

## Japan

Kiyoshi Ohahim and Seiji Niimi  
Japan Society of Logopedics and Phoniatics

### *1 Introduction*

Although the history of phoniatics of our country is not so long, it has been making a great progress in this rather short period and now become ahead of the world. There were reasons why the progress was so rapid. One of them was that phoniatics was considered to belong to the clinical medicine. So many practitioners have been willing to participate in this field and the practice fee was assured by the health insurance plan.

It gives Japanese phoniatics a unique character. Phoniatics in Europe corresponds to 'Phoniatics' in Japan. In Phoniatics in Europe, instructors of vocal music and voice trainers work in a central role. It's just recently that medical researchers participate in this field.

Meanwhile in the United States, the field, which corresponds to 'Phoniatics' in Japan, doesn't exist independently and considered as part of speech pathology. Naturally, speech pathologists and speech scientists play a central role, not medical doctors. It is true that 'Phoniatics' is an interdisciplinary field and requires a good knowledge and technique of various specialized fields. Actually in Japan, researchers of not only engineering but also non-medical field made a great contribution. But it is also a case that researchers in the medical field have cut conspicuous figures in our country.

Among those medical researchers, two leaders, that is, Kotoji Satta (Univ. of Tokyo) and Yoshio Hayashi (Keio Univ.) had especially big influence on establishing Phoniatics. Satta had enlightened many researchers with many papers and lectures, including 'Experimental study on vocal system and speech control' (J Otolaryngol Jpn, Status report, 1939). Hayashi had induced interests on this field to otolaryngologists with a lot of papers, including the lecture series 'Logopedics and Phoniatics' appeared in from vol.33 to vol.35 in the journal, Jibirin.

Japan Society of Logopedics and Phoniatics was established in 1956 supported by the interest on this field, and has been making a great progress until today. As there is a description in detail on the history of its progress elsewhere, in this paper, overlooking from a different point of view, through discussing major research methods, we will look back the leaders work.

### *Addendum*

sent in by N. Isshiki

Isshiki, N.: Laryngeal framework surgery. *Advances in Otolaryngol.* HNS 5 (1991), 37-56

Mechanical and dynamic aspects of voice production as related to voice therapy and phonosurgery. *Journal of Voice* 12 (1998), 125-137

Vocal mechanics as the basis for phonosurgery. *Laryngoscope* 108 (1998), 1761-1766

*research, main topics*

### 1 Vibration of the vocal fold

Among all the works on vibration of the vocal folds, Kirikae's (Univ. of Tokyo: 1943) paper with the stroboscopic movie should be discussed first. In that paper, not only the vocal fold during vibration was observed, but also quantitative analysis of the vibratory figures was done, showing the difference among the registers. It was an astonishing work considering the technique standard of that period. Hiroto's work (Kurume Univ.: 1966); research with high-speed cinematography was followed. This work pointed out the importance of the mucous membrane's transformation during vibration. It has a great influence over the later research on the vocal fold vibration.

Together with these results and histological research results, Hirano (Kurume Univ.: 1975) established Body-cover theory, which had a big influence on the later research, especially on vocal fold vibration model. Research on voice production system, using vibration model, had been worked also in the communication-engineering field for a long time. Wegel and Flanagan's models are famous. A lot of models by Japanese researchers had also been published, such as Ishizaka and Matsudaira's model (SCRL: 1972).

For voice production analysis by these vibration models, concepts and physiological information investigated by medical researchers as shown above were adopted and utilized. It is one of the evidences of the interdisciplinary aspects of phoniatics' development. It should be notified that these vocal fold vibration models are far from perfect and not delicate enough to explain the pathological vibration. A lot more research is necessary to comprehend pathology of vibration and pathology of voice thoroughly.

There is a Saito (Keio Univ.: 1977) et al's research with x-ray stroboscopy. These research results were also a great reference on vibration model. Meanwhile Honda (Univ. of Tokyo: 1985) et al's method was an important key to clarify the relationship between vocal fold vibration and acoustic wave.

### 2 Electromyographical studies

Among the fundamental respects of Phoniatics, there is a research field of laryngeal muscle activities. There also activities of Japanese researchers are notified. Nakamura (Kyoto State Univ.: 1954)'s work, which recorded the single motor unit of laryngeal intrinsic muscle, Hiroto (Kurume Univ.: 1962)'s work, which established the method of recording electromyography of the laryngeal intrinsic muscles percutaneously, and other works show the high standard of research in our country.

