The Role of Trait Emotional Intelligence in Quality of Life, Anxiety, and Depressive Symptoms After Radiotherapy in Lung Cancer Patients with Brain Metastases

ABSTRACT

Objective: We aimed to investigate the association of trait emotional intelligence (TEI), anxiety, depression, and quality of life (QoL) in lung cancer individuals with brain metastases receiving radiotherapy.

Methods: A total of 289 individuals with brain metastases from lung cancer after radiotherapy participated. Data were collected from October 2018 to December 2022. Data were collected on variables such as patient demographics, medical characteristics, TEI, anxiety, depression, and QoL. Pearson correlation analysis and structural equation modeling were used to analyze the data.

Results: Correlation coefficients between TEI and anxiety, depression, and QoL scores were −0.451 (P = .007), −0.580 (P = .002), and 0.391 (P = .009). The correlation coefficient for depression and QoL was −0.433 (P = .008). Anxiety and depression mediate the positive correlation between trait EI and QoL.

Conclusion: Individuals with high idiosyncrasies of emotional intelligence are able to more effectively regulate negative emotions associated with cancer symptoms and treatment, and thus better perceive QoL. Trait EI training can reduce anxiety and depression symptoms and further improve the QoL of lung cancer individuals.

Keywords: Trait emotional intelligence, anxiety, depressive, quality of life, radiotherapy, lung cancer patients with brain metastasesm

Introduction

Lung cancer, also named primary bronchogenic carcinoma, is a malignant tumor arising from the bronchial mucosa or glands of the lungs.[1] Lung cancer may present with symptoms such as recurrent cough, sputum, intermittent hemoptysis, chest pain, or dyspnea.[2] Lung cancer is a common malignancy, and its burden of disease is increasing year by year, with 2018 data indicating 2.09 million new cases and 1.76 million deaths worldwide, respectively.[3] According to different tumor size, location, lymph node status, and distant metastasis, lung cancer can be categorized as stages I, II, III, and IV.[4] Although the capillaries in the lungs are rich and have a certain filtration function for cancer cells, there are anastomotic branches between the pulmonary blood vessels and the vertebral veins, so the shed cancer cells may not directly enter the brain through the lungs, and brain metastasis of lung cancer occurs, which is a very serious and common clinical complication, usually with poor prognosis, and one of the important reasons for the failure of treatment.[5] Therefore, radiation therapy has been used as one of the most important tools for patients with brain metastases from lung cancer.[6]

Compared with other cancers, lung cancer has rapid progression and more severe symptoms due to the dense capillaries in the lungs, which make it easy for the cancer cells to spread.[7] Lung cancer patients have symptoms such as shortness of breath, coughing up blood, and

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pain in the early stage, and with the development of the disease, patients with brain metastasis may even have symptoms such as vomiting, visual impairment, and mental abnormality, etc. In addition, in the course of the treatment, the cycle of radiation therapy is long and the number of times is also high, and the frequent radiation therapy will also largely damage the patients' physical functions and reduce the quality of life (QoL).[8] Therefore, it is particularly important to know how to improve the QoL of patients during the treatment process. First, we investigated the influencing factors for QoL in previous studies. In addition to the symptoms of the disease and burden of treatment,[7] a systematic review of 13 original studies suggests that social support from medical staff, family, and friends is associated with QoL.[9] Evidence suggests that sleep problems also affect the QoL.[10] Fatigue is also involved in the process of QoL impact, and this feeling may arise from the pain of symptoms or from insomnia and emotional states, several manifestations that are usually observed simultaneously.[11] A meta-analysis including 835 participants found that exercise prescription improved the QoL as well as symptoms of lung cancer individuals.[12] Self-assessed QoL helps to predict survival in the lung cancer population.[13]

In these studies we found that emotional intelligence (EI) is an important factor influencing QoL. Emotional intelligence refers to the ability of people to recognize, express, regulate, and utilize their own and others' emotions and guide their thoughts and behaviors in the best way.[14] Trait EI mainly includes 3 aspects, cognition of emotional and emotional abilities, ability to apply in emotional scenes, and characteristics or tendencies to use EI in daily life.[15] Trait EI is closely related to physical and mental health in the general and clinical populations.[16] For individuals with cancer, they may face more severe psychological problems, while higher levels of trait EI are associated with less anxiety as well as higher perception of social support.[17] Recent studies have found that individuals with polycystic ovary syndrome may have a lower QoL, but high levels of trait EI may be a protective factor.[18] However, there are still few studies on the relationship between trait EI and QoL in lung cancer individuals.

