Perioperative Medicine

RESEARCH

Open Access

Changes of perioperative cognitive function and its effect on quality of life in laryngeal cancer

Zehui Gao[1†], Lina Jia[1†], Jianli Yao[1], Chenxin Wang[1] and Hui Huang-Fu[1*]

Abstract

Background Few studies have been published on the cognitive function and its relationship with quality of life (QoL) in patients with laryngeal squamous cell carcinoma (LSCC) undergoing surgery.

Objective This study aimed to assess the association between changes in cognitive function perioperatively with QoL among patients with LSCC.

Methods This was a prospective study. Eighty-eight cases with LSCC treated with radical surgery were assessed using the Montreal Cognitive Assessment (MoCA), Self-Rating Anxiety Scale (SAS), Self-Rating Depression Scale (SDS) and EORTC QLQ-C30. Statistical analysis was performed using SPSS 21.0 software.

Results The MoCA scores were 24.78 ± 2.42 before surgery and 23.02 ± 3.06 after surgery ($p < 0.001$). Correspondingly, 39 patients (44.32%) had cognitive impairment before surgery, and 47 patients (53.41%) had cognitive impairment after surgery. Age ($p = 0.003$) and preoperative anxiety ($p = 0.016$) were independent factors related to preoperative cognitive dysfunction, while age (p = 0.023), postoperative anxiety ($p = 0.041$), operation mode ($p = 0.05$, $p = 0.016$ respectively) and preoperative MoCA score ($p = 0.008$) were associated with postoperative cognitive dysfunction. Patients with cognitive impairment postoperatively had poorer QOL in the score of the overall health function scale ($p = 0.030$).

Conclusion LSCC patients exhibit a high prevalence of cognitive dysfunction, which significantly associated with reduced overall QoL. Age, postoperative anxiety, operation mode, and preoperative MoCA score were significantly associated with postoperative cognitive dysfunction.

Keywords Squamous cell carcinoma of the larynx, Cancer-related cognitive impairment, Quality of life, Operation, Perioperative period

Introduction

Cancer-related cognitive impairment (CRCI) refers to the decline in cognitive abilities among adult cancer patients with non-central nervous system diseases during cancer diagnosis and treatment (Demos-Davies et al., 2024). This impairment primarily affects memory, spatial sense, attention, reasoning and execution (Onzi et al., 2022). The exact causes of CRCI are not fully understood, but several factors may contribute: chemotherapy drugs and radiation therapy may affect healthy brain cells, leading

†Zehui Gao and Lina Jia are co-first author and contributed equally to the study.

*Correspondence:
Hui Huang-Fu
13934518228@163.com
[1] First Hospital of Shanxi Medical University, Departent of Otorhinolaryngology, Head and Neck Surgery, Taiyuan 030000, China

to cognitive changes. These treatments may cause inflammation, oxidative stress, and damage to neural networks (Ahles and Saykin 2007; Apple et al. 2018). Chronic inflammation associated with cancer and its treatment may impact brain function, as inflammatory cytokines may disrupt neural pathways and contribute to cognitive decline (Behranvand et al. 2022; Williams et al. 2018). Hormonal imbalances due to cancer or its treatment (e.g., hormone therapy) may affect cognition, since hormones play a role in brain health and neurotransmitter function (Seigers and Fardell 2011). The emotional stress of cancer diagnosis, treatment and uncertainty may impact cognitive abilities, with anxiety, depression and fatigue potentially contributing to CRCI (Lange et al., 2019b). Some cancer treatments may weaken the blood–brain barrier, allowing harmful substances to enter the brain and affect cognitive function. Individual genetic variations may influence susceptibility to CRCI, as certain genes related to brain health and repair mechanisms could play a role (Crowder et al. 2025). Additionally, older age and pre-existing cognitive conditions (e.g. mild cognitive impairment) may increase vulnerability to CRCI (Small and Jim, 2020; Chao et al. 2021; Hutterer and Oberndorfer, 2021; Ho et al., 2024).

With new iterations of hormone therapy, targeted therapy and immunotherapy, the survival rate of cancer patients has improved. However, the potential impact on patients' cognitive function should not be ignored. Since the International Cognition and Cancer Task Force published neuropsychological tests and clinical data studies of chemotherapy in 2011 (Wefel et al. 2011) and 2015 (Joly et al. 2015), the academic community has increasingly paid attention to the possible impact of cancer treatment and its pathophysiological mechanisms. Long-term toxic effect on neurological function during treatment has become one of the key factors affecting patients' quality of life (QoL), including patients' ability to live, work and perform social skills (Joly et al. 2020; Wefel et al., 2015). While research on CRCI has gained attention globally, most existing studies focus on breast cancer patients undergoing chemotherapy (Stavraka et al. 2012). More than 50% of breast cancer patients describe symptoms of subjective cognitive decline after chemotherapy as reported by Lange et al. (2019a). However, CRCI related with head and neck cancer, particularly laryngeal squamous cell carcinoma (LSCC), is rarely reported. LSCC, the second-largest malignant cancer in the head and neck, is primarily treated through surgery. Post-laryngeal surgery, changes in respiratory function, pronunciation and swallowing significantly impact patients' QoL (Ali et al. 2018). Few explore the correlation between CRCI and postoperative QoL among LSCC patients.

