CLINICAL AND EPIDEMIOLOGICAL CHARACTERIZATION, ANESTHETIC-SURGICAL PROCEDURE, AND INTRAOPERATIVE PHARMACOLOGICAL MANAGEMENT: ELECTIVE CRANIOPLASTY

CARACTERIZAÇÃO CLÍNICO-EPIDEMIOLÓGICA, ATO ANESTÉSICO-CIRÚRGICO E ABORDAGEM FARMACOLÓGICA INTRAOPERATÓRIA: CRANIOPLASTIA ELETIVA

CARACTERIZACIÓN CLÍNICO-EPIDEMIOLÓGICA, ACTO ANESTÉSICO-QUIRÚRGICO Y ABORDAJE FARMACOLÓGICO INTRAOPERATORIO: CRANEOPLASTIA ELECTIVA

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ABSTRACT

Elective cranioplasty is a complex neurosurgical procedure aimed at reconstructing cranial defects resulting from trauma, tumor resections, post-craniectomy syndromes, and other neurological conditions. Although planned, this intervention involves relevant physiological challenges, particularly regarding anesthetic management and the maintenance of hemodynamic stability, which are essential factors to ensure adequate cerebral perfusion and prevent perioperative complications. In light of the above, this study aims to describe the clinical-epidemiological profile, anesthetic-surgical act, and intraoperative pharmacological approach. This is a cross-sectional study conducted in a tertiary hospital, including patients who underwent elective cranioplasty between January 2020 and December 2022, whose data were collected from electronic medical records. In the sample (n = 53), the following characteristics were highlighted: female sex (58.5%), age equal to or greater than 60 years (34.0%), white skin color (100.0%), current or previous smoking (22.6%), current or previous alcohol consumption (54.7%), non-eutrophic patients (62.5%), with comorbidities (98.1%) and previous surgeries (84.9%). In the anesthetic-surgical act, surgical time between 241 and 320 minutes (37.7%), general anesthesia (100.0%), orotracheal intubation (100.0%),

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and dorsal decubitus (92.5%) were observed. The most commonly administered intraoperative medications were propofol, remifentanil, sevoflurane, intravenous lidocaine, cisatracurium, neostigmine, and levobupivacaine, and a high use of ondansetron, cefazolin, ephedrine, dexamethasone, mannitol, and metaraminol was also observed. Patients undergoing elective cranioplasty in the neurosurgery service in question are predominantly women, older adults, non-eutrophic, with comorbidities and previous surgeries, undergoing procedures in dorsal decubitus, with prolonged surgical time, general anesthesia, and orotracheal intubation. The proper integration of patient clinical characteristics, surgical technique, anesthetic management, and pharmacological approach in elective cranioplasties is essential to optimize perioperative care, in-hospital safety, and clinical prognosis.

Keywords: Neuroanesthesia. Neurosurgery. Hospital Care. Perioperative Period. Health Profile.

RESUMO

A cranioplastia eletiva é um procedimento neurocirúrgico complexo destinado à reconstrução de defeitos cranianos decorrentes de traumatismos, ressecções tumorais, síndromes pós-craniectomia e outras condições neurológicas. Embora planejada, essa intervenção envolve desafios fisiológicos relevantes, sobretudo no que se refere ao manejo anestésico e à manutenção da estabilidade hemodinâmica, fatores essenciais para garantir perfusão cerebral adequada e prevenir complicações perioperatórias. Diante do exposto, este estudo tem como objetivo descrever perfil clínico-epidemiológico, ato anestésico-cirúrgico e abordagem farmacológica intraoperatória. Trata-se de um estudo transversal, desenvolvido em um hospital terciário, com pacientes submetidos à cranioplastia eletiva entre janeiro de 2020 e dezembro de 2022, cujos dados foram coletados de prontuários eletrônicos. Na amostra (n = 53), destacaram-se sexo feminino (58,5%), idade igual ou superior a 60 anos (34,0%), cor de pele branca (100,0%), tabagismo atual ou prévio (22,6%), consumo de bebida alcoólica atual ou anterior (54,7%), pacientes não-eutróficos (62,5%), com comorbidades (98,1%) e cirurgias prévias (84,9%). No ato anestésico-cirúrgico, evidenciaram-se tempo cirúrgico entre 241 e 320 minutos (37,7%), com anestesia geral (100,0%), intubação orotraqueal (100,0%) e decúbito dorsal (92,5%). Os medicamentos intraoperatórios mais administrados foram propofol, remifentanil, sevoflurano, lidocaína endovenosa, cisatracúrio, neostigmina e levobupivacaína e, foi observado uso elevado de ondansetrona, cefazolina, efedrina, dexametasona, manitol e metaraminol. Os pacientes submetidos à cranioplastia eletiva no serviço de neurocirurgia em questão são, predominantemente, mulheres, com idade avançada, não-eutróficos, com comorbidades e cirurgias prévias, submetidos a procedimentos em decúbito dorsal, com tempo cirúrgico elevado, anestesia geral e intubação orotraqueal. A integração adequada entre características clínicas do paciente, técnica cirúrgica, ato anestésico e abordagem farmacológica em cranioplastias eletivas é essencial para otimizar o cuidado perioperatório, a segurança intra-hospitalar e o prognóstico clínico.