Anxiety and depression are also common mood problems in cancer populations, and these mood disorders may affect the QoL of individuals.[19] A meta-analysis found that anxiety and depression were associated with an increased risk of specific cancer death as well as all-cause death from lung cancer and also with an increased risk of lung cancer.[20] Another meta-analysis also suggests that anxiety and depression are associated with cancer recurrence and prognosis.[21] The aforementioned evidence suggests the important role of anxiety and depression in cancer populations and other studies have also found that anxiety and depression may be related to trait EI and QoL. It has been suggested that fewer anxiety and depressive symptoms are associated with higher trait EIs in individuals undergoing surgery

for esophageal or gastric cancer, which can further improve the QoL of individuals.[15]

Based on the above considerations, we aimed to understand and analyze the effect of trait EI on the QoL of individuals with lung cancer brain metastases after radiotherapy and to explore the correlation between trait EI and anxiety and depression, providing a reference perspective for clinical managers to take intervention measures to reduce anxiety and depressive symptoms and improve the QoL of individuals.

Material and Methods

Participating Population
In total, 289 individuals with brain metastases from lung cancer receiving radiotherapy completed questionnaires and scales. Table 1 indicates the clinical characteristics of the participating population.

Study Procedures
From October 2018 to December 2022, eligible participants were recruited from patients who had been diagnosed with brain metastases from lung cancer at our institution and had received 3 courses of radiotherapy. Inclusion criteria were as follows: confirmed diagnosis of lung cancer brain metastases based on medical history, laboratory

MAIN POINTS

- *Trait emotional intelligence (EI) is significantly negatively correlated with anxiety and depression, and significantly positively correlated with quality of life.*
- *Trait EI can directly affect quality of life.*
- *Trait EI can affect quality of life by influencing anxiety and depression.*

Table 1. Demographic and Medical Characteristics

Variable	n	%
Number	289	100
Gender		
Male	181	63
Female	108	37
Age (years)		
<45	68	23
45-<65	123	43
≥65	98	34
Marital status		
Single	32	11
Be engaged	37	13
Cohabitation	35	12
Married	170	59
Divorce	15	5
Educational level		
Junior high school or below	58	20
High school education	119	41
Bachelor degree	87	30
Postgraduate degree	25	9
Occupational status		
In work	98	34
Self-employed	29	10
No work	20	7
Have retired	142	49
Lung cancer-related symptoms		
Cough/phlegm	268	93
Hemoptysis	143	49
Chest pain	251	87
Dyspnea	97	36
Nausea/vomiting	205	71
Headache	188	65

tests, imaging, and pathological examination and received radio-therapy; to be more than 18 years old; if the patient had not received psychiatric and/or psychological treatment at the time of assessment; had severe cardiac, hepatic, or renal disease; failed to pass a psychological test with sufficient cognitive ability to understand; or had other conditions that could prevent cooperation to complete the study.

All participants who completed or dictated their answers in person and authorized their family members to assist in completing the form were informed and signed the consent form. The study was conducted in accordance with the Declaration of Helsinki and was approved by the Ethics Review Committee of our hospital (approval number: 2023KE-KUAI063; date: October 27, 2023).

Measures

Trait Emotional Intelligence: Trait EI was assessed by completing the Trait Emotional Intelligence Questionnaire Short Form.[18] The scale was designed to cover the sampled domains of trait EI and was categorized into 15 dimensions based on subjective feelings of emotional experience, forming 4 correlates for assessing one's level of trait EI. The 4 sections are divided into: well-being, self-control, emotionality, and sociability and consist of 30 questions, with scores ranging from 1 (totally disagree) to 7 (totally agree) for each question.

Anxiety and Depression: The assessment of anxiety and depression was done by filling out the Hospital Anxiety and Depression Scale (HADS).[15] The HADS, as a self-measurement scale, is important for disease treatment as it helps physicians understand patients' mood changes as their disease progresses and after surgery and target counseling interventions. The scale consists of 7 questions, each of which is used to assess a person's anxiety and depression symptoms. Each question consists of a score of 0 to 3.

