Vol.8|No. 3|Issue 32|Oct-Dec, 2010

Phonatory Vocal Tract Stability in Stuttering Children before and after Fluency – Enhancing Therapy

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Kathmandu Univ Med J 2010;9(32):405-9

ABSTRACT

Background

Stuttering is a complex disorder. Essentially, it is a neuromuscular disorder whose core consists of tiny lags and disruptions in the timing of the complicated movements required for speech.

Objective

The purpose of the current study was to collec and comparg jitters and shimmer values in children who stutter before and aftea fluency – enhancing therapy.

Methods

Subjects consisted of 15 Iranian preschool girls with stutterg, and 15 Iranial preschool girls without afflictions, matched according to age. Vocal jittering and shimmer measurements of thesphonation of the children were compared before and after therapy. Each subject phonated vowels nine times in a random order. Each phonation was sustained for at least five seconds and was recorded. The middle three-second portion of each recorded vowel phonation was subjected to jitter and shimmer analysis.

Results

On shimmer measures between pre-treatment and post treatment, significant differences were found in all sustained vowels of persons who stutter group and means of shimmer in post therapy were significantly lower than pre-treatment. Differences in jitter measurements were not significant between pre-treatment and post-treatment statuses and this parameter did not change after therapy.

Conclusion

The findings showed that therapy resulted in decreaseg irregularity in the amplitude of vibrations (shimmer). In other words, the therapy increases the steady-state of the laryngeal system. Moreover, this parameter may be used as an index for the effectiveness of therapy.

Key Words

children, jitter, phonation, shimmer, stuttering, voice

INTRODUCTION

Stuttering is a complex disorder and essentially it is a neuromuscular disorder whose core consists of tiny lags and disruptions in the timing of the complicated movements required for speech.[1,2] Obvious disturbances in the speech production system of stuttering individuals might be related to generalized temporal incoordination between respiration, phonation and articulation.[3]

A large body of literature has accumulated in support of this view that individuals who stutter, differ from individuals who do not stutter in at least some of the neuromuscular processes involved in speech production.[4-8] Several authors have proposed incoordination of these actions as a specific version of the general hypothesis that stuttering is a disorder of timing.[9,10-15]

One of the most important factors that predict high precision temporal coordination is phonatory vocal tract stability. Vocal perturbation measures are short-term indices of the stability of the phonatory system and both may be associated with poor laryngeal control. [3]

Irregularity of the fundamental frequency or of the period of subsequent glottal cycles is called jittering. Shimmer is due to the overlapping of the fundamental frequency of the voice with a noise which leads to amplitude irregularities.[16]

Several studies that examined speech acoustics of persons who stutter (PWS) and Persons who do not stutter (PWDS) have found that PWS, as a group, show longer voice onset times (VOTs), vowel durations, stop gap durations, and consonant-vowel transition durations.[17] Baer (1979) considered that stuttering children have weaker laryngeal neuromuscular control and greater disturbances in integrating respiratory and laryngeal control which justifies measurements of voice disturbances.[18] On the other hand, few studies have examined the differences in vocal tract stability during speech production betwer (WS) ar (PDS). Klich and May (1982) suggested that the stutterers were producing vowels using an eutral vocal tract posture as a means of controlling speech fluency.[19] Most researchers have examined the possible differences in oral-laryngeal coordination between stuttering and non-stuttering individuals. Pesák and Urbánek (1993) studied incoordination of the phonation start in individuals with stuttering and found that in the group of children and adolescents with stuttering only less than 4% of the cases showed undisturbed regular phonation starts, whereas in the control group it was almost as much as 90 percent.[20] Falck, Lawler and Yonovitz, (1985) found that adults who stuttered exhibited measurable cycle-to-cycle temporal changes prior to moments of stuttering.[21] Such changes were absent in the identical but fluent utterances of the same speaker. Newman, Harris and Hilton (1989) found that PWS as a group showed higher amplitude irregularities during sustained vowel productions and their findings showed differences between stutterers and non-stutterers in the laryngeal behavior (i.e., F_0 perturbation). This finding was interpreted as maintaining a fixed laryngeal posture during vowel steady-state production.[22] Bamberg, Hanley, and Hillenbrand (1990) also reported significantly higher vocal shimmer values in the fluent speech of PWS than their fluent peers. Hall and Yairi (1992) examined acoustic correlates of phonatory control in the speech of 10 preschool-aged boys who were stutterers and in the speech of 10 boys who were non-stutterers. Significant differences were found between the two groups for shimmer measures.[3] Robb, Blomgren and Chen (1998) found that PWS enrolled in fluency-shaping therapy displayed the least formant frequency fluctuation (FFF) (most vocal tract stability) and the untreated PWS displayed the most FFF (least stability).[23] Salihović et al. (2009) compared the speech of 67 children who stutter with the speech of 46 fluent speakers and concluded that there were significant differences between the two groups for jitter and shimmer measures.[24]

