e-ISSN:2602-2079

Volume 10
Issue 7
2026

JOURNAL of Surgery and Medicine

International Medical Journal

JOSAM

Editorial Team

Kuwait City, Hawally, Kuwait
Website
Email

Fahmi Khan, MB, BS, CABMs
Hamad Medical Corporation | HMC
Department of Medicine (Hamad General Hospital)
Doha, Qatar
Website
Email

Elroy Patrick Weledji, Professor, BSc, MBBChBAO, MSc, FRCS(Edinburgh)
Department of Medicine
University of Buea
Buea, Cameroon
Website
Email

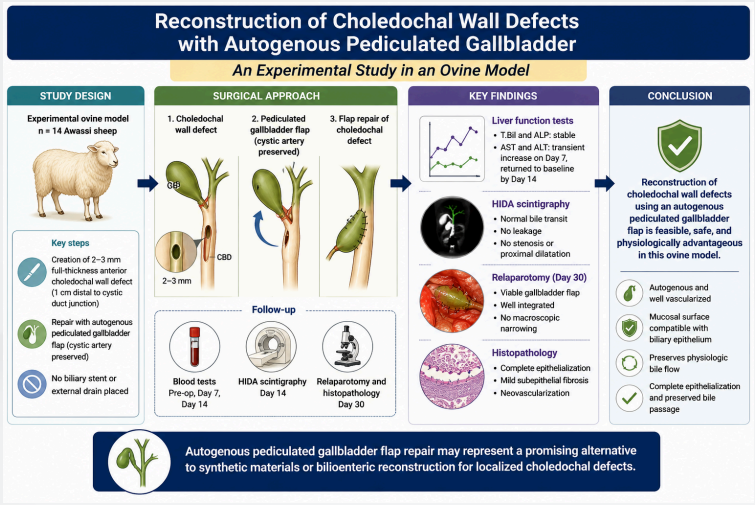
Prasenjit Das, Professor, MD, DNB, MNAMS, MNASc
Department of Pathology
All India Institute of Medical Sciences
New Delhi, India
Website
Email

Seyed Vahid Hosseini, Professor
Shiraz University of Medical Sciences, Shiraz, Iran
Website
Email

Vol. 10 No. 7 (2026)

Published: 2026-07-31

Research Article

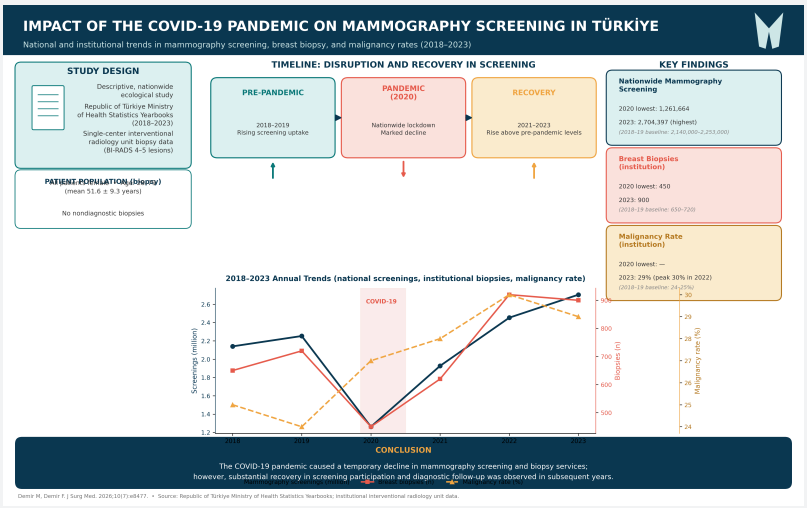


Reconstruction of choledochal wall defects with autogenous pediculated gallbladder

Reconstruction of choledochal wall defects

Mehmet Hatip Adıgüzel, Guvenc Diner, Recep Çağlar

e8446



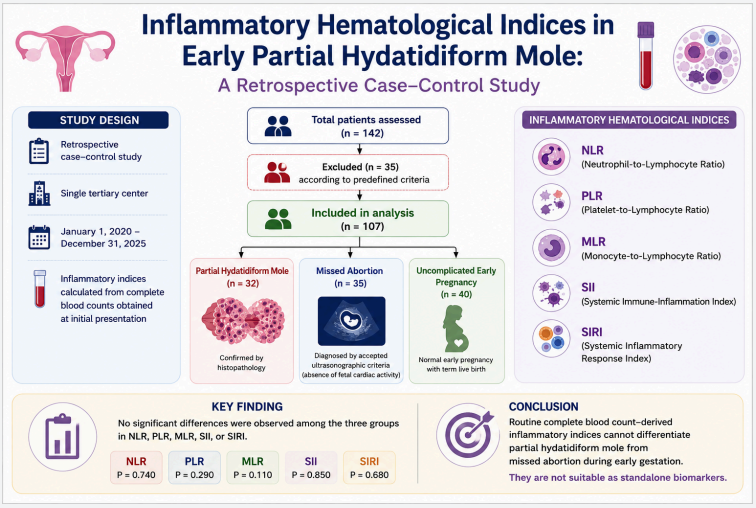
The impact of COVID-19 on mammography screening: Trends in Türkiye between 2018 and 2023

The impact of COVID-19 on mammography screening

Mehmet Demir, Feza Demir

e8477

PDF 52 33 Citations 0



Inflammatory hematological indices in early partial hydatidiform mole: A retrospective case-control study

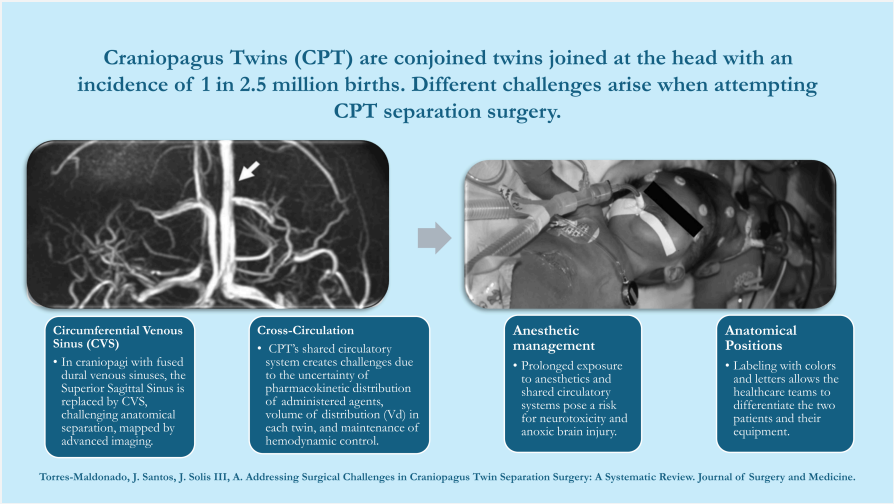
Inflammatory indices in partial hydatidiform mole

Arif Caner Erdoğan, Emine Türen Demir

e8630

PDF 36 27 Citations 0

Review



Addressing surgical challenges in craniopagus twin separation surgery: A systematic review

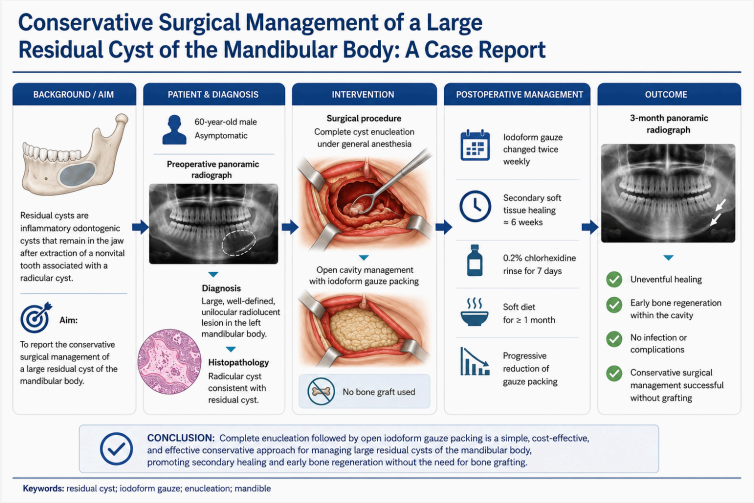
Challenges in craniopagus twin separation surgery

Juliet Torres-maldonado, Javier Santos González, Armin Solis Iii

e8418

PDF 118 63 Citations 0

Case Report

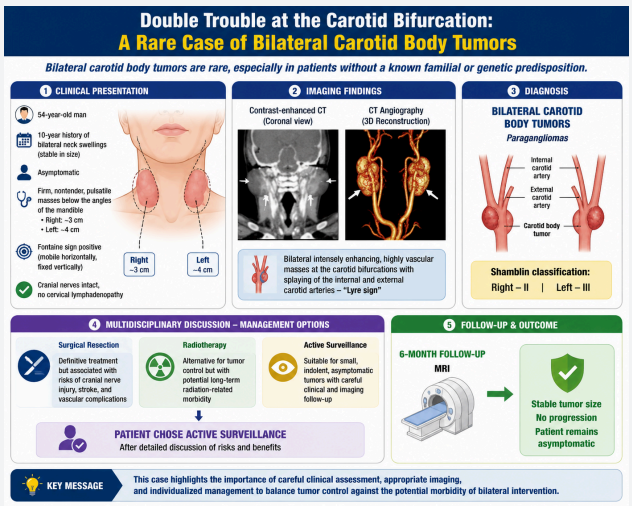


Conservative surgical management of a large residual cyst of the mandibular body: A case report

Residual cyst of the mandibular body

Alba Likaj, Remi Likaj

e8474



Double trouble at the carotid bifurcation: A rare case of bilateral carotid body tumors

Rare bilateral carotid body tumors

Nor Anis Elini Ismail, Aiman A Hamid

e8475

J Surg Med. 2026;10(7):e8477.
https://doi.org/10.28982/josam.8477

JOSAM

Research Article
https://jsurgmed.com/

Journal of Surgery and Medicine
e-ISSN: 2602-2079

The impact of COVID-19 on mammography screening: Trends in Türkiye between 2018 and 2023

Mehmet Demir[1], Feza Demir[2]

[1]Department of Radiology, Faculty of Medicine, Kahramanmaraş Sütçü İmam University, Kahramanmaraş, Türkiye
[2]Department of Public Health, Faculty of Medicine, Kahramanmaraş Sütçü İmam University, Kahramanmaraş, Türkiye

ORCID of the author(s)

MD: https://orcid.org/0000-0002-5031-6324
FD: https://orcid.org/0000-0002-6377-1545

Corresponding Author
Mehmet Demir
Department of Radiology, Faculty of Medicine, Harran University, 63300, Şanlıurfa, Türkiye.
E-mail: dr.mehmetdemir@hotmail.com

Ethics Committee Approval
The study was approved by the Harran University Noninterventional Clinical Research Ethics Committee (decision no. 25.06.56; March 24, 2025). The study was conducted in accordance with the principles of the Declaration of Helsinki.

Conflict of Interest
No conflict of interest was declared by the authors.

Financial Disclosure
The authors declared that this study has received no financial support.

Published
2026 July 9

Abstract

Background/Aim: Breast cancer screening programs are essential for early detection, but they may be disrupted during major public health crises. This study evaluated trends in mammography screening, breast biopsy numbers, and malignancy detection rates in Türkiye between 2018 and 2023, with particular attention to the effects of the COVID-19 pandemic.

Methods: This descriptive study used nationwide mammography screening data obtained from the Health Statistics Yearbooks of the Republic of Türkiye Ministry of Health for 2018-2023. In addition, breast biopsy data and malignancy rates from the interventional radiology unit of the study center were reviewed for the same period. Annual changes were analyzed to assess the effect of the pandemic and the subsequent recovery period on breast cancer screening and diagnosis.

Results: Nationwide mammography screenings increased from 2,139,813 in 2018 to 2,252,815 in 2019 and then decreased markedly to 1,261,664 in 2020. A recovery trend was observed in 2021 (1,926,717) and continued through 2022 (2,453,042) and 2023 (2,704,397). Similarly, the number of breast biopsies decreased from 720 in 2019 to 450 in 2020, then increased to 920 in 2022 and slightly decreased to 900 in 2023. Malignancy rates increased from 24.0% in 2019 to 30.0% in 2022 and then slightly decreased to 29.0% in 2023.

Conclusion: The COVID-19 pandemic temporarily disrupted breast cancer screening and biopsy services in Türkiye. However, substantial recovery was observed in subsequent years in both screening participation and diagnostic follow-up. These findings underscore the importance of resilient health care systems and strategies that sustain cancer screening services during public health crises.

Keywords: mammography, breast cancer screening, COVID-19 pandemic

Introduction

Cancer remains a major global health problem and affects millions of people each year [1, 2]. Breast cancer is the most common cancer among women, and early detection is critical for improving treatment outcomes and reducing mortality [3]. In Türkiye, approximately one in eight women is at risk of developing breast cancer during her lifetime. Therefore, effective screening programs are essential for timely diagnosis and treatment.

Mammography is an imaging method that uses X-rays to evaluate breast tissue and is particularly valuable for detecting asymptomatic tumors at an early stage [4]. Current evidence supports the benefits of mammography screening, although its implementation and performance may vary across settings [5]. In Türkiye, mammography screening programs conducted by the Ministry of Health aim to facilitate early diagnosis in eligible women. However, participation in these programs remains below the desired level, and multiple barriers may influence screening uptake [6].

In this context, the present study evaluated nationwide mammography screening trends in Türkiye between 2018 and 2023 by using Ministry of Health data [7]. In addition, breast biopsy numbers and biopsy outcomes from our hospital's interventional radiology unit were examined to better understand the potential impact of the COVID-19 pandemic on diagnostic follow-up after screening. By evaluating national screening activity together with institutional biopsy trends, this study sought to provide a practical overview of disruption and recovery in breast cancer screening services during and after the pandemic.

Materials and methods

Study design and data sources

This descriptive study used data from the Health Statistics Yearbooks of the Republic of Türkiye Ministry of Health for the years 2018-2023 [7]. The analysis focused on annual trends in mammography screening in Türkiye. In addition, data from our hospital's interventional radiology unit regarding the number and results of breast biopsies performed during the same period were reviewed to assess changes in diagnostic follow-up during and after the COVID-19 pandemic.

Breast biopsy data

Breast biopsies were performed in patients with suspicious breast lesions detected on mammography or ultrasonography and classified as Breast Imaging Reporting and Data System (BI-RADS) category 4 or 5. All cases were evaluated by radiologists in the interventional radiology unit according to BI-RADS criteria, and lesion characteristics were recorded accordingly. Patients with BI-RADS category 3 or lower lesions were followed up and were not considered for biopsy. All biopsies were performed under ultrasound guidance with a 14-gauge core needle. Pathology results were categorized as malignant, benign, or atypical lesions. This standardized protocol supported consistency in patient selection, lesion assessment, and biopsy procedures.

Statistical analysis

The numbers of mammography screenings, breast biopsies, and malignancy rates were summarized by year using descriptive statistics, including frequency and percentage. Trend graphics and annual comparisons were used to illustrate changes over time. Statistical analyses were performed with IBM SPSS Statistics for Windows, Version 25.0 (IBM Corp., Armonk, NY, USA). Because the present report primarily aimed to describe annual trends in an ecological nationwide dataset together with institutional summary biopsy data, the findings are presented descriptively.

Ethics statement

The study was approved by the Harran University Noninterventional Clinical Research Ethics Committee (decision no. 25.06.56; March 24, 2025). The study was conducted in accordance with the principles of the Declaration of Helsinki.

Results

All breast biopsy cases included in the study were female patients; no male patients were identified during the study period. The age of the patients who underwent biopsy ranged from 28 to 79 years, with a mean of 51.6 (9.3) years. All biopsied lesions were classified as BI-RADS category 4 or 5 on mammography or ultrasonography.

No nondiagnostic biopsy reports were recorded during the study period. All cases were histopathologically categorized as benign, malignant, or lesions with atypical cells. If a patient underwent more than one biopsy, only the first biopsy result was included in the analysis. Therefore, the reported numbers represent individual patients rather than the total number of biopsy procedures.

Mammography screening in Türkiye increased during the pre-pandemic period, from 2,139,813 screenings in 2018 to 2,252,815 in 2019, and then decreased markedly to 1,261,664 in 2020. Screening activity recovered to 1,926,717 in 2021 and exceeded pre-pandemic levels in 2022 (2,453,042) and 2023 (2,704,397) (Table 1, Figure 1).

A similar pattern was observed for breast biopsies performed in our hospital's interventional radiology unit. The number of biopsies increased from 650 in 2018 to 720 in 2019, decreased to 450 in 2020, increased again to 620 in 2021, peaked at 920 in 2022, and slightly decreased to 900 in 2023 (Table 1).

