# Use of Voice Handicap Index (VHI) as Predictor of Outcome of Non-surgical Treatment in Vocal Nodules

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**ABSTRACT**

***Introduction:***
*Vocal Nodule is commonest benign vocal cord lesion which causes varying degree of dysphonia having serious impact on personal and professional well being. Voice Handicap Index (VHI) is a psychometrically validated tool for measuring pshycosocial handicapping effect of voice disorder.*

***Materials and Methods:***
*From data available since last 18 months, patients who had undergone treatment for vocal nodule were selected as study population. In Group A, 50 patients were selected who required surgery and Group B, 50 patients who responded to medical treatment. Patients filled in VHI-30 form at time of diagnosis and subjected to voice therapy and adjunctive medical treatment for 1 month and reassessed using VHI-30. Successful treatment consisted of absence of pathology by laryngoscopy and decrease of VHI total score ≥18.*

***Results:***
*The cut-off score was calculated using Receiver Operating Characteristics (ROC). VHI cut-off of total score was 45 (Sensitivity 94%, Specificity76%). The cut-off score for functional, physical and emotional domains are 14(Sensitivity 94%, Specificity 64%), 15(Sensitivity 92%, Specificity 60%) and 15(Sensitivity 90%, Specificity 66%) respectively.*

***Discussion:***
*Hard consistency of nodules can explain refractoriness to speech therapy and higher VHI score. The physical subscale of VHI was higher among both groups indicating patients' perceptions of laryngeal discomfort and voice output affected them more. According to our study patients with higher VHI score should be counselled for MLS at earliest instead of speech therapy for one month which would not have given good outcome.*

***Conclusion:***
*These scores give a good idea about categories of patients who will not benefit by non-surgical treatment and hence early surgical intervention will obviate the duration of handicap and delay in appropriate treatment..*

***Keywords:***
*Vocal Nodule; Dysphonia; ROC Curve; Speech Therapy*

Vocal fold nodules are small bilateral swelling (less than 3mm in diameter) that develop on the free edge of vocal fold at approximately the midmembranous portion. They are characterized histologically by thickening of epithelium with a variable degree of underlying inflammation. The aetiology of vocal nodules is not known, but traditionally they are thought to be due to voice abuse rather than overuse. It may be precipitated by talking for prolonged periods in a loud voice (often above background noise), repeated shouting and or singing above one's natural range and occasionally repeated coughing and throat clearing. The vocal folds are thought to impact on each other in such a way that the repeated trauma of the midmembranous portions leads to localized swelling and epithelial thickening.[1]

Psychological factors, nasal, throat and chest infections, allergies and extraoesophageal reflux are

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increasingly being recognized as playing an important part in the aetiology of vocal nodules.[2,3,4] In the UK, the mainstay of treatment for persistent vocal nodules is voice therapy. Not infrequently, the voice and voice function improves, but the nodules persist. Some argue that complete and rapid return of voice function is only possible if the nodules are excised. Others would reserve surgery for those who fail voice therapy and remain symptomatic.[5] Most would agree that a significant number of nodules recur if surgery is performed without voice therapy either pre- or postoperatively.[6]

Vocal nodule is commonest benign vocal cord lesion which causes varying degree of dysphonia having serious impact on personal and professional well being. They influence quality of life in different manner. The evaluation of patients with voice disorders is a multidimensional process, including at least a laryngeal examination, perceptual, and acoustic analysis.[7] However, the patient's experience of living with dysphonia cannot be inferred directly by these standard clinical assessments. Measuring what patients perceive about their health condition is essential, especially because there is typically a low correlation between the patient's and the clinician's subjective voice analyses.[8,9] Therefore, only the patient can provide real information about his/her experience with the voice problem, which cannot be obtained with any objective analysis.[10,11]