Palavras-chave: Neuroanestesia. Neurocirurgia. Assistência Hospitalar. Período Perioperatório. Perfil de Saúde.

RESUMEN

La craneoplastia electiva es un procedimiento neuroquirúrgico complejo destinado a la reconstrucción de defectos craneales derivados de traumatismos, resecciones tumorales, síndromes post-craniectomía y otras condiciones neurológicas. Aunque planificada, esta intervención implica desafíos fisiológicos relevantes, especialmente en lo que respecta al manejo anestésico y al mantenimiento de la estabilidad hemodinámica, factores esenciales para garantizar una perfusión cerebral adecuada y prevenir complicaciones perioperatorias. Ante lo expuesto, este estudio tiene como objetivo describir el perfil clínico-epidemiológico,

el acto anestésico-quirúrgico y el abordaje farmacológico intraoperatorio. Se trata de un estudio transversal, desarrollado en un hospital terciario, con pacientes sometidos a craneoplastia electiva entre enero de 2020 y diciembre de 2022, cuyos datos fueron recolectados de historias clínicas electrónicas. En la muestra (n = 53), se destacaron: sexo femenino (58,5%), edad igual o superior a 60 años (34,0%), color de piel blanca (100,0%), tabaquismo actual o previo (22,6%), consumo de alcohol actual o previo (54,7%), pacientes no eutróficos (62,5%), con comorbilidades (98,1%) y cirugías previas (84,9%). En el acto anestésico-quirúrgico, se evidenciaron tiempo quirúrgico entre 241 y 320 minutos (37,7%), con anestesia general (100,0%), intubación orotraqueal (100,0%) y decúbito dorsal (92,5%). Los medicamentos intraoperatorios más administrados fueron propofol, remifentanilo, sevoflurano, lidocaína intravenosa, cisatracurio, neostigmina y levobupivacaína, y se observó un alto uso de ondansetrón, cefazolina, efedrina, dexametasona, manitol y metaraminol. Los pacientes sometidos a craneoplastia electiva en el servicio de neurocirugía en cuestión son predominantemente mujeres, de edad avanzada, no eutróficos, con comorbilidades y cirugías previas, sometidos a procedimientos en decúbito dorsal, con tiempo quirúrgico prolongado, anestesia general e intubación orotraqueal. La adecuada integración entre las características clínicas del paciente, la técnica quirúrgica, el acto anestésico y el abordaje farmacológico en craneoplastias electivas es esencial para optimizar el cuidado perioperatorio, la seguridad intrahospitalaria y el pronóstico clínico.

Palabras clave: Neuroanestesia. Neurocirugía. Atención Hospitalaria. Período Perioperatorio. Perfil de Salud.

1 INTRODUCTION

Elective cranioplasty is a highly complex neurosurgical procedure aimed at repairing cranial defects that may result from trauma, tumor resections, post-craniectomy syndromes, and congenital anomalies. In addition to restoring the physical and aesthetic integrity of the skullcap, cranioplasty has important functional implications, including improved brain protection and potential influence on cerebrovascular dynamics and intracranial pressure (ICP) post-craniectomy. Recent studies indicate that elective cranial reconstructive procedures, although planned, present relevant physiological challenges, especially related to anesthetic management and intraoperative hemodynamic stability, requiring therapeutic approaches strictly based on the best available evidence (MEE *et al*., 2022; ZANUTO *et al*., 2024).

In this scenario, it is noteworthy that the maintenance of hemodynamic stability is one of the main intraoperative challenges in elective cranioplasty. Abrupt variations in blood pressure can occur during different stages of the procedure, especially in anesthetic induction, cranial bed manipulation, and implant positioning (MEE *et al*., 2022; ZANUTO *et al*., 2024). Such alterations can compromise adequate cerebral perfusion and require strict control of mean arterial pressure, volume and anesthetic depth. Thus, continuous hemodynamic monitoring and precise titration of anesthetic and vasoactive agents become central elements to ensure adequate cerebral perfusion and patient safety during the procedure (COTTRELL; PATEL, 2017; PETERSEN *et al*., 2003; HALDAR *et al*., 2015).

