Predictors of Recurrence after Resection of Thymoma: a Long-term Outcome

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Abstract

Backgrounds: Recurrence of thymoma is common even after complete resection, but how to predict the recurrence after resection still remain controversial. This study aimed to define the predictors of recurrence after complete resection of thymoma. Methods: A single-institution retrospective study was performed with 235 patients who underwent radical resection of thymoma from Jun 2009 to May 2019. Results: After a median follow-up of 46 months, the recurrence rate was 6.0% (14/235). Relapse occurred in 14 patients with the pleura and chest wall (4) and tumor bed (9) as the most common sites of recurrence. According to the definitions of the International Thymic Malignancy Interest Group, 9 (64.3%) patients had local relapse, 5 (35.7%) had regional relapse, and none of patient had distant relapse. The OS rates were not differed significantly between local and adjacent recurrence (P=0.232). The recurrence rates also correlated with the initial Masaoka stage (P=0.064). Further, recurrence also related to World Health Organization tumor type (P=0.038). The accompanying myasthenia gravis was also found as an independent prognostic factor (P=0.002). The recurrence-free survival rates in patients with tumor size≥8cm were worse than those of patients with tumor size<8 cm (P=0.012). In addition, positive surgical margin also seemed as a negative predictor of survival rate (P=0.005). Conclusions: Regional recurrence is the most common relapse pattern of thymoma. Advanced Masaoka stage, myasthenia gravis accompanying, larger tumor size, positive surgical margin, and type B/C are risk factors of recurrence.

Keywords

Thymoma, Recurrence, Predictor.

1. Introduction

As a lymphoid organ that offers the site for T lymphocytes maturation, thymus is largest during infancy and early childhood and decreases significantly in both size and function with age[1]. The definition and explanation of thymic epithelial tumors (TETs) has been clarified by “Histological Typing of Tumors of the Thymus” as an infrequent epithelial neoplasm of the thymus[1, 2]. Yet, it represents the most common tumor of the mediastinum in adults[3]. Although TETs include a series of tumors that differ biologically as well as morphologically, the most common histologic type is thymoma[4]. Traditionally, we classified thymoma as “benign” or “malignant” based on the presence or absence of capsular invasion. As a type of neoplasm in lymphoid organ, thymoma frequently has an accompanying rich infiltrate of T lymphocytes[4]. These abnormally conditioned T lymphocytes are released into the blood circulation which may likely responsible for the autoimmune dysfunctions that often accompany thymoma, such as myasthenia gravis (MG), connective tissue disorders and so on[5, 6]. And sometimes, thymoma plays as a partly lesion of other systematic disorders, like Good’s syndrome [7].

With the rapid development of minimally invasive surgical techniques, the techniques used for video-assisted thoracoscopic surgery (VATS) have improved over time. With a less operative trauma, a shorter hospital stays, better preservation of pulmonary function, and better cosmetic outcomes than transsternal (TS) thymectomy, VATS thymectomy is being valued and widely used in thymus

resection[8, 9]. Landreneau et al. [10] reported VATS partial thymectomy without total thymectomy, that report was questioned and suspected because of a limited resection for thymoma. Until now, the total thymectomy has always been performed as a standard method of resection for thymoma. A systematic review reported by Youshida et al. [11] also concluded that the current evidence regarding the long-term outcomes of minimally invasive surgery for thymoma is insufficient. Therefore, evaluating the long-term outcomes could help to determine the indications for VATS thymectomy as an optional operation method. The benefit of VATS thymectomy still needs to be defined.

