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Morphometrical study on senile larynx

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The aim of the study was a morphometrical macroscopic evaluation of senile larynges, according to its usefulness in ORL diagnostic and operational methods. Larynx preparations were taken from cadavers of both sexes, of age 65 and over, about 24 hours after death. Clinically important laryngeal diameters were collected using common morphometrical methods. A few body features were also being gathered. Computer statistical methods were used in data assessment, including basic statistics and linear correlations between diameters and between diameters and body features. The data presented in the study may be very helpful in evaluation of diagnostic methods. It may also help in selection of right operational tool' sizes, the most appropriate operational technique choice, preoperative preparations and designing and building virtual and plastic models for physicians' training.

key words: morphometry, anatomy, otorhinolaryngology, larynx, age, senile

INTRODUCTION

Morphometrical evaluation of the larynx has always been interesting for both morphologists and physicians. It is obvious for every head and neck surgeon that a knowledge of larynx anatomy is very important and this is verified during each ORL neck procedure. Practical knowledge of the anatomy is even more important than theoretical knowledge. In accordance with clinical and surgical progress, it is evident that this knowledge, especially information useful during surgical and diagnostic procedures, has to be deepened. This kind of data may be provided during precise morphometrical macroscopic study on larynx.

Elderly pathology seems to be very topical nowadays, especially from a clinical and sociological point of view. According to Żakowska, elderly age starts at 65 [9]. Most European societies (including the Polish one) can be described as ageing ones. The latest sociological data demonstrate that society ageing is not over yet, and the process concerns men and women, rural and urban residents. Prolonged longevity, the increasing number of elderly people, biological variability in the group of both healthy and ill old people, diagnostic and treatment difficulties, make senility a big sociological and clinical issue. The high frequency of ORL notifiability in an elderly population makes this also an otorhinolaryngological problem. It is known that ORL illnesses are only slightly less frequent than lower airways diseases, vascular system, digestive system and osteoarticular system diseases in the population. Many authors notice the strong correlation of epithelial tissue malignant tumour evidence and old age [1]. It is known that epiglottis locations of larynx carcinomas are also more frequent in old patient populations. Histological and functional changes in larynx during ageing make it also a special organ from the geriatric point of view [3,7].

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Obtaining morphometrical data concerning the ageing larynx would be thus very important from both the clinical and cognitive point of view. Few authors put a morphometrical study on the larynx beyond their interests. Clinically very important measures were not taken although the studies were carried out on muscle- and ligament-less and(or) fixed larynges. Moreover the studies were not specially interested in elderly population, or special plastination procedures were performed in order to measure laryngeal cavity diameters.

The aims of the study were:

— to acquire and present macroscopic morphometrical data concerning diameters of larynx, which is important from a clinical point of view;
— statistical evaluation of the data in order to find qualitative correlations, especially between body features and laryngeal diameters;
— proposal of practical use of morphometrical data on the basis of the author's study and bibliography study.

MATERIAL AND METHODS

Data presented in the study were collected between 1998 and 2000. 52 laryngeal preparations were gathered from cadavers of both sexes, including 28 preparations from men (age: 65–87, mean 71.7), and 24 preparations from women (age: 65–81, mean 69). Larynges excised from persons, with any possibilities of laryngeal damage as a result of diseases, diagnostic or surgical manipulations, were not taken into consideration. The preparations were taken out of the cadavers as soon as possible, in accordance with Polish law (approximately 24 hours after death). They were not fixed in any way with any morphological method in order to avoid any fixation deformities. This kind of morphometrical preparation was similar to one proposed by Sprinzl and Eckel [8]. Personal attributes were noticed during autopsies such as: age, sex, height of body, collum circumference (laryngeal prominence level), and nourishment type, which was described in a simple statistical way: 1 — hypotrophic, 2 — normotrophic, and 3 — hypertrophic. Larynges were cut out of the bodies together with surrounding tissues and organs (especially important for further investigations: cervical part of oesophagus, cervical part of trachea, thyroid gland and hyoid bone).

Diameters were divided into groups according to ease of access during assessment and cervical diagnostic and operational procedures. The population was divided into two sex groups, in accordance with reports about big differences in diameters of upper respiratory system in men and women [6]. Micrometer and Vernier calliper were used during morphometric assessment. The diameters are shown in pictures below (Figs. 1–5). Data were charted and submitted to statistical evaluation including: basic statistical evaluation and finding important and strong linear correlations between variables describing body features and larynx diameters. Linear character of correlation was proven in cases with similar or identical Pearson and Spearman correlation indexes.

