

# Obstetric Brachial Plexus Palsy of Newborns and Infants: Functional Outcomes after Rehabilitation by Their Own Parents

Ngo Yamben Marie-Ange<sup>1,2\*</sup>, Manga Alexandre<sup>2</sup>, Muluem Kennedy<sup>1,3</sup>,  
Mvondo Obama Serge Arnaud<sup>2</sup>, Nseme Etouckey Eric<sup>1</sup>, Nana Chunteng Theophile<sup>4</sup>,  
Tsiagadigui Tsiagadigui Jean-Gustave<sup>1</sup>, Mosoh Franklin Muluh<sup>1</sup>, Mbassi Awa<sup>1,5</sup>,  
Ibrahima Farikou<sup>1,2</sup>

<sup>1</sup>Faculty of Medicine and Biomedical Sciences, University of Yaoundé I, Yaounde, Cameroon

<sup>2</sup>National Centre for the Rehabilitation of Persons with Disabilities in Yaoundé, Yaounde, Cameroon

<sup>3</sup>Yaoundé General Hospital, Yaounde, Cameroon

<sup>4</sup>Faculty of Health Sciences, University of Buea, Cameroon

<sup>5</sup>Mother-Children Center of the Chantal Biya Foundation of Yaoundé, Yaounde, Cameroon

Email: \*marieyamben@gmail.com

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## Abstract

**Introduction:** Obstetric palsy of the brachial plexus (OPBP) is a paralytic lesion common to obstetric trauma, whose clinical presentation varies according to the severity and extent of the root lesions at birth. Early and appropriate rehabilitation is necessary in order to improve the functional prognosis of the injured limb. Under special conditions, parents could carry out this physiotherapy themselves. **Objective:** The aim of this work was to assess limb functional recovery in newborns and infants with OPBP after rehabilitation by their parents. **Patients and Methods:** We conducted a prospective study at the NCRDP in Yaoundé over a period of 18 months. We included all patients aged 0 to 2 years with OPBP, isolated or associated with other lesions and followed at least two (02) years at the NCRDP. **Results:** We recruited 69 cases. The hospital frequency of OPBP was estimated at 1.02%. The age at first consultation was [0 - 28 d] in 50.8% of cases. The sex ratio was 0.68. The right side was reached in 54.4% of cases. The Erb's palsy predominated in 79.7% of cases. The risk factors for OPBP were vaginal delivery, cephalic presentation, shoulder dystocia and macrosomia. Physiotherapy was performed as prescribed in 94.9% of cases allowing excellent and good functional recovery in 76.81% of cases. **Conclusion:** In the care of their children's OPBP rehabilitation by sensitized, actively involved and supervised parents would be a good alternative to professional physiotherapy in all situations where the latter would not be possible.

## Keywords

Obstetric Palsy, Brachial Plexus, Functional Rehabilitation, Macrosomia, Childbirth, Dystocia

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## 1. Introduction

Obstetric palsy of the brachial plexus (OPBP) is a flaccid sensory paralysis secondary to trauma to one or more roots of the brachial plexus that occurred during childbirth. It affects 0.5 to 5.1 newborns per 1000 live births [1] [2] [3]. Its occurrence is correlated with many fetal and maternal risk factors, but also with the quality of obstetric care. The diagnosis of OPBP is essentially clinical, based on the immediate postnatal finding of the absence of spontaneous movements of the shoulder, elbow, wrist and/or fingers [3]. Additional examinations may be necessary to diagnose associated lesions, the most common of which are clavicular fracture, shoulder dislocation and proximal humeral fracture, and to determine the type of nerve damage when planning corrective or palliative surgery [2] [4]. Early and appropriate management allows a satisfactory recovery in more than 50% of cases [5] [6] [7] but sequelae are frequent [4] [8]. In a context marked by insufficiency of health structures [9], equipment and experienced staff [10], the occurrence of OPBP is more frequent and their care is conditioned by the economic power of the populations and the absence of health insurance. In front of this observation, we developed “NCRDP self-rehabilitation protocol” which is a simple rehabilitation protocol, for parents who could not respect the conditions of a professional physiotherapy and to be carried out by these parents, on their children with OPBP. The aim of this work was to evaluate after 2 years, the functional recovery of OPBP in these infants re-educated by their parents and followed at the NCRDP of Yaoundé, reference center for the management of disabling diseases.