Therefore, our study aimed to assess the association between changes in cognitive function perioperatively with QoL among patients with LSCC. Due to the negative impacts of cognitive dysfunction on QoL of cancer survivors, this study may provide some literature basis for promoting the cognitive function rehabilitation training among LSCC patients, to further improve the QoL of LSCC cancer survivors.

Materials and methods

Study design

This was a prospective study. From July 2017 to August 2018, patients with LSCC treated with radical surgery at the First Hospital of Shanxi Medical University were selected for this study vie the method of random sampling. Ethics approval was obtained from the Ethics Committee of the First Hospital of Shanxi Medical University (No. K-K011). Written informed consents were obtained from the patients.

Patients

Inclusion criteria were as follows: LSCC pathologically diagnosed, the patients received no other treatment prior to surgery; patients and their family members understood the study and signed the informed consent form. Exclusion criteria included the following issues: presence of cognitive impairment or learning disability and inability to complete the surveys; unable to complete the scale independently due to illiteracy; patients with poor hearing or poor vision, which prevent them to do normal communication and answer the questions in the survey questionnaire; use of psychotherapy within the first two months of evaluation; primary cognitive dysfunction caused by brain injury; drug abuse or mental illness.

The cognitive function and focus of these patients were assessed using the Montreal Cognitive Assessment (MoCA) within 1 week before surgery and again 1–2 months after surgery. Additionally, the Self-Rating Anxiety Scale (SAS), Self-Rating Depression Scale (SDS) and EORTC Quality of Life Questionnaire (QLQ-C30) were used to evaluate anxiety, depression and QoL within 1 week before surgery and again 1–2 months after surgery. A questionnaire survey was conducted on patients in Chinese in a quiet ward of the hospital before preoperative admission and during follow-up period.

Tools of Investigation

The investigation recorded the age, sex, education level, cancer stage, operation mode and marital status of the patients.

MoCA (Nasreddine et al. 2005): It is a rapid screening tool for mild cognitive dysfunction with high sensitivity and specificity. It assesses different cognitive domains:

attention and concentration, executive functions, memory, language, visuo-constructional skills, conceptual thinking, calculations and orientation. The full score is 30. If the education period is 12 years or less, 1 point is added to the score. A score below 26 indicates cognitive impairment. The Chinese version of MoCA was used in this study. The reliability of MoCA is Cronbach α 0.857 and the validity was KMO 0.867 (Committee Group of Chinese Guidelines for the Diagnosis and Treatment of Dementia and Cognitive Impairment, 2018). Based on preoperative MoCA scores, changes in cognitive function were evaluated post-operation, and a difference of more than 2 points was considered significant (Committee Group of Chinese Guidelines for the Diagnosis and Treatment of Dementia and Cognitive Impairment, 2018).

SAS (Knight et al. 1983): It is a 20-item scale, with some items keyed positively and others negatively. Responses are given on a four-point scale ranging from 1 (none or a little of the time) to 4 (most or all of the time). After conversion to a standardized score, a cut-off score of 50 is used to define anxiety according to the Chinese version of the scale (Zhang 1998). Scores are interpreted as follows: 50–59: mild anxiety; 60–69: moderate anxiety; above 69: severe anxiety. The Chinese version of SAS was used in this study. The reliability of SAS is Cronbach α 0.777 and the validity was KMO 0.788 (Duan and Sheng 2012).

SDS (Knight et al. 1983): It is a 20-item self-reported measure assessing symptoms of depression, encompassing cognitive, somatic, psychomotor and affective dimensions. Each item is rated on a scale from 1 to 4. The raw scores are then converted into standardized scores. A cut-off score above 53, according to the Chinese version of this scale, is used to indicate the presence of depression (Zhang 1998). The scores are categorized as follows: 53–62: mild depression; 63–72: moderate depression; above 72: severe depression. The Chinese version of SDS was used in this study. The reliability of SDS is Cronbach α 0.782 and the validity was KMO 0.788 (Duan and Sheng 2012).

EORTC Quality of Life Questionnaire (QLQ-C30) (Aaronson et al., 1993): The QLQ-C30 is a QoL scale for all cancer patients. It contains 30 items across 15 domains, including: 1 overall health status, 5 functional areas (physical, role, cognitive, emotional and social function), 3 symptom areas (fatigue, pain and nausea/vomiting), 6 single items (each considered a domain). Raw scores are converted to standardized scores ranging from 0 to 100. Higher scores in overall health status and functional dimensions indicate better QoL and function, while higher scores in symptom scales and single items indicate more severe symptoms and worse QoL. The QLQ-C30 reliability was greater than 0.7 in all fields except physical function and cognitive function: physical functional 0.69, role functional 0.86, cognitive functional 0.61, emotional functional 0.81 and social function 0.84); 3 symptom areas (fatigue 0.72, pain 0.74 and nausea/vomiting 0.89). The Chinese version of QLQ-C30 was used in this study. The validity was KMO 0.81 (Wan et al. 2005).

