RETROSPECTIVE LONGITUDINAL ANALYSIS OF PHONETIC AND PHONOLOGICAL CLEFT PALATE SPEECH CHARACTERISTICS

Erika Schulz[1], Wendy Cohen[1], Anja Lowit[1], Lisa Crampin[2]

[1]University of Strathclyde,[2]Glasgow Dental Hospital
erika.schulz@strath.ac.uk, a.lowit@strath.ac.uk, wendy.cohen@strath.ac.uk, lisa.crampin@ggc.scot.nhs.uk

ABSTRACT

In this study, we analysed phonetic and phonological consonant characteristics of cleft palate speech (CPS) at ages 5 and 10 in cleft palate with/without cleft lip (CP±CL) based on Cleft Audit Protocol for Speech – Augmented (CAPS-A) data collected in the Dental Hospital in Glasgow. The nature and extent of CPS characteristics at different ages were investigated. Video-recordings of 42 cleft palate (CP), unilateral cleft lip and palate (UCLP) and bilateral cleft lip and palate (BCLP) boys and girls were analysed based on narrow transcription and automatic PROPH (profile of phonology) of types of articulation features. Results of this study showed that CP±CL children produce a significantly higher number of phonetic CPS characteristics than phonological processes at both ages.

Keywords: Clinical phonetics, Speech and language therapy, Cleft palate speech, Computerised Profiling, CAPS-A.

1. INTRODUCTION

CP±CL is the most common facial birth defect in the UK with a prevalence of 1.2 in 1000 newborns [22]. CP±CL children are born with a cleft in their palate with/without an additional cleft in their upper lip. Structural deviations in children with repaired clefts can affect speech production and intelligibility. Specific phonetic features and compensatory strategies associated with CP±CL have been described as cleft palate speech (CPS) [8].
In the UK, CP±CL speakers are subject to regular auditing at the age of 5, 10 and 15 years with help of the national protocol CAPS-A which was designed as a standardised, valid and reliable audit protocol of CPS of native English speakers in 2006 [12]. The CAPS-A protocol does not include an assessment of phonological development. At regular intervals, specialised cleft speech and language therapists (SLTs) assess phonetic speech outcomes of CP±CL children based on CAPS-A video recordings using consensus transcription. Due to limited resources this analysis has only focused on individuals and could not result in a longitudinal comparative analysis of a large sample of CP±CL speakers.

2. BACKGROUND

Most previous studies on CPS have focused on the phonetic characteristics of CP±CL speakers [8]. Deviations in place (e. g. retraction or double articulation) and manner of articulation (e. g. nasal fricatives or devoicing) have been identified as typical consonant characteristics for speakers with repaired CP±CL [9]. Longitudinal CPS research has shown that these deviations decrease with maturation [3]. For instance, retracted articulation disappeared by the age of 7 [20]. Compensatory mechanisms, such as glottalisation of pressure consonants, almost completely disappeared by the age of 10 in CP±CL speakers [13].
Since the 1980s phonological development of CP±CL children has also been investigated [10]. This research has suggested that structural differences, such as velopharyngeal insufficiency (VPI), hearing issues or palatal fistula, influence children with repaired CP±CL in their phonological development [6]. At ages 3 and 4, CP±CL children showed significantly more overall instances of phonological processes than their non-cleft peers. These differences at an early age between cleft and non-cleft groups did not prevail until the age of 5. At this age, cluster reduction was found to be the only productive process in CP±CL children, i. e. it occured at least in 20 % of all possible cases [2].
There is, however, only a small number of studies which have analysed phonetic and phonological characteristics of CPS systematically [17, 3]. These studies used the PROPH tool integrated in the software Computerised Profiling (CPro) as the basis of their perceptual analysis [15]. None of these studies evaluated whether phonetic or phonological characteristics were more prevalent in CPS at any given age. Also, only little information was available on the types of phonetic errors used because PROPH automatically grouped them under the cat-

egory "other distortions and substitutions" [15].
In this study, we analysed the consonant characteristics of CPS based on CAPS-A sessions recorded at the Glasgow Dental Hospital in order to investigate whether phonetic characteristics or phonological processes dominated children's speech at age 5 and 10 and give detailed information on the types of speech outcomes used at these ages.