## 2. Patients and Methods

We conducted a prospective cohort study over an 18-month period, from January 2018 to June 2019, at the National Center for the Rehabilitation of People with Disabilities (NCRDP) in Yaoundé. Created in 1971, it now has 250 staff including 4 orthopedists, 1 ENT, 1 neuropediatrician, 1 neurologist, 3 general practitioners, 20 physiotherapists, 5 psychomotor therapists, 3 ergotherapists, many psychologists, social workers and nearly 11,000 patients rehabilitated per year; making it a sub-regional reference centre for the holistic management of disabling diseases.

The diagnosis of OPBP was clinical, retained in front of a total or partial flaccid paralysis of one or both upper limbs, occurring during childbirth, dystocic or not. It was called proximal or Duchenne-Erb's palsy in front of the functional impotence of the shoulder and elbow; distal or Klumpf-Dejerine's palsy in front

of paralysis of the hand and wrist; total in front of the proximal and distal involvement of the limb. Because of its unavailability in children under 5 years of age, no electroneuromyogram (ENMG) has been performed at the inclusion of our patients.

Patients were received in specialized consultation by orthopedists who diagnosed and explained to parents what is an OPBP (**Figure 1**), made them aware of the importance of rehabilitation and regular follow-up. If the associated fracture was suspected, a standard X-ray was performed. Fractures associated with the OPBP of newborns were orthopedically immobilized for up to three weeks. When on the control X-ray, a primary callus was visible, rehabilitation was allowed.

Included in our study was any patient, male or female, aged 0 to 2 years, with obstetric paralysis of the brachial plexus, regardless of stage and clinical form, isolated or associated with other lesions such as clavicular fracture, fracture of the proximal humerus or glenohumeral dislocation AND whose parents lived either far from the health facilities or near the hospital which did not have physiotherapists and parents with financial difficulties to pay the fees for the rehabilitation of their child. We excluded any patient with non-obstetric paralysis of the brachial plexus (traumatic, tumor, infectious), paralysis associated to cerebral palsy or stroke; any patient who has missed 2 consecutive appointments.

Sampling was consecutive and extensive. The follow-up schedule was one consultation every month for 3 months then every 2 months for 6 months then every 3 months for 6 months and finally, every 6 months. The minimum required follow-up was set at 24 months.

The rehabilitation protocol by the parents, developed by a team of orthopaedic surgeons and physiotherapists of the NCRDP and which we will call in the rest of the text “NCRDP self-rehabilitation protocol” (**Figure 2**), was explained to them from the first consultation. It consists of three groups of exercises. The



**Figure 1.** Incomplete active motion in Erb's palsy in a 3 months old girl.




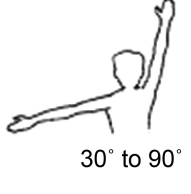
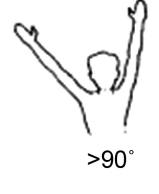
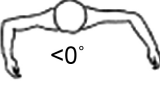
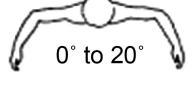
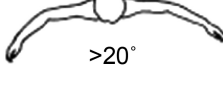









**Figure 2.** “NCRDP self-rehabilitation protocol” executed by the mother of this girl. (A): elbow extension; (B): elbow flexion; (C): wrist flexion; (D): wrist extension; (F): shoulder circumduction; (G): shoulder abduction.

first group consists of passive, gentle, repeated and systematic mobilization of the shoulder, elbow, wrist and fingers, regardless of age and lesion type of OPBP. Flexion and extension movements are reserved for elbows, wrists and fingers while at the shoulders, abduction movements, antepulsion, internal and external rotation, time and counter-clockwise circumductions are applied. Sessions of 15 to 20 minutes at least 08 times per day were encouraged to avoid parents having to practice long sessions of several hours in a row. The second group of exercises includes tactile sensory stimulation by the outcrops and caresses of the injured limb. The third group, for infants aged at least of 3 months, includes fun interactive activities with colorful and sound toys (rattles, balls, ...) and light balloons to stimulate recovery through bimanual gripping.