Investigation process

Upon approval from the ethics committee, two researchers trained by the professional mental health department were assigned to explain the research content and objectives to patients and their families, obtain informed consent from patients, and ensure signatures on consent forms. Questionnaire evaluations were administered on-site using a one-question-one-answer format, with confirmation of correctness before collection. Out of 95 questionnaires distributed, 88 valid responses were received, resulting in a 92.6% effective response rate.

Statistical methods

Statistical analysis was performed using SPSS 21.0 software. The data were categorized as follows: general data (e.g. age, sex) and clinical information (e.g. cancer stage according to the eighth AJCC stage, operation method, education level, marital status) were presented as frequencies and percentages. Measurement data with a normal distribution were described using mean ($\bar{x}$) ± standard deviation (s). Analytical methods included single-factor analysis using Student's t test or analysis of variance (ANOVA). All independent variables for preoperative and postoperative cognitive dysfunction were determined by univariate analysis. Then the significant variables were taken as independent variables, and multivariate analysis using multivariable logistic regression analysis was performed to identify factors associated with preoperative and postoperative cognitive dysfunction. Age was taken as a continuous variable, and cancer stages were divided into early stage (stage I, stage II) and late stage (stage III and stage IV). Statistical significance was set at $p < 0.05$. These methods were employed to rigorously analyze the data and draw meaningful conclusions from the study.

Results

General information

Ninety-five cases of laryngeal squamous cell carcinoma were initially collected, with 5 cases not undergoing surgery (3 cases discontinued treatment, 2 cases chose radiotherapy), and 2 cases not evaluated post-operation, resulting in analysis of 88 cases (Table 1). None of the patients received neoadjuvant therapy.

Table 1 Demographic and clinical profile of study participants ($n=88$)

Entry	Patients with laryngeal cancer (n %)
Age	
≤60 years old	41 (46.59)
>60 years old	47 (53.41)
Sex	
Male	88 (100)
Female	0 (0)
Cancer stage	
I/II	49 (55.68)
III/IV	39 (44.32)
Operative method	
Minimally invasive surgery	6 (6.82)
Partial laryngectomy	52 (59.09)
Total laryngectomy	30 (34.09)
Education level	
Primary and secondary schools and below	64 (72.73)
High school and above	24 (27.27)
Marriage status	
Married	77 (87.5)
Unmarried	2 (2.30)
Divorced	5 (5.70)
Widowed spouse	4 (4.50)

Table 2 Total scores of anxiety, depression, and MoCA and comparison before and after surgery

Entry	Preoperative	Postoperative	*t*	*p* values
MoCA total score	24.78 ± 2.42	23.02 ± 3.06	6.753	< 0.001*
Visual space and executive ability	3.94 ± 0.73	3.84 ± 0.71	1.624	0.109
Name	2.95 ± 0.37	2.95 ± 0.27	0.000	1.000
Attention	5.35 ± 0.89	4.45 ± 1.13	8.162	< 0.001*
Language	2.52 ± 0.53	1.96 ± 0.86	5.790	< 0.001*
Abstract	1.26 ± 0.62	1.30 ± 0.66	−0.725	0.471
Delayed recall	1.82 ± 1.07	1.57 ± 1.13	2.159	0.035*
Directional force	5.94 ± 0.24	5.92 ± 0.27	0.375	0.709
Anxiety	41.32 ± 6.31	45.70 ± 5.62	−5.798	< 0.001*
Depression	43.31 ± 7.83	47.15 ± 6.88	−4.132	< 0.001*

MoCA Montreal Cognitive Assessment

* $p<0.05$

Cognitive function assessment

Before surgery, 39 patients (44.32%) exhibited CRCI; post-operation, this number increased to 47 patients (53.41%). Among 24 (27.27%) patients with decreased cognitive function post-operation, 8 had normal cognitive function preoperatively, and 16 had pre-existing cognitive dysfunction before surgery.

Results indicated lower total MoCA scores postoperatively ($p<0.001$), with decreased scores in attention ($p<0.001$), language ($p<0.001$) and delayed memory dimensions ($p=0.035$) compared to preoperative levels (Table 2). Additionally, anxiety ($p<0.001$) and depression ($p<0.001$) scores were higher postoperatively (Table 2).

Univariate and multivariable analysis

Univariate analysis identified age ($p<0.001$), education level ($p=0.025$), preoperative anxiety ($p<0.001$) and preoperative depression ($p=0.042$) as related to preoperative cognitive dysfunction (Table 3). Multifactor analysis revealed that only older age ($p=0.003$) and preoperative anxiety ($p=0.016$) were significant factors associated with preoperative cognitive dysfunction (Table 3). Univariate analysis found that postoperative cognitive dysfunction associated with age ($p<0.001$), operation mode ($p=0.05$, $p=0.016$, respectively), cancer stage ($p=0.002$), postoperative anxiety ($p<0.001$) and preoperative MoCA score ($p<0.001$) (Table 3). However, multivariable analysis demonstrated that older age ($p=0.023$), operation mode ($p=0.022$), postoperative anxiety ($p=0.041$) and preoperative MoCA score ($p=0.008$) were significant factors related to postoperative cognitive dysfunction (Table 3).