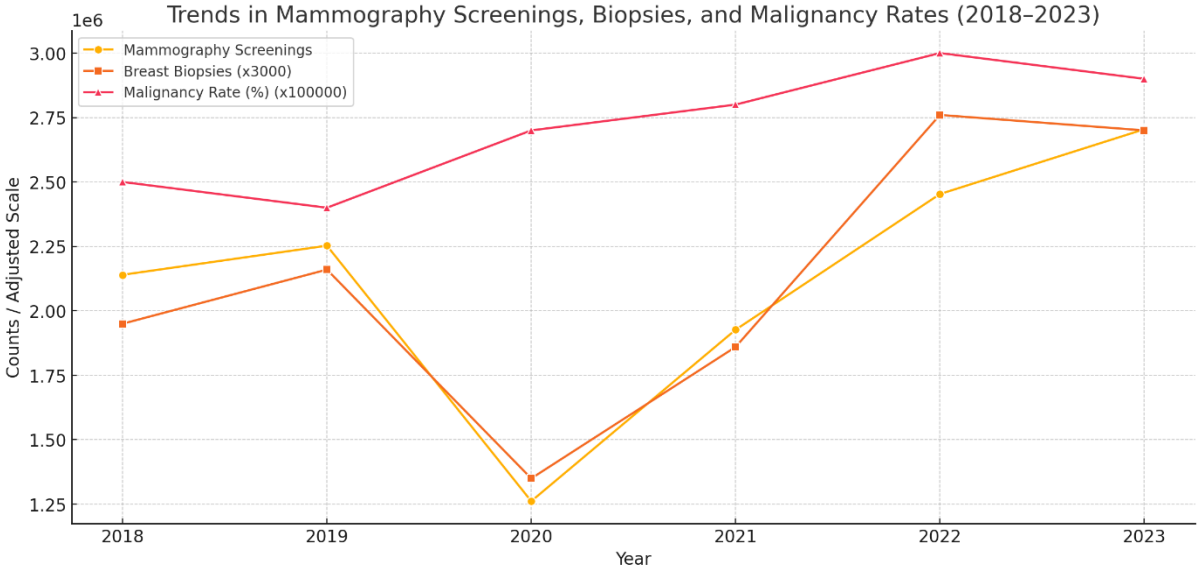
Malignancy rates showed annual variation across the study period. The malignancy rate was 25.0% in 2018 and 24.0% in 2019, increased to 27.0% in 2020 and 28.0% in 2021, peaked at 30.0% in 2022, and slightly decreased to 29.0% in 2023 (Table 1). Overall, these findings suggest that the decline in screening activity during the pandemic was accompanied by a reduction in biopsy volume, followed by recovery in both screening participation and diagnostic follow-up in the subsequent years.

Table 1. Annual mammography screenings, breast biopsies, and malignancy rates in Türkiye (2018-2023).

Year	Mammography screenings (nationwide)	Breast biopsies (n)	Malignancy rate (%)
2018	2,139,813	650	25.0
2019	2,252,815	720	24.0
2020	1,261,664	450	27.0
2021	1,926,717	620	28.0
2022	2,453,042	920	30.0
2023	2,704,397	900	29.0

n: number. Nationwide mammography screening data represent the total number of screenings performed across Türkiye between 2018 and 2023. Breast biopsy data and malignancy rates were obtained from the XXX University Interventional Radiology Unit.

Figure 1. Annual trends in mammography screenings, breast biopsies, and malignancy rates in Türkiye between 2018 and 2023. The blue line represents nationwide mammography screenings. The orange line represents the number of breast biopsies performed in the Harran University Interventional Radiology Unit, scaled by a factor of 3,000 for visual comparability. The green line represents the malignancy detection rate (%), scaled by a factor of 100,000.



Discussion

This study showed that mammography screening activity in Türkiye increased before the COVID-19 pandemic, decreased substantially in 2020, and then recovered progressively through 2023. Similar disruptions in breast cancer screening were reported internationally during the pandemic, including marked reductions in the United States and the United Kingdom, as well as in several other countries [8-11]. The subsequent recovery observed in our study is also consistent with reports showing the restoration of screening services after the most restrictive phase of the pandemic [12].

The biopsy data from our interventional radiology unit complemented the nationwide screening findings. The reduction in biopsy numbers during the pandemic period was followed by a rebound in the post-pandemic years, suggesting that reduced screening activity was accompanied by reduced diagnostic follow-up. In parallel, malignancy rates increased modestly after the pandemic onset, which may reflect changes in biopsy referral patterns, delayed presentation, or the detection of previously missed clinically significant lesions after services resumed [10, 12, 15].

The observed post-pandemic increase in malignancy rates should be interpreted cautiously. Higher malignancy proportions do not necessarily indicate a true rise in disease incidence; rather, they may reflect selective referral of higher-risk cases when access to screening and diagnostic services was limited. Nevertheless, the findings reinforce the importance of maintaining continuity in screening pathways and implementing adaptive strategies, such as mobile screening, risk-based prioritization, and stronger public outreach, particularly during periods of health system disruption [13, 14, 16].

This study has several limitations. First, it combined nationwide mammography screening data with breast biopsy results from a single institution, which may limit generalizability. Second, detailed clinical staging data and long-term patient outcomes were not available, which restricted the ability to evaluate the direct effect of delayed screening on disease progression. Third, the lack of individual-level sociodemographic data limited further analysis of factors associated with screening participation and malignancy detection. Finally, multiple pandemic-related confounders, including changes in referral practices, resource allocation, and health-seeking behavior, could not be fully assessed.

Despite these limitations, the study provides a practical overview of screening disruption and recovery in Türkiye during an unprecedented public health crisis. From a health policy perspective, the findings support the need for resilient and flexible breast cancer screening systems that can preserve access during future emergencies.

Conclusion

The COVID-19 pandemic temporarily disrupted mammography screening and breast biopsy activity in Türkiye. However, both screening participation and diagnostic follow-up recovered in the post-pandemic period. Sustained accessibility, public awareness, and health system preparedness are essential to protect breast cancer screening services during future public health crises.

References

1. Anastasiadi Z, Lianos GD, Ignatiadou E, Harissis HV, Mitsis M. Breast cancer in young women: An overview. Updates Surg. 2017;69(3):313-7. doi: 10.1007/s13304-017-0424-1.
2. Sung H, Ferlay J, Siegel RL, Laversanne M, Soerjomataram I, Jemal A, et al. Global cancer statistics 2020: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. CA Cancer J Clin. 2021;71(3):209-49. doi: 10.3322/caac.21660.
3. Freedman RA, Partridge AH. Management of breast cancer in very young women. Breast. 2013;22 Suppl 2:S176-9. doi: 10.1016/j.breast.2013.07.034.
4. Jackson VP. Diagnostic mammography. Radiol Clin North Am. 2004;42(5):853-70. doi: 10.1016/j.rcl.2004.06.002.
5. Løberg M, Lousdal ML, Bretthauer M, Kalager M. Benefits and harms of mammography screening. Breast Cancer Res. 2015;17(1):63. doi: 10.1186/s13058-015-0525-z.
6. Luleci D, Kilic B. Factors affecting women's participation in breast cancer screening in Turkey. Asian Pac J Cancer Prev. 2022;23(5):1627-34. doi: 10.31557/APJCP.2022.23.5.1627.
7. Republic of Türkiye Ministry of Health. Health Statistics Yearbooks [Internet]. Ankara: General Directorate of Health Information Systems; 2024 [cited 2025 Apr 1]. Available from: https://www.saglik.gov.tr/TR-84930/saglik-istatistikleri-yilliklari.html.
8. Song H, Bergman A, Chen AT, Ellis D, David G, Friedman AB, et al. Disruptions in preventive care: Mammograms during the COVID-19 pandemic. Health Serv Res. 2021;56(1):95-101. doi: 10.1111/1475-6773.13596.
9. Sprague BL, Lowry KP, Miglioretti DL, Alsheik N, Bowles EJA, Tosteson ANA, et al. Changes in mammography use by women's characteristics during the first 5 months of

the COVID-19 pandemic. J Natl Cancer Inst. 2021;113(9):1161-7. doi: 10.1093/jnci/djab045.
10. Gathani T, Dodwell D, Horgan K. The impact of the first 2 years of the COVID-19 pandemic on breast cancer diagnoses: A population-based study in England. Br J Cancer. 2023;128(3):481-3. doi: 10.1038/s41416-022-02054-4.
11. Ng JS, Hamilton DG. Assessing the impact of the COVID-19 pandemic on breast cancer screening and diagnosis rates: A rapid review and meta-analysis. J Med Screen. 2022;29(4):209-18. doi: 10.1177/09691413221101807.
12. Grimm LJ, Lee C, Rosenberg RD, Burleson J, Simanowith M, Fruscello T Jr, et al. Impact of the COVID-19 pandemic on breast imaging: An analysis of the National Mammography Database. J Am Coll Radiol. 2022;19(8):919-34. doi: 10.1016/j.jacr.2022.04.008.
13. van den Bruele AB, Sevilimedu V, Jochelson M, Formenti S, Norton L, Sacchini V. Mobile mammography in New York City: Analysis of 32,350 women utilizing a screening mammogram program. NPJ Breast Cancer. 2022;8(1):14. doi: 10.1038/s41523-022-00381-6.
14. Rahman WT, Helvie MA. Breast cancer screening in average and high-risk women. Best Pract Res Clin Obstet Gynaecol. 2022;83:3-14. doi: 10.1016/j.bpobgyn.2021.11.007.
15. Duffy SW, Seedat F, Kearins O, Press M, Walton J, Myles J, et al. The projected impact of the COVID-19 lockdown on breast cancer deaths in England due to the cessation of population screening: A national estimation. Br J Cancer. 2022;126(9):1355-61. doi: 10.1038/s41416-022-01714-9.
16. Seely JM, Alhassan T. Screening for breast cancer in 2018-what should we be doing today? Curr Oncol. 2018;25(Suppl 1):S115-24. doi: 10.3747/co.25.3770.

J Surg Med. 2026;10(7):e8477.
https://doi.org/10.28982/josam.8477

JOSAM

Research Article
https://jsurgmed.com/

Journal of Surgery and Medicine
e-ISSN: 2602-2079

The impact of COVID-19 on mammography screening: Trends in Türkiye between 2018 and 2023

Mehmet Demir[1], Feza Demir[2]

[1]Department of Radiology, Faculty of Medicine, Kahramanmaraş Sütçü İmam University, Kahramanmaraş, Türkiye
[2]Department of Public Health, Faculty of Medicine, Kahramanmaraş Sütçü İmam University, Kahramanmaraş, Türkiye

ORCID of the author(s)

MD: https://orcid.org/0000-0002-5031-6324
FD: https://orcid.org/0000-0002-6377-1545

Corresponding Author
Mehmet Demir
Department of Radiology, Faculty of Medicine, Harran University, 63300, Şanlıurfa, Türkiye.
E-mail: dr.mehmetdemir@hotmail.com

Ethics Committee Approval
The study was approved by the Harran University Noninterventional Clinical Research Ethics Committee (decision no. 25.06.56; March 24, 2025). The study was conducted in accordance with the principles of the Declaration of Helsinki.

Conflict of Interest
No conflict of interest was declared by the authors.

Financial Disclosure
The authors declared that this study has received no financial support.

Published
2026 July 9

Abstract

Background/Aim: Breast cancer screening programs are essential for early detection, but they may be disrupted during major public health crises. This study evaluated trends in mammography screening, breast biopsy numbers, and malignancy detection rates in Türkiye between 2018 and 2023, with particular attention to the effects of the COVID-19 pandemic.

Methods: This descriptive study used nationwide mammography screening data obtained from the Health Statistics Yearbooks of the Republic of Türkiye Ministry of Health for 2018-2023. In addition, breast biopsy data and malignancy rates from the interventional radiology unit of the study center were reviewed for the same period. Annual changes were analyzed to assess the effect of the pandemic and the subsequent recovery period on breast cancer screening and diagnosis.

Results: Nationwide mammography screenings increased from 2,139,813 in 2018 to 2,252,815 in 2019 and then decreased markedly to 1,261,664 in 2020. A recovery trend was observed in 2021 (1,926,717) and continued through 2022 (2,453,042) and 2023 (2,704,397). Similarly, the number of breast biopsies decreased from 720 in 2019 to 450 in 2020, then increased to 920 in 2022 and slightly decreased to 900 in 2023. Malignancy rates increased from 24.0% in 2019 to 30.0% in 2022 and then slightly decreased to 29.0% in 2023.

Conclusion: The COVID-19 pandemic temporarily disrupted breast cancer screening and biopsy services in Türkiye. However, substantial recovery was observed in subsequent years in both screening participation and diagnostic follow-up. These findings underscore the importance of resilient health care systems and strategies that sustain cancer screening services during public health crises.

Keywords: mammography, breast cancer screening, COVID-19 pandemic

Introduction

Cancer remains a major global health problem and affects millions of people each year [1, 2]. Breast cancer is the most common cancer among women, and early detection is critical for improving treatment outcomes and reducing mortality [3]. In Türkiye, approximately one in eight women is at risk of developing breast cancer during her lifetime. Therefore, effective screening programs are essential for timely diagnosis and treatment.

Mammography is an imaging method that uses X-rays to evaluate breast tissue and is particularly valuable for detecting asymptomatic tumors at an early stage [4]. Current evidence supports the benefits of mammography screening, although its implementation and performance may vary across settings [5]. In Türkiye, mammography screening programs conducted by the Ministry of Health aim to facilitate early diagnosis in eligible women. However, participation in these programs remains below the desired level, and multiple barriers may influence screening uptake [6].

In this context, the present study evaluated nationwide mammography screening trends in Türkiye between 2018 and 2023 by using Ministry of Health data [7]. In addition, breast biopsy numbers and biopsy outcomes from our hospital's interventional radiology unit were examined to better understand the potential impact of the COVID-19 pandemic on diagnostic follow-up after screening. By evaluating national screening activity together with institutional biopsy trends, this study sought to provide a practical overview of disruption and recovery in breast cancer screening services during and after the pandemic.

Materials and methods

Study design and data sources

This descriptive study used data from the Health Statistics Yearbooks of the Republic of Türkiye Ministry of Health for the years 2018-2023 [7]. The analysis focused on annual trends in mammography screening in Türkiye. In addition, data from our hospital's interventional radiology unit regarding the number and results of breast biopsies performed during the same period were reviewed to assess changes in diagnostic follow-up during and after the COVID-19 pandemic.

Breast biopsy data

Breast biopsies were performed in patients with suspicious breast lesions detected on mammography or ultrasonography and classified as Breast Imaging Reporting and Data System (BI-RADS) category 4 or 5. All cases were evaluated by radiologists in the interventional radiology unit according to BI-RADS criteria, and lesion characteristics were recorded accordingly. Patients with BI-RADS category 3 or lower lesions were followed up and were not considered for biopsy. All biopsies were performed under ultrasound guidance with a 14-gauge core needle. Pathology results were categorized as malignant, benign, or atypical lesions. This standardized protocol supported consistency in patient selection, lesion assessment, and biopsy procedures.

Statistical analysis

The numbers of mammography screenings, breast biopsies, and malignancy rates were summarized by year using descriptive statistics, including frequency and percentage. Trend graphics and annual comparisons were used to illustrate changes over time. Statistical analyses were performed with IBM SPSS Statistics for Windows, Version 25.0 (IBM Corp., Armonk, NY, USA). Because the present report primarily aimed to describe annual trends in an ecological nationwide dataset together with institutional summary biopsy data, the findings are presented descriptively.

Ethics statement

The study was approved by the Harran University Noninterventional Clinical Research Ethics Committee (decision no. 25.06.56; March 24, 2025). The study was conducted in accordance with the principles of the Declaration of Helsinki.

Results

All breast biopsy cases included in the study were female patients; no male patients were identified during the study period. The age of the patients who underwent biopsy ranged from 28 to 79 years, with a mean of 51.6 (9.3) years. All biopsied lesions were classified as BI-RADS category 4 or 5 on mammography or ultrasonography.

No nondiagnostic biopsy reports were recorded during the study period. All cases were histopathologically categorized as benign, malignant, or lesions with atypical cells. If a patient underwent more than one biopsy, only the first biopsy result was included in the analysis. Therefore, the reported numbers represent individual patients rather than the total number of biopsy procedures.

Mammography screening in Türkiye increased during the pre-pandemic period, from 2,139,813 screenings in 2018 to 2,252,815 in 2019, and then decreased markedly to 1,261,664 in 2020. Screening activity recovered to 1,926,717 in 2021 and exceeded pre-pandemic levels in 2022 (2,453,042) and 2023 (2,704,397) (Table 1, Figure 1).

A similar pattern was observed for breast biopsies performed in our hospital's interventional radiology unit. The number of biopsies increased from 650 in 2018 to 720 in 2019, decreased to 450 in 2020, increased again to 620 in 2021, peaked at 920 in 2022, and slightly decreased to 900 in 2023 (Table 1).

