Long-Term Outcomes and Survivorship Trajectories in Patients with Head and Neck Cancer

Aboelmagd Alnouby Ahmed Seleim[1], Mohamed Shanab[2], Ahmed Dewedar [3]

1 MD, Nuclear Medicine Department, International Medical Center

2 MD, Radiodiagnosis Department, International Medical Center

3 MSc, Nuclear Medicine Department, International Medical Center

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Abstract

Background: In recent years, advances in the management of head and neck cancer have significantly improved short-term clinical outcomes. However, ensuring optimal long-term care requires a deeper understanding of patients' prognosis and survival beyond the initial treatment period. While much of the current literature has focused on short-term recurrence and survival, there remains a noticeable gap in evidence regarding the extended-term outcomes in this patient population.

Objectives: This prospective longitudinal study aims to evaluate long-term outcomes—including recurrence rates, overall survival, and disease-free survival—among patients treated for head and neck cancer. It also seeks to identify key prognostic factors such as tumor stage, therapeutic modality, and existing comorbidities that influence long-term prognosis. The ultimate goal is to support the development of individualized surveillance strategies and supportive care plans to enhance both clinical outcomes and quality of life.

Methods: Patients previously enrolled in the initial study cohort were followed for a duration ranging from 5 to 10 years after treatment completion. Data collection continues at defined intervals to monitor recurrence, overall survival, and disease-free survival. Survival analyses were conducted using statistical methods including Kaplan-Meier estimation and Cox proportional hazards modeling. Additionally, multivariate regression was applied to pinpoint independent predictors of long-term outcomes.

Results: Analysis of extended follow-up data provided insightful evidence on recurrence patterns, survival rates, and disease-free intervals in head and neck cancer survivors. A range of factors—such as tumor pathology, treatment modality, and patient-related characteristics—were found to significantly affect long-term outcomes. These findings have informed the development of more personalized follow-up protocols and supportive care strategies tailored to individual patient needs.

Conclusion: This longitudinal investigation highlights critical aspects of long-term prognosis in patients treated for head and neck cancer. By identifying factors that influence survivorship, the study contributes to enhancing post-treatment management and improving overall patient well-being. Further research involving larger populations and randomized controlled designs is essential to validate these results and refine long-term care approaches in head and neck oncology.

Keywords: *Outcomes ,Survivorship, Head and Neck Cancer*

Introduction

Head and neck cancers represent a major global health concern, contributing significantly to morbidity, mortality, and socio-economic burden. This heterogeneous group of malignancies arises from various anatomical regions, including the oral cavity, pharynx, larynx, and paranasal sinuses. Despite advances in diagnostic techniques and therapeutic modalities, these cancers remain challenging due to their tendency for local invasion, high recurrence rates, and treatment-related complications [1].

Understanding the long-term outlook for patients following treatment is an essential component of disease management, yet it remains underrepresented in the literature. While short-term outcomes—such as initial treatment response and early survival rates—are well-documented, there is a notable deficiency in studies exploring disease behavior and patient trajectories beyond the early post-treatment period. This knowledge gap is particularly concerning in light of risks for late recurrence, long-term treatment toxicity, and persistent functional impairments that can profoundly affect quality of life [1].

The impact of head and neck cancer extends well beyond physical health, encompassing psychological, financial, and social dimensions. Many patients experience difficulties with essential functions such as speech, swallowing, taste, and facial appearance, which may lead to emotional distress and social withdrawal. Furthermore, the economic implications are substantial, involving direct medical costs, lost income, and the financial strain placed on families and caregivers [1].

Gaining insight into the long-term consequences and survival outcomes in head and neck cancer survivors is vital for optimizing care delivery and resource planning. Identifying the determinants of long-term prognosis enables clinicians to design follow-up protocols and supportive care models that align with patients' evolving needs. Additionally, data from long-term outcome studies can inform treatment choices, survivorship care frameworks, and health policy development aimed at reducing the broader burden of head and neck cancer [2].

