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Original Article

Hearing, speech, and language outcomes in school-aged children after cleft palate repair

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Background: Following primary cleft palate repair, individuals face a heightened risk of hearing problems, particularly conductive hearing loss, compensatory articulation disorders (CADs), resonance disorders, delayed speech and language development, and voice disorders. This study aimed to investigate the prevalence and impact of these challenges in children with cleft palate with or without cleft lip (CP±L).
Methods: This cross-sectional study included 38 children with CP±L aged 5 to 13 years. A comprehensive evaluation involved audiological assessments (audiograms, tympanograms) by an audiologist and speech-language pathology assessments (Thai Speech Parameters for Patients with Cleft Palate, Articulation Screening Test) by speech-language pathologists.
Results: The prevalence of hearing loss affected 27.63% of participants (21 out of 76 ears) and majority of cases involved conductive hearing loss. Velar substitution was the most common CAD, followed by nasalized voiced pressure consonants, phoneme-specific nasal air emission, and pharyngeal substitution. A moderate correlation was found between these CAD patterns and hypernasality at the word, sentence, and screening levels ($r=0.44$, $p<0.01$; $r=0.43$, $p<0.01$; and $r=0.40$, $p=0.01$).
Conclusion: For summary, the most common type of hearing loss was conductive hearing loss. The predominant CAD pattern was velar substitution. The protocol could be designed to enhance early improvement in hearing and articulation, thereby supporting academic achievement and long-term quality of life.

Abbreviations: CAD, compensatory articulation disorder; CI, confidence interval; CP±L, cleft palate with or without cleft lip; PSNE, phoneme-specific nasal air emission

Keywords: Cleft palate / Hearing / Outcome / Resonance / Speech

INTRODUCTION

Children with cleft palate with or without cleft lip (CP±L) are at risk of several auditory and speech-related issues. These include conductive hearing loss, compensatory articulation disorders (CADs), resonance disorders, delayed speech and language development, and voice disorders following primary repair. A previous study found high prevalence rates of speech-related problems among these children: articulation defects were found in 94.44% (95% confidence interval [CI], 81.34%–99.32%), resonance abnormalities in 36.11% (95% CI, 20.82%–53.78%), speech and language delays in 8.33% (95% CI, 1.75%–22.47%), reduced understandability in 50.00% (95% CI, 32.92%–67.08%), and voice disturbances in 30.56% (95% CI, 16.35%–48.11%) [1]. A more recent study reported that between 30% and 35% of children with bilateral cleft lip and palate exhibited abnormal articulation and resonance skills by the age of 5 [2].

School-based speech-language pathologists primarily address

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articulation (79.2%) and resonance (78.4%) disorders, often employing specific therapeutic techniques (76.9%). These findings highlight the significance of such interventions in clinical practice [3]. CADs, characterized by non-oral misarticulations such as velar substitutions, glottal stops, pharyngeal fricatives, and nasal fricatives, are common in individuals with CP ± L. These speech errors, long associated with CP ± L, adversely affect speech intelligibility, acceptability, and comprehension. Previous research in Thailand and Laos has confirmed the high prevalence of CADs in children with CP ± L, with velar, glottal, pharyngeal, and nasal substitutions being the most common patterns [4-6]. This is similar to findings in Saudi Arabic-speaking children with CP ± L, who frequently exhibit consonant backing, final consonant deletion, gliding, and stopping [7].

The prevalence of hypernasality in individuals with cleft palate ranges from 31.7% to 37.5% [1,8,9], and hypernasality has often been linked to velopharyngeal dysfunction [10,11]. It is also associated with deficits in language skills, intelligibility, and reading ability. Children with CP ± L frequently experience hoarseness, with prevalence rates between 5.5% and 20.0% [9,12-14]. This vocal symptom is attributed to an inability to generate adequate oral air pressure due to velopharyngeal dysfunction, leading to compensatory laryngeal adjustments. Previous studies have reported delayed speech and language development in 8.33% to 27% of children with CP ± L [1,9,15]. These speech abnormalities significantly impair speech intelligibility in individuals with cleft palate, hindering their daily communication.

