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Original Article

## High Prevalence of Early Language Delay Exists Among Toddlers With Neonatal Brachial Plexus Palsy



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## ABSTRACT

**AIM:** An association of language impairment with neonatal brachial plexus palsy has not been reported in the literature. The current treatment paradigm for neonatal brachial plexus palsy focuses on upper extremity motor recovery with little formal assessment of other aspects of development, such as language. We performed a cross-sectional pilot study to investigate early language delay prevalence in toddlers with neonatal brachial plexus palsy and potential neonatal brachial plexus palsy–related factors involved. **METHOD:** Twenty toddlers with neonatal brachial plexus palsy were consecutively recruited (12 males and eight females; mean age, 30 months). Preschool Language Scale Score (4th edition), demographics, and socioeconomic status were collected. Neonatal brachial plexus palsy–related factors such as palsy side, treatment type, Narakas grade, muscle Medical Research Council score, and Raimondi hand score were reported. Student *t* test, chi-square test, or Fisher exact test were applied. Statistical significance level was established at  $P < 0.05$ . **RESULTS:** Of study participants, 30% had language delay, whereas the prevalence of language delay in the population with normal development in this age range was approximately 5–15%. **INTERPRETATION:** We observed high language delay prevalence among toddlers with neonatal brachial plexus palsy. Although our subject sample is small, our findings warrant further study of this phenomenon. Early identification and timely intervention based on type of language impairment may be critical for improving communication outcome in this population.

**Keywords:** brachial plexus injury, brachial plexus palsy, language delay, neonate

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### Introduction

Speech-language development during the period from 24 to 36 months of age is an important indicator of a toddler's global development and cognitive function. Early language impairment can lead to other developmental impairments and affect future school performance.<sup>1</sup> The prevalence of language delay among preschool children (2–4.5 years old) is approximately 5–8%;<sup>2</sup> for children at age

36 months, the incidence is approximately 14%.<sup>3</sup> Early identification of children with language delay is necessary for timely treatment. Similarly, recognizing perinatal conditions that are associated with early language delay may facilitate the identification and treatment of children at risk for language delay. Potential risk factors for language delay include physical impairment, birth deficits, and environmental factors such as family socioeconomic status and parent education level.<sup>4,5</sup> Of interest with regard to our study, investigators have reported an association between language delay and motor impairments in school-aged children.<sup>6–8</sup>

In treating patients with neonatal brachial plexus palsy (NBPP) for >30 years, our senior clinician has anecdotally observed a higher prevalence of language delay among NBPP patients than in the general

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**What this paper adds?**

- High prevalence of language delay exists in neonatal brachial plexus palsy (NBPP) population.
- Early language delay identification and timely interventions are crucial.
- Identifying body and verbal language coordination at early stages improves outcomes.
- Biological and environmental language delay risk factors should be considered.
- Contributes improved clinical treatment paradigms for NBPP.

population within the 24- to 36-month age group. NBPP manifests as paralysis and/or paresis and loss of sensation in the affected arm in approximately 0.4–2.6 per 1000 live births<sup>9,10</sup>; the condition results from stretching of the nerves of the brachial plexus in the perinatal period. Previous studies revealed NBPP might be associated with hand preference and language lateralization<sup>11,12</sup>; we hypothesized that partial or whole arm function loss might interfere with language development and be associated with language delay. No studies have reported a potential association of unilateral motor impairment in NBPP with language delay. Therefore, we assessed the prevalence of early language delay associated with NBPP and attempted to identify any NBPP characteristics that may also be associated with language delay. The contribution of this new knowledge could result in improved clinical treatment paradigms for NBPP in the context of childhood development.

