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HOSPITAL COST OF KNEE ARTHROPLASTY IN THE BRAZILIAN UNIFIED HEALTH SYSTEM (SUS) IN GOIÁS: AN ANALYSIS OF DATASUS DATA

JOÃO VIEIRA DA MOTA NETO¹, PEDRO DE FREITAS QUINZANI¹, WALTER MORI JUNIOR¹, GABRIEL BARCELOS DE FREITAS¹, CLÁUDIO SILVA SANTOS¹

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ABSTRACT

Introduction: Knee arthroplasty represents a significant portion of orthopedic surgical procedures within the Unified Health System (SUS), generating substantial hospital costs. However, regional disparities in resource allocation and expenditure patterns remain underexplored, particularly in the state of Goiás. **Objectives:** Analyze the hospital cost, temporal trends, and geographic distribution of knee arthroplasties funded by the SUS in the state, using public data from the Department of Informatics of the SUS (DATASUS). **Methods:** A retrospective analysis was conducted using public data from the DATASUS database. Hospital Admission Authorizations (AIH) for knee arthroplasties performed between January 2008 and July 2025 in Goiás were collected. Descriptive statistics were applied to assess temporal trends, geographic distribution, and mean cost per procedure. A statistical test for trend analysis was performed for the 2008–2024 period. **Results:** The analysis of DATASUS data revealed a total of 2,521 approved Hospital Admission Authorizations (AIH), corresponding to a total expenditure of R\$ 11,949,392.25. The data include four types of procedures: non-conventional knee arthroplasty, revision/reconstruction total knee arthroplasty, primary total knee arthroplasty, and primary unicompartmental knee arthroplasty. The annual average was 148.3 procedures, with significant variability over the years. The lowest number of procedures was recorded in 2008 (37 AIH), and the highest in 2019 (330 AIH). An overall upward trend was observed until 2019, followed by a decline in 2020–2021, possibly related to the COVID-19 pandemic, and subsequent recovery in 2022–2024. The geographic distribution of knee arthroplasty procedures and expenditures in Goiás shows an extreme concentration in the capital and metropolitan region. Procedures were performed in only six municipalities throughout the study period, highlighting a severe centralization of high-complexity services in the state. Goiânia accounted for 85.0% of all AIH (2,144 procedures) and 81.2% of all expenditures (R\$ 9,700,469.96), followed by Anápolis with 6.1% of AIH (155 procedures) and 8.9% of expenditures (R\$ 1,069,067.04). The metropolitan region of Goiânia, including Aparecida de Goiânia, accounted for 87.5% of all procedures performed in the state. **Conclusion:** The analysis of hospital costs of knee arthroplasties in the SUS in Goiás reveals a scenario of extreme geographic concentration, with only six municipalities performing procedures across the entire state during the period from 2008 to 2024. Goiânia concentrated 85.0% of the procedures and 81.2% of the expenditures, highlighting a centralization that significantly compromises equitable access to treatment for the population living in non-metropolitan areas. The mean cost per procedure (R\$ 4,739.94) was slightly higher than the national average, with important variability between municipalities, warranting further investigation into its determining factors.

Keywords: Knee, Arthroplasty, Hospital Cost, Surgery, SUS.

INTRODUCTION

Osteoarthritis (OA) is one of the most prevalent joint diseases worldwide and one of the leading causes of pain and chronic disability in the adult population. In Brazil, studies indicate that the prevalence of OA may reach up to 33% among individuals over 25 years of age, representing a significant burden on both the healthcare system and society.¹ The knee joint is one of the most commonly affected, and in advanced stages of the disease, arthroplasty emerges as a procedure that provides substantial pain relief and restores function in patients with advanced osteoarthritis, rheumatoid arthritis, and other degenerative joint conditions. Preoperative evaluation includes the patient's medical history, physical examination, laboratory tests, and imaging studies.

With the aging of the Brazilian population, the demand for these procedures has increased, placing greater pressure on the resources of the Brazilian Unified Health System (SUS). A comprehensive study of procedures performed in Brazil between 2012 and 2021 identified 65,602 primary knee arthroplasties, with a total cost exceeding R\$ 271 million.² The same study highlighted the uneven distribution of procedures across the country's regions, with the Midwest—where the state of Goiás is located—accounting for only 4% of the total surgeries.²

Understanding the distribution and costs of these procedures at the state level is crucial for planning healthcare policies, allocating resources, and organizing the specialized care network. Given the scarcity of analyses focusing on Goiás, this article aims to examine hospital costs, temporal trends, and the geographical distribution of knee arthroplasties funded by SUS in the state, using public data from the Department of Informatics of the Brazilian Unified Health System (DATASUS).

METHODOLOGY

A descriptive, cross-sectional study was conducted based on secondary data from a public domain source. The data source was the Hospital Information System (SIH/SUS), accessed through the DATASUS TabNet platform on September 25, 2025.³

Data were extracted by selecting the geographic coverage "Goiás" and the option "Hospital Production (SIH/SUS)." Knee arthroplasty procedures were filtered using the codes from the SUS Procedures, Medicines, and Orthoses, Prostheses and Materials (OPM) Table, specifically those from subgroup 04.08.05 (Knee Arthroplasty), which include: 0408050047 (Non-conventional knee arthroplasty), 0408050055 (Total knee arthroplasty – revision/reconstruction), 0408050063 (Primary total knee arthroplasty), and 0408050071 (Primary unicompartmental knee arthroplasty).

The variables collected were "Approved AIHs (Hospital Admission Authorizations)" and "Total Value," aggregated by "Year of Service" and "Municipality of Hospitalization." The analysis period covered January 2008 to December 2025. For trend analysis, the year 2025 was excluded due to containing partial data.

Additionally, a literature review was carried out using scientific databases (PubMed and SciELO) to contextualize the findings within the national literature on the epidemiology of osteoarthritis and the costs of arthroplasty.

Temporal trends were assessed using simple linear regression and Pearson's correlation. The

geographical distribution of costs was analyzed through descriptive statistics.

RESULTS

Anesthetic The analysis of DATASUS data revealed a total of 2,521 approved Hospital Admission Authorizations (AIHs) for knee arthroplasty procedures in Goiás between January 2008 and December 2024, corresponding to a total cost of R\$ 11,949,392.25. The data include four types of procedures: non-conventional knee arthroplasty, total knee arthroplasty – revision/reconstruction, primary total knee arthroplasty, and primary unicompartmental knee arthroplasty.

3.1. Temporal Analysis

Considering the full period from 2008 to 2024, a total of 2,521 Hospital Admission Authorizations (AIHs) were recorded. The annual average was 148.3 procedures, with significant variability over the years. The lowest number of procedures occurred in 2008 (37 AIHs), while the highest was recorded in 2019 (330 AIHs).

A general upward trend was observed until 2019, followed by a decline in 2020–2021, likely related to the COVID-19 pandemic, and a subsequent recovery between 2022 and 2024.

3.2. Geographical and Cost Analysis

The geographical distribution of knee arthroplasty procedures and expenditures in Goiás shows an extreme concentration in the capital and metropolitan area. Procedures were performed in only six municipalities throughout the entire period analyzed, demonstrating a severe centralization of high-complexity services in the state.

Goiânia accounts for 85.0% of all AIHs (2,144 procedures) and 81.2% of all expenditures (R\$ 9,700,469.96), followed by Anápolis with 6.1% of AIHs (155 procedures) and 8.9% of expenditures (R\$ 1,069,067.04). The metropolitan region of Goiânia, including Aparecida de Goiânia, concentrates 87.5% of all procedures performed in the state.

3.3. Average Cost per Procedure and Variability

The average cost per knee arthroplasty in Goiás, calculated from the total data for the period 2008–2024, was R\$ 4,739.94. This value shows significant variability among municipalities, with the lowest average recorded in Rio Verde (R\$ 4,446.71) and the highest in Aparecida de Goiânia (R\$ 7,470.24)—a 68.0% difference between the extremes. When compared with the national average of R\$ 4,135.50, reported in a study that evaluated the period from 2012 to 2021², the average value for Goiás is 14.6% higher. This difference may reflect both inflation over the period and possible methodological differences between studies. In 2024, the average hospital length of stay ranged from 1.6 days (Mineiros) to 4.1 days (Rio Verde), with most municipalities reporting stays between 2.0 and 3.0 days—values consistent with rapid recovery protocols in arthroplasty procedures.

Table 1 – Distribution of Procedures and Costs by Municipality in Goiás (2008–2024)

Municipality	AIH	% of AIH	Total value(R\$)	% of Total Value	Average Value 2024 (R\$)
GOIÂNIA	2,144	85.0%	9,700,469.96	81.2%	4,627.98
ANAPOLIS	155	6.1%	1,069,067.04	8.9%	4,802.81
CERES	90	3.6%	405,774.60	3.4%	4,526.33
APARECIDA DE GOIÂNIA	63	2.5%	470,491.50	3.9%	7,470.24
RIO VERDE	53	2.1%	218,391.58	1.8%	4,446.71
MINEIROS	15	0.6%	85,197.57	0.7%	5,679.84
TOTAL	2,521	100%	11,949,392.25	100%	4,739.94

Source: SIH/SUS, DATASUS. Prepared by author.

Table 2 – Approved Hospital Admission Authorizations (AIHs) by Municipality and Year of Service, from January 2008 to December 2024, Goiás, Brazil.

Municipality	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	Total
520110 ANAPOLIS	-	-	-	-	3	20	14	14	6	16	21	14	9	21	1	11	5	155
520140 APARECIDA DE GOIÂNIA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	16	47	63
520540 CERES	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	87	90
520870 GOIÂNIA	37	30	30	17	17	80	134	149	128	237	274	316	113	132	114	165	171	2144
521310 MINEIROS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	15	15
521880 RIO VERDE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	13	40	53
Total	37	30	30	17	20	100	148	163	134	253	295	330	122	153	115	208	365	2521

Procedure: 0408050047 – Non-conventional knee arthroplasty; 0408050055 – Total knee arthroplasty – revision/reconstruction; 0408050063 – Primary total knee arthroplasty; 0408050071 – Primary unicompartmental knee arthroplasty.
Source: Ministry of Health – Hospital Information System of the Brazilian Unified Health System (SIH/SUS).

Table 3 – Average AIH Value by Municipality and Year of Service, from January 2008 to December 2024, Goiás, Brazil..

Municipality	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
520110 ANAPOLIS	...	...	...	...	4585.75	5016.79	4711.84	5092.13	3910.09	4283.59	5147.78	5445.84	4943.49	5126.09	5265.3	5494.84	4802.81
520140 APARECIDA DE GOIÂNIA	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	7461.9	7470.24
520540 CERES	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	3994.6	4526.33
520870 GOIÂNIA	3456.59	3726.4	4188.87	4554.67	4219.52	4666.66	5060.19	5085.04	4032.08	4337.45	4385.83	4738.82	4709.04	4502.06	4107.52	4529.84	4627.98
521310 MINEIROS	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	5679.84
521880 RIO VERDE	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	3117.17	4446.71

Procedure: 0408050047 – Non-conventional knee arthroplasty; 0408050055 – Total knee arthroplasty – revision/reconstruction; 0408050063 – Primary total knee arthroplasty; 0408050071 – Primary unicompartmental knee arthroplasty.
Source: Ministry of Health – Hospital Information System of the Brazilian Unified Health System (SIH/SUS).

Table 4 – Total Value by Municipality and Year of Service, from January 2008 to December 2024, Goiás, Brazil.

Municipality	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
ANAPOLIS	-	-	-	-	13757.24	103335.8	85965.71	71289.8	23460.57	68537.46	908103.4	78241.81	44491.44	107647.8	5286.3	60443.2	24014.04
APARECIDA DE GOIÂNIA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	110390.4	351101.1
CERES	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	11983.8	393790.8
GOIÂNIA	127893.9	111792.1	125666	77429.35	71731.86	373333.2	678054.9	757671	516106.2	1027976	1201718	1497466	532121.2	594272.1	468257.4	747424.2	791385.4
MINEIROS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	85197.57
RIO VERDE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	40523.18	177868.4

Procedure: 0408050047 – Non-conventional knee arthroplasty; 0408050055 – Total knee arthroplasty – revision/reconstruction; 0408050063 – Primary total knee arthroplasty; 0408050071 – Primary unicompartmental knee arthroplasty.
Source: Ministry of Health – Hospital Information System of the Brazilian Unified Health System (SIH/SUS).