Children with CP ± L frequently experience ear infections due to issues with the Eustachian tube. The prevalence of ear infections in this group is remarkably high, ranging from 72% to 97% [16-19]. This rate is significantly higher compared to children without cleft lip, where the rates are 74.7% versus 19.4% [19]. Additionally, 50% (95% CI, 35.57%–64.43%) of these children suffer from conductive hearing loss [20]. In terms of age-related differences, children aged 4–7 exhibit poorer hearing (up to 21.2 dB) compared to those aged 8–14 (up to 17.5 dB). However, both age groups experience severe hearing loss at certain frequencies (up to 70 dB) [21]. Children with cleft palate often experience mild to moderate hearing loss, ranging from 10 to 25.91 dB, which can adversely affect their language development [22].

The Center of Cleft-Palate and Craniofacial Deformities at Khon Kaen University performs lip repair (cheiloplasty) when a child is 3 months old, followed by palate repair (palatoplasty) using the two-flap technique at approximately 12 months of age. If a patient requires myringotomy to address middle ear effusion, this procedure can be performed concurrently with the standard two-flap palatoplasty. Speech and language evaluations are conducted around the age of 6 months to facilitate early stimulation. It is essential to assess hearing, speech, and language skills to enhance protocols and better plan further management.

The aim of this study was to quantify the outcomes of treatment in terms of hearing, speech, and language in school-age children with CP ± L.

METHODS

This cross-sectional study was part of a larger project titled "Speech Therapy for Children with Cleft Lip and Palate: Application for Articulation Therapy-Thai (AAT-T) and Traditional Approaches in the COVID-19 Pandemic: Randomized Control Trial." The protocol received approval from the Ethics Committee for Human Research at Khon Kaen University on April 22, 2022 (HE 6540002). Research assistants provided children and their caregivers with a detailed explanation of the study. Subsequently, the guardians of interested participants provided their signatures on informed consent documents. Caregivers were given the original copies, while the research team retained duplicates for their records.

Participants

The participants were children with CP ± L, aged 5–13 years old, who received primary palatoplasty with or without cheiloplasty during a 1-year period. The sample size (38 participants) was calculated based on the main project with a type I error of 0.05 (i.e., 95% confidence) and a type II error of 0.2, with a dropout rate of 5%.

Inclusion criteria were children with CP ± L who were registered for treatment in the Center of Clip-Palate and Craniofacial Deformities. Exclusion criteria were children with CP ± L who had syndromic or multiple disabilities (e.g., craniofacial abnormality, autism, brain damage, physical defects, etc.), hearing loss ≥ 40 dB in both ears, or articulation errors with only 1 sound (not including /r/, which is the sound with the most common error in Thai language phonetics). Thirty-eight children with CP ± L were ultimately included in the study.

Procedure

After enrollment, children with CP ± L underwent hearing and articulation tests as follows: (1) Oral examination; (2) Articulation test: Thai Speech Parameters for Patients with Cleft Palate in a Universal Reporting System at both word and sentence levels and the Articulation Screening Test (connected speech level) were administered; (3) Outcomes: articulation errors and types of CADs, resonance disorders, voice disorders, abnormality of facial constrictor, understandability, and acceptability from perceptual assessment were determined based on consensus between two speech and language pathologists (SLPs). If there was disagreement regarding any outcome, retesting was performed, followed by discussion and consensus with a senior SLP. Hearing tests were qualified audiologists who conducted both audiometry using an audiometer (Interacoustics: AC 40) and tympanometry (Grason-Stadler: GSI 39). The language was assessed using the Utah Test of Language Development.