While collecting the data it was necessary to use abbreviations. The names of the abbreviations of diameters collected during gathering of measurements are listed below.

ARY	distance between apexes of arytenoid cartilages
CO	height of crico-thyroid median ligament (median line)
CR1	height of arc of cricoid cartilage (median line)
CR2	height of lamina of cricoid cartilage (median line)
CR3	transverse diameter of infraglottic cavity (inferior margin of cricoid cartilage level, sagittal plane)
CR4	transverse diameter of infraglottic cavity (inferior margin of cricoid cartilage level, frontal plane)
EPI1	height of laryngeal vestibule (median line)
EPI2	transverse diameter of epiglottis in its widest dimension
EPI3	height of epiglottis (glossal facies, median line)
EPIC	thickness of epiglottis (level of basis of glossal facies of epiglottis, median line)
GLAP	length of rima glottidis (sagittal plane, "cadaver position")
GLLAT	width of rima glottidis (middle of the lengths of vocal folds level, "cadaver position")
INF	height of infraglottic cavity (median anterior line)
LOBLS	length of oblique line, left side
LOBLD	length of oblique line, right side
TY1	distance between apex of superior thyroid incisure and apex of inferior thyroid incisure
TY2S	width of thyroid cartilage's lamina measured between superior thyroid incisure and superior thyroid tuberculum, left side

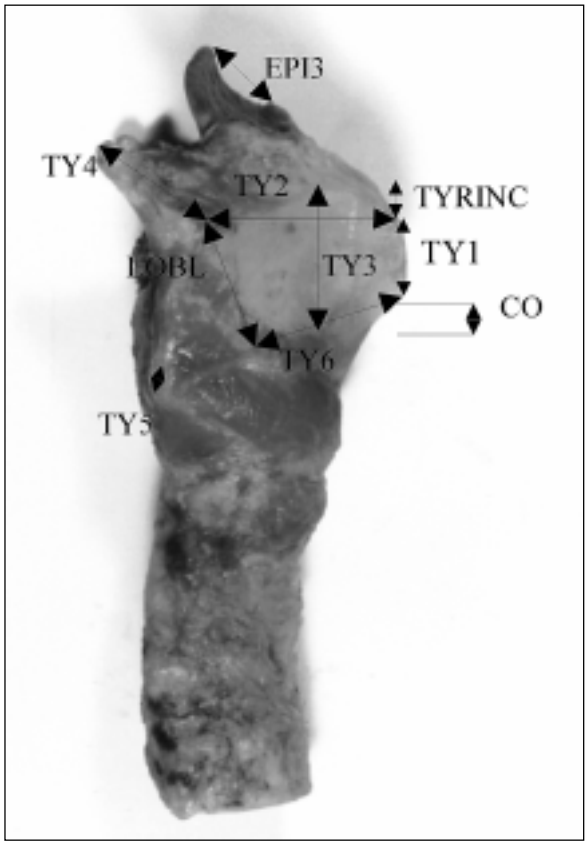

Figure. 1. Diameters describing thyroid cartilage and epiglottis, lateral view.