The influence of surgical methods on CRCI was further analyzed. There were 6 patients who received minimally invasive surgery, of which postoperative cognitive dysfunction occurred in 1 patient, accounting for 16.7%. There were 52 patients who received partial laryngectomy, of which postoperative cognitive dysfunction occurred in 18 patients, accounting for 34.6%. There were 30 patients in total laryngectomy, of which 28 patients with postoperative cognitive dysfunction, accounting for 93.3%. There was significant difference between the three groups with different surgical methods ($F=21.819$, $p<0.001$; 95% CI: 0.173–0.464). The greater was the scope of surgery, the higher was the likelihood of postoperative cognitive dysfunction.

Quality of life assessment

Among patients with cognitive impairment post-surgery ($n=47$), the average MoCA score was 21.74. Conversely, those with normal cognitive function ($n=41$) had an average MoCA score of 26.93. Evaluation of EORTC Quality of Life Questionnaire (QLQ-C30) after operation revealed that scores for general health and functional scales ($p=0.030$) were better in the normal cognitive function group compared to the cognitive

Table 3 Statistical analysis of factors influencing cognitive function in patients with laryngeal squamous cell carcinoma before and after surgery

Entry	Preoperative cognitive function				Postoperative cognitive function			
	Univariate analysis		Multivariate analysis		Univariate analysis		Multivariate analysis	
	T (95%CI)	*p*	OR (95%CI)	*p*	T (95%CI)	*p*	OR (95%CI)	*p*
Age (Y)	−4.570 (−9.033 to −3.557)	< 0.001*	1.156 (1.049–1.274)	0.003*	−5.250 (−9.631 to −4.340)	< 0.001*	1.269 (1.033–1.560)	0.023*
Anxiety	−3.652 (−11.405 to −3.360)	< 0.001*	1.073 (1.013–1.137)	0.016*	−5.890 (−14.330 to −7.098)	< 0.001*	1.204 (1.007–1.438)	0.041*
Depression	−2.067 (−7.329 to −0.136)	0.042*	1.047(0.981–1.117)	0.169	−0.940 (−4.948–1.772)	0.350	–	–
Marital status	−2.067 (−7.329 to −0.136)	0.920	–	–	−1.164 (−0.517–0.135)	0.247	–	–
Cancer stage	−1.604 (−0.383–0.041)	0.113	–	–	−3.229 (−0.529 to −0.126)	0.002*	0.238 (0.021–2.746)	0.250
Education level	2.274 (0.027–0.400)	0.025*	0.351 (0.097–1.269)	0.110	1.351 (−0.061–0.318)	0.180	–	–
Operative method	0.534 (0.000–0.076)	0.467	–	–	−6.242 (−0.854 to −0.441)	< 0.001*	0.000(0.000–0.988)[a]	0.050*
							0.022(0.001–0.491)[a]	0.016*
Preoperative MoCA score	–	–	–	–	6.395 (1.738–3.305)	< 0.001*	0.500 (0.299–0.834)	0.008*

T student *t* test, *OR* odds ratio, *CI* confidence interval, *MoCA* Montreal Cognitive Assessment

[a] The operation modes included minimally invasive laser surgery, partial laryngectomy, and total laryngectomy, thus, in the analysis of postoperative cognitive function of the operation modes, the three methods were stratified and pairwise analysis was proceeded

* $p < 0.05$

impairment group in the physical ($p < 0.001$), cognitive ($p < 0.001$), role ($p = 0.032$), emotional ($p = 0.005$) and social ($p = 0.036$) (Table 4). Postoperative scores for insomnia ($p < 0.001$) and loss of appetite ($p < 0.001$) were significantly lower in the normal cognitive function group across the six items assessed (Table 4). No significant differences were observed in symptom scales (fatigue, nausea/vomiting, pain), dyspnea, constipation, diarrhea and economic difficulties postoperatively between the two groups (Table 4).

Table 4 Comparison of quality of life (QLQ-C30) between patients with postoperative cognitive impairment and those with normal cognitive function