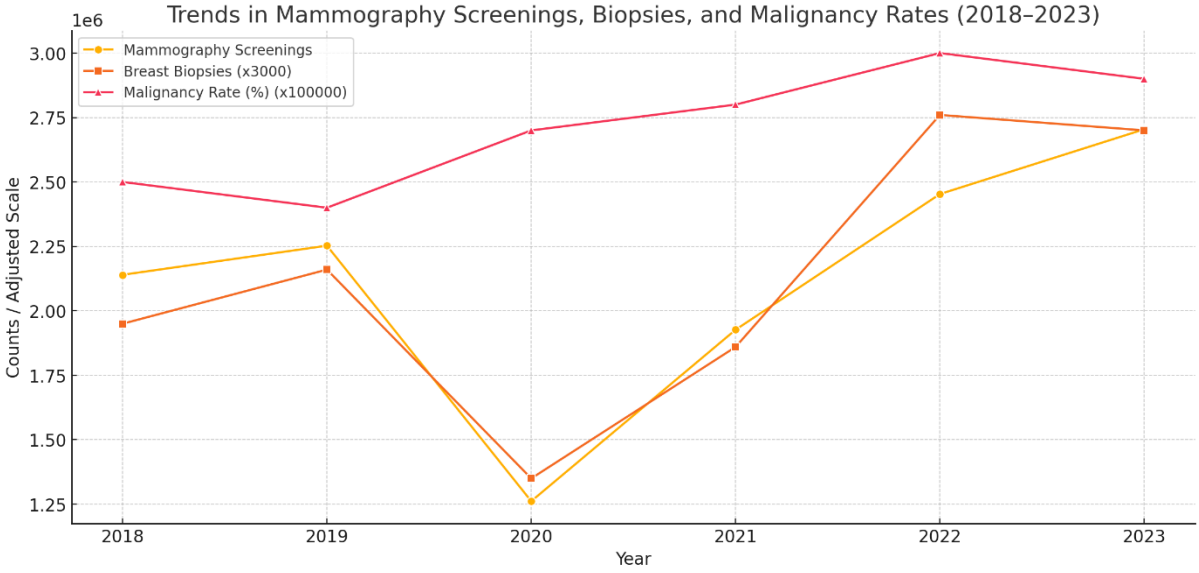
Malignancy rates showed annual variation across the study period. The malignancy rate was 25.0% in 2018 and 24.0% in 2019, increased to 27.0% in 2020 and 28.0% in 2021, peaked at 30.0% in 2022, and slightly decreased to 29.0% in 2023 (Table 1). Overall, these findings suggest that the decline in screening activity during the pandemic was accompanied by a reduction in biopsy volume, followed by recovery in both screening participation and diagnostic follow-up in the subsequent years.

Table 1. Annual mammography screenings, breast biopsies, and malignancy rates in Türkiye (2018-2023).

Year	Mammography screenings (nationwide)	Breast biopsies (n)	Malignancy rate (%)
2018	2,139,813	650	25.0
2019	2,252,815	720	24.0
2020	1,261,664	450	27.0
2021	1,926,717	620	28.0
2022	2,453,042	920	30.0
2023	2,704,397	900	29.0

n: number. Nationwide mammography screening data represent the total number of screenings performed across Türkiye between 2018 and 2023. Breast biopsy data and malignancy rates were obtained from the XXX University Interventional Radiology Unit.

Figure 1. Annual trends in mammography screenings, breast biopsies, and malignancy rates in Türkiye between 2018 and 2023. The blue line represents nationwide mammography screenings. The orange line represents the number of breast biopsies performed in the Harran University Interventional Radiology Unit, scaled by a factor of 3,000 for visual comparability. The green line represents the malignancy detection rate (%), scaled by a factor of 100,000.



Discussion

This study showed that mammography screening activity in Türkiye increased before the COVID-19 pandemic, decreased substantially in 2020, and then recovered progressively through 2023. Similar disruptions in breast cancer screening were reported internationally during the pandemic, including marked reductions in the United States and the United Kingdom, as well as in several other countries [8-11]. The subsequent recovery observed in our study is also consistent with reports showing the restoration of screening services after the most restrictive phase of the pandemic [12].

The biopsy data from our interventional radiology unit complemented the nationwide screening findings. The reduction in biopsy numbers during the pandemic period was followed by a rebound in the post-pandemic years, suggesting that reduced screening activity was accompanied by reduced diagnostic follow-up. In parallel, malignancy rates increased modestly after the pandemic onset, which may reflect changes in biopsy referral patterns, delayed presentation, or the detection of previously missed clinically significant lesions after services resumed [10, 12, 15].

The observed post-pandemic increase in malignancy rates should be interpreted cautiously. Higher malignancy proportions do not necessarily indicate a true rise in disease incidence; rather, they may reflect selective referral of higher-risk cases when access to screening and diagnostic services was limited. Nevertheless, the findings reinforce the importance of maintaining continuity in screening pathways and implementing adaptive strategies, such as mobile screening, risk-based prioritization, and stronger public outreach, particularly during periods of health system disruption [13, 14, 16].

This study has several limitations. First, it combined nationwide mammography screening data with breast biopsy results from a single institution, which may limit generalizability. Second, detailed clinical staging data and long-term patient outcomes were not available, which restricted the ability to evaluate the direct effect of delayed screening on disease progression. Third, the lack of individual-level sociodemographic data limited further analysis of factors associated with screening participation and malignancy detection. Finally, multiple pandemic-related confounders, including changes in referral practices, resource allocation, and health-seeking behavior, could not be fully assessed.

Despite these limitations, the study provides a practical overview of screening disruption and recovery in Türkiye during an unprecedented public health crisis. From a health policy perspective, the findings support the need for resilient and flexible breast cancer screening systems that can preserve access during future emergencies.

Conclusion

The COVID-19 pandemic temporarily disrupted mammography screening and breast biopsy activity in Türkiye. However, both screening participation and diagnostic follow-up recovered in the post-pandemic period. Sustained accessibility, public awareness, and health system preparedness are essential to protect breast cancer screening services during future public health crises.

References

1. Anastasiadi Z, Lianos GD, Ignatiadou E, Harissis HV, Mitsis M. Breast cancer in young women: An overview. Updates Surg. 2017;69(3):313-7. doi: 10.1007/s13304-017-0424-1.
2. Sung H, Ferlay J, Siegel RL, Laversanne M, Soerjomataram I, Jemal A, et al. Global cancer statistics 2020: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. CA Cancer J Clin. 2021;71(3):209-49. doi: 10.3322/caac.21660.
3. Freedman RA, Partridge AH. Management of breast cancer in very young women. Breast. 2013;22 Suppl 2:S176-9. doi: 10.1016/j.breast.2013.07.034.
4. Jackson VP. Diagnostic mammography. Radiol Clin North Am. 2004;42(5):853-70. doi: 10.1016/j.rcl.2004.06.002.
5. Løberg M, Lousdal ML, Bretthauer M, Kalager M. Benefits and harms of mammography screening. Breast Cancer Res. 2015;17(1):63. doi: 10.1186/s13058-015-0525-z.
6. Luleci D, Kilic B. Factors affecting women's participation in breast cancer screening in Turkey. Asian Pac J Cancer Prev. 2022;23(5):1627-34. doi: 10.31557/APJCP.2022.23.5.1627.
7. Republic of Türkiye Ministry of Health. Health Statistics Yearbooks [Internet]. Ankara: General Directorate of Health Information Systems; 2024 [cited 2025 Apr 1]. Available from: https://www.saglik.gov.tr/TR-84930/saglik-istatistikleri-yilliklari.html.
8. Song H, Bergman A, Chen AT, Ellis D, David G, Friedman AB, et al. Disruptions in preventive care: Mammograms during the COVID-19 pandemic. Health Serv Res. 2021;56(1):95-101. doi: 10.1111/1475-6773.13596.
9. Sprague BL, Lowry KP, Miglioretti DL, Alsheik N, Bowles EJA, Tosteson ANA, et al. Changes in mammography use by women's characteristics during the first 5 months of

the COVID-19 pandemic. J Natl Cancer Inst. 2021;113(9):1161-7. doi: 10.1093/jnci/djab045.
10. Gathani T, Dodwell D, Horgan K. The impact of the first 2 years of the COVID-19 pandemic on breast cancer diagnoses: A population-based study in England. Br J Cancer. 2023;128(3):481-3. doi: 10.1038/s41416-022-02054-4.
11. Ng JS, Hamilton DG. Assessing the impact of the COVID-19 pandemic on breast cancer screening and diagnosis rates: A rapid review and meta-analysis. J Med Screen. 2022;29(4):209-18. doi: 10.1177/09691413221101807.
12. Grimm LJ, Lee C, Rosenberg RD, Burleson J, Simanowith M, Fruscello T Jr, et al. Impact of the COVID-19 pandemic on breast imaging: An analysis of the National Mammography Database. J Am Coll Radiol. 2022;19(8):919-34. doi: 10.1016/j.jacr.2022.04.008.
13. van den Bruele AB, Sevilimedu V, Jochelson M, Formenti S, Norton L, Sacchini V. Mobile mammography in New York City: Analysis of 32,350 women utilizing a screening mammogram program. NPJ Breast Cancer. 2022;8(1):14. doi: 10.1038/s41523-022-00381-6.
14. Rahman WT, Helvie MA. Breast cancer screening in average and high-risk women. Best Pract Res Clin Obstet Gynaecol. 2022;83:3-14. doi: 10.1016/j.bpobgyn.2021.11.007.
15. Duffy SW, Seedat F, Kearins O, Press M, Walton J, Myles J, et al. The projected impact of the COVID-19 lockdown on breast cancer deaths in England due to the cessation of population screening: A national estimation. Br J Cancer. 2022;126(9):1355-61. doi: 10.1038/s41416-022-01714-9.
16. Seely JM, Alhassan T. Screening for breast cancer in 2018-what should we be doing today? Curr Oncol. 2018;25(Suppl 1):S115-24. doi: 10.3747/co.25.3770.

J Surg Med. 2026;10(7):e8630.
https://doi.org/10.28982/josam.8630

JOSAM

Research Article
https://jsurgmed.com/

Journal of Surgery and Medicine
e-ISSN: 2602-2079

Inflammatory hematological indices in early partial hydatidiform mole: A retrospective case-control study

Arif Caner Erdoğan[1], Emine Türen Demir[2]

[1]Department of Obstetrics and Gynecology, Konya Dr. Ali Kemal Belviranlı Obstetrics, Gynecology and Pediatric Diseases Hospital, Konya, Türkiye
[2]Department of Obstetrics and Gynecology, Division of Gynecologic Oncology, Faculty of Medicine, Necmettin Erbakan University, Konya, Türkiye

ORCID of the author(s)

ACE: https://orcid.org/0000-0001-5749-4134
ETD: https://orcid.org/0000-0001-5510-4411

Corresponding Author
Arif Caner Erdoğan
Konya Dr. Ali Kemal Belviranlı Obstetrics, Gynecology and Pediatric Diseases Hospital, Fatih Neighborhood, Yeni İstanbul Avenue No. 30, 42285 Selçuklu, Konya, Türkiye
E-mail: arifcanererdogan@gmail.com

Ethics Committee Approval
The study was approved by the Necmettin Erbakan University Ethics Committee for Non-Drug and Non-Medical Device Research (approval date: January 23, 2026; approval number: 2026/6286). All research procedures were conducted in accordance with the Declaration of Helsinki. Because of the retrospective design and use of anonymized clinical and laboratory data, the ethics committee waived the requirement for informed consent.

Conflict of Interest
No conflict of interest was declared by the authors.

Financial Disclosure
The authors declared that this study has received no financial support.

Previous Presentation
This study was presented orally at the KSDF 2026 - Kadın Sağlığı Dernekleri Federasyonu Congress, held April 22-26, 2026, at Rixos Sungate, Antalya, Türkiye.

Published
2026 July 21

Abstract

Background/Aim: Early differentiation of partial hydatidiform mole from missed abortion remains challenging because clinical and ultrasonographic findings may overlap during the first trimester. The contribution of systemic inflammatory response to this diagnostic process is unclear. This study aimed to compare inflammatory hematological indices derived from routine complete blood counts among patients with partial hydatidiform mole, missed abortion, and uncomplicated early pregnancy, and to assess whether these parameters provide clinically meaningful diagnostic discrimination during early gestation.

Methods: Electronic medical records of patients presenting to a university hospital between January 1, 2020, and December 31, 2025, were reviewed retrospectively. Patients with histologically confirmed partial hydatidiform mole (n = 32) were compared with patients with missed abortion (n = 35) and uncomplicated early pregnancy (n = 40). Neutrophil-to-lymphocyte ratio (NLR), platelet-to-lymphocyte ratio (PLR), monocyte-to-lymphocyte ratio (MLR), systemic immune-inflammation index (SII), and systemic inflammatory response index (SIRI) were calculated from complete blood counts obtained at initial presentation.

Results: Age did not differ significantly among groups (P = 0.860), whereas gestational age differed significantly (P < 0.001). No significant differences were observed among groups for NLR, PLR, MLR, SII, or SIRI (P = 0.740, P = 0.290, P = 0.110, P = 0.850, and P = 0.680, respectively). Gestational age was not significantly correlated with NLR, PLR, MLR, SII, or SIRI (P = 0.154, P = 0.524, P = 0.238, P = 0.371, and P = 0.781, respectively). Receiver operating characteristic analysis showed poor discriminatory performance for all indices, with AUC values ranging from 0.522 to 0.639.

Conclusion: Complete blood count-derived inflammatory indices did not provide sufficient diagnostic discrimination to support their use as standalone biomarkers for differentiating partial hydatidiform mole from missed abortion during early gestation. Larger prospective studies are needed to clarify the role of systemic inflammation in this clinical setting.

Keywords: hydatidiform mole, gestational trophoblastic disease, inflammation, neutrophils, lymphocytes, first trimester

Introduction

Hydatidiform mole is a gestational disorder resulting from abnormal fertilization and characterized by atypical trophoblastic proliferation. It is the most common benign entity within the spectrum of gestational trophoblastic disease and is classified as complete or partial hydatidiform mole based on genetic and histopathological features [1, 2].

Despite advances in ultrasonography and beta-human chorionic gonadotropin (beta-hCG) testing, early diagnosis, particularly of partial hydatidiform mole, remains challenging. Sonographic findings and beta-hCG levels may have limited diagnostic accuracy during the first trimester, and partial moles are frequently misclassified because their clinical and imaging features overlap with those of other early gestational conditions [3-5]. Missed abortion, a common form of early pregnancy loss, may show similar ultrasonographic features, making early differentiation from partial hydatidiform mole difficult in routine practice [6]. Nevertheless, this distinction is clinically important because molar pregnancies require post-evacuation beta-hCG surveillance and specialized follow-up because of the risk of gestational trophoblastic neoplasia. Some partial molar pregnancies may also continue to later gestational weeks if they are not recognized early [6, 7].

Molar pregnancy may alter maternal immune and inflammatory responses through abnormal trophoblastic proliferation and placental development. Increased expression of inflammatory mediators and placental factors in molar gestational tissue suggests that systemic inflammatory changes may accompany molar pregnancy [8].

Hematological indices derived from routine complete blood counts, including the neutrophil-to-lymphocyte ratio (NLR), monocyte-to-lymphocyte ratio (MLR), platelet-to-lymphocyte ratio (PLR), systemic immune-inflammation index (SII), and systemic inflammatory response index (SIRI), have been investigated as accessible markers of systemic inflammation in various obstetric and medical conditions [9-11]. Because these indices reflect different components of the systemic inflammatory response, they have attracted interest as potential diagnostic and prognostic biomarkers in diverse clinical settings.

However, evidence regarding the diagnostic value of these inflammation-based hematological indices for distinguishing partial hydatidiform mole from missed abortion remains limited. This distinction is particularly relevant because the two conditions often present with similar clinical and ultrasonographic findings during early pregnancy but differ substantially in subsequent management and follow-up.

Therefore, this study aimed to compare inflammatory hematological indices among patients with partial hydatidiform mole, missed abortion, and uncomplicated early pregnancy and to determine whether these routinely available indices provide meaningful diagnostic discrimination, particularly between partial hydatidiform mole and missed abortion.

Materials and methods

This retrospective case-control study was conducted in the Department of Obstetrics and Gynecology, Faculty of Medicine, Necmettin Erbakan University, Konya, Türkiye. Electronic medical records of patients evaluated for early pregnancy between January 1, 2020, and December 31, 2025, were reviewed. Patients with complete clinical and laboratory data were eligible for inclusion.

Three groups were defined. Patients with partial hydatidiform mole confirmed by histopathological examination constituted the first group. Patients with missed abortion, diagnosed according to the accepted ultrasonographic criteria for early pregnancy loss during first-trimester evaluation [12], constituted the second group. In accordance with routine institutional practice, products of conception obtained after uterine evacuation in the missed abortion group were also submitted for histopathological examination. The control group comprised patients evaluated during the first trimester whose pregnancies progressed without complications and resulted in term live birth. Pregnancy outcomes were verified from hospital delivery records. To ensure complete outcome ascertainment, the uncomplicated early pregnancy group was selected retrospectively only from pregnancies with completed delivery records confirming term live birth.

The missed abortion group was selected as the most clinically relevant comparison group because partial hydatidiform mole frequently mimics missed abortion during first-trimester evaluation. The uncomplicated early pregnancy group was included to provide reference values for inflammatory hematological indices during normal early gestation. Gestational age was determined from the last menstrual period and confirmed by first-trimester ultrasonographic measurements.

