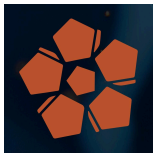


ART ^ NEUROSCIENCES

SEMILLA 06: A Prisoner Brain

0. CONTACT DETAILS

0.1 Surname and first name

Jorge Tirado Caballero

0.2 Contact e-mail address

jtiradocaballero@gmail.com

0.3 Let us get to know you a little bit through your participation in websites, blogs, social networks, etc.

Jorge Tirado-Caballero (researchgate.net)

Jorge Tirado Caballero - Google Académico

(29) Jorge Tirado Caballero | LinkedIn

0.4 What is your background and in which institution do you work?

Bachelor's Degree in Medicine from the University of Sevilla

Specialist in Neurosurgery at the Intercenter Neurosurgery Unit, Virgen Macarena Hospital – Virgen del Rocío Hospital.

Associate Professor of Health Sciences at the Faculty of Medicine, University of Cádiz (2022-2023).

0.5 Gender

Male

0.6 Age range

31-40

1. ESSENTIAL DIMENSION

1.1 Seed name

A prisoner brain: the chess-table cranial expansion.

1.2 Seed summary

The Skull as a Protective Structure: Chessboard Cranial Expansion

The skull constitutes the bony structure that surrounds the brain, protecting it from impacts and atmospheric pressure changes. It is made up of several bones that, at birth, are separated from each other and gradually fuse by around the age of two. These bones include the frontal, the two parietal bones, the two temporal bones, and the occipital bone.

Inside the skull, the brain, brainstem, and cerebellum are housed. All these neurological structures "float" in cerebrospinal fluid (CSF), a liquid produced by the brain itself to cushion and maintain buoyancy within the skull, preventing them from impacting the surrounding bones.

During the early years of life, the skull grows rapidly, following the growth of the brain mass and adapting to its volume. Thus, the volume and shape of the skull are defined by the volume and shape of the structures it contains.

However, this process can be altered by various diseases. Hydrocephalus, a condition that causes an excess of cerebrospinal fluid within the brain, can lead to uncontrolled brain expansion, potentially resulting in the patient’s death. Treatment for this disease involves implanting a cerebrospinal fluid shunting system. This system, consisting of a set of tubes attached to a valve, removes CSF from inside the skull and directs it to the patient's abdomen for reabsorption in the peritoneum.

But what evolutionary changes occur in the skull if too much cerebrospinal fluid is removed during this cranial growth stage? The skull's expansion is likely to be less than in physiological conditions, resulting in a smaller skull than what would be

expected for that individual. As a consequence, the skull expands less than the patient needs, leading to "insufficient" intracranial volume.

Cranio-cerebral disproportion (CCD) syndrome encompasses a group of diseases characterized by insufficient intracranial volume (the volume inside the skull cavity) to house the physiological neural structures (brain, brainstem, cerebellum, etc.) under normal pressure. This volume compromise (the "prisoner brain") in a virtually sealed cavity results in an increase in intracranial pressure, causing symptoms such as headaches (the first and most common symptom), nausea, vomiting, vision loss, and, in severe cases, patient death.

The treatment of this disease involves cranial expansion surgery to restore the necessary volume for patients whose skull has become "too small." The chessboard cranial expansion technique is a surgical method developed at the Virgen del Rocío Hospital in Seville to treat this condition.

The surgery involves making multiple cuts in the skull, simulating the pattern of a chessboard, reopening the skull (as it was during the growth phase) to make it a movable structure. Following the principles of cranial growth, the pulsatile pressure inside the skull will progressively expand its volume, reducing intracranial pressure and improving the patient's symptoms.

This technique has been employed in over one hundred cases at our center, achieving circumferential cranial volumetric expansion and providing a therapeutic alternative in the management of a highly complex disease.

1.3 Metaphor

One metaphor for this concept could be that of a pressure cooker, which accumulates a great deal of pressure inside, requiring a valve to eventually release steam in order to alleviate the pressure within the cooking chamber.

Ventricular shunting systems have been used for decades to manage various pathologies. As a side effect, these systems can cause the skull to become "too small" for what is required by the patient. This is why we refer to cranio-cerebral disproportion.

At this point, the structures contained within the skull begin to exert great pressure, generating the symptoms described earlier. Cranial expansion provides mobility to the skull, allowing it to harmoniously regain the necessary size for the individual, acting as the pressure valve that alleviates the patient’s symptoms.

