

**Doctoral School in Medical Sciences**

With manuscript title

C.Z.U: 616.22-006.04-073.75(043.2)

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**CONTEMPORARY CONSIDERATIONS ON RADIOLOGICAL  
DIAGNOSIS OF LARYNX CANCER**

**324.01. MEDICAL RADIOLOGY AND IMAGING**

**Summary of Doctor of Medical Sciences Thesis**

**Chisinau, 2024**

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## INTRODUCTION

Among the malignant tumors of the ENT organs, laryngeal cancer ranks first and occurs more often in young men [1-11]. In surgical practice, organ-saving surgery for laryngeal cancer is increasingly being developed, which allow the patient to return to a normal life and do not limit contact with other people. For this, a correct assessment of tumor extension to different compartments of the larynx, soft tissues of the neck and adjacent organs is required [12].

According to Cancer-Registry data, in the Republic of Moldova, laryngeal cancer has a tendency of permanent increase in morbidity 2000 – 2.4%, (109 cases); 2010 – 2.5%, (138 cases); 2016 – 2.8%, (143 cases). At the same time, late addressing cases predominate, in advanced stages (stages III - IV) 80-85% of the patients registered are detected annually. Local recurrences develop in stages I and II up to 15%, and stages III and IV up to 70% of cases, the occurrence of locoregional metastases in the lymph nodes in stages I and II is 10 - 20%, and in stages III and IV 50-70% of cases, survival at 5 years, at the moment, in the Republic of Moldova in the initial stages, I and II, is 83-92%, and in st. III-IV, the 5-year survival is 35-45% [13].

The purpose of using imaging diagnosis in laryngeal cancer is to specify the extent of deep cancer extension that may be underestimated by clinical and endoscopic examination [14]. In the available sources of literature, currently there are no published works that would consider the Tomosynthesis diagnostic methodology in laryngeal cancer. In order to answer these questions and to develop a comprehensive approach to the diagnosis by the Tomosynthesis method in patients with laryngeal cancer, this scientific study was carried out, which includes the results of the examination of patients with laryngeal cancer by the radiological methods that have become standards - Digital Radiography and Computer Tomography, and which will be analyzed in comparison with the results obtained from the examination with a new radiological method - Tomosynthesis.

**Purpose:** To determine the performance and the role of Tomosynthesis in the evaluation of patients with laryngeal cancer, as well as the need for its inclusion in the imaging diagnostic algorithm of laryngeal cancer.

### **Objectives:**

1. Evaluation of the usefulness of the data obtained by Tomosynthesis in patients with laryngeal cancer and their diagnostic value.
2. Comparative evaluation of the imaging parameters obtained by Tomosynthesis, Digital Radiography and Computer Tomography in patients with laryngeal cancer and their statistical processing.
3. Perfecting the Tomosynthesis examination technique in patients with laryngeal cancer.
4. Development of an algorithm for imaging diagnosis of laryngeal cancer patients with the inclusion of Tomosynthesis examination. Defining the role of Tomosynthesis and Computer Tomography in the imaging diagnostic algorithm of patients with laryngeal cancer.

### **Scientific research methodology:**

The study represents a complex, structured and prospective analysis of the examination data of patients with laryngeal cancer by 3 radiological methods: Digital Radiography, Computer Tomography and Tomosynthesis. The direct and indirect examination (radiological examination completed with the clinical data of the patients and the analysis of the observation sheets) and the comparative analysis of the obtained results were the basis of the conducted study. Inclusion and exclusion criteria were used to select patients included in the study. The groups of patients included in the study and compared were homogeneous and comparable.

### **The novelty and scientific originality of the results obtained:**

1. For the first time in the Republic of Moldova, the method of radiological diagnosis of laryngeal cancer through Tomosynthesis was implemented.

2. The results of the investigation of patients with laryngeal cancer by 3 radiological methods were accumulated and comparatively analyzed: Digital Radiography, Computer Tomography and Tomosynthesis.
3. The results obtained through the analysis of different radiological diagnostic methods, the comparative assessment of the diagnostic effectiveness of these methods, allowed the determination of the clinical importance and the place of Tomosynthesis both in diagnosis and in the development of treatment tactics for patients with different forms of larynx cancer growth.
4. The investigation for the first time by Tomosynthesis of patients with laryngeal cancer allowed an original approach to the methodology of the investigation process of these patients with the improvement of the method and the patenting of the proposed new elements (Invention Patent No: 1488)
5. The results obtained in the study allowed the scientific elaboration of the algorithm for the radiological diagnosis of laryngeal cancer at the present time (copyright Series O No: 6642) "Algorithm for the radiological diagnosis of laryngeal cancer using Multisectional Digital Tomography (Tomosynthesis)", elaborated and scientifically argued based on the results obtained, is original by positioning Tomosynthesis in the foreground, because it allows the determination of an informative diagnosis, comparable, to a large extent, with CT. Also through this algorithm, the need for examination by Digital Radiography is excluded, and the additional examination by Computer Tomography was necessary in very few cases.
6. It was scientifically argued, through the results obtained in the study, the need to include Tomosynthesis in laryngeal cancer screening programs, as a less expensive method, lower radiation dose, more accessible for medical institutions and, respectively, for patients. This will contribute to reducing the number of patients diagnosed with stage III-IV laryngeal cancer, which currently exceed 80-85% of cases.

#### **Scientific problem solved:**

For the first time, were determined the diagnostic possibilities of Tomosynthesis in patients with laryngeal cancer, which were evaluated in comparison with Digital Radiography and Computer Tomography. The methodology of performing the Tomosynthesis examination was perfected, which allows obtaining more informative images and a better diagnosis. The clinical importance of Tomosynthesis in determining the treatment strategy was demonstrated. It has been scientifically demonstrated the need to include Tomosynthesis in the radiological diagnosis algorithm of laryngeal cancer in order to improve the imaging screening methodology of people from risk groups for the development of laryngeal cancer by including the laryngeal Tomosynthesis in the investigation protocol.

#### **The theoretical importance and applied value of the work:**

The diagnostic possibilities in laryngeal cancer using the Tomosynthesis method were studied for the first time, being scientifically argued and demonstrated the need to implement this method for the diagnosis of laryngeal cancer, and the results obtained in the study by the Tomosynthesis method, demonstrated comparable laryngeal cancer diagnostic possibilities, to a certain extent, with those obtained by Computer Tomography.

Tomosynthesis, unlike Computer Tomography, requires much cheaper equipment and maintenance, having a low radiation dose (below 3mSv), which makes it much more affordable for medical institutions and, respectively, for patients, and can be used in laryngeal cancer early diagnosis programs (screening). The Tomosynthesis investigation method was perfected and patented. The algorithm for radiological diagnosis of laryngeal cancer was also developed with the inclusion of Tomosynthesis.

#### **Argumentation of scientific results:**

The advantages and disadvantages of a new method of radiological diagnosis of laryngeal cancer - Tomosynthesis - were scientifically argued. The results obtained in the diagnosis of laryngeal

cancer by other radiological methods, Digital Radiography and Computer Tomography, were compared from a scientific point of view and statistically confirmed with the results obtained by the Tomosynthesis method.

**Main scientific results submitted for support:**

- Comparative determination of diagnostic possibilities in laryngeal cancer by different radiological methods.
- The role of Tomosynthesis in the imaging diagnosis of laryngeal cancer.
- Tomosynthesis as a screening method in the early detection of laryngeal cancer in risk groups for the development of laryngeal cancer.

**Implementation of scientific results:**

The results of the work were implemented in the diagnostic imaging sections of the Diagnostic Consultative Center and the stationary of the Oncological Institute of Republic of Moldova as study bases of the Department of Radiology and Imaging, SUMF "Nicolae Testemițanu".

**Approval of scientific results:**

The results of the study were published, presented and discussed in 21 national and international congresses and conferences. 21 papers were published on the topic of the thesis, including articles published in peer-reviewed national journals (category B) - 5, summaries/theses in the papers of national and international scientific conferences - 16, publications without co-authors - 10, short-term invention patent- 1, author certificates- 1, innovator certificates- 5, innovation implementation documents- 5.

**Summary of thesis sections:**

The thesis is presented on 133 pages and includes the list of abbreviations, the list of tables, the list of figures, introduction, 3 chapters, the synthesis of the results obtained, general conclusions, practical recommendations, bibliography, information regarding the valorization of the research, the statement on the assumption of responsibility and the author's CV.

The scientific study is set out on 109 typed pages. The iconographic material includes 42 figures, 12 tables. The work is based on 218 bibliographic sources.