Quality of Life: Quality of life was assessed by completing the Quality of Life Measurement Scale for Cancer Patients (QLQ-C30), a questionnaire for measuring QoL in cancer populations, to which modules for different cancers have been added and was used in this study to assess individuals' perceptions of QoL. The QLQ-C30 consists of 5 functional dimensions and 9 symptom dimensions. According to the aim and involvement of the study, we used only the overall score of QoL. The overall score consists of 2 questions ranging from 1 to 7, with higher scores indicating better QoL.

Statistical Analysis

Descriptive and correlation analyses were conducted for all measures. Cronbach α was set at 0.05 for the correlation analyses. The Pearson correlation coefficient was used to indicate the strength and direction of the linear relationship between the correlation coefficients used to measure the correlation between trait EI and QoL. If the correlation coefficient is positive, then there is likely to be a positive correlation between them, i.e., as trait emotionality increases, QoL is likely to increase. Conversely, if the correlation coefficients are negative, then there may be a negative correlation between them, i.e., an increase in trait emotions may lead to a decrease in QoL. Structural equation modeling (SEM) allows for the assessment of the effect of single factors on the total and the interactions between single factors, with trait EI as the predictor variable, anxiety and depression as the mediator variables, and QoL as the outcome variable. Path

analysis, which is part of the SEM, was used to explain the relationship between the individual variables and was used to explain the direct and indirect effects between trait EI, anxiety, depression, and QoL. The model used maximum likelihood estimation for determining the values of the parameters in the model in order to make the observations most likely to occur.

We used the wrapping method to train the learner multiple times to select a subset of features until the optimal subset was selected in order to obtain the latent variable measurements in the structural equation model and categorize the items in the questionnaire (randomly selected) into 3 measurements for each latent variable.[22] Grouping (parceling) better satisfies the normality test and is less likely to be influenced by methodology.[22,23]

Model fit was determined by calculating the chi-square (χ^2, <3 suggesting good fit), comparative fit index (CFI, ≥ 0.9 suggesting an acceptable model), root mean square error of approximation (RMSEA, <1 suggesting a better fit, <0.05 suggesting a good fit), and standardized mean residual squared (SRMR, <0.05 suggesting a good fit). Besides, the χ^2/v (fit indices) were examined: ≤ 2 was found suitable, 3 was acceptable, and > 3 was not suitable. Statistical analysis was completed by Lavaan package for Statistical Package for the Social Sciences (SPSS) version 22.0 (IBM SPSS Corp.; Armonk, NY, USA), Analysis of Moment Structure (AMOS) version 20.0 (IBM SPSS Corp., Armonk, NY, USA), and R, and the significance level was determined as $\alpha = 0.05$.

Results

Descriptive Results and Correlations

Skewness and kurtosis showed that all 4 scores roughly fit a normal distribution (Table 2). The mean (tandard deviation) of trait EI, anxiety, depression, and QoL were (4.31 (0.75)), (1.57 (0.69)), (1.78 (0.81)), and (3.27 (1.35)), respectively. Correlation coefficients between trait EI and anxiety, depression, and QoL scores were −0.451 ($P = .007$), −0.580 ($P = .002$), and 0.391 ($P = .009$). The correlation coefficient for depression and QoL was −0.433 ($P = .008$).

Path Analysis and Structural Equation Model

Figure 1 shows the structural equation model of TEI, anxiety, depression and QoL. The model showed acceptable fitting index: χ^2 (68) = 189.76, χ^2/v = 2.79; CFI = 0.96, RMSEA = 0.10 (90% CI = 0.08-0.11), SRMR = 0.04.

In structural equation models, we found significant pathways from trait EI to anxiety ($\beta = -0.41$, $P < .001$), depression ($\beta = -0.57$, $P < .001$), and QoL ($\beta = 0.31$, $P < .001$). In addition, the results showed a significant path from anxiety to depression ($\beta = 0.28$, $P < .001$) and QoL ($\beta = -0.47$, $P < .001$). Finally, depression was associated with QoL ($\beta = -0.35$, $P < .001$).

To further explore the indirect effects that occur, we used a bootstrap-generated confidence interval correction method (Table 3). We found a significant indirect effect between trait EI and depression ($\beta = -0.13$) and QoL ($\beta = 0.21$) mediated by anxiety. A significant indirect effect was found between trait EI and QoL ($\beta = 0.20$, $P < .001$) and anxiety and QoL ($\beta = -0.11$, $P < .001$) mediated by depression. Finally, a significant indirect effect was found between trait EI and QoL mediated by anxiety and depression ($\beta = 0.10$, 95% CI 0.04-0.15, $P < .001$).

