reduction of incessant increased intracranial pressure in the absence of abdominal compartment syndrome: A case report

Mark Armanious, Louise N Bacon, Johnny Harris, Shayla George, Kristen-Kaye Goulbourne, Omar K Danner, L Ray Matthews, Kenneth L Wilson

ABSTRACT
Introduction: A novel approach for the management of severe traumatic brain injury is to perform a decompressive laparotomy when controlling intracranial hypertension (ICH) appears futile. Bladder pressures measured above 20 mmHg are used to signify the presence of an abdominal compartment syndrome and indicate the need for a decompressive laparotomy. Case Report: We are presenting a case study of a 16-year-old male who sustained a gunshot wound to the head that resulted in a severe traumatic brain injury and incessantly elevated intracranial pressures (IVP). The patient did not demonstrate a sustained and significant reduction in his ICH following a decompressive craniectomy. We performed a decompressive laparotomy successfully reducing the patient’s ICP below 20 mmHg. The patient survived to discharge and was neurologically improved at follow-up. Conclusion: This case highlights the importance of regarding the body a continuous compartment allowing a reduction in intracranial pressure by decompressing the abdomen even in the absence of an abdominal compartment syndrome measured by elevated bladder pressures above 20 mmHg.

Keywords: Intracranial hypertension (ICH), Cerebral perfusion pressure (CPP), Abdominal compartment syndrome (ACS), Decompressive laparotomy, Brain injury

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INTRODUCTION

One of the most formidable complications of traumatic brain injury (TBI) is increased intracranial pressure (ICP). An increased ICP is a neurologic emergency that if left untreated may cause cerebral ischemia, brain herniation, and possibly death [1]. The primary treatment for patients with TBI is to lower ICP readings below 20 mmHg and to maintain cerebral perfusion pressure (CPP) between 60 mmHg and 90 mmHg in order to provide sufficient cerebral perfusion [1]. Proper head elevation is an effective strategy promoting optimal venous flow for TBI, but more aggressive therapies are needed when elevated ICP accompanies severe TBI. Some of the therapies to lower ICP after TBI include hyperventilation (HV), intravenous mannitol and cerebrospinal fluid drainage from a ventriculostomy (EDV). Decompressive laparotomy...
cranectomy and barbiturate-induced coma are at the
desperate end of the continuum necessary to save a
patient suffering from both TBI and increased ICP
[2–3].
When all typical and heroic therapeutic treatments
have been exhausted for sustained high ICP, an
innovative approach termed a decompressive
laparotomy can be implemented. This treatment which
had been exclusively reserved for abdominal
compartment syndrome involves cutting the anterior
fascia of the abdomen allowing the abdominal viscera to
expand thereby relieving intra-abdominal pressure. The
elevation of intra-abdominal pressure displaces the
diaphragm cephalad, increasing intrathoracic pressure
and central venous pressure. The pressure is then
transmitted through the venous system, causing
increases in ICP and decreases in CPP [4–6]. We are
presenting a case study of a 16-year-old male with a
severe TBI and incessant elevated ICP who
demonstrated a reduction in his ICP following a
decompressive craniectomy without the presence of an
abdominal compartment syndrome (ACS).

CASE REPORT
A 16-year-old male presented to our level I trauma
center in Atlanta, Georgia after sustaining a single
gunshot wound (GSW) to the left occipital region of
head. He was confused and combative, requiring
intubation in the trauma bay for a glasgow coma score
of eight. Significant findings included comminuted
fractures of the left thumb and an entry wound to the
left temporal bone of the skull. The computed
tomography (CT) scan of the head revealed retained
bullet fragments and multiple facial fractures, it also
revealed a comminuted fractures of the left posterior
parietal, occipital and temporal bones. Intracranial
damage included a left-sided subdural hematoma;
intraparenchymal hemorrhage and diffuse cerebral
edema with sulcal effacement of 6 mm with a left to
right midline shift (Figure 1).

The patient was taken to the operating room for
debridement of the brain parenchyma and a right
decompressive craniotomy by the neurosurgery service.
Postoperatively, the ICP remained elevated (41–54) and
would not respond to propofol sedation, 3% saline
infusion and cerebrospinal fluid drainage. The following
morning a repeated CT scan of the head was performed
which revealed blossoming of the left intraparenchymal
hematoma. The patient was transported to the
operating room for a left hemispherectomy and
duralplasty. Despite this intervention, the ICP remained
in the thirties and a metabolic coma with phenobarbital
was induced.

