

Chronicling Subtle Nuances of Childhood Apraxia of Speech (CAS) through Exclusive Non- standardized tool

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Abstract

Childhood Apraxia of Speech is one of the most interesting motor speech disorders. Child with CAS will not be able to produce speech voluntarily. Due to its subtle nature CAS is either under-diagnosed or over-diagnosed in general. Another challenge faced in practice is the barrier of language as most of the standardized test uses English language based questionnaire format. Henceforth, we developed a tool to qualitatively assess various aspects of CAS.

Introduction

Childhood Apraxia of Speech (CAS) is a very intriguing yet complicated motor speech disorder. It is a disorder that stems from neurological insult to the developing brain due to causes ranging from pre, peri and post natal complications. The salient features of CAS include inability to voluntarily produce speech in the absence of any evident weakness, sensory deficits or lack of language skills. Based on a number of studies, it is clear that the fundamental problem with CAS is a lack in planning and programming, which prevents the affected child from speaking at will [1,2,3,4,5]. At core, in CAS, the voluntary speech differs significantly from involuntary speech [6,7]. Speech in CAS follows a definite pattern. The child will have deficits predominantly in articulation and prosody. ASHA reports three major diagnostic markers in the speech of children with CAS. These include (a) inconsistent errors on consonants and vowels in repeated productions of syllables or words, (b) lengthened and disrupted coarticulatory transitions between sounds and syllables, and (c) inappropriate prosody, especially in the realization of lexical or phrasal stress [emphasis added]. The articulatory errors detected are highly inconsistent in nature [3,7,8]. Evidently, there exists a visible difference in articulation during voluntary and involuntary speech [3,9]. According to the survey by Shakibayi et.al the predominant articulatory errors reported in CAS other than their hallmark inconsistencies include oromotor difficulties, groping, polysyllabic word errors, sequencing problem and general unintelligibility. Prosody is another aspect of speech that also showed evident abnormalities. The prosodic errors reported in CAS ranges from increased duration in between speech segments and decreased variations in fundamental frequency in different intonation patterns. There are also reports of reduced

or erroneous lexical stress placement [10,11] and disrupted rhythms as evidenced by the timing errors [12].

The features of CAS are intriguing yet confusing due to its subtle nature. The chief reason for this is being the negative description of the disorder. i.e, most of the definitions of CAS are given in terms of what should not be present as opposed to what to look for. Another reason is that CAS is categorized under many umbrella disorders. For instance, on one hand ASHA classifies CAS under speech sound disorder whereas on other hand DSM classifies it under development coordination disorder. Yet another school of thought considers CAS as a sensory processing disorder [13]. The definitions are also given accordingly. These controversies make it difficult to define the features of CAS. The lack of crispness in description of CAS leads to many challenges in clinical practice. Due to its concealed nature, in many instances CAS is either under diagnosed or over diagnosed. Further, CAS co-occurs with other disorders with overlapping features. For instance, clinically a child with CAS shares many feature akin to general speech language disorders like speech sound disorders, Autism and even to some extent cerebral palsy. So when these disorders co-exist it becomes practically impossible to differentially diagnose CAS from other co-existing conditions. Yet another challenge faced by diagnostician is the language barrier. All the standardized tests and checklist developed use English language as medium. Hence, it is ineffective for a non-english speaker.

Need for the study

Assessing CAS is a cumbersome process as due to all of the above mentioned factors. A qualification of the features of CAS makes in more confusing rather than resolving the issues. Therefore, to bring clarity for diagnosis we put forth the idea

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of a qualitative tool. This tool uses descriptive data to record the features of CAS.

Method

About the tool

The tool possesses checklist like format with eleven subsets and a provision for differential diagnosis. The eleven subsets include (i) History, (ii) Motor functions, (iii) Sensory evaluation, (iv) Psycho social evaluation, (v) Speech analysis, (vi) Speech analysis, (v) Language evaluation, (vi) Prosodic aspects (vii) Other Speech subsystem evaluation, (ix) Inconsistency and variability, (x) other observation, (xi) Testing for non-verbal apraxia and finally (xii) differential diagnosis. The subsets were isolated after in depth research. We reviewed nearly fifty articles published regarding CAS from the last decade through open access platforms including Google scholar, Academia, Pubmed, Sciencedirect, Core and Base. Additionally, Information was gathered from professionals working in the field of speech-language pathology using Delphi method and Interview. The efficacy of these materials were discussed and debated in a focus group comprised of four academics, ten undergraduate, and five postgraduate students in the field of Speech Language Pathology. The conclusive points from this focus group discussion were given to three speech language pathologist with minimum ten year of experience working in the area of CAS to fact check. Each subset had numerous questions under them that have to be answered in a descriptive format. No discrete scoring was carried out. The tool is attached in **appendix 1**.

