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Research Article

Oropharyngeal tumors: characteristics and computed tomography images value in the tumor staging. One-year study

[1]Mihaela Hedeșiu, [2]Oana Almășan, [1]Grigore Băciuț, [1]Vasile Pop, [1]Mihaela Băciuț, [1]Cristian Dinu

[1] Department of Maxillofacial Surgery and Implantology, Iuliu Hațieganu University of Medicine and Pharmacy, Cluj-Napoca, Romania; [2] Department of Prosthetic Dentistry and Dental Materials, Iuliu Hațieganu University of Medicine and Pharmacy, Cluj-Napoca, Romania.

Abstract. Objective: This study aimed to assess the prevalence and characteristics of oropharyngeal tumors in a patient group at a regional teaching hospital and to emphasize the value of imaging analysis in the diagnosis. Material and Method: We performed an observational, analytical, and retrospective study of the medical charts of patients with oropharyngeal tumors diagnosed in a regional university hospital. Results: A number of 43 patients aged between 42 and 77 years were enrolled. In terms of the size and extent, the predominant stage of the primary tumor (T) was T4, with a percentage of 60.46%, followed by stages T2 and T1 with percentage values of 20.93% and 16.27%, respectively; the fewest cases being T3 stage with a percentage of 2.32%. 5% of the subjects displayed tumor metastases. The most prevalent histopathological types of tumors were keratinized squamous cell carcinoma (56%) and non-keratinized squamous cell carcinoma (40%). Four patients (9.31%) had a perineural invasion. Conclusion: Our findings highlighted the fact that the pattern of the spread of oropharyngeal cancers is influenced by the tumor's origin and stage. A more thorough radiological report depends on the depiction of the critical anatomic regions' involvement.

Key Words: tumor; oropharynx; computed tomography (CT)

Corresponding Author: O. Almășan, email: oana.almasan@umfcluj.ro

Introduction

Oropharyngeal cancer has the sixth-highest cancer incidence globally, with squamous cell carcinoma accounting for more than 90% of it (Chimenos-Küstner et al 2019). Oropharyngeal cancer prevalence decreased annually (from 129.8 cases per 100,000 enrollees in 2012 to 88.5 cases per 100,000 enrollees in 2019), and its incidence decreased (51.4-37.6 cases per 100,000) (Tranby et al 2022).

Significant modifications in head and neck cancer staging have been proposed (Escrig Sos et al 2019), with important improvements to the TNM stages brought by the new 8th edition of the American Joint Committee on Cancer (AJCC)/International Union Against Cancer (UICC) staging classification system (Zanoni et al 2019).

There is a relationship between oropharyngeal cancer and Human Papilloma Virus (HPV) and Epstein-Barr Virus (EBV) (Migliaro et al 2022). It has been stated that human papillomavirus-derived circulating tumor DNA is a biomarker of p16-positive oropharyngeal cancer (Akashi et al 2022). Oropharyngeal cancer associated with the human papillomavirus, also known as p16-positive oropharyngeal cancer, is more common in young people and they are more likely to respond to radiotherapy even in patients with advanced-stage disease (Zanoni et al 2019). Therefore, separate staging systems are utilized for oropharyngeal cancers, with p16-positive tumors having a better prognosis than p16-negative oropharyngeal malignancies.

The physical examination in oropharyngeal cancers is frequently restricted to the assessment of palpable adenopathy and the surface evaluation of tumor extension, which frequently understages the spread of the tumors. Therefore, pretreatment staging and planning have become the standard of care for determining the pattern of tumoral spreading and distant metastasis.

MRI and CT are complementary for evaluating tumor size and loco-regional extension. Computed tomography is typically sufficient to delineate the primary tumor and bone invasion (Park et al 2021) On a non-contrast CT scan, oropharyngeal tumors had a similar attenuation to muscles and lymphoid tissue, making it difficult for the small tumors to be distinguished. CT evaluation is also limited by beam hardening artifacts from dental prosthetic reconstructions.