In treatment for thymoma, surgery still as a mainstream choice, radiotherapy and chemotherapy also have been adopted widely as adjuvant and palliative procedures[12, 13]. Many reports demonstrate that a total thymectomy is the most important factor in survival rate[14-19] but rarely report presented whether radiotherapy or chemotherapy during postoperation bring any benefits to patients with completely thymectomy, and whether so-called "positive surgical margin" in thymectomy has negative effect for survival time for patients with invasive thymoma or thymic carcinoma. However, the relapse of thymoma is not uncommon, even the rate of recurrence is generally low, also the outcome of retreatment after recurrence is well. To set a standardized, uniform of definitions for thymoma relapse, the International Thymic Malignancy Interest Group (ITMIG) listed standard outcome measures and definitions for thymoma recurrence and relapse patterns in 2010[20]. However, the patient's quality of life might be poor after multiple treatments for multiple recurrences. Thus, freedom from recurrence is a better measure than survival in the case of patients who have successfully undergone radical resection. Based on ITMIG definitions, we explored the recurrence patterns and factors that might bolster strategies for the prevention, surveillance, and treatment of recurrent thymoma. In this study, we followed 235 patients who underwent surgical therapy for thymoma and analyzed factors and characteristics during perioperative period like histological type, tumor stage, accompanying symptoms, size of tumor and surgical margin, to found out which of them will affect the prognosis of these patients.

2. Materials & Methods

2.1 Patients

We retrospectively reviewed the medical dossiers of 235 patients with thymoma. All patients were initially treated with complete surgical resection at The First Affiliated Hospital of Nanjing Medical University from Jun 2009 to May 2019. Patients who had undergone surgical resection at other hospitals priorly, biopsy or palliative resection were excluded. The gender, age, accompanying symptom, surgical resection option (thoracoscopic or transsternal resection), tumor size, tumor staging, histopathologic result, postoperation therapy, recurrence and the survival status were evaluated. All patients' data of tumor staging were according to Masaoka-Koga staging systems[21], and the World Health Organization (WHO) histological classification[22] were adopted to classified histologic results. This study was approved by the medical ethics committees of the First Affiliated Hospital of Nanjing Medical University.

2.2 Surgical options: VATS or VT

According to the intraoperative policies for the surgeon during resection from International Thymic Malignancy Interest Group (ITMIG) definitions[23, 24], the complete thymectomy is the standard surgical strategy for performing thymoma resection, both in the VATS and TS approaches, regardless the accompany of MG or not. Likewise, we performed the VATS resection for thymoma patients who accorded with the following terms: 1) tumor located within the thymic lobes and separate from the brachiocephalic vein; 2) tumor measuring less than 50mm in diameter; 3) clinical stage I or II thymoma; 4) well health condition; 5) myasthenia symptom was well controlled (i.e. by using pyridostigmine bromide) or absent. The possibility of conversion from a VATS to the TS approach was also included in the informed consent. All patients have comprehended surgical risks and potential complications about both VATS and TS resection before the operations were performed. Cases that did not meet the indications 1~3 were undergone resection via the TS approach, cases that

did not meet the terms 4 and 5 transferred to departments of neurology or oncology for a further treatment, also those that could not provide informed consent were operation excluded.

2.3 Perioperative managements

All thymectomy performed a complete resection, involved the thymoma, thymus and mediastinal fat. During operation, we dissected and visualized the innominate vein and both phrenic nerves for preventing injury accidentally. And conversion to open was required if oncologic principles were being compromised such as incomplete resection, perforation of the capsule, risk of the tissues nearby exposing the tumor. Whatever the VATS or TS resection, the access incision for retrieval should be large enough to prevent specimen disruption. Before chest was closing, we examined the whole removed specimen to assess for completeness of the resection. The specimens resected were send for pathological diagnosis. After operation, those patients with MG accompanied were required to pyridostigmine bromide continuous infusion in the next 24 or 48 hours for preventing the occurrence of myasthenia crisis.

Patients who undergone radiotherapy, chemotherapy or both after operation were recorded by telephone inquiring, also the radiotherapy or chemotherapy courses, doses and date of starting therapy. The recurrence of thymoma by ITMIG clinical guideline was defined as a strong clinical suspicion of thymoma recurrence, without a specific requirement of pathological proof. So, we also recorded the recurrence time as the date when a strong suspicion first existed.

