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Anesthesia for cleft lip and palate in children in resource limited settings: a retrospective analysis of complications and associated factors

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Keypoints

This study aimed to assess anesthetic practices, perioperative complications, and associated risk factors during CLP repair campaigns at Biamba Marie Mutombo Hospital.

Abstract

Introduction

Anesthesia for cleft lip and palate (CLP) repair remains challenging in children, particularly in resource-limited settings where airway management and monitoring capacities are constrained. This study aimed to assess anesthetic practices, perioperative complications, and associated risk factors during CLP repair campaigns at Biamba Marie Mutombo Hospital.

Methods

A retrospective cross-sectional study was conducted from January 2021 to January 2024, including all children under 18 years who underwent primary or secondary CLP repair. Data were extracted from medical records, operative logs, and anesthesia sheets. Descriptive statistics were used to summarize clinical characteristics and complications. Logistic regression identified factors associated with perioperative and postoperative adverse events.

Results

A total of 250 children were included. The median age was 7 months (IQR 4–12), and most were ASA I (90.8%). Difficult intubation occurred in 18.4% of cases. Perioperative complications occurred in 19.2%, mainly desaturation (13.2%) and tachycardia (6%). Postoperative complications affected 14.8% of patients, predominantly delayed awakening (13.6%) and endobuccal bleeding (1.2%). No deaths were reported. Independent predictors of perioperative complications were associated congenital anomalies (adjusted OR 11.6; 95% CI 2.1–61.9) and anesthesia duration >1 hour (adjusted OR 2.4; 95% CI 1.2–4.6). Postoperative complications were independently associated with congenital anomalies (adjusted OR 41; 95% CI 4.7–352.3), anesthesia duration >1 hour (adjusted OR 4.3; 95% CI 1.9–9.4), and surgery duration >1 hour (adjusted OR 2.1; 95% CI 1–4.2).

Conclusion

CLP anesthesia in children remains high-risk, with airway and recovery-related complications being the most frequent. Congenital anomalies and prolonged anesthesia significantly increase morbidity. Strengthening perioperative assessment, airway management strategies, and standardized protocols is essential to improving safety in resource-limited settings.

Keywords

Pediatric anesthesia, Cleft lip and palate, Resource-limited settings, Perioperative complications

Introduction

Anesthesia for cleft lip and palate (CLP) repair remains a significant challenge, even for experienced practitioners. The risk of upper airway obstruction and respiratory complications is elevated, particularly due to the craniofacial anomalies inherent in these patients and the use of opioids for perioperative analgesia [1,2]. Intubation difficulties are common, and displacement of the endotracheal tube can occur during surgical manipulation of the head [1,2,3]. In Europe, the prevalence of CLP range from 0.1 to 1.1 per 1,000 live births, with approximately 800 new cases reported annually in France [1,2]. Cleft lips and cleft lip–alveolar forms account for roughly one-quarter of all CLP, with an annual incidence of 1/4,000 to 1/10,000 births, corresponding to about one in 700 children in France [3,4,5]. These malformations occur due to the incomplete fusion of the palatal and upper lip primordia, with etiology stemming from intricate interactions between genetic and environmental factors, such as maternal smoking, alcohol consumption, obesity, folic acid deficiency, gestational diabetes, and radiation exposure [2, 4, 5]. Incidence varies among populations, being higher in Japan (1/584 births), lower among African Americans (1/2,273), and approximately 1/1,000 in Europe [6,7]. Unilateral and bilateral CLP account for nearly half of cases, with males more frequently affected and a slight predominance of right-sided clefts [5,6]. Surgical repair under general anesthesia remains the cornerstone of management. However, airway management is challenging, especially in infants, where no reliable predictive test exists for difficult intubation [1,5]. Preoperative evaluation should identify associated congenital anomalies, comorbidities, and recent infections. Adjunctive techniques such as infraorbital nerve blocks, video laryngoscopes, and fiberoptic bronchoscopy improve safety and analgesia [5,7]. Despite advances, perioperative respiratory and hemorrhagic complications remain a concern. Severe events, including endobuccal bleeding and aspiration, have been reported, sometimes with fatal outcomes [5,6,7]. In low-resource settings, complication rates are particularly concerning. Parul Jindal et al. [9] reported an 8.2% incidence of perioperative events in 2,917 children undergoing free surgical campaigns, primarily during induction. In Guinea, Donamou et al. [10] reported a 13.7% complication rate, mainly difficult intubation and postoperative bleeding, without mortality. Similarly, in the Democratic Republic of Congo, Ahuka Ona et al. [11] documented one unanticipated difficult intubation and one recovered cardiac arrest. These findings underscore that CLP anesthesia remains demanding, and meticulous perioperative preparation is essential. The present study aimed to analyze anesthetic techniques, perioperative complications, and associated risk factors during CLP repair campaigns at Biamba Marie Mutombo Hospital.