3. METHOD

3.1. Participants

The West of Scotland multidisciplinary cleft team based in the Dental Hospital in Glasgow has been collecting standardised speech assessment data from children with repaired CP±CL for more than 15 years. To date, around 100 children have been assessed with the CAPS-A audit at the age of 5 and 10. In the current study, video recordings of 42 boys (n=26) and girls (n=16) at both age 5 and 10 were chosen for analysis based on their cleft type and gender.

3.2. Materials

The data used for analysis consisted of 20 CAPS-A sentences with all high pressure consonants of the English language which have been specifically designed to analyse CPS. They contain all English pressure consonants in initial and final word position. In addition, they meet the minimum size of 100 words for representative speech samples for phonological and phonetic analysis of CPS [14]. Because of their basic vocabulary and syntax they are easy enough to imitate for children at the age of 5. These data were preferred over spontaneous speech samples because they guaranteed comparable and stable phonetic context.
The audit sessions had been video recorded with a Canon Legria FS200 video recorder in a quiet room in the Dental Hospital in Glasgow. Only two SLTs had been responsible for performing the assessments, thus minimising examiner variability.

3.3. Data analysis

CPS was analysed with an approach that incorporated phonetic and phonological aspects. This strategy aimed at discriminating typical speech patterns in phonological development from speech patterns that can be traced back to structural issues related to CP±CL, such as VPI, reduced lip mobility or malocclusion. The analysis process consisted of several steps: narrow transcription, reliability measurements, transfer of transcript to computer software CPro, automatic PROPH, and statistical analysis with R 3.1.1 [21].
Video recordings were screened for sufficient quality and narrowly transcribed using the International Phonetic Alphabet (IPA) [11] and the extended IPA [5]. Intrajudge reliability was conducted on 10 % of the sample and yielded a total of 89.63 % (3.50 %). Interrater-reliability was not measured because of restricted access permissions to the NHS video recordings. Information from the narrow transcripts was transferred into the computer software CPro [15] and analysed with the PROPH segment of this tool. PROPH rendered an extensive analysis of phonological processes and phonetically based articulation deviations. In contrast to most previous research, we did not measure process usage of phonetic CPS characteristics based on perceptual ratings but proportional distribution of these features.

4. RESULTS

Phonological process usage Only cluster reduction (ClusRed) reached the productivity threshold of 20 % process usage at age 5, and it was close to that threshold at age 10 (see table 1). Phonological process usage of nasal assimilation, final consonant deletion (FinConsDel), palatal and velar fronting, cluster reduction, and later stopping (LaterStop) decreased significantly from age 5 to 10.

Table 1: Mean percentage of most frequent phonological processes used at age 5 and 10 in % (sd)

Phonological	Age 5		Age 10	
ClusRed	34.24	(21.97)	19.86	(11.33)
LiquidDel	12.17	(8.91)	9.52	(8.18)
LaterStop	10.48	(7.13)	6.02	(6.05)
FinConsDel	16.10	(14.44)	4.79	(5.75)

Phonetic CPS characteristics In sum, palatalisation, nasal emission, lowering and backing made up half of the phonetic CPS characteristics at age 5 and 10. Other prominent CP±CL phonetic features in both age groups were devoiced or dentalised consonants. In total, these six characteristics formed about 70 % of the phonetic CP±CL characteristics found. Comparative analysis showed that nasal emission, nasal turbulence, and nasal fricatives, as well as backing made up a significantly higher percentage of the total of phonetic CPS characteristics at 5 than at age 10. Lowering and weakening of pressure consonants, on the other hand, formed a smaller percentage of the phonetic CPS characteristics at 5

than at age 10.