**Methods***Participants*

In this observational study, 20 toddlers with NBPP (12 males and eight females) were consecutively recruited from the University of Michigan Interdisciplinary Brachial Plexus Program from May 2012 to July 2013. All participants had passed hearing screening. Developmental screening was performed by physiatrists and those with delays in areas other than speech or related to arm function were excluded from the study population. Inclusion criteria included patients 24–36 months of age with a diagnosis of NBPP without other comorbid diagnoses, from monolingual English-speaking only families. To control biological or physical risk factors that could possibly lead to language delay, patient medical records were reviewed before recruitment. Infants and toddlers who were preterm, had low birth weight (<1500 g), low or unknown Apgar score, or other physical impairments not associated with NBPP, were excluded from recruitment. Once parents of NBPP patients consented, they were asked to complete a questionnaire regarding demographics (child's and main parent's age, gender, ethnicity, and family history of language delay) and socioeconomic status (main parent's marital status, parents' highest education level, and family's health insurance). Study protocol was approved by the University of Michigan Institutional Review Board.

*Data collection*

A single board-certified speech-language pathologist administered the Preschool Language Scale, 4th edition (PLS-4), to assess each patient's speech-language development. The PLS-4 is a norm-referenced standardized measurement for identifying children from birth through 6 years 11 months who have a language disorder or delay.<sup>13–15</sup> The test targets receptive and expressive language skills in the areas of attention, play, gesture, vocal development, social communication, vocabulary, concepts, language structure, integrative language skills,

and phonological awareness. Administration and scoring time is 20–45 minutes. The PLS-4 provides age-based standard scores, percentile ranks, and age equivalents for the auditory comprehension and expressive communication subscales, as well as a total language score. Scales are normalized at 100, with a standard deviation of 15. PLS-4 reliability and validity have been established in previous studies for preschool children.<sup>15</sup>

NBPP-related characteristics, such as palsy side, treatment type, Narakas grade, Raimondi hand score, and deltoid and biceps power (expressed as British Medical Research Council [MRC] score) were evaluated by one of two occupational therapists using standard measurement protocol. The Narakas classification is an accepted measure of the extensiveness of NBPP based on the number of affected nerve roots of the brachial plexus, and the Narakas grade expresses the clinical continuum of NBPP.<sup>16,17</sup> The classification grades range from I to IV, with I as the least extensive palsy (C5–C6) and IV as the most extensive palsy (flail extremity and Horner syndrome, involving C5–T1). Raimondi hand score is used to evaluate hand function; scores range from 0 to 5, with 0 representing complete paralysis and 5 representing excellent function. MRC score is designed to measure muscle power with motor strength graded from 0 (no movement) to 5 (normal strength).

*Statistical analysis*

Participant and parent demographics were summarized using descriptive statistics. Numerical variables (age and PLS scores) were compared among delayed and non-delayed groups by Student *t* test and categorical variables by chi-square or Fisher exact test. Logistic regression was applied to analyze factors associated with language impairment. Analyses were performed using SPSS software, version 20 (SPSS Inc, Chicago, IL), with statistical significance level established at  $P < 0.05$ .

**Results**

During the study period, 53 toddlers with NBPP were within the 24- to 36-month age range. After initial screening using the exclusion criteria (bilingual families, preterm infants and toddlers, low birth weight, low and/or unknown Apgar score, or other physical impairments not associated with NBPP), 40 toddlers with NBPP were eligible for the study, and a recruitment letter was sent to the families. Twenty families declined study participation because of commute or no interest in the study. A total of 20 toddlers with NBPP (12 males and 8 females) were included in the study.

Thirty percent of toddlers with NBPP studied were diagnosed with language delay, approximately twice the incidence of normally developed, age-matched children. Overall, mean age of the toddlers was 30 months (S.D., 4 months), with the majority being white (65%) and male (60%). Mean parent age was 36 years (S.D., 11 years), with the majority being white (70%), female (85%), and married (50%). There was a trend in parent education level among delayed and non-delayed groups, but with no statistical significance. Two families did not report father's educational level. Essentially, most mothers in the delayed group had a high school diploma (50%), whereas 43% of mothers in the non-delayed group had a college degree. Only two (10%) families reported a family history of language delay, and most families had Medicaid as their primary insurance (55%). As for NBPP-related factors, palsy side was evenly distributed with one bilateral participant, and only 15% of patients were treated by surgical intervention. Overall, most children had good arm function with MRC scores of III–IV for deltoid (80%) and biceps (85%), and a Raimondi score of III–V (90%). Approximately, half of the children had less-

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