Analysis of Voice in Yakshagana Singers

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Abstract

Yakshagana (street play) is a performing art of Karnataka in which different channels of communication like dance, music, costume are utilized. Yakshagana songs are sung by a member of the troupe known as Bhagavata. Using a standard comparison study design, the parameters viz. fundamental frequency[F0], speaking fundamental frequency[SFF], jitter percent[JITT], shimmer dB[SH dB], noise to harmonic ratio[NHR]), maximum phonation duration(MPD) and S/Z ratio of Bhagavata's voice were compared with age matched nonsingers. Results of the study revealed, significantly higher fundamental frequency, speaking fundamental frequency and reduced MPD in Bhagavatas as compared to their non-singing counterparts. Laryngeal evaluation (rigid telescopy) in Bhagavatas revealed signs of vocal abuse.

Key words: Yakshagana, Bhagavatas, Rigid telescopy, Acoustic evaluation

Vocal music is a large artistic field where Hindustani, Carnatic and Light music occupy an important portion of music in India. Other than these types of music, Yakshagana (street play) a folk art and a traditional vernacular drama is the largest and possibly most popular style of music in South Karnataka. The term "Gana" signifies music and Yakshagana means a particular style of music with characteristics of its own, distinct from the other two systems of Indian music, "Hindustani" and "Carnatic". It is a combination of music and dance. A character called Bhagavata (Yakshagana Singer) sings songs, conducts the play and edits the prasanga (theme of the play). Bhagavata who is present on the stage through out the performance exercises total artistic control over the proceedings on the stage (Gururao Bapat, 1998).

In Yakshagana, the kind of formal training imparted to the learners of the classical music is never done. The novitiate normally learns the skill by copying the songs sung by senior Bhagavatas. The emphasis here is on learning the tunes of songs rather than learning the parameters of 'raagas' (special combination of notes in ascending or descending order in a scale of notes or swaras) in which they were set. One of the unique features of Yakshagana music is the dominance of high pitch as compared to other schools of music. The 'sruti' (the base note of the singer) is always on a higher note. Starting from there, the singer moves in the middle and higher octaves and almost never in the lower octave. Such a high-pitched singing is attributed to the singer's need to be audible to a large audience in open air. The voice of Bhagavatas needs to compete with the musical instruments like Maddale and Chande (percussion instruments) to be heard. Bhagavatas, though indulge predominantly in singing, also participate occasionally in dialogue delivery. Most of the time, they will be doing so, above the level of background music which could lead to vocal abuse (Karanth, 1997; Gururao Bapat, 1998).

Many studies have explored the incidence of vocal fold pathology in singers using self-reported questionnaires. Singing teachers were more likely to have self-reported voice problems than controls and were 1.7 times more likely to have had a history of vocal disability compared to non-singers (Miller & Verdolini, 1995; Phyland, Oates, Greenwood, 1999). Perkner, Fennelly and Balkisson, (1999) compared three types of singers – opera, musical theatre and contemporary singers with 'friendship' controls. They found a significant increase in voice disorders (44% versus 21% in controls) and voice disability (69% versus 41% in controls) in the singers, with no difference between the different types of singers.

Research in the past few decades has grown up predominantly with the singers' voice reflecting instances of getting partially or totally incapacitated due to vocal abuse (Sundberg, 1987; Fritzell, 1996). Vocal abuse has been reported to be a vital factor of vocal disorders amongst professional singers and occupations, who are often considered

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to be at risk for development of voice problems (Aaltonen, 1989; Fritzell, 1996). In singing, it is common for an untrained but professional singer to attempt to use tones at the extreme limits of their range, either too high or too low causing damage to the vocal structure in the long run (Proctor, 1980). Upper respiratory tract infection, reflux laryngitis, voice abuse in singing, voice abuse from speaking, poor general health, aging, anxiety have been reported to be the common causes of voice problems in singers (Proctor, 1980; Sataloff, 2000).

High risk performers are often exposed to unique vocal abuse characteristics which include high environmental and performance demands. Each type of professional uses the voice in a different manner. The country/pop singer may use a breathy or "rough" type of voice while an opera or classically trained singer will strive for a very specific balance of tonality and rehearse or perform on a limited time schedule. Musical theater performers typically sing during a highly exhausting choreographed production and actors may strictly use their voice in projected dialogue. It can be these attributes that make these professionals to perceive different types of voice difficulties (Rapheal, 1998). The typical abuse related changes of the vocal folds are hyperemia and edema of the vocal folds, where viscous sputum clings to the free edges of the vocal folds (Chernobelsky,1996). Music teachers are also prone to develop vocal symptoms due to extended voice use, higher pitch and higher intensity (Fritzell, 1996). Depending on the environmental and performance demands, distinguishing laryngostroboscopic and acoustic characteristics are reported by Ruddy, Lehman, Crandell, Ingram & Sapienza (2001) in musical theater, choral ensemble and street theater performers.