A handicap, as defined by WHO, is social, economic or environmental disadvantage resulting from any disability or impairment. The term disability refers to restriction or inability to perform daily task. Voice is an indispensible tool in individual's life and loss of which may result in functional, psychological and financial implications.[12] Thus, any test that does not measure the effect of a disease on the patient's quality of life does not provide a comprehensive picture and should be deemed as inadequate.[7,13] The VHI is one such parameter, introduced by Jacobson et al.[14] It quantifies the functional, physical, and emotional aspect of the voice. The functional subscale includes statements that describe the effect of a person's voice on daily activities. The emotional subscale indicates the patient's affective responses to the voice disorder. The items in the physical subscale are statements that relate to either the patient's perception of laryngeal discomfort or the voice output characteristics, such as too low or too high a pitch. Each subscale was found to be significantly different if it differed by eight points, whereas the total VHI score was found to be significantly different if it varied by 18 points. Thus, a shift in the total score of 18 points or greater is required to be certain that a change is caused by intervention and not by the unexplained variability inherent in such tests. The advantage that the VHI holds over other voice-analyzing methods is that it capitulates how the dysphonia has affected a person's well-being and his daily life.10 The VHI can be used to track the disease progress and the effect of treatment on the same. It can be used as an endpoint to decide the efficacy of a new treatment protocol.[15] Our objective of this study was to determine the cut-off score of VHI total score and 3 domains for predicting outcome of non-surgical treatment.

## Materials and Methods

A randomised case-control study was undertaken in our Institute. All patients presenting with complaint of hoarseness and diagnosed with vocal nodule at our Institute were subjected to detailed history evaluation like duration of complaint, history of vocal abuse or misuse, status of hydration, allergy, dyspepsia, addictions and profession. Examination include general examination and ENT including Indirect Laryngoscopy. Objective evaluation was done by flexible fibre-optic laryngoscope (FOL). Subjective evaluation was done by Voice Handicap Index-30 Questionnaire at diagnosis and after 4 weeks.

All patients are treated conservatively with voice therapy, voice rest and treatment of coexisting infections, allergy and reflux for 4 weeks. The patients were reassessed by VHI-30 questionnaire and FOL done for outcome. Those patients who did not show improvement on reassessment were counselled for microlaryngeal surgery and the patients showing improvement continued their nonsurgical treatment and followed up. Improvement criteria included absence of pathology on FOL and decrease in VHI total score more than equal to 18.

From the data available since last 18 months a total of

150 patients were selected as study population. Out of which 60 patients had to be counselled for microlaryngeal surgery and 90 patients showed improvement by nonsurgical treatment. Out of 60 patients who required surgery, 50 patients were randomly selected and classified into Group A. Out of 90 patients who showed improvement, 50 patients were randomly selected and classified into Group B.

All participants were informed of the research purposes and signed a consensus letter. They were also informed that their personal data will remain confidential.

The ROC curve was used for the assessment of the cutoff value for VHI. All reported P values were two-tailed. Statistical significance was set at $P < 0.05$.

Sensitivity and specificity are two components that measure the inherent validity of a diagnostic test for dichotomous outcomes against a gold standard. Sensitivity or true positive rate (TPR) is conditional probability of correctly identifying the diseased subjects by test. Specificity or true negative rate (TNR) is conditional probability of correctly identifying the non-diseased subjects by test Receiver Operating Characteristic (ROC) curve is the plot that depicts the trade-off between the sensitivity and (1 -specificity) across a series of cut-off points. Area under the ROC curve is considered as an effective measure of inherent validity of a diagnostic test. PubMed search of pediatric journals reveals that ROC curve is extensively used for clinical decisions like comparing predictability of mortality in extreme preterm neonates by birthweight with predictability by gestational age and with clinical risk index of babies score.[16] ROC curve is graphical display of sensitivity (TPR) on y-axis and (1 – specificity) (FPR) on x-axis for varying cut-off points of test values. (Fig 1) If this curve passes near the upper corner, then both sensitivity and specificity are equal to 100%, whereas the curve's performance deteriorates at a diagonal line of 45° (y = x), which will act as a random guessing operation. If the type of line includes points of (0,0) and points near (0,1), then it is considered as a perfect classification. The area under the curve (AUC) is an effective and combined measure of sensitivity and

