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Comparison of Diagnostic Value for Glioblastoma Between Conventional and Multi-Slice Spiral Computed Tomographies and Analysis of Factors Affecting Patients' Prognosis

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Abstract

Purpose: To explore the correlation of the computer tomography (CT) examination results of glioblastoma (GBM) patients with their histopathology.

Methods: A retrospective analysis was performed on 40 patients with suspected GBM, treated in our hospital from November 2011 to May 2015. Among them, there were 30 cases diagnosed with positive GBM by pathology. These 40 patients were scanned via conventional and multi-slice spiral CTs, respectively, and the scanning results were compared with those of the histopathology to analyze the efficacy of two kinds of CTs in the diagnosis of GBM. Logistic univariate and multivariate analyses were used in the analysis of factors affecting the prognosis of GBM.

Results: In the diagnosis of GBM, the sensitivity, specificity and consistency rate of conventional CT were lower than those of multi-slice spiral CT ($p<0.05$). According to the results of Logistic univariate and multivariate regression analyses, the independent risk factors for the poor prognosis of GBM included the position where GBM occurred, its degree of resection, cystic degeneration, intracranial infection, concurrent radiotherapy and chemotherapy.

Conclusions: The application of multi-slice spiral CT in GBM excels the conventional CT scanning and screening in the diagnostic efficacy. When conventional CT is not accurate enough to determine GBM lesions, multi-slice spiral CT is able to provide more refined imaging. The independent risk factors for the poor prognosis of GBM were the position where GBM occurs, its degree of resection, cystic degeneration, intracranial infection, concurrent radiotherapy and chemotherapy.

Keywords: glioblastoma, conventional CT, diagnostic value of multi-slice spiral CT, prognosis

Introduction

Glioblastoma (GBM) is a WHO grade IV tumor with extremely high malignancy, which is differentiated from astrocytes (Wang et al.,2016). GBM is characterized by low survival rate and high disability rate, bringing heavy losses to patients and their families (Verhoeff et al.,2016). GBM grows quite rapidly, and the patients are attacked in a very short process, thus causing great challenges to clinical treatments of GBM . Currently, the clinical treatment methods for the GBM patients are mainly radiotherapy, chemotherapy and resection, and discovering GBM as early as possible and conducting the corresponding treatments timely can improve the survival rate of GBM patients and prolong the survival time of them to a certain degree (Tosoni et al.,2016; Mujokoro et al, 2016). Therefore, accurate qualitative or quantitative diagnosis, grading and classification in the early stage greatly help to develop the GBM treatment schemes and predict the prognosis.

Clinically, computed tomography (CT) and other imaging technologies are often utilized to observe and diagnose GBM more intuitively, and the CT imaging was used to analyze the disease and predict prognoses. As scientific technologies develop, the latest multi-slice spiral CT allows three-dimensional imaging, thus providing more reliable bases for the

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diagnosis of the skull, liver and lung (Zunterer et al.,1999; Burger,1983; Hiwatashi et al. 2016). Studies have demonstrated that multi-slice spiral CT offers objective bases to the development of GBM treatment schemes and can not only analyze and measure the morphology of preoperative lesions in GBM patients, but also analyze the therapeutic effect on GMB, which is of great significance for predicting the treatment outcome of GBM patients and their prognoses (Zhuet al.,2017; Konar et al. 2017). In this study, the diagnostic value for GBM patients was compared between conventional CT and multi-slice spiral CT, and the clinical factors associated with the prognosis of GBM patients were analyzed.

1 General information and methods

1.1 General information

40 patients with suspected GBM, treated in our hospital from November 2011 to May 2015 were selected, and among them, there were 30 cases diagnosed with positive GBM by pathology. These 30 patients consisted of 20 males and 10 females, who were aged 28-79 years old and (55.86±18.75) years old on average (Table 1).

Inclusion and exclusion criteria: 1) Only GBM patients treated in our hospital were enrolled, and the inclusion criteria of all patients conformed to the international diagnostic criteria of GBM. 2) Patients with various familial hereditary diseases, patients complicated with other cancers besides GBM and those with allergic reaction to contrast agents, claustrophobia and other contraindications were excluded. All subjects or their family members signed the informed consent.