Even though CT frequently remains the first-line imaging modality, MRI is more reliable for early-stage tumor detection and recurrence surveillance providing a greater soft tissue contrast with far less dental amalgam artifact. The advanced MRI techniques as non-invasive magnetic resonance imaging (MRI) biomarkers may help predict disease behavior and patient outcomes (D'Urso et al 2022).

Computed tomography (CT) and positron emission tomography (PET) CT can be used as imaging tools in oropharyngeal cancer (Kowalchuk et al 2021). Single-photon emission computed tomography (SPECT CT) may aid in sentinel node (SN) identification of oral cancer (Karamchandani et al 2021).
Positron emission tomography (PET) computed tomography (CT) of the oral cavity and oropharyngeal cancers has a vital role in the staging, planning, and evaluation of treatment and has a significant advantage in the detection of nodal metastases and second primary malignancies (Marcus and Subramaniam 2022). PET CT as a standardized imaging protocol for head and neck oropharyngeal cancer is a reliable indicator of a disease's recurrence (Fatima et al 2022). It has been shown that PET CT is superior to triple endoscopy in detecting oropharyngeal squamous cell carcinoma (Muller et al 2022).
In the case of an oropharyngeal tumor, the spread patterns and the lymphatic drainage vary with the site of origin. Therefore, it's crucial to understand and accurately describe in the radiological report the invasion into the essential anatomical regions for tumors originating in the anterior tonsillar pillar, posterior tonsillar pillar, tonsillar fossa, soft palate, and tongue base (Glastonbury 2020).
This paper aimed at assessing the prevalence and imaging characteristics of oropharyngeal tumors in the patient group of a regional teaching hospital and emphasizing the key anatomic structures for staging oropharyngeal tumors.

Materials and methods

A clinical observational, analytical, and retrospective study was conducted. The inclusion criteria were patients hospitalized between 2018-2019 at the Cluj-Napoca Regional Hospital for Emergency Care, diagnosed with oropharyngeal malignant tumors. The exclusion criteria were the absence of a malignant oropharyngeal tumor, refusal to retrieve medical records, the impossibility of performing radiological examinations, patients with incomplete data, no imaging of the tumor structures or its extension, lack of histopathologic examination, and benign tumors.
CT examination of the head and neck area was performed with sections parallel to the infraorbital plane, with a thickness of 2-3 mm in the axial plane with intravenous contrast administration. Coronal sections were indicated for evaluating the tumoral spreading to the skull base and palate invasion. Chest CT images were used for the evaluation of distant metastasis. The CT images with important dental-related artifacts have been excluded.
The fundamental structures for the origin of oropharyngeal tumors were as follows: base of tongue (posterior to circumvallate papillae or posterior third), tonsillar fossa, glossotonsillar sulcus, tonsillar (faucial) pillars, vallecula, and soft palate.
The evaluated subjects were divided into five categories based on the involvement of local lymph nodes (N) (Zanoni et al 2019). Distant metastases were evaluated for all patients on CT examination.

