

Rehabilitation of Obstetric Brachial Plexus Palsy at the National Orthopedic Rehabilitation Center of Mali: A Longitudinal Study of 150 Children Followed between 2020 and 2023

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Abstract

Background: Obstetric brachial plexus palsy (OBPP) remains a neonatal neurological complication associated with dystocic deliveries despite recent advances in obstetric practice. African and Malian data regarding prognostic factors and responses to rehabilitation remain scarce. **Objective:** To investigate the epidemiological, clinical, and prognostic characteristics of children with OBPP managed at the National Orthopaedic Rehabilitation Center of Mali (CNAOM). **Methods:** We conducted a prospective longitudinal study at the CNAOM between October 2020 and December 2023. Children aged 0 - 5 years with clinically confirmed OBPP according to the Narakas classification and who underwent standardized rehabilitation follow-up were included. Patients were assessed at admission and subsequently at 3, 6, and 18 months. The primary outcome was the evolution of the global active movement score of the affected upper limb. Statistical analyses included descriptive methods, bivariate analyses,



and multivariable logistic regression using generalized estimating equations (GEE). **Results:** Among 28,939 admissions to the CNAOM, 1,123 cases of OBPP were identified, corresponding to a hospital frequency of 3.8%. A total of 150 children were included in the final analysis. The median age at diagnosis was four months. The male-to-female ratio was 1.34. Partial Narakas forms (types I - II) accounted for 56.7% of cases, whereas complete forms (types III - IV) represented 43.3%. Complete recovery was observed in 78% of children after follow-up. Independent predictors of favorable outcomes included partial OBPP (adjusted OR = 3.86; 95% CI: 2.78 - 5.36; $p < 0.001$), maternal age below 35 years (adjusted OR = 2.30; 95% CI: 1.45 - 3.67; $p < 0.001$), primiparity (adjusted OR = 1.55; 95% CI: 1.08 - 2.21; $p = 0.017$), and normal or low birth weight (adjusted OR = 1.75; 95% CI: 1.16 - 2.63; $p = 0.007$). **Conclusion:** OBPP is a common condition encountered in pediatric rehabilitation services in Mali. Early functional rehabilitation significantly improves motor outcomes, particularly in children presenting with partial lesions. Delayed diagnosis and complete lesions remain associated with an increased risk of long-term disability.

Keywords

Obstetric Brachial Plexus Palsy, Rehabilitation, Physiotherapy, Narakas Classification, Prognosis, Mali

1. Introduction

Obstetric brachial plexus palsy (OBPP) is a peripheral neurological injury resulting from birth-related trauma occurring during delivery. It mainly arises from excessive traction applied to the neck and shoulder of the newborn during shoulder dystocia or difficult obstetric maneuvers [1]. This condition remains an important cause of upper-limb functional disability in children.

Lesions involving the upper roots (C5-C6), classically referred to as Erb-Duchenne palsy, represent the most common form of OBPP [2] [3]. More extensive lesions involving the C5 to T1 roots are associated with greater severity and an increased risk of persistent motor impairment [4]. Despite improvements in obstetric techniques and perinatal monitoring, the global incidence of OBPP has remained relatively stable and is estimated to range from 0.3 to 3 cases per 1000 live births [5] [6].

Spontaneous recovery has been reported in 50% to 90% of cases, depending on the initial severity of the lesion, the timing of management, and the therapeutic interventions implemented [7]-[10]. However, severe forms may lead to permanent functional limitations, joint deformities, and considerable psychosocial consequences [11].

In sub-Saharan Africa, epidemiological and prognostic data regarding OBPP remain scarce. Limited access to specialized care, delayed diagnosis, and deficiencies in patient follow-up systems probably contribute to an underestimation of the true burden of the disease [12]-[16].

In Mali, only a few studies have explored the functional outcomes of rehabili-

tation programs in children with OBPP. Nevertheless, the National Orthopaedic Rehabilitation Center of Mali (CNAOM) remains the country's principal referral institution for physical and functional rehabilitation.

