Surgical treatment of mediastinal neoplasm in children

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Background: **Mediastinal tumors in children comprise a heterogeneous group of lesions from a range of embryonic origins. They may present as benign cysts or malignant lesions. Mediastinal tumors in children and adolescents result in significant morbidity and mortality. Lymphoma is more common in the anterior mediastinum and neurogenic tumors are more common in the posterior mediastinum. Surgery is an important measure used in the diagnosis and treatment of such lesions. This study was to evaluate the strategy of surgical treatment of mediastinal tumors in children.**

Methods: **We retrospectively analyzed the clinical data from 61 children with mediastinal tumor treated in our department from 1994 to 2006.**

Results: **Forty-four patients had benign tumors (72.1%), and 17 malignant tumors (27.9%). Fifty patients were subjected to complete resection, 8 to partial resection, and 3 to biopsy. Thirty-nine patients were followed up for 3 years; the survival rate of patients with benign tumors was 100%, and that of patients with malignant tumors was 44%.**

Conclusions: **Thoracic computerized tomography (CT) scan is the first choice before operation; patients with benign mediastinal tumors may have good outcome after surgical treatment. Anaesthesia and perioperative management are of crucial importance.**

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Introduction

Primary mediastinal tumor is not common in infants and children with a morbidity of 0.38%.[1] These lesions are often neoplastic in origin and have a high risk of malignancy. With various pathological types and clinical manifestations, 34%-41% of primary mediastinal neoplasms are malignant.[2] Surgery is fundamental in the management of mediastinal masses, either for biopsy used to establish the etiology of the tumor and devise a course of therapy or for curative resection. We reviewed the clinical data of 61 children with primary mediastinal tumor treated at our department from 1994 to 2006. According to their mediastinal location, the tumors were classified as anterior, middle and posterior. Patients with tumors in the chest wall or pulmonary parenchyma were excluded.

Methods

Of the 61 patients, 43 were males and 18 females, aged from 8 months to 13 years (average 6.2 years). Thirty-seven patients complained of coughing, dyspnea, chest distress, and chest pain, and 32 of them had fever. Four patients showed compression symptoms of the superior vena cava, and 6 had lung consolidation. In the rest 14 patients, mediastinal neoplasm was detected by physical examination without any obvious symptoms. All patients underwent computerized tomography (CT) or magnetic resonance imaging (MRI) examination. Tumor types were confirmed by post-operative pathological examinations (Table).

Results

No death occurred during operation. Fifty patients were subjected to complete resection, 8 to partial resection, and 3 to biopsy.

In 2 patients, huge teratoma (12×12×10 cm, 15×11×9 cm) was resected completely (Fig.). Partial resection was carried out in 4 patients with malignant teratoma, 1 patient with malignant thymoma, 1 patient with yolk sac tumor, and 2 patients with neuroblastoma. Neuroblastoma was removed with support of neuro-

Table. Pathological types and locations of tumors

Pathological type	Benign/malignant	*n*	Location of tumors
Teratoma	benign	13	2 in posterior mediastinum, 11 in front superior mediastinum
	malignant	6	All in front superior mediastinum
Mediastinal bronchial cyst	benign	16	2 in front superior mediastinum, 10 in middle mediastinum, 4 in posterior mediastinum
Thymoma	benign	1	Front superior mediastinum
	malignant	3	All in front superior mediastinum
Schwannoma	benign	13	Posterior mediastinum
Neuroblastoma	malignant	3	Posterior mediastinum
Spermatocytoma	malignant	2	All in front superior mediastinum
Yolk sac tumor	malignant	1	Front superior mediastinum
Lymphoma	malignant	2	1 in front superior mediastinum, 1 in middle mediastinum
Liparomphalus	benign	1	Posterior mediastinum

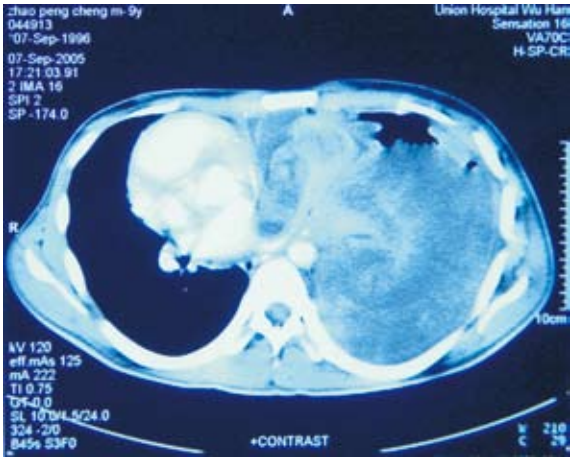

Fig. CT scan for a 9 year-old boy with a huge mediastinal tumor. The left thoracic cage full of tumor tissue, a pathological diagnosis of malignant teratoma.

surgeons because of the tumor tissue intruding into the vertebral canal. Two patients with lymphoma infiltrating into the superior vena cava, and 1 patient with liparomphalus with too rich blood supply to stop bleeding failed to have tumor resection, but biopsy was done instead. Because compressed lungs failed to ventilate or became consolidated, 1 patient received left pneumonoresection, 1 right pneumonoresection, 3 left lower lobectomy, and 1 right lower lobectomy. Because of tumor invasion, 2 patients received partial resection of pericardial sac, 1 partial resection of the left atrium, 3 combined reconstruction of the superior vena cava, 4 ligation and incision of the anonymous vein.

