Cleft Speech Type Characteristics in Patients with Cleft Lip/Palate in Lao PDR

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Objective: *To explore cleft speech type characteristics (CTCs) in individuals with cleft lip and/or palate in Bokeo Province, Lao People's Democratic Republic (LPDR).*
Material and Method: *Twelve children with repaired cleft lip and/or palate (CLP) who lived in Bokeo Province were registered in a speech camp between July 2014 and October 2015. A Thai speech-language pathologist (SLP) and a Laotian health care provider assessed articulation and resonance using the Lao standard test. Descriptive analysis of the cleft speech type characteristics (CTCs) were used.*
Results: *General articulation types in children with CLP were functional/physiological (25.0%), developmental/phonological (25.0%), and compensatory articulation disorders (CAD) (50.0%) that might be associated with velopharyngeal insufficiency (VPI). Non-oral, glottal articulation (glottal stop /?/ and glottal fricative /h/) and active nasalized consonants for oral pressure consonants (45.45 %) were the most common CTCs, followed by posterior oral: backed to velar/uvular (36.36 %). Omission of final consonant with nasalized consonants (41.7%) was a common error in Laotian children with CLP.*
Conclusion: *CTCs were glottal productions, backing velar consonant substitution and nasalized consonants.*

Keywords: *Cleft Type Characteristic, Articulation, Cleft Lip/Palate*

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The epidemiological incidence of cleft lip and palate (CLP) ranged between 0.38-2.39:1000 live births[1-6]. In the Lao People's Democratic Republic (LPDR), the prevalence of newborns with CLP was 0.02/1,000 live births[7]. Surgery is generally the critical early treatment for correction of configuration as well as for avoiding social stigmatization. After corrective surgery, the majority of children with CLP continued to have speech problems[8-10], including cleft speech type characteristics (CTCs) and velopharyngeal insufficiency (VPI). Apart from anatomical or physical factors, there are (a) physiological or functional factors which result in the faulty learning of speech sounds and (b) cognitive and linguistic development factors which can cause articulation errors[10-12].

Speech sounds are recognized as one of the key outcomes of cleft team care. If speech defects are not solved properly within a critical period, children exhibit communication deficits that result in educational difficulties and psychosocial problems[13,14]. Speech disorders include articulation disorders (difficulties making the motor movements of speech sounds) and phonological disorders (difficulties acquiring the underlying linguistic representations of speech sounds)[15,16]. The core parameters required for speech production and perceptual cleft speech assessment are intelligibility, voice quality, nasality, nasal airflow, grimace, coexistence of developmental speech errors, and CTCs. CTCs are described as compensatory articulation disorders (CADs)[17]. CTCs or CADs are related to higher linguistic rules rather than phonetic rules, thus they represent phonological disorders rather than articulation disorders[15].

In terms of types of errors, articulation disorders are generally classified in the pattern of substitution, omission, distortion, and addition. By way of perceptual assessment, the procedure for

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transcribing all of the phonetics of the target consonants are categorized according to the nature of the error based on their placement(s) and manner of articulation. Sell et al (1999) summarized that consonant errors were described as CTCs in a hierarchy of severity, primarily in relation to place of articulation. These CTCs were grouped in relation to structure and function in four categories: anterior CTCs and posterior CTCs, non-oral CTCs, the passive group, and non-cleft speech errors[14].

Anterior CTCs comprise dental/dentalization/ interdentalization, lateral/ lateralization and palatal/ palatalization. Posterior CTCs refer to backing to velar or uvular and double articulation. Non-oral CTCs are pharyngeal, glottal articulation, nasal fricatives, and double glottal articulation. The passive group includes weakened production of pressure consonants, passive or obligatory nasal realizations of plosives and fricatives, gliding of fricatives or affricates, and an overall absence of pressure consonants[16]. With these definitions of speech CTCs, speech and language pathologists (SLPs) can identify the type of deficiency and work to stimulate a child to produce more correct sounding oral consonants and normal articulation skills[14].