Statistical analysis

The hearing level in decibels was treated as continuous data, and types of hearing were quantified through descriptive analysis. Another primary outcome of this study was articulation scores, which were assigned as follows: 0 for correct or normal articulation and 1 for incorrect articulation or articulation errors, with specific patterns identified. For other language and speech skills, including language, resonance, voice, facial grimace, understandability, and acceptability, the scores were categorized as follows: (1) Language (0 = pass or normal: correctly answers all items on a language test at their chronological age or age-appropriate language skills; 1 = delayed speech and language development: unable to correctly answer any item on a language test at their chronological age); (2) Resonance (0 = normal; 1 = mild; 2 = moderate; 3 = severe hypernasality); (3) Voice (GIRBAS score was used for quantification voice abnormality. G = the grade or degree of hoarseness; R = roughness or the impression of irregular vibration of the vocal folds; B = breathiness or the degree to which air escaping from between the vocal folds can be heard; A = asthenia or the degree of weakness in the voice; S = strain or the extent of hyperfunctional use of phonation; and I = instability or changes in voice quality over time [23]. The scoring was 0 = normal and 1–8 = abnormal); (4) Facial grimace (0 = normal; 1 = ala constriction; 2 = nasal bridge constriction; 3 = forehead constriction); (5) Understandability (0 = within normal limits or speech is always easy to understand; 1 = speech is occasionally hard to understand; 2 = speech is often hard to understand; 3 = speech is hard to understand most or all of the time); or (6) Acceptability: 0 = within normal limits or speech is normal; 1 = speech deviates from normal to a mild degree; 2 = speech deviates from normal to a moderate degree; 3 = speech deviates from normal to a severe degree.

Descriptive statistical analysis was conducted using StataCorp 2023 Stata Statistical Software: Release 18 (StataCorp LLC).

RESULTS

Forty-four children with CP ± L were included in this study. Six children were excluded for the following reasons: four had either only or no articulation errors (T05C, T14D, T20D, A15C); one child had bilateral hearing loss greater than 40 dB (T17D; hearing level 53 dB in the right ear and 55 dB in the left ear); and one child had attention deficit hyperactivity disorder and was unable to participate in the articulation test. The remaining 38 children, aged 5–13 years, were enrolled in the study. The gender distribution was 14 females to 24 males (63.16% male). The types of cleft lip and palate included: cleft palate only in eight children (21.05%); left unilateral CP ± L in 10 children (26.32%); right unilateral CP ± L in eight children (21.05%); and bilateral cleft lip and palate in 12 children (31.68%).

The results of the hearing evaluation, which include the types of hearing loss, degree of hearing thresholds, and tympanometry types, are presented in Tables 1 and 2. Twenty-four out of the 38 children with CP ± L (63.16%) exhibited normal hearing in both ears. Seven children (18.42%) experienced bilateral hearing loss, and another seven had unilateral hearing loss in both ears. The majority of these cases involved mild hearing loss, except for three children who exhibited more severe impairments. Specifically, child A03C had unilateral profound sensorineural hearing loss; T03C had unilateral moderately severe conductive hearing loss; and T09C had unilateral moderate conductive hearing loss. Among the children with CP ± L who had bilateral hearing loss, two (T06D and T21C) displayed mild hearing loss at speech frequencies in one ear, while the other ear exhibited a gradually sloping loss at high frequencies. Most of the children had a tympanogram type A (47 out of 96 ears; 61.84%).

Articulation errors were categorized into types of CAD, functional articulation disorders, and trill errors. Descriptive data illustrating these articulation patterns can be found in Table 3.

Table 3 displayed the CAD patterns of children with CP ± L who had two or more articulation errors. The most common CAD patterns identified in this study were velar substitution, followed by nasalized voiced pressure consonant, phoneme-specific nasal air emission (PSNE), and pharyngeal substitution, respectively. These patterns were prioritized at the word level, with the most common being backing or non-oral patterns. Most children with CP ± L also exhibited a high rate of trill and other articulation patterns.

Various speech and language skills—including language, resonance, voice, facial grimace, understandability, and acceptability—are quantified and presented as descriptive data in Tables 4 and 5.