2.4 Statistical analysis

The rates of recurrence-free survival (RFS) and overall survival (OS) rates following recurrence were calculated by using the Kaplan-Meier method. RFS was measured from the date of operation until the date of recurrence, death or last follow-up visit. OS rates following recurrence was measured from the date of recurrence until the day of death or last follow-up visit. Univariate analysis was performed by the Kaplan-Meier method to assess recurrence factors for RFS, with comparison using a log-rank test for initial analysis. $P<0.05$ was considered as statistical significance. Statistical analysis was performed using GraphPad Prism (Vision 8.0.1, GraphPad Software, USA) and SPSS (Version 21.0, IBM Software, USA).

3. Results

Patient characteristics are summarized in Table 1. The thymoma patients consisted of 123 men and 112 women. The patients age ranged from 22 to 79 years, with a mean age of 54.7±12.0 (standard deviation, SD). Thymoma and thymic carcinomas were classified according to Masaoka-Koga staging system into the four following types: I: grossly and microscopically completely encapsulated tumor (n=120), II: microscopic transcapsular invasion or macroscopic invasion into thymic or surrounding fatty tissue, or grossly adherent to but not breaking through mediastinal pleura or pericardium (n=59), III: macroscopic invasion into neighboring organ (i.e. pericardium, great vessel or lung) (n=56), IV: pleural, pericardial lymphogenous or hematogenous metastasis (n=0). And pathologic types were classified by followings the 2015 WHO classification(22): A (considered a benign/low-grade tumor, n=15), AB (n=70), B1 (n=33), B2 (n=43), B3 (n=53), C: (considered as thymic carcinoma, n=20) (if there were two or more pathologic types in one specimen, chosen the graver one as a result).

Table 1: Characteristics of the 235 patients and results of recurrence factor analysis

Variables		Patients	Recurrence	Recurrence(%)	RFS rates (%)	*P*-value
ages (years)	⩾50	163	10	6.1%	93.9%	0.995
	< 50	72	4	5.6%	94.4%	
gender	male	123	6	4.9%	95.1%	0.995
	female	112	8	7.1%	92.9%	
MG	presence	61	9	14.8%	85.2%	0.002

	absence	174	5	2.9%	97.1%	
tumor size (cm)	⩾8	56	8	14.3%	85.7%	0.012
	<8	169	6	3.6%	96.4%	
	unknown	10	0	0.0%	100.0%	
Masaoka stage	I	120	3	2.5%	97.5%	0.122
	II	59	5	8.5%	91.5%	
	III	56	6	10.7%	89.3%	
	IV	0	0	0.0%	N/A	
WHO type	A	15	0	0.0%	100.0%	0.038
	AB	70	1	1.4%	98.6%	
	B1	33	2	6.1%	93.9%	
	B2	44	3	6.8%	93.2%	
	B3	53	5	9.4%	90.6%	
	C	20	3	15.0%	85.0%	
PORT	yes	121	9	7.4%	90.1%	0.205
	no	114	5	4.4%	98.2%	
PORCT	yes	31	4	12.9%	87.1%	0.045
	no	204	10	4.9%	95.1%	
Capsular invasion	yes	124	9	7.3%	96.0%	0.283
	no	111	5	4.5%	91.9%	
surgical options	VATS	139	4	2.9%	97.1%	0.037
	VT	96	10	10.4%	89.6%	
surgical margin	positive	4	1	25.0%	75.0%	0.005
	negative	231	13	5.6%	94.4%	

Abbreviations: RFS, Recurrence-free survival; MG, myasthenia gravis; PORT, postoperative radiotherapy; PORCT, postoperative radiochemotherapy; VATS, video-assisted thoracoscope; TS, transsternal thymectomy.