Hirano (UCLA: 1969)'s work, which applied, hooked wire electrodes, which had been used in the field of motor dynamics, to human laryngeal intrinsic muscles and Sato (Nagasaki Univ.: 1974) et al. 's work which revealed the features of evoked electromyography of normal and abnormal subjects had a great influence not only on electromyographical study in our country but also on international one. Many other advanced researches on this field have been studied in our

country. Uda (Tokushima Univ.: 1985) et al. Is method guided by fiberscope is one of them.

Japanese researchers have been not only investigating electromyography itself but also trying to explore a new field combining the information of electromyography and other one. Those include Hirose (Univ. of Tokyo: 1969) et al.'s work, which investigate the relationship with prosodic feature, Niimi (Univ. of Tokyo: 1974) et al.'s work, which correlates the laryngeal muscle activities and fiberscope findings, and Hirano (Kurume Univ.: 1970)'s work, which refers to the control system of singing voice.

### 3 Aerodynamic studies

Japan played an important role in establishing and developing the research method in aerodynamic study. There was an Isshiki (ILVD:1964)'s pioneer work on measuring airflow during phonation. Yanagihara (ILVD: 1966) et al pursued the standard of mean airflow rate during maximum sustained phonation. This area includes Koike (ILVD: 1968) et al. 's work, which defined Vocal Velocity Index (VVI), Iwata (ILVD: 1970) et al.'s work, which examined VVI of various laryngeal disease cases.

As the equipment of vocal function examination with the mean airflow rate scale showed on the market (Minato-Ikagaku, Nagashima-Ikakikai, Rion) and the measurement of mean airflow low rate was made to be contained in the health insurance plan, it rapidly became popular. These days, in many clinical practices, flow rate measurement is being done ordinarily.

In measuring subglottal pressure, there was Nishida (Kyushu Univ. :1964) et al.'s work, which introduced an airway interruption method. In this method, airflow low during phonation is temporary interrupted, the subglottal pressure and intraoral pressure are balanced, and the subglottal pressure is known indirectly from the intraoral pressure. Later, as Sawashima (Univ. of Tokyo: 1983) greatly improved this method and special equipment for this measurement (Nagashima-Ikakikai) was developed, it has been used in the usual practice. Knowing air flow rate and subglottal pressure, clinically useful index like glottal resistance of airflow can be calculated. Thus it has rapidly been becoming popular in our country.

Meanwhile, for direct measuring method, there is Koike (SCRL:1968) et al.'s one, which brings an ultra-small I pressure transducer to the sub-glottal space through nose and glottis. This method can be applied not only to the sustained vowel phonation but also to various types of speech and to rapid change of pressure. So with this method many investigations have been made. The investigation on laryngeal disease patients is one of them, and many researchers like Iwata (Hokensei Univ.:1990) et al. are involved.

### 4 Acoustical study

In acoustical analysis of pathological voice, spectral analysis system (Sonagraph: Kay Elemetrics, Sound spectrograph: Rion) has been used from relatively early period. Other than qualitative analysis, there was also an extensive quantitative study by Imaizumi (Kinki Univ. :1980) et al. and it has been the landmark for the later studies. With the development and wide spread of computer, it has become possible to use personal computers for spectral analysis. Further introduction of personal computers to spectral analysis is expected in Japan.

In perturbation analysis of pathological voice, PPQ (Period Perturbation Quotient) and APQ (Amplitude Perturbation Quotient) in Koike (Kyoto Univ. :1973)'s work, which introduced time course analyzing method, had an impact in the field. PPQ and APQ have become an international standard later. While Kasuya (Utsunomiya Univ.1985) paid attention to noise component of hoarseness and defined NNE (Normalized Noise Energy). He made it a guideline of the degree of hoarseness. PPQ, APQ and NNE are employed as parameters in examination equipment on the market (Rion, Nagashima, Onosokki, Kay Elemetrics and so on) and have been widely adopted.