**Key words:** laryngeal cancer, radiological diagnosis, Digital Radiography, Computer Tomography, Tomosynthesis.

The subject of the study, the structure and methodology of the study were positively approved by the Research Ethics Committee for the conduct of the study, verbal process no. 14 of 14.11.2016.

**1. THE ROLE OF IMAGING IN THE DIAGNOSIS OF LARYNX CANCER, POSSIBILITIES AND PERSPECTIVES**

Laryngeal cancer constitutes 3% of all malignant diseases and is an extremely complicated disease for diagnosis, especially for determining the local spread of the process and for treatment tactics. According to Cancer-Registry data, in the Republic of Moldova, laryngeal cancer has a tendency of permanent increase in morbidity 2000 – 2.4% (109 cases), 2010 – 2.5% (138 cases), 2016 – 2.8%, (143 cases). At the same time, late addressing cases predominate, in advanced stages (st. III - IV) 80-85% of the patients registered are detected annually. This determines even more the cardinal importance of determining as precisely as possible the degree of cancer extension and the damage to the larynx, which will determine the tactics of conservative treatment and the volume of surgical treatment. Local recurrences develop in stages I and II up to 15%, and in stages III and IV up to 70% of cases, the occurrence of locoregional metastases in the lymph nodes in stages I and II is 10 - 20%, and in stages III and IV of 50-70% cases, the survival at 5 years, at the

moment, in the Republic of Moldova in the initial stages, I and II, is 83-92%, and in st. III-IV, the 5-year survival is 35-45% [15].

### **1.1 Radiological imaging techniques in the evaluation of laryngeal cancer diagnosis.**

In the case of laryngeal cancer, the cure or progression of the disease depends same on early diagnosis and on the maximally correct determination of the spread of the process. This determines the volume of the surgical treatment and the individualization of the radiotherapeutic treatment. The imaging examination by DR, CT, MRI and, in recent years, by Tomosynthesis (TS) can provide important information for the assessment of treatment tactics [15]. Digital Radiography (DR), Computer Tomography (CT) and Tomosynthesis (TS) methods are based on the use of roentgen X-rays, so the results of examination by these methods can be compared and were included in our study. The Magnetic Resonance Imaging (MRI) method is based on the use of a magnetic field and for this reason was not included in our study.

The purpose of using imaging diagnosis in laryngeal cancer is to specify the extent of deep cancer extension that may be underestimated by clinical and endoscopic examination [14]. It allows at the same time to highlight the possible regional nodal extension as well as the distant extension of the disease. Imaging diagnosis is a complementary examination that cannot in any case replace the clinical examination and endoscopy. The imaging diagnosis allows the correct evaluation of the tumor extension thus allowing the establishment of the possibility of performing a conservative surgical intervention. In this way, the imaging balance sheet is part of the extension balance sheet of the disease. Imaging examinations are performed, as a rule, in accordance with the results obtained by performing direct laryngoscopy, specifying to the radiologist the location of the tumor and the areas of maximum interest, which are to be evaluated according to the location of the tumor: extension in the subglottis at the level of the anterior and posterior commissure, invasion paraglottic space and hyotyrepioglottic box, tumoral infiltration of cartilages and prelaryngeal tissues, tongue base invasion [15-17]. The literature mentions that the Digital Radiography method is still used, which is simple to perform, does not require expensive equipment and is more accessible to medical institutions and patients [18]. Although DR does not allow for a series of sectioned images, only a frontal, lateral image and a linear tomogram, still modern systems with digital technologies, with which simple radiological devices are completed, allow obtaining quite important radiological information for determining the presence of pathology in the larynx and the characteristic of some particularities of the tumor formations. These limitations of the DR are compensated by the CT examination, which allows the evaluation of the tumor extension and the assessment of the possibility of local and regional surgical resection of the invaded ganglia. The progress of digital technologies has allowed the development of new radiological diagnostic methods such as Tomosynthesis (TS), which are based on the scanning of anatomical structures with the performance of multiple sections with a step of 1-3 mm and the possibility of performing the reconstruction of the obtained images, as well as an irradiation at minimum doses below 3mSv [19-26]. Thus, from an economic point of view, Tomosynthesis has significant advantages with the reduction of the number of patients for CT, MRI or SPECT-CT nuclear scans. Tomosynthesis presents advantages over DR in the following applications: chest imaging, mammography, orthopedics-traumatology, brachytherapy, dental imaging, nephrology, pediatrics, etc. [15, 16]. It can also be used for dynamic evaluation and assessment of treatment response [27].

## **2. CHARACTERISTICS OF THE OBSERVATION MATERIAL AND RESEARCH METHODS**

**General characteristic of radiological examination material.** The study represents a structural and prospective analysis of the results of the examination of patients with laryngeal cancer by different radiological methods, investigated and treated within the Public Health Institution Oncological Institute of the Republic of Moldova during the years 2015 - 2020.

**Research inclusion criteria:** The study includes prospective material.

1. Patients primarily diagnosed with laryngeal cancer and confirmed histologically.
2. Persons over the age of 18.
3. Patients who have no contraindications for performing the aforementioned investigations, such as pregnancy, breastfeeding, cachexia, serious condition, metal prostheses, peace-maker, fear of closed spaces.
4. Patients who signed the informed consent to participate in the study.

**Exclusion criteria from the research:**

1. Suspect patients for laryngeal cancer without morphological confirmation.
2. Patients under the age of 18.
3. Pregnant and lactating women, patients in serious condition, cachexia, with metal prostheses, peace-maker, fear of closed spaces.
4. Patients who did not sign the informed consent for examination and participation in the study.

During the years 2015 - 2019, 1675 patients were examined by radiological methods within the PHMI Oncological Institute of the Republic of Moldova. From the total investigated patients, the diagnosis of laryngeal cancer was confirmed in 253 patients, who were included in this study (Table 2.1). All patients were investigated by Digital Radiography and Tomosynthesis. Computed Tomography was performed on 41 patients who signed the informed consent for this examination.

**Table 2.1. The number of patients with laryngeal cancer confirmed histologically and investigated by DR, TS, CT included in the study (n = 253).**

Examination method	Years					Total patients investigated (DR+TS+CT)
	2015	2016	2017	2018	2019	
Radiography	3	40	71	115	24	253
Tomosynthesis	3	40	71	115	24	253
CT	3	7	10	11	10	41 (of 253)
Total investigations (DR+TS+CT)						547

**Table 2.2. Characteristics of the age of the patients included in the study (%).**

Patients	40-50 years	51 – 60 years	61 – 70 years	71 – 80 years
<b>DR + TS (n=253)</b>	15 (5,92%)	77 (30,43%)	132 (52,17%)	29 (11,46%)
<b>DR+TS+CT (n=41)</b>	5 (12,19%)	16 (39,02%)	18 (43,90%)	2 (4,87%)

**Table 2.3. Characteristics of disease stages in patients included in the study (n= 253)**

Stage I T1N0M0	Stage II T2N0M0 / T2N1-2M0	Stage III T3-4N0-3M0	Stage IV TxNxM1
15 (5,92%)	68 (26,87%)	136 (53,75%)	34 (13,43%)

In the study group, male patients predominated - 250 (98.81%), women being only 3 (1.18%). The characteristic of the age of the patients included in the study is presented in Table 2.2, and of the stage of laryngeal cancer at the time of diagnosis - in Table 2.3.

**Statistical analysis procedures.** The statistical data were processed with the help of IMB/PC, using the statistical processing software "Statistical Package for the Social Sciences" SPSS 17 for Windows 10.0.5 (SPSS, Chicago; IL, USA) and "GraphPad PRISM 5.0 for Windows 5.0 (GraphPad Software, Inc.). Comparative statistical methods were applied for the comparative



evaluation of the imaging parameters obtained by TS versus CT and DR versus CT. A series of parameters were also calculated which included the concordance correlation coefficient ( $\rho_c$ ), the correlation coefficient  $\rho$  reflecting the precision (Pearson correlation coefficient -  $\rho$  [precision]) and the correction factor  $C_b$  reflecting the accuracy (Bias correction factor -  $C_b$  [accuracy]) [28]. The results were also confirmed by the linear regression plots of the values obtained by TS versus CT (the reference method) and those obtained by DR versus CT and which is a statistical modeling tool used to determine a pattern of the links that are established between pairs of numerical data, in our case obtained by various imaging methods [29]. Another statistical method that has been used is the "Mountain plot" diagram, which is based on the calculation of a percentile for each ranking difference between a new method and the reference method [30]. The method allows the evaluation of data obtained by new diagnostic methods compared to a reference method and provides relevant information about the distribution of differences between methods [30]. The statistical processing program MedCalc, version 20.106 was used to calculate the concordance coefficients, obtain the linear regression diagrams and the "Mountain plot" type diagram [31].

