Review Article

Red flags in minimally invasive thymoma resections

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Abstract: Despite all the efforts for the standardization of the minimally invasive procedures for mediastinal mass lesions, there still exists traps for surgeons to fall into. In this manuscript, possible red flags are discussed. This could prevent a minimally invasive surgeon from meeting possible problems related to the minimally invasive intervention. Operating on a non-thymomatous, non-myasthenia gravis (MG) thymus (useless surgery) is one of the most common problems that a minimally invasive thoracic surgeon could meet. Performing thymomectomy instead of thymothymectomy, in order to perform the operation minimally invasively, is another potential problem. Technically difficult or oncological risky operation is another red flag. These operations could be performed by some surgeons who had the chance to develop their minimally invasive surgery (MIS) capabilities. However, not so many surgeons could demonstrate similar performance. Insisting on not converting to open surgery although it is necessary. This may cause major morbidity or even mortality which is the reddest flag.

Keywords: Red flag; thymoma; minimally invasive

Received: 08 March 2019; Accepted: 24 April 2019; published: 04 June 2019.
doi: 10.21037/med.2019.04.07
View this article at: http://dx.doi.org/10.21037/med.2019.04.07

Introduction

Minimally invasive surgery (MIS) for thymoma resection became popular in the last 2 decades because it provided similar oncological outcomes with open surgery, providing a shorter duration of stay, less pain, and superior cosmetics. Although there are efforts for the standardization of the procedures, there still exists traps for surgeons to fall into. In this manuscript, the author presents the possible red flags which could prevent a minimally invasive surgeon from a catastrophic complication or a medico-legal problem to meet. These are as follows:

(I) Operating on a non-thymomatous, non-MG thymus (useless surgery);
(II) Performing thymomectomy instead of thymothymectomy, in order to perform the operation minimally invasively [possible recurrence, development of postresectional myasthenia gravis (MG) and etc.];
(III) Technically difficult or oncological risky operations. These operations could be performed by some surgeons who had the chance to develop their capabilities. However, there are not so many surgeons who could demonstrate similar performance (positive surgical margins and recurrences);
(IV) Insisting on not to converting to open surgery although it is necessary (major morbidity or catastrophe).

Operating on a non-thymomatous, non-MG thymus

Some surgeons underestimate the diagnostic capabilities of radiologic investigation and prefer to perform the surgery just because they could use minimally invasive techniques properly. In general, practice, if a patient has MG, an unenhanced computerized tomography (CT) is initially performed. If there exists a mass, and the patient is non-myasthenic, contrast-enhanced CT is performed. If the patient is myasthenic, magnetic resonance imaging (MRI)

could be the preferred method for further investigation, instead of contrast-enhanced CT and PET CT, MRI could be done as a complementary method of investigation, to decide the aggressiveness of the thymoma and the possible need for mediastinal lymph node dissection. MR could also provide details about the extension of resection and decision for MIS intervention.

With all these radiologic and nuclear medicine investigations, there may not be a need for diagnostic thymectomy with video-assisted thoracoscopic surgery (VATS) or robotic-assisted thoracic surgery (RATS). Although it was presented and studied rarely, there exist several investigations for useless thymectomy operations (1). In one of these studies, nontherapeutic thymectomies were analyzed, and the rate was found to be 43.8%. The nontherapeutic thymectomy was performed mostly with the concern of thymoma to lymphoma (54.3%), thymic bed cysts (24.3%) and thymic hyperplasia (17.1%) and reactive or atrophic tissue (4.3%). Actually, among these lesions, there should be significant differences in location, morphology, circumscription, homogeneity of attenuation, fatty intercalation, coexistent lymphadenopathy, obvious pericardial invasion and mass effect (1). In another study, a total of 1306 patients were identified, and 27.8% of the thymectomies were classified as nontherapeutic thymectomies (2). The most common diagnosis in nontherapeutic patients was thymic hyperplasia. Non-therapeutic patients were identified as younger and more likely to undergo VATS (2). Thymic hyperplasia has high diagnostic accuracy with MRI. Surgeons may use more MRI to decrease the number of useless thymectomy operations in non-MG and non-thymoma patients.

Thymomectomy instead of thymothymectomy

The term thymectomy is used to describe the complete removal of the thymus, and thymomectomy refers to the resection of a tumor within the thymus gland. Thymomectomy is the complete resection of the thymic tumor with leaving residual thymic tissue behind. The surgical management of thymic malignancies did not yet come on an agreement despite all the efforts given by ITMIG (3). In an ITMIG reference (3), it has been recommended to perform resection to thymus, thymoma and all fatty mediastinal tissue (3). The thymic epithelial tumors (TETs) should be resected together with the surrounding thymus and fatty tissue rather than shelled out because all TETs are considered malignant and trans capsular invasion is difficult to detect intraoperatively (3). However, there is an abundance of publications and videos on thymic surgery which study and demonstrate the equal outcome with both techniques confuses the readers. All efforts of thoracic and oncology organizations to standardize the surgical approaches become not only useless but also confusing. This uncertainty has been presented in the literature (4-6).