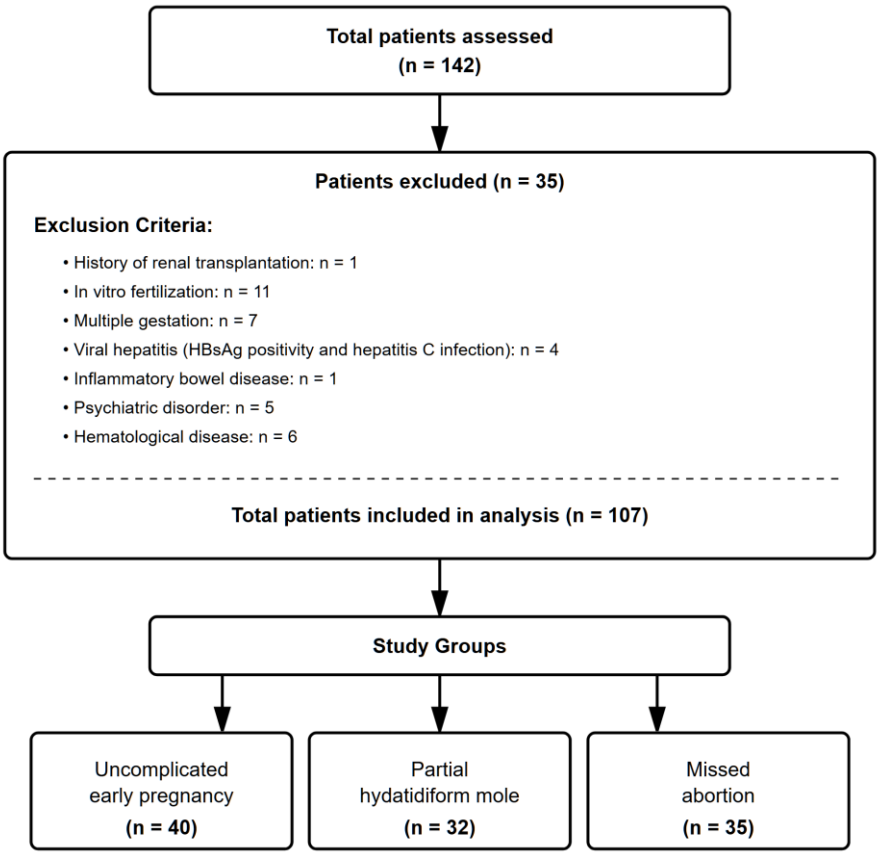
Patients with a history of renal transplantation, pregnancies conceived through in vitro fertilization, multiple gestations, viral hepatitis (hepatitis B surface antigen positivity or hepatitis C infection), inflammatory bowel disease, psychiatric disorders, hematological diseases, or clinical evidence of acute infection were excluded. A total of 142 patients were initially assessed during the study period. After 35 patients were excluded according to the predefined criteria, 107 patients remained for analysis: 32 with partial hydatidiform mole, 35 with missed abortion, and 40 with uncomplicated early pregnancy. The patient selection process is shown in Figure 1.

Partial hydatidiform mole was diagnosed by routine histopathological examination of products of conception. A single pathologist performed the histopathological evaluations, and p57 immunohistochemical staining was used in all cases as an ancillary aid to diagnostic classification. Ploidy analysis was not routinely performed. No equivocal cases requiring additional ploidy analysis or genotyping were encountered during the study period. Inflammatory hematological indices, including NLR, PLR, MLR, SII, and SIRI, were calculated from routine complete blood count parameters.

Calculations used absolute neutrophil, lymphocyte, monocyte, and platelet counts obtained by automated complete blood count analysis; leukocyte percentages were not used. The same hematology analyzer system was used throughout the study period (2020-2025). SII was calculated as (neutrophil count × platelet count)/lymphocyte count, and SIRI was calculated as (neutrophil count × monocyte count)/lymphocyte count.

Demographic data were obtained from patient records, and laboratory parameters were derived from complete blood

Figure 1. Flow diagram of patient selection and group allocation



Among 142 patients assessed for eligibility, 35 were excluded according to predefined exclusion criteria. A total of 107 patients were included in the final analysis and classified into three groups: partial hydatidiform mole (n = 32), missed abortion (n = 35), and uncomplicated early pregnancy (n = 40). Abbreviations: HBsAg: hepatitis B surface antigen.

counts obtained during the first trimester. All hematological measurements were based on blood samples collected at initial admission and before any medical or surgical intervention. Acute infection was excluded through medical record review for a documented clinical diagnosis or recorded fever at presentation.

The study protocol was approved by the Necmettin Erbakan University Ethics Committee for Non-Drug and Non-Medical Device Research (approval date: January 23, 2026; approval number: 2026/6286). The study was conducted in accordance with the Declaration of Helsinki. Because of the retrospective design and use of anonymized clinical and laboratory data, the ethics committee waived the requirement for informed consent. Patient confidentiality was maintained throughout data extraction and analysis. This study was reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines.

Statistical analysis

Statistical analyses were performed using IBM SPSS Statistics version 26.0 (IBM Corp., Armonk, NY, USA). The distribution of continuous variables was assessed with the Shapiro-Wilk test. Normally distributed variables are presented as mean (SD), and non-normally distributed variables are presented as median (minimum-maximum).

Age, which was normally distributed, was compared among the three groups using one-way analysis of variance. Continuous variables without normal distributions were compared using the Kruskal-Wallis test. When an overall difference was statistically significant, pairwise comparisons were performed using the Mann-Whitney U test with Bonferroni correction.

To assess potential confounding by gestational age, associations between gestational age and inflammatory hematological indices were examined using Spearman's rank correlation analysis. Multivariable adjusted analyses were not performed because of the relatively limited sample size.

Receiver operating characteristic (ROC) curve analyses were performed to evaluate the ability of inflammatory hematological indices to distinguish partial hydatidiform mole from missed abortion. The area under the curve (AUC) and 95% confidence interval (CI) were calculated for each marker.

A P-value < 0.05 was considered statistically significant for all analyses.

Results

A total of 107 patients were included. Demographic characteristics, gestational age, and inflammatory hematological indices are summarized in Table 1. Age did not differ significantly among the groups (one-way analysis of variance, $P = 0.860$).

Table 1. Demographic characteristics and inflammatory hematological indices of patients

Variable	Uncomplicated early pregnancy (n = 40)	Missed abortion (n = 35)	Partial hydatidiform mole (n = 32)	*P*-value
Age (years)	29.9 (4.5)	30.0 (5.5)	29.3 (5.9)	0.860
Gestational age (weeks)	12 (6-13)[a]	10 (7-13)[b]	8.5 (5-13)[c]	<0.001
NLR	2.92 (1.2-7.1)	3.01 (0.7-6.1)	2.65 (1.76-8.09)	0.740
PLR	130.6 (63.1-210.9)	118.4 (66.4-266.4)	133.45 (67-272.7)	0.290
MLR	0.24 (0.14-0.41)	0.22 (0.11-0.49)	0.26 (0.17-0.81)	0.110
SII	746.93 (262.8-1672.5)	803.83 (153.3-1740.9)	790.07 (314.9-2427.3)	0.850
SIRI	1.493 (0.6-3.8)	1.53 (0.4-4.6)	1.53 (0.9-7.3)	0.680

Abbreviations: NLR: neutrophil-to-lymphocyte ratio, PLR: platelet-to-lymphocyte ratio, MLR: monocyte-to-lymphocyte ratio, SII: systemic immune-inflammation index, SIRI: systemic inflammatory response index, SD: standard deviation. Data are presented as mean (SD) or median (range). Different superscript letters indicate statistically significant pairwise differences after Bonferroni-corrected Mann-Whitney U testing. $P < 0.05$ was considered statistically significant.

Gestational age differed significantly among the groups (Kruskal-Wallis test, $P < 0.001$). Bonferroni-corrected post hoc comparisons showed significant differences between partial hydatidiform mole and uncomplicated early pregnancy (adjusted $P < 0.001$), between missed abortion and uncomplicated early pregnancy (adjusted $P < 0.001$), and between partial hydatidiform mole and missed abortion (adjusted $P = 0.030$).

No statistically significant group differences were observed in NLR, PLR, MLR, SII, or SIRI (Kruskal-Wallis test; $P = 0.740$, $P = 0.290$, $P = 0.110$, $P = 0.850$, and $P = 0.680$, respectively). The distributions of all indices showed broad overlap across the groups, with no consistent pattern suggesting greater systemic inflammation in partial hydatidiform mole.

Spearman's rank correlation analysis showed no significant associations between gestational age and NLR (rho = 0.139, $P = 0.154$), PLR (rho = 0.062, $P = 0.524$), MLR (rho = -0.115, $P = 0.238$), SII (rho = 0.087, $P = 0.371$), or SIRI (rho = -0.027, $P = 0.781$) (Table 2).

ROC curve analyses showed poor discrimination between partial hydatidiform mole and missed abortion for all evaluated indices (Table 3). AUC values ranged from 0.522 to 0.639. MLR had the highest AUC (0.639, 95% CI 0.507-0.772; $P = 0.050$), but none of the markers achieved clinically meaningful diagnostic accuracy.

Table 2. Correlation between gestational age and inflammatory hematological indices

Variable	Spearman rho	*P*-value
NLR	0.139	0.154
PLR	0.062	0.524
MLR	-0.115	0.238
SII	0.087	0.371
SIRI	-0.027	0.781

Abbreviations: rho: Spearman correlation coefficient, NLR: neutrophil-to-lymphocyte ratio, PLR: platelet-to-lymphocyte ratio, MLR: monocyte-to-lymphocyte ratio, SII: systemic immune-inflammation index, SIRI: systemic inflammatory response index.

Table 3. Receiver operating characteristic analysis of inflammatory hematological indices for differentiating partial hydatidiform mole from missed abortion

Marker	AUC	95% CI	*P*-value
NLR	0.558	0.418-0.698	0.415
PLR	0.610	0.475-0.745	0.123
MLR	0.639	0.507-0.772	0.050
SII	0.522	0.383-0.662	0.754
SIRI	0.537	0.396-0.678	0.607

Abbreviations: AUC: area under the curve, CI: confidence interval, NLR: neutrophil-to-lymphocyte ratio, PLR: platelet-to-lymphocyte ratio, MLR: monocyte-to-lymphocyte ratio, SII: systemic immune-inflammation index, SIRI: systemic inflammatory response index, ROC: receiver operating characteristic.

Discussion

Although several studies have reported differences in systemic inflammatory markers between molar and normal pregnancies [13, 14], early pregnancy is itself a physiologically pro-inflammatory state in which systemic inflammatory indices may be elevated [15]. This background may obscure pathological inflammation associated with molar pregnancy, particularly in partial moles, in which trophoblastic proliferation is less pronounced than in complete moles. It remains uncertain whether inflammation in partial hydatidiform mole exceeds the inflammatory milieu of early gestation. The absence of group differences in NLR, PLR, MLR, SII, and SIRI in this study suggests that complete blood count-derived inflammatory indices have limited value for distinguishing partial hydatidiform mole from missed abortion or uncomplicated early pregnancy.

Several factors may explain the difference between the present findings and earlier reports of inflammatory changes in molar pregnancy. First, many previous studies combined complete and partial molar pregnancies or predominantly included complete moles, which have more pronounced trophoblastic proliferation and may produce a stronger systemic inflammatory response [16]. In contrast, this study focused specifically on partial hydatidiform mole, which may be associated with subtler inflammatory changes. Second, early pregnancy and pregnancy loss are both accompanied by physiological and pathological inflammatory changes that may reduce the contrast between groups [17, 18].

The evaluated hematological indices are also broad, nonspecific markers of systemic inflammation and may be influenced by physiological stress, vaginal bleeding, subclinical infection, and chronic medical conditions [19]. These factors may have limited the ability of routine complete blood count-derived indices to detect disease-specific inflammatory changes in partial hydatidiform mole.

NLR and PLR values in patients with missed abortion and uncomplicated early pregnancy were similar, consistent with some previous reports [9, 10]. In a systematic review and meta-analysis, Hantoushzadeh et al. [11] reported higher NLR and PLR values in recurrent pregnancy loss and spontaneous abortion. However, the included studies involved heterogeneous populations with different abortion subtypes and did not consistently control for potential confounders such as infection, chronic inflammatory conditions, and gestational age. Differences in patient selection and the timing of blood sampling relative to pregnancy failure may therefore account for the inconsistent findings.

Direct comparison of partial hydatidiform mole with missed abortion showed no differences in inflammatory hematological indices. ROC curve analyses supported this finding by demonstrating poor discrimination for all evaluated indices. Although MLR had the highest AUC, its diagnostic accuracy remained modest and below a clinically useful level. Routine inflammation-based hematological indices are therefore unlikely to serve as reliable standalone markers for differentiating partial hydatidiform mole from missed abortion during early gestation.

Both pathological conditions may produce similar inflammatory response patterns during early gestation. Under the conditions of this study, complete blood count-derived inflammatory indices did not meaningfully distinguish the groups. Whether this similarity reflects a shared pathway of placental dysfunction or the common inflammatory background of early pregnancy remains unclear. Direct comparisons of partial hydatidiform mole and missed abortion in early gestation remain scarce, limiting the interpretation of these findings.

From a clinical perspective, partial hydatidiform mole and missed abortion constitute the most relevant differential diagnostic comparison because they may present similarly during early pregnancy evaluation and often lead to uterine evacuation. The uncomplicated early pregnancy group primarily provided reference values for inflammatory hematological indices during normal early gestation.

The principal clinical implication is that routine complete blood count-derived inflammatory indices should not be used to determine whether a suspected early pregnancy loss represents partial hydatidiform mole. Although NLR, PLR, MLR, SII, and SIRI are inexpensive and readily available, neither group comparisons nor ROC curve analyses showed clinically meaningful discrimination. Histopathological examination of

products of conception therefore remains essential for definitive diagnosis and appropriate post-evacuation beta-hCG surveillance.

Gestational age differed among the groups. Partial molar pregnancies were identified earlier, whereas uncomplicated pregnancies were evaluated at later gestational ages, a pattern that may reflect differences in clinical presentation and the timing of routine prenatal care. No association was identified between gestational age and any evaluated inflammatory index. Gestational age alone is therefore unlikely to fully explain the absence of group differences, although residual confounding cannot be excluded.

The simultaneous comparison of partial hydatidiform mole with both missed abortion and uncomplicated early pregnancy is a strength of this study. Age distributions were comparable, reducing the likelihood of confounding by age. The cohort was restricted to early gestation, when diagnostic uncertainty is greatest and pre-evacuation discrimination is most clinically relevant. Multiple indices reflecting different components of systemic inflammation were assessed. Because these indices are derived from routine complete blood counts, they are inexpensive and widely available.

This study contributes clinically relevant negative evidence: routine complete blood count-derived inflammatory indices add little diagnostic value when differentiating partial hydatidiform mole during early gestation, the period in which diagnostic uncertainty is greatest.

Limitations

The retrospective design, single-center setting, and relatively limited sample size are important limitations. In particular, the small number of patients with partial hydatidiform mole may have reduced the statistical power to detect subtle differences in inflammatory hematological indices. No a priori or post hoc power analysis was performed; therefore, a type II error cannot be excluded.

Residual confounding is another limitation. Although major exclusion criteria were applied to minimize factors known to affect inflammatory markers, unmeasured variables may still have influenced the evaluated indices. Gestational age differed among the groups, but multivariable adjusted analyses were not performed because the limited sample size restricted the feasibility and reliability of more complex models. Consequently, confounding by gestational age cannot be completely excluded.

The analyzed hematological parameters are broad and nonspecific markers of systemic inflammation and may be affected by physiological stress, vaginal bleeding, subclinical infection, and other clinical factors that could not be fully controlled in a retrospective study. The analysis was also limited to inflammation-related indices derived from routine complete blood counts; cytokine profiles and other biochemical inflammatory markers were not evaluated. In addition, serum beta-hCG levels were not included because beta-hCG data were not available for all patients owing to the retrospective study design. Beta-hCG is central to the biological behavior, diagnosis, and clinical suspicion of molar pregnancy, the lack of adjustment for beta-hCG is an important limitation.

Other limitations arise from retrospective data collection. Complete blood counts were obtained during routine clinical care, and the timing of blood sampling relative to symptom onset, vaginal bleeding, or pregnancy failure could not be standardized. This variability may have affected inflammatory marker levels and contributed to interindividual heterogeneity.

Histopathological diagnosis served as the reference standard; however, diagnostic misclassification cannot be completely excluded in a retrospective pathology-based study. All diagnoses were established by routine histopathological evaluation, and p57 immunohistochemical staining was performed in all cases classified as partial hydatidiform mole.

Finally, the uncomplicated early pregnancy group included pregnancies that ultimately resulted in term live birth and therefore represented a selected healthy control population. Although this approach allowed estimation of baseline inflammatory index ranges during early gestation, these controls may not fully represent the heterogeneous population presenting with early pregnancy symptoms in routine practice. The findings should therefore be interpreted within these methodological limitations.

Conclusion

Inflammatory hematological indices did not provide clinically meaningful discrimination between partial hydatidiform mole and missed abortion in this cohort. Histopathological examination of products of conception remains essential for definitive diagnosis and appropriate beta-hCG surveillance. These indices should not be used as standalone diagnostic markers in the differential evaluation of partial hydatidiform mole. Larger prospective studies incorporating complementary biomarkers are needed to define whether systemic inflammation has a clinically useful role in this setting.