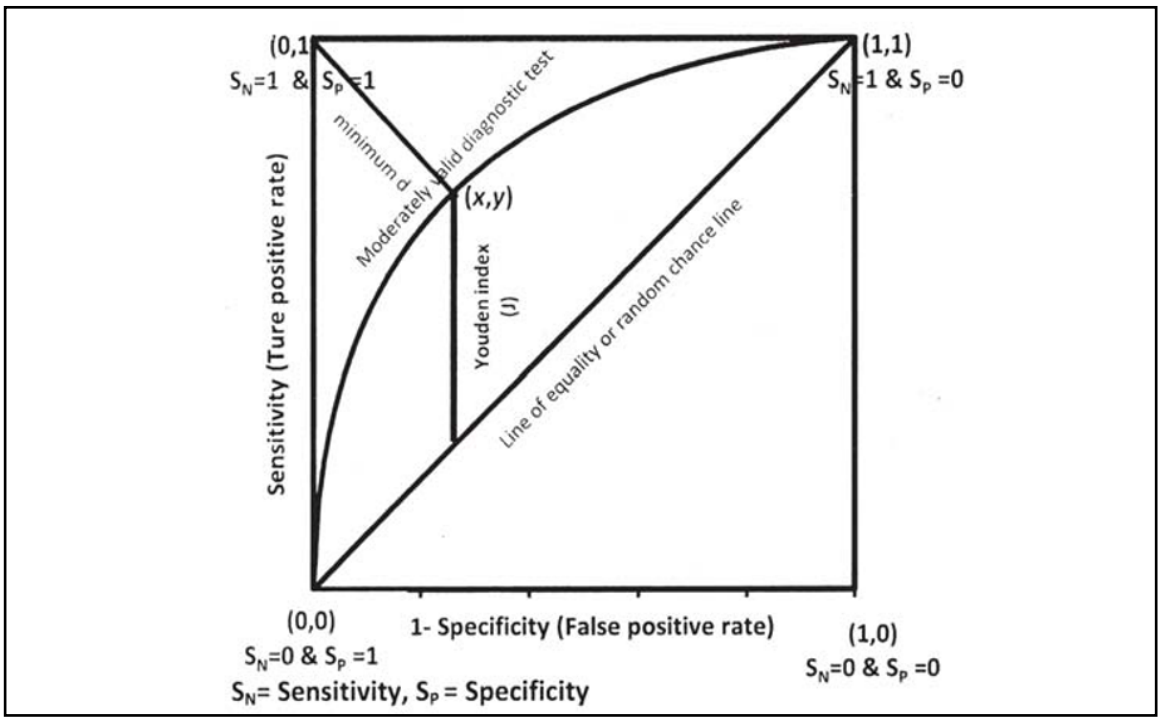


**Fig. 1. ROC Curve And Its Components.**

**Table I : Age demography**

| AGE (YRS) | GROUP A | GROUP B |
|---|---|---|
| 20-30 | 4 (8%) | 6 (12%) |
| 31-40 | 43 (86%) | 42(84%) |
| 41-50 | 2 (4%) | 2 (4%) |
| 51-60 | 1 (2%) | 0 |
| Mean | 34.5 | 33.84 |
| SD | 4.77 | 3.93 |

**Table II : Profession demography**

| PROFESSION | GROUP A | GROUP B |
|---|---|---|
| TEACHER | 25 (50%) | 21 (42%) |
| HAWKER | 7 (14%) | 10 (20%) |
| SINGER | 8 (16%) | 8 (16%) |
| HOUSEWIFE | 6 (12%) | 7 (14%) |
| MAID | 3 (6%) | 2 (4% |
| OTHERS | 1 (2%) | 2 (4%) |

specificity for assessing inherent validity of a diagnostic test. This area can be split into four categories with predictive abilities named as "No predictive" (AUC < 0.5), "Acceptable" (0.7 to less than 0.8), "Excellent" (0.8 to less than 0.9), and "Outstanding" (≥0.9).[17]