In acoustical analysis, a lot of works of Japanese Phoniatics researchers have been published, such as Yumoto (Ehime Univ.:1982)'s work, which defined H/N ratio (harmonics-to-noise ratio). Koike (Tokushima Univ. :1986)'s work on cepstrum analysis has become the basis of the application of cepstrum on clinics, as the acoustical guideline applicable to the severe hoarseness.

### 5 Auditory Psychological Studies

Perceptual evaluation of pathological voice has been studied, and every effort has been made to pursue the evaluation scale objective and universal as possible. Among those includes many important works, such as Takahashi (SCRL: 1975) et al.'s work, which investigate the relationship with acoustical index using factorial analysis. With this background, the evaluation method using GRBAS scale, which was proposed by the subcommittee of auditory psychology in the committee of vocal function examination in the Japan Society of Logopedics and Phoniatics, has widely spread in Japan.

Although GRBAS scale method has various issues to be discussed, such as the validity of choice of the kind of scale, it also has good points, such as introducing the evaluation method with multiple scales, trying to correlate the target with a standard voice sample and so on. Many other countries have been interested in it. Meanwhile Abe (Kinki Univ. :1986) et al.'s work, which revealed the relationship between acoustical index and auditory psychological scale, is supposed to show a new direction in this field.

In the field of vocal ability examination, there are many important works, such as, Sawashima (Univ. of Tokyo:1966) et al.'s work of standardization of phonation time and Komiyama (Kyushu Univ. :1972) et al.'s work of phonogram, which displays voice two-dimensionally by loudness and pitch. In the field of articulatory movement, there have been many unique works, such as Kiritani (Univ. of Tokyo: 1975) et al.'s work of developing the method of analyzing tongue movement using x-ray micro-beam. They have had influence on the phonetics research not only in Japan but also in other countries.

Besides with all these research results, with many other excellent papers being published one after the other, Phoniatics in Japan has been shaped.

### Note

- 1) SCRL Speech Communications Research Laboratory, Inc., Santa Barbara.
- 2) UCLA University of California at Los Angeles, Los Angeles.
- 3) ILVD Institute of Laryngology and Voice Disorders, Los Angeles.

Additional web sites (added by Wendler)  
URL <http://www.ky.xaxon.ne.jp/~isshiki/>  
<http://www.ky.xaxon.ne.jp/~isshiki/spasmodic-dysphonia.html>

## Bibliography

Taken from Gutzmann-Festschrift, Berlin 1980, article by N. Isshiki

Asai, R.: Laryngoplasty after total laryngectomy. *Arch. Otolaryng.* 95 (1972), 114.

Fujimura, O.; Lindquist, J.: The sinewave response of the vocal tract. *STLQPSR.* 1 (1964), 5.

Fujita, K.: Study on the vocal cord length in the Japanese. *Jap. Journ. Otol. Tokyo.* 50 (1934).

Hirano, M. et al.: Use of hooked-wire electrodes for electro-myography of the intrinsic laryngeal muscles. *J. Speech Hear. Res.* 12 (1969), 362-373.

Hirano, M. et al.: Regulation of register, pitch and intensity of voice. *Folia Phoniatic,* 22 (1970), 1-20.

Hirano, M.: Morphological structure of the vocal cord as a vibrator and its variations. *Folia Phoniatic.* 26 (1974), 89-94.

Hirano, M. et al.: The function of laryngeal muscles in regulating fundamental frequency and intensity of phonation. *J. Speech. Res.* 12 (1969), 616.

Hirano, M.; Ohala, J.; Vennard, W.: The function of laryngeal muscles in regulating fundamental frequency and intensity of phonation. *J. Speech Hearing Res.* 12 (1969), 616-628.

Hirose H.: Afferent impulses in the recurrent laryngeal nerve in the cat. *Laryngoscope* 71 (1961), 1196.

Hirose H. et al.: An experimental study of the contraction properties of the laryngeal muscles in the cat. *Ann. Otol.* 78 (1969), 297.

Hiroto, I. et al.: Electromyographic investigation of the intrinsic laryngeal muscles related to speech sounds. *Ann. Otol.* 76 (1967), 861.

Hiroto, I. et al.: Electromyographic investigation of human vocal cord paralysis. *Ann. Otol.* 77 (1968), 296-304.