Results

A total number of charts of 43 patients aged between 42 and 77 years were studied. Thirty-eight patients were males (88%), and 5 patients were females (12%). Twenty-three patients (53.48%) were over the age of 60, fifteen (34.88%) were between the ages of 51 and 60, and five (11.62%) were under the age of 50. A number of twenty-four patients (55.81%) had keratinized squamous cell carcinoma: seventeen had keratinized squamous cell carcinoma G2 (39.53%); seven had keratinized squamous cell carcinoma G1 (16.27%); nine had non-keratinized squamous cell carcinoma G3 (20.93%); 8 had non-keratinized squamous cell carcinoma G2 (18.60%) and two had B cell lymphoma. All patients included were p16 (HPV)-negative. Four patients (9.31%) had a perineural invasion. Perineural spread only occurred in two patients.
In the group of studied patients, the predominant stage in terms of the size and extent of the primary tumor (T) was T4, with a percentage of 60,46%, followed by stages T2 and T1, with percentage values of 20,93% and 16,27%, respectively. The fewest cases were part of the T3 stage with a percentage of 2,32%. Lymph nodes involvement stage N2b had the second-highest preponderance with a percentage of 33%, followed by category N0, 40%. The other three stages were present in percentages with similar values: N2c-14 %, N1-9 %, and N3-5 %. The presence of metastases was the third factor in tumor staging (M). Only 5% of the subjects displayed metastases, with the remaining 95% demonstrating their absence.
Regarding the tumors' origin, CT imaging could establish various situations: tumors located in the anterior tonsillar pillar (Figure 1), tonsillar fossa (Figure 2), soft palate (Figure 3), the posterior tonsillar pillar (Figure 4), tongue base (Figure5) and glossotonsillar sulcus (Figure 6).
The spread patterns of tumors according to their origin are indicated in Table 1.

Discussion

Demographic and epidemiological considerations
The patients selected in the study were between 42 and 77 years old, of which the majority of subjects with oropharyngeal cancer were over 60 years of age, namely 52%. It has been found that the rate of oropharyngeal cancer increases with age, with a higher growth after the age of 50, reaching the peak in the 60-70 years range (National Cancer Institute, DCCPS, Surveillance Research 2022).
A study from Brazil reported the results of 344 patients, showing main tumor locations of the oropharynx in 72 cases (20.9%), hypopharynx in 13 cases (3.8%), and the other sites being the oral cavity and the larynx. TNM clinical stage I tumors was present in 61 patients, 17.7%; stage II tumors in 80 patients, 23.3%; stage III tumors in 115 patients, 33.4%; and stage IV tumors in 88 patients, 25.6 % (Vartanian et al 2004). Most patients in our study were in advanced stages: stage IV (60.46%) and stage T3 (2,32%), illustrating that oropharyngeal cancer patients visit medical facilities when the disease is more advanced, and there are fewer available therapeutic options.
Considering the World Health Organization (WHO) classification's definitions (International Agency for Research on Cancer 2022) highlighted two main types of carcinomas for the histopathological classification: keratinized squamous cell carcinoma, which is entirely composed of mature squamous cells, and non-keratinized squamous cell carcinoma, which consists of immature tumor cells arranged in layers (Fujimaki et al 2013). In our study, the most prevalent histopathological types of tumors

Table 1. The pattern of tumor spread according to the origin and stage of oropharyngeal tumors[α]

The pattern of tumor spread	Origin of the tumor					
	anterior tonsillar pillar	tonsillar fossa	posterior tonsillar pillar	soft palate	base of the tongue	glosso-tonsillar sulcus
Soft palate	T1, T2, T3, T4	T2, T3, T4	T1, T2, T3, T4	T1, T2, T3, T4	T1, T2, T3, T4	T1, T2, T3, T4
Tonsillar fossa	T1, T2, T3, T4	T1, T2, T3, T4	T2, T3, T4	-	T3, T4	T1, T2, T3, T4
Base of tongue	T3, T4	T3, T4	T3, T4	T4	T1, T2, T3, T4	T1, T2, T3, T4
Glosso-tonsillar sulcus	T3, T4	T3, T4	T3, T4	T4	T2, T3, T4	T1, T2, T3, T4
Tongue muscle	T4	T4	T4	T4	T4	T4
Retromolar trigone	T4	T4	T4	-	T3, T4	T4
Pterygomandibular raphe	T4	T4	T4	T4	T4	T4
Hard palate	T4	T4	T4	T4	T4	-
Skull base	T4	-	-	T4	-	-
Mandibular jaw	T4	T4	-	-	T4	T4
Preveretebral space	-	T2, T3, T4	T4	T4	T4	-
Parapharyngeal space ± ICA[β]	T2, T3, T4	T3, T4	T4	T4	T4	-
Nasopharynx	T4	T4	-	T4	T4	-
Vallecula	T3, T4	T3, T4	T3, T4	-	T3, T4	-
Supraglottic larynx	-	T4	T4	-	T4	-