Items	Cognitive impairment group ($n = 47$)	Normal cognitive function group ($n = 41$)	*t* (95%CI)	*p*
Overall health function scale	58.94 ± 10.92	64.15 ± 11.20	2.203 (0.507–9.913)	0.030*
Body	69.21 ± 11.83	79.83 ± 11.75	4.216 (5.609–15.624)	< 0.001*
Cognition	61.89 ± 11.83	71.83 ± 8.58	4.055 (5.065–14.806)	< 0.001*
Role	73.23 ± 11.32	79.78 ± 16.62	2.182 (0.583–12.510)	0.032*
Emotion	73.43 ± 12.32	81.59 ± 13.74	2.916 (2.593–13.727)	0.005*
Social symptom scale	75.51 ± 11.31	80.34 ± 9.92	2.135 (0.334–9.328)	0.036*
Fatigue	35.87 ± 7.67	33.27 ± 5.97	−1.788 (−5.500–0.291)	0.077
Nausea and vomiting	18.38 ± 6.43	17.32 ± 5.40	−0.845 (−3.574–1.442)	0.401
Pain	18.26 ± 5.17	17.07 ± 4.55	−1.141 (−3.242–0.878)	0.257
Dyspnea	23.38 ± 6.84	24.37 ± 6.91	0.669 (−1.941–3.906)	0.506
Insomnia	23.43 ± 6.97	24.37 ± 6.91	−3.710 (−7.621 to −2.303)	< 0.001*
Decreased appetite	19.40 ± 5.04	15.63 ± 4.04	−3.892 (−5.696 to −1.844)	< 0.001*
Constipation	20.38 ± 5.91	21.32 ± 5.53	0.766(−1.490–3.358)	0.446
Diarrhea	28.34 ± 7.65	28.32 ± 6.71	−0.015(−3.065–3.018)	0.988
Financial difficulties	32.32 ± 8.11	31.83 ± 5.98	−0.318(−3.549–2.569)	0.751

* $p < 0.05$; *t* = Student *t* test, *CI* confidence interval

Discussion

In this study, 44.32% of patients exhibited cognitive impairment before surgery, a figure that increased to 53.41% postoperation. Postoperative cognitive decline was observed in 37.5% of patients, particularly affecting attention, language and delayed memory functions. Older age and preoperative anxiety were identified as factors associated with preoperative cognitive function, while an older age, a greater scope of operation (total laryngectomy), a higher postoperative anxiety score and a lower preoperative MoCA score were linked to a worse postoperative cognitive function. The subgroup of patients with cognitive dysfunction experienced significantly reduced QoL post-operation, particularly in overall health scores, sleep quality and dietary aspects.

Previous research has highlighted cognitive dysfunction among patients with various primary malignancies, characterized by attention deficits, short-term memory issues and reduced responsiveness (Treanor et al., 2016; Vardy et al. 2015). The incidence of CRCI among head and neck cancer patients before treatment ranges from 17 to 47% (Bond et al. 2012), with potential increases post-treatment. Studies, such as those by Piai et al. (2019), have reported cognitive impairment in 75% of adult cancer patients due to treatment, affecting attention, executive function, language expression, memory, reasoning and learning abilities. These findings align closely with the outcomes of our study, particularly highlighting the significant impact on general health and functions following laryngeal cancer surgery.

This study identified older age and preoperative anxiety as independent factors associated with preoperative cognitive dysfunction. Studies by Plas et al. (2017) and Yao et al. (2019) have highlighted accelerated cognitive decline after cancer treatment in elderly patients. Research by Mandelblatt et al. (2014) has indicated a higher incidence of CRCI in elderly patients with non-metastatic breast cancer compared to controls.

Anxiety diagnosis among cancer patients has also been linked to an increased risk of cognitive impairment (Febo and Foster 2016). Studies, such as those by Williams et al. (2017), have shown associations between negative emotions and cognitive deficits, particularly in delayed recall among patients with head and neck cancer. However, conflicting findings exist; for instance, Ramalho et al. (2017) found no significant correlation between pretreatment anxiety and cognitive impairment in patients with breast cancer. For patients undergoing laryngeal squamous cell carcinoma treatment, factors such as the disease itself, medical environment, surgical trauma and specific speech impairments (e.g. hoarseness, aphasia) contribute significantly to postoperative anxiety (Chen et al. 2014). Additional stressors include increased expectoration, physical appearance changes, postoperative tubes, impaired sleep function, complications (e.g. pharyngeal fistula, dyspnea) and extended hospitalization periods, all of which may exacerbate anxiety levels post-surgery (Chen et al. 2014). Our study revealed that postoperative anxiety and surgical methods were independent factors related to postoperative cognitive impairment, which is consistent with the above stated studies.

In this study, patients exhibited more severe anxiety after surgery compared to before, which has been demonstrated by previous evidence (Plas et al. 2017; Yao et al. 2019). Notably, there is limited research on how preoperative cognitive function influences post-treatment cognitive dysfunction in cancer patients. This study identifies the preoperative MoCA score as an important factor for postoperative cognitive dysfunction, aligning with findings from Plas et al. (2017). A lower preoperative MoCA score indicates poorer cognitive flexibility in patients, predisposing them to further cognitive decline following surgery. These findings underscore the multifaceted nature of cognitive impairment in cancer patients undergoing surgical treatment.

QoL can be defined as an individual's subjective experience of happiness, covering multiple dimensions such as physical, psychological, environmental, social and spiritual (The World Health Organization, 1995). The QoL of cancer survivors is significantly affected by the decline in physical function, social interaction and occupational ability (Pituskin 2022; Yang et al., 2024). QoL has become a key factor of the health of cancer survivors (Pituskin 2022). The decline of QoL in cancer survivors is closely related to CRCI, and has adverse results at multiple levels such as economic, emotional and interpersonal relationships (Boykoff et al. 2009; Von et al., 2022). The evaluation with QLQ-C30 in this study revealed that scores for general health and functional scales were poorer in the cognitive impairment group than the normal cognitive group in the physical cognitive, role, emotional and social aspects (Table 4) with more insomnia and loss of appetite. These results validated that CRCI greatly affected QoL in LSCC patients. However, Maeir et al. suggested that some patients with perceived cognitive impairment may have a normal QoL score, and QoL in these patients may be affected by the confounding factors such as age and gender (Maeir et al. 2023). Therefore, multi-dimensional and careful assessments should be provided for the patients with CRCI.