Unfortunately, research addressing laryngeal functioning in people who stutter has been primarily focused on adults. When children mature, they exhibit a greater control over laryngeal adjustments that is reflected in the increasing stability of vocal fold vibration.[3] Similarly, data shows that vocal jitter and shimmer decreases a lg with age, , as it is interpreted to having greater cntrol.[25] A Lower indices of magnitude one either jitter or shimmer indicate less vocal perturbation and greater stability in the fine motor control of phonatorehavior. If Should the magnitude of voca er or shimmer, in the fluent phonatory behaviours of PWS (either jitte shimer) was shown to be significantly greater than of PWNS, this it would provide additional support to the hypothesis that PWS may demonstrate generally less competent neurophysiologic regulation.[22] Moreover, research has not documented the acoustic measures of jitter, or shimmer in the phonations of young children in pre-theapy and post-therapy. Data on the various aspects of laryngeal function in children who stutter may enhance the understanding of the disorder within the context of developmental processes of the speech.[3, 22]

The current study was designed to gather and compare the jitter and shimmer values of PWS in two different conditions (i.e. pre-theapy and p for obtaining in order to gain a better undersing about the phonatory motor c PWS population. The results this study It can be used in future therapy sses and used as an index of the progression of therapy.

METHODS

Subjects: Subjected of fifteen 15 ss and ffteen 15 non-stutterers matched according to age and sex. The age rangeofthestuttererswasfrom67to79monthsndofthe nntuttererswasrangedfrom66to79monthswithamean age of 72.6 for both groups. All subjects werefemale.

The Study design was a quasi-experithat was done conducted at the rehabilitation clinic of Zahedan UniversityofMedicalwas8months.studywascarriedout over eight months,

Severalcriteriawereemployedforsubjectclassificationtoberegardedwereobservedbybothparentsandtwospeech therapistsasexhibitingastutteringproblemandhadto demonstrateatleastsixstuttering-likebehaviours(SLDs)[3] per100wordsduringa300-wordsampleofconversation withtheirmothers,and/orifpeopleintheirenvironments hadexpressedconcernregardingtheirspeechfluency.[26]

The presence and magnitude of stuttering at the time of testing was verified using the Stuttering Severity Instrument.[27] All were moderate level in SSI-3 Scale· Allsubjectswereperceptuallyassessedfornormalityof their voices with the GRBAS scale, By means of sound reproductionofeachvocalsample,thefollowingitems weregradedconjunctlybytwoprofessionalsexperiencedin vocalpathology,from0to3usingtheGRBASmethod;(0 =normal,1=slight,2=moderate,3=severe):G(Grade), the global grade of vocal affliction. R (Roughness), the qualityofthevoicerelatedtotheimpressionofirregular glotticpulsesfromanoisecomponentoflowfrequency,of roughnessorvocalfry.B(Breathiness),thevoicerelated tothenoisethatoriginateswiththeturbulencecreated by an incompetent glottis. A (Asthenia), the auditory impressionfweaknessinspontaneousphonation.Hypo kineticorhypofunctionalvoice.S(Strain,vocaltension), theauditoryimpressionofexcessiveeffortandoftension associated with spontaneous phonation.[28]Those with ratingshigherthan0,evenifitwasononemeasure,were excluded.Theratingwasperformedonavoicesampleof one1minuteofspontaneousspeech.Subjectswerealso screenedonformerproblemswithbreathing,theirvoice, neurological diseases, and structural abnormalities in the larynx, mouth, or throat with a questionnaire. The second author checked their vocal folds with a flexible laryngoscopetoconfirmthatnoonehadorganiclesions of the vocal folds.

Theacousticexaminationwasperformedinasoundproof room with the subjects in a sitting position. Subjects attendedfluencyreinforcementpluscorrectivefeedback. The criterion of treatment success was less than 2% stuttering rate in all stages.[29]The number of sessions of therapy depended on the individual child and varied from26-90hours.Datacollectionwasperformedbefore starting treatment protocols, using the Dr. Speech 4.0 software(subprogramme:vocalassessmentversion4.0 fromTigerElectronics,USA)atthespeechtherapyclinic. Themicrophone(type:ECM-717condensermicrophone, SonyCorporation)wasplacedoastandatomthefrontof mouth.Thesamesampleswererecordedaftertermination of terapy.