To assess the functional recovery of the injured limb, in our patients, we used 3 rating scales: the Raimondi score (**Figure 3**) to assess the hand and wrist in distal and total OPBP; Mallet score (**Figure 4**) to assess shoulder and elbow in

0	Complete paralysis or functionally useless finger flexion Nonusable thumb without grasping function Little or no sensation
1	Limited finger flexion No finger or wrist extension Key grip possible
2	Active wrist extension and use of the tenodesis effect Passive key grip in pronation
3	Complete active finger and wrist flexion Active thumb movement, including abduction and opposition Intrinsic equilibrium No active supination

**Figure 3.** Raimondi score for hand.

	Grade I	Grade II	Grade III	Grade IV	Grade V
Global Abduction	None	 <math><30^\circ</math>	 <math>30^\circ</math> to <math>90^\circ</math>	 ><math>90^\circ</math>	Normal
Global external rotation	None	 <math><0^\circ</math>	 <math>0^\circ</math> to <math>20^\circ</math>	 ><math>20^\circ</math>	Normal
Hand to neck	None	 Not possible	 Difficult	 Easy	Normal
Hand on spine	None	 Not possible	 S1	 T12	Normal
Hand to mouth	None	 Marked trumpet sign	 Partial trumpet sign	 <math><40^\circ</math> of abduction	Normal

**Figure 4.** Mallet score for shoulder.

Erb and total OPBP; and the British Medical Council for upper limb (BMC) score (Figure 5) for scoring overall muscle strength.

We built our database using CsPro Software Version 6.0.1 and the analysis was done using Statistical Package for the Social Sciences (SPSS) Version 20 and Microsoft Excel 2010. The Chi2 test was used with a  $p$  value < 0.05 considered statistically significant.

Grade	Muscle Power
5	Normal power
4	Active movement against resistance and gravity
3	Active movement against gravity but not resistance
2	Active movement possible only with gravity eliminated
1	Flicker or trace of contraction
0	No contraction

**Figure 5.** British medical council score for muscle strength.

### 3. Results

We included 69 patients in our cohort. The hospital prevalence of newborn and infant OPBP at the NCRDP was estimated at 1.02% (6749 paediatric consultations).

#### 3.1. Epidemiological Patterns

Girl was predominant in 41 cases (59.42%) with a sex ratio (G/F) of 0.68. The right side was affected in 53.62% of cases (37) and no bilateral form was diagnosed.

At the first consultation, newborns aged [0 - 28 d] were the most common with 35 cases (50.72%) followed by infants aged 18 - 24 months in 31 cases (44.92%) (**Figure 6**).

#### 3.2. Maternal and Fetal Obstetric History

In our series, 91.30% of the women (63) had regular follow-up of their pregnancy with a minimum of 04 prenatal consultations (PNC). All patients were born after vaginal delivery, no cases of caesarean section were reported. Cephalic presentation was found in 66 cases (95.65%). Shoulder dystocia was documented in 37 cases (53.62%). A clavicular fracture was associated with OPBP in 3 infants (4.35%). Macrosomia was reported in 60.87% of patients (42) with an average birth weight of 4028.18 g  $\pm$  671.87 g.

#### 3.3. Clinical Patterns

According to clinical forms, Erb's palsy was predominant in 55 cases (79.71%), total palsy in 13 cases (18.84%) and Klumpf-Dejerine palsy in one case (1.45%).