CTCs were explored in a speech camp, as part of a community-based speech therapy model in LPDR, which was adapted from a successful model run in neighboring Thailand[18]. The speech camp recruited children with CLP from remote areas of Bokeo Province, LPDR for speech correction. The objective of the current study was to explore CTCs in individuals with cleft lip and/or palate in LPDR attending this speech camp in order to plan further articulatory correction.

Material and Method

Based on the Helsinki Declaration, the study protocol was reviewed and approved by the Ethics Committee of the Faculty of Medicine, Ramathibodi Hospital, Mahidol University, Bangkok, Thailand (No. ID 09-55-12) and The Khon Kaen University Ethics Committee (HE571181).

Participants: Twelve children with repaired cleft palates from three districts (Ton Pheung, Houayxai, and Pha Oudom) in Bokeo Province were registered in a speech camp set between July 2014 and October 2015. The camp curriculum was based using the Khon Kaen University Community-Based Speech Model, as applied in Chiangrai, northern Thailand[18]-a geographically similar area to Bokeo, LPDR. Two of the participants were Laotian while the rest represented ethnic minorities in LPDR (5 Hmong, 3 Khmu, 1 Lao Theung, and 1 Tai Lu).

Procedures: An SLP able to speak a native northeastern language similar to Laotian with a speech assistant and a Laotian health care volunteer assessed the articulation of participants by consensus. The resonance tests included hypernasality, audible nasal emission, nasal turbulence, and consonant errors both single word and sentence level using the Lao Articulation and Resonance Standard test (Lao Speech Parameters for Patients with Cleft Palate in a Universal Reporting System) adapted from the Thai Speech Parameters for Patients with Cleft Palate in a Universal Reporting System[19] because Thai and Lao are linguistically similar languages so such borrowing of tools is common.

Articulation errors were classified as functional/physiological, developmental/ phonological and CAD or CTCs. CTCs were defined as anterior and posterior oral CTCs. Non-oral CTCs included pharyngeal, glottal articulation, nasal fricatives, double glottal articulation, and passive.

Descriptive analysis was used for classification of CTCs. An analysis of the number of misarticulations by VPI (with or without VPI) using Levene's test for equality determined the variances were equal. The independent t-test was used to compare differences in means.

Results

The general characteristics of the children. The number of error sounds at a single word level ranged between 4 and 24. The rate of functional/ physiological, developmental/phonological articulation disorders, and CADs were presented in Table 2. Nine of the children with CLP (75%) had CTCs, which were classified into various types. The majority of CTCs were non-oral and posterior oral. The independent t-tests revealed no statistically significant differences between these two groups.

Discussion

The pattern of general speech errors in children with cleft palate is well-documented as compensatory articulation disorders classified in terms of cleft speech type characteristics (CTCs)[17]. The most commonly observed error pattern are posterior placement of oral targets and non-oral targets[20]. Several explanations have been proposed for understanding the nature and cause of these error patterns in this group of children. Many studies have

focused on structural factors such as velopharyngeal insufficiency (VPI), oronasal fistulae, and dental/occlusal anomalies. Children with velopharyngeal insufficiency (VPI) attempt to achieve valving at a point inferior to the velopharyngeal valve to produce intraoral stop/plosive or fricative sounds. Children with oronasal fistulae attempt to achieve a valve at a place posterior to the fistulae to prevent nasal escape of air. In case of dental/occlusal anomalies-where the tongue has reduced sensation in the alveolar region due to scar tissue following surgery-the child targets a palatal region with more sensation. Apart from structural deficits, it has been suggested that these impairments also involve higher levels of language organization.

Table 1. General characteristics of children with CLP

Items	Number	Percentage
Gender		
Male	6	50.0
Female	6	50.0
Mean age ± SD	7.13±4.55 years (min 3: 6 years, max 16: 0 years)	
Diagnosis		
Unilateral CLP	8	66.7
Bilateral CLP	3	25.0
Submucous cleft	1	8.3

Speech errors that initially occur because of structural limitations (phonetic disorder) may later result in a phonological disorder. The current study demonstrated an error pattern that affects more than one phoneme in a sound class. These are linguistically based, suggesting a deficit in the child's abstract knowledge or underlying representation of the sound system[15,17]. Even if the physiological speech mechanism were adequately corrected, there may be a habitual, learned aspect to these patterns. For example, an early feeding pattern, wherein the child had an established posterior tongue posture. Based on motor learning theory, some researchers suggest that children