The median follow-up duration was 46 months (range, 2~125 months), and recurrence was observed in 14 of the 235 patients (6.0%) during follow-up, including local recurrence (9 of 14 patients) and regional recurrence (all of 5 patients). The median recurrence time was 74.5 months (range 3.0 to 93.5 months), and 7 of 14 relapse patients died after recurrence (3 of 7 died of local recurrence directly and 4 of patients died of other diseases or accident). Table 2 shows the recurrence sites and patterns in the 14 patients with relapse. The recurrence rates of stage I, II and III thymomas were 2.5%, 8.5% and 10.7%, respectively, the rate of histologic types A, AB, B1, B2, B3 and C were 0%, 1.4%, 6.1%, 6.8%, 9.4% and 15.0%, respectfully. Recurrences were found at the following sites: chest wall and diaphragm (1 patients), tumor bed (9), lung (1), chest wall (1) and pleura (2). The most common recurrence site was the tumor bed, accounting for 64.3% of the cases, followed by the chest wall (14.3%), diaphragm (7.1%) and lung (7.1%). According to the ITMIG classification, 9 patients (64.3%) had local recurrence, 5 (35.7%) had adjacent recurrence, none of patients had distant recurrence (0.0%). The OS rates were described following recurrence was measured from the date of recurrence until the day of death or last follow-up visit, and it showed that there were not differed significantly between local and adjacent recurrence (78.6%, 100.0%, respectively, P=0.232). Patients with histological type A or AB thymoma also had a longer RFS rate (82.8%) compared to those with type B or C (68.9%, P=0.03, HR=0.15[95%CI 0.05, 0.48]). And the RFS rates of stage I, II, III thymomas were 97.5%, 91.5% and 89.3%, respectively. The survival rate of stage I tumors was significantly higher than those for stage II neoplasms (P=0.024, HR=0.24 [95%CI 0.07, 0.87]), but not significant difference was found between stage II and III neoplasms (P=0.681). Table 1 also summarizes that age (P=0.995), gender (P=0.995) had no statistically significant impact on recurrence.

Table 2: Detailed recurrence information

Patient No.	Gender	Age	Date at diagnosis (year)	Surgical options	Tumor size (cm)	WHO type	Masaoka stage	Recurrence site	Time to recurrence (month)
1	F	42	2009/6/15	VATS	7×4×3	B3	III	Tumor bed	93.5
2	M	79	2009/8/26	VATS	8×6×6	B2	I	Tumor bed	82.2
3	F	59	2010/2/11	TS	9×7×7	B3	II	Tumor bed	85.7
4	F	64	2010/3/1	TS	10×8×6	C	III	Left chest wall	63.0
5	F	57	2010/5/11	TS	7×5×2	B1	II	Tumor bed	38.7
6	F	61	2011/12/19	TS	11×8×6.5	B3	II	Tumor bed	68.9
7	M	59	2012/3/28	TS	6×5×2	B2	III	Tumor bed	13.1
8	M	32	2012/5/14	TS	7×6×3	B3	II	Right Pleura	89.5
9	F	66	2012/5/22	TS	15×10×8	B3	I	Tumor bed	15.3
10	F	60	2012/12/13	VATS	7×5×2	B2	II	Diaphragm & right chest wall	3.0
11	F	65	2013/4/15	TS	6.5×3×3	B1	III	Left pleura	40.5
12	M	22	2013/10/17	TS	10×8×6	C	III	Tumor bed	35.5
13	M	53	2015/5/18	VATS	2.5×1.8×2	AB	I	Tumor bed	20.9
14	M	48	2016/1/27	TS	8×6×6	C	III	Left lung	12.1

Abbreviations: VATS, video-assisted thoracoscope; TS, transsternal thymectomy.

In this study, myasthenia gravis was associated with 61 cases (26.0%) of thymoma, the MG accompanying of stage I, II and III thymomas were 32 (26.7%), 17 (28.9%) and 12 (21.4%), respectfully. The RFS rates of thymomas with or without MG were 85.2% and 97.1% respectively. Significant differences in survival rate were observed between MG positive and negative according to analyzed the RFS curve (*P*=0.002, HR=0.21 [95%CI 0.07, 0.67], Fig.1).