The present study aimed to assess the epidemiological, clinical, and prognostic characteristics of children with OBPP treated at the CNAOM between 2020 and 2023 and to identify factors associated with functional recovery.

2. Methods

2.1. Study Design and Setting

This prospective longitudinal study was conducted at the National Orthopaedic Rehabilitation Center of Mali (Centre National d'Appareillage Orthopédique du Mali [CNAOM]), the country's main public referral institution for physical medicine, rehabilitation, and orthopaedic care.

2.2. Study Period

The study was carried out from October 3, 2020, to December 31, 2023.

2.3. Study Population

The target population consisted of children admitted to the functional rehabilitation unit of the CNAOM for obstetric brachial plexus palsy.

2.4. Inclusion Criteria

The following criteria were required for inclusion:

- age between 0 and 5 years;
- clinically confirmed diagnosis of OBPP according to the Narakas classification;
- availability of complete medical records;
- regular participation in the rehabilitation program;
- informed parental consent.

2.5. Exclusion Criteria

The following patients were excluded:

- children lost to follow-up after the initial evaluation;
- incomplete medical records;
- absence of standardized functional assessment.

2.6. Sample Size

The minimum sample size was calculated according to Cochran's formula, assuming a 95% confidence level, an 8% margin of error, and an estimated prevalence of 50%. The minimum required sample size was 150 patients.

2.7. Study Variables

2.7.1. Primary Outcome

The primary outcome was functional recovery of the affected limb, as assessed by

the global active movement scale.

2.7.2. Independent Variables

The following variables were investigated:

- maternal age and parity;
- obstetric characteristics;
- mode of delivery;
- birth weight;
- delay between birth and diagnosis;
- Narakas classification;
- side of involvement.

2.8. Assessment Procedures

Patients were evaluated at admission and subsequently after 3, 6, and 18 months of follow-up. Joint range of motion was measured using a standardized goniometer by experienced physiotherapists.

Motor function was graded on a scale ranging from 0 to 7, where:

- 0 indicated the absence of muscle contraction;
- 7 indicated complete movement against resistance.

The severity of OBPP was classified according to the Narakas classification:

- Narakas types I and II were considered partial lesions;
- Narakas types III and IV were considered complete lesions.

2.9. Rehabilitation Protocol

The rehabilitation program combined the following therapeutic interventions:

- postural immobilization;
- passive mobilization exercises;
- sensory stimulation;
- electrical stimulation;
- progressively increasing active exercises.

The therapeutic strategy was individualized according to the child's age and the severity of the neurological impairment.

2.10. Statistical Analysis

Data were analyzed using SPSS software (version 22.0) and R statistical software.

Continuous variables were summarized using means, medians, and standard deviations, whereas categorical variables were expressed as frequencies and percentages.

Bivariate analyses were performed using Pearson's chi-square test, Fisher's exact test, or Yates' continuity correction, as appropriate.

Multivariable logistic regression using generalized estimating equations (GEE) with an exchangeable correlation structure was performed to identify factors associated with functional recovery during follow-up.

Statistical significance was defined as a two-sided p-value below 0.05.

2.11. Ethical Considerations

This study was based on routinely collected data obtained during the standard clinical management of patients. Verbal informed consent was obtained from parents or legal guardians before enrolment. Patient anonymity and data confidentiality were strictly maintained throughout the study.

3. Results

3.1. Hospital Frequency

During the study period, 28,939 admissions were recorded at the National Center for Orthopedic Rehabilitation of Mali (CNAOM), among which 1123 cases of obstetric brachial plexus palsy (OBPP) were identified, corresponding to a hospital frequency of 3.8%. A total of 150 children were included in the final analysis.

3.2. Maternal Characteristics

Maternal age ranged from 17 to 40 years, with a mean age of 28.4 ± 5.2 years. Most mothers had attended at least four antenatal consultations.