References

1. Braga A, Coutinho L, Chagas M, Soares JP, Callado GY, Alevato R, et al. Molar pregnancy: early diagnosis, clinical management, and the role of referral centers. Diagnostics (Basel). 2025;15(15):1953. doi: 10.3390/diagnostics15151953.
2. Laviola GM, Fortini AS, Salles D, da Silva Lourenço C, Ribeiro DA, Sun SY, et al. Complementary tool in diagnosis of hydatidiform mole: review. Pathol Res Pract. 2022;237:154041. doi: 10.1016/j.prp.2022.154041.
3. Lin LH, Polizio R, Fushida K, Francisco RPV. Imaging in gestational trophoblastic disease. Semin Ultrasound CT MR. 2019;40(4):332-49. doi: 10.1053/j.sult.2019.03.002.
4. Cavoretto P, Cioffi R, Mangili G, Petrone M, Bergamini A, Rabaiotti E, et al. A pictorial ultrasound essay of gestational trophoblastic disease. J Ultrasound Med. 2020;39(3):597-613. doi: 10.1002/jum.15119.
5. Ngan HYS, Seckl MJ, Berkowitz RS, Xiang Y, Golfier F, Sekharan PK, et al. Diagnosis and management of gestational trophoblastic disease: 2021 update. Int J Gynaecol Obstet. 2021;155(Suppl 1):86-93. doi: 10.1002/ijgo.13877.
6. Memtsa M, Johns J, Jurkovic D, Ross JA, Sebire NJ, Jauniaux E. Diagnosis and outcome of hydatidiform moles in missed-miscarriage: a cohort-study, systematic review and meta-analysis. Eur J Obstet Gynecol Reprod Biol. 2020;253:206-12. doi: 10.1016/j.ejogrb.2020.07.030.
7. Fowler DJ, Lindsay I, Seckl MJ, Sebire NJ. Routine pre-evacuation ultrasound diagnosis of hydatidiform mole: experience of more than 1000 cases from a regional referral center. Ultrasound Obstet Gynecol. 2006;27(1):56-60. doi: 10.1002/uog.2592.
8. Iriyama T, Wang G, Yoshikawa M, Mimura N, Matsui H, Sayama S, et al. Increased LIGHT leading to sFlt-1 elevation underlies the pathogenic link between hydatidiform mole and preeclampsia. Sci Rep. 2019;9(1):10107. doi: 10.1038/s41598-019-46660-4.
9. Tekin S, Ocal A, Yarsilikal Guleroglu F, Ozgün Selcuk CG, Eyisoy OG, Büyükkaya Ocal EU, et al. Comparison of inflammatory markers in women experiencing both missed abortion and healthy pregnancy: a self-controlled case study. Medicine (Baltimore). 2025;104(25):e42938. doi: 10.1097/MD.0000000000042938.
10. Liu D, Huang X, Xu Z, Chen M, Wu M. Predictive value of NLR and PLR in missed miscarriage. J Clin Lab Anal. 2022;36(3):e24250. doi: 10.1002/jcla.24250.
11. Hantoushzadeh S, Gargar OK, Jafarabady K, Rezaei MM, Asadi F, Eshraghi N, et al. Diagnostic value of neutrophil-to-lymphocyte and platelet-to-lymphocyte ratio to predict recurrent pregnancy loss and abortion; a systematic review and meta-analysis. Immun Inflamm Dis. 2024;12(3):e1210. doi: 10.1002/iid3.1210.
12. Doubilet PM, Benson CB, Bourne T, Blaivas M, Barnhart KT, Benacerraf BR, et al. Diagnostic criteria for nonviable pregnancy early in the first trimester. N Engl J Med. 2013;369(15):1443-51. doi: 10.1056/NEJMra1302417.
13. Abide Yayla C, Özkaya E, Yenidede I, Eser A, Ergen EB, Tayyar AT, et al. Predictive value of some hematological parameters for non-invasive and invasive mole

pregnancies. J Matern Fetal Neonatal Med. 2018;31(3):271-7. doi: 10.1080/14767058.2017.1281906.
14. Özgen L. The distinctive role of systemic immune-inflammatory parameters in gestational trophoblastic diseases. Ann Clin Anal Med. 2023;14(6):498-501. doi: 10.4328/ACAM.21576.
15. García-Morales A, Lomas-Soria C, Granados-Higa G, García-Quiroz J, Avila E, Olmos-Ortiz A, et al. Inflammation in pregnancy: key drivers, signaling pathways and associated complications. Arch Med Res. 2026;57(2):103301. doi: 10.1016/j.arcmed.2025.103301.
16. Ngan HYS, Seckl MJ, Berkowitz RS, Xiang Y, Golfier F, Sekharan PK, et al. Update on the diagnosis and management of gestational trophoblastic disease. Int J Gynaecol Obstet. 2018;143(Suppl 2):79-85. doi: 10.1002/ijgo.12615.
17. Mor G, Cardenas I. The immune system in pregnancy: a unique complexity. Am J Reprod Immunol. 2010;63(6):425-33. doi: 10.1111/j.1600-0897.2010.00836.x.
18. Mor G, Aldo P, Alvero AB. The unique immunological and microbial aspects of pregnancy. Nat Rev Immunol. 2017;17(8):469-82. doi: 10.1038/nri.2017.64.
19. Fest J, Ruiter R, Ikram MA, Voortman T, van Eijck CHJ, Stricker BH. Reference values for white blood-cell-based inflammatory markers in the Rotterdam Study: a population-based prospective cohort study. Sci Rep. 2018;8(1):10566. doi: 10.1038/s41598-018-28646-w.

J Surg Med. 2026;10(7):e8418.
https://doi.org/10.28982/josam.8418

JOSAM

Review
https://jsurgmed.com/

Journal of Surgery and Medicine
e-ISSN: 2602-2079

Addressing surgical challenges in craniopagus twin separation surgery: A systematic review

Juliet C. Torres-Maldonado, Javier A. Santos González, Armin A. Solis III

Autonomous University of Guadalajara, International Medical School, Guadalajara, Mexico

ORCID of the author(s)

JCT: https://orcid.org/0009-0006-1795-0039
JASG: https://orcid.org/0009-0006-1511-1231
AAS: https://orcid.org/0009-0005-8650-3411

Corresponding Author
Juliet Torres-Maldonado
1919 Mile High Stadium Circle, Apt 1106, Denver, CO 80204, USA
E-mail: torresmaldonado.md@gmail.com

Ethical Approval
This manuscript is a review of the existing literature. Therefore, ethics committee approval and written informed consent were not required. Original studies included in this review obtained written informed consent and ethical clearance from their respective hospital or institutional ethics committees, where applicable.

Conflict of Interest
No conflict of interest was declared by the authors.

Financial Disclosure
The authors declared that this study has received no financial support.

Scientific Congress Presentation
A poster version of this work was presented at Research Day at the Universidad Autónoma de Guadalajara, International Medical School, Guadalajara, Mexico, in May 8, 2024.

Published
2026 July 7

Abstract

Craniopagus twins (CPTs) are conjoined twins fused at homologous regions of the crania in either vertical or angular orientations, with the face and foramen magnum spared. They account for approximately 6% of conjoined twins and occur in 0.6 per million births worldwide. The degree of circulatory interconnection is a central consideration when planning separation surgery, particularly when deciding between a single-stage and a multistage approach. In craniopagus twins with fused dural venous sinuses, the superior sagittal sinus is replaced by a circumferential venous sinus (CVS); these cases are classified as total CPTs. Surgical challenges become increasingly complex in the presence of a CVS, prolonged anesthetic exposure, substantial cross-circulation, and the unique anatomical position of the twins. This review compiles data on the surgical management of these challenges and their outcomes, contributing to the continued development and refinement of surgical planning in CPT separation surgery. A Google Scholar search restricted to English-language articles published from 2020 to 2024 identified 329 articles. After detailed review, 19 open-access articles were selected for this manuscript. The reviewed literature showed that the degree of cross-circulation can be assessed through laboratory and physiologic measurements after pharmacologic challenges and can be mapped using multiple imaging modalities. The data also showed that a multistage surgical approach is preferentially selected for total CPTs because it reduces the high risks of hemorrhage, ischemic brain injury, and neurotoxicity associated with a CVS and extensively connected circulatory systems. In addition, staged surgery limits anesthetic exposure, decreasing the risk of anesthesia-induced cerebrospinal fluid stasis and hypotension. It also allows cerebral vasculature to redevelop between operations, thereby supporting adequate venous drainage. During surgery, each twin, their equipment, and their care team should be labeled with a number, letter, and color to provide safe and efficient patient care. This literature review maintains the clinical relevance of craniopagus twin separation surgery by presenting an up-to-date summary of methods and protocols designed to ensure surgical precision and safety when unique preoperative and perioperative challenges arise.

Keywords: conjoined twins, cross circulation, collateral circulation, anesthesia, pharmacokinetics, superior sagittal sinus

Introduction

Craniopagus twins (CPTs) account for 6% of conjoined twins, with an incidence of 0.6 per million births worldwide [1-3]. This congenital anomaly is characterized by fusion of the twins' crania at homologous regions, in either vertical or angular orientations, while sparing the face and foramen magnum [1]. CPTs are classified as total, when shared dural venous sinuses are present, or partial, when venous structures are separate (Figure 1) [1, 4]. The superior sagittal sinus (SSS), which is involved in venous clearance through the glymphatic system, is the most commonly conjoined venous sinus [3, 5]. In a longitudinal, or vertical, arrangement, the SSS is replaced by a circumferential venous sinus (CVS), which runs along at least half of the circumference of the conjoined region (Figure 2) [1]. The degree to which the twins share circulatory systems, termed cross-circulation, varies by case [2].

Two theories have been proposed to explain the pathophysiology of conjoined twins. The fission theory suggests incomplete cleavage of embryos at the primitive streak stage, whereas the fusion theory proposes rejoining of embryos after their separation [1, 6]. The fission theory is supported by the high incidence of situs inversus in conjoined twins, as dividing cell masses maintain a mirror image; the fusion theory is supported by the various angles of fusion along both the dorsoventral and rostrocaudal axes [1]. Craniopagi are monochorionic and monoamniotic and share both a placenta and an amniotic sac [6, 7]. Early pregnancy symptoms may mimic those of uncomplicated twin pregnancies, most commonly increased uterine size, underscoring the importance of routine prenatal ultrasonographic imaging for diagnosis [7].

Craniopagi may experience complications such as patent ductus arteriosus, aortic coarctation, hypertension, hypotension, and developmental delay [1]. These physical manifestations, combined with the psychological and social challenges of living as conjoined twins, often lead to consideration of surgical separation [1]. However, only approximately 25% of live-born twins are candidates for surgery, largely depending on the anatomical relationship of shared vital organs [8, 9]. As of July 2022, 62 CPT separation attempts had been reported worldwide; 55% used a single-stage approach and 45% used a multistage approach [8]. Total versus partial classification remains the main determinant of the selected surgical approach [1, 4]. Regardless of approach, these operations are highly complex, multifaceted, and extensive, and are often considered among the most complex neurosurgical procedures [4]. Surgical risks, including blood pressure alterations, disrupted cerebral perfusion, cerebral hemorrhage, and stroke, combined with the prolonged anesthetic exposure required for these lengthy procedures, may have detrimental effects on the developing brain [10]. Advances in medical research and practice have increased long-term survival and quality of life among craniopagi who undergo separation surgery, emphasizing the importance of continued research [1, 3].

The four main challenges of CPT separation surgery arise from the presence of a CVS, extensive anesthetic exposure, the degree of cross-circulation, and the unique anatomical position of the twins. Substantial cross-circulation alters the volume of distribution (Vd) and, therefore, drug pharmacokinetics [11]. Uneven drug distribution, fluid shifts, and blood loss must be carefully managed to maintain hemodynamic control and prevent perioperative complications [9]. In addition, the twins' anatomical position and the need to care for two patients simultaneously create challenges in airway management and patient positioning [12]. Despite the low incidence of CPTs, several case reports describing surgical procedures were published throughout the 1900s and early 2000s [4]. This review aims to compile and analyze data on the surgical management of these challenges and their outcomes, thereby contributing to the continuing development of circulatory understanding, anesthetic management, and refinement of surgical planning, simulation, and execution.

Materials and methods

This review analyzes the surgical challenges of CPT separation surgery related to shared dural venous sinuses, anesthetic exposure, cross-circulation, and unique anatomical position. References were selected from Google Scholar and PubMed using searches limited to 2020-2024. Search terms included craniopagus anesthesia; conjoined twins; craniopagus twins separation surgery; anesthesia effects on craniopagus twins; sagittal sinus in anesthesia; craniopagus twins by a multidisciplinary team; and cross-circulation. References were restricted to English-language publications, and only open-access articles were selected. Both original manuscripts and review articles were reviewed. Initially, 23 articles were selected based on their abstracts. After detailed review of each article, 19 articles were selected for discussion in this paper. Original studies included in this review received ethical clearance from their respective hospital or institutional ethics committees and were conducted in accordance with recognized ethical standards, including the principles outlined in the Declaration of Helsinki. Where applicable, written informed consent was obtained from patients or, in the case of neonatal surgical interventions and case reports, from parents or legal guardians. Images were used with preserved patient anonymity and appropriate permissions and licensing.

Discussion

Evolution of surgical approaches over the years

The first recorded successful separation of CPTs was performed in 1953 by Grossman and colleagues in five surgical stages on 14-month-old male twins with a parietal connection [4, 13]. However, one twin died 34 days postoperatively because of hemorrhage, and the second died 11.5 years postoperatively because of hydrocephalus [4]. These outcomes were attributed to limited anatomical understanding caused by poor imaging modalities, as well as the absence of a robust surgical strategy and technique [4].

In contrast, the first successful separation with long-term survival of both twins was performed by Voris and colleagues in 1957 on 7-month-old female twins with a limited parietal connection [3, 4, 13]. Both girls survived for more than 28 years, although one was severely disabled; their deaths were attributed to complications such as hemorrhage and neurological injury [3, 4, 13].

Successful separations were achieved from the 1960s through the 1970s by Oscar Sugar, who used stepwise venous vasculature clipping and ligation and placed polyethylene sheets to delineate the separation plane [4]. Improvements in surgical outcomes were attributed to advances in neuroanesthesia, intensive care, neuroradiology, and surgical instrumentation [4]. However, perioperative complications limited the possibility of long-term survival until the 1980s, when Dr. Robbers successfully performed a multistage separation of total vertical CPTs with record long-term survival [4].

In 1987, Winston et al. reported 31 CPT separation attempts in which only 27 of 62 twins survived; survival of both twins was reported in only 7 cases [13].

New vascular techniques were reported in 1991, when Dr. Drummond and colleagues performed multistage separation using screw clamps to slowly close the connecting veins [4]. However, long-term survival is unknown because of the absence of updates to the case study [4].

In 2004, 4-month-old female twins conjoined in a left-to-left frontotemporal and orbital fashion were successfully separated by Di Rocco and colleagues in Greece [13]. A single-stage approach was planned and consisted of two phases: separation and subsequent reconstruction [13]. The twins shared a unique thin layer of dura mater that was kept nearly intact in one twin during cortical separation, whereas preservation of the arachnoidal covering was prioritized in the other twin [13]. Favorable defect location, good clinical condition in both twins, and the absence of significant vascular and neural anomalies facilitated this separation [13].

Data collection and analysis allowed the development of practice-based surgical protocols. Surgical staging for separation soon began to be determined based on one of the most critical anatomical structures shared by craniopagi: the SSS, one of the dural venous sinuses [4, 14].

CPTs' conjoined dural venous sinuses and their influence on surgical approach

During the early stages of embryonic and fetal life, the SSS plexus aids cerebral venous drainage [14]. The portion of the plexus closest to the cranial adhesion zone may conjoin if the skull boundary and falx cerebri, which separates the cerebral hemispheres, coincide [14]. The SSS is therefore replaced in CPTs by a CVS, which traverses at least half of the circumference of the conjoined region [1]. O'Connell devised a classification in 1976 to estimate prognosis: partial classification refers to craniopagi with separate venous sinuses, in which the dura mater or leptomeninges of both twins separate the twin brains, whereas total classification refers to craniopagi with a CVS, in which a single transverse dural septum separates the twins' cerebrums (Figure 3) [1, 4, 13]. Digital subtraction angiography can be used to determine sinus anatomy and possible hemodynamic changes after separation by inflating a balloon in the communication defect (Figure 4) [4].

Two theories have been proposed to predict postoperative survival in relation to the CVS. The first suggests that survival is associated with the axial orientation of the junction; the second suggests an association with the anatomical classification of dural venous sinuses as total or partial [4]. Total classification had the worst survival rate, with a 48% mortality rate ($P = 0.004$) [4, 15]. Several years later, Dr. Kenneth Winston proposed a classification based on the deepest shared structure: A, scalp and subcutaneous tissues only; B, dura mater; C, leptomeninges; and D, brain structures [13]. However, even this classification did not accurately predict surgical difficulties or postoperative survival rates [13].