Table 2: Mean percentage of significantly different proportions of phonetic CPS characteristics at 5 and 10 in % (sd) (*p<.05; **p<.01)

Phonetic	Age 5		Age 10	
Backing**	9.73	(10.19)	3.88	(7.25)
NasalEm**	13.21	(10.63)	6.87	(10.71)
NasalTurb**	3.62	(6.12)	0.88	(1.90)
NasaFric*	1.43	(2.93)	0.45	(2.18)
Lowering**	12.34	(9.46)	16.96	(10.67)
Weakening*	2.90	(4.15)	4.89	(6.28)

Distribution of CPS characteristics At both ages, phonetic characteristics of CPS formed a significantly higher proportion of the overall articulation features than phonological processes. The proportional distribution of the CPS characteristics stayed relatively stable from age 5 to 10. At age 10, CP±CL children produced a significantly smaller percentage of phonological substitutions and a higher proportion of distortions than 5 years earlier.

Table 3: Mean percentage of proportion of types of articulation characteristics at age 5 and 10 in % (sd) (*p<.05; **p<.01)

Characteristic	Age 5		Age 10	
Phonological				
Omission	15.29	(7.63)	14.06	(7.03)
Substitution*	9.06	(5.16)	6.32	(4.99)
Phonetic				
Distortion**	28.02	(11.81)	34.17	(11.56)
Substitution	30.56	(11.65)	27.48	(14.51)
Omissions	11.16	(5.74)	10.75	(5.44)
Additions	5.92	(4.26)	7.16	(8.34)

5. DISCUSSION

We could confirm previous findings on the occurrence of common phonological processes in CP±CL children and the fact that cluster reduction was the only productive process at age 5 [2]. In normal phonological development, cluster reduction should be in decline from 3;5 to the age 6 [7, 16]. Almost 20 % process usage of cluster reduction at age 10 deviates from expected performance in normal phonological development. We assumed that this high number is due to coarticulation in connected speech. Adolescents have been found to be similar in their degree of gestural overlap of consonants and use of reduction to adults [4]. Automatic phonological analysis was not sensitive towards these assimilation and reduction processes in natural speech [18]. Interpretation of these results should therefore be done with caution.

High percentages of palatalisation at age 5 and 10 did not cause major concern since according to CAPS-A this feature cannot indicate further velopharyngeal surgery [12]. It could, however, be related to palatal fistula which may need fistula repair. High proportion of palatalisation of the overall phonetic CPS characteristics would also be a concern if the CP±CL children had received speech and language therapy since it would then indicate that they probably did not respond to it.

The fact that lowering and weakening of pressure consonants increased significantly in their proportion of phonetic CPS characteristics, while retraction and features related to insufficient VPI decreased, was seen as an overall improvement in speech outcomes of CP±CL children. Both lowering and weakening of pressure consonants were not necessarily due to cleft-related issues but could be interpreted as gestural weakening in connected speech [1].

Based on previous findings on the phonological development of CP±CL children [2] and phonetic characteristics of CPS in different age groups [19] it was to be expected that phonetic characteristics make up the majority of all articulation features in CPS at the ages 5 and 10. At age 10, the proportion of phonological substitutions decreased and distortions increased significantly compared to age 5. This finding showed that cleft-related errors prevail in CPS at an age when phonological processes are fading.

6. CONCLUSION

As expected, CP±CL children used more phonetic than phonological characteristics of CPS at both ages. They did not show many prominent common phonological processes in their speech but typical phonetic articulation deviations associated with CPS. The different proportional distributions of phonetic characteristics at ages 5 and 10 has indicated an improvement in speech outcomes with maturation since directly cleft-related articulation deviations made up less of the phonetic CPS features used at age 10 than at age 5.

7. REFERENCES

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