Table 5 – Average Length of Stay by Municipality and Year of Service, from January 2008 to December 2024, Goiás, Brazil.

Municipality	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
520110 ANAPOLIS	...	...	...	...	3	3.3	3.7	4	2.8	2.3	2.3	2.6	2	1.9	2	2.1	2
520140 APARECIDA DE GOIÂNIA	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2.8	3
520540 CERES	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2.3	2.8
520870 GOIÂNIA	5.6	8.3	7.5	12.1	6.6	5.6	4.4	4.1	3.4	3.5	3.8	3.8	3.8	3.5	3.5	3.4	3
521310 MINEIROS	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1.6
521880 RIO VERDE	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1.6	4.1

Procedure: 0408050047 – Non-conventional knee arthroplasty; 0408050055 – Total knee arthroplasty – revision/reconstruction; 0408050063 – Primary total knee arthroplasty; 0408050071 – Primary unicompartmental knee arthroplasty.
Source: Ministry of Health – Hospital Information System of the Brazilian Unified Health System (SIH/SUS).

DISCUSSION

The stability in the number of knee arthroplasty procedures in Goiás may reflect multiple systemic factors. First, limitations in the installed capacity of the healthcare network may be restricting service availability, creating an artificial ceiling on procedures regardless of actual demand. Second, the underdiagnosis and undertreatment of early-stage osteoarthritis, identified by Brazilian specialists¹, may result in patients reaching the public healthcare system

at more advanced stages of the disease, when additional comorbidities can contraindicate surgery. Third, changes in regulatory policies and in the authorization criteria for high-complexity procedures may have influenced the approval of Hospital Admission Authorizations (AIHs) throughout the study period.

The extreme concentration of procedures in a few urban centers constitutes the main finding of this study and even exceeds national patterns of regional inequality. National data indicate that the Midwest region accounts for only 4% of all knee arthroplasties performed in Brazil, despite representing approximately 7.8% of the national population². Within the state of Goiás itself, the concentration is even more pronounced: only six municipalities performed knee arthroplasty procedures throughout the entire study period, in a state with 246 municipalities.

Goiânia alone accounts for 85.0% of all procedures³ and 81.2% of total expenditures, while the metropolitan region (including Aparecida de Goiânia) concentrates 87.5% of all procedures. This extreme centralization reflects a healthcare network organization model that concentrates high-complexity services almost exclusively in large urban centers, creating virtually insurmountable access barriers for populations in rural and remote areas. The complete absence of procedures in 240 municipalities highlights a significant care gap that may compromise the principle of universality underpinning the Brazilian Unified Health System (SUS).

Several hypotheses may explain this difference. The first relates to the type of implant used. Brazilian studies have shown that national prostheses achieve clinical outcomes comparable to imported ones at a 5-year follow-up, with 78.4% satisfaction for Brazilian implants versus 90.7% for imported models (a difference that was not statistically significant, $p = 0.053$).⁴ Considering that domestic implants are substantially less expensive, it is possible that Goiás has predominantly adopted this option, resulting in significant cost savings without relevant clinical compromise.

The average cost per procedure in Goiás (R\$ 4,739.94) is 14.6% higher than the national average (R\$ 4,135.50)², a difference that can be explained by temporal and methodological factors. The significant variability among municipalities (a 68.0% difference between the highest and lowest averages) warrants careful analysis, as it may reflect differences in case complexity, implant types used, or hospital management practices. To contextualize these figures, international studies report hospital costs for total knee arthroplasty ranging between US\$ 14,910 and US\$ 48,325⁵⁻⁶, demonstrating wide variability even within developed healthcare systems.

A second hypothesis concerns case composition. The national study included all types of arthroplasty (primary, revision, unicompartmental), with revision surgeries typically costing 30–50% more than primary ones due to greater technical complexity and operative time². It is possible that Goiás performs a lower proportion of revision surgeries, either due to technical limitations in local centers or because such complex cases are referred to other states.

Methodological differences may also contribute to the discrepancy. The national study analyzed data from 2012 to 2021, whereas the present study covers 2008 to 2025, encompassing different SUS reimbursement policies over time. Additionally, variations in cost-recording practices among states may influence the values reported in the SIH/SUS database.

The quality of care and clinical outcomes are fundamental aspects that could not be assessed in this study but may be related to the observed costs. International studies have shown that

the use of specific surgical technologies, such as patient-specific instrumentation, can reduce both hospital costs and readmission rates by 31% at 30 days and 28% at one year.⁵ Periprosthetic infections, which occur in 1–2% of patients, represent the main cause of revision surgeries and can significantly increase costs, with values reaching US\$ 55,707 for septic cases versus US\$ 30,224 for aseptic ones.⁷

A fourth and more concerning possibility is the relative underfunding of procedures in Goiás, which could affect the quality of implants used, length of hospital stay, or other aspects of care. The average national hospital stay for the Midwest region was 4.81 days², but specific data for Goiás were not available for comparison. International studies have identified specific factors associated with increased hospital costs in arthroplasty, including a body mass index (BMI) greater than 35, ASA classification 3–4, peripheral vascular disease, chronic pulmonary disease, renal disease, and diabetes⁸. A systematic review confirmed that the presence of comorbidities is positively correlated with both length of stay and hospital costs in arthroplasty⁹. The prevalence of these risk factors in the Goiás population may therefore influence the average costs observed.

The temporal analysis also reveals interesting aspects when contextualized with national data. The study by Naito et al. identified a sharp reduction in procedures in 2020 and 2021 due to the COVID-19 pandemic, a pattern that may have influenced our findings, although specific data are insufficient to quantify this impact in Goiás.²

This study has important limitations that must be considered when interpreting the results. The use of secondary data from SIH/SUS, although it allows for comprehensive population-based analyses, may contain inconsistencies or underreporting. The data analyzed refer exclusively to the period between 2008 and 2024, providing a consistent 17-year time series for analysis. The data collection and recording methodology remained stable throughout the period, allowing for reliable temporal comparisons and trend analysis.

The results of this study provide a detailed overview of the costs and distribution of knee arthroplasty procedures in Goiás, revealing marked characteristics of centralization and cost variability. The total of 2,521 procedures performed between 2008 and 2024, representing an investment of R\$ 11.9 million, demonstrates the magnitude of this high-complexity service in the state. The growth trend observed until 2019, followed by a decline in 2020–2021 and subsequent recovery, aligns with the national pattern of the COVID-19 pandemic's impact on elective procedures. In the United States, for instance, approximately 800,000 total knee arthroplasties are performed annually¹⁰, highlighting the scale of these procedures in healthcare systems with greater installed capacity.

Future studies should investigate the determinants of the cost differences observed, including detailed analyses of implant types used, case complexity, and clinical outcomes. It is also recommended that geographic access studies be conducted to quantify the barriers faced by patients from rural areas, as well as analyses of care quality and complication rates to assess whether the lower costs observed in Goiás have any impact on clinical results.

CONCLUSION

The analysis of hospital costs for knee arthroplasty procedures within the SUS in Goiás reveals a scenario of extreme geographical concentration, with only six municipalities performing these surgeries across the entire state between 2008 and 2024. Goiânia accounts for 85.0% of all procedures

and 81.2% of total expenditures, highlighting a centralization that significantly compromises equitable access to treatment for populations living in the interior. The average cost per procedure (R\$ 4,739.94) is slightly higher than the national average, with notable variability among municipalities that warrants further investigation into the underlying determinants.

It is recommended that healthcare managers use these data to plan the expansion and decentralization of high-complexity orthopedic surgery services. Future studies using primary data are suggested to investigate the factors influencing procedure costs in Goiás and to evaluate clinical outcomes and patient quality of life following knee arthroplasty in the state.

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EPIDEMIOLOGY OF PROXIMAL FEMUR FRACTURES IN BRAZIL: REGIONAL ANALYSIS OF INCIDENCE, IN-HOSPITAL MORTALITY, AND AVERAGE LENGTH OF STAY

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ABSTRACT

Introduction: Proximal femur fractures represent a serious public health problem, especially among the elderly population, due to their high morbidity and mortality rates and significant socioeconomic impact. In Brazil, a country of continental dimensions and great demographic diversity, regional epidemiological analysis is essential for the planning of effective health policies. **Objective:** To analyze the incidence, in-hospital mortality, and average length of stay for proximal femur fractures in the state of Goiás, Brazil, from 2014 to 2024, based on data from the Unified Health System (SUS). **Methods:** This was a descriptive ecological study using secondary data from the Department of Informatics of the SUS (DATASUS), referring to the surgical treatment of proximal femur fracture/injury (code 0408050489) in Goiás. The variables analyzed were: approved Hospital Admission Authorizations (AIH), deaths, mortality rate, and average length of stay, stratified by municipality. **Results:** Over the 10-year period, 4,158 hospitalizations for proximal femur fractures were recorded in Goiás, with 100 in-hospital deaths, resulting in an overall mortality rate of 2.41% and an average length of stay of 6.5 days. A high concentration of cases was observed in the capital, Goiânia (70.3% of the total), which nonetheless showed a mortality rate (2.26%) lower than the average of other municipalities (2.76%). Smaller municipalities, such as Jaraguá, presented notably high mortality rates (7.69%), while others, such as Paraúna, recorded atypically long hospital stays (32 days), despite the low number of cases. **Conclusion:** The data reveal significant heterogeneity in the distribution and management of proximal femur fractures in Goiás, with strong centralization of care in the capital. Disparities in mortality rates and hospital stay lengths among municipalities suggest the need to investigate the factors associated with these outcomes and to strengthen the orthopedic care network in the state's interior.

Keywords: Proximal femur fractures, Epidemiology, Mortality, Length of stay, Public health, Brazil.

INTRODUCTION

Negative Fractures, particularly those of the proximal femur, represent one of the greatest challenges for healthcare systems worldwide and are considered a silent epidemic associated

with population aging.^{1,2} These fractures not only generate a substantial economic impact due to hospitalization, surgical, and rehabilitation costs but also lead to a drastic reduction in quality of life, loss of independence, and, most critically, high morbidity and mortality rates.^{3,4}

The incidence of hip fractures is on the rise, especially in developing countries. In Latin America, projections indicate a continuous increase, in contrast to the stabilization or decline observed in some North American and European nations.^{5,6} Brazil, undergoing a rapid process of demographic and epidemiological transition, lies at the epicenter of this trend. It is estimated that the incidence of fractures in the country could increase by more than 60% by 2030, making the understanding of their epidemiological profile a public health priority.⁷

Mortality following proximal femur fractures remains alarmingly high. International studies show that the mortality rate may reach up to 33% within the first year after the fracture. Factors such as advanced age, comorbidities, nutritional status, and—crucially—the time to surgery, are key determinants of outcome.^{8,9} A surgical delay of more than 48 hours has consistently been associated with a significant increase in mortality and postoperative complications.^{9,10}

Mortality, as well as the length of hospital stay, serves as a key indicator of care efficiency and a predictor of complications. Prolonged hospitalizations are linked to a higher risk of infections, thromboembolism, and functional decline, in addition to increasing healthcare costs.^{11,12}

In this context, the analysis of regional epidemiological data is essential to identify disparities, optimize resource allocation, and develop prevention and treatment strategies tailored to local realities. The objective of this study is to outline the epidemiological profile of proximal femur fractures in the state of Goiás, Brazil, by analyzing incidence, in-hospital mortality, and average length of stay, in order to provide evidence to support public health planning and to improve care for elderly patients with hip fractures.

METHODS

An ecological, descriptive, and retrospective study was conducted using secondary public-domain data obtained from the Department of Informatics of the Unified Health System (DATASUS), accessed through the TabNet platform (<http://tabnet.datasus.gov.br>).

Data were collected on September 25, 2025, covering the period from January 2014 to December 2024. The search was filtered for the state of Goiás, including all municipalities that recorded the procedure “Surgical treatment of proximal femur fracture/injury,” under code 0408050489 of the SUS procedure table.

