Clinicopathological Characteristics, Survival Outcomes and Prognostic Factors in Pleomorphic Carcinoma: A SEER Population-based Study

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Abstract

Background: Pulmonary pleomorphic carcinoma (PPC) is a rare tumor, and it usually has an aggressive clinical course and poor prognosis. We aim to analyze the clinicopathological features, management and prognostic factors of pulmonary pleomorphic carcinoma.

Patients and methods: Using the Surveillance, Epidemiology, and End Results (SEER) database, we identified 310 patients of pulmonary pleomorphic carcinoma from 2004 to 2014 including clinicopathological characteristics, treatment modalities and outcome data.

Results: The mean age of all PPC patients was 66 years and 59.4% of the patients were male. Most patients (79.4%) were white people, 51.6% were found in the right lung, and lesions were mostly observed in upper lobe (57.7%). The median overall survival was 12 months and overall 1-, 3- and 5- year survival rate was 42.5%, 28.6%, 24.1%. In Kaplan-Meier analysis, tumor primary site, lymph node metastases, distant metastases, summary stage, chemotherapy and surgery were associated with overall survival. Patients with surgery or chemotherapy have a better OS for patients with PPC. However, we found that radiotherapy did not significantly improve OS Multivariate Cox analysis revealed that SEER summary stage, distant metastases, surgery and chemotherapy were found to be independently associated with the OS.

Conclusions: PPC mostly occurred in white people, with a median age of 66 years, and men were more susceptible to this disease. The SEER summary stage, distant metastases, surgery and chemotherapy were independently associated with prognosis.

1. Background

Pleomorphic carcinoma (PC), also called sarcomatoid carcinoma, is a rare malignancy pathological type and it has a dual-cell component of spindle and/or giant cells, and epithelial cells[1, 2]. According to the revised 2004 World Health Organization classification, PC was one of the five subtypes of sarcomatoid carcinomas, including spindle cell carcinoma, giant cell carcinoma, carcinosarcoma, pleomorphic carcinoma, and pulmonary blastoma[3]. PC could be found in almost any site in the body and most of this originated from the respiratory system. This tumor originated from respiratory system is called pulmonary pleomorphic carcinoma (PPC). PPC is defined as a poorly differentiated non-small-cell lung cancer (NSCLC) with a sarcomatoid tumor component of at least 10% and a poor prognosis compared to other types of NSCLC[2, 4]. In the past, because of the lack of a conclusive definition and the rarity of pulmonary pleomorphic carcinoma, no consensus had been reached regarding its diagnosis[5]. After 1999, a unified diagnostic standard was established for PPC, which was recognized as a neoplasm with pleomorphic, sarcomatoid or sarcomatous elements in the category of carcinomas[6]. The pathological type of diagnosis is no longer a problem by using advanced pathological diagnostic techniques[5, 7, 8].

PPC had a worse outcome than other NSCLC and the optimal treatment of patients remains unknown[9]. Treatment modalities of PPC has varied across previous reports. In the early stage of this type of cancer,

surgical excision may be the preferred method of treatment and the key to prevent recurrence and metastasis[10]. However, some researchers documented that the prognosis of patients with pleomorphic carcinoma was poor despite surgery and adjuvant chemotherapy, even in the case of local disease[11]. Effective therapeutic modalities combined with surgery should be evaluated to improve outcomes, even when the tumor is at an early stage[10, 12, 13]. Thus, systemic therapy of PPC needed to be explored.

Owing to the PPC is a rare histologic subtype, patients with this type of pathology are rare[14]. A review of the literature did not find any specific systematic reports of this tumor[15]. The general population, clinicopathological characteristics of patients with this type of pathology are not well known. Therefore, we aimed to explore a retrospective analysis of patients with PPC by using the Surveillance, Epidemiology, and End Results (SEER) database, predict trends in overall demographic features, basic clinicopathologic characteristics and compare treatment modalities and outcome of PPC.