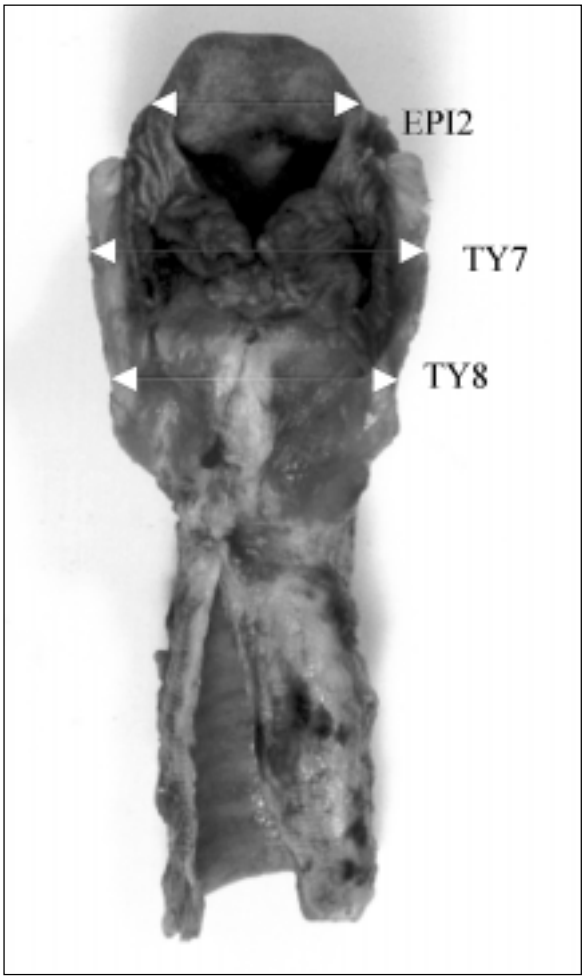

Figure. 2. Diameters describing thyroid cartilage and epiglottis, posterior view.

TY2D width of thyroid cartilage's lamina measured between superior thyroid incisure and superior thyroid tuberculum, right side
TY3S height of thyroid cartilage's lamina (level of middle of TY6 diameter) left side
TY3D height of thyroid cartilage's lamina (level of middle of TY6 diameter) right side
TY4S height of superior thyroid cornu, left side
TY4D height of superior thyroid cornu, right side
TY5S height of inferior thyroid cornu, left side
TY5D height of inferior thyroid cornu, right side
TY6S width of thyroid cartilage's lamina measured between inferior thyroid incisure and inferior thyroid tuberculum, left side
TY6D width of thyroid cartilage's lamina measured between inferior thyroid incisure and inferior thyroid tuberculum, right side
TY7 width of thyroid cartilage (frontal plane, bases of thyroid superior cornua level)
TY8 width of thyroid cartilage, frontal plane (bases of thyroid inferior cornua level)
TYRINC depth of thyroid superior incisure

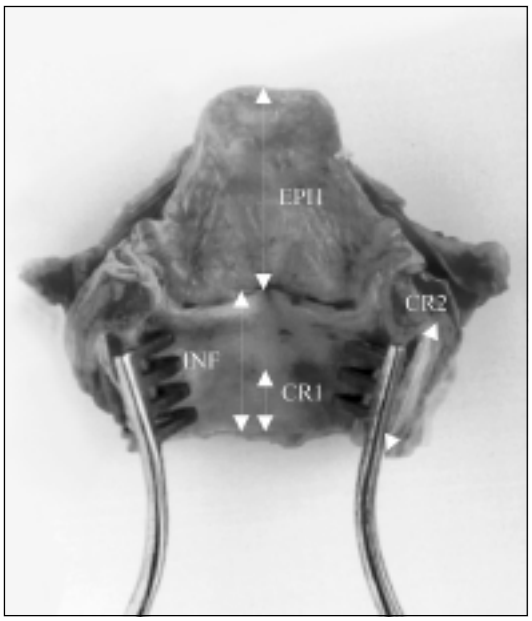

Figure. 3. Diameters describing epiglottis, cricoid cartilage and height of infraglottic cavity, posterior view.

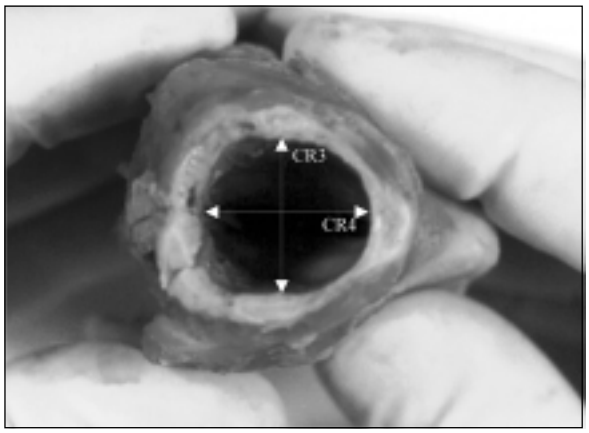

Figure. 4. Diameters describing infraglottic cavity in sagittal plane and frontal plane, inferior view.