The variables of interest selected for analysis were the number of approved Hospital Admission Authorizations (AIH), used as a proxy for hospitalization incidence; the number of in-hospital deaths; the average AIH reimbursement value; and the average length of hospital stay, expressed in days. The in-hospital mortality rate was calculated as the ratio between the number of deaths and the total number of approved AIHs, multiplied by 100.

Descriptive statistical analysis was performed, including the calculation of frequencies, means,

and rates. A stratified analysis by municipality and municipal size was conducted, along with a direct comparison between the state capital (Goiânia) and the other municipalities of Goiás. Because this study was based on secondary, anonymized, and publicly accessible data, submission to a Research Ethics Committee was not required, in accordance with Resolution No. 674/2022 of the National Health Council of Brazil.

RESULTS

Between January 2014 and December 2024, a total of 4,158 Hospital Admission Authorizations (AIH) were approved for the surgical treatment of proximal femur fractures in the state of Goiás. Of this total, 100 patients died during hospitalization, corresponding to an overall in-hospital mortality rate of 2.41%. The average length of hospital stay for this procedure in the state was 6.5 days.

Table 1 – Approved Hospital Admission Authorizations (AIH) by Municipality for Surgical Treatment of Proximal Femur Fracture, Goiás, 2014–2024

MUNICIPALITY	Approved Hospital Admission Authorizations
TOTAL	4.158
520110 ANAPOLIS	544
520140 APARECIDA DE GOIÂNIA	104
520170 ARAGARCAS	13
520410 CACHOEIRA ALTA	2
520430 CACU	1
520450 CALDAS NOVAS	7
520510 CATALAO	89
520540 CERES	133
520800 FORMOSA	11
520870 GOIÂNIA	2.924
521130 ITARUMÃ	2
521150 ITUMBIARA	39
521180 JARAGUA	13
521190 JATAI	18
521308 MINACU	3
521375 MONTIVIDIU	1
521380 MORRINHOS	1
521450 NEROPOLIS	1
521640 PARAUNA	1
521880 RIO VERDE	51
521930 SANTA HELENA DE GOIAS	128
522160 URUACU	72

Source: Ministry of Health – Hospital Information System of the Unified Health System (SIH/SUS)

Table 2 – Average Length of Stay by Municipality for Surgical Treatment of Proximal Femur Fracture, Goiás, 2014–2024

Municipality	Average Length of Stay
TOTAL	6.5
520110 ANAPOLIS	5.5
520140 APARECIDA DE GOIÂNIA	7.4
520170 ARAGARCAS	3.7
520410 CACHOEIRA ALTA	0.5
520430 CACU	7.0
520450 CALDAS NOVAS	4.3
520510 CATALAO	5.3
520540 CERES	3.2
520800 FORMOSA	3.5
520870 GOIÂNIA	6.7
521130 ITARUMÃ	1.5
521150 ITUMBIARA	7.4
521180 JARAGUA	3.1
521190 JATAI	5.4
521308 MINACU	1.3
521375 MONTIVIDIU	3.0
521380 MORRINHOS	3.0
521450 NEROPOLIS	7.0
521640 PARAUNA	32.0
521880 RIO VERDE	7.1
521930 SANTA HELENA DE GOIÁS	9.9
522160 URUACU	9.6

Source: Ministry of Health – Hospital Information System of the Unified Health System (SIH/SUS)

Table 3 – Deaths by Municipality for Surgical Treatment of Proximal Femur Fracture, Goiás, 2014–2024

Municipality	Deaths
TOTAL	100
520110 ANAPOLIS	20
520140 APARECIDA DE GOIÂNIA	2
520510 CATALAO	2
520540 CERES	1
520870 GOIÂNIA	66
521150 ITUMBIARA	1
521180 JARAGUA	1
521930 SANTA HELENA DE GOIÁS	4
522160 URUACU	3

Source: Ministry of Health – Hospital Information System of the Unified Health System (SIH/SUS)

Tabela 4 - Taxa mortalidade segundo Município em tratamento cirúrgico de fratura proximal do fêmur de 2014-2024 em Goiás

Municipality	Death rate
TOTAL	2.41
520110 ANAPOLIS	3.68
520140 APARECIDA DE GOIÂNIA	1.92
520510 CATALAO	2.25
520540 CERES	0.75
520870 GOIÂNIA	2.26
521150 ITUMBIARA	2.56
521180 JARAGUA	7.69
521930 SANTA HELENA DE GOIÁS	3.13
522160 URUACU	4.17

Source: Ministry of Health - Hospital Information System of the Unified Health System (SIH/SUS)

The distribution of cases revealed a marked concentration in the capital, Goiânia, which accounted for 2,924 hospitalizations, representing 70.3% of all cases in the state. Anápolis ranked second with 544 cases (13.1%), followed by Ceres (133; 3.2%), Santa Helena de Goiás (128; 3.1%), and Aparecida de Goiânia (104; 2.5%). Together, these five municipalities accounted for 92.2% of all hospital admissions for proximal femur fractures in Goiás (Table 5).

Table 5 - Distribution of Cases, Mortality, and Length of Stay by Municipality (2014–2024)

Municipality	Approved Hospital Admission Authorizations	Deaths	Death rate(%)	Average Length of Stay (days)
GOIÂNIA	2.924	66	2.26	6.7
ANAPOLIS	544	20	3.68	5.5
CERES	133	1	0.75	3.2
SANTA HELENA DE GOIÁS	128	4	3.13	9.9
APARECIDA DE GOIÂNIA	104	2	1.92	7.4
URUACU	72	3	4.17	9.6
RIO VERDE	51	0	0.00	7.1
ITUMBIARA	39	1	2.56	7.4
JATAI	18	0	0.00	5.4
ARAGARCAS	13	0	0.00	3.7
JARAGUA	13	1	7.69	3.1
TOTAL	4.158	100	2.41	6.5

Table 5 - Distribution of Cases, Mortality, and Length of Stay by Municipality (2014–2024)

The in-hospital mortality rate showed significant variation among municipalities. Jaraguá, despite having a relatively low number of cases (13), recorded the highest mortality rate (7.69%).

Uruaçu (4.17%) and Anápolis (3.68%) also presented rates above the state average. In contrast, Goiânia, while accounting for the majority of deaths in absolute numbers (66), had a mortality rate (2.26%) slightly below the state average.

The average length of hospital stay also varied considerably. The municipality of Paraúna recorded an atypically high average of 32 days, although it had only one reported case. Among municipalities with a higher volume of admissions (≥ 20 cases), Santa Helena de Goiás (9.9 days) and Uruaçu (9.6 days) had the longest average stays, while Ceres (3.2 days) and Jaraguá (3.1 days) showed the shortest durations.

When comparing Goiânia with the group of other municipalities, it was observed that although the capital accounted for 70.3% of all cases, its mortality rate (2.26%) was lower than that of the rest of the state (2.76%). On the other hand, the average hospital stay in Goiânia (6.7 days) was slightly higher than in other municipalities (6.1 days). This finding may suggest either a greater complexity of cases referred to the capital or differences in hospital management and care processes.

DISCUSSION

This epidemiological study on proximal femur fractures in Goiás reveals a complex and heterogeneous landscape, consistent with trends observed in other regions of Brazil and Latin America, while also presenting important regional particularities. The overall in-hospital mortality rate of 2.41% found in Goiás is comparable to, though slightly lower than, international data reporting hospital mortality rates ranging from 2.3% to 5.7%.⁸ However, it is essential to emphasize that in-hospital mortality represents only the “tip of the iceberg,” as mortality within the first year after a fracture can exceed 30%.^{8,9}

The marked concentration of cases (70.3%) in the capital, Goiânia, is a prominent finding and reflects a pattern of centralized high-complexity care, common throughout Brazil. This phenomenon can be explained by the greater availability of referral hospitals, specialized teams, and diagnostic and therapeutic resources in the capital. However, such centralization may impose geographic and socioeconomic barriers to access for patients from the countryside, potentially resulting in delayed surgical treatment - a well-established risk factor for increased mortality and postoperative complications. The slightly higher mortality rate in the group of smaller municipalities (2.76% vs. 2.26% in the capital) may indirectly reflect these access challenges and the more limited local healthcare infrastructure.

The high mortality rates observed in small municipalities, such as Jaraguá (7.69%), though based on a small number of cases, serve as a warning sign. This variability may be related to multiple factors, including local hospital infrastructure, availability of surgical and intensive care teams, and the comorbidity profile of patients in each region. Studies show that the patient's risk classification, such as the American Society of Anesthesiologists (ASA) score, is a strong predictor of mortality. The absence of clinical profile data in DATASUS represents a limitation of this study, but the observed disparities justify further local investigations to identify specific risk factors.

The average hospital stay of 6.5 days in Goiás is notably shorter than that reported in older studies from developed countries, which described averages between 15 and 30 days.¹³ However, it aligns more closely with recent trends toward hospital management optimization and implementation of evidence-based care protocols. Nevertheless, the

variation among municipalities remains significant. The prolonged hospital stays in places such as Santa Helena de Goiás (9.9 days) and Uruaçu (9.6 days) may indicate a higher rate of postoperative complications, delays in discharge processes, or the need for extended in-hospital rehabilitation—all of which increase costs and the risk of adverse events. The extreme case of Paraúna (32 days) likely represents an outlier but underscores the possibility of highly complex cases or severe complications managed in smaller, less-resourced hospitals.

CONCLUSION

The data reveal significant heterogeneity in the distribution and management of proximal femur fractures in Goiás, with a marked concentration of care in the state capital. The disparities in mortality rates and hospital stay durations among municipalities underscore the need to investigate factors associated with these outcomes and to strengthen the orthopedic care network in the state's interior.

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ANESTHETIC APPROACH TO ENDOSCOPIC GASTRIC BALLOON REMOVAL IN A 257 KG SUPEROBESE PATIENT: A CASE REPORT

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ABSTRACT

Introduction: Obese patients, who will undergo surgical procedures, are challenging cases for anesthesiologists, since, in the majority, obesity is associated with other comorbidities (hypertension, diabetes and others), making the anesthetic management difficult. Therefore, understanding the cardiopulmonary pathophysiology of obese people, as well as techniques to minimize their effects on the induction and maintenance of anesthesia, are essential to guarantee a safe and successful procedure. The objective of this case report was to demonstrate the perioperative management of a patient with a body mass index (BMI) 78 kg/m², classified as "super-super obese". **Case Report:** Male patient, 27 years old, weight 257 kg, height 1.81 m, BMI: 78.4 kg/m² with difficulty moving, physical status III (ASA classification) without other comorbidities, scheduled for endoscopic gastric balloon removal. He was intubated by direct laryngoscopy on the first attempt, with the aid of video laryngoscopy. **Conclusion:** Perioperative management including airway preparation, positioning, mechanical ventilation and decision on the drugs used are of great importance for the success of the anesthetic procedure, avoiding complications, which could be devastating in a patient of this size.

Keywords: Obesity, Anesthesiology, Airway management, Intubation intratracheal, Patient Safety.

INTRODUCTION

Obesity is a metabolic disease whose prevalence has been increasing exponentially worldwide. The World Health Organization (WHO) estimates that by 2025, more than two billion adults around the globe will be overweight, with 700 million classified as obese.¹ An individual with a BMI ≥ 30 is considered obese, ≥ 40 is classified as morbidly obese, ≥ 50 as super-obese, and ≥ 60 as super-super-obese.²

In most cases, obesity is closely associated with several comorbidities, including hypertension, type 2 diabetes mellitus, coronary artery disease, hyperlipidemia, obstructive

sleep apnea (OSA), liver and gallbladder disease, osteoarthritis, cancer, and reproductive and psychological disorders.³

Obese patients have an increased risk of perioperative complications compared to non-obese individuals, particularly those related to respiratory function. Patients with morbid obesity, also known as super-obese, are considered high-risk surgical candidates, with significantly higher rates of perioperative morbidity and mortality than overweight or moderately obese patients. Therefore, the presence of comorbidities and the type of surgical procedure are key factors in assessing the perioperative risk of these individuals, which must be conducted with caution and care.⁴

Moreover, obese patients often present fat deposits around the face, pharynx, and tongue, which can make mask ventilation and endotracheal intubation more challenging compared to normal-weight patients.⁵

Thus, anesthesia for obese patients poses a series of unique challenges, from the preoperative to the intraoperative and postoperative phases. The anesthesiologist must be aware of potential comorbidities, specific risks, and pathophysiological alterations in order to provide appropriate and safe care for this group of patients.