2. Patients And Methods

2.1. Patients

The SEER database was used to extract basic clinicopathologic characteristics and survival data. Clinicopathological information was extracted by using the SEER*Stat 8.5.0 software. According to the International Classification of Diseases for Oncology codes (ICD-O-3), all cases with a diagnosis of PC were identified in the SEER database between 2004 and 2014. Preliminary selection criteria for study cases included: 1) diagnosis of PC; 2) histological confirmation of pleomorphic carcinoma (8022/3); 3) diagnosis between 2004 and 2014. Exclusion criteria were: 1) not the first primary malignancies; 2) non-American Joint Committee on Cancer (AJCC); 3) unknown summary stage; 4) unknown regional lymph nodes examination; 5) unknown survival time; 6) unknown treatment. Institutional review board approval was not required, as SEER does not uncover sensitive patient information.

2.2. Statistical analysis

In the present study, we used overall survival (OS) as the time from diagnosis to death from any cause, and patients alive were censored at the time of the last recording. Patients who died from other causes unrelated to pleomorphic carcinoma diagnosis or were alive were censored on the date of death or the date of last contact.

For statistical analysis, the demographic and clinicopathologic parameters were selected on the following propensity factors: age, gender, race, marital status, tumor primary site, pathologic grade, treatment modality, outcome status and so on. We identified some of all the cases don’t contain all these data. Statistical analysis was performed using the software Graph Pad Prism 7.0 and SPSS (version 22; IBM, Chicago, IL). Continuous data were compared using a Student’s t-test, and categorical data were compared using a Chi-square test. To adjust for differences between patients receiving radiotherapy and those not receiving radiotherapy, a propensity 1:1 matched analysis was conducted. Propensity scores were calculated using logistic regression model for each patient in the comparing groups. The covariates

included in the regression were sex, age, marital status, primary site, SEER summary stage, lymph node surgery and so on. Covariates balance between two groups was examined by Chi-square test. The OS was estimated using the Kaplan-Meier product-limit method and compared by log-rank test. To predict the predictors of the prognosis, the Cox proportional hazards model was used. In statistical analysis, variables with $p < 0.1$ in univariate analysis were included in a multivariate analysis. Univariate and multivariate Cox proportional hazard models were applied to identify factors associated with survival, with hazard ratios (HRs) and 95% confidence intervals (CIs) reported. The values of $p < 0.05$ were considered statistically significant, and all statistical tests were two sided.

3. Results

3.1. Patient characteristics

According to the inclusion criteria mentioned above, a total of 582 patients with PC in the SEER database. A peak incidence occurred at 60~70 years. This type of pathology was found in almost any site of the body. However, the most common position of the PC was the lung and bronchus (n = 310, 53.2%). This tumor originated from lung and bronchus is called pulmonary pleomorphic carcinoma (PPC). The second most common site for this type of pathology is in the breast (n =148, 25.4%). Details of these analysis were shown in Figure 1.

As described in Table 1, the PPC 310 patients had a median age of 66 (16-95), and most patients (51.3%) were married. Of the patients, 184 was male (59.4%) and 126 female (40.6%). Most patients (79.4%) were white people and 51.6% of lesions were observed in the right lung. Most lesions were observed in upper lobe (57.7%) and lower lobe (23.2%). Regional lymph node metastasis was found in 144 (46.4%) patients and 107 (34.5%) had distant metastasis at diagnosis. Among 310 included cases, 57 were categorized with a localized stage, and 121 had regional stage; but 132 had distant stage.

Table 1

Characteristics of 310 patients with PPC

	Value (310)		
Variable	Alive	Dead	Total
Age			
≤66 years	52	104	156
> 66 years	35	119	154
Gender			
Female	39	87	126 (40.6%)
Male	48	136	184 (59.4%)
Ethnicity			
White	71	175	246 (79.4%)
Black	12	35	47 (15.2%)
Other	4	12	16 (5.2%)
Unknown	0	1	1
Marital Status			
Married	47	112	159 (51.3%)
Single(Unmarried)	10	33	43 (13.9%)
Separated/Divorced/Widowed	23	70	93 (30.0%)
Unknown	7	8	15
Grade			884
Well	0	1	1 (0.3%)
Moderate	0	1	1 (0.3%)
Poor	50	97	147 (47.4%)
Undifferentiated	15	26	41 (13.2%)
Unknown	22	98	120 (38.7%)
Summary Stage			
Distant	11	121	132 (42.6%)
Regional	46	75	121 (39.0%)
Localized	30	27	57 (18.4%)
Laterality			