Dystocic deliveries accounted for 71.3% of cases, and instrumental extraction was performed in 24.7% of patients (**Table 1**, **Figure 1**).

Table 1. Distribution of mothers according to maternal age at delivery.

Age group (years)	Number	Frequency
15 - 19	6	4.0%
20 - 24	41	27.3%
25 - 29	38	25.3%
30 - 34	37	24.7%
35 - 39	21	14.0%
≥40	7	4.7%
Total	150	100%

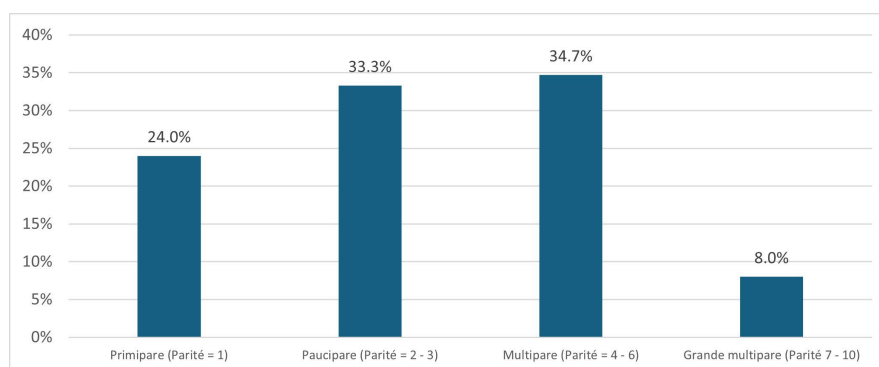


Figure 1. Distribution of mothers according to parity.

3.3. Children's Characteristics

The median age at diagnosis was 4 months. Boys accounted for 57.3% of the study population (**Table 2**).

The median birth weight was 3765 g, and macrosomia was identified in 38.7% of newborns.

Partial Narakas lesions (types I and II) represented 56.7% of cases, whereas complete lesions (types III and IV) accounted for 43.3%.

3.4. Functional Outcome

After three months of follow-up, all children exhibited a motor score greater than 2 (**Figure 2**).

At the 18-month evaluation, most children demonstrated substantial functional improvement, with scores ranging from 6 to 7.

The overall recovery rate reached 78%, whereas 22% of children presented persistent motor sequelae.

Table 2. Distribution of all cases of obstetric brachial plexus palsy admitted during the study period and of the study cohort according to age.

Age group (months)	Total OBPP cases	Study cohort
0 - 1	12 (1.1%)	0 (0.0%)
1 - 3	989 (88.1%)	64 (42.7%)
4 - 6	46 (4.1%)	35 (23.3%)
7 - 9	24 (2.1%)	17 (11.3%)
10 - 12	21 (1.9%)	10 (6.7%)
13 - 22	17 (1.5%)	13 (8.7%)
23 - 36	14 (1.2%)	11 (7.3%)
Total	1.123 (100%)	150 (100%)

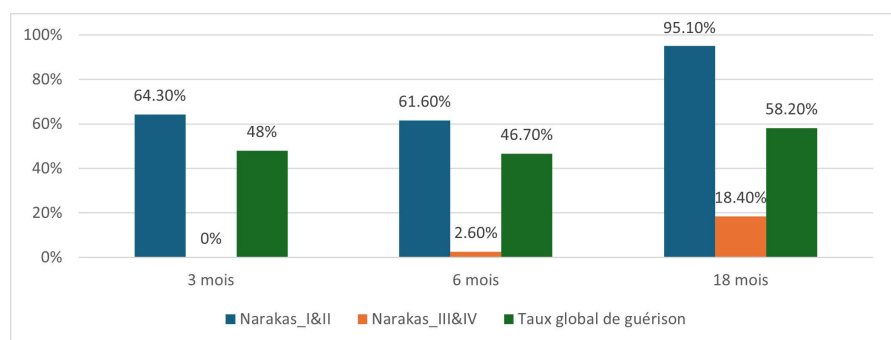


Figure 2. Changes in recovery rates in the two groups.