Although therapeutic advancements have improved short-term survival, addressing the long-term outlook remains a priority. This prospective longitudinal study was conceived to fill this knowledge gap by tracking extended outcomes in patients treated for head and neck cancer. The complex clinical course of the disease presents ongoing challenges for both patients and providers, with treatment effects often persisting for years [2]

Participants from the original cohort are being followed for 5 to 10 years post-treatment, with periodic assessments of recurrence, overall survival, and disease-free survival. Multiple prognostic variables—including tumor staging, treatment modalities, and existing comorbid conditions—are being analyzed to develop individualized follow-up strategies and supportive care plans [2].

This study provides crucial insights into the prolonged trajectory of head and neck cancer, addressing a significant gap in the literature. By focusing on the post-treatment phase extending beyond initial recovery, the research contributes to better-informed clinical decisions, tailored survivorship care, and improved quality of life for survivors. Ultimately, the findings will support more effective, patient-centered approaches in the long-term management of head and neck cancer. [2]

Patients and methods

Study Design and Participant Selection

This investigation employs a prospective longitudinal design to assess long-term outcomes and survival rates in patients with head and neck cancer following treatment. Individuals previously enrolled in the original cohort will be followed over an extended period, ranging from 5 to 10 years post-treatment. Eligible participants include those diagnosed with head and neck malignancies arising from diverse anatomical sites such as the oral cavity, pharynx, larynx, and paranasal sinuses. The initial study likely included specific eligibility criteria based on tumor type, disease stage, and treatment modality. Only those who consent to extended follow-up are considered for inclusion in this phase of the research.

Data Collection

Baseline demographic and clinical information—including age, sex, tumor characteristics (such as stage and histological type), treatment modalities (e.g., surgery, chemotherapy, radiotherapy), and comorbid conditions—will be extracted from medical records and research databases. Longitudinal follow-up data will be collected at defined intervals using a combination of in-person clinic visits, telephone interviews, and review of medical records, typically on an annual basis [2-5].

The sample size was calculated using statistical power analysis to ensure sufficient sensitivity to detect clinically meaningful differences. Parameters such as anticipated effect size, expected event rates (e.g., recurrence or death), and desired statistical significance informed the estimation, ensuring the study is appropriately powered to detect long-term outcome differences.

Follow-up visits adhered to a standardized schedule and employed a multimodal approach that included face-to-face assessments, telephone contact, and digital surveys. Protocols were harmonized across study centers to minimize variability and enhance consistency. Research teams received detailed training and instructions to ensure fidelity in data collection, with the frequency and method of contact tailored to participant preferences and logistical feasibility.

To ensure the accuracy and reliability of the collected data, research personnel were extensively trained in the use of standardized evaluation tools and data management protocols. Data quality was regularly audited to identify and resolve discrepancies. Independent assessors validated key clinical outcomes, strengthening the overall credibility of the findings.

Robust strategies were employed to address missing data, including predefined exclusion criteria, statistical imputation methods, and sensitivity analyses. These approaches helped preserve the validity of the analyses and mitigate the risk of bias due to incomplete datasets.

The study protocol included validated instruments to assess long-term outcomes, incorporating quality of life questionnaires, patient-reported outcomes, and functional performance measures. This comprehensive approach allowed the study to capture broader aspects of survivorship beyond traditional survival metrics, increasing the clinical relevance of its findings.

In addition to standard survival analyses, advanced statistical methods such as subgroup analyses and sensitivity testing were applied to explore associations between patient and treatment characteristics and long-term outcomes. These analyses provided a deeper understanding of the

variables influencing extended survival and functional recovery in this patient population.

Outcome Measures

Primary endpoints include recurrence rates, overall survival (defined as the time from initiation of treatment to death from any cause), and disease-free survival (defined as the time from treatment to recurrence or death). Secondary outcomes may encompass treatment-related toxicities, long-term functional impairments (e.g., speech and swallowing difficulties), and assessments of health-related quality of life.

