

Which Type of Decompressive Craniectomy Is Better? Advantages and Challenges of Fresh Cadaver Practices Based on Experiences from the Last 20 Years. The Effect of Jesus Prayers in Science

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Abstract

Aim of Study: Reviewing the large number of publications about DC in the case of severe traumatic brain swelling, there is no clear position on which one is preferable for the patient. Bifrontal or bilateral fronto-parieto-temporo-partial occipital craniectomy. One of the most critical points, the behaviour of brainstem and its vascular structures during the protrusion of the traumatized swelling brain, which can expand in different directions, depending on where the skull has been opened. **Method:** After the high ICP created on a simple fresh cadaver model, we examined the brainstem displacements and compressions with the help of an endoscope-guided transnasal transsphenoidal transclival and analyzed their possible harmful effects on brainstem structures and blood vessels. **Results:** In bilateral bifronto-parieto-temporo-partial occipital craniotomy, no significant bulging or forward movement of the brainstem was detected. In the course of bifrontal craniectomy, significant forward movement and thus compression of vascular structures and pons were detected. **Conclusion:** Our assumption has been confirmed. In bifrontal craniectomy, the expansion is not parallel to the course of the brainstem, but perpendicular so that the pons and the blood vessels running along its anterior surface are compressed by moving forward against the clivus, which leads to circulatory compression and damage to the brainstem. In bilateral DC, the expansion is axially parallel to the course of the brainstem. Based on the fresh cadaver model, the use of the latter method is preferable for the traumatized swelling brain. In both cases, bridging veins of the protruding brain at the bone edge must be protected by the vascular tunnel method against compression. We

examined this scientific question not only from a neurosurgical perspective but also in terms of the general ethical possibilities and psychological difficulties of conducting fresh cadaver practices. Additionally, we provided an answer on how we can ease the work of research doctors practicing on the deceased through the power of spiritual exercises and prayer. The dissection room offers fantastic opportunities for surgeons to discover new paths.

Keywords

Decompressive Craniectomy, Traumatic Brain Swelling

1. Introduction

Authors experience over the past 20 years, many neurosurgical scientific ideas and surgical innovations have been born during the daily morning fresh cadaver practices [1] [2], and the most important aspect of testing these was to avoid practicing on the living. It is also a fact that it is unpleasant to be in the morgue with the dead at 6 a.m. and perform these practices within regular dissections. Interestingly, 500 years ago, this was much less of an issue; not only doctors but artists (Leonardo da Vinci, Michelangelo) were regular visitors to the dissection rooms.

Today, the dissection rooms are almost empty. Why is that? The reason can again be found in spirituality. Even doctors today almost dread death and do not want to face it. In the dissection room, however, the cold reality confronts them. This unpleasant feeling is eliminated by faith in the resurrection, and dissection practices take on a completely different perspective. If the doctor performing the dissection recognizes in the fresh deceased the body of Jesus taken down from the cross, which has been resurrected, then these bad feelings associated with death can disappear. "Our future has already happened with the resurrection, we are not waiting for something that has not yet happened," said a Christian scientist, and this is truly the case for a person living with faith. The Jesus prayer [1] helps to achieve this kind of spiritual attitude which helps to bear the spiritual difficulties of fresh cadaver work.

Summarizing the advantages of fresh cadaver practice is the next:

1) Realistic Learning Environment: Fresh cadaver practices provide a realistic and tactile learning environment, allowing students and professionals to gain hands-on experience with human anatomy in a way that textbooks and simulations cannot replicate.

2) Surgical Skill Development: These practices are invaluable for developing and refining surgical skills. Surgeons can practice and perfect their techniques on real human tissue, which enhances their proficiency and confidence in the operating room.

3) Understanding Anatomical Variations: Working with fresh cadavers allows for the study of anatomical variations that are not always visible in preserved

specimens or digital models, offering a deeper understanding of human anatomy.

4) Improved Clinical Outcomes: The practical experience gained from cadaveric dissection and surgery can lead to improved clinical outcomes as healthcare professionals are better prepared for real-life medical procedures.

Challenges:

1) Ethical Considerations: There are significant ethical concerns surrounding the use of human cadavers for educational purposes. Ensuring that bodies are donated voluntarily and treated with respect is crucial.

2) Resource Intensive: Maintaining a program that uses fresh cadavers requires substantial resources, including specialized facilities, preservation equipment, and trained personnel to handle and prepare the bodies.

3) Emotional Impact: For some students and practitioners, working with cadavers can be emotionally challenging, potentially causing distress or discomfort.

4) Regulatory and Legal Issues: There are strict regulations and legal considerations related to the use and disposal of human remains, which can complicate the logistics of such programs.

Context and Conclusion: These exercises are conducted with great reverence, often in a spirit of prayer, to honor the donors and the invaluable contribution they make to medical science and education.