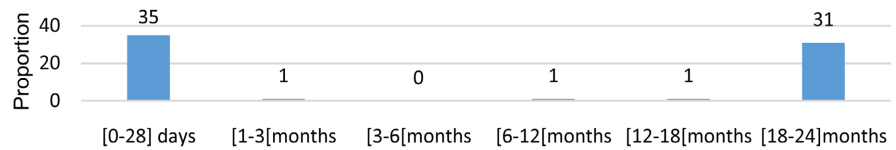
12 patients in our series (17.39%) had, at their first consultation, a complication: active limitation of external rotation in 6 patients (8.70%), gross limb hypotrophy in 4 patients (5.80%) and scapula detachment in 2 patients (2.9%).

#### 3.4. Therapeutic Patterns

"The NCRDP self-rehabilitation protocol" was performed as prescribed in 95.65% of patients (66). The parents of the other three patients (4.35%) were absent

from one check-up appointment.

The evolution of functional recovery (**Table 1**) shows a gradual improvement at 3 months, 6 months and 12 months. On the other hand, between 12 and 24 months, it stagnated while muscle strength continued to progress.



**Figure 6.** Age repartition of the population of the study.

**Table 1.** Evolution of the functional recovery of OPBP according to different scores at different terms of the follow-up.

Mallet score					
Variables	Inclusion	3 months	6 months	12 months	24 months
None (0 - 4)	9 (13.24%)	6 (8.82%)	3 (4.41%)	1 (1.47%)	0
Poor (5 - 9)	21 (30.88%)	16 (23.53%)	8 (11.76%)	1 (1.47%)	0
Fair (10 - 13)	12 (17.65%)	13 (19.12%)	16 (23.53%)	18 (26.47%)	20 (29.41%)
Satisfactory (14 - 17)	12 (17.65%)	14 (20.59%)	17 (25%)	18 (26.47%)	18 (26.47%)
Good (18 - 22)	8 (11.76%)	10 (14.7%)	11 (16.18%)	14 (20.59%)	14 (20.59%)
Excellent (22 - 25)	6 (8.82%)	9 (13.24%)	13 (19.12%)	16 (23.53%)	16 (23.53%)
<b>Total</b>	<b>(55 Erb palsy + 13 Total palsy=) 68</b>				
Raimondi score					
Variables	Inclusion	3 months	6 months	12 months	24 months
None	8 (57.14%)	5 (35.71%)	2 (14.29%)	1 (7.14%)	1 (7.14%)
Poor	4 (28.57%)	2 (14.29%)	2 (14.29%)	1 (7.14%)	1 (7.14%)
Fair	0	2 (14.29%)	2 (14.29%)	1 (7.14%)	1 (7.14%)
Satisfactory	1 (7.14%)	1 (7.14%)	1 (7.14%)	2 (14.29%)	2 (14.29%)
Good	1 (7.14%)	2 (14.29%)	2 (14.29%)	2 (14.29%)	2 (14.29%)
Excellent	0	2 (14.29%)	5 (35.71%)	7 (50%)	7 (50%)
<b>Total</b>	<b>(1 Klumpf palsy + 13 Total palsy =) 14</b>				
BMC Upper limb					
Variables	Inclusion	3 months	6 months	12 months	24 months
1/5	11 (15.94%)	6 (8.7%)	4 (5.8%)	2 (2.9%)	1 (1.45%)
2/5	22 (31.88%)	14 (20.29%)	8 (11.6%)	1 (1.45%)	1 (1.45%)
3/5	19 (27.54%)	24 (34.78%)	22 (31.88%)	18 (26.09%)	8 (11.59%)
4/5	17 (24.64%)	20 (28.98%)	22 (31.88%)	33 (47.82%)	43 (62.32%)
5/5	0	5 (7.25%)	13 (18.84%)	15 (21.74%)	16 (23.19%)
<b>Total</b>	<b>69</b>				

**Table 2.** Evolution of functional recovery by type of OPBP.

Types of OPBP	Full recovery		Total	<i>p</i> value
	Yes	No		
Erb's palsy	11 (15.94%)	44 (63.77%)	55 (79.71%)	<b>0.189</b>
Klump's palsy	0 (0%)	1 (1.45%)	1 (1.45%)	
Total palsy	0	13 (18.84%)	13 (18.84%)	
<b>Total</b>	<b>11 (15.94%)</b>	<b>58 (84.06%)</b>	<b>69 (100%)</b>	

Functional recovery was good to excellent in 44.12% of cases according to the Mallet score and in 64.29% of cases according to the Raimondi score. Muscle strength was greater than or equal to 4/5 in 85.5% of the children in our series.