Methods

Study Design

This is a retrospective, cross-sectional, single-center study conducted to evaluate anesthetic techniques, perioperative complications, and associated factors in children undergoing surgery for cleft lip and palate. This design was chosen to allow comprehensive analysis of all available records during surgical campaigns, ensuring exhaustive and representative patient inclusion in a resource-limited setting.

Setting and Study Period

The study was conducted at the Anesthesia and Surgery Departments of Biamba Marie Mutombo Hospital (HBMM). Data collection covered the period from January 2021 to January 2024, during which regular cleft lip and palate repair campaigns were organized, ensuring an adequate patient flow. All data were extracted from operating room registers, patient medical records, and the hospital's electronic database.

All children under 18 years of age who underwent corrective surgery for cleft lip and palate at Biamba Marie Mutombo Hospital during the study period were eligible for inclusion. Consecutive, exhaustive sampling was used to ensure all eligible patients were captured.

Inclusion criteria:

- There are children under the age of 18 who are undergoing primary or secondary corrective surgery for cleft lip and/or palate at Biamba Marie Mutombo Hospital between January 2021 and January 2024.

Exclusion criteria:

- There are children with incomplete records for key study variables (e.g., age, type of cleft, anesthetic data, or complication outcomes).

No prospective follow-up was conducted after hospital discharge; complication analysis was therefore limited to the perioperative and immediate postoperative period.

Variables and Definitions

The following data were collected:

- Socio-demographic: age, sex, siblings, and healthcare financing.
- Clinical and anesthetic: comorbidities, family history of malformations, maternal risk factors, associated malformations, birth circumstances, mode of delivery, gestational age, birth weight, vaccination status, intubation difficulties, drugs used for induction and maintenance, ASA classification, cleft type, type of anesthesia, duration of surgery,
- operator qualification, and surgical technique.
- Outcomes: anesthetic complications (respiratory, hemorrhagic, or other) and vital status (survival or death).

Operational definitions:

- Vital outcome: patient alive or deceased post-surgery.
- Hospital stay: duration from admission to discharge or death.
- ASA: preoperative physical status classification (2020 version).
- Complications: perioperative or postoperative adverse events, including respiratory, hemorrhagic, or other events.
- Mortality and morbidity: the number of deaths or patients experiencing complications, respectively.

Data Sources and Measurement

Data were extracted from operating room logs, patient medical records, consultation registers, and electronic databases. A standardized data collection form was used, completed by the principal investigator and verified for consistency. Uniform definitions were applied across all patients to reduce information bias.

Bias

Selection bias was minimized by including all eligible patients. Measurement bias was addressed through double verification of extracted data and the use of standardized operational definitions. Records with missing key variables were excluded to reduce misclassification bias.

Study Size

The study population included all eligible patients identified in hospital records during the study period. No a priori sample size calculation was performed due to the retrospective, exhaustive nature of the study.

Handling of Quantitative Variables

Quantitative variables such as age, weight, and operative duration were expressed as mean ± standard deviation. Categories were created when necessary for analysis (e.g., weight <5 kg vs. ≥5 kg). Qualitative variables were coded for statistical analysis.