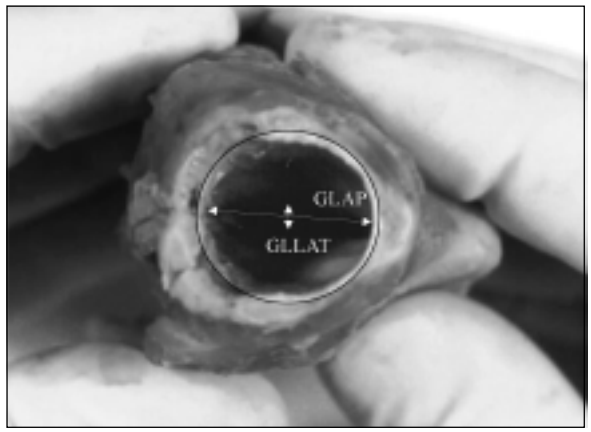

Figure. 5. Diameters describing rima glottidis, inferior view.

RESULTS

Results of basic statistical computations are presented in tables below (Tab. 1–10). Age is presented in years, nourishment type is listed on a 3-point scale, other measurements are presented in centimetres.

True glottis and glottis limitations' diameters, although measured, were not taken into consideration because of the measurements' inaccuracies coming from the softness and elasticity of these structures. Other morphometrical techniques have to be used for that purpose.

Table 1. Men: body features

	Mean value	Median value	Minimum value	Maximum value	Std dev.
Age	71.6786	70.5	65	87	6.64471
Height	172.714	172	164	182	6.67143
Nouri--shment	2.21429	2	1	3	0.56811
Collum circumfe-rence	41.2143	42	34	44	3.15474

Table 2. Women: body features

	Mean value	Median value	Minimum value	Maximum value	Std dev.
Age	69.6364	67	65	81	5.42082
Height	160.727	160	157	166	2.99495
Nouri--shment	2.18182	2	1	3	0.58849
Collum circumfe-rence	37.6364	38	34	43	2.62851

In the male population proven linear strong correlations were observed in pairs of variables (Pearson indexes are listed in brackets): age and CR2 (–0.61), nourishment type and collum circumference (0.52), nourishment type and CR3 (–0.55), nourishment type and CR4 (–0.58), collum circumference and CR4 (–0.43), collum circumference and EPIC (0.42), EPI2 and CR1 (0.64), CR1 and EPI2 (0.64), CR3 and CR4 (0.59), TY5S and TY5D (0.65), TY6S and TY6D (0.53).

In the female population strong (and/or important from the clinical or cognitive point of view) linear correlations were also found. The most important relations appeared to be between variables: age and CR2 (–0.42), height and INF (–0.50), height and TY7 (–0.59), EPI2 and CR2 (0.79), EPI2 and TY7 (0.58), EPI3 and CR2 (0.49), CR3 and TY8 (0.70), TY2S and TY2D (0.87), TY4S and TY4D (0.71).

Table 3. Men, diameters: TY1, TYRINC, CO

	Mean value	Median value	Minimum value	Maximum value	Std dev.
TY1	2.01429	2.05	1.73	2.23	0.19951
TYRINC	1.055	1.025	0.65	1.57	0.21488
CO	0.68286	0.77	0.07	0.91	0.20175

Table 4. Women, diameters: TY1, TYRINC, CO

	Mean value	Median value	Minimum value	Maximum value	Std dev.
TY1	1.62818	1.69	1.15	1.92	0.22924
TYRINC	0.73364	0.69	0.52	0.95	0.14686
CO	0.74091	0.71	0.45	1.1	0.17832

Table 5. Men, diameters: TY2, TY3, TY4, TY5, TY6, LOBLS, LOBLD, TY7, TY8

	Mean value	Median value	Minimum value	Maximum value	Std dev.
TY2S	3.57714	3.525	2.6	4	0.35001
TY2D	3.47214	3.5	2.5	3.95	0.33447
TY3S	3.32	3.225	2.83	4.6	0.43625
TY3D	3.23286	3.15	2.5	4.5	0.44348
TY4S	2.10929	2.33	0.1	2.72	0.66506
TY4D	2.21	2.375	0.1	2.79	0.65533
TY5S	0.64929	0.3	0.1	2.2	0.71113
TY5D	0.81929	0.3	0.1	2.52	0.86074
TY6S	2.33714	2.25	1.89	2.95	0.32504
TY6D	2.22786	2.265	1.5	2.8	0.33758
LOBLS	2.4	2.305	1.89	3.15	0.35874
LOBLD	2.26071	2.31	1.5	2.65	0.2894
TY7	4.05214	4.125	3.22	5.05	0.50795
TY8	3.57286	3.585	3	4.11	0.32518