Another possible metaphor is the Big Crunch – Big Bang sequence. This sequence can be defined as the initial collapse of neural structures due to the lack of cerebrospinal fluid caused by the effect of the ventricular shunt, leading to

the closure of the skull with insufficient volume and eventually causing the disproportion. In a second phase, with cranial expansion surgery, the "Big Bang" would occur as the skull expands when reopened using the surgical technique.

1.4 Keywords

Craniocerebral disproportion, slit-ventricle syndrome, chess-table cranial expansion.

1.5 Scientific field (general)

Neurosciences

1.6 Scientific subfield (specific)

Neurosurgery
Hydrocephalus
Cranial expansion

1.7 Resources (File)

Shared folder

1.8 Resources (Links)

Video of ventriculoperitoneal shunt (the system that removes cerebrospinal fluid):
https://www.youtube.com/watch?v=ZSV1LauJlYk

2. ADDITIONAL DIMENSIONS

2.1 SYNAESTHITIC DIMENSION

This dimension seeks to associate certain sensory characteristics to the seed.

2.1.1 What colours does this seed suggest to you?

The expansion suggests vibrant colors such as orange, red, and yellow bright, intense hues that evoke a sense of energy and power.

2.1.2 What sounds or music does this seed inspire you?

A rocky sound, like tectonic plates colliding with each other, causing an earthquake, also an expanding, volcanic sound, beginning faintly audible and increasing in intensity. This sound could represent the gradual buildup of pressure, followed by a release, symbolizing the cranial expansion process as it progresses from tension to relief. The increasing intensity of the sound mirrors the growing pressure and eventual release that occurs during the surgical procedure.

2.1.3 What aromas would you associate with this seed?

The smell of smoke, warm, from the craniotomy motor gliding along the multiple axes of the skull.

2.1.4 What flavours does this seed avoke in you?

A taste that increases progressively, from bland to umami.

2.2 EMOTIONAL DIMENSION

This dimension seeks to explore the personal meaning of the seed.

2.2.1 What was your motivation to dedicate yourself to this field of research?
What are your personal reason to suggest this seed?

The chess-table cranial expansion technique represents a significant advancement in the management of cranio-cerebral disproportion syndrome. This syndrome, with a highly complex etiopathogenesis and treatment, has been treated using this unique technique at the Virgen del Rocío Hospital in Seville since 2010. Being pioneers in the development of such a surgical technique is the primary motivation that drives me to propose it as the seed for this project.

2.2.2 What metaphysical reflections does this seed provoke in you?

The dynamic equilibrium, almost impossible to achieve, of managing a condition like hydrocephalus while replicating the physiological situation of cranial growth. A body that changes, grows, and expands, with the volume of cerebrospinal fluid (CSF) fluctuating periodically.

The specialists in the pediatric neurosurgery unit maintain close monitoring during the first years of life for patients treated with a ventriculoperitoneal shunt. However, it is exceptionally complex to control exactly how much CSF each human brain needs: different brains, different skulls, each with its own requirements.

Achieving this virtuous balance, where the patient's brain neither suffers from excess fluid (hydrocephalus) nor from the lack of cranial expansion linked to the treatment, is extremely difficult. It is the main factor that “traps the brain” in an insufficient skull. Therefore, the chessboard cranial expansion surgery solves the current medical inability to achieve a dynamic balance that adapts to the patient throughout their development.

Our commitment and future lines of work are focused precisely on attempting to address this problem early on, by controlling the amount of CSF extracted from the patient's brain to prevent the skull from becoming “too small.” Cranial expansion, in this sense, is the final stop for patients who have not managed to reach equilibrium during their growth.

2.2.3 What ethical reflection or challenges would you associate with this seed?

The main ethical issue I face is the current inability of medicine to replicate the physiological functioning conditions of the human body. Pediatric hydrocephalus is a disease that has existed for millennia, capable of causing death in infancy if not treated. The cerebrospinal fluid (CSF) shunting systems, designed in the 1960s, attempt to remedy the excess fluid in the brain by trying to replicate the situation of a healthy individual. However, these systems still fall far short of faithfully reproducing the physiological reality of a human being.

This imperfect system, being the best we currently have for treating hydrocephalus, is nevertheless the main cause of the lack of brain expansion in the first stage of life. That is why the syndrome of cranio-cerebral disproportion is particularly common when the shunting system is implanted during the first year of life.

Cranio-cerebral disproportion is, in this sense, an "adverse effect" of the best treatment we have to try to control hydrocephalus. As a result of this treatment, we alter the nature of physiological cranial growth, leading to a small skull for the patient, requiring expansion years later.