On postoperative day-5, a decompressive
laparotomy was performed as an intervention for his
refractory intracranial hypertension. The abdominal
fascia was left open allowing room for bowel
visceration. ICPs measured immediately following the
decompressive laparotomy were lowered ranging
between 11–12 mmHg. On postoperative day-14, the
patient was taken to the operating room for an
abdominal washout and fascial closure because of ICP
measurements that were less than 20 for 9 days since
the decompression. By postoperative day-18, the
induced pentobarbital coma had been reversed and the
external ventricular drain (EVD) had been removed.
The patient survived and was discharged to a
rehabilitation facility with a glasgow coma score of
seven. One year following his gun shot wound to the
head, the patient is at home with his parents. He is
communicative and writing music. He has gained the
ability to ambulate with the assistance of a cane and
hopes to walk independently before reaching college.

![Figure 1: On admission, computed tomography of the brain
demonstrating comminuted fracture of the left occipital bone.
A left frontoparietal subdural hematoma is noted along with
intraventricular hemorrhage.](image)

DISCUSSION
Approximately, 1.7 million people sustain a TBI
annually [7]. In the context of a TBI, the brain has a
limited capacity to autoregulate the CPP because of
increased intracranial pressure as established by the
Monro–Kellie doctrine. The Monro–Kellie doctrine
describes the brain as a fixed bone that has decreased
compliance when compared to other body
compartments. An increase in intracranial volume
causes a significant increase in the ICP negatively
impacting the CPP of the brain [8]. Systemic vasoactive
responses from shock remote to the abdomen can cause
“capillary leak” that leading to fluid accumulation inside
the abdomen or thorax deleteriously increasing ICP.
Intracranial pressure studies have demonstrated that
there is a direct correlation between intracranial,
intrathoracic and intra-abdominal compartments
[9–10]. Multiple-compartment syndrome or
polycompartment syndrome, stresses the importance of increased pressure in closed anatomic spaces threatening the viability of surrounding tissue [11]. Joseph et al. demonstrated a decompressive laparotomy was successful in decreasing ICP, thus supporting the correlation of pressures in the polycompartment syndrome theory. In this study, decompressive laparotomies were utilized for 17 patients and all 17 patients experienced a decrease in the ICP of 10 mmHg or greater [6]. A case report by Dorfman et al. documented the treatment of a 17-year-old female following a motor vehicle collision with TBI that was effectively treated with a decompressive laparotomy in a last ditch effort to control intractable ICPs as a consequence of a massive resuscitation leading to an ACS [12].

When bladder pressures are performed and measured above the normal range (greater than 20 mmHg), a decompressive laparotomy in selective patients can be performed to release an abdominal compartment syndrome. As mentioned by Scalea et al. the performance of decompressive laparotomies for refractory ICP can be associated with an unacceptably high rate of morbidity and mortality, and should be utilized with well-defined criteria [10]. In our study, and with subsequent success with an adult patient, we have expanded our decompressive laparotomies to not only include when medical management, which includes an induced pentobarbital coma, fails to reduce elevations of ICP above 20 mmHg, but also to include when the bladder pressures are normal. Our earlier intervention without bladder pressure elevation may suggest intervening before a measured increase in ACS that would negatively impact perfusion of the injured brain.

Our case outlines the utility of a decompressive laparotomy for an isolated head injury when the abdomen is affected by a massive trauma resuscitation and a polycompartment syndrome can be presumed while the bladder pressures may not yet reflect the volume expansion leading to an abdominal compartment syndrome. The immediate and significant drop of the ICP, which was sustained below 20 mmHg following the decompressive laparotomy highlights regarding the body as being multi-compartmented when treating intractable ICPs. Studies have demonstrated that the pediatric population performs more favorably to decompressive craniectomies than their adult counterparts [13–14].

CONCLUSION

This case study of a 16-year-old male patient and that of a 17-year-old patient by Dorfman et al. perhaps further demonstrates that the pediatric population with TBI with refractory intracranial hypertension can be treated more aggressively with less mortality and a lesser vegetative state when maximal medical therapy fails. The number of published cases and sample sizes are limited in the treatment of incessant intracranial pressures with abdominal compartment syndrome. Our success with this patient and another young adult demonstrates that a decompressive laparotomy can be safely applied as an alternative to improve cerebral perfusion in the absence of abdominal compartment syndrome when medical therapy fails.

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Author Contributions
Mark Armanious – Substantial contributions to conception and design, Acquisition of data, Analysis and interpretation of data, Drafting the article or revising it critically for important intellectual content, Final approval of the version to be published
Louise Bacon – Substantial contributions to conception and design, Acquisition of data, or analysis and interpretation of data, Drafting the article or revising it critically for important intellectual content, Final approval of the version to be published
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Guarantor
The corresponding author is the guarantor of submission.

Conflict of Interest
Authors declare no conflict of interest.

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