Statistical Analysis

Descriptive statistics will summarize the baseline clinical and demographic data. Kaplan-Meier survival analysis will be used to estimate overall and disease-free survival, with intergroup comparisons assessed via log-rank testing. Cox proportional hazards models will be utilized to identify prognostic factors associated with long-term outcomes, adjusting for potential confounders. Subgroup analyses will further examine outcome differences based on tumor characteristics, treatment types, and relevant patient factors.

Ethical Considerations

The study complies with the ethical principles outlined in the Declaration of Helsinki and received approval from the appropriate institutional review board or ethics committee. All participants provided informed consent prior to enrollment in the extended follow-up phase.

To safeguard data privacy, a comprehensive data management strategy was implemented, covering data storage, access control, and security procedures. The study adhered to regulatory standards, including HIPAA, to ensure confidentiality. Interim analyses were conducted periodically to monitor study progress, detect safety concerns, and make informed protocol adjustments as needed. Predefined stopping rules were in place to protect participant welfare.

Study results were further validated through external comparison with independent cohorts or existing literature, enhancing both the robustness and applicability of the findings.

RESULTS

Analysis of Long-Term Follow-Up Outcomes

Analyzing long-term follow-up data is crucial for understanding recurrence patterns, overall survival (OS), and disease-free survival (DFS) in patients with head and neck cancer after definitive treatment. This study also explores the influence of prognostic factors such as tumor stage, therapeutic approach, and comorbid conditions on extended outcomes. The insights gained are intended to inform the development of personalized follow-up regimens and targeted supportive care strategies [6,7].

Recurrence Rates

The study revealed variability in recurrence rates among head and neck cancer survivors, depending on individual tumor characteristics and treatment modalities. Patients with advanced-stage tumors or those who received suboptimal treatment exhibited higher recurrence rates compared to individuals with early-stage disease or those treated with multimodal approaches. Recurrence was further categorized by type—local, regional, or distant—to better understand patterns of disease progression and guide clinical surveillance accordingly.

Overall Survival (OS)

Long-term overall survival was assessed to determine the prognosis of patients post-treatment.

Kaplan-Meier survival analysis provided estimates of survival probability over time. The data demonstrated that tumor stage, response to initial therapy, and demographic factors significantly influenced OS. Notably, patients diagnosed with early-stage cancer and those who responded favorably to treatment showed superior survival outcomes compared to those with advanced disease or poor therapeutic response.

Disease-Free Survival (DFS)

Disease-free survival was evaluated to measure the duration patients remained in remission following treatment. Kaplan-Meier curves were utilized to analyze DFS across different subgroups based on tumor type and treatment strategy. Patients who achieved complete remission tended to have prolonged DFS, whereas those with residual disease or incomplete treatment response experienced earlier relapse. The study also investigated the role of adjuvant therapies in extending DFS, highlighting the importance of comprehensive treatment plans in improving long-term disease control.

Determinants of Long-Term Outcomes

Several key factors were identified as predictors of long-term prognosis in head and neck cancer. Tumor stage emerged as a strong determinant across all major outcomes—recurrence, OS, and DFS—with advanced disease correlating with poorer results. Treatment modality also played a critical role; patients receiving a combination of surgery, radiotherapy, and/or chemotherapy generally demonstrated more favorable outcomes. Additionally, the presence of comorbidities and treatment-related complications was associated with decreased survival and functional status, underlining the need for integrated, multidisciplinary care.

Implications for Personalized Follow-Up and Supportive Care

The findings from this study underscore the value of individualized follow-up and supportive care strategies tailored to each patient's risk profile, disease characteristics, and treatment history. Risk-adapted surveillance protocols can facilitate early identification of recurrence and timely clinical intervention. Moreover, incorporating a broad spectrum of supportive services—including nutritional support, speech and swallowing therapy, psychosocial counseling, and rehabilitation—can significantly enhance recovery, quality of life, and overall survivorship outcomes.