Table 2. Descriptive Statistics and Correlation of Trait Emotional Intelligence, Anxiety, Depression, and Quality of Life

	Cronbach *α*	*M*	SD	Skewness Kurtosis	Skewness Kurtosis	1	2	3	4
1. Trait EI	0.87	4.31	0.75	0.14	−0.18	-			
2. Anxiety	0.85	1.57	0.69	0.03	−0.89	−0.451[a]	-		
3. Depression	0.83	1.78	0.81	-0.05	−0.91	−0.580[b]	0.650[c]	-	
4. Quality of life	0.92	3.27	1.35	0.16	−0.42	0.391[d]	−0.410[e]	−0.433[f]	-

EI, emotional intelligence; M, Mean; SD, Standard Deviation.
[a]*P* = .007.
[b]*P* = .002.
[c]*P* = .001.
[d]*P* = .009.
[e]*P* = .007.
[f]*P* = .008.

Discussion

The aim of this study was to test the direct and indirect effects of trait EI on anxiety and depressive symptoms and post-radiotherapy QoL in lung cancer patients presenting with brain metastases. To the best of our knowledge, this is the first study to assess the direct and indirect effects of trait EI on QoL after radiotherapy in lung cancer patients.

Since complications and discomfort tend to be more severe after the development of brain metastases in lung cancer than in other cancers. Trait EI serves as a good predictor of patients in emotional distress. It is also consistent with our hypothesis that a high trait EI can facilitate the emotional identity process required for patients to adapt to potentially traumatic events (e.g., radiotherapy-induced adverse effects) in patients with brain metastases from lung cancer treated with radiation therapy. This trait EI is positively correlated with QoL and negatively correlated with anxiety and depression. Individuals with a high Trait Emotionality Index may be more willing to confront and manage negative emotions and develop positive emotions through healthy behavioral and lifestyle changes. A number of previous cancer studies have also tested the relationship between the Trait Emotion Index and QoL. For example, a study including 215 breast cancer patients found that the trait EI was positively correlated with QoL, and fear of cancer recurrence may be involved in moderating the relationship between the trait EI and QoL.[24] Another study also elucidated the validity of the trait EI in predicting health-related QoL in cancer patients.[25] All of this evidence suggests the potential value of incorporating trait EI into psychoeducational approaches to improve health-related QoL in cancer patients. Positive correlations between the Trait Affective Index and QoL have also been demonstrated in patients with polycystic ovary syndrome[18] and healthy adolescents.[26]

Thus, patients with high trait EI had less anxiety and depressive symptoms and relatively better QoL during treatment. This is consistent with a previous follow-up study of patients with esophageal or gastric cancer, which showed that a high trait EI predicted less postoperative anxiety and depressive symptoms.[15] Furthermore, radiotherapy would largely mitigate the effect of trait EI on the degree of QoL in lung cancer patients. In fact, radiotherapy and cycles of radiotherapy lead to a significant decrease in their QoL afterward. In addition, some patients are not fully aware of the effects of radiotherapy and the long-lasting changes to QoL, and this aspect can also have an impact. Although several moderators can improve the experience of trait EI on QoL after radiotherapy in these patients, high trait EI does not always have the same effect at all stages after radiotherapy. In subsequent studies, a deeper understanding of the changes in trait EI during the disease process and the role of modifying factors is needed. It is noteworthy that trait EI did not produce significant direct effects, but rather emotional distress such as anxiety and depression, which resulted in lower QoL. Increasing trait EI could reduce anxiety and depression due to physical discomfort after radiotherapy to predict better QoL after radiotherapy.

