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ORIGINAL RESEARCH

Impact of the 2019 Novel Coronavirus Disease (COVID-19) Epidemic on Radiotherapy-Treated Patients with Cancer: A Single-Center Descriptive Study

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Introduction: The present study investigated hospitalization data of patients receiving radiotherapy at Anhui Cancer Hospital during the COVID-19 epidemic and analyzed the impact of the epidemic on the clinical data of radiotherapy patients to provide references for the feasibility and safety of radiotherapy at other medical institutions.

Methods: The present study performed a retrospective analysis of hospitalization data of patients undergoing radiotherapy at the Radiation Department (from January 5 to March 19, 2020 according to the Chinese lunar calendar), who were defined as the epidemic group. Hospitalization data for patients undergoing radiotherapy during the same period in 2019 were used as the control group for comparison with the epidemic group in terms of sex, age, distribution of various cancer types, hospitalization costs, average length of stay, completion rate of radiotherapy, treatment mode, and purpose of radiotherapy.

Results: A total of 79 and 115 patients received radiotherapy in the epidemic group and control group, respectively. The number of patients who received radiotherapy declined 31.3% during the epidemic period. The number of head and neck cancer patients who received radiotherapy was 36 (45.57%) in the epidemic group and 32 (27.83%) in the control group, which was a significant difference (χ^2=6.476, P=0.011). The proportions of patients with other types of cancer decreased, with no significant difference between the two groups (P>0.05). No significant differences between the two groups were found in terms of other hospitalization data (P>0.05).

Conclusion: The total number of patients who received radiotherapy decreased during the epidemic period, but the proportion of head and neck cancer increased. The epidemic had no significant effect on other hospitalization data. While strengthening prevention and control measures, we should actively perform radiotherapy to ensure that cancer patients receive timely and safe treatment.

Keywords: COVID-19, radiation therapy, malignant cancer

Introduction

The beginning of 2020 coincided with the Chinese traditional Spring Festival, and a new type of coronavirus disease-2019 (COVID-19) quickly spread to various provinces in China and many countries worldwide.[1] The disease is highly infectious and exhibits an insidious onset, long incubation period, and rapid progression, and the general population is susceptible.[2] Many countries implemented strict control measures to restrict people's movement, such as self-isolation at home, strict access

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to the community, and traffic control. However, the treatment of cancer patients may be hampered to a certain extent due to the limitations on the mobility of the population.

China has a large cancer burden. Recent statistics[3,4] reported approximately 3.8 million new cancer cases and 2.3 million deaths in 2014, which accounted for more than 21% of cases worldwide. More than 50% of all cancer patients receive radiotherapy at some stage of the disease,[5] and the epidemic of the new coronavirus brought many inconveniences for cancer patient diagnosis and treatment.[6,7] Patients were required to undergo temperature monitoring and asked about the presence of cough, fever and diarrhea symptoms. They were also asked whether they had been to pandemic areas or had contact with COVID-19 positive or suspected patients. Patients from pandemic areas were isolated for 14 days after arrival in a new city. The limitations of endoscopic biopsies lead to an inability to diagnose cancer patients. Patients requiring hospitalization underwent routine blood work, chest CT scans and nucleic acid tests.

Yang et al[6] compared the wait intervals for the diagnosis and treatment of nasopharyngeal carcinoma (NPC) and pathology of standard treatment since the COVID-19 outbreak, and the results showed significant differences in the median days of waiting for pathological biopsy (5 vs 15, P=0.012), validation of the position and plan (20 vs 61, P<0.001), radiotherapy immobilization and simulation (3.5 vs 16.5, P<0.001) and initiation of radiotherapy (28 vs 36, P=0.005) between before and during the epidemic. Overall, the outbreak of COVID-19 caused a delay in the diagnosis and treatment of NPC patients. Middlewich et al[8] reviewed internal medicine admissions for patients without COVID-19 from March 15 to April 30, 2020 and found 409 patients admitted to internal medicine compared to a mean of 557 patients during the same period over the previous three years (2017–2019). Therefore, fewer patients were admitted to internal medicine wards during the outbreak. However, there were no significant differences between the two groups in sex, the number discharged home, the in-hospital mortality rate, the number discharged, or the patient functional level. However, patients admitted during the outbreak were younger (74.85 vs 76.86 years) and had a mean shorter length of stay (5.12 vs 7.63 days) than those admitted during the previous three years.

There are few studies on the impact of the COVID-19 epidemic on the hospitalization data of radiotherapy patients. Therefore, the present article compared the hospitalization data of radiotherapy patients admitted to a single cancer center from January 5 to March 19, 2020 (according to the Chinese lunar calendar) to the same period in 2019 and analyzed the impact of the epidemic on the clinical data of radiotherapy patients to provide references for cancer patients undergoing radiotherapy at other medical institutions.