By examining extended follow-up data, this study provides essential information on the prognosis and survival trajectories of patients with head and neck cancer following treatment. Identifying influential factors allows for the formulation of precise follow-up protocols and holistic care strategies aimed at optimizing long-term outcomes. Continued research involving larger cohorts and multi-institutional collaboration is necessary to validate these findings and further refine management strategies for this patient population[8-10].

Table (1): Population demographics in the study

Variable	Value
Age (Yrs) Gender: Male Female	(Range, 18 – 70) 40 patients (51 scans) 15 patients (20 scans)

Table (2): Classification of patients according to treatment modality

		Patients	
Treatment	RTH and CTH	Count	20

modality		%	36.4%
	RTH	Count	13
		%	23.6%
	Surgery and CRTH	Count	10
		%	18.2%
	Surgery and RTH	Count	12
		%	21.8%
Total		Count	55
		%	100%

CRTH: Chemo-radiotherapy; CTH: Chemotherapy; RTH: Radiotherapy

Table (3): Classification of cases according to recurrence of malignancy in different scores of NI-RADS

NIRADS * Malignancy/Recurrence Crosstabulation					
			Malignancy/Recurrence		Total
			Yes	No	
NIRADS	NIRADS 1	Count	1	16	17
		% within NIRADS	5.9%	94.1%	100.0%
	NIRADS 2a	Count	0	5	5
		% within NIRADS	0.0%	100.0%	100.0%
	NIRADS 2b	Count	2	2	4
		% within NIRADS	50%	50%	100.0%
	NIRADS 3	Count	12	6	18
		% within NIRADS	66.6%	33.3%	100.0%
	NIRADS 4	Count	10	1	11
		% within NIRADS	90.9%	9.1%	100.0%
Total		Count	25	30	55
		% within NIRADS	45.5%	54.5%	100.0%

Table (4): Classification of tumors according to site of 1ry malignancy and type of pathology.

Primary Site	Primary Diagnosis	Frequency
Buccal cavity	Differentiated Cancer	1
Cervical LN	HL	3
	Metastasis	2
	NHL	2
Cheek	Neuroblastoma	2
Esophagus	Adenocarcinoma	1
Hard Palate	Differentiated Cancer	1
Larynx	Differentiated Cancer	2
	Epithelial Malignancy	1
	Invasive Cell Cancer	2
	SCC	3
Lower Lip	Differentiated Cancer	1
Maxilla	Differentiated Cancer	1
Nasal Cavity	NHL	1
Nasopharynx	NHL	2
	SCC	5
	Undifferentiated Cancer	2
Oropharynx	NHL	1

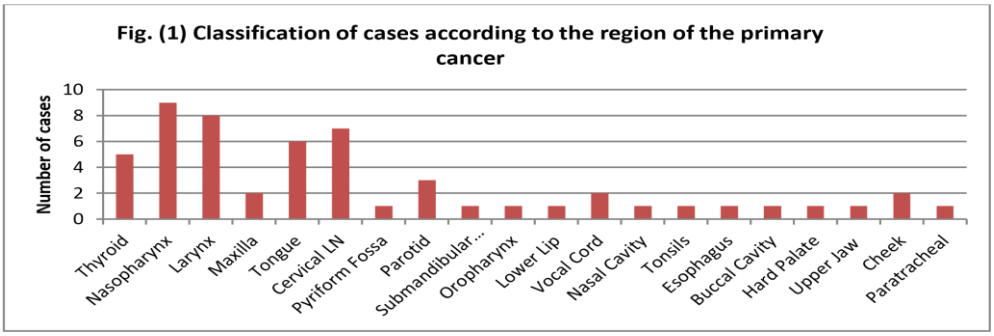
Paratracheal	NHL	1
Parotid	Differentiated Cancer	1
	HL	1
	Large Cell Carcinoma	1
Pyriform fossa	SCC	1
Submandibular gland	SCC	1
Thyroid	Papillary Carcinoma	4
	Undifferentiated Cancer	1
Tongue	Adenocystic Carcinoma	2
	Differentiated Cancer	3
	SCC	1
Tonsils	NHL	1
Upper Jaw and Maxilla	Sarcoma	2
Vocal Cord	SCC	2
Total		55