VoicesSamplestakenconsistedofthefivesustainedvowels of the Persian language, /â/, /a/, /e/, /o/ and /u/ in a comfortableandhabitualway,andeachsubjectphonated vowelsninetimesinrandomorder.Eachphonationwas sustainedforatleastfivesecondsandwasrecorded.The mid-3-secondportionofeachrecordedvowelphonation was subjected to jitter and shimmer analyzes.

Statisticsdatawereanalyzedwiththestatisticssoftware SPSS 18.0 for Windows and data were subjected to a two-way analysis of variances (ANOVA) with repeated measures.

RESULTS

Means and standard deviations of jitter of PWS and normalpeershowedintheTtable1and2forpre-treament and post- treatment statuses. On the jitter measures in pre-treatment and post-treatment conditions of both groupstherewerenotsignificantdifferences.Meansand standarddeviationsofshimmerofPWSandnormalpeers werpresentedint4,respectively.Onshimmermeasures betweenpre-andpost-treatment,significantdifferences were found in all sustained vowels of PWS group and means of shimmer in post- therapy were significantly lowerthanpre-treatment(p5).AsnotedicedinTtablere wasnotanysignificantdifferenceonshimmermeasuresin control group.

DISCUSSION

Asignificantdifferencewasfoundbetweenpre-treament and post-treatment statuses on measures of shimmer. However,thedifferencesofnjitterbetweenthetwostatuses werenottobestatisticallysinificant.TheMmeansfshimmer inofallofthevowelsinpre-treatmenstatuseswereasarger thanthoesemeauresdinpost-treatmentstatus,indicating thatthesustainedphonationsofthepre-treatmentwas lessstablethanthosethepost-treatmentintermofvocal intensity.Ontheotherhand,forshimmermeasures,there wasnotanysignificantdifferenceinthecontrolgroupthat wecanconcludethechangesinthemeasuresofsimmer inpost-treatmentstatusresultsfromtherapyanditisnot dependtogrowing.Althoughthespecificneuromuscular components of vocal jitter and shimmer have not been

identified,itispossiblethatshimmectsthegreaterficulty of with integrating respiratory, laryngeal, and cortical controlthanjitter.[3]Although,itisdifficulttocompareour acousticdatawiththefindingsofotherstudiesbecausepast variousresearcheshasusedthevarietyofmethodologies that it limits comparisons across studies. However, it is interestingtonotesimilaritiesbetweenthepresentresults andacousticdatafromliteratureforchildrenandadults whostutter.[3,22,24]Thedirectionofourfindingdifferenes were obtained, suggest that stutterers have less stable neuromuscular control over the events regulating the aerodynamics of the laryngeal and respiratory system during sustained fluent vowel articulations and fluency therapyincreasesteady–stateinlaryngealandrespiratory system and led to decrease irregularity in the amplitude of vibration (i.e. shimmer). The steady state, sustained phonationinvolvesanevenmaintenanceofsuchforcesas vocalfoldtension,mass,length,andsubgloticpressures, while it also maintains the supralaryngeal articulatory adjustmentsrequiredforproductionofthevowel.Onthe otherhand,itwasdeterminedthatstutteringindividuals havevariable,sometimesevenchaoticsubglotalpressure.[30] Itisthoughtthatthisiscausedbymuscularincoordination ofthertact.[31]However,Ddifferenceshavebeenobserved, however,betweenthetwostatuseswhichsuggestthat children are better able to control these forces after the terminationoftment.Therefoonthebasisofthecurrent studyfindings,measurementsofamplitudeperturbation ofvoicesuchasformantfrequencyfluctuationmeasures canbeusedasanindexofvocalttstability,astheithasalso beenusediresearchesut.[23,32,33] Also,Thestudy willalsoit canhelpcliniciantopursuetheprocessoftherapyandcan thenbeusedasanindexofeffecnarrowagerange;Itmust beacknowledgedthatthestudyhaspresentedwithcertain limitations,suchasthenumberofparticipantswhichwere used,andthenarrowagegroup,thus,itisrecommended thatthisstudybereplicatetherlargerorwidealargeranage rangesamplesofstutteringspeakers.stutteringadults.

CONCLUSION

The findings from the present study showed that there aren'tsignificantdifferencesonjittermeasuresbetween pre-reatmentandpost-treatmentconditionsbutontheotherhand,therearesignificantdifferencesonshimmer measuresbetweenpre-reatmentandpost-treetconditions. So, tThe latter parameter or shimmer has an important roleinthetherapeuticyprocessandcanbeusedasanindex of progression of therapy.

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