Left	35	103	138 (44.5%)
Right	52	108	160 (51.6%)
Bilateral	0	6	6 (1.9%)
Unknown	0	6	6
Primary Site			
Main Bronchus	0	7	7 (2.3%)
Upper lobe, lung	63	116	179 (57.7%)
Middle lobe, lung	4	9	13 (4.2%)
Lower lobe, lung	18	54	72 (23.2%)
Overlapping lesion of lung	2	6	8 (2.6%)
Lung, NOS	0	31	31 (10.0%)
Lymph Node Metastases			
Yes	35	109	144 (46.4%)
No	52	102	154 (49.7%)
Unknown	0	12	12
Distant Metastases			
Yes	8	99	107 (34.5%)
No	78	117	195 (62.9%)
Unknown	1	7	8
Surgery			
Yes	69	96	165 (53.2%)
No	17	127	144 (45.5%)
Unknown	1	0	1
Radiation			
Yes	25	75	100 (32.2%)
No	60	147	207 (66.7%)
Unknown	2	1	3
Chemotherapy			
Yes	41	86	127 (41.0%)

No	46	137	183 (59.0%)

3.2. Patient survival

Among the 310 PPC cases, the median length of follow-up time was 20.45 months (range, 0-129 months). The 1-, 3- and 5-year OS rate of PPC was 42.5%, 28.6%, 24.1% (Figure 2A). In Kaplan-Meier analysis, tumor primary site, summary stage, lymph node metastases, distant metastases, chemotherapy and surgery were associated with OS. Lesions in right lung tended to have better prognosis than those with left lung ($p = 0.051$, Figure 2D). Figure 2B shows patients with distant stages had significantly poorer OS than those with localized or regional stage ($p < 0.001$ for both). Univariate and multivariate Cox proportional hazard models were utilized to further investigate factors associated with survival. In univariate analysis, factors were proved to be significantly associated with OS including tumor primary site, summary stage, lymph node metastases, distant metastases, chemotherapy and surgery. Table 2 reveals patients with lymph node metastases or distant metastasis were associated with poor prognosis ($p < 0.001$). Surgical resection and chemotherapy were protective factors. Patients with lesions in lung lobes had a better OS compared with those in the main bronchus ($p < 0.001$), but prognosis did not differ in patients with different lung lobes. Multivariate Cox analysis found that the distant metastases [$p = 0.042$, HR 95% CI: 0.565 (0.326-0.979); no distant metastases - as Ref], regional stage [$p < 0.001$, HR 95% CI: 0.368 (0.223-0.609), distant stage - as Ref], localized [HR 95% CI: 0.216 (0.117 - 0.400), $p < 0.001$, distant stage - as Ref], surgery [$p = 0.011$, HR 95% CI: 0.530 (0.324-0.867); no surgery - as Ref], chemotherapy [$p = 0.001$, HR 95% CI: 0.582 (0.422-0.803); no chemotherapy - as Ref] were found to be independently associated with the OS.

Table 2

Univariate and multivariate Cox proportional hazard analyses of clinical characteristics for overall survival rates in patients with PPC

	Univariate		Multivariate	
Characteristic	HR (95%CI)	*p* value	HR (95%CI)	*p* value
Age		0.130		
≤ 66 years	Reference			
> 66 years	1.225 (0.941-1.595)	0.131		
Gender		0.067		
Male	Reference		Reference	
Female	0.777 (0.593-1.018)	0.067	0.997 (0.733-1.356)	0.983
Marital Status		0.183		
Married	Reference		Reference	
Single	0.703 (0.476-1.038)	0.076		
S/D/W	0.816 (0.539-1.236)	0.338		
Grade		0.833		
I/II	Reference			
III	1.334 (0.316-5.633)	0.695		
IV	0.925 (0.600-1.427)	0.725		
Summary Stage		< 0.001		0.002
Localized	Reference		Reference	
Regional	1.702 (1.092-2.652)	0.019	1.959 (1.191-3.223)	0.008
Distant	0.134 (0.085-0.209)	< 0.001	3.440 (1.658-7.136)	0.001
Laterality		0.060		
Left	Reference		Reference	
Right	0.771 (0.587-1.012)	0.061	0.950 (0.696-1.295)	0.744
Primary Site		< 0.001		0.550
Upper lobe	Reference		Reference	
Main Bronchus	6.738 (3.04-14.819)	< 0.001	3.008 (1.268-7.137)	0.012
Middle lobe	1.159 (0.587-2.286)	0.671	1.436 (0.703-2.934)	0.321
Lower lobe	1.309 (0.948-1.809)	0.102	1.385 (0.983-1.952)	0.063
Overlapping lesions	1.051 (0.460-2.401)	0.907	1.363 (0.545-3.409)	0.509