Table 1. Audiological hearing evaluation and tympanogram results

Code (n = 38)	Right ear			Left ear		
	Type	PTA at 500–2,000 Hz (dB)	Tympanograms[a)]	Type	PTA at 500–2,000 Hz (dB)	Tympanograms[a)]
A01C	NH	15	A	NH	7	A
A02D	CHL	25	B	CHL	22	B
A03C	NH	17	C	SNHL	112	A
A04D	NH	17	A	NH	12	A
A05C	NH	12	A	NH	12	A
A06D	NH	15	A	NH	13	A
A07C	NH	8	A	NH	8	A
A08D	NH	10	A	CHL	28	B
A09D	NH	12	Ad	NH	17	B
A11D	CHL	20	B	CHL	23	B
A12D	CHL	17	B	CHL	30	B
A13C	CHL	18	B	NH	0	Other[b)]
A14C	NH	7	A	NH	15	B
A16D	NH	12	As	NH	12	C
A17D	NH	17	A	NH	13	A
A18C	NH	18	A	NH	15	A
A19D	NH	18	A	NH	18	A
A20C	SNHL	28	A	SNHL	20	A
A21C	NH	13	A	NH	18	A
T01C	CHL	13	B	CHL	18	B
T02D	NH	13	C	NH	15	As
T03C	NH	7	Ad	CHL	57	B
T04D	NH	10	A	NH	8	A
T06D	Mixed HL	38	B	SNHL	15	A
T07D	NH	8	A	NH	10	A
T08C	NH	8	A	NH	8	A
T09C	NH	25	C	CHL	42	B
T10D	NH	18	A	NH	15	A
T11C	NH	23	A	NH	22	A
T12C	NH	18	A	CHL	33	B
T13D	NH	22	A	NH	25	C
T15D	NH	13	B	NH	17	A
T16C	NH	22	C	NH	13	A
T18C	NH	10	A	NH	8	A
T19C	NH	15	A	NH	12	A
T21C	SNHL	15	A	SNHL	38	A
T22D	NH	10	A	NH	5	A
T23D	NH	3	A	CHL	17	B

PTA, pure-tone average; NH, normal hearing; CHL, conductive hearing loss; SNHL, sensorineural hearing loss; HL, hearing loss.
[a)]Tympanometry test results are classified into 5 types: type A indicates a normal middle ear system; type B is consistent with middle ear pathology; type C indicates negative pressure in the middle ear; type As indicates ossicular fixation in the middle ear; type Ad indicates an overly mobile tympanic membrane; [b)]Hypermobility.

Children with CP ± L who exhibited articulation errors of two or more sounds demonstrated the following prevalence rates for various speech and language issues: delayed speech and language development was observed in 34.21% (95% CI, 19.63%–51.35%), resonance disorders in 84.21% (95% CI, 68.75%–93.98%), voice disorders in 23.68% (95% CI, 11.44%–40.24%), abnormalities of the facial constrictor in 84.21% (95% CI, 68.75%–93.98%), issues with understandability in 44.74% (95% CI, 28.62%–61.70%), and problems with acceptability in 78.95% (95% CI, 62.68%–90.45%).

Table 2. Summary of types of hearing loss and tympanometry

	No. (%)	95% CI
NH	55 (72.37)	62.08–82.65
Hearing loss		
CHL	14 (66.67)	41.97–91.36
SNHL	6 (28.57)	8.92–48.23
Mixed HL	1 (4.76)	0–13.50
Tympanogram types[a)]		
A	47 (61.84)	46.12–77.56
B	18 (23.68)	12.11–35.26
C	6 (7.89)	1.34–14.44
Ad	2 (2.63)	0–6.44
As	2 (2.63)	0–6.43
Others[b)]	1 (1.32)	0–2.84

CI, confidence interval; NH, normal hearing; CHL, conductive hearing loss; SNHL, sensorineural hearing loss; HL, hearing loss.
[a)]Tympanometry test results are classified into 5 types: type A indicates a normal middle ear system; type B is consistent with middle ear pathology; type C indicates negative pressure in the middle ear; type As indicates ossicular fixation in the middle ear; type Ad indicates an overly mobile tympanic membrane; [b)]Hypermobility.