The ROC curve displays all possible cut-off points, and one can read the optimal cut-off for correctly identifying diseased or non-diseased Subjects. The ROC curve is independent of prevalence of disease since it is based on sensitivity and specificity which are known to be independent of prevalence of disease. Sometimes sensitivity is more important than specificity or vice versa, ROC curve helps in finding the required value of sensitivity at fixed value of specificity. Optimal threshold is the point that gives maximum correct classification The Youden index (Fig I) is that maximizes the vertical distance from line of equality to the point [x, y]. Youden index is more commonly used criterion because this index reflects the intension to maximize the correct classification rate and is easy to calculate. ROC analysis was done by using MedCalc software version 18.11.6

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## Results

The mean age in Group A is 34.5 years and in Group B 33.8 yrs. Maximum patients in Group A and Group B belonged to age group 31-40 years, 86% & 84% respectively. Overall mean age was 34.1 yrs (Table I).

Majority in Group A and Group B were females, 74% & 68% respectively. The mean VHI Score was higher in males compared to females in both Group A & Group B (56.38 v/s 54.91 & 48.62 v/s 41.82)

The Table II shows distribution of profession in both groups where teachers are majority in both groups.

The mean VHI Score including Total, Functional, Physical and Emotional was significantly higher in Group A compared to Group B (Table III).

**Table III: Mean VHI score of both Group A and Group B**

| VHI | GROUP A (MEAN± SD) | GROUP B ((MEAN± SD)) | P VALUE |
|---|---|---|---|
| TOTAL | 55.3 ± 5.89 | 44 ± 8.72 | <.0001 |
| FUNCTIONAL | 17.56 ± 2.18 | 13.7 ± 3.18 | <.0001 |
| PHYSICAL | 19.56 ± 3.15 | 15.44 ± 3.72 | <.0001 |
| EMOTIONAL | 18.18 ± 2.52 | 14.86 ± 2.94 | <.0001 |

**Table IV: ROC analysis**

| VHI | AUC | SE | P VALUE | 95% CI |
|---|---|---|---|---|
| TOTAL | 0.832 | 0.044 | <0.001 | 0.744 to 0.899 |
| FUNCTIONAL | 0.826 | 0.042 | <0.001 | 0.738 to 0.895 |
| PHYSICAL | 0.806 | 0.043 | <0.001 | 0.715 to 0.879 |
| EMOTIONAL | 0.803 | 0.044 | <0.001 | 0.712 to 0.876 |

A ROC analysis was done to see whether the VHI Total and its 3 domains could estimate whether microlaryngeal surgery would be required or conservative treatment would suffice. The analysis revealed statistically positive discrimination between Group A and Group B (Table IV).

ROC curve test determined the cutoff points for VHI-T score and the three domains of VHI.. The cutoff score for VHI-T was positive if greater than or equal to 45 with sensitivity of 0.94 and specificity of 0.76 (Fig 2). The cutoff score for VHI-F was positive if greater than or equal to 14 with sensitivity of 0.94 and specificity of 0.64 (Fig 3). The cutoff score for VHI-P was positive if greater than or equal to 15 with sensitivity of 0.92 and specificity of 0.60 (Fig 4). The cutoff score for VHI-E was positive if greater than or equal to 15 with sensitivity of 0.90 and specificity of 0.66 (Fig 5).

## Discussion

Most patients in both groups belonged to age group 31-40 yrs. However in adults they are reported to be common under 30 yrs.[18] Mean age group in our study was 34.1 yrs whereas other studies report it to be 36.4 years[19] and 31.56 years[20] respectively.