The literature has increasingly explored the specific anesthetic aspects of elective neurosurgical interventions, emphasizing that adequate maintenance of cerebral perfusion and control of mean arterial pressure are crucial to prevent cerebral ischemia and other perioperative complications. Anesthesia for cranioplasty and other elective intracranial neurosurgery often involves techniques that optimize anesthetic depth, minimize harmful increases in ICP, and stabilize the patient's hemodynamics, and are often performed under general anesthesia with orotracheal intubation. The anesthetic approach can vary between total intravenous anesthesia (TIVA) or combined with inhalational agents, depending on the clinical presentation and individual anesthetic goals (ANDRABI *et al*., 2017; LIU *et al*., 2025).

From the pathophysiological point of view, neurosurgical procedures imply potential alterations in cerebral autoregulation and circulatory homeostasis, which makes integrated anesthetic planning essential to optimize cerebral blood flow and maintain a stable hemodynamic profile. The management of anesthesia in elective cranioplasties should consider, for example, the cardiovascular response to anesthetic induction, surgical

manipulations, and nociceptive stimuli, as well as specific strategies for brain relaxation and prevention of ICP elevations (CHUI *et al*., 2014).

The literature also highlights that the proper management of anesthesia includes the balance between effective analgesia and minimization of adverse events. The use of opioids, with rapid pharmacokinetics, allows control of the sympathetic response to intubation and surgical stimuli, in addition to contributing to hemodynamic stability and anesthetic titration. Along with neuromuscular blockers, sedatives, antiemetic agents, or adjunctive analgesics, this therapeutic arsenal should be considered within a multimodal protocol guided by the best available evidence, in order to reduce adverse events and optimize clinical outcomes (BHATIA *et al*., 2019; KIANIAN *et al*., 2024).

Regarding epidemiology, the profile of patients undergoing elective cranioplasty is heterogeneous, and is often composed of individuals with multiple comorbidities, chronic use of medications, and varied demographic characteristics, which can influence both the anesthetic-surgical procedure and the pharmacological response. Comorbidities such as oncological disease, hypertension, neurological disease, and psychiatric disorder require detailed preoperative evaluation and individualized anesthetic planning to maintain adequate cerebral perfusion, avoid significant hemodynamic fluctuations, and provide a favorable postoperative recovery (EYELADE *et al*., 2016; FERREIRA *et al*., 2024).

In this context, it is evident that anesthetic practice in elective cranioplasty should be based on principles of evidence-based medicine, combining physiological knowledge with up-to-date clinical data to guide therapeutic decisions at all stages of perioperative care.

Therefore, this study aims to describe the sociodemographic, behavioral, and health aspects of patients undergoing elective cranioplasty, as well as to characterize the anesthetic-surgical procedure and the intraoperative pharmacological approach.

2 METHODOLOGY

This was a cross-sectional study conducted in a tertiary hospital located in Passo Fundo, Rio Grande do Sul, Brazil, with ethical approval (opinion No°. 6,282,730) and compliance with the Declaration of Helsinki. The study and the results were described according to the guidelines of *the Strengthening the Reporting of Observational Studies in Epidemiology* (STROBE - VON ELM *et al*., 2007).

To compose the sample, a list of the hospitalization management system was obtained, considering the data on hospitalization by medical specialty. Patients who underwent elective cranioplasty between January 2020 and December 2022, of both sexes,

aged 18 years or older, and with documents descriptive of the surgery available in the electronic medical record, were defined as eligible for this study.

Data collection covered two hospitalization periods: the clinical-epidemiological profile was analyzed in the medical records of the hospital admission consultation, while the anesthetic-surgical procedure and the pharmacological approach were investigated intraoperatively.

The clinical-epidemiological profile included sex, age, skin color, marital status, origin, exercise of paid activity, education, religion, smoking, alcoholism, use of illicit drugs, nutritional status classified by body mass index (BRASIL, 2011), drug atopy, continuous use medications, comorbidities and previous surgeries. The anesthetic-surgical procedure included surgical time, anesthetic technique, orotracheal intubation, and patient positioning. The intraoperative pharmacological approach included sedatives, opioid anesthetics, inhalational anesthetics, adjuvant analgesics, neuromuscular blockers, neuromuscular blockade reversers, local anesthetics for conductive or regional anesthesia, and other medications used during the surgical procedure.