The present study aims to describe the preparation and execution of a safe anesthetic approach for a patient with a difficult airway, as well as the precautions and necessary measures to ensure a successful procedure. The CAAE approval number from the Research Ethics Committee is 67365023.2.0000.0033.

CASE REPORT

A 27-year-old male patient, weighing 257 kg and measuring 1.81 m in height, presented with a body mass index (BMI) of 78.4 kg/m² and limited mobility, being classified as super-super-obese/morbidly obese, with no other comorbidities. He was on liraglutide, which had been discontinued 72 hours prior to the procedure. The patient denied allergies, hypertension, diabetes, smoking, alcohol use, or any other substance use.

During pre-anesthetic evaluation, a difficult airway was anticipated. The patient had a beard, neck circumference of 56 cm, mouth opening of 3 cm, and Mallampati class IV airway, with abundant oropharyngeal tissue. The sternomental distance measured 20 cm, and the thyromental distance was 5 cm, with moderate cervical extension, poor mandibular space compliance, and grade II mandibular protrusion (Figure 1).

On physical examination, pulmonary auscultation revealed bilateral vesicular breath sounds with good chest expansion and no adventitious sounds. Cardiac auscultation was within normal limits for the patient's age and sex. Laboratory results were within normal ranges, showing no significant abnormalities, and the electrocardiogram (ECG) was normal. The anesthetic technique was planned and performed by an anesthesiologist assisted by an anesthesiology resident.



Figure 1. Airway assessment.

The patient was positioned supine on the stretcher, in the “sniffing position”, in order to align the oral, laryngeal, and pharyngeal axes, thereby improving laryngoscopy and intubation conditions. The patient was monitored with ECG, pulse oximetry, capnography, noninvasive blood pressure, and anesthetic depth assessment. A peripheral intravenous line (18G) was placed in the left upper limb.

The chosen technique was balanced general anesthesia, aiming to ensure patient safety during the procedure and to allow for rapid recovery. For induction of general anesthesia, the patient was pre-oxygenated with 100% oxygen via nasal cannula for five minutes, followed by face mask oxygenation for another five minutes. Sufentanil 10 mcg, propofol 300 mg, and rocuronium 150 mg were administered. Once the patient reached the desired anesthetic depth, manual ventilation was performed for three minutes. Subsequently, video laryngoscopy was carried out using a size 4 articulating blade, achieving a Cormack–Lehane grade I view, followed by orotracheal intubation with an 8.0 mm endotracheal tube (Figure 2). The patient’s vital signs remained stable throughout the procedure.



Figure 2. (A) Patient positioning for pre-oxygenation. (B) Video laryngoscopy.

DISCUSSION

Anesthetic induction and orotracheal intubation in morbidly obese patients require careful and premeditated planning, based on the assessment of predictors of a difficult airway. The most effective test for this evaluation is measurement of neck circumference. Obese patients present a 30% increase in the probability of difficult intubation when this measurement exceeds 60 cm. In such cases, awake tracheal intubation combined with fiberoptic bronchoscopy is the recommended approach.⁶ However, rapid sequence induction or gradual intravenous induction, with manual ventilation after reaching the anesthetic plane, can also be used, provided that the team is prepared for potential complications. In the present case, a prolonged pre-oxygenation period was performed, followed by gradual intravenous induction and manual mask ventilation after achieving the anesthetic plane, and subsequently, intubation using video laryngoscopy with an articulating blade.

Proper positioning is a crucial factor in intraoperative management, as it optimizes circulation and oxygenation, facilitates procedures such as endotracheal intubation, and helps prevent nerve injuries.² In obese patients, excess adipose tissue in the cervical region forms a fat pad, resulting in excessive neck flexion.³ It is recommended that obese patients be intubated by direct laryngoscopy only after being carefully positioned in the “ramped position”,⁶ in which the upper body, head, and neck are elevated above chest level until the external auditory meatus is aligned horizontally with the sternal notch. In the present case, the patient was positioned supine on the stretcher, with elevation of the upper back and a support pad placed under the scapular region.

The respiratory physiology of obese patients presents particular challenges that complicate anesthetic management during pre-anesthetic induction, intubation, intraoperative care, and postoperative recovery. Increased intra-abdominal pressure reduces total lung capacity, vital capacity, and functional residual capacity, promoting atelectasis formation. Therefore, the use of Positive End-Expiratory Pressure (PEEP) is essential to prevent atelectasis. On the other hand, excessively high PEEP levels may cause barotrauma and hemodynamic instability. Furthermore, both oxygen consumption and respiratory effort are increased, leading to reduced oxygenation.⁴⁵

Obstructive sleep apnea (OSA) is another risk factor for difficult intubation and is associated with an increased incidence of postoperative complications, such as postoperative desaturation, acute respiratory failure, and cardiac events. Therefore, OSA risk assessment protocols should be available as an integral part of the preoperative evaluation of obese patients, preferably including the gold standard examination—polysomnography.⁵

Preoperative respiratory evaluation should also include neck circumference measurement, distance between the chin and the upper border of the thyroid cartilage, extent of mouth opening and mandibular protrusion, neck mobility, the presence of excessive cervical adipose tissue, and general head and facial characteristics.³ These data were collected for the patient in question, confirming measurements that predisposed to a difficult airway.

Obese patients exhibit pharmacokinetic differences compared with those whose BMI falls within the normal range, requiring adjusted doses of anesthetic drugs. Lipid-soluble medications are metabolized more rapidly in obese patients, and tissue distribution is also altered, which can result in variable effects.² Propofol is a highly lipophilic anesthetic agent;

therefore, it has a large volume of distribution and is rapidly cleared from the bloodstream after administration. Due to these characteristics, propofol is the preferred agent for induction in morbidly obese patients.³ In the present case, the propofol dosage was calculated based on total body weight, given the super-morbid obesity, to avoid unpredictable pharmacodynamic variations in this population.

Considering the high incidence of opioid-induced respiratory depression, current guidelines recommend the most restrictive possible use of opioids, favoring multimodal pain management, such as combinations with lidocaine or ketamine, or the use of regional anesthesia techniques.⁵ The choice of sufentanil as the induction opioid was based on the procedure's expected duration, its well-established single-dose pharmacology, and its residual analgesic effect, which could improve postoperative recovery. A small dose was used, as the procedure was brief, thereby minimizing adverse drug effects.

The neuromuscular blocking agent rocuronium was selected for its limited distribution to peripheral tissues and because its pharmacokinetics are not significantly affected by the increased extracellular fluid volumes observed in obese patients. To avoid prolonged neuromuscular blockade, the dose should ideally be calculated based on ideal body weight.³ However, in the present case, the dose was calculated using total body weight, and no adverse effects or complications were observed.

Regarding inhalational agents, obese patients often experience delayed recovery after the use of highly lipophilic anesthetic gases, due to the continuous release of the drug from adipose tissue. In contrast, sevoflurane, which was used in this case, has low lipid solubility, resulting in rapid emergence and recovery in obese patients.²

CONCLUSION

Obesity increases the risk of intraoperative and postoperative complications. However, with the adoption of an effective multidisciplinary and collaborative approach, the occurrence of such complications can be significantly reduced. In conclusion, in the case presented, the airway management and preparation, protective mechanical ventilation, and the carefully planned anesthetic induction strategy were essential for the favorable outcome, avoiding complications that could have been potentially life-threatening for the patient.

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NEGATIVE PRESSURE PULMONARY EDEMA IN THE IMMEDIATE POSTOPERATIVE PERIOD OF MASTOPEXY WITH SCAR REVISION: A CASE REPORT

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ABSTRACT

Introduction: Negative pressure pulmonary edema (NPPE) is a rare and potentially severe respiratory complication, usually associated with acute upper airway obstructions such as laryngospasm. It is characterized by sudden hypoxemia resulting from extreme negative intrathoracic pressures, leading to fluid extravasation into the alveoli. **Case report:** A 28-year-old previously healthy female patient underwent mastopexy with scar revision under total intravenous general anesthesia associated with erector spinae plane block. In the immediate postoperative period, she presented with sudden desaturation and clinical signs consistent with NPPE. Lung ultrasound (US) revealed multiple coalescent B-lines, with favorable response after noninvasive ventilatory support. **Discussion:** This case reinforces the pathophysiology of NPPE described in the literature, associating vigorous inspiratory efforts against a partially obstructed airway with the development of edema. The importance of early diagnosis, point-of-care lung ultrasound, and noninvasive ventilation in the rapid reversal of the condition is highlighted. **Conclusion:** NPPE can occur even in young patients without comorbidities, following low-risk surgeries. Vigilance during the post-extubation period and early recognition of clinical signs are essential to avoid adverse outcomes. This report emphasizes the need for preventive strategies and training of the multidisciplinary team for the proper management of such complications.

Keywords: Pulmonary edema, Laryngospasm, Extubation, Hypoxemia, Lung ultrasound.

INTRODUCTION

Negative pressure pulmonary edema (NPPE) is a rare but potentially severe respiratory complication that occurs predominantly after acute upper airway obstruction, with laryngospasm being the main trigger¹. The pathophysiology involves the generation of extreme negative intrathoracic pressures during forced inspirations against an occluded glottis, resulting in increased

venous return, elevation of pulmonary capillary hydrostatic pressure, and fluid extravasation into the alveoli². Clinically, it manifests as sudden dyspnea, stridor, tachypnea, cyanosis, hypoxemia, and frothy pink secretions. Diagnosis is suggested by the clinical picture and confirmed by chest radiography, which reveals diffuse pulmonary infiltrates³.

Treatment is based on ventilatory support, oxygen therapy and noninvasive ventilation, such as CPAP (Continuous Positive Airway Pressure) or BiPAP (Bilevel Positive Airway Pressure), with invasive ventilation or vasoactive drugs rarely being required⁴. Although often underdiagnosed due to its transient course, early recognition of NPPE is crucial to prevent adverse outcomes. Preoperative screening for respiratory diseases and careful monitoring during extubation are effective strategies for its prevention³. In this context, the objective of the present study is to report a case of NPPE in a young, previously healthy patient undergoing elective aesthetic surgery, highlighting the clinical presentation, the utility of lung ultrasound in diagnosis, and the response to noninvasive treatment.

CASE REPORT

A 28-year-old previously healthy female patient underwent mastopexy with scar revision under total intravenous general anesthesia, associated with bilateral erector spinae plane (ESP) block. The procedure was uneventful, and the patient was extubated on command at the end of surgery, still in a mild drowsy state, maintaining hemodynamic stability and spontaneous respiratory pattern.

During transfer from the operating table to the transport stretcher en route to the post-anesthesia care unit (PACU), the patient presented with sudden desaturation, accompanied by decreased level of consciousness and immediate need for ventilatory support with face mask and airway clearance maneuvers. Despite partial recovery of consciousness and ventilatory status, she remained hypoxemic even with supplemental oxygen via nasal cannula.

Given the acute clinical presentation and suspicion of a respiratory complication, point-of-care lung ultrasound (POCUS) was performed, showing a characteristic interstitial pattern: presence of multiple coalescent B-lines, associated with preserved areas with A-lines, consistent with NPPE. The observed pattern presented a ground-glass distribution (Figure 1), with involvement of the upper lung fields, as shown in Figure 2 by evident B-lines in the apices.

The patient was managed with supportive ventilatory measures, rest in an elevated supine position, supplemental oxygen therapy, and continuous monitoring. Clinical progression was satisfactory, with gradual clinical improvement and regression of ultrasound findings. Figures 3A, 3B, and 3C show serial images of the pulmonary apices after interventions, demonstrating decreased quantity and coalescence of B-lines, with progressive reappearance of A-lines, consistent with resolution of alveolar edema.

In Figure 4 (A, B, and C), a global recovery pattern is observed, with predominance of A-lines and residual presence of few B-lines, indicating progressive resorption of interstitial edema and evident ventilatory improvement. The patient progressed well in the postoperative period, without the need for reintubation or admission to the intensive care unit.