Recent research on the management of CRCI reveals significant advancements in understanding and managing this condition. A review published in *Breast Cancer Research and Treatment* highlights the use of neuroimaging techniques to evaluate the neurobiological

mechanisms of CRCI in breast cancer patients. Techniques such as functional magnetic resonance imaging (fMRI), event-related potential (ERP) and near-infrared spectroscopy (NIRS) have been widely applied to explore brain structure, function, metabolism and blood perfusion changes related to CRCI (Yao et al. 2023). Another study emphasizes the role of nuclear medicine brain imaging in evaluating biological changes causing CRCI, commonly known as "chemo-brain" (Bernstein et al., 2021). This imaging provides patients with a better understanding of changes in their cognitive status during and after treatment (Saward et al., 2022). Additionally, researchers are exploring neuropsychological interventions to manage CRCI, aiming to identify effective strategies for improving cognitive function in cancer patients (Cheng et al. 2022).

Limitations of the study

This study faces several limitations that merit consideration. Firstly, the analysis was confined to a narrow timeframe of 1–2 months before and after surgery, limiting the ability to capture longer-term cognitive changes. Future investigations should extend follow-up periods to better understand the persistence and trajectory of cognitive function post-surgery. Secondly, the relatively small sample size might obscure the identification of all relevant influencing factors, which highlights the need to expand the sample size for further investigation. Thirdly, while the MoCA is effective for overall cognitive screening, its sensitivity to changes in specific cognitive domains may be limited (Pugh et al. 2018). The debate over the optimal cut-off score of 26 points for diagnosing cognitive impairment underscores the need for more nuanced neuropsychological assessments in future studies. Finally, this study was a cross-sectional study, limiting the ability to establish causality. The significant results are only associations which need to be further explored.

Conclusion

This study reveals significant findings regarding cognitive dysfunction in patients undergoing surgery for laryngeal squamous cell carcinoma. Nearly half of the patients exhibited cancer-related cognitive dysfunction before surgery, which appears to correlate with age and preoperative anxiety levels. Furthermore, over a quarter of patients experienced cognitive deterioration following surgery. Postoperative cognitive dysfunction was associated with older age, higher levels of anxiety, specific surgical procedures, and lower preoperative cognitive function scores. Importantly, the occurrence of cognitive dysfunction was associated with reduced overall QoL.

Abbreviations

CRCI	Cancer-related cognitive impairment
HC	Healthy controls
MoCA	Montreal Cognitive Assessment
SAS	Additionally, the Self-Rating Anxiety Scale
SDS	Self-Rating Depression Scale
QLQ-C30	EORTC Quality of Life Questionnaire
fMRI	Functional magnetic resonance imaging
ERP	Event-related potential
NIRS	Near-infrared spectroscopy

Acknowledgements

Not applicable.

Authors' contributions

Guarantor of integrity of the entire study: Hui Huang-Fu. Guarantor of integrity of the entire study: Hui Huang-Fu Study concepts: Zehui Gao Study design: Zehui Gao, Lina Jia Definition of intellectual content: Lina Jia Literature research: Jianli Yao Clinical studies: Lina Jia, Jianli Yao Experimental studies: Jianli Yao Data acquisition: Chenxin Wang Data analysis: Chenxin Wang Statistical analysis: Zehui Gao, Chenxin Wang Manuscript preparation: Zehui Gao, Lina Jia Manuscript editing: Zehui Gao Manuscript review: Hui Huang-Fu. Study concepts: Zehui Gao.Study design: Zehui Gao, Lina Jia.Definition of intellectual content: Lina Jia.Literature research: Jianli Yao.Clinical studies: Lina Jia, Jianli Yao.Experimental studies: Jianli Yao.Data acquisition: Chenxin Wang. Data analysis: Chenxin Wang.Statistical analysis: Zehui Gao, Chenxin Wang. Manuscript preparation: Zehui Gao, Lina Jia.Manuscript editing: Zehui Gao. Manuscript review: Hui Huang-Fu.

Funding

No funds, grants or other support was received.

Data availability

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request. The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.The authors declare no competing interests.