For data analysis, descriptive statistics were used based on mean and standard deviation estimates for numerical variables, and absolute (n) and relative (%) frequencies for categorical variables.

3 RESULTS

The final sample was composed of 53 participants, from 37 municipalities, predominantly from the north of Rio Grande do Sul. As shown in Table 1, the following stood out: female (58.5%), age 60 years or older (34.0%; 51.7 ± 2.0 years), white skin color (100.0%), individuals with a spouse (58.5%), from municipalities other than Passo Fundo (81.1%), with paid activity (60.0%), 9 years or less of schooling (63.3%), and Catholics (67.9%). Regarding behavioral aspects, 22.6% were or were smokers, 54.7% reported current or previous consumption of alcoholic beverages and 100.0% had never used illicit drugs. Regarding health, 62.5% had non-eutrophic nutritional status, 13.2% had drug atopy, 45.3% used 3 to 6 daily medications (mean 3.2 ± 0.3 daily medications) and 98.1% had comorbidities, especially oncological disease (69.8%), systemic arterial hypertension (49.1%), neurological disease (46.5%), psychiatric disorder (37.7%) and cerebrovascular disease (18.9%). In addition, 83.0% had the simultaneous presence of two or more comorbidities and 84.9% had undergone previous surgeries.

Table 1

Clinical-epidemiological profile of patients undergoing elective cranioplasty at a tertiary hospital in Passo Fundo, Rio Grande do Sul, Brazil, 2020 - 2022 (n = 53)

Variables	n	%
Gender		
Male	22	41,5
Women	31	58,5
Age, in full years		
18 - 39	12	22,6
40 - 49	10	18,9
50 - 59	13	24,5
≥ 60	18	34,0
Skin color		
White	53	100,0
Other	0	0,0
Marital status		
With spouse	31	58,5
No spouse	22	41,5
Provenance		
Passo Fundo	10	18,9
Other municipalities	43	81,1
Paid activity (n = 45)		
Yes	27	60,0
No/not informed	18	40,0
Schooling, in years of study (n = 49)		
≤ 9	31	63,3
10 - 12	16	32,6
≥ 13	2	4,1
Religion		
Catholic	36	67,9
Other/Not Informed	17	32,1
Smoking		
Yes	6	11,3
Former smoker	6	11,3
No/not informed	41	77,4
Alcoholism		
Yes	25	47,2
Former drinker	4	7,5
No/not informed	24	45,3
Illicit drug use		
Yes	0	0,0
Former user	0	0,0
No/not informed	53	100,0
Nutritional status (n = 48)		
Eutrophic	18	37,5
Non-eutrophic	30	62,5
Drug atopy		
Yes	7	13,2
No/not informed	46	86,8
Number of medicines for continuous use		
0	6	11,3
1 - 2	19	35,9
3 - 6	24	45,3
≥ 7	4	7,5
Comorbidity		
Yes	52	98,1
No	1	1,9
Comorbidities		
Oncological disease	37	69,8
Systemic arterial hypertension	26	49,1

Neurological disease	24	45,3
Psychiatric disorder	20	37,7
Cerebrovascular disease	10	18,9
Diabetes mellitus	8	15,1
Dyslipidemia	7	13,2
Cardiovascular disease	7	13,2
Endocrine disease	6	11,3
Obesity	4	7,5
Liver disease	2	3,8
Lung disease	1	1,9
Haematological disease	1	1,9
Renal disease	1	1,9
Number of comorbidities		
0 - 1	9	17,0
≥ 2	44	83,0
Previous surgeries		
Yes	45	84,9
No/not informed	8	15,1

Regarding the anesthetic-surgical procedure, described in Table 2, the predominance of surgical time between 241 and 320 minutes (37.7%), general anesthesia (100.0%), orotracheal intubation (100.0%) and supine (92.4%) was observed.

Table 2

Characterization of the anesthetic-surgical procedure of patients undergoing elective cranioplasty at a tertiary hospital in Passo Fundo, Rio Grande do Sul, Brazil, 2020 - 2022 (n = 53)

Variables	**n**	**%**
Surgical time, in minutes		
≤ 60	0	0,0
61 - 120	5	9,4
121 - 180	7	13,2
181 - 240	6	11,4
241 - 320	20	37,7
> 320	15	28,3
Anesthetic technique		
General anesthesia	53	100,0
Local anesthesia	35	66,0
Sedation	0	0,0
Orotracheal intubation		
Yes	53	100,0
No	0	0,0
Patient positioning		
Supine position	49	92,4
Prone position	0	0,0
Lateral decubitus	2	3,8
Other positioning	2	3,8