### 3. OWN RESULTS AND SYNTHESIS OF DATA OBTAINED

The data obtained by Digital Radiography, Computer Tomography and Tomosynthesis in patients with laryngeal cancer in the study are shown in Table 3.1, Table 3.2 and Table 3.3 respectively. Thus, through the Digital Radiography method cancer was diagnosed based on the presence of the tumor in 54.94% (CI 48.58-61.18%) cases, by the unilateral thickening of the ligament apparatus - in 54.42% (CI 58.19- 70.32%) cases, in 57.31% (CI 50.96-63.49%) cases the Morgagni ventricle was leveled and in 44.26% (CI 38.05-50.62%) cases it was observed leveling the subligamentous space (Table 3.1).

Table 3.1. The number of cases, detected symptoms and their frequency in patients with laryngeal cancer investigated by the Digital Radiography method

<b>Radiological symptoms determined in laryngeal cancer by the Digital Radiography method</b>	<b>Number of patients (n-253)</b>	<b>100% n-253</b>	<b>95% confidence interval</b>
The presence of volume formation	139	54,94%	48,58 – 61,18%
Unilateral thickening of the ligament apparatus	163	64,42%	58,19 – 70,32%
Bilateral thickening of the ligament apparatus	42	16,6%	12,23 – 21,77%
Arytenoid thickening	5	1,97%	0,65 – 4,55%
Morgagni ventricle leveling	145	57,31%	50,96 – 63,49%
Incomplete closure of the ligament apparatus	130	51,38%	45,04 – 57,69%
Leveling of the subligamentous space	112	44,26%	38,05 – 50,62%
Dilation of the prechondral space	72	28,45%	22,98 – 34,45%
Cartilage damage	48	19,87%	14,33 – 24,36%
Unilateral piriform sinus involvement	102	40,31%	34,22 – 46,64%
Bilateral piriform sinus involvement	19	7,50%	4,58 – 11,48%

Table 3.2. Characteristic of the frequency of radiological signs in the CT examination in patients examined with cancer of the larynx.

<b>Radiological symptoms in case of examination by the Computer Tomography method</b>	<b>CT (n=41)</b>	<b>Percentage (%)</b>	<b>95% confidence interval</b>
The presence of volume formation	41	100,0	91,40 – 100,00
Unilateral thickening of the ligament apparatus	35	85,36	70,83 – 94,43
Bilateral thickening of the ligament apparatus	6	14,63	05,57 – 29,17
Arytenoid thickening	6	14,63	05,57 – 29,17

Morgagni ventricle leveling	33	80,48	65,13 – 91,18
Incomplete closure of the ligament apparatus	35	85,36	70,83 – 94,43
Leveling of the subligamentous space	25	60,97	44,50 – 75,80
Dilation of the prechondral space	9	21,95	10,56 – 37,61
Cartilage damage	12	29,26	16,13 – 45,54
Unilateral piriform sinus involvement	27	65,85	49,41 – 79,92
Bilateral piriform sinus involvement	6	14,63	05,57 – 29,17

By Computer Tomography, according to the data presented in Table 3.2, the most common imaging signs, based on which the diagnosis of laryngeal cancer was determined, were: the presence of the tumor (exophytes or endophytes) in 100% (CI 91.40-100.00) cases, unilateral thickening of the ligamentous apparatus as well as incomplete closure of the ligamentous apparatus in 85.36% (CI 70.83-94.43%), leveling of the Morgagni ventricle in 80.48% (CI 65.13-91.18 %) cases, unilateral damage to the piriform sinus in 65.85% (CI 49.41-79.92%) cases and leveling of the subligamentous space in 60.97% (CI 44.50-75.80%) cases.

The results obtained by the Tomosynthesis method are presented in Table 3.3. The most frequent symptoms detected during the examination of patients with laryngeal cancer (with a frequency greater than 70%) were the following: the presence of volume formation - 100% (CI 98.55-100.00%), unilateral thickening of the ligament apparatus 81.02% (CI 75.64-85.67), leveling of the Morgagni ventricle – 73.12% (CI 67.21-78.48), incomplete closure of the ligament apparatus – 71.54% (CI 65.55- 77.02) (Figure 3.8).

**Table 3.3. The frequency of radiological symptoms of laryngeal cancer when examined by the Tomosynthesis method (n- 253, 100%).**

<b>Radiological symptoms in case of examination by the Tomosynthesis method</b>	<b>TS (n-253)</b>	<b>%</b>	<b>95% confidence interval</b>
The presence of volume formation	253	100,0	98,55 – 100,00
Unilateral thickening of the ligament apparatus	205	81,02	75,64 – 85,67
Bilateral thickening of the ligament apparatus	48	18,97	14,33 – 24,36
Arytenoid thickening	12	4,74	2,47 – 8,14
Morgagni ventricle leveling	185	73,12	67,21 – 78,48
Incomplete closure of the ligament apparatus	181	71,54	65,55 – 77,02
Leveling of the subligamentous space	87	34,38	28,55 – 40,59
Dilation of the prechondral space	22	8,69	5,53 – 12,87
Cartilage damage	82	32,41	26,68 – 38,56
Unilateral piriform sinus involvement	108	42,68	36,51 – 49,04
Bilateral piriform sinus involvement	24	9,48	6,17 – 13,79

### **Comparative analysis of the results of laryngeal cancer diagnosis through the methods of Digital Radiography, Computer Tomography and Tomosynthesis.**

The progress of medical technologies has led to the emergence of new diagnostic methods with possibilities comparable to Computer Tomography, but with a much simpler, less expensive apparatus and low radiation dose, which makes them more available to patients, including those with cervical metal implants. Here are presented the data obtained in our study by implementing the Tomosynthesis method in the diagnosis of laryngeal cancer in comparison with the Digital Radiography and Computer Tomography method.

Table 3.4. **Comparative analysis of the frequency of the manifestation of radiological signs when examined by the DR, CT and TS methods (%).**

<b>Radiological signs</b>	<b>DR (n=41)</b>	<b>DR (%)</b>	<b>CT (n=41)</b>	<b>CT (%)</b>	<b>TS (n=41)</b>	<b>TS (%)</b>
The presence of volume formation	26	63,41	41	100	39	95,12
Unilateral thickening of the ligament apparatus	20	48,7	35	85,36	32	78,04
Bilateral thickening of the ligament apparatus	3	7,31	6	14,63	5	12,19
Arytenoid thickening	1	2,43	6	14,63	3	7,31
Morgagni ventricle leveling	17	41,46	33	80,48	30	73,17
Incomplete closure of the ligament apparatus	13	31,70	35	85,36	32	78,04
Leveling of the subligamentous space	14	34,14	25	60,97	21	51,21
Dilation of the prechondral space	8	19,51	9	21,95	9	21,95
Cartilage damage	8	19,51	12	29,26	13	31,70
Unilateral piriform sinus involvement	13	31,70	27	65,85	22	53,65
Bilateral piriform sinus involvement	2	4,88	6	14,63	5	12,19