Variables related to speech abnormalities, such as hearing level in the better ear, the number of CAD patterns at the word, sentence, and screening levels, resonance severity (0–3), and voice abnormality (GIRBAS scores = 0–18), were analyzed for normal distribution using the Shapiro-Wilk W test. The data on voice severity did not follow a normal distribution.

Spearman correlation analysis (r) was employed to determine the relationships between voice severity and other variables, while Pearson correlation was used to assess the relationships between the number of CAD patterns (word, sentence, and screening levels) and both resonance severity and hearing levels. The results revealed a significant moderate correlation between resonance severity and the number of CAD patterns at the word, sentence, and screening levels ($r = 0.44$, $p < 0.01$; $r = 0.43$, $p < 0.01$; and $r = 0.40$, $p = 0.01$, respectively).

DISCUSSION

This study revealed that most children with CP ± L who exhibited two or more articulation errors also had cleft lip and palate (30/38 or 78.94%). This finding aligns with previous studies that reported a 79.2% prevalence of articulation disorders requiring treatment in school-aged children [3]. The majority of children with more articulation errors had unilateral cleft lip and palate. Additionally, 24 out of the 38 children with CP ± L (63.16%) exhibited normal hearing in both ears.

The current study reported that 21 out of 76 ears (27.63%) in children with CP ± L experienced hearing loss, predominantly conductive in nature (Table 1). This rate contrasts with previous findings where the prevalence of hearing problems ranged from 50% to 97% [18,20,24]. The discrepancy likely stems from variations in the age groups of the subjects studied. Consistent with earlier research, the majority of children with CP ± L in this study (52.63%), who were older than 6 years, exhibited hearing loss, mainly conductive. This type of hearing loss may improve with age [25-27] as the average recovery time for Eustachian tube function post-palatoplasty is 6 years. Additionally, morphological changes in the Eustachian tube can lead to enhanced tube function and better hearing outcomes. In the subgroup with other types of hearing loss, one child exhibited unilateral sensorineural hearing loss, likely due to unidentified factors, while three children had bilateral sensorineural hearing loss. The researchers hypothesize that sensorineural hearing loss in children with cleft palate may result from prolonged middle ear infections, which damage the hair cells in the inner ear. The round window may act as a conduit for toxins to reach the inner ear [24,28-30]. However, it is crucial to focus on early hearing conservation to mitigate adverse effects on language and speech development in children with CP ± L.

The study found no correlation between the number of CAD patterns (word, sentence, and screening levels) and hearing level. All the children with CP ± L in this study exhibited either normal or mild hearing levels at speech frequencies in at least one ear (hearing level ≤ 30 dB), enabling them to hear speech clearly during communication. This finding is consistent with previous studies [31]. The results confirmed that overall speech and language skills in children with CP ± L, who have mild hearing loss or normal hearing in one ear, are comparable to those of children with normal hearing.

The most common CAD patterns observed in this study (Table 2) were velar substitution, followed by nasalized voiced pressure consonant, PSNE, and pharyngeal substitution, respectively. These findings are similar to those of previous studies, which identified velar production as the most prevalent type [4,32], followed by glottal and pharyngeal productions (43.75%) [4]. Other studies have also reported that the glottal stop pattern was the most frequent in Thai and Laotian children with CP ± L [5,6]. Additionally, pharyngeal substitution was a common articulation pattern among Thai and Laotian children with CP ± L, corroborating earlier research [4-6]. Nasalized voiced pressure consonants and PSNE were also prevalent CAD patterns in this study. These results are consistent with a study of Saudi Arabic-speaking children with repaired cleft lip and palate, which found the following prevalence rates: pharyngeal pattern at 37%, glottal pattern at 28%, velar pattern at 33%, uvular pattern at 48%, active nasal fricative pattern at 22%, nasal consonant for oral pressure consonant pattern at