Table 1. **General clinical information of 30 patients diagnosed with GBM**

Factor		[n (%)]
Sex	Male	20 (66.67)
	Female	10 (33.33)
Age (years old)	≤55	12 (40.00)
	>55	18 (60.00)
BMI (kg/m^2)	≤23	15 (50.00)
	>23	15 (50.00)
Type	Isocitrate dehydrogenase (IDH) mutant GBM	16 (53.33)
	IDH wild-type GBM	14 (46.67)
Position of tumor	Frontal lobe	11 (36.67)
	Temporal lobe	7 (23.33)
	Parietal lobe	2 (6.67)
	Temporo-parietal lobe	5 (16.67)
	Parieto-occipital lobe	5 (16.67)
Cranial nerve damage	Yes	20 (66.67)
	No	10 (33.33)
Hemiplegia	Yes	18 (60.00)
	No	12 (40.00)
Intelligence decline	Yes	6 (20.00)
	No	24 (80.00)
Unilateral sensory disturbance	Yes	13 (43.33)
	No	17 (56.67)
Lymph node metastasis	Yes	6 (20.00)
	No	24 (80.00)

1.2 Main instruments and methods

1.2.1 Main instruments

Light Speed 16 CT scanner (SIEMENS, Germany) and ANATOM 16 HD multi-slice spiral scanner (Anke High-tech Co., Ltd., Shenzhen, China) were used.

1.2.2 Detection methods of conventional CT and multi-slice spiral CT

(1) Conventional CT examination: The Light Speed 16 CT scanner was applied to scan the transverse sections of patients' heads, with the scanning matrix, current and voltage set as 512 512, 300 mA and 120 kV, respectively.

(2) Multi-slice spiral CT examination: The ANATOM 16 HD multi-slice spiral scanner was utilized, and its voltage, current, scanning pitch, interval

and layer thickness were set as 120 kV, 240 mA, 0.3 mm, 0.33 mm and 0.67 mm, respectively. After the patients were instructed to lie in the supine position, the layered CT scanning was conducted for the skull, while the patients were injected with 60-80 mL Ultravist through the median veins of elbows. The low-dose test-bolus technique was adopted to scan the patients from the skull base to the calvaria.

1.2.3 Intracranial CT diagnostic standard of GBM (Burger et al.,1988)

The intracranial CT diagnostic standard of GBM was shown in Table 2.

Table 2. **Intracranial CT diagnostic standard of GBM**

Group	CT findings
Normal people	Low-density intra-cranial soft tissues
GBM lesion site	High-density lesions with a few solid parts at the front edges, visible cystic degeneration and necrosis inside and obvious edema around, which had irregular forms and unclear boundary.

1.3 Statistical methods

SPSS 17.0 (Bizinsight Information Technology Co., Ltd., Beijing, China) software system was used for statistical analysis. The measurement data were expressed as [n (%)]. The diagnostic accuracy rates of the two kinds of CTs were compared using χ^2 test. CT scan results and histopathological results were compared, and the diagnostic efficacy of two CTs for GBM was analyzed. Logistic univariate and multivariate analyses were used in the analysis of factors affecting the prognosis of GBM. $p<0.05$ suggested that the difference was statistically significant.

2 Results

2.1 Comparison of the diagnostic efficacy on GBM between conventional CT and multi-slice spiral CT

In the diagnosis of GBM, the conventional CT showed lower sensitivity (66.7%), specificity (60.00%) and consistency rate (65.00%) than the multi-slice spiral CT (93.33%, 80.0% and 90.00%), and according to the comparisons of sensitivity and diagnostic consistency rate between two kinds of CTs, there were statistically significant differences ($p<0.05$) (Tables 3, 4, 5).

Table 3. **Comparisons of conventional CT scanning results with the histopathological results**

Group	Pathological diagnosis		Total
	Positive	Negative	
Positive diagnosed via conventional CT	20	4	24
Negative diagnosed via conventional CT	10	6	16
Total	30	10	40

Table 4. **Comparisons of multi-slice spiral CT scanning results with the histopathological results**

Group	Pathological diagnosis		Total
	Positive	Negative	
Positive diagnosed via multi-slice spiral CT	28	2	30
Negative diagnosed via multi-slice spiral CT	2	8	10
Total	30	10	40

Table 5. **Comparison of diagnostic value for GBM between conventional CT and multi-slice spiral CT**

Group	Conventional CT	Multi-slice spiral CT	χ^2	*p*
Sensitivity	66.67% (20/30)	93.33% (28/30)	6.667	0.010
Specificity	60.00% (6/10)	80.00% (8/10)	0.952	0.329
Consistency rate	65.00% (26/40)	90.00% (36/40)	7.168	0.007

Note: The count data in the table is tested by 2. When the P value is less than 0.05, the difference is statistically significant.