Horiguchi, S.: Experimental study on resonance in the nasal and other cavities. *Jap. Journ. Otol. Tokyo.* 49 (1933), 6 .

Ishizaka, K.; Flanagan, J. L.: Synthesis of voiced sounds from a two-mass model of the vocal cords. *The Bell System Technical J.* 51 (1972), 1233-1268.

Ishizaka, K.; Isshiki, N.: Computer simulation of pathological vocal-cord vibration. *J. Acoust. Soc. Amer.* 60 (1976), 1193-1198.

Isshiki, N.: Regulatory mechanism of voice intensity variation. *J. Speech Hearing Res.* 7 (1964), 17-29.

Isshiki, N.; von Leden, H.: Hoarseness. Aerodynamic studies. *Arch. Otolaryng.* 80 (1964), 206-213.

Isshiki, N. et al.: Approach to the objective diagnosis of hoarseness. *Folia Phoniatic.* 18 (1966), 393-400.

Isshiki, N.; Snidecor J. C.: Air intake and usage in esophageal speech. *Acta Otolaryng.* 59 (1965), 559-574.

Isshiki, N.; Honjow, I.; Morimoto, M.: Effect of velopharyngeal incompetence upon speech. *Cleft Palate J.* 5 (1968), 297-310.

Isshiki, N.; Okamura, H.; Morimoto, M.: Maximum phonation time and air flow rate during phonation. Simple clinical tests for vocal function. *Ann. Otol. Rhinol. Laryngol.* 76 (1969), 998-1008.

Isshiki, N.; Okamura, H.; Tanabe, M.; Morimoto, M.: Differential diagnosis of

hoarseness. *Folia Phoniatic.* 21 (1969), 9-19.

Isshiki, N.; Tanabe, M.: Acoustic and aerodynamic study of a superior electrolarynx speaker. *Folia Phoniatic.* 24 (1972), 65-76.

Isshiki, N.; Morita, H.; Okamura, H.; Hiramoto, M.: Thyroplasty as a new type of phonosurgical technique. *Acta Otolaryng.* 78 (1974), 451-457.

Isshiki, N.; Okamura, H.; Ishikawa, T.: Thyroplasty type 1 (Lateral compression) for dysphonia due to vocal cord paralysis. *Acta Otolaryng.* 80 (1975), 465-473.

Isshiki, N.; Tanabe, M.; Ishizaka, K.; Broad, D.: Clinical significance of asymmetrical vocal cord tension. *Ann. Otol. Rhinol. Laryng.* 36 (1977), 58-66.

Isshiki, N.; Kitajima, K.; Kojima, H.; Harita, Y.: Turbulent noise in dysphonia. *Folia Phoniatic.* 30 (1978), 214-224.

Isshiki, N.; Tanabe, M.; Sawada, M.: Arytenoid adduction for unilateral vocal cord paralysis. *Arch. Otolaryng.* 104 (1978), 555-558.

Iwamura, S.: Functioning remobilization of the paralyzed vocal cord in dogs. *Arch. Otolaryng.* 100 (1974), 122.

Iwata, S.; von Leden, H.: Pitch perturbation in normal and pathologic voices. *Folia Phoniatic.* 22 (1970), 413.

Iwata, S.; von Leden, H.: Voice prints in laryngeal disease. *Arch. Otolaryng.* 91 (1970), 346-352.

Kakeshita, T.: Über eine neue Methode zur Messung der beim Stimmbandverschluß wirkenden Kräfte. I. *Mitt. Pflügers Arch.* 215 (1927), S. 19.

Katsuki, Y.: The function of the phonatory muscles. *Jap. J. Physiol.* 1 (1950), 29.

Kirikae, I.: Strobocinematographic study on the human vocal cord vibration during phonation. *Jap. Oto-rhino-laryng. Soc. Tokyo.* (in Japanese). 49 (1943), 236.

Koike, Y.: Vowel amplitude modulations in patients with laryngeal disease. *J. Acoust. Soc. Amer.* 45 (1969), 839-844.

Koike, Y.; von Leden, H.: Pathologic vocal initiation. *Ann. Otol. Rhinol. Laryngol.* 78 (1969), 138-148.

Koike, Y.; Markel, J.: Application of inverse filtering for detecting laryngeal pathology. *Ann. Otol. Rhinol. Laryngol.* 84 (1975), 117-12-3.