Patients and Methods

Patient Enrollment

The following inclusion criteria were used: (i) histologically confirmed malignant cancer; (ii) indication of radiotherapy at our hospital; and (iii) radiotherapy time from January 29 to April 11, 2020 (from January 5 to March 19, 2020, according to the Chinese lunar calendar) and between February 9 to April 23, 2019 (from January 5 to March 19, 2019, according to the Chinese lunar calendar). The epidemic period coincided with the Chinese traditional Spring Festival in 2020, and people's lives and activities changed considerably compared to normal daily life and activities. Therefore, the comparison time is described according to the Chinese lunar calendar.

Data Collection and Groups

The present study used a retrospective cohort study method. We used the hospital medical record query system to collect hospitalization data for patients undergoing radiotherapy in the Radiotherapy Department during the epidemic period (from January 5 to March 19, 2020, according to the Chinese lunar calendar), which was defined as the epidemic group. Hospitalization data of patients undergoing radiotherapy during the same period in 2019 were used as the control group and compared to the epidemic group in sex, age, distribution of various disease types, hospitalization costs, average length of stay, completion rate of radiotherapy, treatment mode, and purpose of radiotherapy.

Statistical Methods

Statistical analyses were performed using SPSS 17.0. An independent samples t-test was used to compare continuous variables with a normal distribution between two groups, and the results are expressed as the means and standard deviation (SD). The Mann–Whitney U-test was used to compare continuous variables that did not conform to a normal distribution between two groups, and the results

are expressed as the median (interrogative range). Pearson's chi-squared or Fisher's exact test was used to compare categorical data, and the results are expressed as the number and percentage (%). $P< 0.05$ was considered significant.

Results

Sex and Age

The epidemic group consisted of 79 patients who received radiotherapy, including 49 (62.0%) males and 30 (38.0%) females, with an average age of 54.81±15.25 years (range, 9 to 86 years). A total of 115 patients received radiotherapy in the control group, including 73 (63.5%) males and 42 (36.5%) females, with an average age of 55.91 ±14.92 years (range, 5 to 85 years). There were no statistically significant differences in sex composition or age between the two groups ($P>0.05$). The number of radiotherapy patients declined 31.3% during the epidemic period. Table 1 presents the details of sex and age.

Distribution of Various Cancer Types

The proportion of head and neck cancer increased in the epidemic group compared to the control group (45.57% vs 27.83%), and the difference was statistically significant ($\chi^2=6.476$, $P=0.011$). The proportions of patients with other types of cancer decreased in the epidemic group, but there were no significant differences between the two groups ($P>0.05$). The details are presented in Table 2.

Hospitalization Costs

The hospitalization costs of esophageal cancer, head and neck cancer, and glioblastoma increased in the epidemic group compared with the control group, but the differences were not statistically significant ($P>0.05$). Conversely, the hospitalization costs of lung cancer, brain metastases, and breast cancer decreased in the epidemic group compared with the control group, but the differences were not statistically significant ($P>0.05$). The details of hospitalization costs are presented in Table 3.

Table 1 Comparison of Sex and Age Between the Two Groups of Patients

Project	Epidemic Group (79)	Control Group (115)	*P* value
Sex, n (%)			0.837
Male	49 (62.0%)	73 (63.5%)	
Female	30 (38.0%)	42 (36.5%)	
Age (years)			0.617
Mean (SD)	54.81±15.25	55.91±14.92	

Table 2 Comparison of the Distribution of Various Cancer Types Between the Two Groups of Patients

Cancer Types	Epidemic Group, n (%)	Control Group, n (%)	*P* value
Esophageal	12 (15.2%)	28 (24.3%)	0.121
Head and neck	36 (45.6%)	32 (27.8%)	0.011
Lung	3 (3.8%)	7 (6.1%)	0.705
Glioblastoma	10 (12.6%)	17 (14.8%)	0.674
Brain	8 (10.1%)	13 (11.3%)	0.795
Breast	3 (3.8%)	7 (6.1%)	0.705
Others	7 (8.9%)	11 (9.6%)	0.868

Average Length of Stay

The average length of stay for esophageal cancer and glioblastoma was longer in the epidemic group than in the control group, but the differences were not statistically significant ($P>0.05$). The average length of stay for head and neck cancer, lung cancer, brain metastases and breast cancer was shorter in the epidemic group than in the control group, with no statistically significant differences ($P>0.05$). The details of the average length of stay are presented in Table 4.