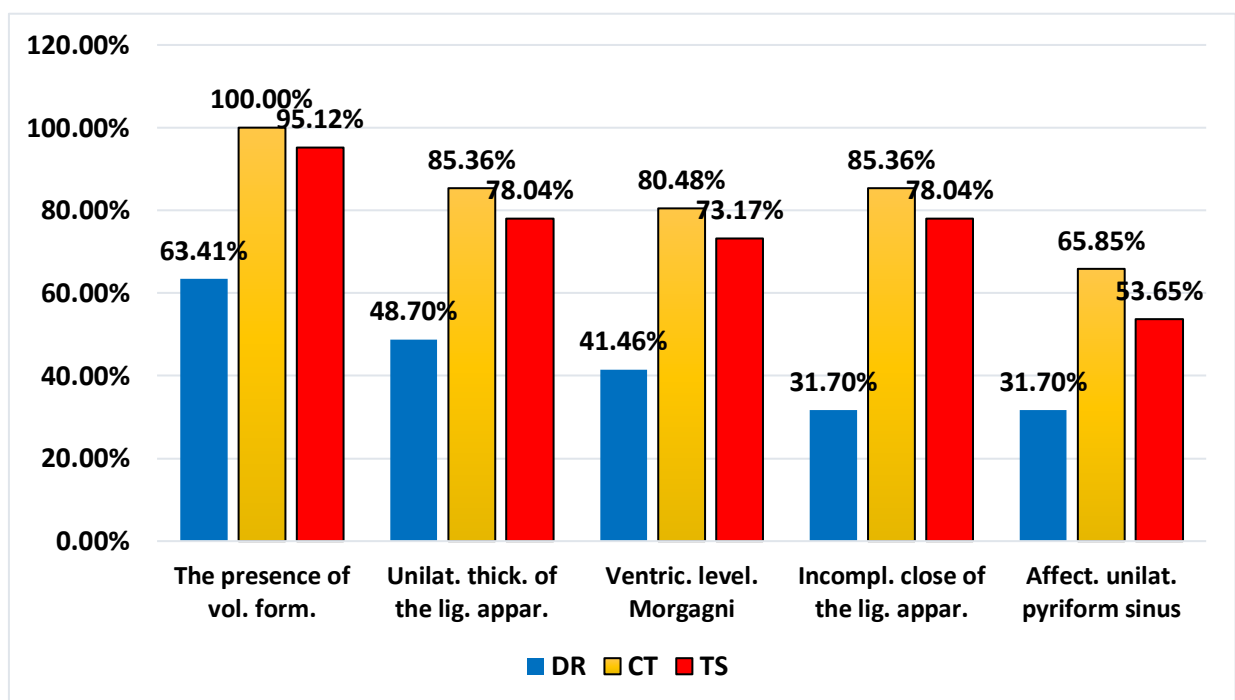


Figure 3.1. **Comparative presentation of the basic radiological signs in the diagnosis of laryngeal cancer in patients investigated by 3 methods: Digital Radiography, Computer Tomography and Tomosynthesis (%)**

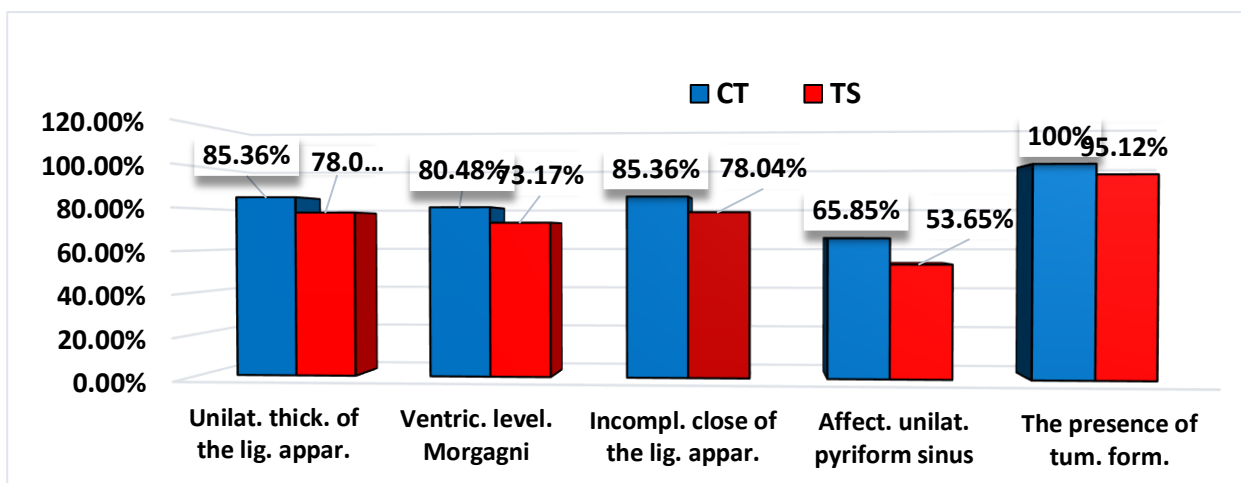


Figure 3.2. Comparative analysis of radiological symptoms characteristic of laryngeal cancer when examined by CT and TS methods (%)

For a comparative statistical analysis of the results obtained by the 3 radiological examination methods, 41 patients were selected for each study group according to the statistical calculations and the study inclusion criteria. The data presented in Table 3.4 and Figure 3.1 clearly demonstrate the limited possibilities in the diagnosis of laryngeal cancer of the Digital Radiography method compared to Computer Tomography and confirm the superiority of the CT examination. However, the results obtained by Tomosynthesis are very close to those obtained by Computer Tomography (Figure 3.2, Table 3.5).

If for DR the detection of laryngeal cancer symptoms were comparatively rare and did not exceed 63.41% at most, the comparative analysis of the results obtained in the case of examination by CT or TS demonstrates the diagnostic possibilities of these much more advanced methods, being even comparable by level. For example, the unilateral thickening of the ligamentous apparatus, caused by the severity of the tumor process, in the CT examination constituted 85.36% (CI 70.83-94.43%) and in TS - 78.05% (CI 62.39-89.44%); leveling of the Morgagni sinus – CT 80.48% (CI 65.13-91.18%) versus TS 73.17% (CI 57.06-85.78%); incomplete closure of the ligament apparatus at CT – 85.36% (CI 70.83-94.43%) versus TS – 78.04% (CI 62.39-89.44%) (Figure 3.2, Table 3.5).

Table 3.5. Comparative evaluation of imaging parameters obtained by TOMOSYNTHESIS versus Computer Tomography

Radiological Signs	Concordance coefficient	Correlation coefficient $\rho$	Correction factor $C_b$ / accuracy
The presence of volume formation	0,6555	0,6982	0,9388
Unilateral thickening of the ligament apparatus	0,8453	0,8556	0,9880
Bilateral thickening of the ligament apparatus	0,8951	0,9001	0,9945
Arytenoid thickening	0,6306	0,6786	0,9293
Morgagni ventricle leveling	0,7960	0,8131	0,9790
Incomplete closure of the ligament apparatus	0,7574	0,7807	0,9701
Leveling of the subligamentous space	0,8038	0,8198	0,9806
Dilation of the prechondral space	1,0000	1,0000	1,0000
Cartilage damage	0,9425	0,9441	0,9983
Unilateral piriform sinus involvement	0,7503	0,7748	0,9683
Bilateral piriform sinus involvement	0,8951	0,9001	0,9945
<i>Average value <math>\pm</math> standard deviation</i>	<i>0,8156 <math>\pm</math> 0,1147</i>	<i>0,8332 <math>\pm</math> 0,0992</i>	<i>0,9765 <math>\pm</math> 0,0236</i>
<i>Median</i>	<i>0,8038</i>	<i>0,8198</i>	<i>0,9806</i>

The determination of the concordance coefficient of the imaging parameters obtained by Tomosynthesis and Computer Tomography is shown in Table 3.5. It is known that the concordance coefficient  $\rho_c$  is the product of the correlation coefficient  $\rho$  reflecting precision and the correction factor  $C_b$  reflecting accuracy [28], i.e.

$$\rho_c = \rho \times C_b [28]$$

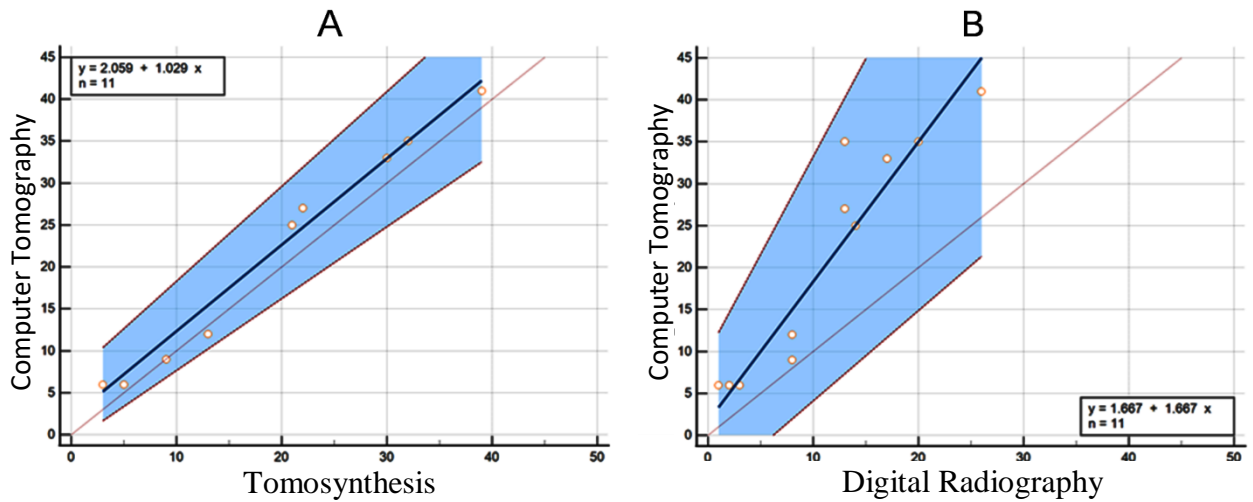
Thus, the concordance correlation coefficient reflects the degree of agreement between two methods or evaluations and can take values between 0 and 1, being a non-directional coefficient. Values close to 0 indicate no agreement, while values close to 1 show perfect agreement [28].