α- according to American Joint Committee on Cancer (AJCC) TNM system (Zanoni et al 2019), βICA - internal carotid artery;

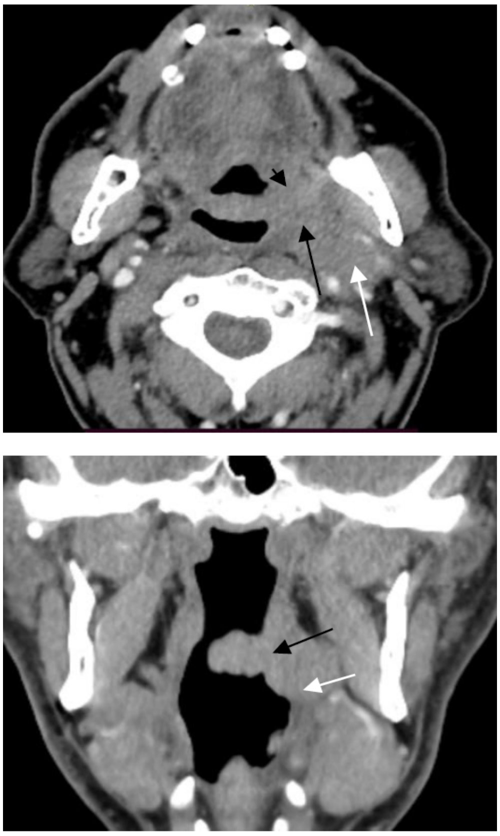


Figure 1. Squamous cell carcinoma of the left anterior tonsillar pillar a. axial CT image demonstrates the enlargement of the left anterior tonsillar pillar (small black arrow) and an enhancing mass into the tonsillar fossa with the parapharyngeal space invasion (large black arrow); b. coronal CT image shows the left anterior tonsillar pillar tumor a level II adenopathy with the encasement of the left internal carotid artery (large white arrow)

Figure 2. Tonsillar fossa tumor (large black arrow) with tongue base invasion(small black arrow) and posterior spread into prevertebral (large white arrow) and parapharyngeal space (small white arrow).

were keratinized squamous cell carcinoma, which was present at 55.81% (G1 and G2), and non-keratinized squamous cell carcinoma, which was present at a percentage of 39.53% (G2 and G3). The degree of differentiation with mitotic activity plays a key role and is illustrated by whether or not these lesions are keratinized. Studies in the literature have shown that the degree of differentiation has a low prognostic value because most oral squamous cell carcinomas are only moderately differentiated (Jerjes et al 2010).

Tumoral spreading pattern

Tumors from the anterior tonsillar pillars spread along the palatoglossus muscle to the hard palate. Another route through which tumors can spread towards the base of the skull is along