LNM		0.004		0.860
Yes	Reference	Reference		
No	0.672 (0.512-0.881)	0.004	0.970 (0.688-1.367)	0.860
DM		< 0.001		
Yes	Reference	Reference		
No	0.217 (0.161-0.294)	< 0.001	0.565 (0.326-0.979)	0.042
Surgery		<0.001		
No	Reference	Reference		
Yes	0.231 (0.173-0.309)	< 0.001	0.530 (0.324-0.867)	0.011
Chemotherapy		0.012		
No	Reference	Reference		
Yes	0.708 (0.540-0.927)	0.012	0.582 (0.422-0.803)	0.001
Radiation		0.375		
No	Reference			
Yes	0.881 (0.666-1.166)	0.376		

I/II: Well/Moderate; III: Poor; IV: Undifferentiated;

S/D/W: Separated/Divorced/Widowed;

LNM: Lymph Node Metastases; DM: Distant Metastases;

Statistical analyses were performed using SPSS.

*$p < 0.05$ was considered significant.

3.3. Patient treatment

Overall, treatment strategies were provided in all the 209 patients. Among these patients, 53.3% (n = 165) patients received surgery, 41.0% (n = 127) patients received chemotherapy and radiotherapy was performed for 32.2% (n =100). Patients with surgical resection (Figure 2F) had significantly better prognosis than those with non-surgery and the median OS improved from 8.7 to 53.6 months ($p < 0.001$). Table 3 shows the demographic and clinicopathological features of between surgery group and non-surgery. From the table, we concluded that patients with surgical resection were more likely to have it in the upper lobe of lung, right lung, and were less likely to undergo radiotherapy, lymph node metastases,

distant metastases and distant stage. Besides, multivariate logistic analyses showed that radiotherapy and SEER stage were significantly associated with surgery ($p < 0.05$ for both). The OS was significantly better in patients with chemotherapy than in the patients with non-chemotherapy (Figure 2G). As showed in the Table 4, patients with chemotherapy were more likely to be younger, have lymph node metastases, receive radiotherapy and without a localized stage. Besides, multivariate logistic analyses revealed that patients with younger age, SEER distant stage and radiotherapy were significantly associated with chemotherapy. However, there was no additional significantly survival benefit to adjuvant radiotherapy ($p > 0.05$ for both, Figure 2H). The PPC patients included 207 with radiotherapy and 100 patients without radiotherapy, patients with radiotherapy tended to be younger, have it in lymph node metastases, distant metastases, receive chemotherapy and were less likely to undergo surgical resection (Supplementary Table 1). Further, multivariate logistic analyses showed that patients with younger age (≤66), chemotherapy and surgery were significantly associated with radiotherapy ($p < 0.05$ for all). PSM method was conducted to reduce the differences of variables between the groups. A total of 67 patients with radiotherapy were matched with 67 patients without radiotherapy. The comparison analysis revealed no significant difference in clinical characteristics between patients with and without radiotherapy after PSM (Supplementary Table 1). And radiotherapy had no significantly better OS than non-radiotherapy group by the survival curve and Log-rank analysis (Supplementary Figure 1).

Table 3

Patient Characteristics by surgery treatment.

Characteristic	Surgery (N=165)	Non-Surgery (N=144)	*p* value
Age			0.945
≤ 66 years	83	73	
> 66 years	82	71	
Gender			0.119
Female	91	92	
Male	74	52	
Ethnicity			0.279
White	135	110	
Black	20	27	
Other	9	7	
Marital Status			0.053
Married	15	27	
Single (Unmarried)	90	69	
S/D/W	50	43	
Grade			< 0.001
I	0	1	
II	0	1	
III	49	98	
IV	12	29	
Summary Stage			< 0.001
Distant	14	118	
Regional	102	19	
Localized	49	7	
Laterality			0.004
Left	68	69	
Right	97	63	
Bilateral	0	6	