Initially, total CPT separation surgery was performed with a single-stage approach, averaging 22 to 100 hours, in which the CVS was donated to one twin and reconstructed for the second twin [1, 4, 8]. This approach did not allow collateral circulation to develop and resulted in high morbidity and mortality rates (47%; $P = 0.030$) [4, 15]. These rates decreased by 26% ($P = 0.030$) with a multistage approach, as shown across 41 cases in which subsequent surgeries were not planned in advance but were instead determined according to postoperative recovery criteria, including improved vital signs and decreased swelling [4, 15]. These favorable outcomes were attributed to the ability of the second twin to develop a deep venous drainage system through serial ligation of draining veins [1, 3]. Therefore, the multistage approach is specifically beneficial for total CPTs. In contrast, partial CPTs may be successfully separated at an earlier age with a single-stage approach [1]. The most recent reports from July 2022 indicated that a single-stage approach had been performed in 55% of cases and a multistage approach in 45% across 62 cases [8].

In support of these findings, the renowned surgeon Dr. Goodrich, considered a leading expert in CPT separation surgery, performed a successful separation of 2-year-old total vertical CPTs in a 4-stage operation over 9.5 months in 2016 [4]. Staged separation allowed time for cerebral vasculature to redevelop and form adequate venous collaterals through dilation of communicating veins, ultimately achieving venous drainage and avoiding serious complications such as cerebral edema, cerebrospinal fluid (CSF) leaks, venous stasis, ischemic injury, and infarction [1, 4]. He used silicone sheets to separate dissection planes between stages (Figure 5) [4]. Essentially, this approach allowed recovery between operations and provided the medical team with an opportunity to carefully plan, time, and design tissue expansion [1, 4].

In addition, Dr. Goodrich strongly advocated appropriate physical and occupational therapy, hypothesizing that it supported vascular supply equilibrium, improved venous drainage stasis, facilitated scalp reconstruction, and reduced medical complications and neurological deficits associated with surgery [4]. With these interventions in the twins' care plan, brain damage was avoided, especially in the twin with the minority blood supply [4].

Anesthesia's role in neurotoxicity and brain injury

The CVS shared by total CPTs can easily become occluded under anesthesia, leading to various neurological complications [16]. Anesthesia itself poses a high risk of hemodynamic instability in neonates and infants, which can subsequently lead to infarction, neurotoxicity, and neurodevelopmental defects [10]. More specifically, neonatal brain development is at risk because of fragile and immature structures, including underdeveloped vascular autoregulation and incomplete vessel growth with weak vessel walls [10].

Figure 1: Representation of the Stone and Goodrich classification for total versus partial CPTs, demonstrating different orientations. Illustrated by Aileen Alexandria Treviño.
CAD/CAM: computer-assisted design/modeling, CPT: craniopagus twins, CSF: cerebrospinal fluid, CT: computed tomography, CVS: circumferential venous sinus, DSA: digital subtraction angiography, MR: magnetic resonance, MRI: magnetic resonance imaging, SSS: superior sagittal sinus, Vd: volume of distribution, VSP: virtual surgical planning, VR/AR: virtual reality/augmented reality.

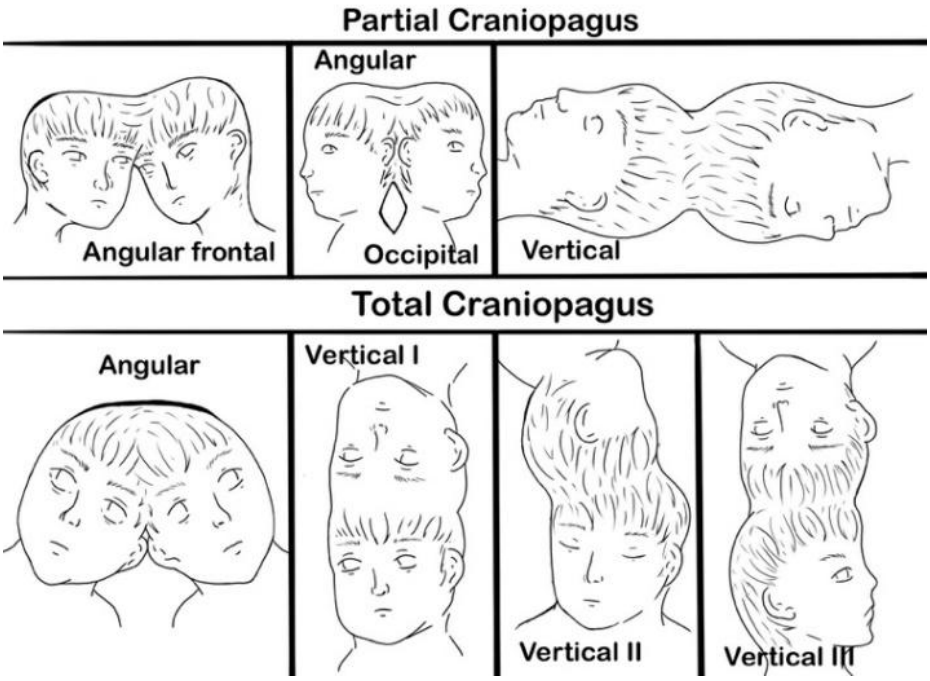
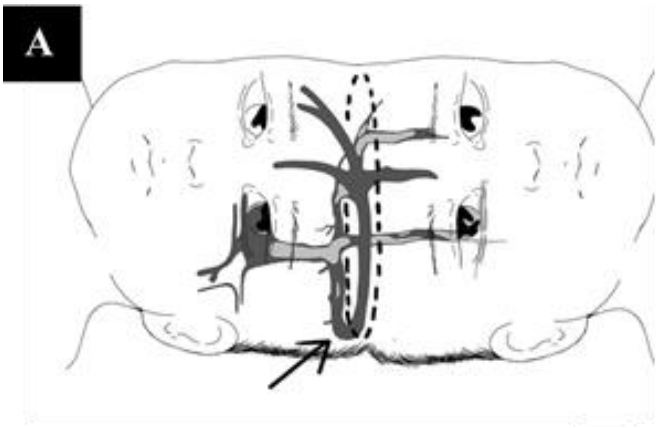


Figure 2 (A, B): Representations of CVS in different orientations. Subunit A demonstrates the anatomical predisposition of the dominant twin to retain the CVS (black arrow) compared with the nondominant twin (dashed line) when fused in a vertical orientation. Illustrated by Aileen Alexandria Treviño. Subunit B is a coronal MRI venography image of a CVS. Reproduced with permission from Mohammad et al. [6].



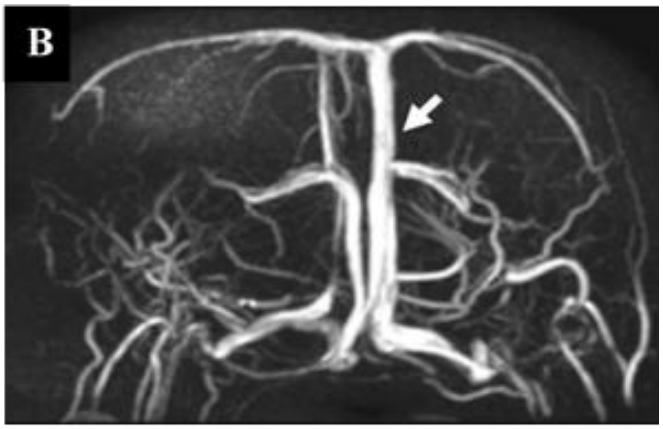


Figure 3: Coronal MRI demonstrating CVS coursing in the periphery of the septum (red arrow) and cerebral tissue separated by a transverse dural septum (black arrow). Reproduced with permission from Goldman-Yassen et al. [1].

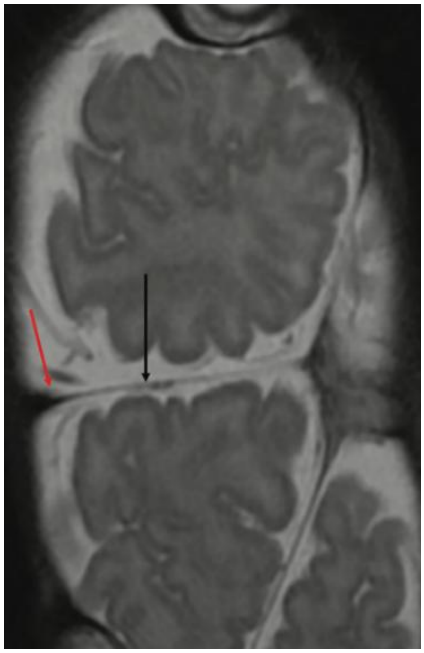


Figure 4: Venography with digital subtraction angiography demonstrates venous flow between twins after balloon inflation in the communication defect, demonstrating expected hemodynamic changes after separation. Reproduced with permission from Goldman-Yassen et al. [1].

Figure 5: Illustration representing silicone sheet placement to separate the dissection plane between surgeries. Reproduced with permission from Lehrich et al. [4].

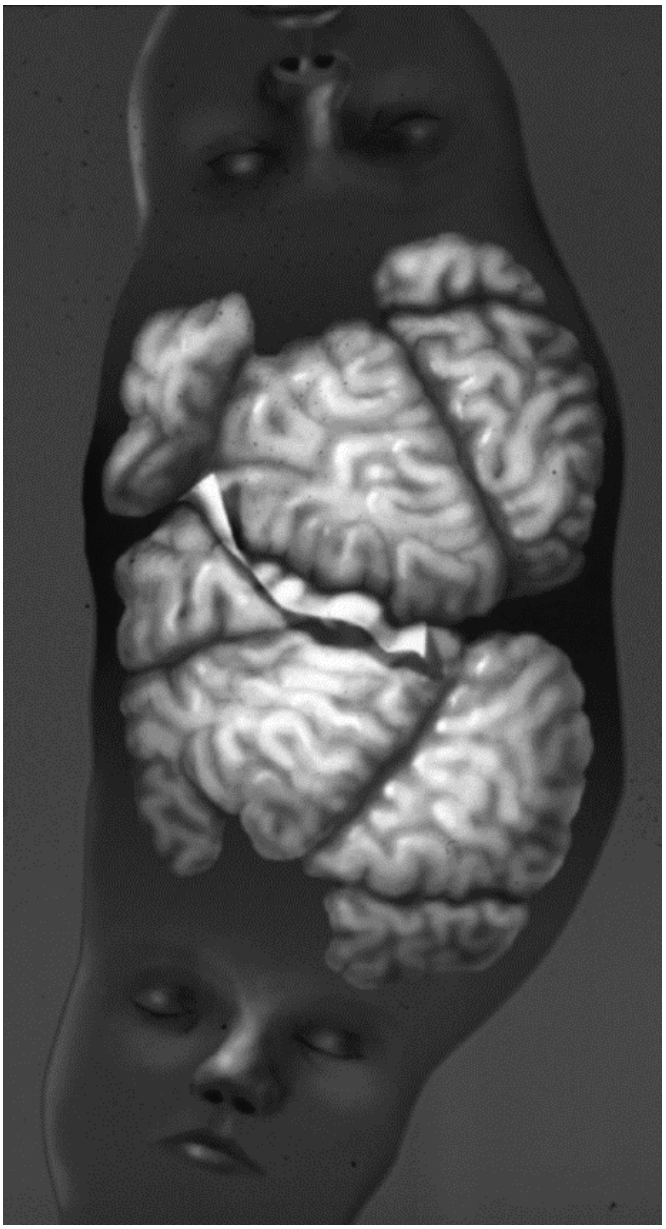


Figure 6: Three-dimensional surface-rendered images. Subunit A demonstrates the site of fusion (arrows). Subunit B demonstrates limited sacral fusion (dashed arrow), crossed fused kidneys in one twin (black arrow), and a single kidney with crossed ectopia in the other twin (white arrow). Subunit C demonstrates continuous thecal sacs (short arrow). Reproduced with permission from Mohammad et al. [6].

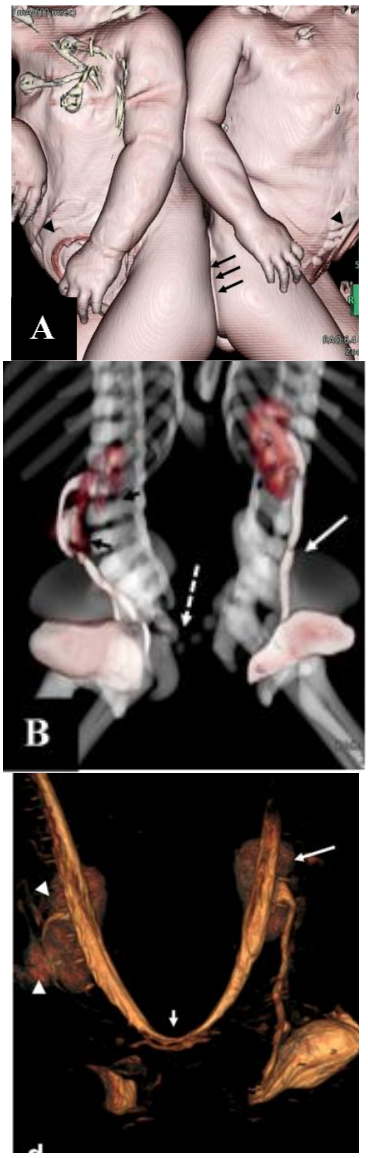


Figure 7: Photograph demonstrating two separate anesthesia teams. Reproduced with permission from Lehrich et al. [4].

When arterial blood pressure falls below intracranial pressure, hypoperfusion ensues, increasing the risk of hypoxic-ischemic brain injury [10, 16]. Some studies in nonhuman primates have shown that exposure to volatile anesthetics, including isoflurane and propofol, for more than 5 hours may exacerbate injury through mitochondrial damage and hyperoxia and may induce widespread neuronal and oligodendrocyte apoptosis, particularly in the cerebrum and cerebellum [10]. Furthermore, increasing doses of anesthesia have been associated with an increased risk of perioperative complications [5, 10, 16].

Ischemic injury is also exacerbated by CSF stasis. The glymphatic system is a waste-clearance system mediated by continuous interstitial replacement through CSF bulk flow [5]. Contrary to the previous belief that cerebral CSF circulation was active only during extracellular space dilation, such as under general anesthesia, recent studies show that it is impaired under general anesthesia [5]. As such, the CVS in total CPTs is at higher risk for occlusion, preventing arachnoid granulations, or villi, from draining CSF from the subarachnoid space into the dural sinuses. This aggravates stasis and causes hydrocephalus and increased intracranial pressure, which typically occur simultaneously [16].

Moreover, inflammation-induced vascular rupture activates microglia to release cytokines, free radicals, and glutamate, which then accumulate because of ongoing anesthesia-induced CSF stasis and hypoperfusion [10]. Glutamate accumulation, known as excitotoxicity, is a neurotoxic and neurodegenerative process involving neurons and highly vulnerable oligodendrocyte precursors, leading to hypomyelination and subsequent neurocognitive decline [10].

CPT separation surgery is extensive, takes many hours, and consequently requires large, continuous doses of anesthesia. The triad of inflammation, immature vascularization, and neurotoxicity associated with prolonged exposure to anesthetic drugs may ultimately result in brain injury; these processes are interrelated and may exacerbate one another [10]. Therefore, craniopagi, particularly total CPTs with a shared CVS, further benefit from a multistage approach because it can decrease the duration of anesthetic exposure and help avoid these complications.

Pharmacokinetic alterations due to cross-circulation

The term cross-circulation refers to the exchange of blood between two parts. In conjoined twins, it refers to connection between their circulatory systems, which may vary from poor to extensive [1, 4, 11]. Most commonly, one twin assumes an increased workload and supports the other [11]. From a pathophysiological standpoint, cross-circulation creates challenges because of uncertainty regarding pharmacokinetic distribution of administered agents, Vd in each twin, and maintenance of hemodynamic control [11]. As Rodman et al. stated, “Containing the effect or risk of adverse effects [...] is not possible with a completely shared circulation system” [11]. A thorough understanding of cross-circulation in craniopagi and its direct influence on drug distribution is crucial for developing surgical protocols that ensure safety and efficacy. Various methods have been developed to this end, including pharmaceutical administration followed by easily obtained laboratory values or measurable physiological changes, as well as advanced imaging modalities [11].

Experimental administration of gentamicin has demonstrated incomplete cross-circulation through comparable levels between twins: elevated values in the neonate who received the medication, but not in the other twin [11].

Anticholinergic drugs have also been used to determine the presence of cross-circulation by comparing vital signs. Yadav et al. ruled out cross-circulation between their twins because no heart rate changes were observed in the second twin, whereas a heart rate spike occurred in the twin who received the medication [17]. In a case study of thoraco-omphalopagus twins, Antônio et al. reported cross-circulation through heart rate changes in both twins after administration of 0.10 mg atropine to only one twin [18]. All drugs and intravenous fluids administered during surgery were calculated based on the total weight of the twins, and half was administered to each twin [18]. Because of cross-circulation, a continuous adrenaline infusion was necessary to maintain hemodynamic control [18].

Benzodiazepine administration was used to assess the extent of cross-circulation before surgery in a case study by Rawat et al., who reported no changes in the second twin after administration of midazolam (0.75 mg/kg) to the sibling, demonstrating the absence of cross-circulation between them [9].