The gender predominance was among females which is consistent with other studies.[18,19,20]

The mean VHI- T score was not significant between males and females in Group A which is consistent with other studies[19] whereas it was significant in Group B. In our study females scored less than males. However mean score of females was higher than males.[19]

The literature does identify several occupational groups potentially at risk of voice disorders. Teachers, singers, actors, cheerleaders and aerobics instructors figure prominently, but the studies are almost always cross-sectional rather than prospective, and many are without controls.[21] In our study, teachers had highest frequency in both groups probably due to better awareness about health compared to other categories. Though singers are more likely to seek help and report problems specifically in their singing voice, the degree of handicap perceived by singers may be variable.[22]

The VHI-Total, Functional, Physical, Emotional Scores were significantly higher in Group A compared to Group B. This can be attributed to consistency of nodules being hard and refractory to voice therapy.[20] The physical subscale of VHI was higher among both

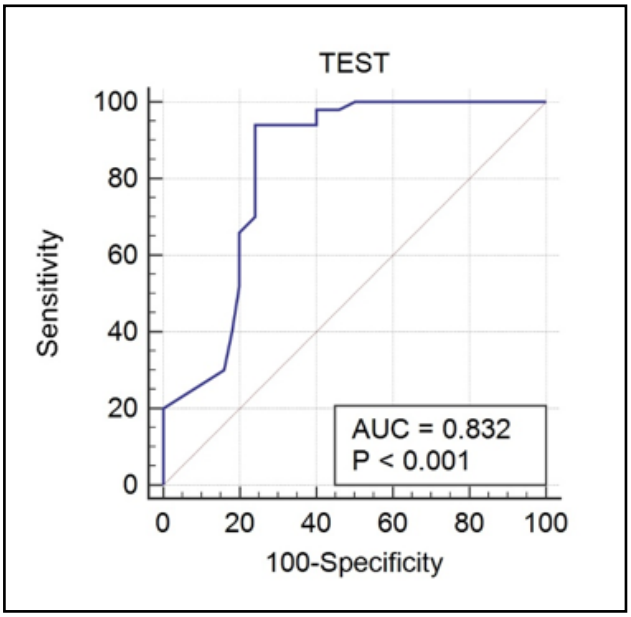


**Fig. 2. ROC Curve for VHI-T**

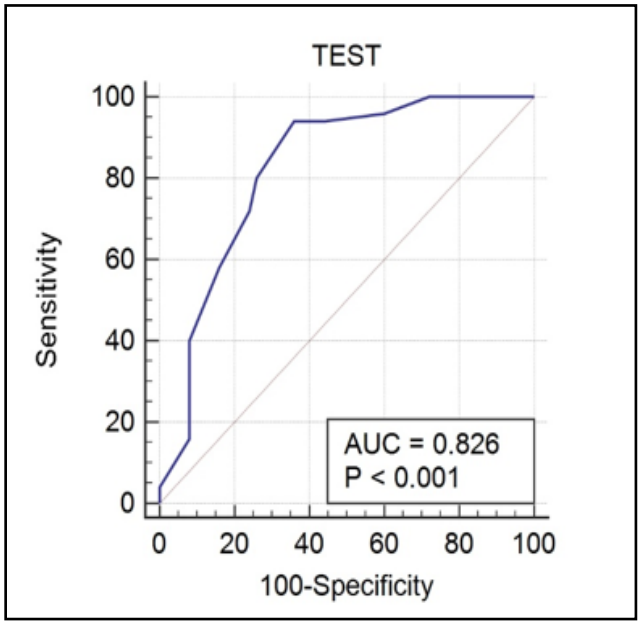


**Fig. 3. ROC Curve for VHI-F**

groups indicating patients' perceptions of laryngeal discomfort and voice output affected them more.