Yakshagana singer (Bhagavata) usually sings in a high pitch. Yakshagana performance spreads from sunset to sun rise. After singing for several hours, the Bhagavata's voice undergoes subtle changes. Hence, in the early morning, he shifts to high pitch. Other than this, the singer has to sing one or two words and stop abruptly most of the times. The singer has no liberty to elaborate on the parameters of the 'raaga' and at all times, has to keep in mind the actor, dancer with no liberty to indulge in pyrotechniques to which the actor dancer cannot respond through his media of expression. Further, the shift from higher pitch to the lower or the reverse is done so suddenly that it creates a jerking effect (Gururao Bapat, 1998). All these factors make Yakshagana singers more vocally abusive and prone to develop laryngeal disturbances.

Even though Yakshagana is the largest and possibly most popular style of music in South Karnataka, till date, only one study is reported in the literature related to the Bhagavatas' voice characteristics (Jayaram & Kalaiselvi, 2006). They studied the short term consequences of vocally violent behaviours in Yakshagana artists (actors and singers) on acoustic parameters by comparing their vocal parameters prior to, and following performance of one episode of Yakshagana and the effect of 12 hours of complete voice rest following an Yakshagana performance. The results indicated increase in frequency and intensity related measures (mean, maximum, speed of fluctuation, extent of fluctuation), increased speaking fundamental frequency, reduced intensity and frequency range, poor perturbation and HNR scores following Yakshagana performance in both the groups. However, improvement in these parameters was reported with 12 hours of complete voice rest in both groups. This study shows that Yakshgana artists, both, the actors and singers are at risk for vocal deterioration and fatigue following performance though these measures showed slight improvement following voice rest. Till date, no study has been done comparing the voice of Bhagavatas with that of age matched non singers. The present study hence aims at comparing the various acoustic and temporal parameters between Bhagavatas and non singers to explore the possible effect of Yakshagana singing.

Method

Subjects

Two groups consisting of 20 male Bhagavatas (group I) and 20 age and gender matched non-singers (group II) participated in the study. Yakshagana singers were in the age range of 24 to 44 years with a mean age of 30 years. Their professional experience varied from 5 to 21 years. All the singers were in good health with no evidence of speech and hearing problems. The comparison group of age-matched non-singers consisted of 20 males, ranging in age from 24 to 45 years with a mean age of 31 years with good health, normal hearing, speech and voice. Non-singers were selected randomly and subjected to rigid telescopic examination and Multidimensional Voice Program (MDVP). The non-singers included in this study had normal vocal fold structure and function with acoustic parameters falling within normative range on MDVP. Their professions did not involve excessive use, misuse or abuse of their vocal mechanism.

Recording & Analysis

Acoustic Parameters

Each subject's phonation of vowel /a/ was recorded in a sound treated room for acoustic analysis. The Shure Dynamic SM 48 microphone was positioned at a constant distance of six inches and connected to a PC. The subjects were instructed to phonate the vowel /a/ at their comfortable pitch and loudness level for a duration of five to six seconds. The initial and final parts of the vowel were eliminated, selecting a signal duration of 3 seconds (the central part of the vowel) for the analysis. The voice samples were analyzed by Multidimensional Voice Program (Multi Dimensional Voice Profile, Kay Elemetrics Corp, model 4305) using Computerized Speech Lab (CSL) at a sampling rate of 44kHz. For the purpose of analyzing the SFF (speaking fundamental frequency), the subjects were asked to read three standardized meaningful Kannada sentences; /idu pa:pu/, /idu ko:ti/, /idu kempu banna/. These sentences were recorded using the same instrumental setup used for recording the vowel phonation. The acoustic parameters viz F0, SFF, jitter percent, shimmer dB and Noise to Harmonic Ratio (NHR) were determined from the recorded samples.

Maximum phonation Duration (MPD)

MPD refers to the maximum amount of time an individual can sustain phonation after taking a deep inhalation. It is the simplest test that demonstrates the status of the respiratory system and the relative efficiency of the interaction of the respiratory and laryngeal system.