Primary Site			< 0.001
Main Bronchus	1	6	
Upper lobe, lung	104	74	
Middle lobe, lung	8	5	
Lower lobe, lung	46	26	
Overlapping lesion of lung	5	3	
Lung, NOS	1	30	
Lymph Node Metastases			< 0.001
Yes	58	86	
No	105	48	
Distant Metastases			< 0.001
No	155	39	
Yes	9	98	
Radiation			< 0.001
Yes	35	65	
No	128	78	
Chemotherapy			0.398
Yes	72	56	
No	93	88	
I: Well; II: Moderate; III: Poor; IV: Undifferentiated;			
S/D/W: Separated/Divorced/Widowed;			
Statistical analyses were performed using SPSS.			
*$p < 0.05$ was considered significant.			

Table 4

Patient Characteristics by chemotherapy treatment.

Characteristic	Chemotherapy (N=165)	Non-Chemotherapy (N=144)	*p* value
Age			< 0.001
≤ 66 years	82	74	
> 66 years	46	108	
Gender			0.810
Female	77	107	
Male	51	75	
Ethnicity			0.132
White	95	151	
Black	24	23	
Other	9	7	
Marital Status			0.559
Married	17	26	
Single (Unmarried)	69	90	
S/D/W	34	59	
Grade			0.287
I /II	2	0	
III	65	82	
IV	18	23	
Summary Stage			< 0.001
Distant	49	83	
Regional	63	57	
Localized	15	42	
Laterality			0.063
Left	50	88	
Right	75	85	
Primary Site			0.350
Upper lobe, lung	86	93	

Main Bronchus	2	5	
Middle lobe, lung	3	10	
Lower lobe, lung	30	42	
Overlapping lesion of lung	5	5	
Lymph Node Metastases			< 0.001
Yes	76	68	
No	50	104	
Distant Metastases			0.374
No	85	110	
Yes	41	66	
Surgery			0.398
Yes	72	93	
No	56	88	
Radiation			< 0.001
Yes	67	33	
No	60	147	

4. Discussion

Pulmonary pleomorphic carcinoma (PPC) is a rare malignant tumor that combines spindle or giant cell carcinoma with any of the more common types of NSCLC[12]. Reviewing the literature, the incidence of PPC has been reported to range from 0.1% to 0.4% of all pulmonary malignancies[6]. Owing to the limitation of biopsy tissues, PPC sometimes may be diagnosed inaccurately and easily misdiagnosed as the other 4 subtypes of sarcomatoid cancer[3]. Some cases have been reported that some atypical symptoms of patients with PPC may appear, such as chest pain, irritate cough, hemosputum, fever and weight loss[16, 17]. Previous studies have shown that PPC commonly occurs in older adults, with a median age of 60-70 years, has a strong male predominance, is associated with smoking[18, 19]. Because of its rarity, except for sporadic case reports and small retrospective case series, there is no adequate data to describe PPC demographics[11]. In our study, PPC is more common in males than in females, with the ratio was about 1.46:1. Patients were diagnosed between the ages of 39 and 94 and the mean age of all patients was 66 years. PPC patients were ever reported in different ethnic groups. The exact incidence was not reported in different ethnic groups because of the rare number[3]. However, our analysis demonstrated about 79.6% of patients with PPC were white people. As the largest analysis of PPC to date, we summarized the correlation between the prognosis of PPC and clinicopathological factors. The 5-year OS and median OS of PPC were 24.1% and 20.45 months, respectively. In addition, our

findings indicated that right lung lesions maybe have a better OS than patients with left lung. Lesions were common observed in upper lobe and lesions in lung lobes had a better prognosis compared with those in the main bronchus.

The effects of lymphatic metastasis on the prognosis of PPC are controversial. Some reports revealed that the lymph node metastasis was the factors deeply affected OS and patients with pNx disease were significantly worse than those in patients with pN0 disease[15, 20]. However, Fujisaki et al. found that lymph node metastasis did not predict OS, and pN1 patients had not significantly a better OS compared with pN0 patients[21]. In our study, we found that patients without lymph node metastasis had a better prognosis compared with those with lymph node metastasis in Kaplan-Meier survival analysis. But there was no significant effect between them by multivariate analysis. Several previous studies, in which large number of patients were analyzed, have reported that TMN stage was associated with poor prognosis[22]. In the present series, TMN stage was also regarded as a prognosis factor of this disease. The TMN stage of PPC was incomplete and only a thirds of them was found in the SEER database. The AJCC stage is a valuable tool for physicians to make treatment plan and prognosis evaluation, which has been widely used in clinical settings[23, 24]. Similarly, the SEER summary stage has simplified and standardized staging to ensure consistent definitions over time, which provide a measure of disease progression[23]. Therefore, we included SEER summary stage instead of TNM stage in COX multivariate analysis. We found that distant metastasis and distant stage were associated with poor prognosis. Furthermore, distant metastasis and SEER summary stage were significantly associated with OS in both univariate and multivariate Cox analysis.