Interestingly, in order to save these patients, we must "go back in time" in their cranial growth. By reopening the skull again, we give the patient the opportunity to finish expanding their skull enough to adapt to the required volume. In a way, cranial expansion is a way to correct an iatrogenic problem (caused by an imperfect surgical treatment), resulting from valvular drainage during the early stages of life.

For the past twenty years, thanks to programmable shunting systems and flow control systems, we have significantly reduced the incidence of this syndrome. However, we still encounter cases that are unmanageable without re-expanding. Chessboard expansion represents an alternative for patients who would otherwise be untreatable, providing an aggressive but effective treatment for disease control.

2.2.4 What aesthetic dimensions does this seed suggest to you?

Expansion, the occupation of space with volume, a brain under tension that releases and literally expands, claiming the space around it. Light that occupies spaces, like a volcano erupting from the Earth's crust, cracking, dispersing, and dilating its dimensions.

2.3 PROCEDURAL DIMENSION

This dimension seeks to explore the scientific processes that are usually followed when investigating this topic.

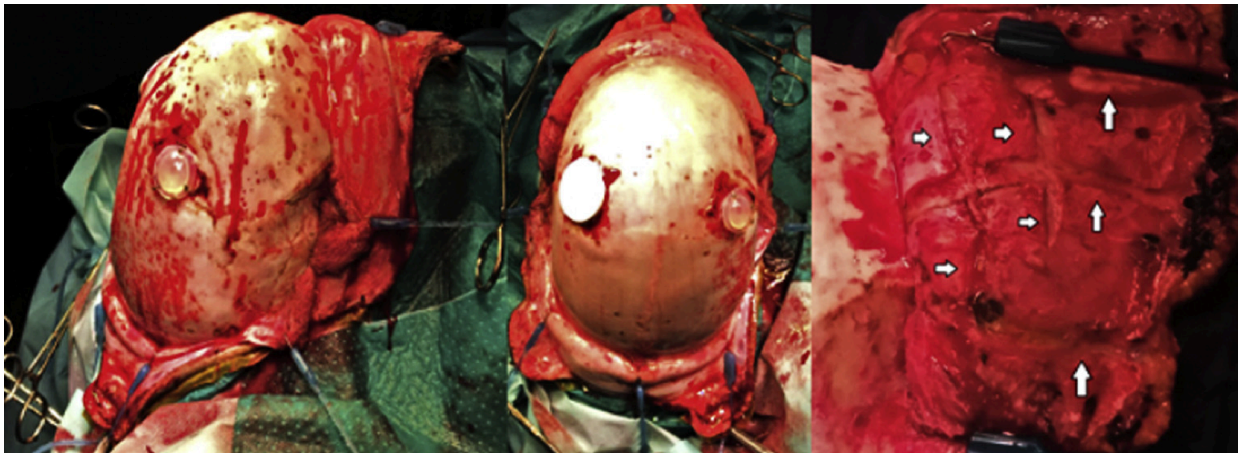
2.3.1 Description of the research process

Surgical procedure technique:

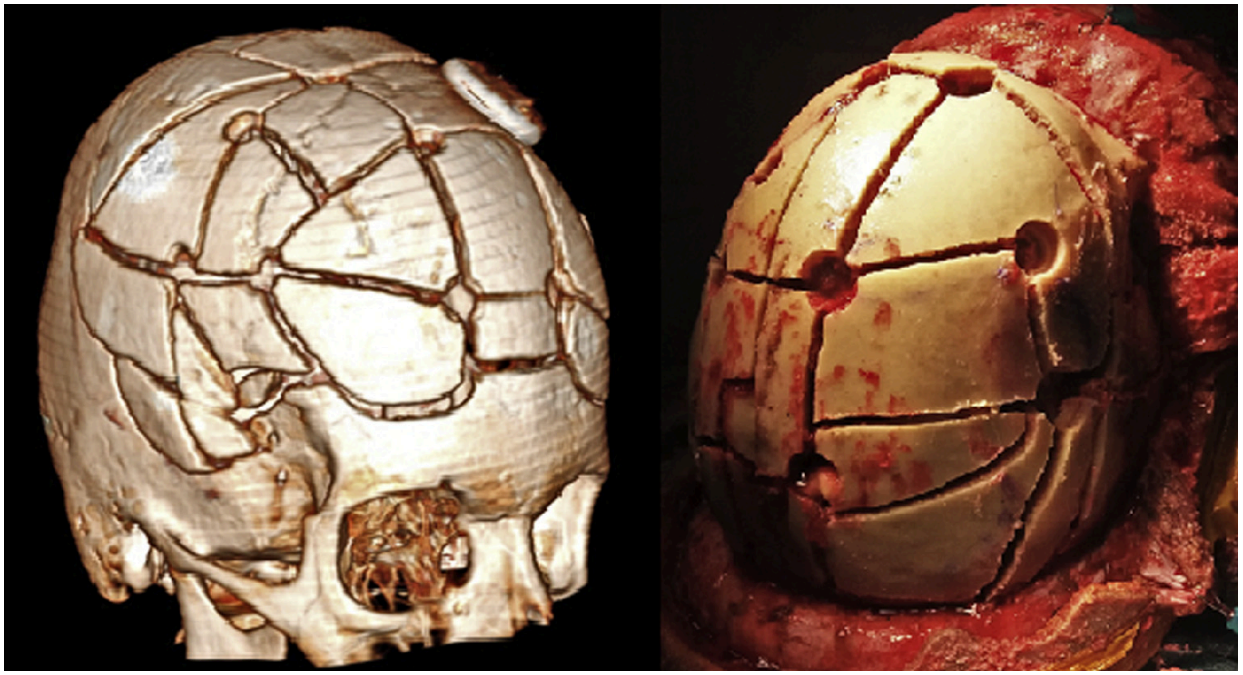
The patient is positioned supine, with the head in a neutral position (without rotation), resting on a surgical donut. A bicoronal incision is made, connecting the region between both ears. We usually make a scalloped incision to facilitate the suturing process during closure.