2.2 Analysis of factors affecting the survival time of GBM patients

The single-factor analysis was conducted for the diagnosed 30 GBM patients, and the results showed

that the sex and age of patients and the onset time of GBM were not associated with the prognosis of GBM, without statistically significant differences (p>0.05). The adverse factors affecting the prognosis of GBM patients involved the position of tumors occurring, size, degree of resection, cystic degeneration, intracranial infection, and concurrent radiotherapy and chemotherapy, and the differences were statistically significant (p<0.05). Cox multivariate regression analyses revealed that the independent risk factors for the poor prognosis of GBM included the position where GBM occurred, degree of resection, cystic degeneration, intracranial infection, concurrent radiotherapy and chemotherapy, with statistically significant differences (p<0.05) (Tables 6, 7).

Table 6. **Single-factor analysis for GBM patients' prognoses**

	p	Hazard ratio (HR)	95% confidence interval
Sex (Male vs. female)	0.485	1.062	0.523-1.946
Age (55 years old vs. ≥55 years old)	0.143	3.765	2.346-4.427
Epilepsy (Yes vs. no)	0.013	0.436	0.356-0.821
Time of onset (≥30 d vs. 30 d)	0.232	3.518	1.265-4.124
Degree of resection (Type P vs. type T vs. type S vs. type Q)	0.001	2.341	1.834-2.701
Position (Frontal lobe vs. Temporal lobe)	0.001	2.853	1.906-3.314
Diameter of tumor (≥5 cm vs. 5 cm)	0.023	1.071	0.675-2.149
Cystic degeneration (Yes vs. no)	0.187	3.024	2.934-4.015
Intracranial infection (Yes vs. no)	0.004	2.746	1.868-4.103
Concurrent radiotherapy and chemotherapy (Yes vs. no)	0.032	0.689	0.535-0.912

Note: Logistic univariate analysis was used in the analysis of risk factors related to GBM prognosis.

Table 7. **Multi-factor analysis for GBM patients' prognosis**

	p	HR	95% confidence interval
Epilepsy (Yes vs. no)	0.016	0.756	0.458-0.937
Degree of resection (Type P vs. type T vs. type S vs. type Q)	0.001	1.548	1.277-2.205
Position (Frontal lobe vs. Temporal lobe)	0.001	2.096	1.906-3.578
Diameter of tumor (≥5 cm vs. 5 cm)	0.136	2.182	1.972-3.819
Intracranial infection (Yes vs. no)	0.012	2.034	1.953-4.503
Concurrent radiotherapy and chemotherapy (Yes vs. no)	0.005	0.471	0.256-0.984

Note: Logistic multivariate analysis was used in the analysis of factorsrelated to the prognosis of GBM.

3 Discussion

Multi-slice spiral CT is developed on the basis of double-layer spiral CT, but it is essentially different from double-slice spiral CT. It is another technical breakthrough in CT development; The goal of development is to scan the whole body with one exposure; the continuous advancement has been observed in detectors and spiral insertion technology in recent years; 64-slice spiral CT is the latest product (Tomizawa et al.,2019).

The main histopathological features of GBM are tumor necrosis, cleaved nucleus, vascular thrombosis, vascular proliferation and tumor cell polymorphism. Due to the space-occupying effect of tumors and the extremely rapid growth of GBM, GBM patients exhibit the increased intracranial pressure, cerebral edema and other adverse reactions, while the headache and vomit are the basic clinical manifestations of patients at the onset of GBM (Paulsson et al.,2014). When the infiltration of GBM has become so severe that it is able to damage cerebral tissues, the patients will suffer from permanent brain dysfunction, such as aphasia, uncontrollable retinal regulation and limb paralysis, greatly affecting GBM patients and their families (Christoffersen et al.,1998; Giovagnoli, 1993). GBM has very poor prognosis. Some related research data have shown that once the patients are diagnosed with GBM, their average survival time is 10 months, and the disease courses of most patients are within half a year, with only 9% of patients surviving for more than 1 year. What's worse, the postoperative 3-year survival rate of GBM patients is less than 5% (Huang et al., 2015; Szekeres et al., 2014). Therefore, early diagnosis and timely implementation of treatment schemes for GBM patients have great influences on the prolonging of GBM patients' survival time and the improvement of prognosis. At present, in addition to the gold standard of the histopathological