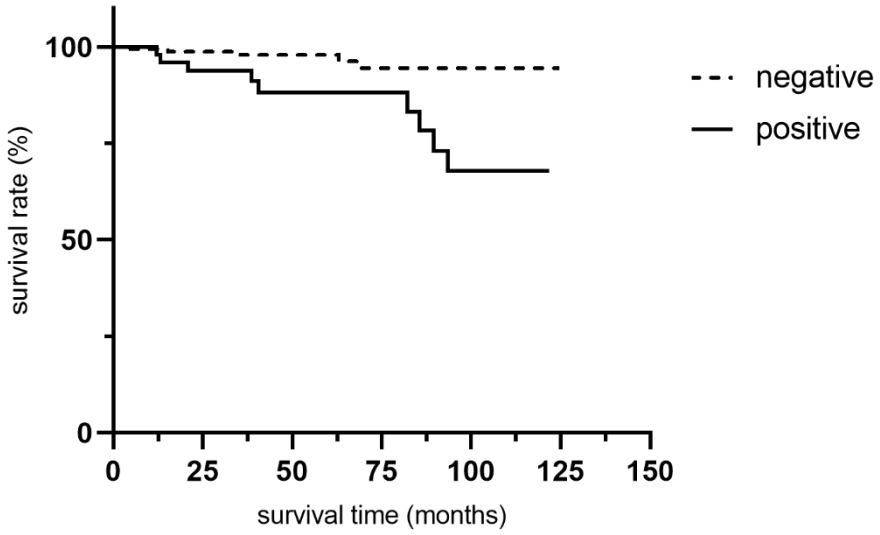

Fig. 1: Comparison of recurrence-free survival in the group of thymomas with or without myasthenia gravis accompanying, 85.2% and 97.1%, respectively, *P*=0.002.

The cut-off value was 8 cm, 56 of 235 patients (23.8%) thymomas size were equal to or larger than 8cm, and others were smaller than 8cm. The RFS rates for patients with tumor size≥8 cm were worse than those for patients with tumor size <8 cm (≥8cm: 91.1%, <8 cm: 97.0%). Statistical analysis showed that the survival rate of larger tumor size (≥8cm) were significant differ from smaller size

(*P*=0.012, HR=3.89 [95%CI 1.08, 14.03]). Therefore, the tumor size less than 8 cm was a negative predictor of recurrence and survival.

Surgical operation for thymoma was classified into three groups: complete resection (with negative surgical margin, which means no tumor remained microscopically, 231 of all patients), imcomplete resection (almost all of the tumor was resected macroscopically, but positive surgical margin was reported by pathologic examination, 4 of 235 patients), and inoperable (including partial resection, exploratory thoracotomy and simple biopsy, none) groups. The resectability rates of stage I, II and III thymomas were 100%, 98.3% and 94.6%, respectively. And the RFS rates of thymomas with total resection or positive surgical margin remained were 85.2% and 97.1% respectively, the differences between them reached a significant statistical standard (*P*=0.005).

We also compared the operation methods of those patients. 96 of 235 patients received transsternal (TS) thymectomy while 139 patients with VATS thymectomy, and it revealed that VATS thymectomy showed a less recurrence ratio than TS thymectomy (*P*=0.036, HR=0.28 [95%CI 0.10, 0.80].

Most of patients (70.5%) with stage I thymoma underwent only surgery. More than a half (61.0%) of the patients with stage II thymoma and more than four-fifths (85.2%) of the patients with stage III thymoma underwent surgery with adjuvant therapy. Most of the adjuvant therapy in stages I, II, and III thymomas consisted of radiotherapy, and none of patients undergone chemotherapy without radiotherapy. Of the 235 patients, 118 received adjuvant radiotherapy (50.2%) and 112 of these 118 patients completed postoperative radiotherapy (95.0%), 1 patient broke away from radiotherapy 5 days later after therapy course begun because of persistent fever and granulocytopenia. Of these 112 patients, 5 received postoperative whole pleural radiotherapy, at a target dose of 30Gy to 40Gy, respectively, and tumor bed radiotherapy at dose of 50Gy. The remaining 107 patients received tumor bed radiation with a median target dose of 50Gy (range 40 to 70Gy) in 1.8~2.0Gy fractions over 4~6 weeks. 23 of 235 patients undergone platinum/paclitaxel-based chemotherapy for 2~6 cycles, the median of chemotherapy cycle was 4 cycles, only 2 patient received cisplatin/bleomycin/paclitaxel combined chemotherapy for 2 cycles (1 of them added prednisone in chemotherapy regimen). The RFS of patients with totally resected thymoma with radiochemotherapy, with radiotherapy, and with no adjuvant therapy were 90.3%, 95.4% and 97.4%, respectively. There was a significant difference in survival rate between patients with no adjuvant therapy and those with radiochemotherapy (*P*=0.012, HR=5.48 [95%CI 0.85, 35.42]).