Declarations

Ethics approval and consent to participate

Ethics approval was obtained from the Ethics Committee of the First Hospital of Shanxi Medical University (No.K-K011). Patients and their family members understood the study and signed the informed consent form.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

Received: 19 August 2024 Accepted: 22 February 2025
Published online: 13 March 2025

References

Aaronson NK, Ahmedzai S, Bergman B, et al. The European Organization for Research and Treatment of Cancer QLQ-C30: a quality-of-life instrument for use in international clinical trials in oncology. JNCI. 1993;85(5):365–76.
Ahles TA, Saykin AJ. Candidate mechanisms for chemotherapy-induced cognitive changes. Nat Rev Cancer. 2007;7:192–201.
Ali FS, Hussain MR, Gutiérrez C, et al. Cognitive disability in adult patients with brain tumors. Cancer Treat Rev. 2018;65:33–40.
Apple AC, Schroeder MP, Ryals AJ, et al. Hippocampal functional connectivity is related to self-reported cognitive concerns in breast cancer patients undergoing adjuvant therapy. Neuroimage Clin. 2018;20:110–8.

Behranvand N, Nasri F, Zolfaghari Emameh R, et al. Chemotherapy: a double-edged sword in cancer treatment. Cancer Immunology Immunother. 2022;71:507.
Bernstein LJ, Edelstein K, Sharma A, Alain C. Chemo-brain: an activation likelihood estimation meta-analysis of functional magnetic resonance imaging studies. Neurosci Biobehav Rev. 2021;130:314–25.
Bond SM, Dietrich MS, Murphy BA. Neurocognitive function in head and neck cancer patients prior to treatment. Support Care Cancer. 2012;20(1):149–57.
Boykoff N, Moieni M, Subramanian SK. Confronting chemobrain: an in-depth look at survivors' reports of impact on work, social networks, and health care response. J Cancer Surviv. 2009;3(4):223–32.
Chao D, Hale A, Henry NL, et al. Cancer-related cognitive impairment or "Chemo-brain:" emerging assessments, treatments, and targets for intervention. Curr Phys Med Rehabil Rep. 2021;9:108–18.
Chen J, Chen C, Zhi S. Retrospective comparison of cognitive behavioral therapy and symptom-specific medication to treat anxiety and depression in throat cancer patients after laryngectomy. Shanghai Arch Psychiatry. 2014;26(2):95–100.
Cheng ASK, Wang X, Niu N, et al. Neuropsychological interventions for cancer-related cognitive impairment: a network meta-analysis of randomized controlled trials. Neuropsychol Rev. 2022;32:893–905.
Committee Group of Chinese Guidelines for the Diagnosis and Treatment of Dementia and Cognitive Impairment, Chinese Medical Doctor Association Neurologist Branch of Cognitive Disorders Committee. 2018 Chinese guidelines for the diagnosis and treatment of dementia and cognitive impairment (section 5): diagnosis and treatment of mild cognitive impairment. Nat Med J China. 2018;98(17):1294–301 (in Chinese).
Crowder SL, Gudenkauf LM, Hoogland AI, et al. Cancer-related cognitive impairment and the potential of dietary interventions for the prevention and mitigation of neurodegeneration. Cancer Res. 2025;85(2):203–17.
Demos-Davies K, Lawrence J, Seelig D. Cancer related cognitive impairment: a downside of cancer treatment. Front Oncol. 2024;14:1387251.
Duan QQ, Sheng L. Differential validity of SAS and SDS among psychiatric non-psychotic outpatients and their partners. Chin Ment Health J. 2012;26(9):676–9.
Febo M, Foster TC. Preclinical magnetic resonance imaging and spectroscopy studies of memory, aging, and cognitive decline. Front Aging Neurosci. 2016;8:158.
Ho MH, So TW, Fan CL, Chung YT, Lin CC. Prevalence and assessment tools of cancer-related cognitive impairment in lung cancer survivors: a systematic review and proportional meta-analysis. Support Care Cancer. 2024;32(4):209.
Hutterer M, Oberndorfer S. Cognitive impairment in cancer patients and survivors—clinical presentation, pathophysiology, diagnosis and management. Memo. 2021;14(2):157–67.
Joly F, Giffard B, Rigal O, et al. Impact of cancer and its treatments on cognitive function: advances in research from the Paris International Cognition and Cancer Task Force symposium and update since 2012. J Pain Symptom Manage. 2015;50(6):830–41.
Joly F, Castel H, Tron L, Lange M, Vardy J. Potential effect of immunotherapy agents on cognitive function in cancer patients. J Natl Cancer Inst. 2020;112(2):123–7.
Knight RG, Waal-Manning HJ, Spears GF. Some norms and reliability data for the state-trait anxiety inventory and the Zung self-rating depression scale. Br J Clin Psychol. 1983;22(Pt 4):245–9.
Lange M, Licaj I, Clarisse B, et al. Cognitive complaints in cancer survivors and expectations for support: results from a web-based survey. Cancer Med. 2019;8(5):2654–63 (a).
Lange M, Joly F, Vardy J, et al. Cancer-related cognitive impairment: an update on state of the art, detection, and management strategies in cancer survivors. Ann Oncol. 2019;30(12):1925–40 (b).