The following statements are very important from an ethical point of view. In connection with familiar permission, our statement has been formed by the Local Legal and Ethical Committee considering the Hungarian patient law in line with the Helsinki Declaration. [2]

- Patients can sign an agreement for treatment in university clinics and teaching hospitals where residency training takes place. They can also give permission for the performance of cadaver operations during regular dissection for educational purposes, considering the propriety.
- In case of not having a report from the patient (for example, due to unconsciousness on admission), after the patient's death, the relatives can declare how their late relative would have decided before his death.
- If the hospital is not a teaching hospital or clinic, this report has to be constructed in a separate statement to be signed.
- The dead should be dissected within 72 hours in Hungary. Meanwhile the dead is in the cool chamber (the cold store). When the post mortem begins the organs are removed and put on the desk at the end of the dissection table.

How can we prepare the model of elevated intracranial pressure in the course of decompressive craniectomy?

The process of the regular calvaria removal changed. First a bifrontal craniotomy or bilateral happens. After the implanted balloon is inflated the clivus removal should be done by endoscopic transsphenoidal transnasal approach. (**Figures 1-3**) Durotomy before the pons allows us to observe the behavior of neural and vascular structures during the different types of decompressive craniectomies. (**Figure 4, Figure 5**)

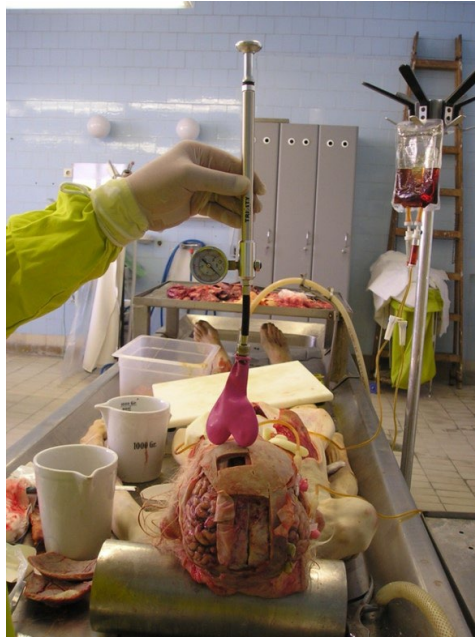


Figure 1. Fresh cadaver model, of bilateral decompressive craniectomy. Inflating the balloon in ventricles modelize the raise of intracranial pressure.

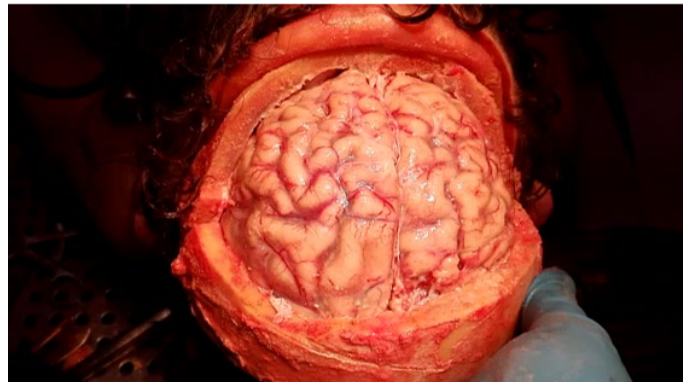


Figure 2. Fresh cadaver model of bifrontal decompressive craniectomy during raised ICP. Frontal lobe protrusion is visible after inflating the balloon placed in posterior horn ventricles.

At the end of observation, the calvaria removal occurs and the complete post-mortem brains are removed in the regular manner. After dividing the cerebellum the brain and medulla and cerebellum are sliced to 0.5 - 1 cm wide pieces as regular pathological slicing is recommended. To summarize, the goal is to observe the brainstem compression similar to live decompressive craniectomy.

Author's article [2] in *Acta Neurochir* authorizes the fresh cadaver practice not only by the Helsinki Declaration and ethical approval but on the basis of the following simple scientific logical reasons:

- The regular dissection of the human brain involving slicing of 1-cm thin pieces is a significantly coarser intervention than the careful inflation of the brain via ventricles modeling the raised ICP. During the procedure, a foreign body must not remain in the dead.

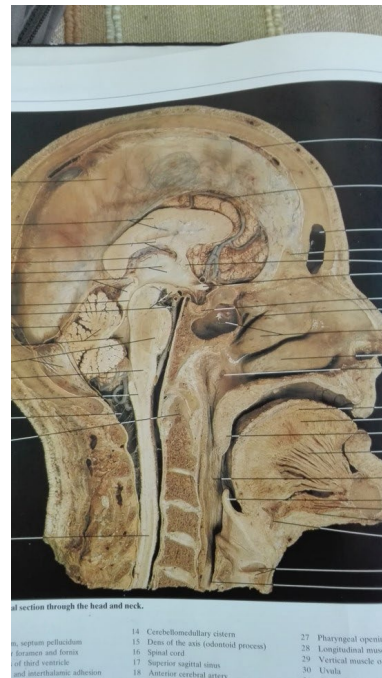


Figure 3. Anatomical situation of the pons and basilar artery. Forward moving causes the compression of pons and basilar artery and perforators by clivus.