Table 3. Articulation patterns

Pattern	Level	No. (%)	95% CI
Articulation patterns			
1. Velar substitution	Word	28 (73.68)	56.90–86.60
	Sentence	26 (68.42)	51.35–82.50
	Screening	33 (86.84)	71.91–95.59
2. Nasalized voiced pressure consonant	Word	26 (68.42)	51.35–82.50
	Sentence	25 (65.79)	48.65–80.37
	Screening	25 (65.79)	48.65–80.37
3. Phoneme-specific nasal air emission	Word	13 (34.21)	19.63–51.35
	Sentence	20 (52.63)	35.82–69.02
	Screening	0	-
4. Pharyngeal substitution	Word	16 (42.11)	26.31–59.18
	Sentence	19 (50.00)	33.38–66.62
	Screening	18 (47.37)	30.98–64.18
5. Dental lisping	Word	17 (44.74)	28.62–61.70
	Sentence	11 (28.94)	15.42–45.90
	Screening	7 (18.42)	7.74–34.33
6. Mid-dorsum palatal	Word	14 (36.84)	21.81–54.01
	Sentence	14 (36.84)	21.81–54.01
	Screening	11 (28.95)	15.42–45.90
7. Glottal substitution	Word	11 (28.95)	15.42–45.90
	Sentence	12 (31.58)	17.50–48.65
	Screening	13 (34.21)	19.63–51.35
8. Co-articulation	Word	9 (23.68)	11.44–40.24
	Sentence	12 (31.58)	17.50–48.65
	Screening	1 (2.63)	0.06–13.81
9. Weak oral pressure	Word	9 (23.68)	11.44–40.24
	Sentence	4 (10.52)	2.94–24.80
	Screening	6 (15.79)	6.02–31.25
10. Gilding for fricative/affricate	Word	7 (18.42)	7.74–34.33
	Sentence	2 (5.26)	0.64–17.75
	Screening	0	-
11. Nasal consonant for oral consonant	Word	5 (13.16)	4.41–28.09
	Sentence	6 (15.79)	6.02–31.25
	Screening	4 (10.53)	2.91–24.80
12. Not phoneme-specific nasal air emission	Word	5 (13.16)	4.41–28.09
	Sentence	6 (15.79)	6.02–31.25
	Screening	0	-
11. Phonological error	Word	2 (5.26)	0.64–17.75
	Sentence	2 (5.26)	0.64–17.75
	Screening	5 (13.16)	4.41–28.09
Other patterns			-
1. Trill error	Word	37 (97.37)	86.19–99.93
	Sentence	34 (89.47)	75.20–97.06
	Screening	38 (100)	
2. Functional articulation disorders	Word	23 (60.53)	43.39–75.96
	Sentence	27 (71.05)	54.10–84.58
	Screening	14 (36.84)	21.81–54.01

CI, confidence interval.

Table 4. Language and speech skills in children with CP±L (38 children)