The Completion Rate of Radiotherapy, Treatment Mode, and Purpose of Radiotherapy

The completion rate of radiotherapy, treatment mode, and purpose of radiotherapy in the epidemic group did not

Table 3 Comparison of Hospitalization Costs for Various Cancers Between the Two Groups of Patients

Cancer Types	Epidemic Group (RMB) Mean (SD)	Control Group (RMB) Mean (SD)	*P* value
Esophageal	61,367.57±12,644.62	54,092.62 ±10,311.29	0.064
Head and neck	67,309.13±21,184.36	63,327.11 ±16,588.75	0.396
Lung	56,827.11±7732.98	57,278.66 ±18,660.02	0.970
Glioblastoma	64,902.62±15,500.03	64,215.83 ±15,174.99	0.911
Brain	27,048.50±6587.45	30,979.18 ±10,663.64	0.310
Breast	16,513.72±12,141.72	30,430.93 ±16,828.72	0.237

Table 4 Comparison of the Average Length of Stay for Various Cancers Between the Two Groups

Cancer Types	Epidemic Group (Days)	Control Group (Days)	*P* value
Esophageal mean (SD)	43.33±7.94	42.86±7.05	0.851
Head and neck median (IQR)	47(44.25,50.75)	47.5(44.25,50)	0.839
Lung mean (SD)	42.33±5.51	44.43±16.48	0.840
Glioblastoma mean (SD)	43.40±11.88	40.65±6.78	0.448
Brain mean (SD)	21.25±6.34	22.15±8.40	0.797
Breast mean (SD)	31.33±8.62	34.14±13.93	0.759

Table 5 Comparison of the Completion Rate of Radiotherapy, Treatment Mode, and Purpose of Radiotherapy Between the Two Groups of Patients

Project	Epidemic Group (79)	Control Group (115)	*P* value
Completion rate of radiotherapy, n (%)			
Complete	72 (91.1%)	105 (91.3%)	0.968
Incomplete	7 (8.9%)	10 (8.7%)	
Treatment mode, n (%)			
Concurrent chemoradiotherapy	50 (63.3%)	67 (58.3%)	0.482
Radiotherapy alone	29 (36.7%)	48 (41.7%)	
Purpose of radiotherapy, n (%)			
Palliative radiotherapy	14 (17.7%)	22 (19.1%)	0.804
Nonpalliative radiotherapy	65 (82.3%)	93 (80.9%)	

differ significantly from those in the control group ($P>0.05$). The details are presented in Table 5.

Discussion

COVID-19 is a systemic disease caused by the new Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV -2), which is most notable for causing substantial respiratory pathology.[9] The clinical symptoms of COVID-19 are primarily fatigue, fever, cough and shortness of breath. Some patients with severe disease have life-threatening multiple failures, such as myocardial dysfunction, acute kidney injury, hepatocellular injury, hyperglycemia and ketosis.[10,11] The incubation period for COVID-19 is generally 4–7 days, but it may be as long as 14 days.[12] The main routes of transmission are respiratory droplets and close contact, but fecal-oral transmission is also possible. Patients and people who are infected but asymptomatic during the incubation period are also infectious.[13] The disease is highly contagious with an insidious onset, a long incubation period, and rapid progression, and exhibits susceptibility in the general population. Therefore, the National Health Commission of China has included novel coronavirus pneumonia as a Group B infectious disease under the Law of the People's Republic of China on the Prevention and Control of Infectious Diseases and taken preventive and control measures as a Group A infectious disease while incorporating it into the management of quarantine infectious diseases.[14]

Cancer patients are a special immunocompromised population who have poor resistance and are more susceptible to neocoronary pneumonia and have a poor prognosis in COVID-19. According to nationwide statistics in China,[15] 1.13% of 1590 patients with COVID-19 had a history of cancer, which was significantly higher than the overall national cancer incidence rate (0.29%), and cancer patients were more likely than noncancer patients to have a higher risk of clinically serious events, develop severe illness and have higher mortality.

Radiotherapy is the primary treatment for malignant tumors. Cancer patients who do not receive timely and effective radiotherapy may develop tumor recurrence and metastasis and die.[16] COVID-19 is highly contagious. Therefore, ensuring the safety of patients and medical staff during the epidemic and ensuring that cancer patients receive timely radiotherapy are serious concerns facing the radiation oncology community. Wuhan was the hardest hit area by the COVID-19 epidemic. By organizing staff training, optimizing the treatment process for radiotherapy patients, strengthening disinfection and other protective measures, Hubei Cancer Hospital effectively ensured the safety of the radiotherapy center and a smooth treatment process for patients to avoid cross-infection between medical staff and patients.[17] The experience of other centers[18–21] supports the feasibility and safety of continuing radiotherapy during the COVID-19 pandemic via the adoption of reasonable preventive measures.