One 8-month-old female patient died of heart failure and acute respiratory distress syndrome despite of cardiopulmonary resuscitation after mediastinal tumor resection plus lung resection for congenital hypoplasia and consolidation of the lung. The patient was diagnosed pathologically to have a mediastinal bronchial cyst.

In the remaining 60 patients, 39 were followed up for 3 years. Thirty patients with benign tumors survived without relapse as confirmed by X-ray or CT, and in the rest 9 patients with malignant tumors, 4 (44%) survived with chemotherapy or radiotherapy after operation.

Discussion

Diagnosis of mediastinal tumor

Mediastinal tumor, a high-malignant tumor in children, is rare and often misdiagnosed.[3] Since the thoracic cage of children is small, the compression of tumors on the heart, lung, and bronchi leads to such respiratory symptoms as coughing, dyspnea, and chest distress, which are complicated by pulmonary infection and fever.[4] The sick children are initially treated at the department of pediatrics, and misdiagnosis of the disease is due to insufficient knowledge of the pediatricians and low verbal expression of young children.[5] Tumor compression leads to pulmonary atelectasis, even consolidation if it continues to exist. Thus the nonfunctional lung has to be removed when the mediastinal tumor is resected. If accurate diagnosis and prompt treatment are ensured, lung function can be reserved.

Timely imaging, especially CT scan including plain and enhanced scan, is the first choice for localizing mediastinal tumor, which is helpful for qualitative diagnosis. Moreover, the membrane and the inside structure, the degeneration and necrosis of the tumor, and lipids or calcification can be observed for qualitation of specific tissue.[6] CT can determine whether the tumor is malignant or benign and its histological features. More importantly, the relationship between the tumor and its neighboring structure, for instance, the involvement of the important vessels, is helpful to evaluate the difficulty and risk of resection.[7] MRI in showing the involved vertebrate and spinal cord is superior to CT.[8]

Laboratory examination is also helpful.[9] The 24-

hour vanillylmandelic acid (VMA) of our patients with tumors in the posterior mediastinum was evaluated, the increased level indicated the presence of neuroblastoma.[10] Three patients with increased 24-hour VMA were confirmed pathologically as having neuroblastoma. In patients with pathologically confirmed malignant germ cell tumor, blood alpha-fetoprotein (AFP) and β-human chorionic gonadotrophin (HCG) were examined. Their increased levels helped to differentiate spermatocytoma from non-spermatocytoma. The former other than the latter has increased levels of blood AFP and β-HCG[11] because few spermatocytomas secrete AFP or β-HCG (<7%), while more than 90% of non-spermatocytomas secrete AFP or β-HCG.[12] This differentiation is to determine the treatment regimen because spermatocytoma is sensitive to radiotherapy and non-spermatocytoma to chemotherapy.[13] In 9 patients with malignant germ cell tumor in our group, 2 patients with spermatocytoma had normal levels of AFP and β-HCG, 1 patient with yolk sac tumor and 6 patients with malignant teratoma had an increased level of AFP, and 3 patients with malignant teratoma had an increased level of β-HCG. Monitoring AFP and β-HCG levels during the period of follow-up is helpful to diagnose a relapse and evaluate the effect of treatment.[14]

Thymic hyperplasia should be excluded when pathological changes are found in the anterior mediastinum[15] because the disease needs follow-up observation instead of operation.[16] By enhanced CT, an enhanced membrane can be seen in thymoma, but not in thymic hyperplasia.[17] If they are hard to differentiate, especially in infants, corticosteroids can be given, and a shrinking mass indicates thymic hyperplasia, which is not suitable for surgical treatment.[16]

Anaesthesia

After anaesthesia, the compression of the tumor may suddenly increase on the heart, great vessels and bronchi because of the use of muscle relaxant. The gravitational effect of the tumor and relaxation of the bronchial smooth muscle may give rise to a risk of pulmonary circulatory arrest. Therefore, patients with a huge mediastinum tumor must be placed in an appropriate position: 45° or 60° in a recumbent position, lifting the head at 30°, to reduce the compression of the tumor on the lungs and to avoid the movement of the heart.[18] Before the removal of the tumor, the chest should be opened immediately after anaesthesia to expose the thoracic cage, while softly lifting the tumor to reduce the compression.[19] For the patients with huge tumor severely compressing the main bronchi, basal anesthesia is given initially, and intubation with muscle relaxant is applied after the chest is open.