Kitajima, K.; Tanabe, M.; Isshiki, N.: Pitch perturbation in normal and pathologic voice. *Studia Phonologica (Kyoto).* 9 (1975), 25-32.

Komiyama, S.: Assessment of voice by phonogram. *Zibi-to-Rinsho* 18 (1972), 428-440.

Murakami, Y.; Kirchner, J. A.: Vocal cord abduction by regenerated recurrent laryngeal nerve. *Arch. Otolaryng.* 94 (1971), 64.

Murakami, Y.; Kirchner, J. A.: Mechanical and physiological properties of reflex laryngeal closure. *Ann. Otol.* 81 (1972), 59.

Nagaishi, C.: Experimental study on the vocal cord movement. *Zibi-Rinsho.* 33 (1938), 518.

Nakamura, F. et al.: Electromyographic study of the laryngeal muscle. *J. of Japan Bronchoesophag. Soc.* (in Japanese) 5 (1964), 5, 1-6.

Saito, S.; Fukuda, H.; Kitahara, S.; Kokawa, N.: Stroboscopic observation of vocal fold with fiberoptics. *Folia Phoniatic.* 30 (1978), 241-244.

Saito, S.; Fukuda, H.; Kitahara, S.: Stroboscopic microsurgery of the larynx. *Archiv. Otolaryng.* 101 (1975), 196-201.

Sato, F.; Ogura, J. H.: Neuroorrhaphy of recurrent laryngeal nerve. *Laryngoscope* 88 (1978), 1034-1041.

Sato, F.; Ogura, J. H.: Functional restoration for recurrent laryngeal nerve paralysis. An experimental study. *Laryngoscope* 88 (1978), 855-871.

Satta, K.: Experimentelle Untersuchungen über die Mechanismen der Stimmbildung and Lautartikulationen. *Jap. Oto-rhino-laryng. Soc. Tokyo.* 45

(1939) S. 1590.

Sawashima, M.; Hirose, H.: New laryngoscopic technique by use of fiberoptics. J. A. S. A. 43 (1968), 168.

Sawashima, M.; Totsuka, G.; Kobayashi, T.; Hirose, H.: Surgery for hoarseness due to unilateral vocal cord paralysis. Arch. Otolaryng. 87 (1968), 289-294.

Sawashima, M.: Measurement of maximum phonation time. Jap. Journ. of Logopedics and Phoniatrics. 7 (1966), 23-28.

Shibata, S.: A study of dynamic palatography. Annual Bulletin, Research Institute of Logopedic and Phoniatrics, University of Tokyo. 2 (1968), 28.

Shin, T.; Rabuzzi, D. D.: Conduction studies of the canine recurrent laryngeal nerve. Laryngoscope 81 (1971), 586.

Shiraiwa, T.: Experimental study on production of Japanese speech sound. Jap. Journ. Otol. Tokyo. 48 (1942), 419-463.

Suzuki, M.; Kirchner, J. A.: Afferent nerve fibers in the external branch of the superior laryngeal nerve in the cat. Ann. Otol. 77 (1968), 1059.

Takahashi, H.; Koike, Y.: Perceptual dimensions and acoustical correlates of pathologic voices. Acta Otolaryng. Suppl. 338 (1976), 1-24.

Takenouchi, S. et al.: Autogenous transplantation of the canine larynx. Laryngoscope 77 (1967), 1644.

Takenouchi, S. et al.: Movements of the vocal cords. Acta Oto-Laryngologica 65 (1968), 33-50.

Tanabe, M.; Isshiki, N.; Kitajima, K.: Vibratory pattern of the vocal cord in unilateral paralysis of the cricothyroid muscle. Acta Otolaryng. (Stockh.) 74 (1972), 339-345.

Tanabe, M.; Kitajima, K.; Gould, J. W.; Lambiase, A.: Analysis of highspeed motion picture of the vocal folds. Folia Phoniat. 27 (1975), 77-87.

Tsuiki, Y.: Methods of laryngeal examination. Kanehara Shuppan 1957.

Yanagihara, N.: Significance of harmonic changes and noise components in hoarseness. J. Speech Hearing Res. 10 (1967), 531-541.