In this study, the comparative evaluation of imaging parameters obtained by Tomosynthesis versus Computer Tomography (which is considered the gold standard) revealed a concordance coefficient between 0.6306 and 1.0 for various parameters with a mean value of  $0.8156 \pm 0,1147$  (Table 3.7). The Pearson correlation coefficient ranged from 0.6786 to 1.0 for various parameters with a mean value of  $0.8332 \pm 0.0992$ , and the  $C_b$  correction factor reflecting accuracy ranged from 0.9293 to 1.0 for various parameters with an average value of  $0.9765 \pm 0.0236$  (Table 3.5). The obtained data reflect a high concordance of the results obtained by Tomosynthesis and Computer Tomography.

On the contrary, the comparative evaluation of the imaging parameters obtained by Digital Radiography versus Computer Tomography revealed a concordance coefficient between 0.0831 and 0.9259 for various parameters with an average value of  $0.4317 \pm 0.2548$  (Table 3.6). The Pearson correlation coefficient varied between 0.2082 and 1.0 for various parameters with an average value of  $0.5196 \pm 0.2114$ , and the  $C_b$  correction factor reflecting accuracy varied between 0.399 and 0.9972 for various parameters with a value average of  $0.7660 \pm 0.1855$  (Table 3.6). The obtained data reflect a much weaker concordance of the results obtained by Digital Radiography compared to those obtained by Tomosynthesis (table 3.5 and 3.6).

**Table 3.6. Comparative evaluation of imaging parameters obtained by DIGITAL RADIOGRAPHY versus Computer Tomography**

<b>Radiological Signs</b>	<b>Concordance coefficient</b>	<b>Correlation coefficient <math>\rho</math></b>	<b>Correction factor <math>C_b</math> / accuracy</b>
The presence of volume formation	0,0831	0,2082	0,3990
Unilateral thickening of the ligament apparatus	0,3279	0,4428	0,7404
Bilateral thickening of the ligament apparatus	0,6306	0,6786	0,9293
Arytenoid thickening	0,2545	0,3819	0,6666
Morgagni ventricle leveling	0,2931	0,4144	0,7073
Incomplete closure of the ligament apparatus	0,1474	0,2821	0,5226
Leveling of the subligamentous space	0,4983	0,5761	0,8651
Dilation of the prechondral space	0,9259	0,9284	0,9972
Cartilage damage	0,7389	0,7654	0,9653
Unilateral piriform sinus involvement	0,3881	0,4907	0,7909
Bilateral piriform sinus involvement	0,4605	0,5469	0,8420
<b><i>Average value <math>\pm</math> standard deviation</i></b>	<b><i>0,4317 <math>\pm</math> 0,2548</i></b>	<b><i>0,5196 <math>\pm</math> 0,2114</i></b>	<b><i>0,7660 <math>\pm</math> 0,1855</i></b>
<b><i>Median</i></b>	<b><i>0,3881</i></b>	<b><i>0,4907</i></b>	<b><i>0,7909</i></b>

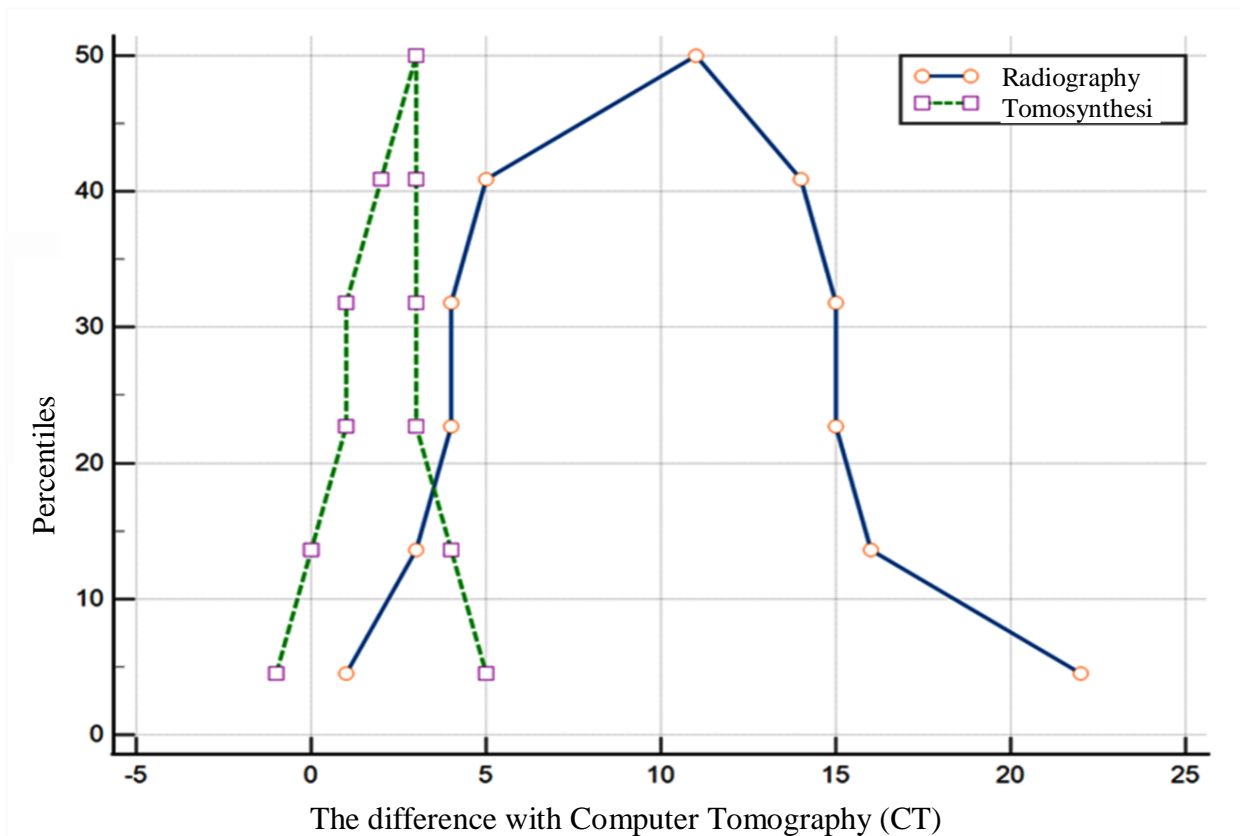


**Figure 3.3. Linear regression diagrams of the data obtained by Tomosynthesis versus Computed Tomography (A) and those obtained by Digital Radiography versus Computed Tomography (B).**

The results are also confirmed by the linear regression diagrams of the values obtained by Tomosynthesis versus Computer Tomography (figure 3.3 A) and those obtained by Digital Radiography versus Computer Tomography (figure 3.3 B). As we know, regression analysis is a statistical modeling tool used to determine a model of the links that are established between pairs of numerical data, in our case obtained by various imaging modalities [29]. It is observed that the dispersion diagram of the values obtained by Tomosynthesis versus Computer Tomography (figure 3.3 A) is more compact compared to the values obtained by Digital Radiography (figure 3.3 B), demonstrating a stronger correlation of the data obtained by Tomosynthesis with a correlation coefficient  $r = 0.993$  ( $p < 0.0001$ ).

Another statistical method that is increasingly used to evaluate the data obtained by new diagnostic methods compared to a reference method is the "Mountain plot" diagram, which is based on the calculation of a percentile for each ranking difference between a new method and the method of reference [30]. The method provides relevant information about the distribution of differences between methods. Thus, if the results of two tests are identical, the plot will be centered around zero. Conversely, long tails in the plot with significant deviations from zero reflect large differences between methods [30].

The data obtained in this study through Digital Radiography and Tomosynthesis compared to Computer Tomography (the reference method) are shown in the form of a "Mountain plot" diagram in Figure 3.4. It is observed that the curve of the data obtained by Tomosynthesis is centered much closer to zero, having a narrow, relatively symmetrical shape, with small deviations of the values between -1 and 5. On the contrary, the curve of the data obtained by Digital Radiography is much deviated to the right against the zero figure, with significant variations of the values between 1 and 22. The diagram clearly demonstrates a very high concordance of the data obtained by Tomosynthesis and Computed Tomography (the standard method), a much higher concordance compared to the data obtained by Digital Radiography.