Code	Race	Age (Y:M)	Misarticulation		Cleft-type characteristics (CTCs)	Affected consonants
			No. of Consonant errors*	Types		
L002	lao	4:7	4	developmental/ phonological	Posterior oral: Backed to velar/ uvular	[kh/th], [l/d], [l/t], [l/r]
L003	Hmong	5:3	8	functional/physiological		[tɕh/s], [j~/ŋ], [l/r],[-p,O/-k], [O,-m/ŋ], [-p,O/-t], [-ŋ/-n], [O/-p]
L004	lao Theung	3:6	6	compensatory	Posterior oral: Backed to velar/ uvular	[th,h/s], [ph/f], [k/d], [k/t], [l/r], [-k/-t]
L007	Hmong	16:0	16	compensatory	Non - oral: Glottal articulation : nasalized consonants for oral pressure consonants	[h,ʔ/b], [h/kh], [s/f], [t/p], [tɕ/k], [n/m], [j~/ŋ], [n/w], [n/l], [th/ph], [l/r], [O/-k], [O,-m/-ŋ],[O,-p/-t], [-m/-,n], [O/-p]
L009	Hmong	6:10	14	functional/physiological	-	[tɕ,tɕh/s], [A-p,ph/f], [A-p/t], [A-p/j], [A-p/tɕ], [A-p/ʔ], [j~/ŋ], [l/r], [-p,O/-k], [-m/-ŋ], [-p/-t], [O,-m/-n], [O/-m], [-m/-p]
L012	lao	3:6	9	developmental/ phonological	Posterior oral: Backed to velar/ uvular	[kh/th] , [tɕ,k/t], [k/tɕ], [tɕ/k], [j~/ŋ], [tɕ/kh], [l/r], [-k/-t], [-ŋ/-n]
L013	Tai Lue	3:6	8	developmental/ phonological	Posterior oral: Backed to velar/ uvular	[t,h/s], [ph/f], [p/b], [tɕ/t], [t/d], [l/r], [-k/-t], [-n/-ŋ]
L014	Hmong	15:6	7	functional/physiological	-	[l/r], [-k,-p/-t], [-m/-n], [O/-k], [O/-ŋ], [-ŋ/-m], [O/-p]
L015	Hmong	7:3	18	compensatory	Non - oral: Glottal articulation	[h,ŋ/ph], [h/th], [h/kh], [tɕh/s], [w/f], [ŋ/b], [n/d], [ʔ/t], [ʔ/p], [ʔ/tɕ], [j,m/ŋ], [ʔ/k], [l/r], [-m,-p,O/-t], [-m/-n], [-p/-k], [-m/-ŋ], [O/-p]
L016	Khmu	4:7	19	compensatory	Non - oral: Glottal articulation	[h/ph], [h,ʔ/th], [ʔ/kh], [ʔ/s], [ʔ/f], [ʔ/b], [ʔ/d], [ʔ/t], [ʔ/p], [ʔ/tɕ], [ʔ/k], [ʔ/m], [ʔ/n], [j/ŋ], [j/l], [-m,O/-t],[ʔ/w], [h,j/ʔ], [l/r]
L020	Khmu	4:11	15	compensatory	Non - oral: nasalized voiced pressure consonants	[p/ph], [j~/th], [j~/kh], [j~/s], [w/f], [m/b], [j~/d], [m/p], [j~/t], [j~/k], [j~/n], [j~/tɕh], [j~/ tɕ], [l/r], [A/-ŋ]
L024	Khmu	11:0	7	compensatory	Non - oral: Active nasal fricatives : Glottal fricative	[h/kh], [w/ŋ], [D,NT/s], [NT/f], [NT,~/b], [l/r], [O/-ŋ]

No. of errors* = number of vowel and consonant error sounds, Types = Types of misarticulation, compensatory = compensatory misarticulation associated with velopharyngeal insufficiency (VPI), NT= nasal turbulence, D = distortion, O = omission, A= addition

Fig. 1 Articulation assessment and Cleft type characteristics.

with cleft palate and posterior placement have a perceptual deficit and the child cannot identify or discriminate phonological contrasts[20]. This motor learning was re-applied to diminish the compensatory articulation in phonetic therapy and to establish new motor routines for affected sounds[21].