4. Discussion

Thymomas are generally considered as a type of indolent neoplasms with slow-growing, tendency to focal invasion, and also has a propensity for local recurrence but showing distant metastases rarely[25]. Like the incidence of thymoma, the recurrence rate after complete resection is also quite low, with recurrence rates of 7.5~36% from previous studies[26-30]. The recurrence rate in our study was lower than those reported previously, at 6.0%. One reason for this may be that those patients with thymoma our study included who had undergone complete resection mostly (only 4 of 235 patients showed a positive surgical margin), while several previous researches included quite a bit of thymoma patients with incomplete or palliative resection, even biopsy resection, another reason may be concluded that stage I-II disease (179 of 235 patients, 76.1%) were mostly included in this series while there was no stage IV patient contained (those IV stage thymoma patients were more tended to conservative therapy rather than operation directly) , and some previously studies only included patients with Masaoka stage II, III and IV thymomas. Furthermore, almost previous studies indicated that the most common recurrence site was the pleura and chest wall, accounting for 53.6~92% [31-33], while other common recurrence sites were the lungs and diaphragm[34]. We also proved this viewpoint during this study, those 14 patients with thymoma recurrence contained 3 with regional recurrence in chest wall or pleura, each 1 in lung or diaphragm.

Generally, the main prognostic factors after surgical resection were the clinical stage from Masaoka-Koga staging system, the histologic type according to the WHO classification, the completeness of the resection, the tumor size and the tumor-related accompanying symptoms[35-37]. WHO histologic characterization has been confirmed to be a powerful prognostic predictor, with a higher survival rates recorded for type A and AB thymomas (low-grade malignancy). In more invasive or distant metastasis tendency of type B and C, survival rates were lower than type A and AB[25, 38]. Okumura et al. [39] retrospectively analyzed the clinical prognostic significance of WHO classification in A group of cases, and found that the proportion of invasive thymoma in 258 cases was increased from WHO type A to B3 and this study also pointed out the 20-year survival rates of A was the highest among type A to B3 (100%), and adversely, type B3 thymoma got the worst survival rate (38%). In our study, we also found that patients with type A or AB thymoma may had a longer recurrence-free survival period compared to those with type B or C (P=0.038, HR=0.15[95%CI 0.05, 0.48]). Which mean that patients with a lower-grade histologic type of thymoma may led to a lower risk of tumor recurrence, which also proved the viewpoint above. Some reports underlined the concept that thymoma might relapse or recurrence several years after the complete thymectomy of the primary lesion, although the occurring of recurrence were rarely[40, 41]. Type A thymoma used to be considered as a benign-like tumor with significantly low risk of local recurrence or distant metastases, even when capsular invasion was presented. But there were several studies rase doubt about this perspective: Mengoil, et al. [42]reported 2 cases of type A thymoma presented a clinical course of indolent but insidious, which were revealed metastases of pulmonary and spine at 2 and 7 years after the completely tumor resection, respectively. Pollack, et al. [43] also reported that 2 cases of recurrence was observed in 11 cases of type A thymoma in a long-term follow-up. These cases clearly show that long-term followed up and checked regularly after operation must be recommended, such as a regular computerized tomography (CT) scan or even enhanced CT scan (with contrast agent like iopromide or iodixanol, etc.), to detect recurrences as early as possible, then a prompt and adequate therapeutic strategy is permitted.

