Wound Complication in Decompressive Craniectomy. Challenge treatment
Complicação de Ferida Operatória Após Cranietomia Descompressiva. Desafio no tratamento

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ABSTRACT
Introduction: Decompressive craniectomy (DC) is a neurosurgical procedure that involves the removal of part of the skull bone to reduce intracranial pressure (ICP). If, on the one hand, its practice is considered beneficial. On the other hand, after DC, there are complications, including the surgical wound. Specific risk factors for developing complications include neurological status and age of the patient. Methodology: A descriptive study was carried out, presenting a case report, and conducting a literature review using data from PubMed, Medline, Science Direct and SciELO electronic databases. The terms “craniectomy” and “postoperative complications” were used, and studies containing postoperative complications of surgical wounds in patients undergoing decompressive craniectomy were selected. Discussion: Wound complications after DC were classified as dehiscence, ulceration or necrosis. Among those mentioned, it is assumed that dehiscence is more easily treated when promptly observed and treated. Differently, ulcers present a greater challenge because they are strictly related to infection, while necrosis presented itself as a rarer but more feared event due to the potential related complications, including infection. Conclusion: Although simple and beneficial to the patient, this procedure puts patients at risk for many complications that can negatively affect the outcome. To date, there are not many specific reports addressing this topic, making it difficult to guide the course of action.

Keywords: Decompressive Craniectomy; Postoperative complications; Surgical wound dehiscence

RESUMO
Introdução: A craniectomia descompressiva (CD) é um procedimento neurocirúrgico que envolve a remoção de parte do osso do crânio para reduzir a pressão intracraniana (PIC). Se, por um lado, sua prática é considerada benéfica. Por outro lado, após a CD, podem ocorrer complicações, inclusive na ferida operatória. Os fatores de risco específicos para o desenvolvimento de complicações incluem o estado neurológico e a idade do paciente. Metodologia: Realizou-se um estudo descritivo, apresentando um relato de caso e realizando uma revisão de literatura usando dados nas bases eletrônicas PubMed, Medline, Science Direct e SciELO. Foram utilizados os termos “craniectomia” e “complicações pós-operatórias” e selecionados trabalhos referentes às complicações pós-operatórias da ferida cirúrgica de pacientes submetidos à craniectomia descompressiva. Discussão: As complicações da ferida após a CD foram classificadas como deiscência, ulceração ou necrose. Dentre as citadas, presume-se que a deiscência seja mais facilmente tratada quando prontamente observada e tratada. Diferentemente, as úlceras representam um desafio maior por estarem estreitamente relacionadas à infecção, enquanto a necrose se apresentou como um evento mais raro, porém mais temido devido a potenciais complicações relacionadas, incluindo infecção. Conclusão: Embora o procedimento seja simples e benéfico para o paciente, ele coloca os pacientes em risco de muitas complicações que podem afetar negativamente o resultado. Até o momento, não existem muitos relatórios específicos abordando este tema, o que torna difícil orientar o curso de ação.

Palavras-chave: Cranietomia descompressiva; Complicações pós-operatórias; Deiscência de ferida cirúrgica
Introduction

Since the modern description by Kocher in 1901, decompressive craniectomy (DC) has been used to treat patients with high intracranial pressure (ICP). After ischemic or traumatic brain injury (TBI), ICP may increase due to late bleeding or cerebral swelling within the fixed skull volume. During DC, a large portion of the skull is removed to allow the swollen brain to herniate outward rather than compressing normal structures and causing brainstem herniation.

Decompressive DC is a neurosurgical procedure that consists in removing part of the skull bone to reduce intracranial ICP resulting from cerebral edema or hemorrhage. These events are due to traumatic brain injury, cerebral infarction, subarachnoid hemorrhage, hemorrhage, neoplasms or intracranial infections. After clinical management failure, DC can be used as a last-line therapy to try to reduce ICP, as its practice is now known to be beneficial, given the widespread publication of randomized controlled trials highlighting its importance in improving patient survival, which justifies the increased use of the technique from the 2000s.