Considering these findings, two types of cross-circulation have been described: incompletely shared circulation, in which doses are based on each twin’s individual weight, and completely shared circulation, in which combined weight is considered [9, 11].

Imaging modalities, including prenatal imaging, high-resolution computed tomography (CT), magnetic resonance (MR) imaging, angiography, and other neuroimaging techniques, are necessary to map and identify craniopagus anatomy [1, 4, 13]. This is essential for preoperative management, surgical planning, and surgical execution.

Preoperative ultrasound evaluated the optimal positioning and size of the internal jugular vein in both twins in a case study by Kaur et al. [19], in which central venous cannulation was needed. By employing preoperative ultrasound scanning and positioning rehearsal for central line cannulation, complications were successfully avoided [19].

Other studies used three-dimensional (3D) depictions and holograms generated from craniofacial CT and MRI/MR venography, which demonstrated clear visualization of the arterial and venous circulations [1]. For instance, in Dr. Goodrich’s 2004 case report, these techniques demonstrated a 2-inch fusion of the posterior parietal lobe before surgery, indicating dominant venous vascular supply in one twin compared with the other [4]. He favored high-resolution CT, MRI, MR venography, angiography, and tractography for bone, brain, and vascular mapping [4]. More recently, computer-assisted design/modeling (CAD/CAM), virtual surgical planning (VSP), and augmented or virtual reality have been used in CPT separation, dramatically improving surgical precision and safety [1, 3]. Goldman-Yassen explains that neuroradiologic imaging data have produced life-sized, 3D, transparent acrylic and ceramic models to better depict surgical anatomy, as well as holograms that demonstrate complex intracranial vascular anatomy in relation to the skull and brain [1].

Three-dimensional techniques were used by Mohammad et al., in whose case study 3D surface-rendered imaging created a roadmap for surgical planning in pygopagus conjoined twins (Figure 6), and by Di Rocco et al., in which trigonocephalic deformation and the left cerebral hemisphere of twin A were reconstructed from CT scans [6, 13].

Intraoperative management of two patients simultaneously

Caring for two patients during one operation presents a challenge for surgical staff, primarily because the unique anatomical position of CPTs impedes airway management and because equipment must be duplicated, which may lead to confusion [1, 4, 12, 13]. Operating room nurses are expected to meet the special positioning and equipment organization needs of extremely rare craniopagi [13].

To accurately distinguish the twins, surgical teams label them with a letter, number, and color [9, 12]. Monitoring cables, intravenous lines, tubing, and all equipment connected to the twins are color-coded with tape [9, 12]. For example, Rawat et al. used red and blue colors for the twins to avoid confusion [9].

A multidisciplinary team consisting of specialists in pediatric surgery, urology, neurosurgery, plastic surgery, anesthesiology, and circulating nursing is crucial in preparation for separation surgery [12, 13]. Two teams are formed, one for each twin (Figure 7), and are then color-coded to ensure that they treat the corresponding twin [9, 12]. Two operating rooms are prepared: one master operating room as the primary operating theater and a second adjacent room for use after separation [20]. This requires two to three anesthesia machines, two multiparameter monitors, two drug trolleys, two airway trolleys, two video laryngoscopes, two ultrasound machines, and two sets of all other required tools and equipment, such as defibrillators and suction devices [18, 20]. Clinical communication is supported by a control table containing patient data, laboratory results, emergency doses, and critical time points [20]. Closed-loop communication is indispensable [13]. These practices ensure patient safety and facilitate transfer to a new operating room once the twins are successfully separated, where further surgical management is needed for closure [18].

Conclusion

Separation surgery for craniopagus twins presents many challenges because of conjoined dural venous sinuses, prolonged anesthetic exposure, cross-circulation, and unique anatomical position. A multistage separation approach supports adequate collateral vasculature development and minimizes anesthetic exposure, thereby reducing potential risks of neurotoxicity and hemorrhagic or ischemic brain injury. Mapping craniopagus anatomy using 3D reconstructions from CT scans and CAD/CAM techniques allows more accurate and precise surgical planning. Surgical rehearsal with VSP and virtual or augmented reality supports successful outcomes with minimal complications. Labeling twins and their respective equipment and healthcare teams supports safe care. Because of the low incidence of CPTs, their preoperative, perioperative, and postoperative challenges remain incompletely evaluated. This literature review presents an up-to-date summary of existing methods and protocols established to address these unique challenges and to maintain the relevance of this condition, encouraging further studies of CPT cases and improvement of long-term surgical outcomes.

Acknowledgments

We would like to acknowledge our professors, Dr. Romero and Dr. de Jesus, for their research instruction and continued faith in our work. We would also like to recognize Aileen Alexandria Treviño's contributions to the medical illustrations.

References

1. Goldman-Yassen AE, Goodrich JT, Miller TS, Farinhas JM. Preoperative evaluation of craniopagus twins: anatomy, imaging techniques, and surgical management. AJNR Am J Neuroradiol. 2020;41(6):951-9. doi: 10.3174/ajnr.A6571.
2. Wong TG, Ong BC, Ang C, Chee HL. Anesthetic management for a five-day separation of craniopagus twins. Anesth Analg. 2003;97(4):999-1002. doi: 10.1213/01.ANE.0000078588.36983.08.
3. Pontell ME, Salinero LK, Wagner CS, Barrero CE, Tepper OM, Marras CE, et al. Putting our heads together: the future of craniopagus twin separation. J Craniomaxillofac Surg. 2024;52(3):378-84. doi: 10.1016/j.jcms.2024.02.007.
4. Lehrich BM, Brown NJ, Shahrestani S, Sahyouni R, Hsu FPK. James T. Goodrich, MD, PhD, 1946-2020: a historical perspective and his contributions to craniopagus separation. J Neurosurg Pediatr. 2020;26(4):454-60. doi: 10.3171/2020.5.PEDS20371.
5. Gakuba C, Gaberel T, Goursaud S, Bourges J, Di Palma C, Quenault A, et al. General anesthesia inhibits the activity of the "glymphatic system". Theranostics. 2018;8(3):710-22. doi: 10.7150/thno.19154.
6. Mohammad SA, AbouZeid AA, Ahmed KA, Abd-Elhamed AM, Rawash Eldieb LM. Postnatal imaging of conjoined twins: a customized multimodality approach. Pediatr Radiol. 2023;53(11):2291-304. doi: 10.1007/s00247-023-05709-3.
7. Pal A, Montero FJ. Conjoined Twins. 2025 Dec 13. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2026 Jan – Available from: https://www.ncbi.nlm.nih.gov/books/NBK560839/
8. Gupta D, Kedia S, Rath GP, Pandia MP, Chauhan S, Sharma R, et al. A century with craniopagus twin separation surgeries: nihilism to optimism. Neurosurgery. 2022;91(1):27-42. doi: 10.1227/neu.0000000000001962.
9. Rawat A, Rai R, Paswan AK, Pandey V. Our experience with anesthetic management of conjoined twins' separation surgery. Saudi J Anaesth. 2020;14(1):100-3. doi: 10.4103/sja.SJA_142_19.
10. Keunen K, Sperna Weiland NH, de Bakker BS, de Vries LS, Stevens MF. Impact of surgery and anesthesia during early brain development: a perfect storm. Paediatr Anaesth. 2022;32(6):697-705. doi: 10.1111/pan.14433.
11. Rodman E, Placencia JL. Pharmaceutical considerations with conjoined twins. Semin Perinatol. 2018;42(6):350-4. doi: 10.1053/j.semperi.2018.07.009.
12. Sato Y, Iura A, Kawamoto Y, Yamamoto S, Iritakenishi T, Fujino Y. Successful anesthetic management of separation surgery for pygopagus conjoined twins: a case report. JA Clin Rep. 2021;7(1):6. doi: 10.1186/s40981-020-00406-8.
13. Di Rocco C, Caldarelli M, Tamburrini G, Koutzoglou M, Massimi L, Di Rocco F, et al. Craniopagus: the Thessaloniki-Rome experience. Childs Nerv Syst. 2004;20(8-9):576-86. doi: 10.1007/s00381-004-0976-5.
14. Lasjaunias P, Kwok R, Goh P, Yeong KY, Lim W, Chng SM. A developmental theory of the superior sagittal sinus(es) in craniopagus twins. Childs Nerv Syst. 2004;20(8-9):526-37. doi: 10.1007/s00381-004-1007-2.
15. Stone JL, Goodrich JT. The craniopagus malformation: classification and implications for surgical separation. Brain. 2006;129(Pt 5):1084-95. doi: 10.1093/brain/awl065.
16. Bateman GA, Siddique SH. Cerebrospinal fluid absorption block at the vertex in chronic hydrocephalus: obstructed arachnoid granulations or elevated venous pressure? Fluids Barriers CNS. 2014;11:11. doi: 10.1186/2045-8118-11-11.
17. Yadav M, Chikkala R, Kulkarni D, Gopinath R. Anesthetic management of craniopagus conjoined twins in a remote location. Saudi J Anaesth. 2017;11(4):516-7. doi: 10.4103/sja.SJA_288_17.
18. Antônio F, Cifuentes S, Delgado M, Damasceno C, Torres M, Jorge V, et al. Anesthetic management of an omphalopagus conjoined twins separation surgery: a case report. Case Rep Rev Open Access. 2021;2(2):125-6. Available from: https://gnoscience.com/.
19. Kaur M, Sinha R, Chowdhury AR, Sharma S, Nagarajan B, Baishya M, et al. Preoperative planning for central venous cannulation in conjoint twins. J Anaesthesiol Clin Pharmacol. 2020;36(4):569-70. doi: 10.4103/joacp.JOACP_596_20.
20. Giwangkancana G, Kusmayadi DD, Kadi F, Utariani A, Haryawan Z. The multidisciplinary perioperative management of conjoined twin separation surgery during the pandemic. J Multidiscip Healthc. 2022;15:2669-78. doi: 10.2147/JMDH.S390419.

J Surg Med. 2026;10(7):e8475.
https://doi.org/10.28982/josam.8475

JOSAM

Case Report
https://jsurgmed.com/

Journal of Surgery and Medicine
e-ISSN: 2602-2079

Double trouble at the carotid bifurcation: A rare case of bilateral carotid body tumors

Nor Anis Elini Binti Ismail, Aiman bin A Hamid

Department of Otorhinolaryngology, Faculty of Medicine, University of Malaya, Kuala Lumpur, Malaysia

ORCID of the author(s)

NAEI: https://orcid.org/0000-0001-9805-5656
AAH: https://orcid.org/0009-0007-6644-8085

Abstract

Carotid body tumors (CBTs) are rare, highly vascular paragangliomas arising from chemoreceptor tissue at the carotid bifurcation. Bilateral tumors are particularly uncommon in patients without a known familial or genetic predisposition. We present a 54-year-old man with bilateral, long-standing, asymptomatic neck masses diagnosed as bilateral CBTs based on clinical findings and computed tomography angiography. After multidisciplinary discussion of staged surgery, radiotherapy, and active surveillance, the patient chose surveillance. The tumors remained stable at the 6-month follow-up. This case highlights the importance of careful clinical assessment, appropriate imaging, and individualized management to balance tumor control against the potential morbidity of bilateral intervention.

Keywords: carotid body tumor, bilateral, paraganglioma, active surveillance, sporadic

Introduction

Carotid body tumors (CBTs), also known as glomus caroticum tumors or chemodectomas, are uncommon neuroendocrine neoplasms arising from paraganglionic cells at the carotid bifurcation. They account for approximately 0.6% of all head and neck tumors, and up to 10% are bilateral [1]. These indolent tumors constitute approximately 60%-70% of cervical paragangliomas, with an estimated incidence of one to two cases per 100,000 individuals [2]. Although CBTs are usually benign and slow-growing, approximately 5% may metastasize [3]. Advances in genetic testing have improved the understanding of paragangliomas, and pathogenic variants in genes encoding the succinate dehydrogenase (SDH) complex are frequently implicated [3]. Surgical excision remains the mainstay of treatment, although it is technically challenging because of the tumors' rich vascular supply and proximity to major neurovascular structures. This report describes bilateral CBTs in a patient with no reported family history or known genetic predisposition, highlighting the rarity and clinical complexity of this presentation and the importance of individualized management.

Corresponding Author
Nor Anis Elini Binti Ismail
Lot 16462, Jalan Tiara Titiwangsa 6, 53200
Setapak, Kuala Lumpur, Malaysia
E-mail: anis_elini@yahoo.com.my

Informed Consent
Written informed consent was obtained from the patient for publication of this case report and the accompanying images. All patient identifiers were removed to protect confidentiality.

Conflict of Interest
No conflict of interest was declared by the authors.

Financial Disclosure
The authors declared that this study has received no financial support.

Published
2026 July 12

How to cite: Binti Ismail NAE, Ahamid A. Double trouble at the carotid bifurcation: A rare case of bilateral carotid body tumors. J Surg Med. 2026;10(7):e8475.

Case presentation

A 54-year-old man with no known comorbidities presented to the outpatient clinic with a 10-year history of bilateral neck swellings that had remained stable in size. He reported no pain, dysphagia, hoarseness, dyspnea, weight loss, or other constitutional symptoms. He also had no history of trauma, previous neck irradiation, or a family history of similar swellings.

On examination, firm, nontender, pulsatile swellings were present bilaterally in the upper neck, immediately below the angles of the mandible (Figures 1 and 2). The right swelling measured approximately 3 cm in diameter, and the left measured approximately 4 cm. Both swellings were mobile horizontally but fixed vertically, consistent with Fontaine's sign. Cranial nerve examination findings were normal, and no cervical lymphadenopathy was detected.

Figure 1: Right-sided neck swelling below the angle of the mandible.

Figure 2: Left-sided neck swelling below the angle of the mandible.

Flexible endoscopy showed slight medialization of the left lateral pharyngeal wall at the oropharyngeal level. Both vocal cords were symmetrically mobile. Contrast-enhanced computed tomography angiography demonstrated intensely enhancing, highly vascular tumors at both carotid bifurcations. The tumors splayed the internal and external carotid arteries, producing the characteristic lyre sign (Figures 3 and 4). These findings were consistent with bilateral carotid body paragangliomas.

Figure 3: Coronal contrast-enhanced computed tomography image showing bilateral masses at the carotid bifurcations (arrows).

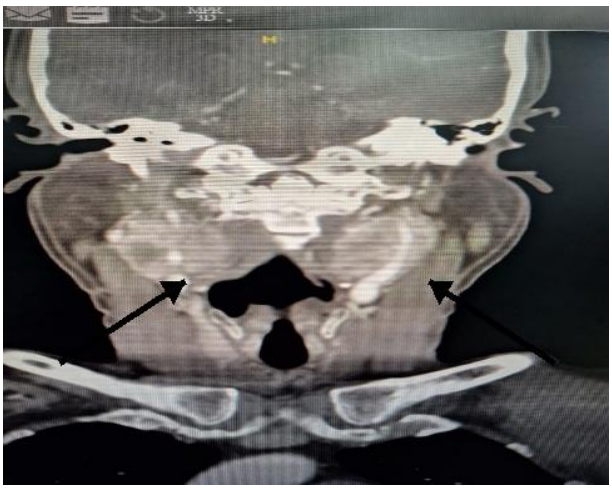
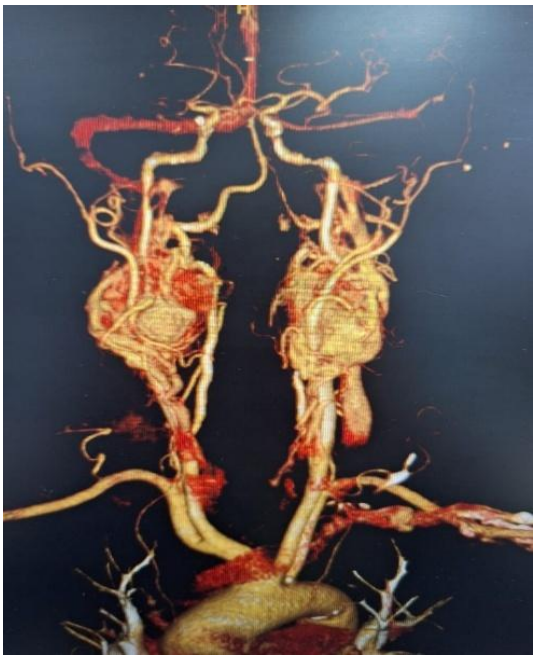


Figure 4: Computed tomography angiogram showing bilateral masses at the carotid bifurcations with splaying of the internal and external carotid arteries.



Given the long-standing, indolent course and absence of symptoms, a multidisciplinary team discussed several management options with the patient, including staged surgical resection, radiotherapy, and active surveillance. The potential risks of surgery, particularly the cumulative complications associated with bilateral intervention, were explained in detail. Considering the stable clinical course and absence of functional deficits, the patient chose conservative management with active surveillance. At the most recent six-month follow-up, magnetic resonance imaging (MRI) demonstrated no significant change in tumor size, and the patient remained asymptomatic.