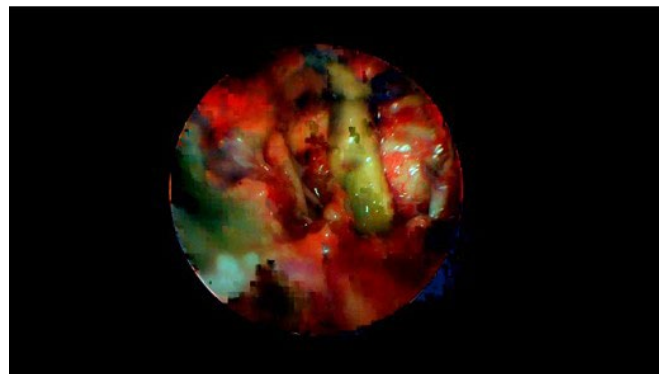


Figure 4. Transclival transdural, endoscopic record. Pons protrusion, basilar artery compression visible in the course of bifrontal craniectomy, during raised ICP.

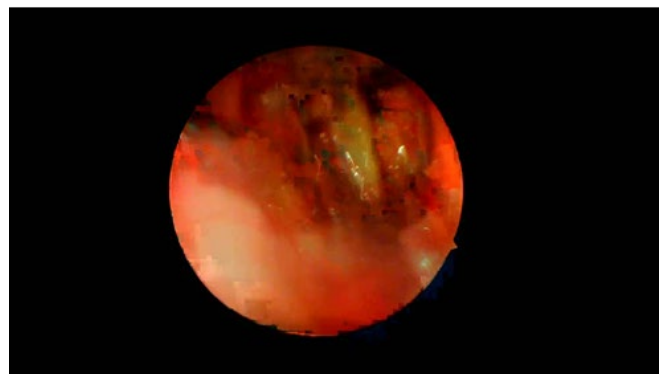


Figure 5. Transclival transdural endoscopic record. No protrusion visible in the course of bifronto-parieto-temporal craniectomy, during raised ICP.

- Due to these reasons, the hospital management and the Ethics Committee have no objection to cadaver practice surgery carried out within an autopsy.

Our recent neurosurgical innovations [3] also originated in the course of fresh cadaver practice. Despite the plethora of publications [4]-[22] on decompressive craniectomy (DC), there is no clear consensus on which approach is more beneficial for the patient, whether it's bifrontal or bilateral fronto-parieto-temporo-partial occipital craniectomy, in cases of severe traumatic brain swelling.

According to the scientific literature, there has been no publication so far on whether it is worthwhile to examine the effectiveness of the two methods from any perspective. [4]-[22]

2. Method

Using a fresh cadaver model, we attempted to examine the evolving brainstem displacements following raised intracranial pressure (mimicking the effect of traumatic brain swelling) and analyzed the potentially harmful effects of clival compression on brainstem structures, arteries, and nerves. We investigated the compression of the brainstem and its associated structures including the basilar artery and perforator arteries after transnasal transsphenoidal clival resection and dural opening using an endoscope. (Figure 4, Figure 5) Intracranial pressure elevation was achieved through an inflated balloon in the ventricles. (Figure 1, Figure 2)

3. Results

In bilateral bifronto-parieto-temporo-partial occipital craniotomy, we did not observe protrusion or anterior displacement of the brainstem towards the clivus, thus avoiding compression of the basilar artery and perforators. However, significant anterior displacement and compression were observed in bifrontal craniectomy.

4. Conclusion

Beyond this simple initial study using fresh cadaver models, more precise investigations are clearly needed. However, it has become evident that the disadvantage of bifrontal craniectomy is not only the possibility of cutting through the sinus in the first third but also the compression of the brainstem and its vessels. Due to the often tragic outcomes, we have not paid attention to this fact so far, as it was beneficial that performing this last-resort surgery was easier for beginners than the extended bilateral decompressive craniectomy. Our hypothesis was confirmed. In bifrontal craniectomy, expansion is not parallel to the course of the brainstem but perpendicular, compressing the pons and the arteries running on its anterior surface against the clivus, leading to brainstem circulation impairment. The removal of bilateral calvarial roof, leaving approximately a 3 cm wide bone edge at the midline above the superior sagittal sinus, provides better mechanical conditions for compression regarding the brainstem and its structures, thus being less hazardous even for diffusely and potentially traumatized brainstems. Without bilateral