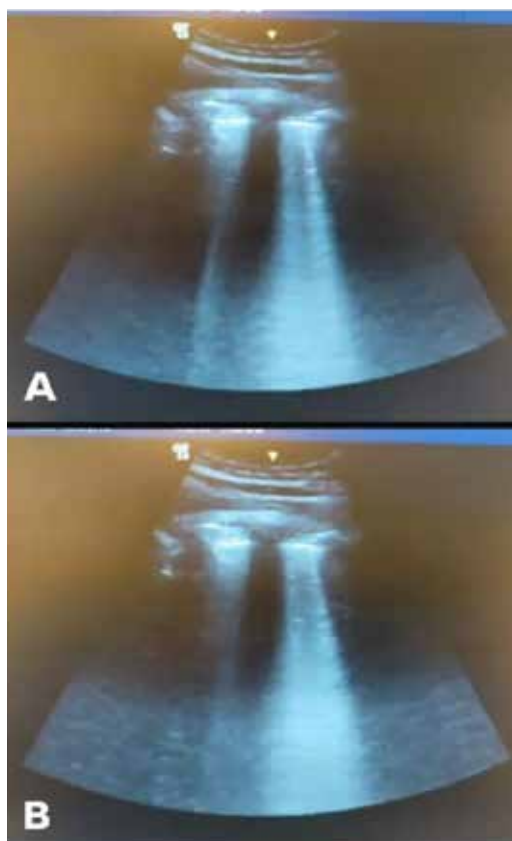


Figure 1. (A) and (B) Images showing the presence of multiple coalescent B-lines, with interspersed areas of preserved A-lines, forming a "ground-glass" pattern, characteristic of Negative Pressure Pulmonary Edema.



Figure 2. Lung ultrasound showing an interstitial pattern in the upper lung fields, with visible B-lines, suggestive of apical involvement in the context of negative pressure pulmonary edema.

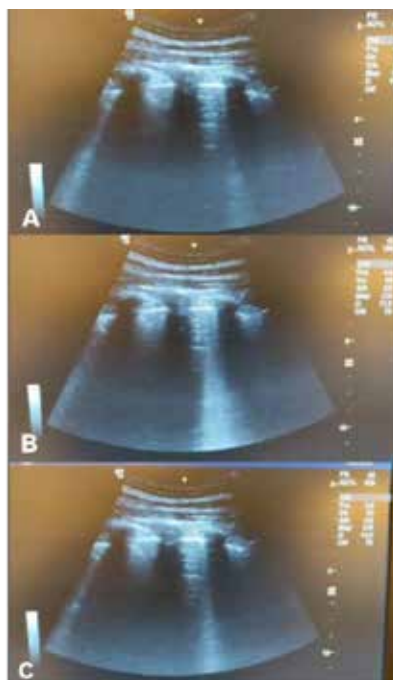


Figure 3 - Apical pattern after interventions. (A), (B), and (C) - Serial images of the pulmonary apices after clinical interventions, showing a reduction in the number and coalescence of B-lines, with the initial reappearance of A-lines, consistent with improvement of alveolar edema.

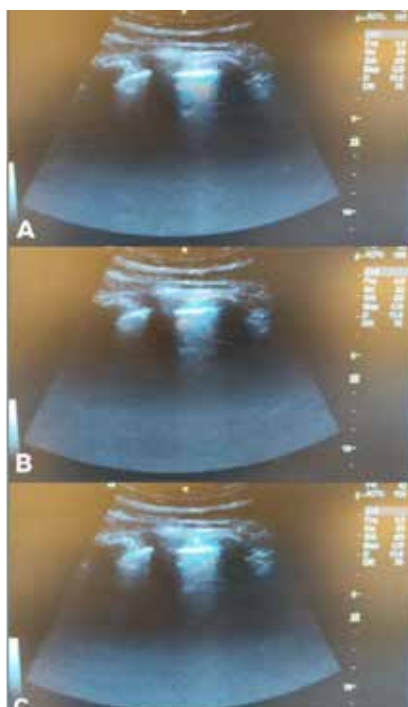


Figure 4. (A), (B), and (C) Lung ultrasound images demonstrating a recovery pattern, with predominance of A-lines and few residual B-lines, indicative of progressive resorption of interstitial edema.

DISCUSSION

Negative pressure pulmonary edema (NPPE) is a rare but serious complication that is often underdiagnosed in the immediate postoperative period. Its pathophysiology is associated with acute upper airway obstruction, with laryngospasm being the most common triggering event¹. During obstruction, inspiratory efforts against the occluded airway generate extreme negative intrathoracic pressures, resulting in increased capillary hydrostatic pressure and alveolar transudation². Although the condition is most often associated with patients who have risk factors, it can occur even in young, healthy individuals³.

We report the case of a 28-year-old female patient, without relevant comorbidities, who underwent mastopexy with scar revision under combined anesthesia. The procedure was uneventful, and the patient was extubated at an adequate level of consciousness, obeying simple commands and with good chest expansion. However, during transfer to the post-anesthesia care unit (PACU), the patient developed sudden desaturation, requiring ventilatory support with a face mask. Despite regaining consciousness, she remained with respiratory difficulty, requiring repeated airway clearance maneuvers, and persistent hypoxemia, even with nasal cannula oxygen.

This clinical presentation is suggestive of early NPPE, probably caused by transient upper airway obstruction that led to vigorous inspiratory effort and generation of extreme negative intrathoracic pressures, a mechanism described in Müller's maneuver⁴. Although the patient had no comorbidities, the acute airway obstruction and dysregulated ventilatory response were determining factors in the development of the complication. The literature suggests that NPPE typically manifests within the first minutes after obstruction, although it may also occur up to 2–3 hours after extubation⁵. Clinical findings such as crackles, rhonchi, and frothy pink secretions are indicative of this condition, associated with refractory hypoxemia that does not adequately respond to oxygen via nasal cannula⁶.

The proper management of NPPE involves early implementation of noninvasive ventilatory support, such as CPAP or BiPAP, which may lead to rapid clinical improvement and avoid the need for reintubation or hemodynamic support⁷. A retrospective study involving 15 patients with NPPE treated eight with noninvasive ventilation and demonstrated significant improvement in the $\text{PaO}_2/\text{FiO}_2$ ratio (from 132 ± 30 to 282 ± 77 mmHg) in less than 24 hours, without major complications or need for intubation⁷. These findings support that early initiation of CPAP/BiPAP, with patent airways and a cooperative patient, should be considered the initial intervention of choice⁷.

In addition, evidence indicates that early recognition of NPPE associated with monitored vigilance is crucial. A systematic review showed that rapid detection and effective management drastically reduced mortality from 11–40% in initial reports, to 2–5% in contemporary cohorts⁸. The application of continuous post-extubation SpO_2 monitoring protocols, especially in high-risk surgeries, can identify edema in its early stages and prevent worsening, even in young patients without risk factors⁸.

This case reinforces the importance of considering NPPE as a differential diagnosis, even in surgeries considered low anesthetic risk, such as aesthetic procedures. The occurrence of sudden postoperative hypoxemia, especially when associated with airway obstruction, should raise suspicion for this complication. Careful extubation strategies, intensive monitoring

during transport to the PACU, and early recognition of clinical signs are essential to avoid adverse outcomes⁸.

Furthermore, the findings of this case corroborate previous studies indicating that even young and healthy individuals may develop severe respiratory complications after stimuli that cause laryngeal obstruction or forced ventilation against resistance⁸. Thus, it is essential to carry out effective risk factor screening, adequately prepare the healthcare team, and establish extubation protocols that minimize the risk of complications such as NPPE.

CONCLUSION

The present case report highlights the occurrence of NPPE as a potentially severe post-extubation complication, even in young and healthy patients undergoing low-risk anesthetic procedures. Partial airway obstruction after extubation was sufficient to trigger an NPPE episode, confirming the pathophysiology associated with extreme negative intrathoracic pressures. Early identification of the condition and the immediate use of noninvasive ventilatory support were crucial for the favorable outcome, without the need for reintubation or hemodynamic support. This case reinforces the importance of strict vigilance in the post-extubation period, continuous monitoring during transport to the PACU, and proper training of the team for the recognition and management of often neglected conditions such as NPPE.

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NONSTEROIDAL ANTI-INFLAMMATORY DRUG-INDUCED ENTERITIS: A CASE REPORT

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ABSTRACT

Non-Steroidal Anti-Inflammatory Drugs (NSAIDs) are among the most frequently prescribed medications worldwide, particularly for the treatment of osteoarthritis, musculoskeletal pain, rheumatoid arthritis, and other inflammatory conditions. They act by inhibiting the activity of cyclooxygenase (COX) enzymes, resulting in the blockade of prostaglandin, prostacyclin, and thromboxane synthesis. This inhibition predisposes patients to adverse effects such as acute gastroduodenal mucosal injury, ulcers, esophagitis, enteritis, reactivation of inflammatory bowel disease, among others. NSAIDs exert deleterious effects throughout the gastrointestinal tract mucosa. Similar to the stomach, the intestine—especially the distal small intestine and colon—is susceptible to the harmful effects of NSAIDs. The ileocecal region is most commonly affected, where erosions, ulcers, strictures, perforations, and diaphragm-like lesions may occur, potentially leading to intestinal obstruction. We report the case of a 33-year-old male patient with chronic and abusive use of NSAIDs, admitted for investigation of abdominal distension and pain, nausea, vomiting, and diarrhea. After ruling out the most common causes of these symptoms, the diagnosis of NSAID-induced enteritis with substenosis formation was established. A review of the clinical and diagnostic aspects of NSAID-induced enteropathy is also presented.

Keywords: NSAIDs, Enteritis, Substenosis, Abdominal pain, Colonoscopy.

INTRODUCTION

Post-spinal Enteritis is defined as inflammation of the small intestinal mucosa and may lead to impaired absorptive function of the organ. The most common causes are infectious, mainly of viral, bacterial, and parasitic origin, but it can also result from ingestion of toxins in contaminated food. Less common causes include food allergy/intolerance, autoimmune diseases, inflammatory bowel disease, diabetes, hypothyroidism, alcohol abuse, and medication use.^{1,3}

Among the drug classes with significant potential to induce enteritis are non-steroidal

anti-inflammatory drugs (NSAIDs). This group of medications acts by inhibiting the activity of cyclooxygenase enzymes, and through this mechanism, several adverse effects may occur, including potential damage to the gastrointestinal tract.^{4,5}

The clinical presentation typically includes diarrhea, abdominal pain, nausea, and vomiting. More severe cases may progress with fever, weight loss, asthenia, muco-bloody diarrhea, melena, as well as symptoms related to malabsorption such as hypovitaminosis and electrolyte disturbances.^{2,3,6} Despite NSAIDs being among the most widely prescribed medications worldwide and well known to be associated with adverse gastrointestinal effects, NSAID-induced enteritis remains a neglected and underdiagnosed condition. The aim of the present report is to describe the case of a young patient with prolonged and abusive NSAID intake, who developed enteritis and partial intestinal obstructions. We also review the clinical features and diagnostic aspects of this condition.

CASE REPORT

A 32-year-old male patient, with no previous comorbidities, social alcohol use but abstinent for the past two years, and a former smoker (16 pack-years, quit one month prior), had a history of right femoral fracture six years earlier due to a motor vehicle accident. Since then, he had been chronically and abusively using NSAIDs for pain control, reporting daily and excessive intake of diclofenac sodium 50 mg and ibuprofen 600 mg tablets. He also reported occasional use of minor analgesics (acetaminophen and dipyrrone) and morphine derivatives (codeine). He denied the use of other medications. He had a previous episode of upper gastrointestinal bleeding three years earlier due to a gastric ulcer. There was no family history of neoplasia or inflammatory bowel disease.

The patient was admitted with a history of abdominal pain and distension for the past three years, worsened by food intake, associated with nausea, vomiting, and diarrhea—sometimes watery, sometimes pasty—of intermittent character, without blood, mucus, or pus, with significant worsening of symptoms one day before hospitalization. He denied fever, significant weight loss, new episodes of upper gastrointestinal bleeding, or respiratory or urinary complaints.