In particular, VHI measurement tool involves many factors that influence vocal behavior (eg, societal attributes, premorbid lifestyle) via its items (questions) and its domains with an equal effect.[23] This is confirmed by this study's findings because all VHI domains had almost the same excellent cutoff scores (VHI-F= 14,

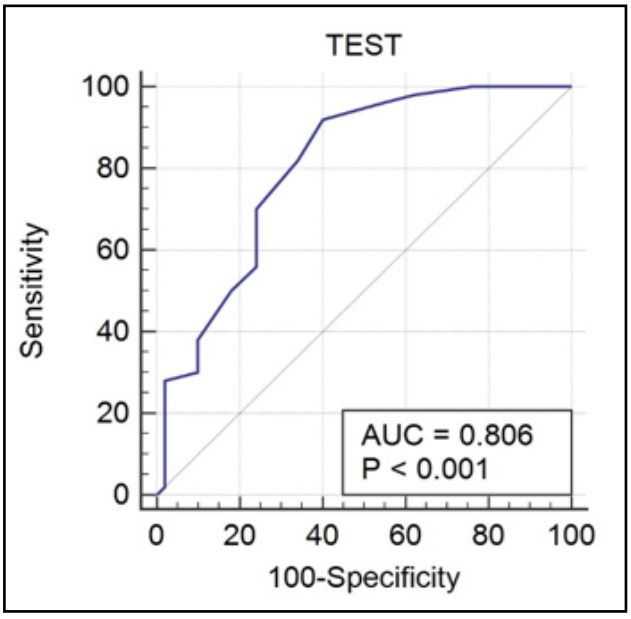


**Fig. 4. ROC Curve for VHI-P**

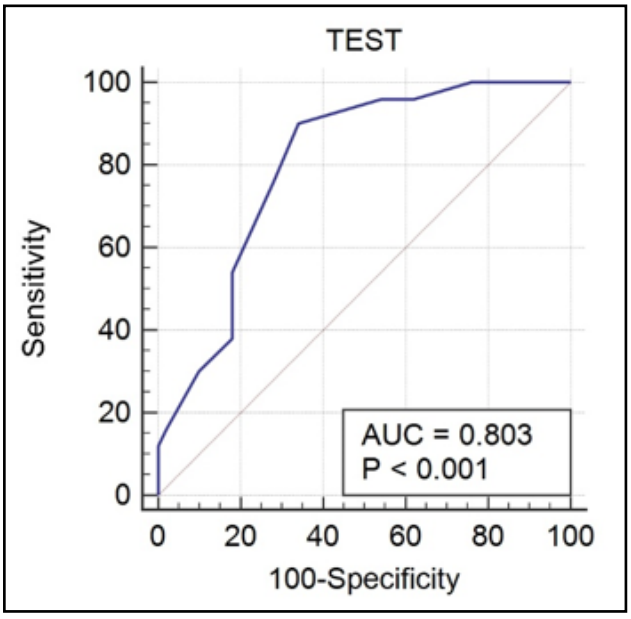


**Fig. 5. ROC Curve for VHI-E**

VHI-P = 15, VHI-E = 15). From the ROC analysis it revealed that score more than 41 was associated with 100% sensitivity which means that all people who scored less than 41 did not require surgery. Those people who scored more than 59 definitely required surgery with 100% specificity.

For people who scored in between 41-59, our study cannot definitely predict outcome. These patients would require correlation of score with FOL findings, frequent follow up with repeated VHI and further studies are required specifically focussing on this group.

The utility of VHI, in predicting whether surgery is required or not, is in attenuating the duration of handicap even though Speech Therapy is required post-operatively. Surgery (recommended for higher VHI score as discussed previously) and post-operative speech therapy together aids in quick recovery from handicapped state, which would not have been possible with Speech Therapy alone. According to our study patients with higher VHI score should be counselled for MLS at earliest instead of Speech Therapy for 1 month which would not have given good outcome.

The VHI-T cut-off score in conjunction with equality of its three domain can identify categories of patients at risk of needing MLS. Hence it can be used at the time of presentation to stratify patients in terms of expected response to treatment and intervention in form of MLS at the earliest.

## Conclusion

From the ROC analysis it can be concluded that patients having VHI-T score less than 41 did not require surgery, whereas scores more than 59 definitely required surgery.

VHI-T score can be used at the time of presentation to stratify patients in terms of expected response to treatment and requirement of intervention in form of MLS at the earliest. VHI is a non-invasive, cost-effective and easy to administer tool to predict outcome of non-surgical treatment in vocal nodules.

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