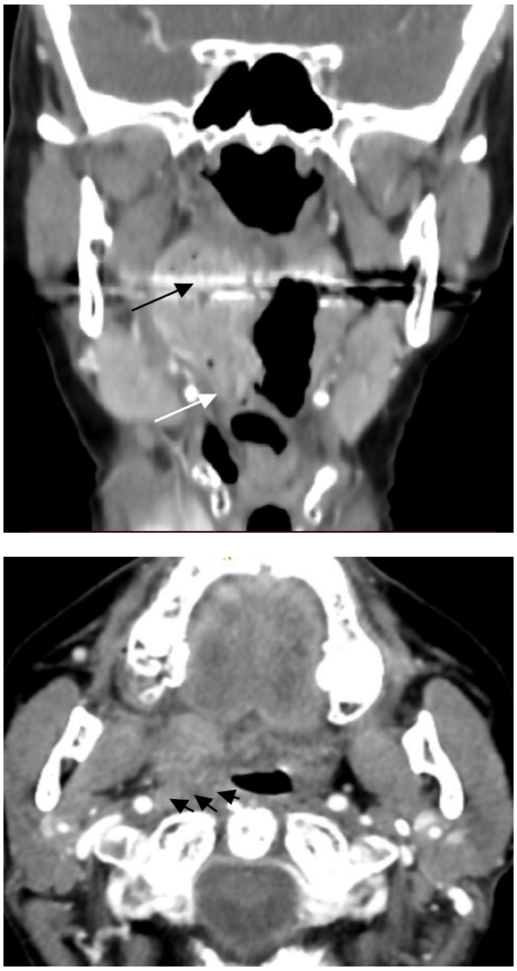


Figure 3. Squamous cell carcinoma of the soft palate a. coronal CT scan shows an enhancement mass of the soft palate (large black arrow) and demonstrates the tumoral spread into the right vallecula (large white arrow); b. axial contrast-enhanced CT image shows a soft palate tumor with invasion into parapharyngeal space and prevertebral space (small black arrows); the internal carotid artery encases the right side.

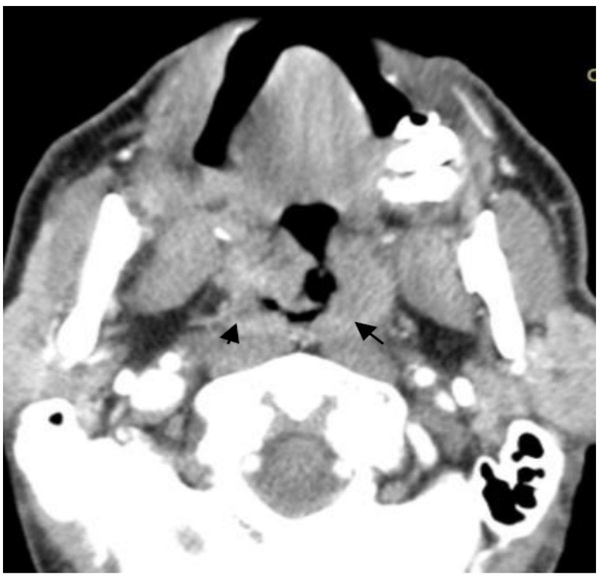
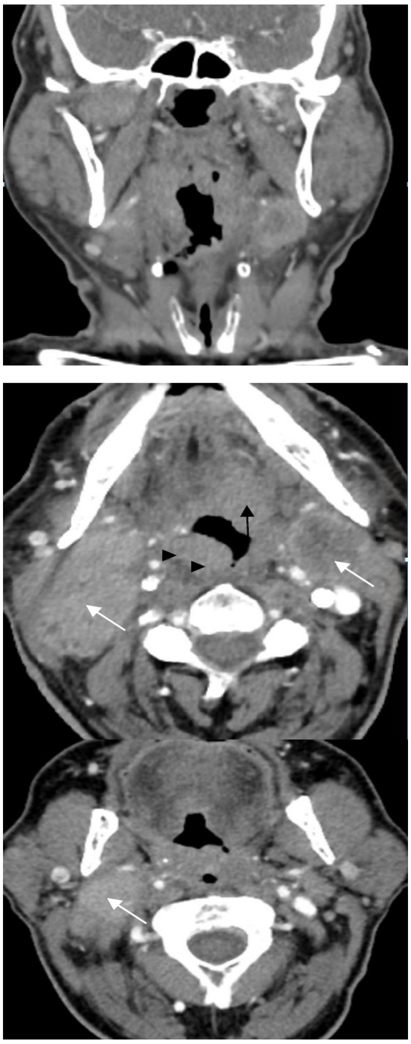


Figure 4. Axial contrast-enhanced CT scan through the oropharynx demonstrates a bilateral enlargement of the soft palate and posterior tonsillar pillars (small black arrows).

a



b

Figure 5. Contrast-enhanced CT scan in a patient with oropharyngeal squamous cell carcinoma; a. axial CT scan shows tumoral infiltration of the soft palate (small black arrows); b. on sagittal CT scan tumor infiltration of the tongue base is better depicted (large black arrows); c. the bilateral spread of the tumor with infiltration of the soft palate is demonstrated on coronal CT image; malignant adenopathy with necrosis on the left level II group of lymph nodes d. axial CT scan: base of the tongue with the involvement of the lingual neurovascular bundle on the left side and bilateral infiltrative lymph nodes with carotid artery involvement (large white arrows).