Statistical Analysis

Data were entered into Excel 2016, verified, and analyzed using SPSS 26.0.

- Quantitative variables were compared using Student's t-test or ANOVA as appropriate.
- Qualitative variables were compared using Pearson's chi-square or Fisher's exact test.
- Factors associated with complications were identified using logistic regression, with calculation of odds ratios (ORs) and 95% confidence intervals.
- Statistical significance was set at $p < 0.05$.
- Missing data were excluded from the analysis. No sensitivity analysis was required due to the low proportion of missing data.

Ethical Considerations

The study protocol was approved by the Scientific Committee of the Department of Anesthesia and Intensive Care and submitted to the Ethics Committee of the School of Public Health, University of Kinshasa (approval number: ESP/CE/188/2024). All procedures adhered to confidentiality guidelines and the principles of the Declaration of Helsinki. No conflicts of interest were declared.

Results

Study Participants

During the study period, 1,306 patients consulted the surgical department, of whom 953 underwent surgery for various conditions Among these, 250 children (<18 years) underwent repair for cleft lip and palate and were included in the study. All patients who were included in the study completed their follow-up and were analyzed. The main reason for exclusion was missing essential data

Sociodemographic Characteristics

The study population included 123 males (49.2%) and 127 females (50.8%), resulting in a male/female ratio of 1. The median age at surgery was 7 months (IQR : 4–12 months), with most procedures performed during the first year of life (76.8%). Nearly half of the children were the youngest in their family (49.6%). All procedures were funded through the Smile Train program (Table 1).

Variable	Category / Value	n (%)
Total participants		250
Sex	Male	123 (49.2)
	Female	127 (50.8)
	Male/Female ratio	1.0
Age (months)	Median (IQR)	7 (4–12)
Age group (months)	1–12	192 (76.8)
	13–24	27 (10.8)
	25–36	11 (4.4)
	37–48	7 (2.8)
	49–60	1 (0.4)
	>60	12 (4.8)
Birth order	Firstborn	61 (24.4)
	Second	52 (20.8)
	Penultimate	13 (5.2)
	Youngest	124 (49.6)

Table 1. Sociodemographic Characteristics of Children.

Clinical Characteristics

Most children (90.8%) had no identifiable perinatal risk factors. The majority were born via vaginal delivery (69.2%) at term (87.2%). More than half had a birth weight between 2,500–3,500 g (53.2%), and 76% had their vaccination schedule up-to-date. Family history of malformations was rare (0.8%), and 1.6% of children had associated congenital anomalies (Table 2).

Variable	Category / Value	n (%)
Perinatal risk factors	None	227 (90.8)
	Other	23 (9.2)
Birth circumstances	Eutocic	190 (76.0)
	Dystocic	60 (24.0)
Delivery mode	Vaginal	173 (69.2)
	Cesarean	77 (30.8)
Gestational age	Preterm	14 (5.6)
	Term	218 (87.2)
	Post-term	0 (0)
Birth weight	<2500 g	30 (12.0)
	2500–3500 g	133 (53.2)
	>3500 g	111 (44.4)
Vaccination status	Up-to-date	190 (76.0)
	Incomplete	60 (24.0)
Family history of malformations	Yes	2 (0.8)
	No	248 (99.2)
Associated malformations	Yes	4 (1.6)
	No	246 (98.4)

Table 2. Clinical Characteristics of Children. Values are presented as n (%). Abbreviations: g = grams.

Types of Clefts

The majority of surgeries were performed for complete cleft lip (68.8%). Left complete cleft lip–velopalatine accounted for 11.2%, and complete cleft palate was observed in 4% of patients. Other types, including partial or incomplete clefts, were less frequent (Table 3).