3.5. Factors Associated with Recovery (Table 3 and Table 4; Figure 3 and Figure 4)

Multivariate analysis revealed that the following factors were independently associated with better functional recovery:

- partial forms of OBPP (adjusted OR = 3.86; 95% CI: 2.78 - 5.36; $p < 0.001$);
- maternal age below 35 years (adjusted OR = 2.30; 95% CI: 1.45 - 3.67; $p < 0.001$);
- primiparity (adjusted OR = 1.55; 95% CI: 1.08 - 2.21; $p = 0.017$);
- normal or low birth weight (adjusted OR = 1.75; 95% CI: 1.16 - 2.63; $p = 0.007$).

Conversely, complete Narakas lesions were associated with slower recovery and an increased risk of long-term functional sequelae.

Table 3. Factors associated with recovery in multivariate analysis.

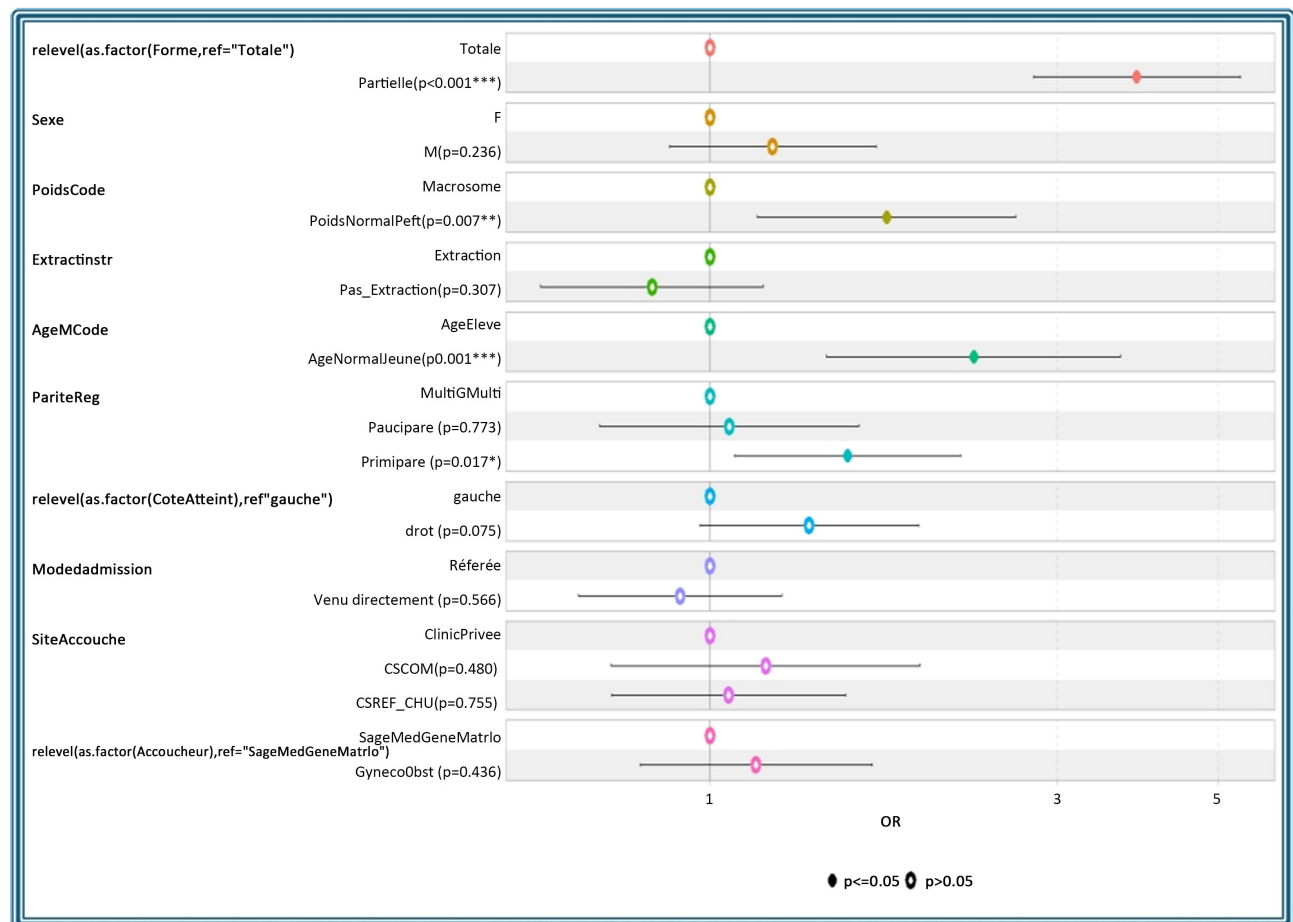
Variables	Recovered (N = 117)	Sequelae (N = 33)	OR	95% CI	p-value
Sex					
Male	60.7%	45.5%	1.8	0.8 - 4.1	0.121
Female	39.3%	54.5%	Reference	-	-
Time to diagnosis					
1 - 6 months	74.4%	36.4%	12.1	4.3 - 33.6	<0.001
7 - 12 months	17.9%	18.2%	5.8	1.7 - 19.5	0.005
≥13 months	7.7%	45.5%	Reference	-	-
Narakas groups					
Narakas I - II	94.0%	6.1%	243.6	48.1 - 1232.3	<0.001
Narakas III - IV	6.0%	93.9%	Reference	-	-
Affected side					
Right	66.7%	54.5%	1.7	0.8 - 3.6	0.203
Left	33.3%	55.5%	Reference	-	-
Birth weight					
<4000 g	68.4%	36.4%	3.8	1.7 - 8.5	0.001
≥4000 g	31.6%	63.6%	Reference	-	-
Instrumental extraction					
Yes	25.6%	21.2%	1.3	0.5 - 3.2	0.603
No	74.4%	78.8%	Reference	-	-