Figure 6 Squamous cell carcinoma of glossotonsillar sulcus a. Axial CT scan depicted spread into the retromolar trigone (small arrows); b. the figure also reveals the measurement of the depth of invasion (DOI) on the right base of the tongue.

the medial pterygoid and palatal levator muscles. If oropharyngeal tumors infiltrate the nasopharynx, they can be confused with the tumors arising from the nasopharynx. A possible differentiation could be done if the tumor spreads bilaterally; it is more likely to originate from the nasopharynx. Tumors of the anterior tonsillar pillar invaded into the pterygomandibular raphe can mimic a retromolar trigone tumor.

Tumors of the posterior tonsillar pillar spread inferiorly and involved the pharyngo-epiglottic fold.

In the case of tumors of the base of the tongue, CT examination revealed the involvement of the following particular anatomic structures: tonsillar pillars, glossotonsillar sulcus, submandibular space, and the inferior submucosally spread into vallecula and supraglottic area. In patients that were a candidate for partial glossectomy, MRI non-contrast T1-weighted images helped determine whether the tumor has crossed the midline.

Evaluation of the tumor's size and depth of invasion (DOI) is a crucial component of staging for tongue base carcinoma. Preepiglottic space involvement was noted in tumors that spread inferiorly into the supraglottic larynx. The large oropharyngeal tumors extended into the parapharyngeal space also affected the internal carotid artery.

The following pattern of tumoral spread was present in cancers of the tonsillar fossa: anterior extension to the anterior tonsillar pillar, glossotonsillar sulcus, and base of the tongue; lateral invasion into the masticatory space and retromolar trigone; posterior involvement of the posterior tonsillar pillar and the inferior spread towards vallecula and suprahyoid structures. The advanced tonsillar carcinoma affected the prevertebral space and invaded the parapharyngeal and skull base.

The malignancies of the soft palate were better observed on coronal CT contrast-enhanced CT scans. Also, the invasion of the hard palate and skull base was present in large tumors.

Perineural invasion can be seen as a separate pathological entity without lymphatic or vascular invasion. This could be the only metastatic spread from the tumor or its distant source. Squamous cell carcinoma with perineural invasion is thought to have a poor prognosis (Ong 2010). In this study, nine percent of the patients had perineural invasion, and 91% did not. The term "spread" identifies a persistent neoplastic extension along the nerve. Imaging is critical to determining the extent of perineural infiltration in malignant head and neck diseases because it can be clinically silent (Medvedev et al 2021). The perineural spread is a significant prognostic indicator in staging head and neck cancers.

A severe prognosis is associated with the extension of the perineural tumor, including a nearly threefold increase in the likelihood of local recurrence and a 30 % drop in survival over five years (Ong 2010). In our study group, only a little percentage of 5% of subjects had perineural tumor spread.

A systematic review, including ninety-four patients from 50 publications, showed that oropharyngeal carcinomas occurred more frequently in male patients, 73.4% (Froehlich et al 2022). This result follows the results found in this study, where we encountered 88% males.

One of the most significant parameters in determining a patient's prognosis is the staging of cervical lymphadenopathy (Yuasa et al 2000). It is not possible to decide on whether lymph nodes are involved in head and neck cancer from a clinical examination alone. Current imaging scans show only sufficiently large metastases (Pouymayou et al 2019). Over 20% of patients who palpate their necks have hidden neck metastases, according to some authors' research (Carvalho et al 2000). Sentinel lymph node biopsy is considered to be a suitable method for finding undetected metastases (Suárez-Ajuria et al 2021). The value of deep learning in identifying benign and metastatic cervical lymph nodes has been described using pre-treatment contrast-enhanced computed tomography (Tomita et al 2021).