**Figure 3.4. "Mountain plot" type diagram of the data obtained by Digital Radiography and Tomosynthesis compared to the reference method (Computerized Tomography). The curve of the data obtained by Tomosynthesis is centered much closer to zero, having a narrow, relatively symmetrical shape, with small deviations of the values between -1 and 5, demonstrating a very high agreement with the reference method.**

According to the data presented in the results of the statistical tests performed, the diagnostic possibilities of Tomosynthesis compared to the CT method are quite impressive, the difference in the diagnostic effectiveness of Tomosynthesis versus the CT examination is quite small and does not exceed 10%. This is due to the sophisticated digital technology based on Tomosynthesis, namely, performing a series of sections with a step of 1-3mm at different depths of the larynx. If we also take into consideration the following moments: that the apparatus for Tomosynthesis is much cheaper, requires room and operating conditions with much simpler and lower cost, and a radioactive load below 3mSv - Tomosynthesis, compared to CT, can be recommended as a method of first line in the radiological examination of patients with laryngeal cancer [32]. The equipment required for Tomosynthesis is simple to install and operate, the cost compared to CT is much lower, which makes it accessible to any hospital and, as a radiological examination method, more accessible to patients as well. Of course, the CT method is more informative and, if necessary, to determine some particularities of the tumor process, in certain cases, the additional examination by Computer Tomography is also necessary. However, the results obtained during the TS examination were sufficiently informative for treatment in most cases, which is very important considering that, at the moment, the PHMI Oncological Institute does not have a Computerized Tomograph.

The analysis of the results of the 3 radiological imaging diagnostic methods (DR, CT, TS) demonstrates the priority of new technologies over Digital Radiography, and the difference in diagnostic possibilities between CT and TS does not exceed 10%, according to our data and makes them comparable according to the results.

The laryngeal cancer diagnostic method with Tomosynthesis allows for a more detailed visualization of the structures of the larynx and tumor formations thanks to digital technology, which allows a series of sections of the investigated organ to be made, with a step of 1-3 mm with the digital processing of the obtained images and their reconstruction, which ensures a more precise and qualitative diagnosis. The Tomosynthesis principle is based on the dynamic performance of a series of sections, radiological images of the anatomical structures of the larynx at different angles to the examined surface. During the procedure of scanning the larynx using the Tomosynthesis method, the device moves on a curved axis with respect to the larynx, which in the standard position is on a linear axis, which can lead to the overlapping of the anatomical elements of the larynx and obtaining low-quality, "wiped" images as well when performing radiological sections in dynamics, with phonation, involuntary movements appear. This may require repeating the radiological investigation, which leads to an increase in the radiation burden for the patient. In order to avoid these situations, it was proposed to change the method of examining the larynx through the Tomosynthesis method (a method that was patented by Patent No. 1488) by fixing the larynx in a curved position, in the form of an arc, thus in this position the direction of the X-rays is positioned perpendicular to the path of the axis of the larynx, but also the limitation of involuntary movements by fixation, which allows reducing the risk of obtaining unclear images, increases the clarity of the image and reduces the need to repeat the investigation and repeated irradiation.

Based on the results obtained in the study, the "X-ray diagnosis algorithm of laryngeal cancer using Multisectional Digital Tomography (Tomosynthesis)" presented in Figure 3.5 was developed, for which the Copyright Registration Certificate Series O No. 6642 of 21.08.2020.

Establishing and confirming the diagnosis of laryngeal cancer requires several actions. As presented in the Algorithm elaborated by us based on our own results, when addressing the patient with suspicion of laryngeal cancer, in the first instance a clinical examination is performed, which, unfortunately, in most cases does not allow to clearly visualize the character of spread of the tumor process. Fibrolaryngoscopy (FLS), as the next stage of investigation, allows visualization of the affected region of the larynx, visual confirmation of the possible tumoral, proliferative or inflammatory process. The main advantage of FLS is the possibility of tissue collection (biopsy), which allows confirmation of the presence of cancer, if the biopsy is successful.

The radiological imaging examination of the larynx, under these conditions, acquires a significant importance for the diagnosis of laryngeal cancer. According to the elaborated Algorithm, at the first stage of the radiological examination, Tomosynthesis is proposed, which can be compared, to a large extent, with the diagnostic possibilities of the CT method, and in complicated cases for diagnosis, especially locally advanced ones, double investigation was necessary, through TS and CT, for the development of an optimal treatment strategy. At the last stage, according to the Algorithm, based on the results of the endoscopic, imaging and morphological examinations, the justified treatment is carried out: surgical, chemotherapy or radiotherapy.



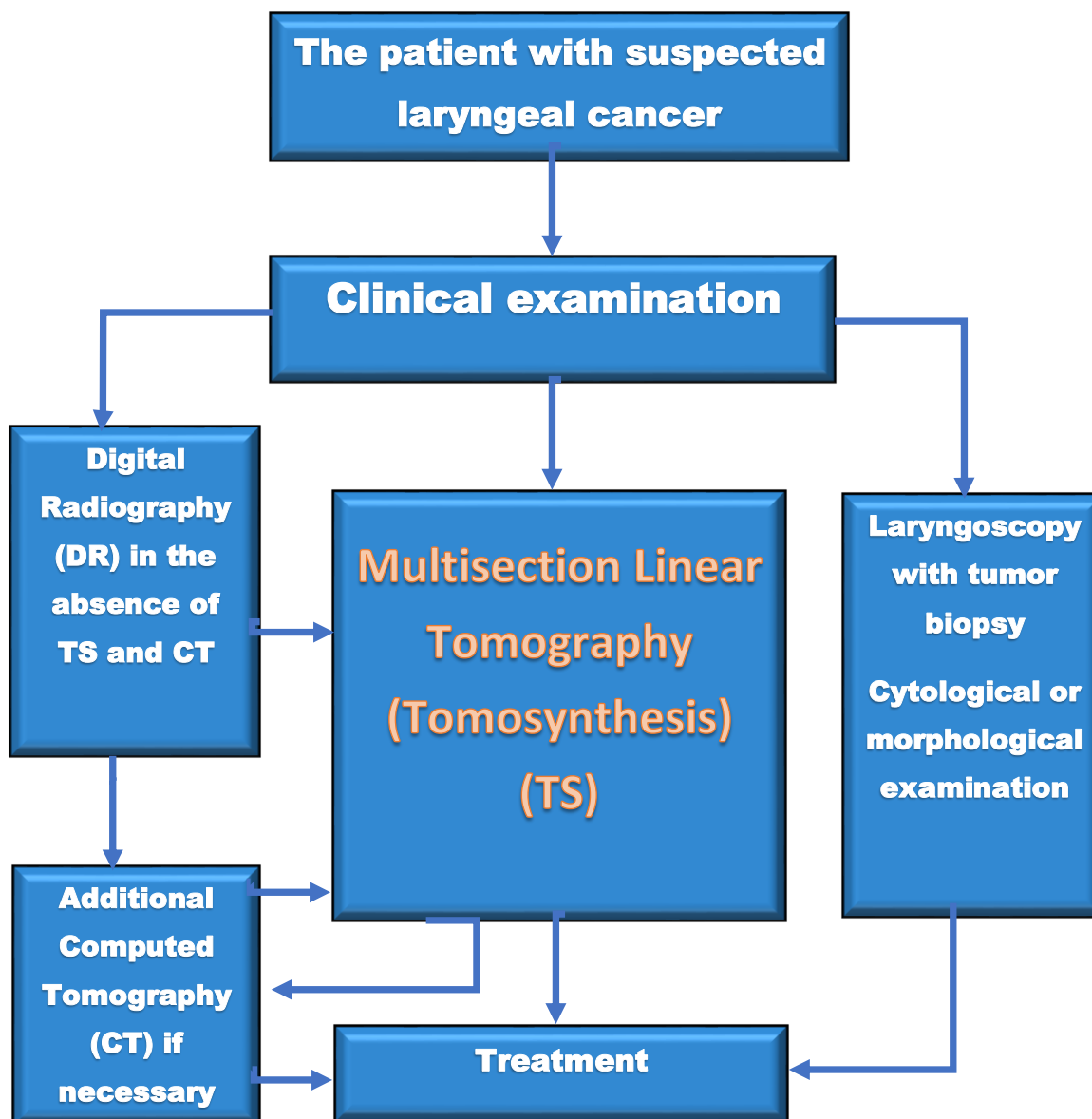


Figure 3.5. The diagnostic algorithm in case of suspected laryngeal cancer

#### Limitations of the study:

The last two decades have been associated with great progress in the field of radiology and medical imaging, both through the modernization of existing investigation methods and the introduction into practice of new diagnostic modalities and techniques that offer new perspectives and diagnostic possibilities. One such modern imaging modality is Tomosynthesis, which allows obtaining high-quality volumetric images at a significantly lower radiation dose compared to Computer Tomography, the dose being close to that received during a Digital Radiography. Due to the fact that patients with oncological diseases require repeated radiological investigations with rather high cumulative radiation doses, Tomosynthesis was introduced for the first time in oncological medical practice in the Republic of Moldova within the PHMI DCC Oncological Institute, a fact that allowed the present study to be carried out.