Regarding the intraoperative medications shown in Table 3, the most commonly used sedative, opioid anesthetic, inhalational anesthetic, and adjuvant analgesic were, respectively, propofol (98.1%), remifentanil (98.1%), sevoflurane (3.8%), and intravenous lidocaine (98.1%). The most frequent neuromuscular blocker, neuromuscular blockade

reverser, and local anesthetic were, respectively, cisatracurium (94.3%), neostigmine (13.2%), and levobupivacaine (73.6%). In addition, other intraoperative drugs showed high use, such as ondansetron (98.1%), cefazolin (96.2%), ephedrine (88.7%), dexamethasone (73.6%), mannitol (69.8%) and metaraminol (58.5%).

Table 3

Intraoperative pharmacological approach to patients undergoing elective cranioplasty at a tertiary hospital in Passo Fundo, Rio Grande do Sul, Brazil, 2020 - 2022 (n = 53)

Variables	n	%
Sedatives		
Propofol	52	98,1
Midazolam	10	18,9
Diazepam	1	1,9
Clonazepam	1	1,9
Etomidate	0	0,0
Other	1	1,9
Intraoperative opioid anesthetics		
Remifentanil	52	98,1
Sulfentanil	47	88,7
Fentanyl	4	7,5
Alfentanil	0	0,0
Methadone	0	0,0
Other	0	0,0
Intraoperative inhalational anesthetics		
Sevoflurane	2	3,8
Intraoperative adjunctive analgesics		
Intravenous lidocaine	52	98,1
Dipyrone	49	92,5
Ketoprofen	43	81,1
Dexmedetomidine	13	24,5
Morphine	12	22,6
Clonidine	7	13,2
Ketamine	5	9,4
Magnesium Sulfate	0	0,0
Acetaminophen	0	0,0
Other	0	0,0
Neuromuscular Blockers		
Cisatracurium	50	94,3
Succinylcholine	3	5,7
Rocuronium	1	1,9
Atracurium	0	0,0
Pancuronium	0	0,0
Vecuronium	0	0,0
Other	0	0,0
Neuromuscular Blockade Reversers		
Neostigmine	7	13,2
Sugammadex	0	0,0
Other	0	0,0
Local anesthetics for conductive or regional anesthesia		
Levobupivacaine	39	73,6
Bupivacaine	5	9,4
Lidocaine	3	5,7
Ropivacaine	1	1,9
Mepivacaine	0	0,0
Other	0	0,0
Other medicines		

Ondansetron	52	98,1
Cefazolin	51	96,2
Ephedrine	47	88,7
Dexamethasone	39	73,6
Mannitol	37	69,8
Metaraminol	31	58,5
Pantoprazole	22	41,5
Gentamicin	15	28,3
Heparin	14	26,4
Atropine	13	24,5
Aminophylline	6	11,3
Phenytoin	5	9,4
Hydrocortisone	5	9,4
Furosemide	4	7,5
Bromopride	2	3,8
Epinephrine	1	1,9
Cefoxitin	1	1,9
Ciprofloxacin	1	1,9
Phenobarbital	1	1,9
Clindamycin	1	1,9
Ceftriaxone	1	1,9
Ethylephrine	1	1,9
Droperidol	1	1,9
Naloxone	1	1,9
Tranexamic acid	0	0,0
Methylprednisolone	0	0,0
Vancomycin	0	0,0
Thrombin	0	0,0
Clopidogrel	0	0,0
Protamine	0	0,0
Millrinone	0	0,0
Isosorbide	0	0,0
Metoprolol	0	0,0
Scopolamine	0	0,0
Tirofiban	0	0,0

4 DISCUSSION

The clinical-epidemiological characterization of individuals undergoing elective cranioplasty revealed a predominance of females, a finding that differs from that described in most of the literature, in which a higher frequency of men is observed (COELHO *et al*., 2023; DO *et al*., 2022; MUSTAFA *et al*., 2025; LEATHERS *et al*., 2025). This difference may be related to the profile of the population included in the study, composed exclusively of patients undergoing elective procedures, in which there is a lower participation of traumatic causes that are more prevalent in males (MUNIVENKATAPPA *et al*., 2016).