Functional recovery was total, without any sequelae, in 15.94% of cases (**Table 2**). This concerned only proximal OPBP without this being statistically significant ( $p = 0.189$ ).

## 4. Discussion

### 4.1. Incidence, Age et Sexe

In our series, the average annual incidence of OPBP in consultation was 1.02%. This figure is much lower than those found in African literature where it varies between 11% and 27.2% [6] [11]. This incidence is largely dependent on the quality of pregnancy monitoring and obstetric care. The improvement of which over the past decade has been reported by several authors [11] [12] [13] [14] [15]. The average age at the first consultation was 15 days with extremes of (1 day-2 years) and a peak frequency at [0 - 28 d] with 50.72% of cases. The delay in consultation, also reported by Tchagbele *et al.* (19.7 days) [6], can be explained by a prolonged stay in neonatology for another reason, the absence of diagnosis in the birth room by the maternity team, the absence of the pediatric consultation of the 48 1st hours of the newborn or the financial difficulties.

The girl predominance in our series (52.3%) is reported by some authors [5] [6] [16] but the opposite observation is made by others [1] [2] [17]. This disparity could reflect a study population representative of the general population or the complete lack of a link between gender and OPBP.

### 4.2. Obstetric and Perinatal Data

In our series, 91.3% of mothers had done at least 4 PNC. The increase in women's attendance at antenatal clinics is in line with the improvement in perinatal care, but despite this, the incidence of OPBP does not appear to be decreasing [12] [15] [18]. However, the technical platform and deliveries in non-conventional health facilities have been highlighted [10].

Cephalic presentation (61.3%) and vaginal delivery (65.9%) are strong providers of OPBP in our study but also for others [8] [11] [16] [19], especially when combined with long and/or dystocic labour [13]. Caesarean delivery is correlated



with a lower risk of occurrence of OPBP in our study (0.4%). Several studies support this idea and even assimilate the caesarean section to protective measure [1] [11] [20]. These low numbers have led some countries to consider caesarean section as a mode of delivery to reduce the risk of OPBP [21].

Macrosomia is also an important risk factor for OPBP in our series (56.1%). Its frequency is widely reported in the literature [1] [8] [13] [21] and may be related to changes in the lifestyle and diet of populations [9].

### 4.3. Clinical and Paraclinical Data

The preferential attack on the right side in our series (56.3%) is found by several authors [1] [5] [6] [11] [16]; correlation made with the anterior left occipito-iliac variety which accounts for about 60% of cephalic presentations [22].

The Erb's palsy was the most common in our series (82.4%) but its predominance is recognized [5] [11] [23]. Deaver *et al.* [24] discussed risk factors for the occurrence of this entity, namely macrosomia, maternal diabetes, instrumentalized childbirth, dystocic childbirth, maternal obesity, excessive maternal weight gain in pregnancy and advanced gestational age.

The standard X-ray was the most performed paraclinical examination, in case of suspicion of associated bone lesions. Diagnostic MRI, because of its relatively prohibitive cost, was not performed in our study. We chose the ENMG whose diagnostic and prognostic contributions are recommended by several authors [2] [5] [16]. But due to the local unavailability [16] of equipment suitable for children under 5 years of age, we opted for a detailed clinical evaluation of our cohort. In a country with limited resources, clinical course over time could make it possible to presume the favourable or unfavourable nature of the prognosis; the only unknowns being the time and the total or partial nature of the functional recovery.