Code	Language	Resonance	Voice (GIRBAS)	Facial grimace	Understandability	Acceptability
A01C	WNL	2	0	1	0	0
A02D	Delayed	1	4	0	0	0
A03C	WNL	2	0	0	1	0
A04D	WNL	2	0	0	2	1
A05C	WNL	0	0	0	0	1
A06D	Delayed	3	5	3	2	2
A07C	WNL	2	0	1	1	1
A08D	WNL	2	0	1	1	1
A09D	WNL	3	0	2	1	2
A11D	Delayed	2	0	1	0	1
A12D	Delayed	1	5	1	1	1
A13C	WNL	0	0	1	0	1
A14C	WNL	1	0	1	0	1
A16D	WNL	1	0	1	0	1
A17D	WNL	1	3	1	0	1
A18C	WNL	0	0	1	0	1
A19D	Delayed	3	7	1	3	3
A20C	WNL	0	0	1	0	1
A21C	Delayed	3	0	1	2	2
T01C	WNL	2	0	1	0	0
T02D	Delayed	2	0	1	2	2
T03C	WNL	1	0	1	0	0
T04D	WNL	0	0	0	0	0
T06D	Delayed	1	0	1	0	1
T07D	WNL	1	0	1	1	1
T08C	Delayed	1	4	1	0	1
T09C	WNL	2	9	1	1	1
T10D	WNL	2	0	1	0	1
T11C	WNL	3	0	1	3	3
T12C	Delayed	3	0	1	3	3
T13D	WNL	2	0	1	0	1
T15D	Delayed	2	7	1	1	1
T16C	WNL	1	8	1	0	1
T18C	Delayed	2	0	1	0	1
T19C	Delayed	1	0	0	1	1
T21C	WNL	2	0	1	1	1
T22D	WNL	1	0	1	0	0
T23D	WNL	0	0	1	0	0

Language: WNL = within normal limits, Delayed = delayed speech and language development; Resonance: 0 = normal, 1 = mild, 2 = moderate, 3 = severe; Voice: 0 = normal, 1–8 = abnormal; Facial grimace: 0 = normal, 1 = ala constriction, 2 = nasal bridge constriction, 3 = forehead constriction; Understandability: 0 = within normal limits or speech is always easy to understand, 1 = speech is occasionally hard to understand, 2 = speech is often hard to understand, 3 = speech is hard to understand most or all of the time; Acceptability: 0 = within normal limits or speech is normal, 1 = speech deviates from normal to a mild degree, 2 = speech deviates from normal to a moderate degree, 3 = speech deviates from normal to a severe degree.
CP ± L, cleft palate with or without cleft lip; GIRBAS, grade, instability, roughness, breathiness, asthenia, and strain.

13%, and nasalized voiced pressure consonants at 7% [7]. They also align with a recent study indicating that most CAD occurred below the level of the defect (18%), followed by CAD at the velopharyngeal port (12.0%) or in front of it (4.9%) [11]. These findings support general phonetic and phonological theories regarding cleft palate anomalies, suggesting that inadequate velar length following palatal repair, oral structural abnormalities, and poor muscle function and/or abnormal size

Table 5. Summary of language and speech skill in children with CP±L (38 children)

Type	Language		Resonance		Voice (GIRBAS)		Facial grimace		Understandability		Acceptability	
	No.	% (95% CI)	No.	% (95% CI)	No.	% (95% CI)	No.	% (95% CI)	No.	% (95% CI)	No.	% (95% CI)
Normal (0/WNL)	25	65.79 (48.65–80.37)	6	15.79 (6.02–31.25)	29	76.32 (59.76–88.56)	6	15.79 (6.02–31.25)	21	55.26 (38.30–71.38)	8	21.05 (9.55–37.32)
Abnormal total	13	34.21 (19.63–51.35)	32	84.21 (68.75–93.98)	9	23.68 (11.44–40.24)	32	84.21 (68.75–93.98)	17	44.74 (28.62–61.70)	30	78.95 (62.68–90.45)
Abnormal severity												
1			12	37.5 (19.77–55.23)			30	93.75 (88.27–99.23)	10	58.82 (34.62–83.03)	23	76.67 (60.60–92.73)
2			14	43.75 (25.58– 61.92)			1	3.13 (0–7.23)	4	23.53 (6.10–40.96)	4	13.33 (0.42–26.24)
3			6	18.75 (4.45–33.05)			1	3.13 (0–7.23)	3	17.65 (1.17–34.12)	3	10.00 (0–21.39)

CP ± L, cleft palate with or without cleft lip; GIRBAS, grade, instability, roughness, breathiness, asthenia, and strain; CI, confidence interval; WNL, within normal limits.

and/or shape of the nasopharynx contribute to CAD. Most CAD patterns were characterized by backing or non-oral sounds, underscoring the critical need for prelinguistic stimulation or early intervention to help reduce the prevalence of CAD over time [33].