The age profile identified in this sample is compatible with that described in the literature on elective cranioplasty (NAM *et al*., 2022; MUSTAFA *et al*., 2025), as well as the predominance of individuals with nine years of schooling or less (COELHO *et al*., 2023; MUSTAFA *et al*., 2025). This characteristic may be related to the higher barriers to access to health services faced by populations with lower levels of education, favoring late diagnosis and, consequently, the indication of specialized surgical treatment (BOCCOLINI; DE SOUZA JUNIOR, 2016; ZAJACOVA; LAWRENCE, 2018). Similarly, the higher frequency of white

individuals has also been described in previous studies involving elective cranial surgeries (LEATHERS *et al*., 2025). There was also a predominance of patients with a spouse and in the exercise of paid activity, findings also reported in national and international investigations on elective cranial procedures (DE ARAÚJO *et al*., 2022; FILIPOVIĆ *et al*., 2025). As for religious aspects, the adoption of Catholicism as the predominant belief was also identified in populations undergoing neurosurgical interventions (REI *et al*., 2023).

With regard to behavioral aspects, the higher proportion of non-smokers observed in the present sample is supported by the previously published literature (LEATHERS *et al*., 2025). On the other hand, with regard to the consumption of alcoholic beverages, the results of this study differ from those reported by Leathers *et al*. (2025), who identified a lower prevalence of alcohol use among patients undergoing cranioplasty. This discrepancy may be related to differences in the care context and in the sociodemographic characteristics of the populations analyzed.

With regard to health conditions, the predominance of non-eutrophic nutritional status observed in this sample is supported by a North American study (MOYA *et al*., 2023). In addition, the high prevalence of oncological disease, systemic arterial hypertension, neurological disease, psychiatric disorder, and cerebrovascular disease is compatible with findings described in the scientific literature on patients undergoing elective cranioplasty (NAM *et al*., 2022; MOYA *et al*., 2023; LEATHERS *et al*., 2025; MUSTAFA *et al*., 2025). A high frequency of multimorbidity and history of previous surgeries was also observed, which may be related to the particularities of the scenario studied, characterized as a macro-regional reference center for the performance of medium and high complexity procedures.

Regarding the anesthetic-surgical procedure, the operative time observed in this study was higher than that described in the international literature on cranioplasty (ANDRABI *et al*., 2017; CHEN *et al*., 2023). This result may reflect the variability inherent to the cranioplasty technique, whose duration is influenced by multiple factors not measured in this study, including particularities of the reconstructive method employed, the need for intraoperative adjustments of the implant, and the time dedicated to the fixation and hemostasis stages. In addition, differences related to the institutional context and care routines may contribute to a longer duration of the procedure, without this necessarily representing an increase in complications or inadequacy of the surgical approach.

With regard to anesthetic management, cranioplasty under general anesthesia, with orotracheal intubation and supine positioning, is in line with the practice described in the national and international literature on elective cranial neurosurgery. These elements are widely adopted as standard in this type of procedure, as they allow safe airway control,

adequate mechanical ventilation, and hemodynamic stability, in addition to favoring surgical access to the operative field, especially in surgeries of longer duration (ANDRABI *et al*., 2017; CHEN *et al*., 2023; DA SILVA; PEREIRA; BROCHADO, 2014; COTTRELL; PATEL, 2017; ZANUTO *et al*., 2024)

Conducting neurosurgery requires the preservation of cerebral perfusion and the reduction of intraoperative risks, which requires adequate preoperative evaluation and careful planning of the intervention, considering its effects on neurophysiology (COTTRELL; PATEL, 2017). In this context, the choice of anesthetic agents (including hypnotics, analgesics, and neuromuscular blockers) directly influences cerebral hemodynamic stability during the procedure (DA SILVA; PEREIRA; BROCHADO, 2014), since variations in intraoperative blood pressure can compromise cerebral perfusion pressure, one of the main challenges in cranioplasty surgeries, reinforcing the need for continuous monitoring and careful titration of anesthetic agents throughout surgery (COTTRELL; PATEL, 2017).

The use of TIVA, based on propofol associated with remifentanil, has been widely used in neurosurgical procedures because it favors greater cerebral hemodynamic control and faster anesthetic recovery, with limited interference on neurophysiological parameters (COTTRELL; PATEL, 2017; NGUYEN *et al*., 2023). This strategy allows early neurological evaluation in the postoperative period and is justified by the pharmacological characteristics of these agents (COTTRELL; PATEL, 2017). The association between propofol and short-acting opioids, especially remifentanil, promotes adequate hypnosis, amnesia, and attenuation of responses to surgical stimulation, in addition to contributing to a lower incidence of adverse events, such as nausea, vomiting, and seizures, reinforcing the benefits of its intraoperative use and the high frequency observed in this study (ZHONG *et al*., 2025; COLES *et al*., 2000)

Although inhalational anesthetics, such as sevoflurane, are widely used in neurosurgical procedures and have beneficial effects on cerebral blood flow, in addition to possible neuroprotective properties, their use may be associated with limitations when compared to TIVA (ZHOU *et al*., 2021). Among these restrictions are the greater occurrence of residual effects, less precise control of anesthetic depth, and increased risk of postoperative nausea and vomiting (WU *et al*., 2023). These characteristics may explain the lower frequency of sevoflurane use in the present sample (3.8%), especially when contrasted with the predominant use of propofol (98.1%).