Table 4. Analysis of factors associated with recovery using a generalized estimating equation (GEE) logistic regression model.

Characteristics	Odds ratio	95% confidence interval	p-value
Type of brachial plexus palsy			
Complete lesion	Reference	-	-
Partial lesion	3.86	2.78 - 5.36	<0.001
Sex			
Female	Reference	-	-
Male	1.22	0.88 - 1.69	0.20
Birth weight			
Macrosomia	Reference	-	-
Normal or low birth weight	1.75	1.16 - 2.63	0.007

Continued

Instrumental extraction			
Extraction performed	Reference	-	-
No extraction	0.83	0.58 - 1.18	0.30
Maternal age			
Maternal age $\geq$ 35 years	Reference	-	-
Maternal age < 35 years	2.30	1.45 - 3.67	<0.001
Parity			
Multiparous or grand multiparous	Reference	-	-
Pauciparous	1.06	0.70 - 1.60	0.80
Primiparous	1.55	1.08 - 2.21	0.017
Affected side			
Left	Reference	-	-
Right	1.37	0.97 - 1.93	0.075



Direct admission: OR = 0.91 (95% CI: 0.66 - 1.26).

Community health centers: OR = 1.19 (95% CI: 0.73 - 1.95).

Referral health centers or university hospitals: OR = 1.06 (95% CI: 0.73 - 1.54).

Obstetrician-gynecologist: OR = 1.16 (95% CI: 0.80 - 1.67).

Figure 3. Forest plot of factors associated with recovery.