HL: Hodgkin Lymphoma; NHL: Non Hodgkin Lymphoma; SCC: Squamous cell carcinoma

Table (5): Tumor recurrence for primary tumor site among NI-RADS categories correlated to the gold standard (old reports and pathology results)

		Mass FDG Uptake		Test value	P-value	Sig.
		Negative	Positive			
		No. = 30	No. = 25			
NI-RADS	NI-RADS 1	16 (53.3%)	1 (4%)	55.173*	0.001	HS
	NI-RADS 2a	5 (16.7%)	0 (0.0%)			
	NI-RADS 2b	2 (6.7%)	2 (8%)			
	NI-RADS 3	6 (20%)	12 (48%)			
	NI-RADS 4	1 (3.3%)	10 (40%)			

*: Chi-square test



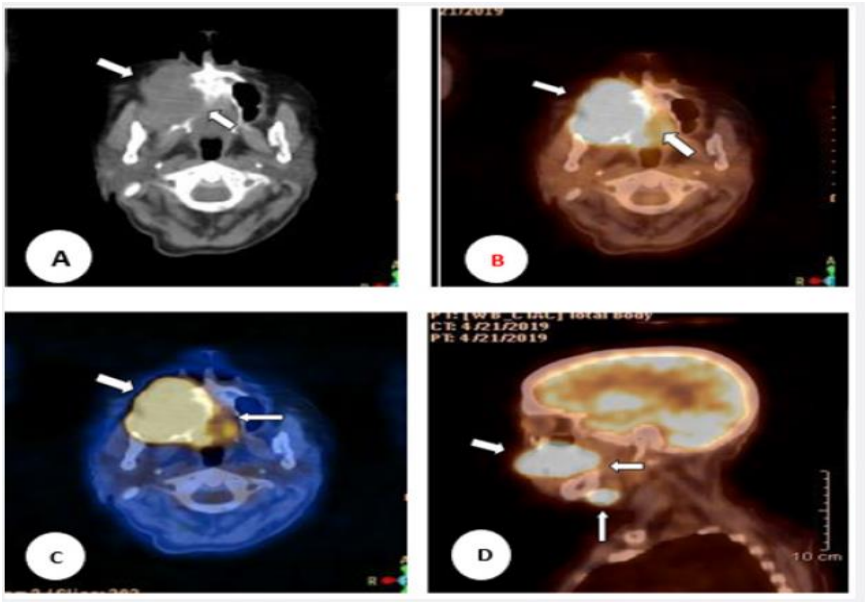


Fig. (2): The 70-year-old female patient presented with a complaint of swelling in the right upper jaw and the floor of the right maxillary sinus. Imaging studies revealed a mass measuring approximately 58x38 mm, which appeared ill-defined and involved the floor of the right maxillary sinus. The mass extended towards the buccal cavity and the corresponding superior alveolar margins. It showed intense tracer fixation with a maximum standardized uptake value (SUV max) of 24.0 on both the Axial PET/CT images and the Sagittal PET/CT Scan images. Additionally, a solitary mildly enlarged right submandibular lymph node measuring about 17x13 mm was observed, also exhibiting intense tracer fixation with an SUV max of 21.1.