### 4.4. Therapeutic Data

Initial conservative treatment of OPBP is recommended by several authors [5] [6] but attitudes differ: immobilization elbow to the body for some [7] [12], orthosis or thoracobrachial plaster in abduction for others [6] or functional rehabilitation for the last [5] [6] [12] [17] [25]. While it is accepted that before 6 months, any surgical option should be reserved for nerve avulsions of the plexus [6] [25], there is no consensus elsewhere. Surgery taking precedence over indications in OPBP whose functional recovery would not be total from 3 months [23] but especially in sequellar OPBP; this ranges from muscle transfers to humeral derotation osteotomies, whether or not associated with microsurgery techniques [6] [8] [23] [26]. But the latter are still difficult to access in countries with limited resources [5] [7] [18]. Our challenge was to propose a solution to newborns but also to infants with OPBP in order to reduce the risk of sequelae, especially for parents who cannot submit to an institutional functional rehabilitation protocol (indigence, remote geographical location, etc.) and pending the rea-

lization of the ENMG. Functional treatment is one of the most widely used treatment options for the early management of OPBP. However, its realization by the parents or tutors of the children has not yet been described in the literature. It is this therapeutic alternative that we have implemented and evaluated. However, unlike most studies that only refer to newborn OPBP [5] [6] [7] [8] [11] [13] [14] [17] [19] [25], frequent consultation delays in our context have led us to include infants up to 2 years of age in order to also look for solutions for this population (49.28% of our series).

We used 3 rating scales for shoulder, hand and muscle strength. Despite a relatively low full (uncomplicated) recovery rate (15.56%), muscle strength was greater than or equal to 4/5 in 85.5% of the children in our series. Functional recovery was satisfactory to excellent in 70.6% of total and Erb's palsy according to the Mallet score and according to the Raimondi score, it was good and excellent in 64.3% of total and Klumpf's palsy. Wilson *et al.* [8] in the USA reports a similar total recovery rate with persistence of OPBP at 1 year in 85% of cases despite good management. It incriminates certain risk factors namely macrosomia, prolonged or induced work, cephalic presentation and the Claude-Bernard-Horner sign whose presence could have a prognostic value of the persistence of OPBP at 1 year and recommends thinking around a decision-making algorithm. Shoulder dystocia is also correlated with the persistence of OPBP beyond 12 months [12] [13]. The meta-analysis of Chauhan *et al.* [14] reports a persistent rate of OPBP in adulthood varying from 10% to 23% depending on the country and justifies the interest of improved early management. The observation of a stagnation of recovery from 12 months in our series confirms the relevance of these recommendations. This also allows, in the absence of any paraclinical exploration, to discuss the absence of full recovery with the parents of these children after a year of rehabilitation in our context. In addition, regarding functional recovery, several authors report good to excellent rates ranging from 52.94% to 83.07% [5] [6] [12] [27]. Also, although our sample is relatively small and includes infants, our results are comparable to those of the literature and have the merit of proposing an alternative to all parents living in precariousness, at a distance from care structures but also to all health systems where qualified human resources would be deficient. We assume that it is this difficult context which inspired and enabled the development of this protocol. We assume that it is the difficult context for our populations that inspired and enabled the development of the "NCRDP self-rehabilitation protocol". We believe that this one is reproducible and could be used in all cases where physiotherapy by professionals is not possible. This would involve awareness-raising, training, participation of parents and guardians of these children as well as their regular medical follow-up by experienced professionals.

## 5. Conclusion

The OPBP are potentially disabling lesions whose early management is essential

for a better functional prognosis. In a context of precariousness and/or inadequacy of the health system, the early and regularly monitored involvement of parents in the early functional rehabilitation of their children is a promising alternative with satisfactory functional results comparable to those of the literature. We can recommend the rehabilitation up to one year in this context. However, the opening of national registries and the conduction of multi-centre studies would further improve the quality of care and develop contextual and consensual decision-making algorithms.

### Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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