Several other reports support the same surgical technique which is complete removal of thymus, mediastinal fat and bilateral pleura located in the mediastinum, even in stage 1 and 2 thymomas (7-9). These studies are recommendations and guidelines. There is no big data study or analyzes behind these recommendations. There is one anecdotal report from Masaoka at 2010 (10), in which he compares his own experience at Osaka (n: 93 patients) and Nagoya (n: 211 patients) series. Patients in both series were investigated in the 30 years follow up (10). He claims that overall survival in stage 1 and 2 thymomas of the Nagoya series are superior to those of Osaka series (10-year survival rates of stage 1: 87.1% *vs.* 66%, those of stage 2: 80.6% *vs.* 60%). These differences are attributed to the change in operative procedures. In the Osaka series, a majority of patients underwent simple thymomectomies whereas a majority of patients in the Nagoya series underwent extended thymectomies. He claims the extended thymectomies could reduce the tumor recurrences particularly in stage 1 and 2 thymomas (10).

Four important theory to perform extended thymoma resection in stage 1 and 2 thymomas are as follows: (I) second thymoma—multicentric thymoma development; (II) development of MG after the operation; (III) prevention of the local and regional recurrences, in this way providing better overall survival and disease-free survival; (IV) control of other associating diseases, i.e., pure red cell aplasia.

There are several published articles in the last decade which claims that, when thymoma is not associated with MG, the complete removal of the thymus gland may not be required for early-stage tumors (10,11). However, there is no consensus on the appropriate extent of thymic resection (12).

It has been claimed that thymectomy may help to prevent potential risks of postoperative MG and intrathymic or locoregional recurrences (12,13). Yet, we do not have any prospective study to evaluate the value of different surgical techniques in early-stage thymoma without MG. In the current practice, thymic registries either ESTS or ITMIG, thymomectomy patients may be noticed (14). Because

Figure 1 Robotic surgery may increase the capabilities and may provide support for more extended surgeries minimally invasively (18). Available online: http://www.asvide.com/article/view/32015

leaving a part of thymus behind or in other words limited thymectomy is a common practice in several institutions. Thymoma operations are common in these centers and surgeons working in these centers commonly report their operations to registries (15).

It has been reported that post-thymectomy MG development is not common. But it is claimed that Development of MG could be estimated. These patients generally have higher levels of Acetyl choline Receptor antibody (ARab). It has been claimed that as ARab levels increase myasthenic status worsens (13,16).

The surgical method of patients with high Arab levels should be extended thymectomy.

Technically difficult or oncological unsuitable situations

Contraindications to minimally invasive thymoma resections are well described. These include severe pleural and pericardial adhesions, great vessel and pericardial invasion. The left innominate vein could be considered as the smallest great vessel to be included. Although it has not been reported as an absolute contraindication, tumor diameter larger than 5 cm is generally accepted as a limit by most of the minimally invasive surgeons. These claimed contraindications are the result of general concerns such as; Increased pleural and mediastinal recurrences. Generally, tumors larger than 5 cm have this potential risk. In one of our studies, we have demonstrated that Masaoka stage 1 and 2 thymomas are ideal candidates for minimally invasive thymoma resection. We have demonstrated that Masaoka Stage 3 and 4 patients are 7.5 times more likely to be converted to open surgery (17). Although pericardial resection has been presented as a contraindication to MIS for thymoma, Robotic surgery may increase the capabilities and may provide support for more extended surgeries minimally invasively (*Figure 1*).

It has been demonstrated that only 14 patients out of 177 were amenable to MIS among type B3 thymomas. Most of them had pleural metastases or invasive to the large vessels or pericardium. Type of thymoma could also be a reference point for deciding a minimally invasive approach (19). Twenty-two percent of these patients reoccurred with 7% distant metastases. This bad outcome brings the question of performing PET/CT to all thymoma patients to have an idea about the type of thymoma. A meta-analysis which was recently performed by the evaluation of 11 studies demonstrated that FDG PET might predict the type of thymoma. There is a significant difference of SUV-max between the low grade and high-grade thymomas. FDG PET results may bring the question of a need for further true cut evaluation in patients with high SUV-max to proceed with a neoadjuvant treatment or to perform a lymph node dissection intraoperatively.

Not converting to open even if it is necessary

Converting to open surgery for a proper oncologic perspective is a must. However, there are immediately vital circumstances that the surgeon should convert to open surgery. These include the injuries to major mediastinal vessels such as the aorta, superior vena cava, and left innominate vein. Although small bleedings may be treated with MIS, some require an immediate thoracotomy. A possible injury or an intentional resection to either of the phrenic nerves may be another reason for conversion to open. In our one of the most recent publications, we have demonstrated that catastrophes may occur during surgery for thymus resections. Out of 441 thymus and thymoma resections, 7 patients (1.5%) experienced catastrophic complications. These include diaphragmatic injury and sudden cardiac arrest, in addition, the above-mentioned vascular injuries. None of the patients died. We recommend converting to open surgery in seconds to overcome the possible mortal complications during the minimally invasive thymic surgery.

Conclusions

The stage of the thymoma, the type of the thymoma, the dimensions of the tumor, individual patient's characteristics

and experience of the surgeon and center are extremely important parameters in the MIS for thymoma. The safety of the surgery and oncological completeness of the resection are the most important criteria for the minimally invasive of the surgery of the thymus.

Acknowledgments

None.

Footnote

Conflicts of Interest: The author has no conflicts of interest to declare.

Informed Consent: Informed consent is obtained from the patient with robotic video.

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doi: 10.21037/med.2019.04.07
Cite this article as: Toker A. Red flags in minimally invasive thymoma resections. Mediastinum 2019;3:20.