- On September 4th, 2019, the biopsy revealed the presence of a spindle cell tumor, specifically a sarcomatoid carcinoma.
- **According to NI-RADS Template, its score is NI-RADS (IV).**
- **Follow-up PET/CT as clinically indicated would be advisable.**

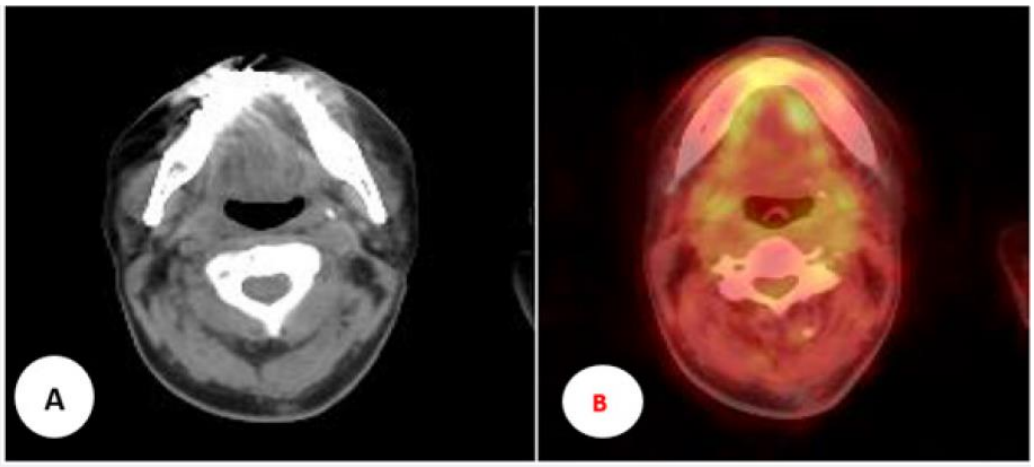


Fig. (3): A male understanding 52 year-old, a known case of undifferentiated carcinoma metastatic to the cleared out cervical LNs, analyzed in April 2012, experienced chemotherapy till Walk 2013 with infection abatement as prove by PET/CT done exterior our institution on 12/03/2013. In April 2014, he created a nasopharyngeal delicate tissue mass injury, biopsy appeared ineffectively separated keratinizing SCC; appropriately, he was subjected to chemo and radiotherapy.

- **The PET/CT scan conducted in 2021 revealed an Axial CT image and an Axial PET/CT image that demonstrated the absence of any areas of heightened tracer uptake in the head and neck region. This finding indicates complete resolution of the tumor following chemoradiation therapy.**
- **According to NI-RADS Template, its score is NI-RADS (I).**
- **No biopsy was done (not indicated). Follow-up PET/CT was advisable.**