At the time of the start of the study, there were no data in the specialized literature regarding the usefulness of Tomosynthesis in the diagnosis of patients with laryngeal cancer. Being the first study in the field, it is also associated with a number of limitations. Since there were no data or

recommendations in the field, the number of patients subjected to the 3 investigations was limited due to ethical considerations and the regulations in force regarding the use of investigations associated with ionizing radiation. Thus, the performance of each investigation required both the patient's agreement with the signing of the informed consent, as well as the referral for the respective investigation by the attending physician. The total number of 41 patients who underwent all 3 investigations allowed a detailed comparative analysis of the parameters obtained by each method, demonstrating the usefulness of Tomosynthesis in the diagnosis of laryngeal cancer and its clear superiority compared to Digital Radiography. Under these conditions, Computed Tomography is reserved for clarifying the diagnosis or extension of the tumor process when the establishment of the therapeutic strategy remains uncertain or requires additional data. The definition of these indications, however, requires new studies in the field with the inclusion of larger groups of patients with various stages of the tumor process.

It should also be noted that in this study a comparative evaluation of the performance of radiological investigations (using ionizing radiation) in the diagnosis of laryngeal cancer was carried out, therefore some imaging investigations such as Ultrasonography (USG) and Magnetic Resonance Imaging (MRI) not associated with ionizing radiation were not included in the study.

Taking into account the low radiation dose of Tomosynthesis (close to that of Digital Radiography), as well as the fact that in the Republic of Moldova about 80-85% of patients are diagnosed in advanced stages (stage III - IV) of laryngeal cancer, Tomosynthesis it can also be useful in screening people from high-risk groups. In this PhD thesis, however, Tomosynthesis was not used as a screening method, and the implementation of a laryngeal cancer screening program using Tomosynthesis is a separate topic and will also require new studies in the field.

Another imaging modality that is increasingly used in recent years to evaluate and stage patients with oncological conditions, including laryngeal cancer, is Positron Emission Tomography (PET) in combination with Computer Tomography (CT), which is also called and hybrid PET/CT investigation. Currently, the PET/CT investigation can be performed within the PHMI Republican Clinical Hospital "Timofei Moşneaga", as well as within the Medpark International Hospital. At the time of initiation of this study, however, PET/CT investigation was not yet available in the Republic of Moldova, therefore the modality was not included in the study.

## GENERAL CONCLUSIONS

1. Tomosynthesis represents a modern diagnostic method with an irradiation dose close to that of Digital Radiography, but with high-quality sectional images and informativeness close to those of CT, a fact demonstrated in this study. Thus, Digital Radiography, Tomosynthesis and CT are relevant for the presence of volume formation in 63.41% vs 95.12% vs 100% patients, unilateral thickening of the ligamentous apparatus in 48.7% vs. 78.04% vs. 85.36% patients, incomplete closure of the ligament apparatus in - 31.70% vs. 78.04% vs. 85.36% patients, leveling of the subligamentous space at 34.14% vs. 51.21% vs. 60.97% patients.
2. The comparative evaluation of the imaging parameters obtained by Tomosynthesis versus CT versus Digital Radiography revealed the concordance coefficient and Pearson correlation coefficient with a high concordance of the results obtained by Tomosynthesis and CT, contrary to the results obtained by Digital Radiography which were associated with a much weaker agreement. The results were also confirmed by the graphic analysis of the results obtained by Digital Radiography and Tomosynthesis compared to the reference method (CT), including linear regression diagrams and "Mountain plot" type diagrams.
3. The study also allowed the improvement of the Tomosynthesis examination technique of patients with laryngeal cancer by fixing the head with the anterior position of the larynx (Patent no. 1488), a fact that contributed to obtaining images of a clearly superior quality by limiting movements involuntarily and the overlapping of anatomical structures.
4. The results of the study demonstrated that Tomosynthesis represents a valuable method in the evaluation of patients with laryngeal cancer, the difference in the data provided compared to

the CT examination being quite small (not exceeding 10% in most radiological signs examined). Considering the lower cost and the lower radiation dose (below 3mSv) compared to the CT examination, Tomosynthesis can be recommended as a first-line method in the X-ray examination of patients with laryngeal cancer. An algorithm for imaging diagnosis of patients with laryngeal cancer with the inclusion of Tomosynthesis examination was developed for this purpose.

5. Computed Tomography, however, remains the most informative method and can be indicated when necessary, to determine some particularities of the tumor process, especially in locally advanced cases when the establishment of a therapeutic strategy remains uncertain and requires obtaining new, more detailed data.

### **PRACTICAL RECOMMENDATIONS**

1. The Tomosynthesis method is currently used more widely in the diagnosis of the pathology of the mammary glands, the bone system, lungs, pediatrics, etc. The results obtained in the study demonstrated the effectiveness of Tomosynthesis in examining the pathology of the larynx and is recommended for implementation in medical institutions that have an imaging diagnostic department.
2. Tomosynthesis is a first-line method in the radiological examination of patients with laryngeal cancer and needs to be used according to the algorithm for imaging diagnosis of patients with laryngeal cancer elaborated in the framework of this study.
3. Tomosynthesis is based on the same principle as CT - performing imaging sections with a step of 1-3mm, with a radioactive load below 3mSv and digital reconstruction of the obtained images. This reduces the need to re-examine patients with more expensive and less accessible methods such as CT or MRI. However, they can be indicated when necessary, especially when the establishment of a therapeutic strategy remains uncertain and requires the acquisition of new, more detailed data.
4. Taking into account the reduced radiation dose of Tomosynthesis (close to that of Digital Radiography), as well as the fact that in the Republic of Moldova about 80-85% of patients are diagnosed in advanced stages (stage III - IV) of laryngeal cancer, Tomosynthesis may also be useful in screening individuals from high-risk groups. However, the implementation of a laryngeal cancer screening program using Tomosynthesis will require new studies in the field.

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#### LIST OF SCIENTIFIC PAPERS ON THE THEME OF THE THESIS

- **Articles in accredited national scientific journals:**
- ✓ **articles in category B magazines**
- 1. **Jovmir-Popa D.** The role of imaging in the diagnosis of laryngeal cancer, possibilities and perspectives (literature review). *Bulletin of the Academy of Sciences of Moldova. Medical Sciences*. 4(56)/2017, pp. 109-116, ISSN: 1857-0011
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## ADNOTARE

Jovmir-Popa Dorina

“Considerații contemporane asupra diagnosticului rentghenologic a cancerului de laringe”

Teză de doctor în științe medicale

Chișinău, 2024

**Structura tezei:** introducere, 3 capitole, concluzii generale, recomandări practice, bibliografie 218 titluri, 109 pagini text cu lucru științific, figuri 42, tabele 12, lucrări publicate 21.

**Cuvinte cheie:** cancer laringe, diagnostic radiologic, Tomosinteză.

**Domeniul de studiu:** Radiologie și imagistică medicală

**Scopul studiului:** determinarea performanței și rolului Tomosintezei digitale în evaluarea pacienților cu cancer de laringe, precum și necesitatea includerii acesteia în algoritmul de diagnostic imagistic al cancerului de laringe.

### Obiectivele studiului:

1. Evaluarea utilității datelor obținute prin Tomosinteza digitală la pacienții cu cancer de laringe și valoarea diagnostică a acestora.
2. Evaluarea comparativă a parametrilor imagistici obținuți prin Tomosinteză, Radiografie Digitală și Tomografie Computerizată la pacienții cu cancer de laringe și procesarea statistică a acestora.
3. Perfectarea tehnicii de examinare prin Tomosinteză la pacienții cu cancer de laringe.
4. Elaborarea unui algoritm de diagnostic imagistic al pacienților cu cancer de laringe cu includerea examenului prin Tomosinteză. Definirea rolului Tomosintezei și Tomografiei Computerizate în algoritmul de diagnostic imagistic al pacienților cu cancer de laringe.