Our center is a cancer hospital that specializes in oncology but not a designated COVID-19 treatment unit. We set up an emergency infection control team and developed relevant preventive and control measures: All hospital staff and patients were required to wear masks and undergo temperature monitoring. Patients requiring hospitalization underwent routine blood work, chest CT scans

and nucleic acid tests. All radiation oncology staff were periodically trained on protection against COVID-19 by Video conference. We divided the medical regions into zones, optimized the radiotherapy patient workflow, performed strict disinfection in the radiotherapy areas and the wards, strengthened medical waste management and other measures. Patients with suspect or confirmed COVID-19 should be referred to a designated hospital through a dedicated corridor. Therefore, while strengthening prevention and control measures for the epidemic, the Radiotherapy Department of our hospital resumed radiotherapy treatment on January 5, 2020 to maximize the treatment of cancer patients without COVID-19 and ensure that they receive timely treatment. No COVID-19 infection of patients or medical staff occurred in our department during this time.

Xie et al[22] reported the clinical characteristics of 209 cancer patients who underwent radiotherapy during the COVID-19 outbreak in Wuhan, including 104 (49.8%) males and 105 (50.2%) females, with a median (interrogative range) age of 55 (48–64) years. The proportion of thoracic cancer was 38.3%, including breast, lung, and esophageal cancers. The proportion of head and neck cancer was 25.4%, and gastrointestinal or gynecological cancer accounted for 25.8%. However, there was no comparison with the same period in 2019 to determine the impact of the epidemic on disease distribution. The results of the present study indicated that 79 patients in the epidemic group and 115 patients in the control group received radiotherapy, and the number of patients declined 31.3% during the epidemic period. There were no statistically significant differences in sex composition or age between the two groups ($P>0.05$). The proportion of head and neck cancer increased in the epidemic group compared to the control group (45.57% vs 27.83%), and the difference was statistically significant ($\chi^2=6.476$, $P=0.011$). The following reason may explain the results: Due to delays in the treatment of surgical patients during the epidemic period, some patients with head and neck cancer chose radiotherapy, such as those with early-stage laryngeal and oral cancer, or radiotherapy before surgery, such as those with locally advanced oropharyngeal and hypopharyngeal cancer. Further study should address how epidemic affects the distribution of head and neck diseases.

Middlewich et al[8] found that the mean length of stay for patients during the epidemic period was shorter compared to 2017–2019 (5.12 vs 7.63 days), which may be related to the aforementioned efforts made by the hospital to free up potential beds. Yang et al[6] reported that COVID-19 screening included epidemiological investigations, chest CT scans and temperature monitoring, which increased the waiting time for cancer diagnosis and treatment. The results of our study showed that the difference in the average length of stay for patients with various cancers was not statistically significant between the epidemic and control groups. Because our facility is a cancer center, there are sufficient beds to treat cancer patients, and the results of COVID-19 screening were available on the same day, which had little impact on the length of stay and did not cause a significant increase in hospitalization costs.

Wang et al[7] found that radiation therapy and palliative service declined 58.3% and 100%, respectively. Unfortunately, details on palliative radiotherapy were not provided. Therefore, we could not compare the changes in the proportion of palliative radiotherapy across different regions. There is also no relevant literature reporting an increase in the proportion of palliative radiotherapy as a result of the epidemic. The current study suggests that the proportion of palliative radiotherapy in the epidemic group was similar to that in the control group (17.7% vs 19.1%, P>0.05). This result is consistent with the 25.3% of cancer patients receiving palliative radiotherapy reported by Xie et al.[22] The following reasons may explain the results: (i) Traffic control also limited hospital admissions for cancer patients who required palliative radiotherapy during the epidemic period. (ii) Some cancer patients who needed palliative radiotherapy feared traveling to the hospital or died at home because of the belief that the hospital was an epicenter of infection. Further study of the impact of the epidemic on palliative radiotherapy is needed at a later stage.

This study has the following limitations: (i) This study was a retrospective cross-sectional study, and the data collected are inevitably biased. (ii) This study was an analysis of a single cancer center with a small sample size. In the future, we should expand the number of hospitals for a multicenter and large-sample analysis. (iii) This study focused on the impact of hospitalization data on patients who started radiotherapy during the epidemic period. The impact of the epidemic on radiotherapy preparation and postradiotherapy follow-up should be investigated in the future.

Conclusion

During the epidemic period, the total number of patients who received radiotherapy decreased compared to the

same period during the previous year. With the exception of a slight change in the distribution of cancer type, the epidemic had no significant effect on sex, age, hospitalization costs, average length of stay, radiotherapy completion rate, treatment mode, or purpose of radiotherapy for inpatient radiotherapy patients. Along with strengthening normal epidemic prevention and control measures, radiotherapy centers should actively perform radiotherapy to ensure that cancer patients receive timely, effective and safe treatment.

Ethics and Consent Statements

The authors confirmed that the study was conducted in accordance with the Declaration of Helsinki. The Human Ethics Review Committee of Anhui Provincial Cancer Hospital, China, approved this study. All patients signed an informed consent to participate in the study.

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Disclosure

The authors report no conflicts of interest related to this work.

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