Compared with other subtypes of non-small cell lung cancer, PPC is prone to invasion of the chest wall and mediastinal tissues and often has a poor prognosis[3, 5, 25]. As reported previously, the biological behavior of pleomorphic carcinoma is highly malignant and even an early tumor may invade the blood vessels, early pulmonary pleomorphic carcinoma without lymphatic metastasis may recur or metastasize[5, 26]. The optimal treatment of patients with pleomorphic carcinoma remains unclear. However, as revealed by most studies, the effects of radical resection on pulmonary pleomorphic carcinoma are better than those of palliative resection. Surgical treatment only had a certain effect on pulmonary pleomorphic carcinoma without lymph node metastasis, and the operative effect of lymph node metastasis was not obvious[6, 22]. Raveglia et al. resported that patients without lymphatic metastasis had a better OS than those with lymphatic metastasis by surgery[15]. In our study, patients with surgery group had a better OS than non-surgery and the prognosis was significantly improved. Furthermore, surgery was independently associated with the OS. Thus, surgery is the first choice for the early stage of pulmonary pleomorphic carcinoma patients. Previous reports documented that the prognosis of patients with pulmonary pleomorphic carcinoma was poor despite surgery and adjuvant chemotherapy[15]. In terms of adjuvant therapies, there is no consensus on the treatment of PPC even among specialists. Since few studies have reported on the use of radiotherapy for PPC, the therapeutic effect remains unclear[12, 14]. In this study, there was no significant effect on outcomes of radiotherapy. Besides, after adjusting for other variables, no significant survival difference betweem radiotherapy and non-radiotherapy could be observed. Bae et al. reported a poor response and high recurrence in advanced

PPC patients treated with chemotherapy regimens effective against NSCLC[27]. Katsuhirocase et al. resported cisplatin and vinorelbine were effective as a neo-adjuvant therapy for PPC patients[28]. In our study, we found that patients who received chemotherapy had better survival than patients without chemotherapy and chemotherapy were found to be independently associated with the OS. Therefore, the effects of chemotherapy and radiotherapy on pulmonary pleomorphic carcinoma need to be further confirmed in multi-center, large-scale clinical studies. In recent years, novel targeted treatments and PD-1 inhibitors have brought new treatment opportunities to advanced patients. Some case revealed Epidermal growth factor receptor (EGFR) mutations or KRAS mutations were identified in some PPC patients[29], but the therapeutic effect is not clear.

Similar to other studies using SEER as a data source, it is acknowledged that our study has limitations. Firstly, as the largest analysis of PPC to date, the sample of our study was still small, due to the low incidence of PPC. However, particularly in the case of the rarer subtypes, it is unlikely that greater case numbers will be found in any other form of study. Secondly, We lack clinical data for most patients,such as pathological grade, TNM stage, lymph node metastases and so on. We found 583 PPC patients in SEER, but just 310 patients had recorded distant metastases and lymph node metastases. Thirdly, a detailed survival analysis of treatment by SEER summary stage was carried out in this study, however the statistical power of this analysis was limited because of low PPC case numbers. Finally, the retrospective nature of our investigation may have introduced bias into the overall analysis.

5. Conclusion

The most common type of pleomorphic carcinoma is pulmonary pleomorphic carcinoma. PPC is a rare type of cancer, which has an aggressive clinical course and poor prognosis. The main interest of this study is to predict basic clinicopathologic characteristics and survival. As the largest database available on PPC, a total of 310 PPC patients with complete case information were found in the SEER database In short, our research indicated that PPC mostly occurred in white people, with a median age of 66 years, has a strong male predominance. Most patients were married and more than half of lesions were observed in the right lung and upper lobe. Moreover, the presence of SEER summary stage, distant metastases were to be an independent prognostic factor for PPC, while surgery and chemotherapy was an independent protective factor.

