Chapter

Early Assessment of Speech: Useful Clinical Indicators of Later Outcomes

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Abstract

Children born with cleft lip and/or palate are at risk of speech problems. These may be related to nasality or to articulation difficulties. In many countries specialist speech and language therapists monitor these children from an early age. For clinicians and families, it is useful to know which children are at risk of later problems so that resources can be allocated appropriately, and families given clear information. The purpose of this study was to investigate whether it was possible to identify risk factors at age 12-months in a clinical setting. Speech assessments from 3-years were compared to findings at 12-months. The following speech variables were analyzed: canonical babbling, presence of anterior plosives and presence of cleft articulation errors. The findings showed that the presence of anterior plosives at 12-months was a predictor of later velopharyngeal function and articulation. These findings support the need for early assessment to determine the provision of early speech therapy intervention for children with cleft lip and/or palate.

Keywords: cleft palate, early speech predictors, canonical babbling, velopharyngeal function, articulation

1. Introduction

Children born with cleft palate +/− lip (CP+/−L) are at risk of developing speech, language, and communication difficulties. There may be ongoing issues with velopharyngeal incompetence (VPI) following primary palate repair, which can lead to hypernasal resonance, nasal airflow during speech and weakened consonants [1]. Atypical articulatory patterns may also prevail, such as posterior or non-oral production of consonants [2–3]. These difficulties have the potential to impair intelligibility, educational attainment, and the child's social interactions [4]. Persistent difficulties with articulation lead to the ongoing need for these children to access speech and language therapy. Data from the United Kingdom (UK), obtained from children born with non-syndromic CP+/−L, has shown that 40% do not achieve normal speech by age five [5]. A review in the UK in 2015 reported that the speech of children with unilateral cleft lip and palate (UCLP) can be severely affected with 17.2% classified as 'only just intelligible to strangers' or 'impossible to understand' at five years of age [6]. Reports from large-scale cohort studies in other countries have also shown that up to 50% of children have ongoing speech difficulties at five-years [7, 8].

Much has been written about speech development in children with CP+/−L. Studies have investigated the babbling patterns in infants with cleft palate [9, 10]; the development of vocabulary related to a restricted speech sound inventory [11]; the impact of different surgical protocols [7, 8]; and the persistent and disordered nature of speech difficulties in this population [12]. There is however, in general, limited longitudinal data that allows us to investigate the trajectories of speech development in these patients and specifically predictors at an early age have not been identified that would allow us to identify those at risk of later difficulties. Identifying early clinical indicators would allow us to allocate resources for intervention effectively. The few papers that have discussed possible predictors of speech outcomes related to cleft palate concluded that results were not robust enough to influence clinical decisions.

1.1 Early speech development

Speech development follows a typical trajectory during the first year of life, in both the cleft and non-cleft populations. Between 4 and 6 months of age, disengagement of the velum and epiglottis takes place, which enables the infant to breathe and produce vocalizations orally. At this stage, typically developing infants develop oral-nasal contrasts when vocalizing. From 6-months of age infants begin to babble, defined as 'the building blocks of speech' in which infants practice consonant-vowel sequences. A canonical syllable contains a fully resonant vowel and at least one consonant attached to the vowel; a rapid, smooth transition between these two phonemes is produced. By 10-months of age, canonical babbling will be frequent in the infant's repertoire. Simultaneous to the canonical babbling phase, at 6–9 months infants experience a peak in development regarding rhythmic stereotypies. This represents a transition from uncoordinated activity to complex, coordinated, voluntary motor control. The development of tongue and lip control supports the onset of canonical babbling. This development appears to be universal with research showing that languages share a commonality with regard to the first sounds acquired [13].

Children born with cleft palate in the developed world typically undergo surgery to repair the palate between six and eighteen months [14]. Timing of the surgery is an area under investigation as an unrepaired cleft of the palate during the period of development described above, can inevitably cause disruption to the typical trajectory. Children born with a cleft palate may experience a disruption in the development of rhythmic motor patterns that underlie canonical babbling [10]. Hagberg et al. [15] observed children with UCLP at 10-months of age and reported only 86% (N = 19) of participants to be babbling canonically. They also noted that the children who were not babbling canonically had reduced consonant inventories and fewer anterior plosives, compared to other participants in their study. This slow development of babble and consonant repertoire in children born with CP+/−L has been observed in other studies. Speech sound inventories may consist only of nasals and approximants - sounds at the extremes of the vocal tract which are unaffected by the cleft, those which do not require high pressure or anterior placement. This can continue, even one year after palate repair, particularly with consonants requiring high oral air pressure [11, 16].