This result reflects our second conclusion that the effect of trait EI on negative emotions is central to patient regulation. Patients with a high trait EI were better able to regulate the effects of adverse reactions that occurred after radiotherapy during the course of treatment. Lung cancer patients with a low Trait Emotionality Index may have higher anxiety and depressive symptoms, which may further reduce QoL. In contrast, cancer patients with a high Ttrait Emotionality Index may regulate their emotions, leading to an improved prognosis.[30] Individuals with a high Trait Mood Index may be better able to handle negative emotions such as anxiety and depression associated with cancer diagnosis and treatment, protecting against or
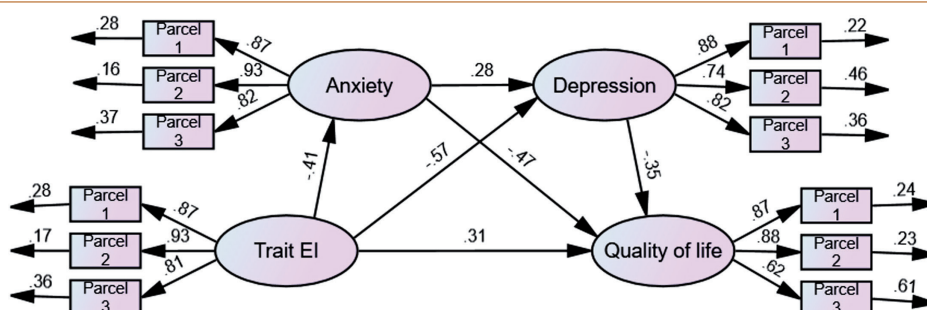

Figure 1. Structural equation model of trait emotional intelligence, anxiety, depression, and quality of life.

Table 3. Path Analysis of Emotional Intelligence, Anxiety, Depression, and Quality of Life

	β	P	SE	95% CI Lower Limit (BC)	95% CI Upper Limit (BC)
Direct effect					
Trait EI → anxiety	−0.41	<.001	0.03	−0.47	−0.30
Trait EI → depression	−0.57	<.001	0.04	−0.48	−0.65
Trait EI → quality of life	0.31	<.001	0.02	0.26	0.39
Anxiety → depression	0.28	<.001	0.03	0.18	0.32
Anxiety → quality of life	−0.47	<.001	0.08	−0.62	−0.32
Depression → quality of life	−0.35	<.001	0.12	−0.56	−0.19
Indirect effects mediated by anxiety					
Trait EI → depression	−0.13	<.001	0.02	−0.15	−0.09
Trait EI → quality of life	0.21	<.001	0.04	0.11	0.27
Indirect effects mediated by depression					
Trait EI → quality of life	0.20	<.001	0.05	0.12	0.30
Anxiety → quality of life	−0.11	<.001	0.04	−0.20	−0.08
Indirect effects mediated by anxiety and depression					
Trait EI → quality of life	0.10	.001	0.02	0.04	0.15

BC, correction deviation; SE, standard error.

minimizing the effects of negative emotions, thereby improving an individual's QoL.[15] Another study of cancer patients found that fear of cancer recurrence also mediated the relationship between trait EI and QoL.[24] A study involving 1388 medical students showed that trait EI was negatively associated with anxiety.[27] Another cross-sectional study found that the trait EI played a significant role in predicting anxiety symptoms in family caregivers.[28] The trait EI helps to prevent and reduce stress and stress-induced negative emotions,[18,29] which partly explains why people with a high trait EI report fewer symptoms.

This study also has some limitations. First, as a single-center cross-sectional study, the findings need to be further validated in future multicenter long-term follow-up cohort studies to explore the relationship between trait EI and QoL in lung cancer patients, and also the time after radiotherapy seems to play an important role in patient QoL. For example, the questionnaire could be set at 3, 7, and 15 days after radiotherapy. Completing the questionnaire at different times may have greater homogeneity to provide a more multidimensional understanding of the effect of trait EI on QoL. Second, this study was conducted only through a single self-questionnaire form, and in future studies, we will study from the objective level to have a comprehensive understanding of patients QoL through the dual assessment of doctors and clinical psychological scales, as well as the feedback from their families. Again, this study was conducted on lung cancer patients with brain metastases after radiotherapy, and in subsequent studies, we will consider more medical variables and objective factors, such as the intensity and cycle of radiotherapy, different complications that occur after brain metastases, and survival rates, in order to enrich the included disease models.

We believe that psychological interventions in the early stage of radiotherapy in lung cancer patients with brain metastases to improve patients' trait EI are particularly important to reduce anxiety and depressive symptoms. It is important for patients who suffer from emotional distress after radiotherapy, making QoL decrease and leading to lower survival. Therefore, training to improve trait EI after radiotherapy can 1) reduce negative emotional distress after psychological intervention, 2) improve QoL after radiotherapy, and 3) improve patient survival.

In conclusion, this study advocates the predictive validity of using trait EI after radiotherapy in lung cancer patients with brain metastases. Trait EI is an important factor affecting QoL, and patients who tend to use trait EI during subsequent treatment can adjust their adverse emotions more quickly, thus limiting the negative effects of radiotherapy.

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