Methods

This study is a descriptive literature review, according to articles indexed in the following databases: PubMed, Medline, Science Direct and SciELO.

The period of selection of articles was carried out in the second half of 2019 and for this selection the terms "decompressive craniectomy" and "postoperative complications" were used.

For selection, as criteria, the analysis of available titles and abstracts was considered, including those describing the complications associated with the decompressive craniectomy procedure, published in English and Portuguese, and between 2008-2019.

Case Presentation

Female patient, 36 years old, admitted to Santa Casa de Misericórdia de Passos Hospital, Minas Gerais, on Aug 18, 2019, with sudden onset headache, neck stiffness and vomiting. The patient presented previous history of systemic arterial hypertension and use of oral contraceptive, a known risk factor for venous sinus thrombosis. She was admitted to the health service with meningeal symptoms. A lumbar puncture was performed, presenting results within the normal range, ending in the exclusion of the first hypothesis. The cranial computed tomography showed a "rope sign" that raised the suspicion of venous sinus thrombosis.

In the case progression, consciousness levels began to drop, requiring orotracheal intubation. In magnetic resonance imaging (MRI), venous sinus thrombosis with cerebral hematoma was observed. After 6 hours of hospitalization, she had cerebral edema, midline deviation greater than 5
mm, requiring decompression craniectomy. As the patient was already anticoagulated, the anticoagulation was reversed and, as soon as possible, decompressive craniectomy was performed with storage of bone flap in the subcutaneous abdominal tissue, further proceeding with postoperative clinical care and subsequent return of the anticoagulation.

During its evolution, the presentation of cerebral edema was intensified, accompanied by the appearance of bilateral mydriasis on two occasions. Therefore, the brain death protocol was initiated, being delayed by pupil reversal and presence of signals responsive to stimuli. The patient also presented dehiscence of the surgical wound and skin necrosis due to the surgical site presenting tension characteristics. Drainage, washing and aspiration of the affected region were performed to improve the surgical wound and, concomitantly, flap rotation (Figure 1).

![Figure 1. Operative site of decompressive craniectomy. A. Surgical site infection after decompression craniectomy; B, C and D. Flap rotation approach in the surgical site.](image)

**DISCUSSION**

Decompressive craniectomy has many known complications. General complication rates range up to 53.9%.

Other study suggested that complications can be classified as those that occur in the first four weeks (early) and those that manifest later. Early complications occurring within the first four weeks are likely to occur while the patient is still hospitalized. Certain complications tend to occur over specific periods of time, and knowledge of this information helps to anticipate and to treat it efficiently. They classified them as hemorrhagic, infectious/inflammatory, and CSF compartment disorders. Also they calculated the overall mean frequency of each complication from a total of 142 eligible reports from thousands of patients undergoing...
decompression procedures, in which one in ten DC patients develop a complication that requires additional medical and/or neurosurgical intervention.

Based on the analysis of 89 patients, specific complications occurred sequentially. Complications such as cerebral contusion expansion (2.2 ± 1.2 days), new subdural or epidural hematoma contralateral to craniectomy defect (1.5 ± 0.9 days), epilepsy (2.7 ± 1.5 days), CSF leak through scalp incision (7.0 ± 4.2 days) and external cerebral hernia (5.5 ± 3.3 days) occurred early. Subdural effusion (10.8 ± 5.2 days) and postoperative infection (9.8 ± 3.1 days) developed between one and four weeks, postoperatively. The trephined hydrocephalus syndrome and post-traumatic disease developed after one month, postoperatively (79.5 ± 23.6 and 49.2 ± 14.1 days, respectively).