For the measure of MPD, the subjects were instructed to take a deep breath and phonate the vowel /a/,/i/ and /u/ at their comfortable pitch and loudness levels and the duration of phonation was measured using stopwatch. The task was recorded for three times with a short gap between the trials. The longest duration of the three trials was considered as the MPD.

S/Z Ratio

For the measure of S/Z ratio, the subjects were instructed to sustain /s/ and /z/ as long as possible and the time is determined using a stop watch. It is the ratio between the durations of sustained /s/ and /z/. This measure provides information about the laryngeal system.

Laryngeal Examination

In order to define the participants' (Bhagavatas and non-singers) vocal fold structure, standard procedure for oral rigid telescopy (Hopkins 8706 CS 70) was used by a qualified and experienced ENT specialist. Vocal structure was assessed during quiet breathing and during phonation of /i/ for any functional inadequacy.

Statistical Analysis

Statistical analysis was carried out using the SPSS Statistical package Version 11.0. Comparison of acoustic parameters between Bhagavatas and non-singers were done using t-Test. The parameters average fundamental frequency (F0), S/Z ratio and MPD of /u/ were compared using Mann-Whitney U test as they violated the assumption of normal distribution.

Results

Results indicated significant differences between the groups on F0, SFF, MPD(/a/, /i/ and /u/). F0 and SFF were significantly higher and MPD was significantly lower in group I as compared to group II. No significant difference between the groups on jitter%, shimmer dB, NHR, and S/Z ratio were observed. Table 1. depicts the mean, SD, t/u values and p values for all parameters.

Laryngeal findings

Rigid telescopic findings in Bhagawathas revealed normal structure and function of the vocal folds in 25% of the subjects. 70% of the subjects had bilateral vocal fold edema with phonatory gap and bilateral arytenoids mucosal edema in 25% of the subjects. All the non-singers had normal rigid telescopic findings.

Parameter	Group I Mean (SD)	Group II Mean (SD)	t / u values	p values
Fo (Hz)	145 (27)	123 (10)	U = 103	0.002
SFF (Hz)	159 (20)	138 (14)	3.928	0.000
Jitter %	0.803 (0.73)	0.604 (0.31)	0.188	0.242
Shimmer dB	0.26 (0.15)	0.25(0.14)	0.203	0.840
NHR	0.132 (0.26)	0.131(0.46)	0.105	0.917
MPD /a/	14 (4)	24 (5)	-7.509	0.000
/i/	13(4)	23(6)	-7.607	0.000
/u/	13 (4)	22 (6)	U=43	0.000
S/Z ratio	1.05 (0.33)	0.94 (0.21)	U = 180	0.227

Table 1: Mean, SD, t/u values, and p values of various measures in two groups.

Discussion

Bhagavatas had significantly high Fo and SFF in comparison to non-singers. This is in consonance with the findings of Jayaram et al,(2006), where they reported an increased

speaking fundamental frequency following Yakshagana performance. Many studies in the literature have reported increase in fundamental frequency following vocal performance (Gelfer, Andrews & Schmidt,1991; Rantala & Vilkman, 1999; Vilkman, Lauri, Alku, Sala & Sihvo, 1999). Higher speaking fundamental frequency in Sopranos, Tenors, Altos and Baritone singers as compared to age matched non-singers has been reported (Brown, Morris, Hollien and Howell, 1991). The possible explanation given in the literature for these changes are the compensation for the symptoms of vocal fatigue (Vilkman et al,1999) and the influence of formal training received by them (Brown et al, 1991). Probably, as a part of the effort to increase the vocal loudness in the presence of background himmela (background music), Bhagavatas tend to tense their vocal apparatus which inturn results in higher F0. Further, it could be hypothesized that the higher F0 in phonation and SFF in Bhagavatas may be the influence of unique features of Yakshagana music, where high pitch dominates during vocal performance. It is felt that this practice of singing for several hours in a high pitch over a period of time could have resulted in a persisting higher F0 in phonation as well as in speech.

The perturbation measures obtained in this group of singers are contradicting those reports in the literature among the professional voice users (Kitch, Oates, & Greenwood 1996, Brown, Rothman, & Sapienza, 2000, Lundy, Roy, Casizno, Xue, Evans, 2000). Slightly increased mean values of perturbation measures observed in Bhagavatas (jitter % 0.803; shimmer dB 0.26) as compared to nonsingers (jitter % 0.604; shimmer dB 0.25), were however not significant between groups. Poor perturbation scores following Yakshagana performance was reported by Jayaram et al,(2006), which improved within 12 hours of complete voice rest. The increase in the perturbation measures though not significant in Bhagavatas in the present study may be attributed to the medical observation of vocal fold mucosal edema and phonatory gap, in nearly 70% of the subjects.