The intravenous administration of lidocaine is consistently part of multimodal analgesia protocols in neurosurgical procedures, acting to attenuate the sympathetic response associated with laryngoscopy and orotracheal intubation (COTTRELL; PATEL,

2017; MAISSAN *et al*., 2022). This effect contributes to greater hemodynamic stability and to the prevention of intracranial pressure elevations in the intraoperative period, in addition to helping to control postoperative pain (ZEILER *et al*., 2015; CHANDRA *et al*., 2022), which may explain the high frequency of use observed in this study (98.1%).

Neuromuscular blockade in the patients in the sample was predominantly performed with cisatracurium, an agent widely used in surgical procedures because it favors adequate conditions for orotracheal intubation and muscle relaxation, with preservation of hemodynamic stability and greater intraoperative safety (HUMMAD, 2025). In addition, this drug is associated with faster and more predictable recovery of motor function in the postoperative period, maintaining comparable rates of adverse events and clinical outcomes in relation to other neuromuscular blockers (HUMMAD, 2025; PARVATI *et al*., 2024), which explains its high frequency of use found in the study (94.3%). It is also noteworthy that the mechanism of action of cisatracurium, based on the competitive blockade of neuromuscular transmission, allows pharmacological reversal with acetylcholinesterase inhibitors, such as neostigmine (STRAWBRIDGE, 2023), justifying the administration of this drug in 13.2% of cases.

Levobupicaine, a long-acting local anesthetic, has been widely used for infiltration of the surgical wound because it promotes effective blockade of sensory and motor neural conduction (BAJWA; KAUR, 2013). Compared to other local anesthetics, it has a lower potential for cardiovascular and neurological toxicity, which confers a more favorable safety profile (KORAT; KAPUPARA, 2017). Although it shares pharmacokinetic characteristics similar to those of racemic bupivacaine, its better clinical tolerability has supported the increasing use in surgical procedures, including neurosurgical interventions (ATHAR *et al*., 2016), which may explain the high frequency observed in the sample (73.6%).

Prophylactic regimens for postoperative nausea and vomiting, based mainly on ondansetron and dexamethasone, play a central role in reducing associated complications, such as bronchial aspiration, bleeding, and surgical wound involvement, positively impacting outcomes in elective neurosurgery (GAN *et al*., 2014; THONGRONG *et al*., 2018). Such clinical relevance may explain the significant use of ondansetron (98.1%) and dexamethasone (73.6%) in the sample analyzed. In addition to its antiemetic efficacy, dexamethasone stands out for its anti-inflammatory and pain-modulating effects, which have been widely explored in the perioperative neurosurgical context (DE OLIVEIRA JR *et al*., 2013). This synthetic corticosteroid also contributes to the control of encephalic edema and to the attenuation of intracranial pressure, favoring neurological recovery. Even so, its

indication must carefully consider the individual clinical profile, weighing potential benefits and risks (GAN *et al*., 2014; GUPTA *et al*., 2014).

Intraoperative antimicrobial prophylaxis was predominantly performed with cefazolin, an antibiotic widely used in neurosurgical procedures due to its coverage against cutaneous pathogens and favorable safety profile. Its use aims to reduce the occurrence of surgical site infections and prevent adverse repercussions on the central nervous system (BRATZLER *et al*., 2013; NGUYEN *et al*., 2019), which may explain the high frequency in the analyzed sample (96.2%).

Regarding vasoactive drugs, ephedrine is one of the preferable vasopressors for the treatment of hypotension in the intraoperative period of neurosurgery due to its adrenergic agonist mechanism of action and its positive chronotropic and inotropic effects (MENG; RASMUSSEN, 2025; UEMURA *et al*., 2023), which may explain the high prevalence (88.7%) in this study. In addition, metaraminol is a pharmacological agent indicated for the treatment and prevention of intraoperative hypotension, especially in situations in which general or regional anesthesia promotes a decrease in systemic vascular resistance (COTTRELL; PATEL, 2017). Metaraminol acts mainly as an alpha-1 adrenergic agonist, promoting peripheral vasoconstriction and increased mean arterial pressure, which translates into maintenance of adequate cerebral perfusion in elective cranial surgeries and avoids episodes of pressure drop that compromise oxygenation and perfusion of brain tissue (MILLER *et al*., 2020), corroborating the important use (58.5%).