Risk factors for developing complications
Patient-specific risk factors for developing complications include poor neurological status and age. A low preoperative Glasgow (ECG) scale (below eight) has been shown to increase the likelihood of all types of complications. Above 65 years of age is another risk factor. Although these factors are not modifiable, the surgical team should identify these risk groups to diligently look for emerging complications.

An overview of complications is provided in Table 1.

### Table 1. Overview of complications associated with decompressive craniectomy.

| DC Complications | Hemorrhage | External Cerebral Herniation | Surgical wound complications | CSF leak / fistulas | Postoperative Infection | Seizures / Epilepsy | Late Complications |
|------------------|------------|-----------------------------|------------------------------|-----------------|------------------------|-------------------|-------------------|
| Premature        | Subdural hygroma | Hydrocephalus | Trefinate syndrome          |                 |                        |                   |                   |

Wound Complications
Wound complications after DC were classified as dehiscence, ulceration or necrosis. Among those mentioned, it is assumed that dehiscence is more easily treated when readily observed and managed. On the other hand, ulcers present a greater challenge because they are strictly related to infection. Necrosis was rarer but the more feared event, due to its potential related to complications including infection, overlapping skin dehiscence (flap) and bone contamination. This was attributed to the inadvertent sacrifice of residual arterial supply after reopening of the flap and to venous congestion.

After elimination of necrotic and infected tissues, the areas of exposure of the skull, meninge and brain tissue require rapid coverage. Since the programming for a surgical incision, primary or secondary incision, must obey the lines that allow better irrigation, the flaps should also be based on the vascular territories of the head and neck.
The techniques depending on the size of the defect and scalp layers help in this aspect. One layer covers the defect and the other remains covering the skull bone. Thus, the skin, subcutaneous and muscle can be transposed, and the galeal and pericranial maintained in position to cover the defect and receive a skin graft, in the same procedure or later. Otherwise, the galeal or temporal fascia flaps could be transported, enabling to receive skin graft in the defect position, and the scalp kept in its original position. Areas without bone exposure or noble tissues may not be covered with total or partial skin grafts. Larger deep defects require pediculated distant tissues in the neck vessels or transferred by microsurgery

In DC, there are two factors that present a challenge in trying to control infections, inflammation and complications of the surgical wound: (a) The large size of the scalp incision and the greater likelihood of superficial temporal artery injury during emergency surgery predisposing the edges of the wound to ischemia in the posterior parietal and temporal areas. Therefore, meticulous preservation the superficial temporal artery would reduce the chance of wound complications; (b) DC accompanied by opening of the dura exposes the underlying necrotic or devascularized brain, which may be susceptible to infection.

Postoperative wound infections
Superficial wound infections, including wound rupture, necrosis, surgical site infection, and subgaleal collections occur in about 10% of patients, and the incidence of deeper infections such as epidural abscess and subdural empyema was just under 4%.

Figure 2. Axial, coronal and sagittal planes of non-enhanced skull CT showing spontaneously hyperdense and cord sign compatible with thrombus in the transverse sinuses, rectus and superior sagittal.

Figure 3. Non-enhanced cranial CT, right intraparenchymal hematoma surrounded by compressive edema, reduced lateral ventricular amplitude, and midline deviation. Possible complication of thrombosis and use of anticoagulants.
CONCLUSION

DC is an effective way of controlling high ICP, which explains the increase in the use of procedure. Although beneficial to the patient, it puts them at risk for complications that can affect the outcome. So far, there are not many reports with the approach of this topic, making it difficult to guide actions that should be taken. A literature review was performed to catalog the complications to operative wound of DC and to estimate the frequency of this complication.

Figure 4. Skull CT scan with bone window and soft tissue, respectively, demonstrating extensive right fronto-parietal craniectomy, herniation of the cerebral parenchyma with hemorrhagic content and edema.

Figure 5. Contrast-enhanced skull CT showing reduced intraparenchymal hematoma, encephalomalacia areas, and soft tissue changes associated with the clinic corresponding to surgical wound dehiscence.
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