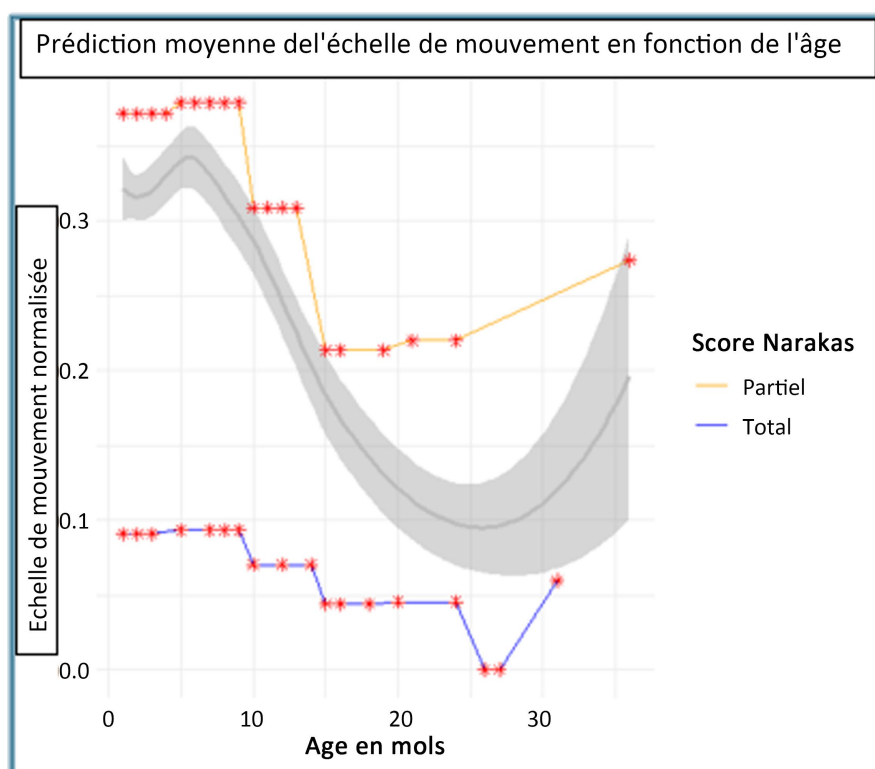


Figure 4. Visualization of changes in the predicted mean scores of global limb movement over time.

4. Discussion

This study represents one of the few African longitudinal series focusing on the rehabilitation management of obstetric brachial plexus palsy (OBPP).

The hospital frequency observed at the National Center for Orthopedic Rehabilitation of Mali (CNAOM) appears high compared with the incidence rates reported in high-income countries. This difference may be explained by the status of the institution as a national referral center and by the difficulties encountered in accessing specialized obstetric care in peripheral settings.

The predominance of Erb-Duchenne palsy observed in our cohort is consistent with findings reported in the international literature. The upper roots of the brachial plexus are particularly vulnerable to lateral traction forces occurring during shoulder dystocia.

The overall recovery rate of 78% observed in our study is comparable to that reported in several international series. Nevertheless, complete Narakas lesions remained associated with a significantly poorer prognosis.

The time to consultation also emerged as a major determinant of functional outcome. Children who received early management achieved better motor recovery, emphasizing the importance of systematic neonatal screening and prompt referral to rehabilitation facilities.

Macrosomia and dystocic delivery were frequently observed in our cohort, confirming their role as major obstetric risk factors for OBPP.

5. Strengths and Limitations

One of the major strengths of this study lies in the standardized longitudinal follow-up protocol, including repeated evaluations over an 18-month period.

However, several limitations should be acknowledged:

- the single-center design;
- the lack of systematic electrophysiological assessment;
- the absence of surgical exploration in severe cases;
- the potential risk of selection bias related to the inclusion of regularly followed patients.

6. Conclusions

Obstetric brachial plexus palsy is a common condition in Mali's leading rehabilitation center.

Early functional rehabilitation significantly improves motor performance, particularly in partial Narakas lesions.

Delayed diagnosis, complete lesions, and certain obstetric factors remain associated with an unfavorable prognosis.

Strengthening neonatal screening programs, improving obstetric prevention strategies, and ensuring earlier access to rehabilitation services could substantially improve the functional outcomes of children affected by OBPP in Mali.

Author Contributions

All authors contributed to the study design, data collection, statistical analysis, and manuscript preparation.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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