Surgical manipulation

Since it is more difficult to resect a large solid malignant mass than a small and benign one, careful exploration is required to detect relationship between the tumor and the neighboring great vessels, heart, and other vital organs. With sufficient exposure, dissection is made along with the membrane of the tumor, from superficial to deep tissues, and from rarefacted to tightly adhesive tissues. For a cyst-solid tumor, cyst fluid could be sucked out for a better exposure. But the fluid can not be sucked too fast because the sudden fall of pressure may cause a rapid rise of return blood volume and the coming right heart failure.[20] Complete resection is not necessary if the tumor invades the great vessels or vital organs, but dehydrated alcohol could be used as a local injection into the rest tumor.[21]

The great vessels invaded by mediastinal tumor include the upper vena cava and anonymous vein. Opening the pericardia helps to detect the relationship between the tumor and great vessels to avoid injury. With a sufficient exposure, the tumor could be separated from the blood vessel wall. If the local infiltration or adhesion area is less than 1/3 of the circumference, an auricle clamp is needed to clamp the lateral wall of the vessel or block it temporarily for a resection and plastic repairment. If the invasion is wider than 1/3, or the injured anonymous vein is not repairable, suturing and ligation should be done to stop bleeding. If the upper vena cava is injured, part of it can be resected and repaired with the pericardia, or replaced with the prosthetic vessel under extracorporeal circulation or temporary bypass between the auricle of the right atrium and anonymous vein.[22]

Radiotherapy and chemotherapy

Radiotherapy or chemotherapy should be given to patients after operation.[23] Among the 17 patients with malignant tumor in our group, 9 received radiotherapy or chemotherapy and were followed up for 3 years after operation. In 4 patients surviving, 2 had malignant teratoma and 2 had non-Hodgkin lymphoma. The former received chemotherapy with vinblastine and cisplatin, and the latter received radiotherapy. One of the latter underwent combined radiotherapy and chemotherapy with cytoxan, oncovine and prednisone (COP). The latter had a complete remission. In the 5 deaths, 1 attributed due to pneumonia as a complication of radiotherapy after operation for neuroblastoma, 1 to chemotherapy with adriamycin and cisplatin after operation for yolk sac tumor, 2 to the same regimen for malignant thymoma, and 1 to radiotherapy after

operation for spermatocytoma. A report suggested[24] that a 1-2 course pre-operative chemotherapy for patients with a huge malignant tumor may reduce the size of the mass, thus improving the rate of resection. We consider that chemotherapy is recommended only if a pathological diagnosis is made in addition to an imaging diagnosis. In our group, 2 patients with malignant teratoma received chemotherapy with vinblastine and cisplatin before operation, and the pathological diagnosis was made through a CT-guided puncture biopsy. Follow-up CT showed marked shrinkage of the tumor, which was removed operatively. CT-guided puncture biopsy has such risks as bleeding; it is not appropriate for all patients or limited by the location of mediastinal tumors.[25] For patients with a pathological diagnosis of malignancy before operation, chemotherapy is suitable for complete resection of the tumor. But for patients without a pathological diagnosis, operation should be performed as soon as possible.

Perioperative management

Reexpansion pulmonary edema (RPE) should be considered during and after operation.[26] Because of the tumor compression, the lung of the affected side is often at a condition of collapse, atelectasis, and consolidation, which leads to a failed lymphatic circulation and a decrease of pulmonary surfactant. After the removal of the tumor and the diafiltration of tissue fluid into alveoli, the expansion of lung alveoli will lead to reexpansion pulmonary edema. In our study, 5 patients had a complication of RPE, and all had an accurate diagnosis and timely treatment. According to our experience, measurements should be taken to prevent RPE by limitating the input volume of crystal fluid during operation; manipulating gently for avoidance of injury to lung tissue; expanding the lung gradually for suction of the sputum, followed by administration of dexamethasone; and intensive monitoring of the saturation of blood oxygen and respiratory sound. RPE should be diagnosed when widespread moist rales, controllable hypoxemia after inhalation of oxygen are observed or lung reexpansion and a large plaque of shadow are shown on X-ray. The onset of RPE is of urgency and quick progress, which could be corrected immediately if timely treatment is given. Once RPE happens, therapeutic measures including limitating input volume and speed of intravenous injection of colloid and glucocorticosteroid, and diuresis should be taken, and if necessary assisted mechanical ventilation is selected (preferable positive end-expiratory pressure mode).

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Contributors: ZX proposed the study and wrote the first draft. All authors contributed to the design and interpretation of the study and to further drafts. WJJ is the guarantor.

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