DC, expansion follows the axis of the brainstem. In bifrontal craniectomy, the anterior third sectioning of the superior sagittal sinus alone can lead to further brain swelling, which may not cause significant additional congestion in a healthy brain but can be detrimental in a swollen brain. Based on the fresh cadaver model, the application of bilateral fronto-parieto-temporo-partial occipital DC proves advantageous for the brainstem and the traumatized brain. In both cases, the bridging veins protruding from the brain must be protected against compression at the bone edge or dural edge using the vascular tunnel method. [3] [8]

5. Discussion

The situation is somewhat similar to the debate that has surrounded DC over the past 120 years, which reached its peak at the beginning of the last decade after the DECRA and RescueICP results were published in the NEJM. One of the largest mistakes of the modern science may be the analyzing of the efficacy of the medical treatment by the rule of the evidence-based medicine in the state around the death. What are the most important bioethical rules in the life threatening extreme emergency status? It is a very important topic as the scientific world has often forgotten the rule of bioethics which says, “In life-threatening illness the scientific rationale for the treatment must be sufficiently strong that a positive result would be widely accepted.” (Warren T. Reich, Encyclopedia of Bioethics, page 2276) In these cases, it is a mistake to insist on the method of evidence-based medicine, which is the prospective randomized study. Bioethics has superiority above all of the medical sciences as a connection between mystery, spirituality, and science. We must not neglect bioethics. What is the rationale base of the afore mentioned rule in the treatment of emergency status around the death?

The status around the death is such a hundred or thousand? unknown equation that we must not fix only one or two constants in analyzing the results as we probably make a lot of mistakes in our consequence. This is the reason why bioethics uses the “scientific rationale” which could be better in the treatment than applying the results of the prospective randomized study fixing some constant. The history of decompressive craniectomy (DC) is a very good example. We took some steps backward during the debate of more than 100 years (first described in 1905 by Cushing [1]). The evidence proved by Decompressive Craniectomy in Diffuse Traumatic Brain Injury (DECRA; issued in 2011) [2], which mixed the analysis of the status of far away from death and the status around the death in its conclusion. Mixing life threatening and curative characteristics, it was obvious that the conclusion of DECRA was false. The application of DC the adults from ICP 20 mmHg is illogical because surgical complication decreases the efficacy against the conservative therapy which is also effective in this ICP status. In the case of children, the situation could be quite different because of the possible extreme acceleration of the ICP. If we can reach the OR quickly and can perform durotomy (craniotomy is not enough) within 15 - 20 min from the beginning of rapidly rising ICP, the limit can remain above 25 mmHg in children’s cases, as well. (I have seen it

only in the popular medical TV films). Our record was 25 min from rapid onset of ICP in ICU until the durotomy on the both sides. If we cannot reach the OR within 20 min, we should do the DC as prevention above 20 mmHg. Probably we are going to operate many times in vain, but we can avoid the mindless death of the child caused by a reversible curative pathological process called brain edema. We have to know that in emergency care around death, we have to make 10 times unnecessary efforts while it is worth doing the DC. The nine DC cause less damage for the patients than only one fatal death. The situation is quite similar to the situation of decision bifrontal or bilateral DC is better. We should continue the debate not about the performance of DC, but on how to increase the efficacy of DC.

Currently, it appears that scientific considerations have prevailed, but not through bioethics, rather because the results indicated so. However, this approach is very dangerous in life-and-death situations, as the closer a disease process gets to a fatal outcome, the more difficult it becomes to study it in a prospective randomized way, due to the increasing number of unknown factors. Therefore, the law of bioethics provides a solution (quote). In the previously outlined issue regarding bifrontal or bifrontal-parietal-temporal craniectomy, the situation is similar. We have been in a similar situation before, when we had to prove the efficacy of the vascular tunnel method [3]. Then, too, we successfully turned to bioethics and fresh cadaver studies for assistance.

6. Additional Notice

The famous masters and schools advise cadaver workshops and often require them before starting work in specific areas (e.g., endoscopic surgery or bypass). The reality is that no one questions the legitimacy of anatomical workshops, due to a high degree of usefulness. The new proposal will add a special practical consideration, which may lead to further professional development. Since regular prosecture consists of the dissection of the cadaveric brain into 1-cm thin pieces, and the prosecture of the skull base is also more invasive than a regular microsurgical approach or a vascular procedure, even the most difficult axial or skull base exposure can be modelled as a part of a dissection without irreverence. During the modelled operations, we do not damage the cadaver brain. Another recommendation is to practice not only once or twice per year in workshops, but every week. Before difficult operations, cadaver practice should be demonstrated twice or even three times. This practice proves to be a very good possibility to prepare for live operations.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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