In the context of intracranial pressure modulation during elective intracranial procedures, mannitol stands out as the most commonly used osmotic agent in neuroanesthetic practice. Its use is associated with obtaining more favorable intraoperative brain relaxation, facilitating exposure to the surgical field and reducing risks related to the handling of the brain parenchyma in cranial surgeries, including cranioplasties (RANGWALA *et al*., 2024). The therapeutic effect results from the establishment of an osmotic gradient between the intravascular space and the brain tissue, promoting water mobilization from the extracellular brain compartment to the systemic circulation, with a consequent reduction in brain volume and intracranial pressure, which contributes to greater technical safety and intraoperative predictability (LI *et al*., 2020). Additionally, the use of mannitol in anesthetic management is pertinent due to its ability to promote a consistent reduction in intracranial pressure in the pre-opening period or during the initial stages of cranial access, favoring more stable surgical conditions (ZHANG *et al*., 2019). This effect contributes to minimizing transient increases in intracranial pressure and the formation of cerebral edema, situations

that can negatively interfere with anesthetic conduction and intraoperative safety (MILLER *et al*., 2020), which is possibly related to the high frequency observed in the sample (69.8%).

In summary, the findings of this study contribute to the literature by integrating the analysis of the clinical-epidemiological profile, aspects related to the anesthetic-surgical procedure, and pharmacological strategies adopted in the intraoperative period of patients undergoing elective cranioplasty. The detailed characterization of these variables allows a better understanding of the care context of these individuals and provides relevant subsidies for the improvement of personalized therapeutic conducts, with a potential positive impact on functional outcomes and perioperative safety.

It is noteworthy that the research was developed in a hospital institution classified as a macro-regional reference for medium and high complexity procedures, which was reflected in a diversified sample, composed of 53 patients from 37 different municipalities. In addition, the results obtained are in line with evidence previously described in the national and international literature, giving scientific solidity to the findings. In this sense, the methodological design employed and the systematic analysis of the information reinforce the potential of the study to support the planning of anesthetic-surgical care and support evidence-based decision-making processes.

However, it is important to recognize limitations inherent to the study. Among them, possible information and selection biases stand out, since the data were extracted from electronic medical records filled out by different professionals, which restricts control over the standardization and completeness of the records. In addition, the sample is limited to a single hospital center, which may limit the extrapolation of the results to other care settings, and should be interpreted with caution in the context of generalization.

5 CONCLUSION

The results indicate that patients undergoing elective cranioplasty are mostly women, aged 60 years or older, white, who consume alcoholic beverages, have non-eutrophic nutritional status, comorbidities and previous surgeries. In the anesthetic-surgical procedure, there is a predominance of surgical time between 241 and 320 minutes, associated with general anesthesia, orotracheal intubation, and supine position. The most commonly used intraoperative medications are propofol, remifentanil, sevoflurane, intravenous lidocaine, cisatracurium, neostigmine, and levobupivacaine. In addition, high administration of ondansetron, cefazolin, ephedrine, dexamethasone, mannitol, and metaraminol is observed. Finally, the results are consistent with the scientific literature and offer relevant contributions to the qualification of anesthesiology and neurosurgery services, with benefits related to the

improvement of patient care, the optimization of resources, and the scientific support of care decisions.

6 AUTHOR CONTRIBUTIONS

Lucas Dalla Maria: conception and planning of the study; data collection and processing; statistical analysis of the collected data and interpretation, conception and writing of the manuscript; critical review of the literature; critical revision of the manuscript; final approval of the manuscript.

Jamerson Fiorentin: conception and writing of the manuscript; critical review of the literature; critical revision of the manuscript; final approval of the manuscript.

Victor Luiz Ferreira Kauer: conception and writing of the manuscript; critical review of the literature; critical revision of the manuscript; final approval of the manuscript.

Marcelo Augusto Landim Arteiro de Oliveira: conception and writing of the manuscript; critical review of the literature; critical revision of the manuscript; final approval of the manuscript.

Eugenio Pagnussatt Neto: conception and planning of the study; critical review of the literature; critical revision of the manuscript; final approval of the manuscript.

Shana Ginar da Silva: conception and planning of the study; critical review of the literature; critical revision of the manuscript; final approval of the manuscript.

Ivana Loraine Lindemann: conception and planning of the study; statistical analysis of the collected data and interpretation, conception and writing of the manuscript; critical review of the literature; critical revision of the manuscript; final approval of the manuscript.

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