Laboratory tests revealed no electrolyte disturbances, renal dysfunction, or liver enzyme abnormalities. Findings included hypoalbuminemia, microcytic hypochromic anemia with anisocytosis, and iron and ferritin levels below the reference range. Oral lactose and fructose tolerance tests were positive. Anti-gliadin IgA and IgG antibodies were non-reactive. Fecal calprotectin was 40 (reference value < 200).

Upper gastrointestinal endoscopy showed distal erosive esophagitis (Los Angeles grade A), moderate enanthematous antral gastritis, and a healing pyloric ulcer (H2 SAKITA classification). Histopathological examination revealed mild non-granulomatous gastritis, moderate chronic duodenitis with crypt hyperplasia, villous-to-crypt ratio of 2:1, and multiple lymphoid follicles in the lamina propria.

Colonoscopy demonstrated deformity of the ileocecal valve with a scar lesion leading to stenosis, accompanied by local edema and enanthema. Histopathological examination showed moderate chronic erosive colitis associated with hyperplasia of lymphoid follicles in the lamina propria.

Enterotomography revealed diffuse distension of small bowel loops with formation of air-fluid levels, without evidence of obstructive factors by this method. No areas of mural thickening suggestive of inflammatory bowel disease were observed.

Retrograde enteroscopy demonstrated partial intestinal obstruction due to stenosis of the

ileocecal valve (FIGURES 1 and 2), which was endoscopically dilated without complications (FIGURES 3 and 4). It also revealed stenoses and aphthoid ulcers in the terminal ileum (FIGURES 5 and 6), from which biopsies were obtained. Histopathological examination of the ileum showed mononuclear lymphoplasmacytic inflammatory infiltrate in the lamina propria and hyperplastic follicles; preserved crypt-to-villous ratio; absence of ulceration or microabscesses; negative search for microorganisms (fungi and acid-fast bacilli); and no histological signs of malignancy.

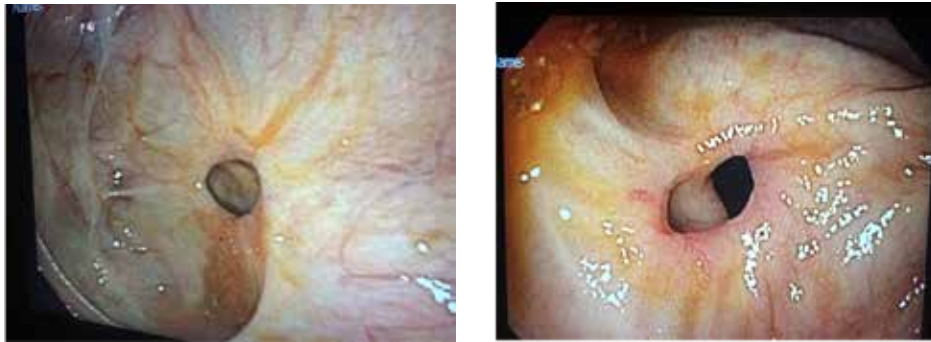


Figure 1 and 2. Ileocecal valve stricture observed on enteroscopy

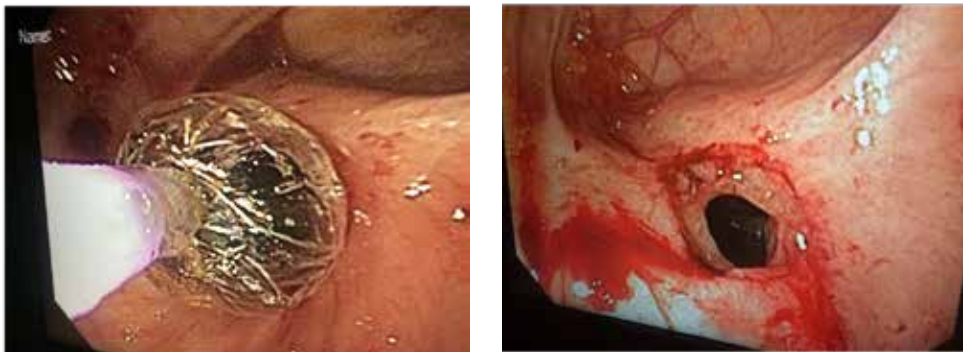


Figure 3 and 4. Endoscopic balloon dilation performed during enteroscopy.

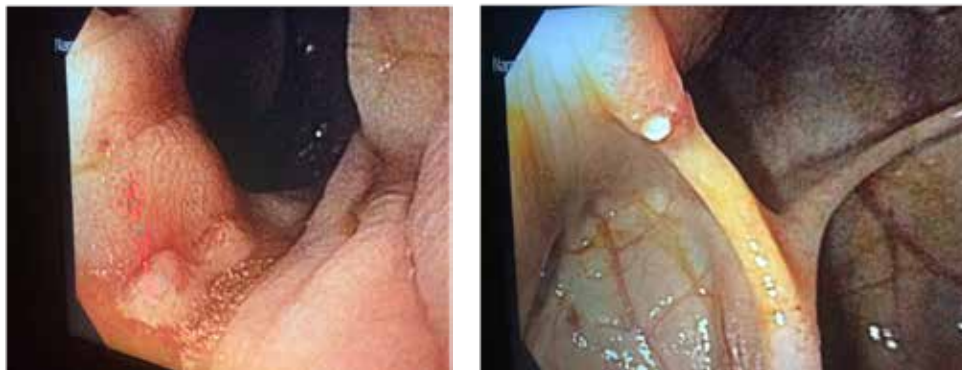


Figure 5 and 6. Strictures and aphthoid ulcers in the terminal ileum observed on enteroscopy.

Small bowel follow-through X-ray showed dilation and mucosal thickening of distal jejunal and ileal loops. The distal portion of the ileum was not visualized, with only a small amount of contrast passing into the right colon. No clear evidence of obstructive processes or caliber reduction of bowel loops was seen (FIGURES 7, 8, 9, and 10).



Figure 7, 8, 9 and 10 - Small bowel follow-through X-ray showing dilation and mucosal thickening of distal jejunal and ileal loops.

Based on the low fecal calprotectin level, histopathological findings, and imaging results, inflammatory bowel disease (Crohn's disease) was excluded, and the diagnostic hypothesis of NSAID-induced enteritis was suggested.

After undergoing endoscopic balloon dilation during enteroscopy, the patient presented with significant clinical improvement and was discharged on mesalazine therapy, with recommendations for continued outpatient follow-up.

DISCUSSION

NSAIDs are among the most widely prescribed medications worldwide, mainly for the treatment of osteoarthritis, musculoskeletal pain, rheumatoid arthritis, and other inflammatory conditions. However, they have adverse effects that can affect the entire gastrointestinal tract mucosa, compromising its functions such as absorption and digestion.¹⁻⁵

The small intestine, particularly the distal segments, as well as the colon, are susceptible to the various deleterious effects of NSAIDs. In the ileocecal region, a wide range of NSAID-induced lesions may occur, such as erosions, ulcers, strictures, perforations, and diaphragm-like lesions, which may lead to intestinal obstruction.^{4,6} When the colonic mucosa is affected, NSAID-related colitis may mimic inflammatory bowel disease, exacerbate pre-existing colitis, or complicate diverticular disease. Although intestinal injury related to NSAID use is common, the proportion of patients who develop significant clinical signs and symptoms of enteropathy remains relatively small. Approximately two-thirds of NSAID users show some degree of intestinal inflammation.⁵⁻⁷

NSAIDs act by inhibiting the activity of cyclooxygenase (COX) enzymes, resulting in blockade of prostaglandin, prostacyclin, and thromboxane synthesis. COX-1 plays a role in maintaining gastroduodenal mucosal integrity, vascular homeostasis, platelet aggregation, and modulation of renal plasma flow. COX-2 is generally undetectable in most tissues, but

its expression increases during inflammatory processes. It is constitutively expressed in the brain, kidney, and bone, and is of major importance in modulating glomerular blood flow and fluid–electrolyte balance.³⁻⁵

Prostaglandins have vasodilatory action and are associated with physiological effects in the renal, cardiovascular, and gastrointestinal systems. Therefore, NSAIDs that non-selectively block cyclooxygenases predispose patients to adverse effects such as acute gastroduodenal mucosal lesions, ulcers, esophagitis, enteritis, reactivation of inflammatory bowel disease, diverticulitis and diverticular perforation, colonic ulcers, as well as renal (dose-dependent) and hepatic injury.³⁻⁵

NSAID-related injury can also be local. At the mucosal level, the mechanisms of damage include inhibition of protective prostaglandins, alterations in blood flow, and increased intestinal permeability. Mucosal damage may lead to inflammation and ulceration, followed by reparative fibrosis and stricture formation. Proton pump inhibitor (PPI)-induced gastric acid suppression is unlikely to protect against NSAID-induced small bowel injury. In attempts to reduce gastroduodenal adverse effects, the use of enteric-coated, sustained-release, or slow-release NSAIDs may have shifted the site of injury to the distal small intestine and colon, since after ingestion or biliary excretion a high local drug concentration is required to increase intestinal permeability, which appears to be a prerequisite for NSAID-induced enteropathy.⁶⁻¹² This increase in mucosal permeability may be associated with bacterial overgrowth and is more frequently linked to NSAIDs that undergo enterohepatic circulation, as drug secretion into bile leads to repeated exposure of the intestinal mucosa to the toxic compound.⁴⁻⁸

The clinical presentation of most NSAID-induced lesions is commonly subclinical and often unrecognized. When present, signs and symptoms are nonspecific and may include: iron-deficiency anemia and/or bleeding from ulcers; hypoalbuminemia or malabsorption due to enteropathy; intermittent or complete intestinal obstruction; watery or bloody diarrhea; and acute abdomen due to perforation or obstruction. In chronic disease, alternating constipation and diarrhea may occur; abdominal pain may be intermittent; food intolerances may develop; and additional symptoms may arise from malabsorption, such as hypovitaminosis, hypokalemia, hypocalcemia, and their consequences. The typical patient is one using NSAIDs for a rheumatologic condition, such as osteoarthritis or rheumatoid arthritis. The relationship between NSAID use and diagnosis may range from a few days to several years.⁶⁻⁹

Intestinal diaphragms are considered pathognomonic lesions of NSAID-related injury. They are strictures (Figure 1), probably resulting from a cicatricial reaction secondary to ulcerative lesions. These lesions consist of thin, concentric septa, leading to the formation of a diaphragm with a narrowed lumen (Figure 2). They are usually multiple, most often found in the mid-small intestine, but have also been described in the ileum and colon. Histologically, they are characterized by submucosal fibrosis with normal overlying epithelium, and in some cases ulceration may be found at the diaphragm tip. The mucosa between diaphragms is normal. They are causes of subacute obstruction, but on abdominal radiographs they are difficult to visualize, appearing as exaggerated circular constrictions. During laparotomy, the surgeon should be alerted to this possibility, since the external appearance of the intestine may seem normal and the lesion is difficult to palpate. For this

reason, intraoperative enteroscopy becomes important.⁹⁻¹²

The diagnosis of NSAID-induced enteropathy is based on clinical presentation, laboratory tests, imaging, and histopathology, while also excluding more common causes of enteritis.

Imaging modalities such as capsule endoscopy, enteroscopy, and colonoscopy may support the diagnosis of NSAID-induced lesions, such as erosions, ulcers (Figure 4), or colitis. However, there are no pathognomonic findings on these examinations, nor is histology specific. Therefore, the differential diagnosis should include infectious etiologies (e.g., *Campylobacter*, *Yersinia*, cytomegalovirus, tuberculosis), irritable bowel syndrome, ischemia, radiation enteritis, vasculitis, and other drug-induced injuries (e.g., potassium chloride tablets).³⁻⁹

NSAID-induced lesions—except strictures and diaphragms—generally improve or resolve completely after drug discontinuation. Endoscopic findings such as a “cobblestone” appearance, longitudinal ulcers, or inflammatory polyps, as well as histological findings of granulomas, crypt abscesses, or crypt distortion, should suggest Crohn’s disease rather than NSAID-induced injury. Similarly, the presence of vasculitis on biopsy would favor a collagen vascular disease.⁸⁻¹²

The mainstay of treatment for NSAID-induced enteritis is discontinuation of the offending drug. In non-stenotic ileocecal lesions, withdrawal of NSAIDs usually results in considerable clinical improvement. A follow-up colonoscopy six to eight weeks later should confirm partial or complete resolution of ulcerations, enteritis, or colitis. If disease persistence or worsening is observed, Crohn’s disease or other etiologies must be considered.¹⁰⁻¹³

Obstructive symptoms due to strictures do not improve solely with drug discontinuation. Strictures or diaphragms accessible to endoscopy may be managed with balloon dilation (Figure 5) or electrocision (Figure 6). However, diaphragm-type strictures tend to be multiple and frequently require intestinal segment resection. Surgery is also indicated for other NSAID-induced complications, such as significant hemorrhage or perforation, and when malignant neoplasia cannot be reliably excluded.⁸⁻¹⁶

CONCLUSION

NSAIDs are among the most widely prescribed medications worldwide; therefore, the consequences of their use must be well recognized. However, NSAID-induced enteritis remains a neglected and underdiagnosed condition. It should be considered in patients using NSAIDs who present with abdominal pain associated with signs and symptoms of partial intestinal obstruction, with or without diarrhea.