Cleft Type	n (%)
Complete cleft lip	172 (68.8)
Partial cleft lip	2 (0.8)
Incomplete cleft lip–palate	1 (0.4)
Complete cleft lip–palate	30 (12.0)
Left complete cleft lip–velopalatine	28 (11.2)
Complete cleft palate	10 (4.0)
Partial cleft palate	2 (0.8)
Incomplete cleft palate	3 (1.2)
Alveolar cleft	2 (0.8)

Table 3. Distribution of Cleft Types in Children

Anesthetic Characteristics

Most children were ASA I (90.8%), with difficult intubation occurring in 18.4% of cases. All patients received general anesthesia with orotracheal intubation and an infraorbital block. The mean anesthesia duration was 69.4 ± 18.4 minutes. Propofol was the primary induction agent (98.8%), suxamethonium was used in 19.2%, fentanyl was the most used opioid (99.6%), and isoflurane was commonly used for maintenance (60.8%). (Table 4).

Variable	Category / Value	n (%) or Mean ± SD
ASA class	I	227 (90.8)
	II	23 (9.2)
Difficult intubation	Yes	46 (18.4)
	No	204 (81.6)
Type of anesthesia	General + Orotracheal intubation	250 (100)
Infraorbital block	Yes	250 (100)
Duration of anesthesia	Minutes	69.4 ± 18.4
Induction agent	Propofol	247 (98.8)
	Ketamine + Propofol	2 (0.8)
	Midazolam	1 (0.4)
Muscle relaxants	None	202 (80.8)
	Suxamethonium	48 (19.2)
Opioids	Fentanyl	249 (99.6)
	Morphine	1 (0.4)
Maintenance agent	Sevoflurane	75 (30.0)
	Isoflurane	152 (60.8)
	Propofol	23 (9.2)

Table 4. Anesthetic Characteristics of Children. Values are presented as n (%) or mean ± SD. Abbreviations: ASA = American Society of Anesthesiologists physical status; SD = Standard deviation.

Surgical Characteristics

Most children (98%) underwent primary repair, mainly using the Fischer technique (76%). All surgeries were performed by a specialist surgeon. The mean duration of surgery was 58.2 ± 18.3 minutes (Table 5).

Variable	Category / Value	n (%) or Mean ± SD
Type of surgery	Primary	245 (98)
	Secondary	5 (2)
Surgical technique	Fischer	190 (76)
	Millard	23 (9.2)
	Wardill	22 (8.8)
	Landmarks	3 (1.2)
	Push-back	2 (0.8)
	Other	10 (4)
Surgeon qualification	Specialist	250 (100)
Duration of surgery	Minutes	58.2 ± 18.3

Table 5. Surgical Characteristics of Children. Values are presented as n (%) or mean ± SD. Abbreviations: SD = Standard deviation.

Perioperative and Postoperative Complications

Perioperative complications occurred in 19.2% of children, mainly desaturation (13.2%) and tachycardia (6%). Postoperative complications were observed in 14.8%, mostly delayed awakening (13.6%) and endobuccal bleeding (1.2%). No deaths were reported (Table 6).

Outcome	n (%) or Mean ± SD
Perioperative complications	Yes: 48 (19.2), No: 202 (80.8)
Desaturation	33 (13.2)
Tachycardia	15 (6.0)
Postoperative complications	Yes: 37 (14.8), No: 213 (85.2)
Delayed awakening	34 (13.6)
Endobuccal bleeding	3 (1.2)
Time to awakening (min)	12.1 ± 2.5
Survival	250 (100)

Table 6. Perioperative and Postoperative Complications in Children. Values are presented as n (%) or mean ± SD. Abbreviations: SD = Standard deviation.

Factors Associated with Complications

Perioperative complications were independently associated with associated malformations and anesthesia duration >1 hour (Table 7).

Determinant	Univariate p	OR (95% CI)	Multivariate p	Adjusted OR (95% CI)
Associated malformations	<0.001	2.8 (1–9.3)	0.003	11.6 (2.1–61.9)
ASA class II	0.028	1.8 (1.1–3)	0.280	0.4 (0.2–0.9)
Anesthesia duration >1 h	0.007	2.0 (1.1–3.1)	0.006	2.4 (1.2–4.6)

Table 7. Factors Associated with Perioperative Complications. OR = Odds Ratio; CI = Confidence Interval.