Rate of types of misarticulation in children with CLP in the current study were similar to previous studies[10,22,23]. Three children with CLP (25%) had developmental or phonological articulation disorders (cases L002, L012, L013) (Fig. 1) which are common errors at a preschool age[13] because of premature articulation and might easily be resolved[14]. Language development from either increasing vocabulary or wider range of meaningful words might facilitate atypical articulatory features or phonological development in those young children[17].

Non-oral, glottal articulation, nasalized consonants for oral pressure consonants (45.5%) was the most common CTC, followed by posterior oral, back to velar/uvular (36.4%) (Fig. 1 and Table 3). These findings agree with previous studies[10,11,14,23]. CAD or CTCs were the most common type in children with clefts (50%) over against other types of articulation error (Table 2)[10,23]. Three children with CLP were classified as having functional or physiological articulation disorders (Table 2), which might be attributed to be a type of mislearning articulation in normal children or due to lacking an incomplete sensory and motor structure of the speech organ and abnormality of structures[24]. For passive CTC, nasalized voiced pressure consonants and nasal consonant for oral pressure consonant were found in 2 children with cleft (Table 3). In fact, typical dialect LPDR normally has both omitted the final consonants and hypernasality[25], therefore, they seemed to have an influence on articulation errors.

According to misarticulation by VPI compensation group (Table 4), there were no significant differences in the number of articulation errors between groups with and without VPI (mean difference 4.17; 95% CI -3.58 to 11.91). This might be due to the small

Table 2. Cleft palate speech differentiated by misarticulation types

Types of articulation	Number	Percentage
Functional/physiological	3	25.0
Developmental/phonological	3	25.0
Compensatory associated with velopharyngeal insufficiency (VPI)	6	50.0

Table 3. Cleft speech type characteristics (CTCs)

Cleft type characteristics (single words)	n*	Percent
Anterior oral CTCs		
Dentalization/inter-dentalization	-	
Lateralization/lateral	-	
Palatalization/palatal/middorsum palatal stop, palatal clicks	-	
Posterior oral CTCs		
Double articulation	-	
Backed to velar/uvular	4	36.36
Non-oral CTCs		
Pharyngeal articulation/pharyngeal fricative, pharyngeal affricate	-	
Glottal articulation/glottal stop/ glottal fricative (h)	4	36.36
Active nasal fricatives/anterior nasal fricatives/voiceless nasal	1	9.09
Double articulation	-	
Passive CTCs		
Weak oral pressures/soft voice syndrome/nasalized voiced pressure consonants	1	9.09
Nasal realization of plosives/ nasal consonant for oral pressure consonant/posterior nasal fricative, nasal substitutions	1	9.09
Gliding of fricatives/affricates	-	
Total	11	100

* Counts reflect children who produced two or more of each error type

Table 4. Comparison of misarticulation with and without VPI compensation in CLP

Group	n	Mean of articulation errors	Standard deviation	Mean difference	*p*-value	95% confidence interval
Misarticulation with VPI compensation	6	15.33	7.31	4.17	0.17	-3.58-11.91
Misarticulation without VPI compensation	6	11.17	4.35			

sample size, so a larger group is required to confirm or deny the effect of secondary CAD from VPI.

In summary, the most commonly affected consonants in cleft palate speech among the participants were alveolar targets /s/ and /f/ (fricatives), followed by lingual plosives /t/, /t^h/, /d/, /k/, respectively. These might result from CAD in CLP or anatomical defects (*e.g.*, L004 who had a large fistula which would likely cause phonetic deviation as a result of articulatory imprecision in intra-oral pressure)[8,10,13,14,17]. The findings of this study provided information that SLPs can use for planning to facilitate more effective clinical speech correction or continuing clinical need for easy intervention[8]. Early intervention with caregivers to prevent CAD and other common articulation errors would encourage early oral consonant development and normal articulation skills.