Abbreviations

PPC: Pulmonary pleomorphic carcinoma；SEER: Surveillance, Epidemiology, and End Results；

NSCLC: non-small-cell lung cancer；OS: overall survival；HR:hazard ratio;

Propensity Scores Method: PSM; PD-1: Programmed cell death-1;

Declarations

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Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Availability of data and material

All data discussed in the manuscript are included within this published article.

Authors' contributions

ZZC and JCL wrote and revised the manuscript. LFM is the main preceptor. All authors read and approved the final manuscript.

Competing interests

The authors declare that they have no competing interests.

Data Availability

The original data came from the SEER database.

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Figures

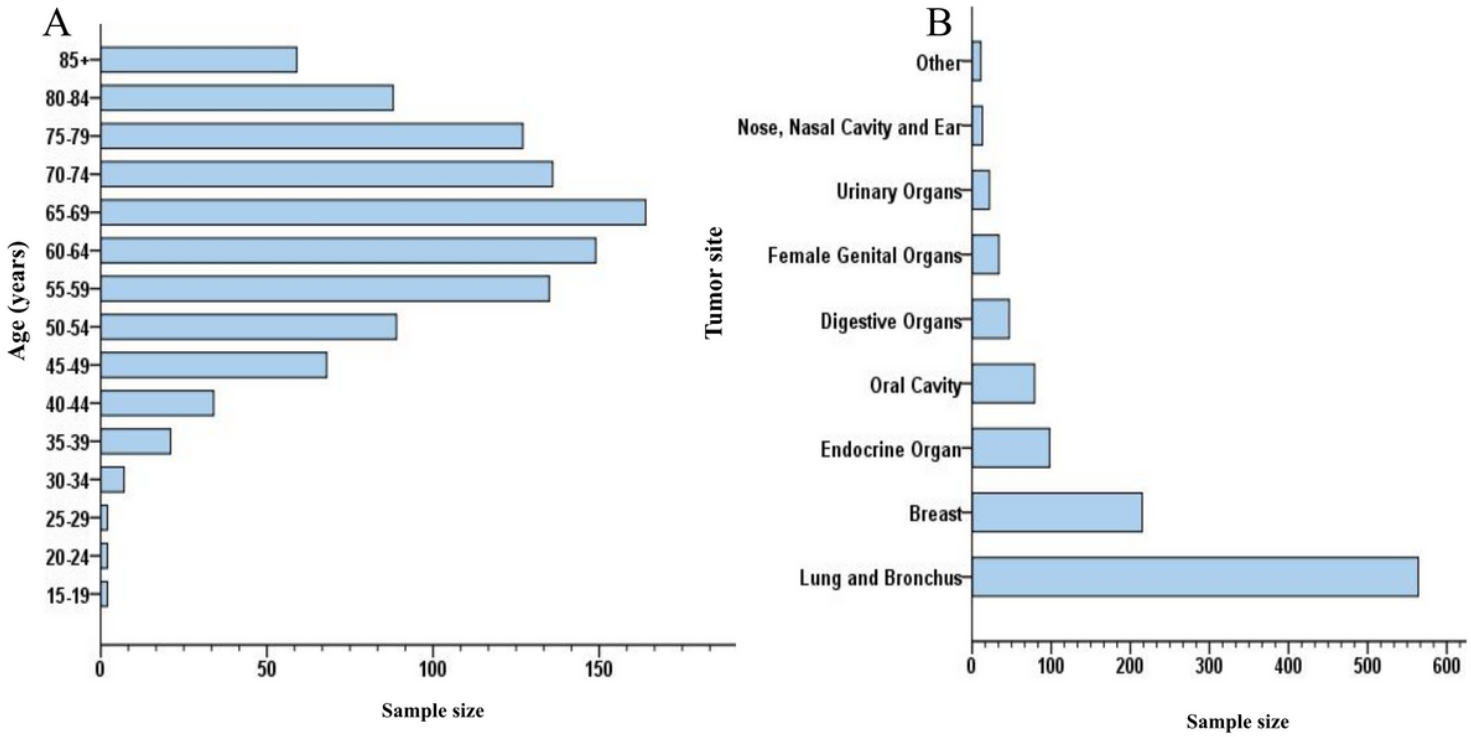

Figure 1

The distribution of age (A) and primary tumor site (B) of all PC cases registered in the SEER database.