Discussion

Bilateral CBTs are an uncommon subset of paragangliomas, accounting for approximately 3%-5% of cases and posing distinct diagnostic and management challenges [4, 5]. The reported incidence of CBTs varies, with earlier epidemiologic studies estimating approximately one case per 30,000 individuals [4]. Bilateral involvement occurs more frequently in familial disease, affecting up to 31.8% of patients with familial tumors compared with approximately 4%-5% of patients with sporadic tumors [6]. In this patient, the absence of a reported family history,

together with his age and prolonged indolent course, supports a presumed sporadic etiology.

Hereditary paraganglioma syndromes are associated with pathogenic variants in genes encoding subunits of the SDH complex, including SDHD, SDHB, SDHC, and SDHA. These variants are particularly associated with multicentric or bilateral disease [7]. Environmental factors, including chronic hypoxia in individuals living at high altitude, have also been implicated in carotid body hyperplasia and neoplasia [8].

Clinically, CBTs typically present as painless, pulsatile neck swellings at the carotid bifurcation that are mobile horizontally but fixed vertically, producing Fontaine's sign [9]. Patients with bilateral tumors may remain asymptomatic or develop symptoms related to mass effect; catecholamine secretion is uncommon. Imaging is central to diagnosis. Doppler ultrasonography, computed tomography angiography, and MRI are commonly used. Splaying of the internal and external carotid arteries produces the characteristic lyre sign on angiographic imaging [7, 10]. MRI may show a salt-and-pepper appearance caused by flow voids and hyperintense foci. Biochemical evaluation with plasma-free metanephrines or urinary catecholamine metabolites may help identify functional tumors.

The Shamblin classification assesses CBTs according to the extent of carotid vessel involvement and helps predict operative complexity and risk. Shamblin I tumors are small and minimally attached to the vessels; Shamblin II tumors partially surround the carotid arteries; and Shamblin III tumors extensively encase the vessels and are associated with greater operative difficulty and a higher risk of neurovascular complications [11]. This classification is therefore important for preoperative planning and shared decision-making.

Management of bilateral CBTs is complex and should be individualized. Surgical excision remains the conventional definitive treatment, whereas radiotherapy and active surveillance are appropriate alternatives in selected patients. Bilateral surgery carries substantial risks, including cranial nerve injury, stroke, and baroreflex dysfunction. When staged resection is planned, some clinicians prioritize the larger or more symptomatic tumor, whereas others operate first on the smaller tumor to reduce the immediate surgical risk [4]. Radiotherapy generally provides durable growth control while preserving cranial nerve function, although substantial tumor shrinkage is uncommon. Reported cranial nerve deficits after surgery range from approximately 20%-40%, whereas radiation-related deficits are generally less frequent and milder [12]. For selected complex tumors, a coordinated endovascular and surgical approach may facilitate treatment [13].

In this patient, the long-standing, asymptomatic tumors presented as pulsatile neck swellings with Fontaine's sign. The larger left-sided lesion produced medialization of the lateral pharyngeal wall and was considered a Shamblin III tumor on imaging. Because of the anticipated neurovascular and cranial nerve morbidity, immediate surgery was deferred in favor of active surveillance. Follow-up was planned with clinical assessment and serial MRI at 6-month intervals during the first year, followed by annual imaging if stability was confirmed. Indications for active intervention include documented tumor growth, new symptoms such as pain, dysphagia, or cranial nerve dysfunction, progressive carotid artery encasement, or newly detected biochemical activity.

This individualized strategy balances the morbidity of intervention against the typically indolent behavior of CBTs, particularly in older or asymptomatic patients. Evidence indicates that many head and neck paragangliomas grow slowly and can be monitored safely with structured follow-up [14]. In conclusion, bilateral CBTs should be considered in the differential diagnosis of chronic, slow-growing neck masses. Active surveillance is a reasonable evidence-based option for carefully selected patients with long-standing, asymptomatic tumors and substantial operative risk. Multidisciplinary assessment and shared decision-making are essential, and longer-term studies are needed to refine criteria for surveillance and intervention in bilateral disease.

References

1. Gurrola-Machuca H, Miranda-Aguirre AP, Gurrola-Luna H. Outcomes in the treatment of carotid body tumor, 20 years of experience. Gac Mex Oncol. 2021;20(3):87-93. doi: 10.24875/j.gamo.21000009.
2. Liu G, Zhao S, Wang J, Duan X, Cai H. Chemoradiotherapy for recurrent CBTs case report. Discov Oncol. 2025;16:1529. doi: 10.1007/s12672-025-03386-2.
3. Ozawa H. Current management of carotid body tumors. Auris Nasus Larynx. 2024;51(3):501-6. doi: 10.1016/j.anl.2024.01.007.
4. Piazza C, Montenegro C, Rampinelli V. Bilateral carotid body tumor management: tips, tricks, strategies, and problems. Curr Opin Otolaryngol Head Neck Surg. 2025;33(2):123-30. doi: 10.1097/MOO.0000000000001035.
5. Pordal A, Morin D, Malik R, Reddy P. A case of bilateral carotid body tumors. Cureus. 2024;16(6):e63402. doi: 10.7759/cureus.63402.
6. Grufferman S, Gillman MW, Pasternak LR, Peterson CL, Young WG Jr. Familial carotid body tumors: case report and epidemiologic review. Cancer. 1980;46(9):2116-22. doi: 10.1002/1097-0142(19801101)46:9<2116::AID-CNCR2820460934>3.0.CO;2-S.
7. Moscona-Nissan A, Saldívar-Rodea CA, Enríquez-García R, Rincón-Ángel LI, Navalón Calzada A, Seidman-Sorsby A, et al. Bilateral carotid body tumor case: a novel preoperative management. Radiol Case Rep. 2022;17(3):1021-9. doi: 10.1016/j.radcr.2021.11.009.
8. Yavapolkul D, Jittreetat T. Five synchronous paragangliomas of the head and neck: a case report. J Med Assoc Thai. 2016;99 Suppl 2:S211-5.
9. Lone GN, Shah AP, Malik PA, Hussain SM, Wani GM. Carotid body tumors: surgical management and review of patients over 10 years. Indian J Vasc Endovasc Surg. 2016;3(3):90-5. doi: 10.4103/0972-0820.186723.
10. Cidral LSR, Penzo LD, Merida KB, Marques MS, Andrade AC, Aragão AH, et al. Bilateral carotid body paraganglioma: a case report and review of management strategies. J Neurol Surg Rep. 2025;86(3):e175-9. doi: 10.1055/a-2654-2376.
11. Shamblin WR, ReMine WH, Sheps SG, Harrison EG Jr. Carotid body tumor (chemodectoma): clinicopathologic analysis of ninety cases. Am J Surg. 1971;122(6):732-9. doi: 10.1016/0002-9610(71)90436-3.
12. Suárez C, Rodrigo JP, Mendenhall WM, Hamoir M, Silver CE, Grégoire V, et al. Carotid body paragangliomas: a systematic study on management with surgery and radiotherapy. Eur Arch Otorhinolaryngol. 2014;271(1):23-34. doi: 10.1007/s00405-013-2384-5.
13. Persky MS, Setton A, Niimi Y, Hartman J, Frank D, Berenstein A. Combined endovascular and surgical treatment of head and neck paragangliomas: a team approach. Head Neck. 2002;24(5):423-31. doi: 10.1002/hed.10068.
14. Jansen JC, van den Berg R, Kuiper A, van der Mey AGL, Zwinderman AH, Cornelisse CJ. Estimation of growth rate in patients with head and neck paragangliomas influences the treatment proposal. Cancer. 2000;88(12):2811-6. doi: 10.1002/1097-0142(20000615)88:12<2811::AID-CNCR21>3.0.CO;2-7.

J Surg Med. 2026;10(7):e8474.
https://doi.org/10.28982/josam.8474

JOSAM

Case Report
https://jsurgmed.com/

Journal of Surgery and Medicine
e-ISSN: 2602-2079

Conservative surgical management of a large residual cyst of the mandibular body: A case report

Alba Likaj[1,2], Remi Likaj[1,2]

[1] Department of Oral and Maxillofacial Surgery, Regional Hospital of Durrës, Durrës, Albania
[2] Private Dental Clinic "Real", Durres, Albania

ORCID of the author(s)

AL: https://orcid.org/0009-0003-8954-6033
RL: https://orcid.org/0009-0000-4208-7317

Corresponding Author
Alba Likaj
Department of Oral and Maxillofacial Surgery, Regional Hospital of Durrës, Durrës, Albania
E-mail: alba.likaj@yahoo.com

Ethics Committee Approval
The study was approved by the Ethics and Disciplinary Committee of the Albanian Dental Order (Merita Bardhoshi, date: July 5, 2025 decision no: 00355674150102).

Informed Consent
Written informed consent was obtained from the patient for publication of this case report and the accompanying images.

Conflict of Interest
No conflict of interest was declared by the authors.

Financial Disclosure
The authors declared that this study has received no financial support.

Published
2026 July 14

Abstract

Residual cysts are inflammatory odontogenic cysts that remain in the jaw after extraction of a tooth associated with a radicular cyst. A 60-year-old man was evaluated in the Department of Oral and Maxillofacial Surgery for a large, well-defined, unilocular cyst of the mandibular body. The lesion was completely enucleated, and the residual cavity was managed by open packing with iodoform gauze to permit secondary healing. This case demonstrates successful management of a large residual cyst of the mandibular body using complete enucleation followed by open iodoform gauze packing.

Keywords: residual cyst, iodoform gauze, enucleation

Introduction

Cysts are among the most common pathologic lesions of the oral cavity. They are broadly classified as odontogenic or nonodontogenic and as inflammatory or noninflammatory, and they may involve either hard or soft tissues. A residual cyst is an inflammatory odontogenic cyst that persists in the jaw after extraction of a nonvital tooth associated with a radicular cyst. Radiographically, it usually appears as a well-defined, round or oval radiolucency with a thin corticated border [1].

The diagnosis is established by biopsy and histopathologic examination. The differential diagnosis includes odontogenic keratocyst, primordial cyst, unicystic ameloblastoma, inflamed lateral periodontal cyst, and glandular odontogenic cyst [1].

A residual cyst may resemble a primordial cyst; however, a primordial cyst develops in place of a tooth, whereas a residual cyst remains after extraction of a nonvital tooth associated with a radicular cyst [2].

A detailed dental history is therefore important. In the present case, the patient reported a previously infected tooth in the left mandibular region, with several episodes of swelling before extraction at a dental clinic. On the basis of this history and the clinical and radiographic findings, a residual cyst was suspected before histopathologic confirmation.

How to cite: Likaj A, Likaj R. Conservative surgical management of a large residual cyst of the mandibular body: A case report. J Surg Med. 2026;10(7):e8474.

Figure 1. Preoperative panoramic radiograph showing the residual cyst. The dimensions of the lesion: 5 cm in width, 2.2 cm in length.

Figure 2. Intraoperative view during complete enucleation of the residual cyst.

Figure 3. Clinical appearance on the first postoperative day with iodoform gauze in the bone cavity.

Figure 4. Clinical appearance on the seventh postoperative day during scheduled replacement of the iodoform gauze.

Figure 5. Clinical appearance of soft-tissue healing after removal of the iodoform gauze.

Figure 6. Panoramic radiograph showing bone healing within the residual cavity at 3 months.

Case presentation

A 60-year-old man presented to the Regional Hospital of Durrës with a cyst in an edentulous mandibular ridge extending from the canine region to the mandibular angle. The large lesion was identified on a routine panoramic radiograph and appeared well defined and unilocular (Figure 1).

The patient had no jaw swelling, clinical signs of infection, or neurosensory disturbance. A conservative surgical approach was selected: complete enucleation of the cyst followed by open packing with iodoform gauze to allow secondary healing. Under general anesthesia, a mucoperiosteal flap was elevated and the buccal cortical plate was removed. The cyst was completely enucleated (Figure 2). Iodoform gauze was then placed in the residual cavity to facilitate drainage of blood and serous fluid and reduce the risk of infection (Figure 3).

The patient was followed regularly, and the iodoform gauze was changed twice weekly (Figure 4) until complete secondary healing of the soft tissues was achieved. Secondary healing required approximately 6 weeks (Figure 5). At subsequent visits, the amount of gauze was gradually reduced to avoid overpacking, which can impede healing by secondary intention. Packing was discontinued when the cavity could no longer accommodate the gauze, allowing mucosal closure.

The patient was instructed to rinse with 0.2% chlorhexidine for 7 days, maintain oral hygiene, and follow a soft diet for at least 1 month. At the 3-month follow-up visit, a panoramic radiograph demonstrated new bone formation within the cavity (Figure 6).

Further follow-up at 6-12 months was not possible because the patient had left the country. The final histopathologic examination confirmed a residual cyst in this edentulous mandibular ridge.

Discussion

Residual jaw cysts are often asymptomatic and may be detected incidentally on routine panoramic radiographs. They occur most frequently in older patients and are commonly located between the canine region and the mandibular angle [3].

Pain and swelling may indicate secondary infection. With progressive enlargement, these lesions can erode the buccal and lingual cortical plates and produce visible jaw swelling. Tsvetanov [1] noted that surgical treatment may be required even in asymptomatic patients, as in the present case.

Surgical options for residual cysts include complete enucleation, marsupialization, and decompression [4]. In this patient, complete enucleation was followed by open packing with iodoform gauze for secondary healing. This approach was selected to achieve complete lesion removal while maintaining drainage and supporting patient comfort during healing.

Complete removal of the cystic lining is important because fragmentation of the lining or wall may leave epithelial remnants within the cavity and permit recurrence. Periodic clinical and radiographic follow-up is therefore essential for detecting recurrence or malignant transformation. Recurrence after complete removal is generally uncommon, and the prognosis is favorable [4, 5].

Histologically, a residual cyst is indistinguishable from a radicular cyst because it represents a radicular cyst that remains in the jaw after extraction of the associated tooth [1].

Enucleation of a large cyst leaves a substantial bone cavity and dead space. In this setting, an unorganized blood clot may become infected [4, 6]. Some authors have advocated autogenous bone grafting to fill large defects and reduce the risk of pathologic fracture [7]. However, grafting may be complicated by material exposure, infection, donor-site morbidity, and increased treatment cost [6, 8]. In the present case, no graft material was used, and spontaneous osseous healing was evident at 3 months.

Iodoform has long been used as an antiseptic packing material and is generally well tolerated, although iodine toxicity and hypersensitivity remain potential concerns [9, 10]. Reported adverse effects include neurotoxicity, systemic symptoms, allergic reactions, and dermatologic reactions such as dermatitis herpetiformis [10].

The patient had no known iodine allergy. Commercially prepared, single-dose iodoform gauze was used, allowing the amount and concentration of the material to be standardized; however, standardized packaging does not eliminate the possibility of toxicity.

Open packing with iodoform gauze has been used successfully to support secondary healing of large bone defects [4]. This conservative approach requires a cooperative patient who can attend regular postoperative clinical and radiographic follow-up visits [5].

This case suggests that complete enucleation followed by open packing with iodoform gauze can be a practical option for selected large residual cysts. The technique permitted secondary soft-tissue healing and early radiographic bone formation without graft material. Longer follow-up is necessary to confirm durable healing and exclude recurrence.

References

1. Tsvetanov TS. Residual cysts: A brief literature review. Int J Med Dent Sci. 2016;5(2):1341-6. doi: 10.19056/ijmdsjssmes/2016/v5i2/100632.
2. Kahn, Michael A. Basic Oral and Maxillofacial Pathology. Volume 1. 2001.
3. Titinchi F, Morkel J. Residual cyst of the jaws: A clinico-pathologic study of this seemingly inconspicuous lesion. PLoS One. 2020;15(12):e0244250. doi: 10.1371/journal.pone.0244250.
4. Kumar V, Sinha RK. Enucleation followed by open packing of iodoform gauze in mandibular unicystic ameloblastoma: A case report. Open Access Libr J. 2014;1:e703. doi: 10.4236/oalib.1100703.
5. Singh V, Mohammad S, Singh N, Das S. Conservative treatment of keratocyst: A follow-up study. Eur J Gen Dent. 2013;2(2):169-73. doi: 10.4103/2278-9626.112322.
6. Sokler K, Sandev S, Grgurevic J. Surgical treatment of large mandibular cysts. Acta Stomatol Croat. 2001;35(2):253-7.
7. Dimitroulis G, Curtin J. Massive residual dental cyst: Case report. Aust Dent J. 1998;43(4):234-7. doi: 10.1111/j.1834-7819.1998.tb00165.x.
8. Perjuci F, Ademi-Abdyli R, Abdyli Y, Morina E, Gashi A, Agani Z, et al. Evaluation of spontaneous bone healing after enucleation of a large residual cyst in the maxilla without graft material utilization: Case report. Acta Stomatol Croat. 2018;52(1):53-60. doi: 10.15644/asc52/1/8.
9. Singh V, Das S, Sharma NK. Iodoform: A boon in disguise. Open J Stomatol. 2012;2(4):322-5. doi: 10.4236/ojst.2012.24055.
10. Halalmeh DR, Ansari YZ, Jader A, Salama HEZ, Venero CV Jr, Moisi MD. Iodoform in surgical practice: A comprehensive review of its historical evolution, clinical applications, and safety profiles. Cureus. 2024;16(12):e75752. doi: 10.7759/cureus.75752.