Table 6. Women, diameters: TY2, TY3, TY4, TY5, TY6, LOBLS, LOBLD, TY7, TY8

	Mean value	Median value	Minimum value	Maximum value	Std dev.
TY2S	2.71182	2.61	2.5	3	0.21116
TY2D	2.74909	2.75	2.4	3.21	0.26089
TY3S	2.44909	2.5	2.12	2.79	0.18759
TY3D	2.44727	2.45	2.16	2.75	0.14469
TY4S	1.97455	2	1.59	2.5	0.27078
TY4D	2.01636	2.1	1.45	2.55	0.33903
TY5S	0.52909	0.3	0.1	1.7	0.53078
TY5D	0.50455	0.2	0.1	1.6	0.55354
TY6S	1.78	1.8	1.42	2.56	0.30777
TY6D	1.88	1.8	1.54	2.85	0.33705
LOBLS	1.81091	1.745	1.43	2.25	0.2441
LOBLD	1.83091	1.785	1.55	2.15	0.17611
TY7	3.51545	3.55	2.75	4.27	0.45583
TY8	2.80818	2.9	2.26	3.2	0.30509

Table 7. Men, diameters: EPI1, EPI2, EPI3, EPIC

	Mean value	Median value	Minimum value	Maximum value	Std dev.
EPI1	4.30857	4.42	3.14	4.92	0.41688
EPI2	2.25286	2.185	1.45	3.16	0.43099
EPI3	1.85571	2	0.75	2.34	0.40062
EPIC	0.51357	0.525	0.39	0.6	0.06308

Table 8. Women, diameters: EPI1, EPI2, EPI3, EPIC

	Mean value	Median value	Minimum value	Maximum value	Std dev.
EPI1	3.31818	3.3	2.92	4.03	0.30422
EPI2	1.96545	2	1.55	2.39	0.23565
EPI3	1.38182	1.46	0.8	2.42	0.42948
EPIC	0.43727	0.45	0.28	0.6	0.10584

Table 9. Men, diameters: INF, CR1, CR2, CR3 and CR4

	Mean value	Median value	Minimum value	Maximum value	Std dev.
INF	2.59071	2.635	1.9	3.5	0.38042
CR1	0.83214	0.82	0.61	1.09	0.14174
CR2	2.795	2.825	2.31	3.5	0.31725
CR3	1.73786	1.75	1.3	2	0.22503
CR4	1.54929	1.55	1.2	1.95	0.19057

Table 10. Women, diameters: INF, CR1, CR2, CR3 and CR4

	Mean value	Median value	Minimum value	Maximum value	Std dev.
INF	2.22182	2.17	1.64	3	0.36759
CR1	0.76636	0.75	0.67	0.95	0.07575
CR2	2.33909	2.34	1.96	2.7	0.24219
CR3	1.42727	1.45	1.1	1.61	0.15163
CR4	1.36727	1.36	1.05	1.9	0.24666

DISCUSSION

The data present a macroscopic morphometrical evaluation of larynx in elderly people. Comparison of child, adult and senile larynx diameters would be very useful. Unfortunately other elaborations concerning the topic do not show morphometrical evaluation of the organs covered with muscles, connective tissue elements and mucous membranes [5], other preparation techniques were used during data gathering [2], clinically important diameters were not

taken into considerations [8]. Those studies do not seem to be comparable to morphometrical evaluation of senile larynx as presented in this paper. It is obvious that comparable child and adult laryngeal morphometry data have to be gathered and compared to data concerning ageing larynx.

Preliminary evaluation of data proved the proper division of preparations in groups of male and female larynges. Morphometrical differences are significant and emphasise sexual dimorphism in morphometry of larynx. This is characteristic for adult larynges and as the study shows also for ageing larynges. In most cases differentiations in diameters are small or very small, in accordance with standard deviation values and mean values. Only a few diameters (TY5, TY4 in both populations) demonstrated high differentiation. The data may be very useful in ORL operational preparation (including common procedures such as conicotomy, total laryngectomy, partial laryngectomies and laryngeal microsurgery procedures) and evaluation of diagnostic technique results. Correlations between age and a few diameters show that relation between age and size of larynx is present also in the elderly population. Linear correlations found between many variables describing body features and larynx may be very useful in evaluating diagnostic methods, helping in right tool size selection, in the most appropriate operational technique choice and preoperative preparations in elderly people. The data may also be very helpful in designing and building virtual and plastic models for physicians' training [4].

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