Administration of the tool

The tool was administered in five children suspected of CAS. The results were tabulated in detail. As it was in a descriptive format no statistical analysis was carried out.

Results

(**Table 1**) describes the results of administration of the checklist in suspected CAS cases. The results of each case in described separately across each section. The table provides a comprehensive data regarding the cases.

Discussion

(**Table 1**) gives a clear account of the results of administering the tool in suspected CAS cases. Each subsection is dedicated to outline the various aspects that point the diagnostician towards CAS. The first section documents any potential neural involvement, while the second, third and fourth sections aid in understanding the child's overall motor, sensory and psychosocial development. The results we were able to gather in the five suspected CAS cases clearly indicate the presence of neuronal injury. All cases had normal motor and psychosocial abilities, with the exception of case 5, in which there was comorbid dysarthria.

Results of speech evaluation concluded that except in case 5, rest all cases the children exclusively showed deficits in articulation and prosody. There were also noteworthy variability and inconsistencies in the errors thus strongly suggesting the presence of CAS. These results strongly support the presence of CAS in the selected cases.

Furthermore, the tool was also successful in isolating CAS from other disorders sharing similar aspects. For instance, in all of the five cases mentioned in the table there was definite language delay. However, the tool was able to differentiate language related disabilities from the apraxic component through series of well-formed questions. The provision for differential diagnosis enabled the diagnostician to charter the features of each concomitant disorder separately. The separate section delineating the consistency and variability of errors enabled the diagnostician to confirm the probability of CAS based of its exact nature i.e. unpredictable error pattern. Finally, the diagnostician might record the existence of any non-verbal apraxias that might co-occur with CAS in the last section. Only case 4 in our subjects exhibited mild oral apraxia.

The major limitation of our tool is that, it doesn't give a quantitative data. But practical experience from professional reported that quantitate value lacked personalization. For instance, the scoring in itself will not allow us to understand the finer deficits in the child. Instead our checklist allows us to record the subtle features and characteristics to the data which enables the interventionist to move with it. However, more information can be added to the tool to increase its sensitivity.

Table 1: Description of CAS features from the developed tool for the five suspected CAS cases.

	Case 1	Case 2	Case 3	Case 4	Case 5
Age/sex	4 yr/F	7.7 yr/F	6 yr/F	4.5 yr/M	10 yr/F
HISTORY	Delayed speech and language development	-Perinatal asphyxia -Motor, speech-language milestones delay	-Perinatal kernicterus followed by 1 week ICU admittance -Delayed speech, Language and motor milestones	-h/o maternal hypertension	-breach delivery -delayed birth cry -Delayed speech, Language and motor milestones
MOTOR FUNCTION	Structurally and functionally normal oral structures	-no general motor/ oromotor weakness	-no general motor/ oromotor weakness	-no general motor/ oromotor weakness	-mild paresis of right hand -mild unilateral weakness towards right for tongue