Maeir T, Nahum M, Makranz C, Tsabari S, Peretz T, Gilboa Y. Predictors of quality of life among adults with self-reported cancer related cognitive impairment. Disabil Rehabil. 2023;45(6):1056–62.
Mandelblatt JS, Stern RA, Luta G, et al. Cognitive impairment in older patients with breast cancer before systemic therapy: is there an interaction between cancer and comorbidity? J Clin Oncol. 2014;32(18):1909.
Nasreddine ZS, Phillips NA, Bédirian V, et al. The Montreal Cognitive Assessment, MoCA: a brief screening tool for mild cognitive impairment. J Am Geriatr Soc. 2005;53(4):695–9.
Onzi GR, D'Agustini N, Garcia SC, Guterres SS, Pohlmann PR, Rosa DD, Pohlmann AR. Chemobrain in breast cancer: mechanisms, clinical manifestations, and potential interventions. Drug Saf. 2022;45(6):601–21.
Piai V, Prins JB, Verdonck-de Leeuw IM, et al. Assessment of neurocognitive impairment and speech functioning before head and neck cancer treatment. JAMA Otolaryngol Head Neck Surgery. 2019;145(3):251–7.
Pituskin E. Cancer as a new chronic disease: oncology nursing in the 21st Century. Can Oncol Nurs J. 2022;32(1):87–92.
Plas M, Rotteveel E, Izaks GJ, et al. Cognitive decline after major oncological surgery in the elderly. Eur J Cancer. 2017;86:394–402.
Pugh EA, Kemp EC, Van Dyck CH, et al. Effects of normative adjustments to the Montreal cognitive assessment. Am J Geriatr Psychiatry. 2018;26(12):1258–67.
Ramalho M, Fontes F, Ruano L, et al. Cognitive impairment in the first year after breast cancer diagnosis: a prospective cohort study. The Breast. 2017;32:173–8.
Saward JB, Ellis EG, Cobden AL, Caeyenberghs K. Mapping cognitive deficits in cancer patients after chemotherapy: an activation likelihood estimation meta-analysis of task-related fMRI studies. Brain Imaging Behav. 2022;16(5):2320–34.
Seigers R, Fardell JE. Neurobiological basis of chemotherapy-induced cognitive impairment: a review of rodent research. Neurosci Biobehav Rev. 2011;35:729–41.
Small BJ, Jim HSL. Understanding the time course of cancer-associated cognitive decline: does impairment precede diagnosis? J Natl Cancer Inst. 2020;112(5):431–2.
Stavraka C, Ford A, Ghaem-Maghami S, et al. A study of symptoms described by ovarian cancer survivors. Gynecol Oncol. 2012;125(1):59–64.
The World Health Organization Quality of Life assessment (WHOQOL): position paper from the World Health Organization. Soc Sci Med. 1995;41(10):1403–9. https://doi.org/10.1016/0277-9536(95)00112-k. PMID: 8560308.
Treanor CJ, McMenamin UC, O'Neill RF, et al. Non-pharmacological interventions for cognitive impairment due to systemic cancer treatment. Cochrane Database Syst Rev. 2016;2022:(8).
Vardy JL, Dhillon HM, Pond GR, et al. Cognitive function in patients with colorectal cancer who do and do not receive chemotherapy: a prospective, longitudinal, controlled study. J Clin Oncol. 2015;33(34):4085.
Von Ah D, Crouch AD, Monahan PO, et al. Association of cognitive impairment and breast cancer survivorship on quality of life in younger breast cancer survivors. J Cancer Surviv. 2022;16(4):812–22.
Wan CH, Chen MQ, Zhang CZ, Tang XL, Meng Q, Zhang XQ. Evaluation of the Chinese version of EORTC quality of life questionnaire in the quality of life scale for cancer patients. 2005;20(4):353–5.
Wefel JS, Kesler SR, Noll KR, et al. Clinical characteristics, pathophysiology, and management of noncentral nervous system cancer-related cognitive impairment in adults. CA Cancer J Clin. 2015;65(2):123–38.
Wefel JS, Vardy J, Ahles T, Schagen SB. International Cognition and Cancer Task Force recommendations to harmonise studies of cognitive function in patients with cancer. Lancet Oncol. 2011;12(7):703–8.
Williams AM, Lindholm J, Cook D, et al. Association between cognitive function and quality of life in patients with head and neck cancer. JAMA Otolaryngol Head Neck Surgery. 2017;143(12):1228–35.
Williams AM, Shah R, Shayne M, et al. Associations between inflammatory markers and cognitive function in breast cancer patients receiving chemotherapy. J Neuroimmunol. 2018;314:17–23.
Yang Y, Von Ah D. Cancer-related cognitive impairment: updates to treatment, the need for more evidence, and impact on quality of life-a narrative review. Ann Palliat Med. 2024;13(5):1265–80.
Yao M, Zhao Z, Wei L, et al. HSF1/HSP pathway in the hippocampus is involved in SIRT1-mediated caloric restriction-induced neuroprotection after surgery in aged mice. Exp Gerontol. 2019;119:184–92.
Yao S, Zhang Q, Yao X, et al. Advances of neuroimaging in chemotherapy related cognitive impairment (CRCI) of patients with breast cancer. Breast Cancer Res Treat. 2023;201:15–26.
Zhang M. Handbook of psychiatry scales. In: Science and techenology publishing company of Hunan. 1998.

Publisher's Note