There was no significant difference in noise to harmonic ratio between the Bhagavatas and nonsingers in the present study. Noise to Harmonic Ratio has been reported to be a useful, quantitative index to confirm a perceptual diagnosis of dysphonia and to evaluate quantitative changes in a dysphonic voice user over time (Kitch et al, 1996; Ferrand, 2002). High degrees of variability in H/N ratio among subjects between pre and post performance have been reported (Lundy et al, 2000). There are also studies in the literature reporting of no significant difference in noise to harmonic ratio between the dysphonic and non-dysphonic group, thus questioning the sensitivity of this acoustic parameter in detecting dysphonic voice from that of a normal voice (Yiu, Worrall, Longland, & Mitchell, 2000; Ma & Yiu, 2005). Poor H/N ratio was reported in Bhagavatas following Yakshagana performance (Jayaram et al, 2006), however some improvement in the scores with 12 hours of complete voice rest have been reported.

MPD provides information on the general state of the subjects' respiratory coordination and overall status of vocal apparatus. Decreased MPDs has been observed in cases of vocal dysfunction. The results of the present study are in consonance with observations in literature in singers (Boone, 1971; Timmerman, De Bodt, Boundewijns, Clement, Peters, & Van de Heying, 2002). Reduced mean MPD in Bhagavatas (13 secs) as compared to nonsingers (23 secs) could be related to the presence of vocal fold edema and phonatory gap observed during rigid telescopic examination in Bhagavatas as a contributing factor in addition to their high pitch phonation.

S/Z ratio, an indicator of vocal fold marginal pathology has been reported to be higher and significant in the presence of laryngeal lesion (Eckel & Boone, 1981). Investigating this measure in laryngeal pathology (nodules or polyps), dysphonic subjects without laryngeal pathology and normal speaking subjects they reported that S/Z ratios were significantly higher for laryngeal pathology with no significant difference in S/Z ratios between dysphonics without laryngeal pathology and normal subjects. These findings suggested that an additive mass present on the glottal margin significantly affects the S/Z ratio. The presence of normal S/Z ratio in Bhagavatas endorses the absence of significant vocal fold marginal lesions usually associated with higher scores. Though vocal fold edema was observed in majority of Bhagavatas, it had no effect on their S/Z ratio. This warrants further research to explore the effect of Yakshagana form of singing on respiratory and laryngeal mechanisms.

In singing, it is common for professional singers to attempt to use tones at the extreme limits of their range, either too high or too low causing damage to the vocal structures in long run (Proctor,1980). Elias, Sataloff, Rosen, & Heuer (1997) reported a higher incidence (58%) of abnormal laryngeal findings in singers without vocal complaints. In professional singers, in addition to the performance demands, environmental factors play a large and unique role in creating dysphonia, such as out door setting with competing noise, excessive amount of

performance time, dusty environment and onstage smoke (Ruddy et.al. 2001). Voice use in such conditions can lead to vocal fold edema, increased vascularity, disruption of the vocal fold edge resulting in vocal fold nodules, polyps, or polypoid changes. Rigid telescopic findings in the present study revealed the presence of bilateral vocal fold mucosal edema (70%). This could be attributed to the performance demands (high pitch singing, no liberty to elaborate on parameters of 'raaga', singing one or two words and stopping abruptly, sudden variation in pitch from higher to lower or the reverse creating jerking effect, raising voice above the background noise) and the environmental factors (high back ground noise of percussion instruments, outdoor setting with competing noise, excessive amount of performance time) of Yakshagana singing.

Conclusions

To conclude, this study is one of the preliminary attempts at providing data on Yakshagana singing, targeting acoustic and temporal parameters along with laryngoscopic findings of Bhagavatas in comparison with age matched non-singers. Significant differences in few acoustic and temporal parameters (F0, SFF and MPD) were observed in Bhagavatas compared with age matched non-singers. Most of the subjects showed changes in bilateral vocal fold mucosa indicating that Yakshagana singers are at risk for vocal fold lesions. Hence, it is warranted that more extensive studies need to be conducted to know the different risk factors leading to voice problems in these singers and their knowledge regarding voice care techniques and the voice care strategies followed by them. This information could help the Speech Language pathologist to device appropriate voice conservation strategies for these singers.

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