SENSORY EVALUATION	Normal hearing and vision	Normal hearing, vision and tactile sensory skills	-Slight squint	-Mild conductive hearing loss (ASOM)	Normal hearing, vision and tactile sensory skills
PSYCHO SOCIAL DEVELOPMENT	Age adequate social and cognitive skills	Age adequate social and cognitive skills	Age adequate social and cognitive skills	Age adequate social and cognitive skills	-Poor prelinguistic skills-Borderline cognitive delay
SPEECH ANALYSIS	<p>Inconsistent articulatory errors</p> <ul style="list-style-type: none"> - Phonemic inventory seems to have consonants and vowel repertoire of /p/,/b/, /n /, /t /, /d /, /g /, /m /, /ng /, /f /, /v /, /th /, /z /, /sh /, /j /, /dz /, /r /, /s/ and /a/,/i/,/u/,/o/,/e/,/ai/,/ei/,/oi/,/ua/ respectively . - Phoneme error variabilities -shows difficulties in achieving initial articulatory configurations for an utterance. - predominant use of simple syllable shapes . - increased errors as the complexity of syllable shapes increases . -Groping errors. - Differences in performance of automatic and volitional speech - sentences composed of combinations of oral words, signs and gestures . 	<p>Low score on DDK rate task.</p> <ul style="list-style-type: none"> - Reduced intelligibility . -Phonemic inventory seems to have consonants and vowel repertoire of /p/,/b/, /n /, /t /, /d /, /g /, /m /, /ng /, /f /, /v /, /th /, /k/, /sh /, /j /, /dz /, /r /, /s/ and /a/,/i/,/u/,/o/,/e/,/ai/,/ei/,/oi/,/ua/ /ia/ respectively . - shows phonemic errors like S,O,D,A errors . -Token to token variability - Contextual variability. - Phoneme error variability -Increased errors as the utterance length and rate of speech increases - Occasional difference in performance of automatic and volitional speech . - Groping errors . 	<p>Inconsistent articulatory errors .</p> <ul style="list-style-type: none"> - Poor intelligibility . -phonemic inventory seems to have consonant and vowel repertoire of /p/ , /b/ , /t/ , /d/ , /m/ , /n/ , /w/ , /j/ , /v/ , /th/ , sh/ and/a/ , /i/ , /u/ , /e/ , /o/ , /ai/ , /ei/ , /ia/ , /ua/... respectively . -phonemic errors – S,O,D,A errors - shows token to token variability-positional variability. -contextual variability. -phoneme error variability . -increased errors as the utterance length. 	<ul style="list-style-type: none"> - phonemic inventory seems to have consonant and vowel repertoire of /p/ , /b/ , /t/ , /d/ , /k/ , /m/ , /n/ , /j/ , /v/ and/a/,/i/,/e/,/o/,/u/,/ai/,/ei/,/ua/,/ia /etc...respectively . - Token to token variability - Phoneme error variability and contextual variability . - Difficulty in achieving initial articulatory configuration for utterance - Uses predominantly simple syllable shapes - Shows difference in performance of automatic versus volitional speech - Shows groping errors -Increased errors with increased complexity of sentences - Slow progress in acquiring sounds - Sentences mainly composed of oral words , signs and gestures -Limited vocalizations and babbling during infancy . 	<ul style="list-style-type: none"> -substitution of /a/ with /r/ -Omission of /k/ -inconsistent errors -no positional variation -normal DDK (on repeated trail) -mild to moderate intelligibility deficits -normal consonant and vowel repertoire
Language evaluation	Expressive and Receptive Language Delay	Expressive language delayed by 1 year; age adequate receptive language	Reception and expression delayed by 6 months	Receptive language skills delayed by 6 months and expressive language skills delayed by 2 years	Delayed receptive language (3 months) Delayed expressive language (1 year)
prosodic aspects	-Insufficient stress placement -flat intonation and monotonicity	-Reduced stress inventory -Faulty rhythm	Insufficient stress pattern.	Monotonous speech	-insufficient syllable stress -abnormal juncture in between words
Other Speech subsystem evaluation	No abnormalities in other speech subsystems	No abnormalities	No abnormalities	No abnormalities	-mild hoarse voice
Inconsistency and variability	-Token to token variability present - phoneme error variability present - positional variability present	-phoneme error variability present -positional variabilityobserved -contextual variability-present	-Difference in performance of automatic and volitional speech.	- Token to token variability - Phoneme error variability and contextual variability .	-Token to token variability -Phoneme error variability and contextual variability -variability in automatic v/s volitional speech

Other observation present	-Difficulty achieving initial articulatory configuration for an utterance. -slow transition between movement gestures - syllable segmentation. - Slow progress in acquiring sounds -Late talker	-slow transition between movement gestures -Predominant use of simple syllable shapes -Struggling to speak	-Groping errors -Predominant use of simple syllable shapes. -Slow transition between movement gestures. -Difficulty achieving initial articulatory configuration. - Slow progress in acquiring sounds. -Sentence composed of combinations of oral words, signs and gestures. -Limited vocalizations /babbling during infancy.	- Difficulty in achieving initial articulatory configuration for utterance - Uses predominantly simple syllable shapes - Shows difference in performance of automatic versus volitional speech - Shows groping errors -Increased errors with increased complexity of sentences	-Groping /struggling to speak -Limited vocalizations / babbling during infancy -Slow progress in acquiring sounds -Late talker- Struggling to speak -sentence composed of combinations of oral words ,signs and gestures
TESTING FOR NON - VERBAL APRAXIA OF SPEECH	Non-verbal apraxia is absent	Non-verbal apraxia is absent	Non-verbal apraxia is absent	Oral apraxia present	Non-verbal apraxia is absent

Note: The table represents the Results of Administration of CAS Tool in five suspected CAS cases. Column 1 represents the sections of tool. Each row records a separate case. Each individual cell describes the features recorded in that particular case across the respective section. yr-years; F-Female; M-Male.

Summary and conclusion

To put comprehensively, the tool is a very good mean to outline the subtle aspects of CAS as it compiles many areas exclusive to CAS and bypasses the hurdle of using language as a mean to evaluate the child. As unorthodox our method is, we can strongly argue that the focus of making such a tool is not for the purpose of diagnosing CAS but rather to work as a basis for intervention. Our tool provides information on the core deficits of these children. When put together these kernels can light strong fire that can aid the process of intervention in such children, thereby fanning the rate of prognosis in them.

Ethical Consideration

The study followed the ethical rules and regulation of Kerala University of Health Sciences and was accepted by ethical committee of AWH Special College, Kozhikode. The client was informed and consent was obtained. The study was conducted by maintain proper respect and anonymity towards the client.

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Conflict of Interest: There is no conflict of interest between the authors and the authors as well the client.

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