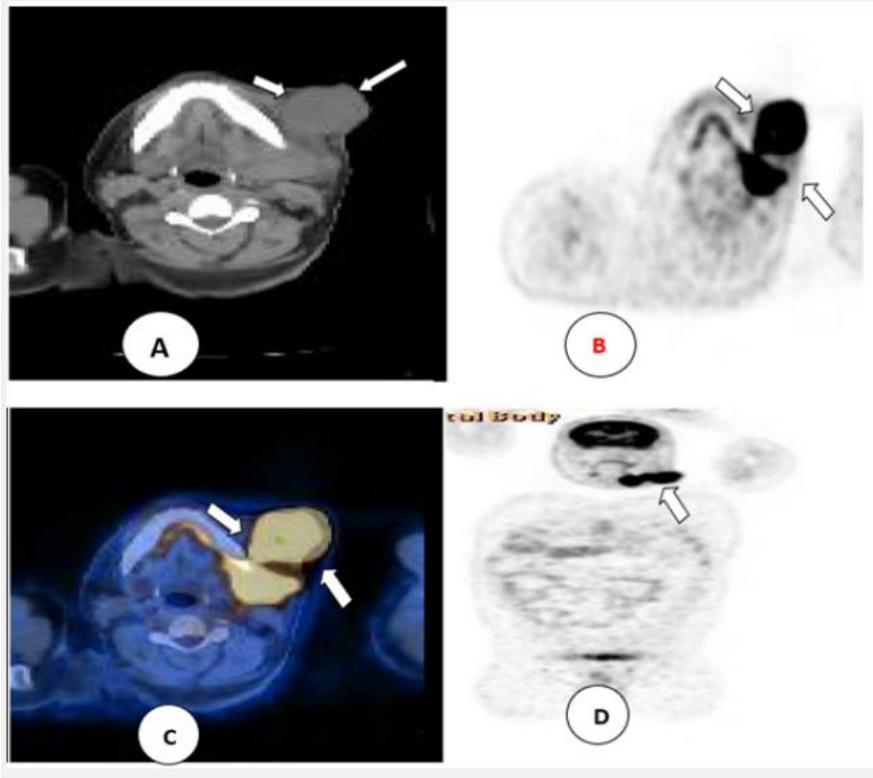


Fig. (4): Male persistent 43-year-old with a known past history of neuroblastoma, displayed with cleared out cheek swelling. MRI was done on 21/02/2020, appeared a cleared-out cheek mass injury (35x40 mm). (A) Hub CT picture, (B) Pivotal PET picture, (C) Pivotal PET/CT picture and (D) Coronal PET Scan picture, appeared a large-sized well-defined cleared out cheek mass injury, (39X42) mm, evoking thick tracer obsession with SUV max. up to 19.1. Numerous variable-sized metabolically dynamic LNs are seen at the cleared out submandibular and cleared out upper and lower profound cervical bunches, the biggest (around 30x38 mm) is the previous, inspiring SUV max. accomplishing 20.0.

- **Radiological opinion was highly suspicious of recurrence of neoplasm, according to NI-RADS template, its score is NI-RADS (III).**
- **Biopsy was done after reporting and revealed a neuroblastic tumor.**
- **Follow-up PET/CT as clinically indicated was advisable.**

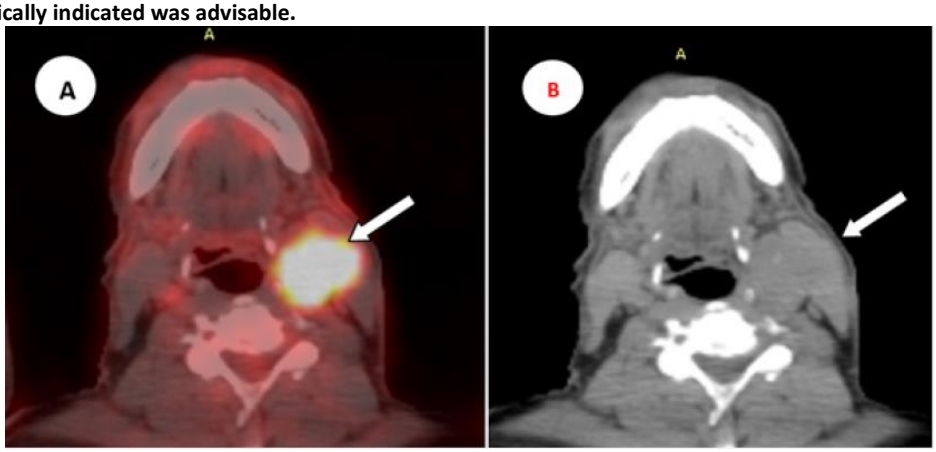


Fig. (5): The patient, a 68-year-old male, was previously diagnosed with metastatic undifferentiated epithelial malignancy in 2011 after a fine-needle aspiration biopsy of enlarged left cervical lymph nodes. A PET/CT scan conducted in the same year revealed metabolically active lesions in the left cervical and left laryngeal regions. Following this, the patient underwent combined chemotherapy and radiotherapy treatment and has since been under observation with no significant developments until recently when he presented with a change in voice.

- **The image depicts (A)** an Axial PET/CT image and (B) Axial CT images conducted for the patient in 2020. In comparison to the PET/CT conducted in 2011, the recent one revealed a glucose-avid, large, amalgamated, well-defined lesion on the left side of the neck, measuring 6 x 5 cm. The image is indicative of tumor recurrence and the persistence/recurrence of left cervical

lymphadenopathy.