1.2 Early outcome predictors for speech

Identification of early predictors of speech outcomes is beneficial in order to rule out children who are not at risk of later speech difficulties and to identify infants who are more likely to develop deviant speech processes. A systematic review of

the literature on children's speech development in the general population concluded that early consonant production and babbling patterns could be analyzed in future research to further our understanding of the relationship between early and later speech development [17]. Other studies have suggested that the absence of canonical babbling at 10–12 months of age may be a predictor of later speech and language problems, with Lohmander et al.'s study suggesting that children who were not canonical babbling were over ten times more likely to fall into a clinically significant group for speech and language problems [18]. Further studies have pointed to the presence of well-formed syllables and a variety of consonants in infancy as predictors of later speech and language outcomes [19].

In the cleft palate population, findings have been mixed. Some have echoed those stated above. Scherer, Williams and Proctor-Williams looked at pre-surgical babbling patterns in 13 children with CLP and found a positive correlation between babbling at 6-months and later speech accuracy at 30-months ($r = .62$, $p < .05$) [11]. In contrast, Chapman and colleagues found no significant correlation between either pre-surgical or post-surgical babbling and later speech outcomes at 21-months [20] and 39-months [21]. With regard to the presence of consonants as a predictor, Chapman, Hardin-Jones and Halter found a significant correlation between the presence of true plosive sounds at 13-months (post-surgery) and speech at 21-months ($r = .67$, $p < .01$) [20]. Klinto et al. also found a significant correlation between the production of plosive sounds at 18-months and speech outcomes at 3-years ($r = .47$, $p = <.05$), in particular the presence of anterior plosives such as/b, d/ ($r = .49$, $p < .05$) and the variety of plosives ($r = .53$, $p < .05$) [22]. In contrast again, Chapman found no significant correlation between the presence of true plosives at 12-months and speech outcomes at 39-months [21]. The development of cleft articulation errors has been written about with regard to older children and so the early development of these would seem to be a variable worthy of interest when thinking about predictors. Hattee et al. looked at the presence of posterior and non-oral sounds in children aged 18-months [23]. They concluded that it was not possible to predict from the presence of these sounds at such a young age as they saw development between 18- and 36-months with a reduction in the number of cleft articulation errors over this time period.

Conclusions from these studies for those of us in the clinical field are therefore difficult. Findings are mixed and are from small-scale studies (9–30 participants). Moreover, these studies focus on the outcome for articulation and not velopharyngeal function, which is also of interest to clinicians treating children with cleft palate.

2. Aims

The aim of this study was to determine if there are any clear predictors in clinical assessment at 12-months of age for later speech outcomes at 3-years of age. We hypothesized that if a 12-month-old child is using anterior plosives and demonstrates canonical babbling, their speech outcomes at 3-years of age will be good. The following questions were posed:

1. Do infants aged 12-months who exhibit canonical babbling have velopharyngeal competence and age-appropriate articulation at 3-years?

2. Do infants aged 12-months who use anterior plosives have velopharyngeal competence and age-appropriate articulation at 3-years?

3. Do infants aged 12-months who exhibit non-oral or posterior articulations have poor velopharyngeal competence and cleft speech characteristics (CSCs) in their articulation at 3-years?

3. Methods

3.1 Participants

Participants were recruited from a regional cleft lip and palate center in the North of England. Data was obtained for 192 participants born between October 2010 and December 2015. Participants were excluded if they had an additional syndromic diagnosis, incomplete datasets or if their palates were unrepaired at 12-months of age (N = 95). The total number of participants included was 97: 58 isolated cleft palate (ICP), 30 unilateral cleft lip and palate (UCLP), 9 bilateral cleft lip and palate (BCLP). Data was collected regarding the participant's age at palate repair. All participants spoke English as their native language. See **Table 1** for more details.

3.2 Design

This study used data collected as part of routine clinical practice within the speech and language team at the regional cleft lip and palate center. Data points were at 12-months and 3-years of age.

3.3 Data collection

Seven Speech and Language Pathologists (SLPs) specializing in working with children with cleft lip and palate were involved in the data collection.

At 12-months of age, the SLP visited the family at their home. During the visit there was approximately 45 minutes of free play with the parent(s) and the SLP using age-appropriate toys, for example, balls, stacking blocks, simple picture books. The sessions were not recorded but the SLP completed a data sheet during the visit. Consistency of the visit procedure and recording of data was achieved by SLPs adhering to clear instructions about the structure of the visit and prompts on the assessment forms. For example, note examples of canonical babbling and true consonants, note attempts at early words used. Validity of naturalistic observations for canonical babbling and when identifying anterior consonants has been shown to be high in a study comparing these to observations made from recordings [24].