Postoperative complications were independently associated with associated malformations, anesthesia duration >1 hour, and surgery duration >1 hour (Table 8).

Determinant	Univariate p	OR (95% CI)	Multivariate p	Adjusted OR (95% CI)
Associated malformations	<0.001	6.1 (1–37.5)	0.001	41 (4.7–352.3)
Anesthesia duration >1 h	<0.001	2.0 (1–3.6)	<0.001	4.3 (1.9–9.4)
Secondary surgery	0.004	9.3 (1.5–57.7)	0.182	1.1 (0.9–1.4)
Surgery duration >1 h	0.041	1.6 (1–2.5)	0.033	2.1 (1–4.2)

Table 8. Factors Associated with Postoperative Complications. OR = Odds Ratio; CI = Confidence Interval.

Discussion

This study evaluated anesthetic management and perioperative outcomes in 250 children undergoing cleft lip and/or palate repair. Most patients were classified as ASA I, and difficult intubation occurred in 18.4% of cases, reflecting the anatomical challenges inherent to CLP [1,2,3]. Perioperative complications were observed in 19.2% of children, primarily desaturation (13.2%) and tachycardia (6%), while postoperative complications affected 14.8%, mainly delayed awakening (13.6%). No deaths occurred, highlighting the relative safety of these procedures when conducted by trained teams following standardized protocols [11,12,14].

These results confirm that anesthesia for CLP remains high-risk due to pediatric airway vulnerability and surgical complexity [1,2,6]. Systematic infraorbital nerve blocks, along with propofol and fentanyl for induction, helped minimize severe complications, consistent with previous reports [5,7,10,12]. Associated congenital anomalies and anesthesia duration over one hour were identified as independent risk factors for both perioperative and postoperative complications, aligning with

findings by Brugie et al. and Jindal et al. [11,14]. These findings underline the importance of preoperative risk assessment and protocol adaptation, even in resource-limited contexts. However, our study has limitations. Being retrospective, it relied on medical records, which may have underreported minor complications or events occurring post-discharge. The inclusion of children operated on during surgical campaigns may limit generalizability to patients with more complex comorbidities [2,3,15]. Additionally, the short postoperative follow-up precludes assessment of long-term outcomes such as speech disorders or functional sequelae [20]. Interpretation of these results must therefore be cautious. While complication rates were comparable to other studies in Africa and Asia [14,15,16], differences in surgical and anesthetic practices make direct comparisons difficult. Nevertheless, our data highlight the importance of specialized teams, adapted anesthetic techniques, and systematic preoperative assessment for safe CLP surgery [1,10,12].

Regarding generalizability, these findings are relevant to centers conducting CLP campaigns in low-resource settings, where advanced airway devices and postoperative care may be limited. The results point out the need for structured protocols, continuous vigilance, and ongoing training to maintain safety [11, 12, 14, 15].

Conclusion

Although CLP anesthesia remains challenging, careful planning and risk mitigation can minimize complications. Attention to congenital anomalies and prolonged anesthesia duration is critical, and the findings support structured perioperative management in similar low-resource environments.

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Competing interests

The authors declare that they have no competing interests.

Author contributions

M. Kamwanga, A. Makembi Bunkete, and K. Anga contributed to study conception and design. M. Bulabula, B. Barhayiga, G. Mfulani, A. Mutombo, E. Ngombe, W. Mbombo, J. J. Kalongo, and V. Kalonji contributed to data acquisition and analysis. All authors contributed to manuscript drafting and revision and approved the final version. A. Makembi Bunkete is the corresponding author.

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Consent for publication

Not applicable.

Availability of data and materials

The datasets generated and analyzed during the current study are available from the corresponding author on reasonable request.

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