- **According to NI-RADS template, its score is NI-RADS (III)**
- **Biopsy was indicated after reporting; the results confirmed the diagnosis.**
- **Follow-up PET/CT as clinically indicated would be advisable.**

DISCUSSION

The extended follow-up data from this prospective longitudinal study provide critical insights into the prognosis and survivorship of patients with head and neck cancer beyond the early post-treatment period. By identifying key factors that influence long-term outcomes—including recurrence rates, overall survival (OS), and disease-free survival (DFS)—this research offers valuable guidance for the development of risk-adapted follow-up protocols and supportive care models aimed at enhancing patient care and quality of life.

The analysis revealed considerable variation in recurrence patterns among patients, influenced by tumor stage, treatment modality, and overall treatment adequacy. Individuals with more advanced disease or suboptimal initial management exhibited higher recurrence rates, emphasizing the importance of aggressive treatment strategies and vigilant long-term monitoring in high-risk populations.

In addition, the study highlighted important prognostic indicators for OS and DFS, including disease stage at diagnosis, treatment response, and the presence of comorbidities. Patients with early-stage disease and favorable treatment responses demonstrated superior long-term outcomes, reinforcing the critical role of early detection, appropriate treatment planning, and comprehensive supportive care throughout the continuum of care.

These findings hold significant implications for clinical practice. Tailoring surveillance and follow-up strategies to individual risk profiles can facilitate earlier detection of recurrence and timely intervention, ultimately improving survival and quality of life. Moreover, integrated supportive care—including nutritional counseling, speech and swallowing therapy, and psychosocial support—can help mitigate treatment-related morbidity and improve overall survivorship experiences. Recognition of key prognostic factors also enhances clinical decision-making, allowing for more personalized therapeutic approaches based on patient-specific risks and needs.

Strengths and Limitations

The strengths of this study lie in its prospective longitudinal design, which enabled a thorough evaluation of long-term outcomes over time. The use of validated assessment tools and standardized data collection protocols strengthened the reliability and consistency of findings. Furthermore, the application of robust statistical methodologies, such as Kaplan-Meier survival curves and Cox proportional hazards models, provided meaningful insights into the predictors of extended outcomes.

However, certain limitations must be acknowledged. Loss to follow-up remains a potential concern in any long-term study, potentially introducing bias. As with most observational studies, there is also the risk of residual confounding, despite statistical adjustments. Additionally, the generalizability of the results may be limited by the demographic and clinical characteristics of the study population and the specific treatments applied.

Recommendations and Future Directions

Future investigations should aim to address these limitations and build on the findings of the current study. Larger, multicenter longitudinal studies with extended follow-up periods are

needed to confirm and refine the associations identified here. Furthermore, evaluating the long-term impact of emerging therapies, including targeted agents and immunotherapy, will be essential in shaping the future management of head and neck cancer.

In parallel, qualitative research exploring the lived experiences of survivors can provide a more comprehensive understanding of the psychosocial and functional challenges faced during survivorship. These insights will be vital in developing holistic, patient-centered care pathways that extend beyond disease control to encompass overall well-being and life quality, this study contributes valuable evidence to the evolving understanding of long-term outcomes in head and neck cancer. By clarifying prognostic factors and emphasizing the importance of individualized care strategies, it supports more effective follow-up and survivorship care—ultimately aiming to improve the lives of those affected by this complex and impactful disease.

CONCLUSIONS

This study contributes meaningfully to our understanding of the long-term outcomes and survival patterns in patients with head and neck cancer following treatment. By identifying key prognostic factors and evaluating their implications in clinical practice, the research supports the development of individualized follow-up protocols and multidisciplinary supportive care strategies aimed at improving both patient outcomes and quality of life. While the study acknowledges certain limitations, its findings highlight the critical importance of integrated, patient-centered care in optimizing long-term prognosis. Continued research, including larger-scale and multi-institutional studies, is essential to validate these findings, refine therapeutic approaches, and ultimately improve survivorship outcomes in this complex patient population.

Conflict of Interest: None

Financial Disclosures: None

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