	N (missing data)	Percentage of cohort	Average (mean (min-max))
Isolated cleft palate	58 (0)	60%	
Unilateral cleft lip and palate	30 (0)	31%	
Bilateral cleft lip and palate	9 (0)	9%	
History of hearing loss	72 (1)	74%	
Delayed language	28 (0)	29%	
SLT intervention for speech	28 (0)	29%	
Age at palate repair	97 (0)		9 months (5-12 m)

Table 1.
Details of participant sample.

Variable	12-months	3-years
Speech development	Presence of anterior plosives from consonant inventory	Speech sound development – normal, disordered
	Presence of canonical babbling (see [18] for example of method)	Presence of retracted or non-oral Cleft Speech Characteristics (CSCs)
		Presence of adequate velopharyngeal function
Hearing history	Not collected	From parental report
SLT intervention	Not collected	From medical records
Age at palate repair	From medical records	n/a

Table 2.
Details of variables and data collection.

At 3-years of age, children were seen in a clinic or their pre-school setting. A formal assessment of articulation and phonology was conducted using a common phonological screening assessment. The SLP made judgments at this age about the child's resonance and presence of airflow errors, based on spontaneous speech during play and categorized their velopharyngeal function as adequate or inadequate.

Details of all data collected including possible confounders are presented in **Table 2**.

3.4 Data analysis

Two primary outcome measures were analyzed: velopharyngeal function at 3-years and articulation at 3-years. Statistical analysis was completed using SPSS v.24. Findings are initially reported descriptively. In order to investigate the significance of any predictors, a binary logistic regression was carried out for both outcome measures. Predictors of interest were the presence of canonical babbling, anterior plosives and posterior or non-oral cleft speech characteristics (CSCs). The impact of hearing history, speech therapy intervention prior to 3-years and age at palate repair was also entered into the model.

4. Results

A comparison of outcomes at 12-months and 3-years can be found in **Table 3**.

4.1 Presence of canonical babbling

At 12-months of age 86% (N = 83) of the children in this study were babbling canonically. Results from the regression analysis with all predictors entered into the model showed that this was not a significant predictor for later velopharyngeal function ($p = .153$, Naglekerke $R^2 = .446$) nor articulation outcomes ($p = .858$, Naglekerke $R^2 = .493$).

4.2 Presence of anterior plosives

At 12-months 55% (N = 53) of participants were using anterior plosives, such as /b/ and /d/. The regression analysis showed this to be a significant predictor for both later velopharyngeal function ($p = .016$) and articulation outcomes ($p = .02$).

		3-year VP function		3-year articulation		
		Good	**Poor**	**Good**	**Poor**	**Totals (12 m)**
12-month canonical babbling	*Present*	66	17	49	34	83
	Not present	13	1	7	7	14
12-month anterior plosives	*Present*	50	3	41	12	53
	Not present	29	15	15	29	44
12-month non-oral or posterior errors	*Present*	17	5	9	13	22
	Not present	62	13	47	28	75
	Totals (3y)	79	18	56	41	

VP, velopharyngeal.

Table 3.
Comparisons of outcomes at 12-months and 3-years.

Those using anterior plosives at 12-months were almost seven times more likely to have good velopharyngeal function at 3-years (Exp (B) = 6.998 (95% CI 1.436–34.092)) and four times more likely to have good articulation (Exp (B) = 3.819 (95% CI 1.230–11.858)) than if no anterior plosives were recorded.

4.3 Presence of posterior or non-oral articulatory patterns

At 12-months 23% (N = 22) of participants exhibited posterior or non-oral articulation errors. The regression analysis showed that this was not a significant predictor of later velopharyngeal function (p = .924) or articulation outcomes (p = .118). The presence of these types of articulation errors increased over time between the 12-month and 3-year assessment points; 42% (N = 41) were reported to have non-oral or posterior errors at 3-years. The disordered speech processes identified were backing to velar placement, the use of active nasal fricatives and ingressive fricatives. This increase was seen specifically in the reporting of fricatives, such as /s, f/ a manner of articulation which develops after 12-months [13].

4.4 Confounding variables

Hearing history, cleft diagnosis and age at palate repair did not predict outcomes at 3-years for velopharyngeal function or articulation. Speech therapy intervention before the age of 3-years was found to significantly predict outcome for both velopharyngeal function (p = .049) and articulation (p < .001).