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AWAKE INTUBATION FOR ANESTHESIA IN A PATIENT WITH MUCOPOLYSACCHARIDOSIS TYPE VI (MAROTEAUX-LAMY SYNDROME)

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ABSTRACT

Mucopolysaccharidoses (MPS) are a group of rare, progressive hereditary diseases caused by the deficiency of 11 lysosomal enzymes responsible for the degradation of glycosaminoglycans (GAGs). Enzymatic dysfunction leads to the progressive accumulation of unmetabolized GAGs in tissues and organs, including the airways, making management difficult and constituting a challenge for the anesthesiologist. This article reports the anesthetic management of a patient with Mucopolysaccharidosis type VI (Maroteaux-Lamy Syndrome) who underwent laparoscopic herniorrhaphy. After pre-anesthetic evaluation, general anesthesia with awake nasotracheal intubation was chosen, performed via fiberoptic bronchoscopy.

Keywords: Mucopolysaccharidosis VI, General anesthesia, Tracheal intubation, Bronchoscopy, Airway management.

INTRODUCTION

Mucopolysaccharidoses (MPS) represent a heterogeneous group of hereditary, progressive, and rare diseases. The etiology of these conditions lies in the deficiency of 11 distinct lysosomal enzymes, essential for the degradation of glycosaminoglycans (GAGs). The resulting enzymatic dysfunction leads to the progressive accumulation of unmetabolized GAGs in various tissues and organs, triggering cellular, tissue, and organ dysfunction. This cascade of events manifests clinically through cardiovascular, pulmonary, gastrointestinal, neurological, and musculoskeletal involvement. In addition, GAG deposition in the upper airways poses a significant challenge for anesthesiologists in airway management.^{1,2}

The classification of MPS into seven main types (I to IX, although types V and VIII are no longer used) is based on the specific pattern of GAG deposition, which is determined by the absence or defect of one of the 11 lysosomal enzymes involved in the process. Most forms of MPS follow an autosomal

recessive inheritance pattern, except for type II, which has X-linked recessive inheritance. The estimated prevalence for the group of MPS forms is approximately one case per 25,000 live births. However, underdiagnosis may occur due to the existence of milder forms.^{1,2}

Given the complex manifestations resulting from disease progression, patients with MPS often require surgical interventions under anesthesia. Airway management in this context may be substantially complicated by the accumulation of GAGs, which causes hypertrophy of the adenoids, tonsils, tongue, and laryngopharynx. Additionally, these patients may present with facial and airway anatomical abnormalities (except in type III), complicating both face mask ventilation and laryngoscopy or intubation procedures. The incidence of difficult intubation in this population varies considerably, ranging between 28% and 44%.^{1,2}

In view of the potential challenges inherent to airway management in this specific group of patients, the present case report aims to emphasize the crucial importance of pre-anesthetic planning as an indispensable tool to ensure patient safety and the success of the anesthetic procedure.

CASE REPORT

A 45-year-old patient, 56 kg, 163 cm, with MPS type VI (Maroteaux-Lamy Syndrome), valvular heart disease (mitral and aortic bioprostheses), and glaucoma, was scheduled for laparoscopic herniorrhaphy. Current medications included Carvedilol 12.5 mg and Aspirin® 100 mg. No known allergies. Airway evaluation revealed Mallampati class III (Figure 1), thyromental distance less than 5 cm, mouth opening less than 3 cm (Figure 2), limited neck extension (Figure 3), and altered dentition. In view of the predictors of difficult airway, pre-anesthetic consultation included planning for awake fiberoptic intubation. The patient was informed about the procedure, its risks, and the need for cooperation.



Figure 1: Mallampati III



Figure 2: Mouth opening less than 3 cm.



Figure 3: Limited neck extension.

Multiparametric monitoring was performed with pulse oximeter, cardiac monitor, pneumatic cuff, and capnography after intubation. The patient was admitted with blood pressure of 129×85 mmHg, heart rate of 84 bpm, and peripheral oxygen saturation (SpO_2) of 100%. Venous access was obtained in the right upper limb with a 20G intravenous cannula. Pre-oxygenation was initiated with face mask oxygen at 10 L/min, and sedation was performed with Dexmedetomidine 25 mcg and Midazolam 1 mg. Atropine 0.5 mg was administered due to its antisialagogue action. Superior laryngeal nerve block was performed with 3 ml of 2% lidocaine without vasoconstrictor (Figure 4), and glossopharyngeal nerve block with lidocaine spray.

Airway evaluation was performed by videolaryngoscopy (Figure 5), visualization being hindered by bleeding, with a Cormack-Lehane grade 4 view. Fiberoptic bronchoscopy was chosen (Figure 6), via the nasal route, with difficulty in tube advancement, requiring two attempts. After visualization of the vocal cords and access to the tracheal carina, a size 6 tracheal tube was passed slowly, requiring 3 minutes and 30 seconds for tube passage and cuff inflation (Figure 7). Intravenous anesthetic induction was then performed with Sufentanil 20 mcg + Propofol 120 mg + Cisatracurium 6 mg, and mechanical ventilation was initiated. Inhalational anesthesia was maintained with Sevoflurane 2%.



Figure 4: Superior laryngeal nerve block.



Figure 5: Airway evaluation by videolaryngoscopy.



Figure 6: Nasotracheal tube placement via bronchoscopy.



Figure 7: Anesthetic induction after nasotracheal tube placement.

The procedure was uneventful, and extubation was performed at the end of surgery after reversal with Atropine 1 mg and Neostigmine 2 mg. The patient remained in the post-anesthesia care unit for one hour and was then discharged to the ward.

DISCUSSION

The anatomical and physiological particularities of patients with MPS impose significant challenges for anesthetic management, especially regarding the airway. Findings such as high epiglottis, limited cervical mobility, micrognathia, restricted mouth opening secondary to temporomandibular joint dysplasia, pectus carinatum, tortuous and narrow trachea, tracheomalacia, skeletal dysplasia, scoliosis, and spinal cord compression, notably in the craniocervical and thoracolumbar regions, are frequently observed.^{1,2}

In addition, the occurrence of odontoid hypoplasia, which predisposes to atlantoaxial instability, requires cervical stabilization in situations that demand movement, aiming to maintain the neck in a neutral position. In procedures requiring cervical manipulation, such as laryngoscopy, the risk of subluxation and spinal cord injury is considerable. In prolonged surgeries involving cervical and cranial manipulation, intraoperative somatosensory evoked potential monitoring is strongly recommended.²

The accumulation of GAGs in the pulmonary parenchyma impairs ventilation, making patients more susceptible to pulmonary infections, obstructive or restrictive lung diseases, upper airway resistance syndrome, and obstructive sleep apnea. Bronchospasm crises and oxyhemoglobin desaturation are also common clinical manifestations.^{1,4}

Given the complexity of the airway in these patients and the need for specialized care, the Salford MPS Airway Score was developed. This comprehensive score evaluates the upper and lower airways through fifteen parameters, each scored from zero (normal) to three (severe abnormality). The sum of the fifteen parameters quantifies the severity of airway involvement. Clinical evaluation (parameters 1–6), nasoendoscopy (parameters 7–10), cross-sectional imaging studies such as computed tomography or magnetic resonance imaging (parameters 11–13), and pulmonary function tests (parameters 14–15) are used to determine the score.³

To ensure patient safety and design the ideal anesthetic strategy, a complete preoperative assessment is required, since MPS is a multisystemic disease. Comprehensive airway inspection is fundamental to evaluating the feasibility of general anesthesia, which strategies may be used, and which alternatives may apply. Older age is associated with a higher risk of difficult intubation, which, if unforeseen, may be fatal during management. Despite the challenges inherent in airway management in patients with MPS—from face mask ventilation to mechanical ventilation—general anesthesia remains the technique of choice and routine for many anesthesiologists. However, in patients with a predictably difficult airway, procedures requiring general anesthesia should be avoided whenever possible.^{4,5}

As an alternative, neuraxial anesthesia should be considered. Musculoskeletal involvement, such as scoliosis, multiple dysostosis, and atlantoaxial instability, and restriction of joint mobility make it difficult to achieve the ideal positioning of the patient for regional block techniques. In addition, poor cooperation, often associated with intellectual disability and behavioral disorders, also limits the use of regional or neuraxial anesthesia in this population.⁴

The application of epidural anesthesia is difficult due to the need for patient cooperation, ideal positioning, and the time required for the technique. In addition, there are reports of epidural block failure, attributed to the deposition of mucopolysaccharides in the epidural space, preventing the distribution of the local anesthetic. It is also believed that mucopolysaccharide deposition may occur around the nerve fiber sheaths, making regional anesthesia more difficult. Failure of the technique due to mucopolysaccharide deposition has not been reported in spinal anesthesia.^{4,5}

In the reported case, the choice of general anesthesia with awake intubation for laparoscopic herniorrhaphy was made after the pre-anesthetic consultation with the patient. The patient's airway was evaluated, possible predictors and complications were established, and alternative anesthetic plans were defined. In addition, the patient was questioned about past surgical history, which revealed no complications or adverse events. The patient's cognitive level, degree of understanding, and ability to cooperate with the procedure were also assessed. In the absence of a history of complications with previous general anesthesia, general anesthesia was chosen as the anesthetic technique. Given the predictors of difficult airway access, awake intubation was planned, with videolaryngoscopy evaluation and bronchoscopy if necessary. The choice of anesthetic technique was only possible due to the patient's understanding of the procedure and his collaboration.

CONCLUSION

MPS are a group of rare, progressive hereditary diseases caused by lysosomal enzyme deficiencies. The accumulation of GAGs in tissues and organs, including the airways, poses a significant challenge for the anesthesiologist. This case report describes the anesthetic management of a patient with Mucopolysaccharidosis type VI (Maroteaux-Lamy Syndrome) who underwent laparoscopic herniorrhaphy. Due to the predictors of difficult airway observed during pre-anesthetic evaluation, general anesthesia with awake nasotracheal intubation performed via fiberoptic bronchoscopy was chosen, an approach that proved effective in ensuring patient safety and the success of the surgical procedure.

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INTESTINAL OBSTRUCTION IN PREGNANCY: A RARE CASE OF ACUTE ABDOMEN

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ABSTRACT

Transverse colon volvulus is a rare, serious cause of acute obstructive abdomen. During pregnancy, this pathology becomes even less prevalent. Bowel obstruction syndrome is defined by a set of signs and symptoms that commonly manifest as intense abdominal pain, cessation of stool elimination and flatus, and has several non-traumatic causes, including volvulus. However, due to pregnancy, this condition may present a variability or overlap of symptoms with early worsening, sometimes due to limitations related to diagnostic imaging tests during pregnancy and, consequently, late diagnosis. In addition, this diversity of symptoms and high incidence of abdominal pain in the general population make its diagnosis difficult and becomes an important factor for hospital admission and, in severe cases, evolves with high morbidity and mortality. Due to its pathophysiology, there is a high risk of progression to complications due to progressive colon ischemia, especially without adequate intervention, therefore, early diagnosis and the appropriate therapeutic approach, whether colonoscopy or surgery, are imperative. Thus, this study demonstrates a clinical case of obstructive acute abdomen due to volvulus of the transverse colon during pregnancy and the therapies employed, from decompression by colonoscopy to a subsequent surgical approach requiring intestinal resection.