Imaging examinations may offer essential details for the correct staging of oral cancer patients, including the depth or extent of the invasion, bone invasion, and evaluation of local lymph nodes. Computed tomography (CT) is a widespread imaging method for head and neck tumors because it is more accessible and less expensive. In addition to examining functional imaging of the larynx and hypopharynx in both the transverse and coronal planes, multislice spiral CT (MSCT) helps to establish the critical connections between tumor and lymph node metastases (Baum et al 2000). In this study, CT was the primary imaging technique for the supplementary evaluation of patients with tumors.

Radiological examinations determined the precise location of the tumors, relationship with the nearby anatomical structures, and involvement of the lymph nodes in the shown clinical cases. Noticing the diverse spread patterns, invasion of several clinical structures, and perineural extension tumors in the head and neck region require a multidisciplinary approach (Andreassen et al 2022, Coke et al 2022, Matos and Cernea 2022).
The strengths of this study rely on highlighting that CT is essential for the identification and follow-up of cancer patients. Also, the imaging features of the contrast-enhanced CT images showed the tumoral origin and spread, and the depth of invasion and adenopathy involvement.

Conclusions

Imaging radiological techniques are essential to making a conclusive diagnosis and offering the best care for patients with oropharyngeal tumors. Our work brought attention to the fact that the pattern of the spread of oropharyngeal cancers is influenced by the tumor's origin and stage. MSCT is considered a standard imaging approach in staging oropharyngeal malignancies. A more thorough radiological report depends on the depiction of critical anatomic regions' involvement.

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Authors

•Mihaela Hedeșiu, Department of Maxillofacial Surgery and Implantology, Iuliu Hațieganu University of Medicine and Pharmacy, 37 Cardinal Iuliu Hossu Street, 400006 Cluj-Napoca, Romania, email: mhedesiu@gmail.com

•Oana Almășan, Department of Prosthetic Dentistry and Dental Materials, Iuliu Hațieganu University of Medicine and Pharmacy, 32 Clinicilor Street, 400006 Cluj-Napoca, Romania, email: oana.almasan@umfcluj.ro

•Grigore Băciuț, Department of Maxillofacial Surgery and Implantology, Iuliu Hațieganu University of Medicine and Pharmacy, 37 Cardinal Iuliu Hossu Street, 400006 Cluj-Napoca, Romania, email: gbaciut@umfcluj.ro

•Vasile Pop, Department of Maxillofacial Surgery and Implantology, Iuliu Hațieganu University of Medicine and Pharmacy, 37 Cardinal Iuliu Hossu Street, 400006 Cluj-Napoca, Romania, email: vasi_pop75@yahoo.com

•Mihaela Băciuț, Department of Maxillofacial Surgery and Implantology, Iuliu Hațieganu University of Medicine and Pharmacy, 37 Cardinal Iuliu Hossu Street, 400006 Cluj-Napoca, Romania, email: mbaciut@umfcluj.ro

•Cristian Dinu, Department of Maxillofacial Surgery and Implantology, Iuliu Hațieganu University of Medicine and Pharmacy, 37 Cardinal Iuliu Hossu Street, 400006 Cluj-Napoca, Romania, email: dinu_christian@yahoo.com

Citation	Hedeșiu M, Almășan O, Băciuț G, Pop V, Băciuț M, Dinu C. Oropharyngeal tumors: characteristics and computed tomography images value in the tumor staging. One-year study. HVM Bioflux 2022;14(3):124-130.
Editor	Antonia Macarie
Received	24 July 2022
Accepted	23 August 2022
Published Online	30 September 2022
Funding	None reported
Conflicts/ Competing Interests	None reported