diagnosis, CT scanning technology is typically applied for the clinical diagnosis of GBM. Numerous clinical applications have demonstrated that CT scanning can accurately reflect the position and features of GBM lesions, but up to date, CT technology has been developing and innovating, with an increasing clinical application value, as scientific technologies progress (Yang et al., 2019; Kim et al., 2009). In the present study, not only were the diagnostic value of the two different CT technologies and GBM histopathology compared, but the correlation of CT diagnosis with the prognosis of GBM patients was also analyzed.

In this study, 40 patients with suspected GBM received the scanning via the conventional CT and multi-slice spiral CT, respectively, and the scanning results were compared with the histopathological results to analyze the diagnostic efficacy of the two kinds of CTs on GBM. According to the analysis results, in the diagnosis of GBM, the sensitivity, specificity and consistency rate of the conventional CT were 66.7%, 60.00% and 65.00%, lower than those of the multi-slice spiral CT (93.33%, 80.0% and 90.00%), and the comparisons of the sensitivity and consistency rate between the two CT methods showed statistically substantial differences (p<0.05). This is similar to the result of the study conducted by Patel et al (Patel and Kazerooni, 2005), who diagnosed GBM using multi-slice spiral CT and found that the multi-slice spiral CT had higher diagnostic sensitivity and consistency rate for GBM than conventional CT, and could reveal the position, size and infiltration range of lesion tissues more clearly and obviously, more conductive to the clinical observation. Subsequently, Logistic univariate regression analysis was firstly conducted, and the analysis results showed that the adverse factors affecting the prognosis of GBM patients included the position where tumors occurred, size, degree of resection, cystic degeneration, epilepsy, intracranial infection and concurrent radiotherapy and chemotherapy, and the differences were statistically significant (p<0.05). Then, the results of Logistic multivariate regression analysis manifested that the above adverse factors except the size served as the independent risk factors for the poor prognosis of GBM, displaying statistically significant differences (p<0.05). These results are consistent with those in the study of Nohelty et al (Chiang et al., 2017). They also analyzed the affecting factors for the survival time of GBM patients and found that the position GBM occurred, its degree of resection, and whether there was intracranial infection and different treatment methods could be the prognosis factors for GBM, perfectly demonstrating the results of the present study. According to the results of this study and the demonstration of the related literature, it is held that multi-slice spiral CT can diagnose GBM more accurately than conventional CT, and the patients are supposed to receive multi-slice spiral CT scanning timely to confirm whether GBM exists, and on the elaborate imaging basis of multi-slice spiral CT, each lesion factor relevant to GBM prognosis should be observed, so as to provide reasonable treatment and important prognosis bases for GBM.

In the present study, the sample size of study subjects is small. The correlation between multi-slice spiral CT and the specific efficacy of GBM has not been studied. Some deviations of experiment results may be produced. The number of study subjects will be increased in future, and the follow-up will be conducted for the included subjects.

Conclusion

In conclusion, the application of multi-slice spiral CT in GBM exhibits better diagnostic efficacy than the conventional CT scanning. When the conventional CT fails to accurately determine GBM lesions, multi-slice spiral CT can provide more refined imaging. According to the results of Logistic univariate and multivariate regression analyses, the independent risk factors for the poor prognosis of GBM included the position where GBM occurred, its degree of resection, cystic degeneration, intracranial infection, concurrent radiotherapy and chemotherapy. Therefore, only the individualized comprehensive treatment schemes are developed based on different conditions of GBM patients, with regular review, and measures targeting complications are timely taken, the survival time of patients may be effectively extended. Multi-slice spiral CT is taken as a screening method and important basis to provide GBM patients with reasonable treatments.

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