In terms of speech and language abnormalities (Table 3), the rates of delayed speech and language development, hypernasality, voice abnormality, facial grimace, understandability, and acceptability in children with CP ± L were 34.21% (95% CI, 19.63%–51.35%), 84.21% (95% CI, 68.75%–93.98%), 23.68% (95% CI, 11.44%–40.24%), 84.21% (95% CI, 68.75%–93.98%), 44.74% (95% CI, 28.62%–61.70%), and 78.95% (95% CI, 62.68%–90.45%), respectively. These findings indicate higher rates than those reported in previous studies [7,9], which found overall rates of delayed language development, resonance disorders, and voice disorders to be 16.33%, 43.26%–47.50%, and 19.13%, respectively. Additionally, this study revealed a significant moderate correlation between resonance severity and the number of CAD patterns at the word, sentence, and screening levels ($r = 0.44$, $p < 0.01$; $r = 0.43$, $p < 0.01$; and $r = 0.40$, $p = 0.01$, respectively). The Spearman correlation coefficient, which measures the monotonicity of the relationship between two variables, indicated a moderate level of correlation. Although not a strong correlation, it suggests that the severity of hypernasality may influence the number of articulation patterns, negatively impacting CAD patterns as well as decreasing speech intelligibility, understandability, acceptability, CAD, and facial grimace in children with cleft palate, thereby affecting their daily communication [34]. This is consistent with a recent study showing that children with Bilateral cleft and palate exhibited abnormal resonance and articulation skills in 30–35% of cases by the age of 5 [2], and rates of hypernasality and compensatory articulation errors persisted at 67% and 85%, respectively, by the age of 10.5 after surgical repair [35]. Ongoing speech therapy should be critically provided to improve speech outcomes.

In summary, outcomes from interdisciplinary approaches, particularly for hearing and speech defects, tend to show improvement when compared to studies involving younger children with CP ± L. The protocol should focus on early diagnosis and interventions that are either prelinguistic or early-stage, for both younger and older children. This is especially crucial for school-aged children, as this period is critical for transitioning into adolescence, which in turn impacts further educational achievements and overall life quality. Despite the effectiveness of these approaches, there are regions in the world, including some developing countries, where there is a notable shortage of SLPs or a lack of school-based services. This issue needs urgent attention, and solutions such as deploying a speech therapy task force should be considered to provide necessary services to these children. SLPs face significant challenges in delivering speech services via telepractice and in developing tools such as applications for articulation therapy or multilingual storybooks for early articulation stimulation. Telepractice, however, has shown potential as an effective tool for administering speech therapy in cases of cleft [36,37].

Based on the exclusion criteria, children with hearing loss ≥ 40 dB in both ears or those with articulation errors involving only one sound were excluded from this study, as these factors could affect the results. Participants in this study with CP ± L did not include those who had moderate to severe hearing loss in both ears.

Most children aged 5–13 with CP ± L experienced a 27.63% incidence of hearing loss, predominantly due to conductive hearing loss. The most common CAD patterns observed were velar substitutions and nasalized voiced pressure. There were moderate associations between the severity of hypernasality and the number of CAD patterns across different levels of speech, including words, sentences, and screening. Early surgical intervention to correct resonance abnormalities or velopharyngeal insufficiency could potentially decrease the occurrence of CADs in children with cleft palate. To effectively tackle this issue, prioritizing a speech task force is crucial, especially in developing countries with limited speech resources, as seen in Thailand.

NOTES

Conflict of interest

No potential conflict of interest relevant to this article was reported.

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Ethical approval

The study was approved by the Ethics Committee of Khon Kaen University (No. HE 6540002) and performed in accordance with the principles of the Declaration of Helsinki. The participants' guardians signed a consent form to provide information.

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