Next, we dissect the skin forward until reaching the orbits and posteriorly as much as possible to expose the patient's skull. In this case, we observe that the patient's skull has a shunt valve and a pressure sensor, which helped us during

the diagnosis. We make incisions in the galea (the subcutaneous aponeurosis of the scalp) to allow the skull to expand with less resistance.



Once the skull is exposed, we begin the process of craniotomy using a trephine to create several holes, which will later be connected using a craniotomy saw. In these images, you can see how the skull appears once opened in the operating room, as well as the reconstruction through a 3D CT scan.



Fuente de las imágenes: Dynamic Chess-Table Cranial Expansion for Treatment of Craniocerebral Disproportion: Technical Note and Volumetric Results. Tirado-Caballero J, Rivero-Garvía M, Gómez-González E, Kaen A, Cardenas Ruiz-Valdepeñas E, Márquez-Rivas J.World Neurosurg. 2019 Feb;122:533-543. doi: 10.1016/j.wneu.2018.11.119.

2.3.2 Research process diagram

1. **Disease: Hydrocephalus**: The accumulation of cerebrospinal fluid within the brain, which, if untreated, will lead to the patient's death.

2. **Ventricular Shunting**: A surgical procedure that drains cerebrospinal fluid from the patient's brain and deposits it into the peritoneum (abdomen) to allow the patient to survive the condition.

3. **Overdrainage and Reduced Cranial Growth**: The drainage of cerebrospinal fluid results in less cranial growth than physiologically expected, causing delayed cranio-cerebral disproportion (the skull becomes too small for the patient due to the ventricular shunt surgery).

4. **Established Cranio-Cerebral Disproportion**: An increase in intracranial pressure occurs because the skull has failed to grow sufficiently due to the drainage effect of the shunt, leading to symptoms such as headaches, nausea, and vomiting.

5. **Cranial Expansion Surgery**: The skull is reopened in a chessboard pattern, allowing it to expand and regain the necessary volume to relieve excess intracranial pressure.

2.3.3 Link to the descriptive video of the process

2.3.4 What tools are typically used in this field of research? Whether instruments, technologies, hardware or software.

1. **Cerebral CT (Tomography Computed)**: A diagnostic imaging technique used to visualize the brain, commonly employed to assess structural abnormalities and intracranial pressure.
2. **Intracranial Pressure Sensor**: A device used to measure and monitor increases in intracranial pressure, essential for diagnosing conditions like hydrocephalus and cranial disproportion.

Surgical Instruments:

- **Electric Scalpel**: A tool used to make precise incisions with the help of electrical current.
- **Bipolar Forceps**: Used to coagulate tissue or vessels during surgery.

- **Trepan**: A surgical instrument used to create holes in the skull, typically employed in cranial surgeries.
- **Craniotomy Saw**: A specialized saw used to remove sections of the skull during craniotomy procedures.

3 PERSONAL SUGGESTIONS

4 INVOLVEMENT OF THE SCIENTIST IN THE CREATIVE TEAM

4.1- What role would you like to play in the co-creation process of the SciArt work?

Participate punctually in the conceptual discussion and co-creation of the work