Conclusion

Children with CLP in Bokeo Province, LPDR had a high rate of CTCs including glottal production, backing velar consonant substitution, and nasalized consonants. Alveolar sounds were the most vulnerable effects. The ethnic dialects in LPDR might be an affected misarticulation and hypernasality.

What is already known on this topic?

Children with CLP generally have abnormalities in oral facial structures that cause speech defects, particularly CAD and CTCs.

What this study adds?

Laotian children with CLP had similar articulation patterns (CAD and CTCs) to previous outcomes in other studies. Early diagnosis and early intervention should be planned in LRPD, where speech services are limited.

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Potential conflicts of interest

None.

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ลักษณะรูปแบบการพูดของเด็กปากแหว่งเพดานโหว่ในสาธารณรัฐประชาธิปไตยประชาชนลาว

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วัตถุประสงค์: เพื่อสำรวจลักษณะเฉพาะของรูปแบบการพูดผิดปกติของเด็กปากแหว่งเพดานโหว่ในแขวงบ่อแก้ว สาธารณรัฐประชาธิปไตยประชาชนลาว

วัสดุและวิธีการ: เด็กปากแหว่งเพดานโหว่ที่ได้รับการผ่าตัดซ่อมแซมแล้วและอาศัยอยู่ในแขวงบ่อแก้ว สาธารณรัฐประชาธิปไตยประชาชนลาว จำนวน 12 คนลงทะเบียนเข้าค่ายฝึกพูด นักแก้ไขการพูดคนไทย 1 คนและอาสาสมัครด้านสุขภาพชาวลาวประเมินการพูดไม่ชัด และการสั่นพ้องของเสียงด้วยแบบทดสอบมาตรฐานภาษาลาว งานวิจัยนี้ได้ทำการวิเคราะห์ลักษณะเฉพาะของรูปแบบการพูดผิดปกติของเด็กปากแหว่งเพดานโหว่โดยใช้สถิติเชิงพรรณนา

ผลการศึกษา: รูปแบบการพูดไม่ชัดทั่วไปของเด็กปากแหว่งเพดานโหว่ได้แก่ การพูดไม่ชัดแบบไม่มีพยาธิสภาพของอวัยวะที่เกี่ยวข้องกับการพูด (functional/physiological articulation disorders) (25.0%) การพูดไม่ชัดที่เกิดในวัยเด็ก หรือการพูดไม่ชัดตามระบบการออกเสียง (developmental/ phonological disorders) (25.0%) การพูดไม่ชัดแบบชดเชย (compensatory articulation disorders: CAD) (50.0%) ซึ่งอาจจะร่วมกับความบกพร่องของการทำงานของเพดานอ่อนและผนังคอหอย (velopharyngeal insufficiency) การพูดไม่ชัดที่เกิดจากการใช้อวัยวะนอกช่องปาก: การใช้เสียงที่สายเสียง การใช้เสียงเสียดสีที่สายเสียง และ (glottal stop /ʔ/ and glottal fricative: /h/) และการออกเสียงขึ้นจมูกแทนการออกเสียงทางปาก (active nasalized consonants for oral pressure consonants) (45.45%) เป็นลักษณะเฉพาะของรูปแบบการพูดผิดปกติที่พบบ่อยที่สุด ตามด้วยการพูดไม่ชัดที่ใช้อวัยวะส่วนหลังของช่องปาก: เพดานอ่อน (posterior oral: backed to velar/uvular)(36.36%). การละไม่ออกเสียงของตัวสะกดร่วมกับการพูดเสียงขึ้นจมูก (omission of final consonant with nasalized consonants) (41.7%) เป็นรูปแบบที่พบได้บ่อยอันหนึ่งของเด็กปากแหว่งเพดานโหว่ลาว

สรุป: ลักษณะเฉพาะของรูปแบบการพูดผิดปกติของภาวะปากแหว่งเพดานโหว่ คือ การออกเสียงที่ใช้สายเสียงการใช้อวัยวะส่วนหลังของช่องปากที่เพดานอ่อนแทนเสียงอื่น และการพูดเสียงพยัญชนะขึ้นจมูก