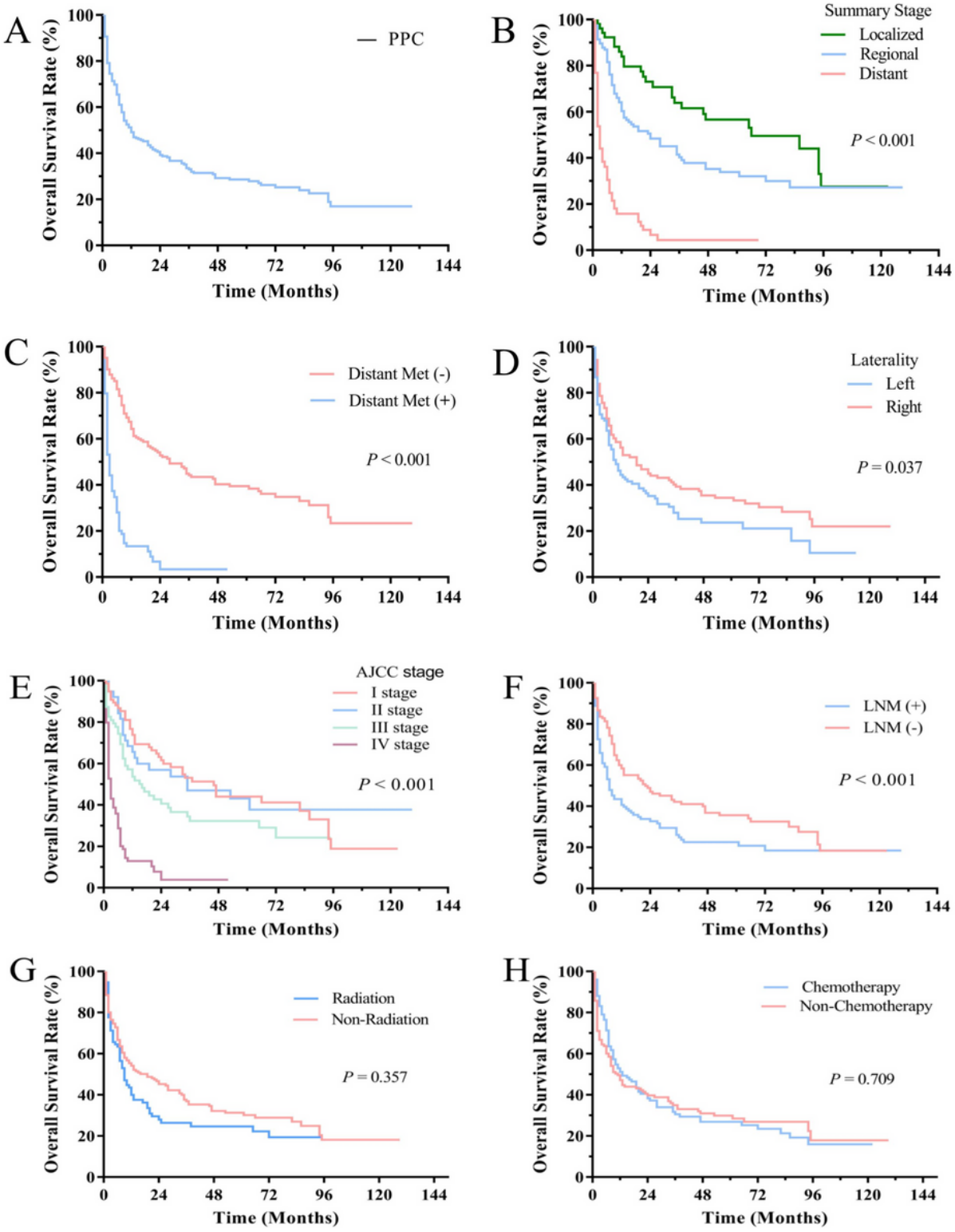

Figure 2

(A) OS for patients with PPC; OS curves of cases with PPC compared according to (B) SEER summary stage; (C): distant metastasis; (D): laterality; (E) lymph node metastases; (F) surgery; (H) radiation. Log-rank test was utilized to compare curves, and significance is presented on each pane.

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