5. Discussion

This study investigated speech predictors for outcomes at 3-years from early clinical speech assessment at 12-months of age in children with repaired cleft palates. Receiving early feedback about the success of the child's primary palatal surgery is of benefit to both cleft surgeons and parents. This study found that the presence of anterior plosive consonants at 12-months can be a useful clinical indicator of good articulation and velopharyngeal function at 3-years. Although primarily a clinical study with associated limitations, this did allow for a larger number of participants. This has not been seen in previous research papers. This study also

shows that early speech assessment can be used by clinicians for the benefit of professionals and families.

The number of infants demonstrating canonical babbling in this study was 86% (N = 83). This is in line with other studies [15]. In this study, the presence of canonical babbling at 12-months of age was found to be insignificant with regards to later velopharyngeal competence and good articulation outcomes at 3-years of age. These findings disagree with some research [18] and corroborate others [20, 21]. The percentage of infants who had developed anterior plosives by 12-months of age was 55% (N = 53). This study found that the presence of anterior plosives in a 12-month-old child's consonant inventory was significant for both velopharyngeal competence ($p = .016$) and articulation outcomes ($p = .02$) at 3-years of age. This adds strength to other studies that found significant correlations with high-pressure oral stop consonants, such as /b/ and /d/ at early ages with correct articulation at a later age [20, 22]. The percentage of infants who were already exhibiting non-oral or posterior articulations at 12-months was 23% (N = 22). This was not found to be a significant predictor of either velopharyngeal competence or articulation skills at 3-years. Some children benefitted from speech and language intervention which improved their articulation outcomes, whilst others developed non-oral articulations as their fricatives emerged. This is in agreement with other findings [23] where changes in non-oral productions from infancy to 36-months were observed. Previous findings suggested that hearing difficulties have an adverse effect on speech development [25]. The results of the current study did not concur with these findings and no significant difference was noted between speech outcomes at 3-years and whether the child had experienced a hearing loss. However, the hearing data collected for the current study was not necessarily reflective of the child's hearing status at the time of their 12-month or 3-year assessments. Due to the inconsistent frequency of audiology appointments only parent reported data on a history of hearing loss was possible.

The importance of being able to identify early clinical indicators has ramifications beyond the speech sound development assessed in this study. Many studies in both children with and without a cleft have shown a relationship between early consonant production and later expressive vocabulary and early language [11, 20, 21]. The development of speech sounds directly influences the words that a child uses in their vocabulary, meaning that the more sounds produced early on will lead to a greater early vocabulary as the child develops. The consequences of these early delays are not known, but studies have shown that children born with a cleft perform poorly compared to peers in tests of language [26, 27]. Although the presence of cleft articulation errors at 12-months was not found to be a significant predictor in this study, the early identification of non-oral and posterior articulation in very young children is of benefit in order for SLPs to provide timely intervention before these patterns become entrenched. The number of children who had received intervention (N = 29) in the current study was small, therefore this relationship requires further investigation in future research. The impact of speech and language therapy intervention on speech outcomes at 3-years was significant in this study but has not been fully explored in previous research.

This was a clinical study and as such has some limitations. Many participants were excluded from the study because they had not undergone palate repair by 12-months, therefore the impact of delayed palate repairs on speech development and later outcomes is not clear from this study. Naturalistic observation methods were used for data collection at the 12-month visit, which could be criticized as an imprecise measure. However, other studies have found that when assessing the presence of canonical babbling following observation in a natural setting, the SLP's overall perception of the infant's vocalizations were reliable and aligned with the caregiver's report [28]. SLPs made clinical decisions based on what they heard on the day, which was often from small samples. Delayed speech and language

development may have been a contributing factor, meaning SLPs were not able to accurately identify predictors. Researchers have suggested than the number of utterances heard is of utmost importance to being able to accurately identify canonical babbling as a predictor, with up to 300 utterances reported a possible measure [29]. The nature of speech development and maturation during the first few years also meant that for sounds such as fricatives, which are acquired later in the child's developmental trajectory, the SLP was not able to predict how these would develop. This suggests that SLPs should be tentative when commenting on the child's later speech sound outcomes at an early age. SLPs were more likely to be over cautious at 12-months with regards to velopharyngeal competence; 28 participants (29%) who were not using anterior plosives at 12 months improved and no concerns were reported at 3-years of age.

6. Conclusion

This study has highlighted factors to consider when carrying out early speech assessment. While the presence of anterior plosives was found to be a good clinical indicator of later velopharyngeal competence, the presence of canonical babbling at 12-months of age was not found to be a good clinical indicator. Prediction of the child's articulation outcomes should be done with caution due to the ongoing development of the speech sound system until the child's fricatives have emerged. Further robust research in this area is needed to confirm findings, but this study has shown that it is possible to carry out an early clinical assessment of children with cleft palate in order to identify those at risk of later difficulties and therefore provide necessary early intervention.

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