Most studies concluded that there was no significant difference between male and female gender ratio in thymoma, neither the age. The data of this study also showed that the numbers of males or females, elder than 50-years-old or younger were neither not reached significantly difference (P=0.995, P=0.995, respectively). Whether myasthenia gravis was considered as a controversial independent prognostic factor, most studies have shown that MG was not a prognostic factor, but our study revealed there were a significant different between MG positive and negative cases (P=0.041, HR=3.42 [95%CI 0.89, 13.12]). This result could be supported by a previous research, which declared that thymomas with MG positive contained a larger number of “pre-emigrants” CD4+ T lymphocytes than MG negative thymomas[44]. So, we suggested that those CD4+ T lymphocytes that matured inside the abnormal microenvironment of thymomas and release into the blood are critical to the development of thymoma-associated MG. Normal CD4+ T lymphocytes have played an important role in tumor immunity, instead, abnormal CD4+ T lymphocytes may interfere or even reverse with normal tumor immunity, which may be related to the high tumor recurrence rate. So, the relationship between myasthenia gravis and the prognosis of thymoma deserves further study.

In addition to WHO histologic classification as prognostic factors postoperation, patients with positive surgical margin or with large size of tumor also led to a higher recurrence rate and shorter tumor-free survival period. Regnard et al. [45] analyzed the long-term survival of 307 thymomas, with only found the surgical integrity as a significant prognostic factor. In our study, 4 cases with positive surgical margin were reported, all of patients received platinum/paclitaxel-based chemotherapy and radiotherapy, only 1 case without chemotherapy because of his accidental death. Even with those adjuvant therapies, 1 of 4 patient with tumor recurrence in chest wall 5 years after radiochemotherapy. Cases with positive surgical margin were not sufficient due to the lack of stage IV thymoma cases, we presumed a positive surgical margin may related to a higher recurrence rate, and it still need a larger sized retrospectively study.

According to the outcomes of previously published studies, tumor size is a prognostic factor for recurrence. Cut-off values of tumor size were reported to range from 7 to 11 cm [46-48]. We set the cut-off value was 8 cm, in that tumor size≥8 cm was a negative predictor of recurrence and survival (*P*=0.012, HR=3.89 [95%CI 1.08, 14.03]). This result also proved that tumor size was one of important prognostic factors which should be handled carefully during the treatment of thymoma.

Furthermore, we compared the operation methods of those patients, and it revealed that VATS thymectomy showed a less recurrence ratio than TS thymectomy (*P*=0.036, HR=0.28 [95%CI 0.10, 0.80]. It seems that VATS was more benefits in survival ratios than TS thymectomy, but we must clarify that VATS thymectomy for patients who only accorded with the lower-grade and smaller size. These indications all referred to early stage thymomas (Masaoka stage I or II), and there were few reasons to believe that VATS is safe and reliable for stage III or IV thymomas. Some researches indicated that the VATS group had a shorter surgery duration, smaller blood loss volume, smaller postoperative pleural drainage volume, shorter postoperative pleural drainage period, and shorter postoperative hospital stay than did the TS group, and no serious postoperative complications occurred in the VATS group[49]. So, a further verification was required to this view that VATS thymectomy may have a better survival benefit than TS thymectomy.

5. Study Limitations

The present study was limited by its retrospective single center design. The team of surgeons who performed the operations was quite large and was a bias of this study. Our series had a limited number of cases, and the follow-up duration was not long enough. More cases series should be investigated to establish the validity of our procedure. However, our findings were still important, because it demonstrated that MG accompanying and different operation methods also affected the prognosis of the thymoma patients, which was not clarified in previous studies.

6. Conclusions

These preliminary results of our series suggested that WHO histological type, Masaoka stage, MG accompanying, size of tumor and surgical margin were predictors of recurrence after resection of thymoma. Surgical operation is still the main treatment, VATS might lead to a better prognosis but still needs a further verification.

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