Keywords: Acute abdomen in pregnancy, Intestinal obstruction, Surgical complications in pregnancy, Partial colectomy, Intestinal anastomosis.

INTRODUCTION

Obesity The volvulus of the transverse colon is a rare etiology of intestinal obstruction caused by twisting of the colon. Intestinal obstruction is a condition with various clinical presentations, ranging from abdominal pain associated with the cessation of fecal and gas elimination, nausea, and vomiting, to simple and mild alterations in bowel habits. It can be classified according to topography (high or low), causative factor (mechanical or functional), and etiology, such

as adhesions, neoplasms, foreign bodies, inflammation, and even torsion — colonic volvulus. The term volvulus derives from the Latin *volvere*, meaning “to twist.” It was first described by Rokitsky in 1836.¹ Since then, it has been recognized as an important cause of intestinal obstruction, with particular characteristics compared to other etiologies.

Colonic volvulus is a less common cause of mechanical intestinal obstruction, accounting for less than 5% of cases. This type of obstruction involves luminal narrowing, creating a closed-loop mechanism and progressive intraluminal distension. Moreover, twisting of the mesenteric vessels leads to reduced perfusion of the affected intestinal segments, and when combined with marked segmental distension, it accelerates colonic ischemia. Consequently, there is a high risk of intestinal perforation and subsequent clinical deterioration due to contamination of the peritoneal cavity.

Anatomically, from the cecum to the sigmoid colon, there are regions more prone to twisting due to factors such as segmental mobility, long mesentery, chronic constipation, previous abdominal surgeries, aging, and weight loss.² Thus, Gingold³ identifies colonic volvulus as the third leading cause of large bowel obstruction, representing 10–15% of all colonic obstructions, while Ballantyne⁴ estimates a prevalence ranging from 1 to 20% of all intestinal obstructions. Furthermore, Halabi⁵, in a nine-year study, reported 63,749 cases of colonic volvulus among 3,351,152 intestinal obstructions, with a stable incidence of sigmoid volvulus and a 5% annual increase in cecal volvulus; distribution: sigmoid 60–75%, cecum 25–40%, transverse colon 1–4%, and splenic flexure 1%.

On the other hand, during pregnancy, due to the marked hormonal increase in progesterone produced by the placenta—essential for fetal development—systemic repercussions occur in the maternal organism, such as decreased gastrointestinal motility caused by mechanical alterations in the abdomen, increased uterine volume, and relaxation of smooth muscle resulting from high progesterone levels. Consequently, pregnant women tend to experience greater constipation compared to the general population². In addition, uterine growth causes distortion and displacement of the colon, which can favor constipation, torsion, and obstruction.

The clinical presentation of acute obstructive abdomen varies greatly depending on the onset of symptoms, which are determined by the site and whether the luminal occlusion is partial or complete. In general, there is a change in bowel habits, ranging from slowed transit to complete cessation of gas and fecal elimination. This may be accompanied by abdominal distension, which may or may not be associated with epigastric pain, nausea, and vomiting. Clinical deterioration occurs mainly due to dehydration secondary to vomiting, prolonged fasting caused by anorexia and nausea, and associated electrolyte imbalances. Partial obstructions are candidates for non-operative management, including hydration, analgesia, correction of electrolyte disturbances, gastric decompression if emesis is present, and, in some cases of colonic volvulus, decompression through colonoscopy or semirigid tubes—provided the patient’s clinical condition is stable^{6–8}. Conversely, complete obstructions require surgical management, which may involve intestinal resection, intestinal diversion, or removal of the obstructive factor, given the high risk of complications such as intestinal perforation and the low rate of spontaneous resolution.²

The diagnosis of intestinal obstruction is established based on clinical suspicion combined with patient history, laboratory tests, and imaging findings. Clinical and physical examination

may, in general, reveal information about the topography of the obstruction, such as palpable masses, abdominal distension, hyperresonance on percussion, and the presence or absence of bowel sounds. Laboratory tests support the investigation by identifying possible inflammatory factors, dehydration, and other abnormalities. Depending on the probable etiology and clinical condition, imaging studies are performed to determine the cause and guide either clinical or surgical management. These include radiography, ultrasonography, computed tomography, and magnetic resonance imaging.

However, it is well known that in this country there is a marked disparity among hospital services — ranging from the availability of laboratory and imaging exams to access to less invasive or surgical treatments. This disparity considerably increases the risk of underdiagnosis or inadequate management, thereby compromising maternal and fetal safety.

OBJECTIVES

This article aims to report the clinical case of a young adult woman who, during pregnancy, developed a transverse colon volvulus and, consequently, an acute obstructive abdomen — an extremely rare etiology, especially during gestation. The objective is to describe the diagnostic methods used, the initial therapeutic approach, and the definitive treatment adopted, as well as the postoperative course and progression during the final phase of pregnancy.

CASE REPORT AND METHOD

The case was analyzed from the moment the patient was admitted to the emergency department of a hospital, allowing the extraction of both qualitative and quantitative information and providing a comprehensive view of the entire case up to its final outcome — that is, the clinical course of the pregnant patient from the onset of intestinal obstruction, the effectiveness of the treatments administered, and the decision-making process of the healthcare professionals involved. Accordingly, the patient described in this study presented to the emergency department on her own initiative, complaining of lower back pain associated with dysuria. She was approximately 22 weeks pregnant, as estimated by obstetric ultrasound. She denied any comorbidities and reported a history of splenectomy following trauma. During the initial assessment, laboratory tests and renal and urinary tract ultrasonography were performed, revealing signs of acute pyelonephritis. Antibiotic therapy was initiated, and the patient was hospitalized.

During hospitalization, she developed abdominal distension associated with cessation of stool and gas elimination. The surgical team was consulted and requested an abdominal computed tomography (CT) scan due to the significant abdominal distension and interruption of intestinal transit.



Figure 1. Abdominal X-ray (anteroposterior view) from the computed tomography scout image.
Source: Patient's personal file (2024).



Figure 2. Abdominal computed tomography scan, coronal section. Green arrow – marked distension of the transverse colon. Red arrow – fetal skull.
Source: Patient's personal file (2024).



Figure 3. Abdominal computed tomography scan, coronal section, showing a "twist" of the colic vessels, suggestive of volvulus.
Source: Patient's personal file (2024).



Figure 4. Abdominal computed tomography scan, coronal section, showing marked distension of the transverse colon.
Source: Patient's personal file (2024).

The abdominal computed tomography scan shown above revealed marked distension with air–fluid levels in the colon and upstream (small intestine), associated with a rotational appearance of the mesenteric vessels near the root and a caliber transition of the bowel loops, suggesting intestinal rotation — transverse colon volvulus.

Due to the patient's clinical stability and the absence of factors indicating complications, an attempt was made to achieve colonic decompression through colonoscopy. However, this approach was unsuccessful. Therefore, an exploratory laparotomy was performed to ensure maternal and fetal well-being.

A midline transumbilical incision was made to allow wide exposure of the peritoneal cavity. A marked distension of the entire transverse colon was identified, which was rotated around its own axis, along with distension of the proximal intestinal segments and a gravid uterus with normal appearance.



Figure 5. Intraoperative view showing marked distension of the transverse colon.
Source: Photograph taken by the medical team (2024).

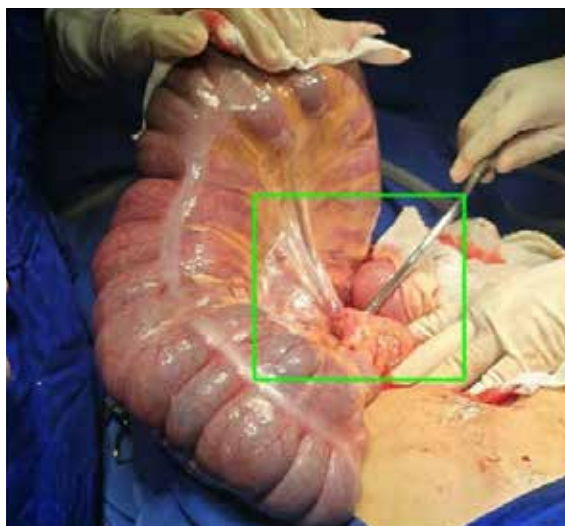


Figure 6. Intraoperative view showing the transverse colon with mesocolon rotation.

Source: Photograph taken by the medical team (2024).

Still during the intraoperative period, after detorsion of the volvulus, lysis of adhesions, and mobilization of the colon, an extended ileocelectomy was performed due to signs of ischemia in the ascending colon — a closed-loop mechanism caused by a competent ileocecal valve — while preserving the descending colon. Subsequently, a side-to-side entero-colonic anastomosis (between the distal ileum and the descending colon) was carried out using a 75 mm linear cutting stapler, with reinforcement of the staple line using 4-0 nonabsorbable suture.

DISCUSSION

The distribution of intestinal volvulus varies significantly according to geographical and epidemiological factors.⁹ In Uganda, this condition is the second most common cause of intestinal obstruction, with an increase in cases over the past four decades¹⁰. However, transverse colon volvulus is relatively rare compared with sigmoid and cecal volvulus, accounting for only 4% of all cases of colonic volvulus, according to another analysis of 306 cases conducted in the 1960s.^{4,9}

The etiology of transverse colon volvulus generally involves congenital, mechanical, and physiological factors that alter normal anatomical relationships. A short transverse mesocolon and broad fixation points at the hepatic and splenic flexures normally prevent torsion of the transverse colon.¹¹ Nevertheless, congenital abnormalities such as redundancy, non-fixation, or other visceral anomalies may predispose to volvulus. In addition, physiological factors such as pregnancy or chronic constipation, a high-fiber diet, and megacolon associated with Hirschsprung's disease may also contribute to the development of volvulus.²

Intestinal volvuli are characterized by abnormal twisting or rotation of the intestine, resulting in closed-loop obstruction and subsequent compromise of blood perfusion.¹² Transverse colon volvulus is an extremely rare condition in surgical practice due to the shorter transverse mesentery and the natural anatomic fixations at the hepatic and splenic flexures. This pathology is often associated with

other abnormalities, such as congenital malformations and bands, chronic constipation, obstructive neoplastic lesions of the distal intestinal segments, neuropsychiatric disorders, and pregnancy.

In the present case, the patient exhibited a redundant and dilated transverse colon that, despite fixation at the hepatic flexure, developed volvulus. It can be hypothesized that her previous splenectomy may have contributed to this condition, as surgical access to the Traube's space may require mobilization of the splenic flexure of the transverse colon, thereby removing one of its fixation points. However, a causal relationship could not be proven, and only inferences can be made regarding possible factors that may have contributed to the development of the volvulus in association with the gestational state.

Surgical management is required due to the high probability of associated necrosis. Treatment options include simple detorsion of the mesenteric twist, detorsion followed by fixation of the involved segment, or colectomy of the affected segments. Nevertheless, even after surgical intervention, there remains a considerable risk of recurrence of volvulus in the remaining bowel segments.

Given the marked distension of the proximal segment and uncertainty about the viability of the twisted bowel, resection of the involved colonic segment with primary anastomosis was performed. During outpatient follow-up, the patient remained asymptomatic, showing good clinical and surgical recovery. Mortality rates associated with volvulus increase significantly in patients with gangrenous bowel, highlighting the importance of early diagnosis and prompt treatment. Fortunately, despite the development of gangrene, the patient underwent timely surgical intervention, preventing perforation and subsequent generalized infection. At the time of writing, the patient remains in good clinical condition, with preserved fetal vitality.

FINAL CONSIDERATIONS

The diagnosis of acute obstructive abdomen can be challenging due to numerous factors — even more so during pregnancy. However, it is the duty of the attending physician to listen to and understand the patient's complaint and to provide the best possible investigation and treatment. Despite the significant disparities in infrastructure, technological resources, and access to healthcare professionals, it is our individual responsibility to compensate for these limitations through a thorough history-taking and an excellent physical examination. In the present case, accurate identification and appropriate management made it possible to save two lives and prevent associated morbidities, such as the need for colostomy or prolonged hospitalization due to infection. Therefore, solid theoretical knowledge is essential to enable early suspicion, correct diagnosis, and timely treatment and resolution of such cases.

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