**Noutatea și originalitatea științifică:** pentru prima dată a fost implementată și apreciată metoda Tomosintezei în diagnosticul cancerului de laringe.

**Problema științifică soluționată:** au fost studiate, pentru prima dată, posibilitățile examinării pacienților cu cancer de laringe prin metoda radiologică, bazată pe tehnologii digitale noi, Tomosinteza. A fost demonstrat că metoda Tomosintezei este net superioară, comparativ cu Radiografia Digitală, în diagnosticul cancerului de laringe, și rezultatele obținute prin Tomosinteză sunt comparabile, în mare măsură, cu cele obținute prin Tomografia Computerizată.

**Semnificația teoretică:** rezultatele obținute au demonstrat necesitatea dezvoltării metodelor noi de diagnostic radiologic, bazate pe tehnologii digitale noi, care permit determinarea mai exactă a caracterului patologiei examinate prin imagini secționare și reconstrucția lor, folosind o doză de iradiere mai mică pentru pacient.

**Valoarea aplicativă a lucrării:** a fost elaborat Algoritmul de diagnostic radiologic a cancerului de laringe în baza metodei Tomosintezei, metodă care poate fi implementată, din punct de vedere economic și tehnic, în instituții medicale periferice pentru depistarea precoce a cancerului de laringe prin screening radiologic, deoarece la moment stadiile III-IV de cancer laringian constituie 80- 85%.

**Implementarea rezultatelor științifice:** în baza rezultatelor studiului a fost elaborat și publicat Algoritmul de diagnostic radiologic a cancerului de laringe, recomandat și pentru screening-ul cancerului de laringe în grupele de risc. A fost modificată și brevetată procedura efectuării Tomosintezei în examinarea laringelui.

## ANNOTATION

Jovmir-Popa Dorina

### ”Contemporary considerations on the radiological diagnosis of laryngeal cancer”

Doctoral thesis in medical sciences

Chişinău, 2024

**Thesis structure:** introduction, 3 chapters, general conclusions, practical recommendations, bibliography 218 titles, 109 pages of scientific text, 42 figures, 12 tables, 21 published works.

**Keywords:** laryngeal cancer, X-ray diagnosis, Tomosynthesis.

**Field of study:** radiology and medical imaging

**Aim of the study:** determining the performance and role of digital Tomosynthesis in the evaluation of patients with laryngeal cancer, as well as the suitability for including the technique in the imaging diagnostic algorithm of laryngeal cancer.

#### **Objectives of the study:**

1. Evaluation of the usefulness of the data obtained by Digital Tomosynthesis in patients with laryngeal cancer and their diagnostic value.
2. Comparative evaluation of imaging parameters obtained by Tomosynthesis, Digital Radiography and Computerized Tomography in patients with laryngeal cancer and their statistical processing.
3. Perfecting the Tomosynthesis examination technique in patients with laryngeal cancer.
4. Development of an algorithm for imaging diagnosis of laryngeal cancer patients with the inclusion of Tomosynthesis examination. Defining the role of Tomosynthesis and Computed Tomography in the imaging diagnostic algorithm of patients with laryngeal cancer.

**Scientific novelty and originality:** for the first time, the method of Tomosynthesis in the diagnosis of laryngeal cancer was implemented and appreciated.

**The scientific problem solved:** for the first time, the possibilities of examining patients with laryngeal cancer by the X-ray method, based on new digital technologies like Tomosynthesis, were studied. It has been shown that Tomosynthesis is clearly superior to Digital X-ray in the diagnosis of laryngeal cancer, and the results obtained by Tomosynthesis are largely comparable to those obtained by Computed Tomography.

**Theoretical significance:** the results obtained demonstrated the need to develop new methods of X-ray diagnosis, based on new digital technologies, which allow more accurate determination of the nature of the pathology examined by sectioned images and their reconstruction, using a lower irradiation dose for the patient.

**The applicative value of the work:** an X-ray diagnosis Algorithm of laryngeal cancer diagnosis was developed based on the method of Tomosynthesis, which can be implemented, from an economic and technical point of view, in peripheral medical institutions for early detection of laryngeal cancer by X-ray screening, because at the moment stages III-IV of laryngeal cancer constitute 80-85%.

**Implementation of the scientific results:** based on the results of the study, the Algorithm for X-ray diagnosis of laryngeal cancer was developed and published, also recommended for the screening of laryngeal cancer in risk groups. The procedure for performing Tomosynthesis in the examination of the larynx has been modified and patented.

## АННОТАЦИЯ

Жовмир-Попа Дорина

### ”Современные представления о рентгенологической диагностике рака гортани”

Докторская диссертация по медицинским наукам

Кишинев, 2024 г.

**Структура диссертации:** введение, 3 главы, общие выводы, практические рекомендации, библиография: 218 наименований, 109 страниц научного текста, 42 рисунка, 12 таблиц, 21 опубликованных работ.

**Ключевые слова:** рак гортани, рентгенодиагностика, Томосинтез.

**Область исследования:** медицинская рентгенология

**Цель исследования:** определение эффективности и роли цифрового Томосинтеза в обследовании пациентов с раком гортани, а также необходимости включения Томосинтеза в алгоритм визуализационной диагностики рака гортани.

**Цели исследования:**

1. Оценить полезность использования данных полученных при цифровом Томосинтезе у пациентов с раком гортани и их диагностическое значение .
2. Сравнительная оценка параметров изображения полученных при Томосинтезе, Цифровую Рентгенографию и Компьютерную Томографию пациентов с раком гортани и их статистическая обработка.
3. Совершенствование методики исследования Томосинтеза у больных раком гортани.
4. Разработка уникального алгоритма лучевой диагностике пациентов с раком гортани, включая обследование Томосинтезом. Определение роли методов Томосинтеза и Компьютерной Томографии в алгоритме диагностике пациентов с раком гортани с помощью рентгенологических методах.

**Новизна и научная оригинальность:** впервые реализован и оценен метод Томосинтеза в диагностике рака гортани.

**Решена научная задача:** впервые изучены возможности обследования больных раком гортани рентгенологическим методом, на основе новых цифровых технологий, Томосинтеза. Показано, что Томосинтез явно превосходит Цифровой Рентген в диагностике рака гортани, а результаты, полученные при Томосинтезе, во многом сопоставимы с результатами, полученными при Компьютерной Томографии.

**Теоретическая значимость:** полученные результаты продемонстрировали необходимость разработки новых методов рентгенодиагностики, основанных на новых цифровых технологиях, позволяющих более точно определять характер исследуемой патологии по секционным изображениям и их реконструкции, используя меньшую радиационную нагрузку для пациента.

**Прикладное значение работы:** был разработан Алгоритм рентгенодиагностики рака гортани на основе метода Томосинтеза, который может быть реализован с экономической и технической точек зрения в периферийных медицинских учреждениях для раннего выявления рака гортани методом рентгенологического скрининга, так как на данный момент III-IV стадии рака гортани составляют 80-85%.

**Внедрение научных результатов:** по результатам исследования разработан и опубликован Алгоритм рентгенологической диагностики рака гортани, рекомендованный также для скрининга рака гортани в группах риска. Методика выполнения Томосинтеза при исследовании гортани модифицирована и запатентована.

## **LIST OF ABBREVIATIONS**

<b>CT</b>	Computer Tomography
<b>DCC</b>	Diagnostic Consultative Center
<b>DR</b>	Digital Radiography
<b>ENT</b>	Ear Nose Throat
<b>FLS</b>	Fibrolaryngoscopy
<b>LC</b>	Laryngeal Cancer
<b>MRI</b>	Magnetic Resonance Imaging
<b>RCH</b>	Republican Clinical Hospital
<b>RDC</b>	Republican Diagnostic Center
<b>PET/CT</b>	Positron Emission Tomography / Computer Tomography
<b>SUMP</b>	State University of Medicine and Pharmacy
<b>TS</b>	Tomosynthesis
<b>USG</b>	Ultrasonography
<b>WHO</b>	World Health Organization

**JOVMIR-POPA, Dorina**

**CONTEMPORARY CONSIDERATIONS ON THE RADIOLOGICAL DIAGNOSIS OF  
LARYNX CANCER**

**324.01. Radiology and medical imaging**

**Summary of Doctor of Medical Sciences Thesis**

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**Approved for printing:**

**Paper size 60x84 1/16**

**Offset paper. Offset printing.**

**Edition            ex.**

**Printing sheets:**

**Order no. ....**

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