CASE REPORT

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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

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craniectomy 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 hemicraniectomy and duraplasty. 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 evisceration. 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.

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 hypotension 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.

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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