8 Robotic Thymectomy: China

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Abstract

Surgical resection of thymus gland has been established as an effective treatment in selected patients with myasthenia gravis (MG). Since April 2006, we have started our robotic thoracic surgical program at the Prince of Wales Hospital, the Chinese University of Hong Kong, Hong Kong (SAR), China. We reported our initial experience of using da Vinci robotic system for complete thymectomy in 12 patients with myasthenia gravis. The mean operative time was 140 min and there was no major complications with mean hospital stay of 4 days. All patients have symptomatic improvement (DeFillipi class) on follow-up. Robotic thymectomy is a safe procedure and is associated with satisfactory clinical outcomes.

Keywords

Thymectomy • Myasthenia gravis • Robotics • Minimally invasive surgery • Mediastinum

8.1 Background

Surgical resection of the thymus as a treatment for myasthenia gravis (MG) was first proposed by Buckingham, and currently thymectomy has been established as an effective treatment option in selected MG patients [1]. In our locality, thymectomy for MG has a 70% response and a 33% remission rate [2].

Traditional methods of surgical access include the transsternal, transcervical and combined approaches. The more recent development of video-assisted thoracoscopic surgery (VATS) and robotic surgery provide further options, with the potential to decrease post-operative pain, shorten hospital stay, and improve cosmesis.

Several case series have been published in recent years [3–10] proving the safety and feasibility of using robotic assisted surgical system to perform thymectomy with good results. Here we describe our early experience using the da Vinci Robotic system, available to our division since 2006, for complete thymectomy in patients with myasthenia gravis, and to share the challenges encountered during the early implementation of the system in our unit.

With increasing popularity of robotic surgery technology, a foreseeable surge in its use in cardiothoracic surgery is anticipated. One main attraction of robotic-assisted surgery over conventional VATS technique is that it provides extra dexterity in a confined space when compared to conventional VATS. This was made possible by the extra wrist action of the instruments which provide 7 degrees of movement. Furthermore, the system provides a stereo-visual representation of the surgical field as opposed to a 2-D image in conventional VATs, providing the surgeon with an accurate sense of depth during the operation. Scale motion with tremor filtering provides better surgical accuracy. One major disadvantage of using the robotic system is the lack of tactile feedback.

However, practicing robotic surgeons have found that the loss of this sense can be compensated by the superior 3-D

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image [3, 5–10, 11]. The use of robotic system enabled precise and accurate dissection of the superior mediastinal structures, the upper horns of the thymic gland together with all the cervical portions of the thymus. A more complete and radical resection can be performed within that limited space by the robotic instrument. The peri-thymic fat over the contralateral hemithorax can easily be dissected free resulting in a more complete thymectomy when compared with unilateral VATS approach [8–10].

Most experts agree that the learning curve for robotic thymectomy is relatively short [3, 5–7, 11]. This has been shown again in our series, with a rapid drop in operative time from 165 to around 100 min just after the first four cases.

There is no consensus on which is the best route for thymectomy in MG. Even in minimally invasive approaches, options of right, left, bilateral, or combined with transcervical incision have all been demonstrated to be feasible and comparable. The right-sided approach is our preference, because the surgical team and operating room staff involved were familiar with this approach when we performed the video-assisted non-robotic thoracoscopic approach (VAT), and that the prior research done in our center confirmed that right sided VAT thymectomy produces satisfactory results [12]. Advocates of the left-sided approach may be concerned about possible incomplete excision of accessory thymic tissue in the aorto-pulmonary window, which has been reported to be present in up to 24% of patients [13]. Some argue that the left phrenic nerve is better exposed in a left-sided approach while the right phrenic nerve is partially protected by the superior vena cava [3]. Experience in this center showed that left phrenic nerve injury has not been a problem with either VATs or robotic thymectomy [12]. Evidence of superiority of a left-sided approach is still lacking.

The use of the appropriate instruments is essential in performing robotic-assisted thymectomy. The Cadiere® forceps are placed within the left-sided port for the manipulation of the relatively fragile thymic tissue. The diathermy blade is useful both for cutting and blunt dissection of tissue. It is crucial to achieve accurate positioning of the bedside cart and docking of the robotic arms. Our experience shows that if the bedside cart is positioned too far away from the operating table, the efficiency and the range of movement of the robotic arms will be reduced. This will result in "crowding" and "fighting" of the robotic arms. Once the operation has started with the ports inserted, change of position of the patient cart becomes very difficult, and re-calibration of the instruments after changing position also takes up a lot of the operating time. Optimal positioning of the patient side-cart with the help of the operating surgeon is essential.

Previously published series on robotic-assisted mediastinal tumor or thymic excision have shown similar [3, 5–6, 11] or even superior results [6] in terms of DeFillipi classification of remission when compared with VATs procedures. Because of the small number of patients and the short follow-up period in our series, direct comparison between robotic surgery versus VATS thymectomy cannot be made. Our initial findings suggest that robotic thymectomy is promising; when compared to VATS thymectomy for non-thymomatous thymectomy in this center [12], the mean operative time was 43 min longer in the robotic group (mean 107 versus 138 min). The mean hospital stay was similar between the two groups. The length-of-hospital stay was determined by the status of the MG as two patients in our series required postoperative intravenous immunoglobulin (IVIG) for MG crisis without any active surgical problems. Complication rate in the VATS group was 11% (including Pneumonia/Chest wall parasthesia) versus 0%. Need for wound extension was 5.5% in VATs, 0% in robotic thymectomy. On follow-up improvement in MG was 99.6% in VATs, 100% in the robotic group (De Filipi 1–3). However, the follow-up time is short when compared with our VATS series.

Robotic thymectomy seems comparable, if not superior to VATS thymectomy. The results of our small series appear to be comparable to the other world larger series [8–10] in terms of operating time and postoperative outcomes.

The initial costs of setting up a robotic surgical service is substantial and its maintenance can be costly. By sharing this technology across all surgical specialties in the hospital, the cost can be significantly reduced. Considering the small number of robotic thymectomy cases performed in Hong Kong, China at the present moment, we expect there is room for improvement and better results may be achieved in the near future.

8.2 Anesthetic Technique

General anesthesia is achieved with Propofol and Fentanyl. Left sided double–lumen endotracheal tube is placed for selective one-lung ventilation of left lung. As all patients undergoing robotic-assisted thymectomy had myasthenia gravis, no muscle relaxant are used during anesthesia. General anesthesia is maintained with isoflurane and nitrous oxide in oxygen. Ventilation is adjusted to maintain normocapnia. Since MG patients are usually more susceptible to the neuromuscular blocking effect of vtolatile gases, non-depolarizing muscle relaxants are not used. Routine pulse oximetry and non-invasive hemodynamic monitoring are employed during the procedure.

8.3 Surgical Technique

All patients are operated on by a team of thoracic surgeons with extensive VATS experience, using the da Vinci Surgical System (Intuitive Surgical, Sunnyvale, CA). All patients are positioned with right side up at 30°, using a silicon gel wedge to support the right shoulder and upper back. The right arm of the patient is then positioned to the side of the patient resting on the operating table with the right shoulder arm slightly extended (Fig. 8.1). The bedside-cart with the robotic arms is positioned on the left side of the operating table (Fig. 8.2). A 30-degree upward endoscope is inserted through a thoracoport via a 15 mm incision at the fifth intercostal space at the mid-axillary line. Two 8-mm accessory ports are then inserted at the third intercostals space/ mid-axillary line and the fifth intercostals space/mid-clavicular line. The two robotic arms of the da Vinci System are then attached to the two accessory ports, while another arm is attached to the

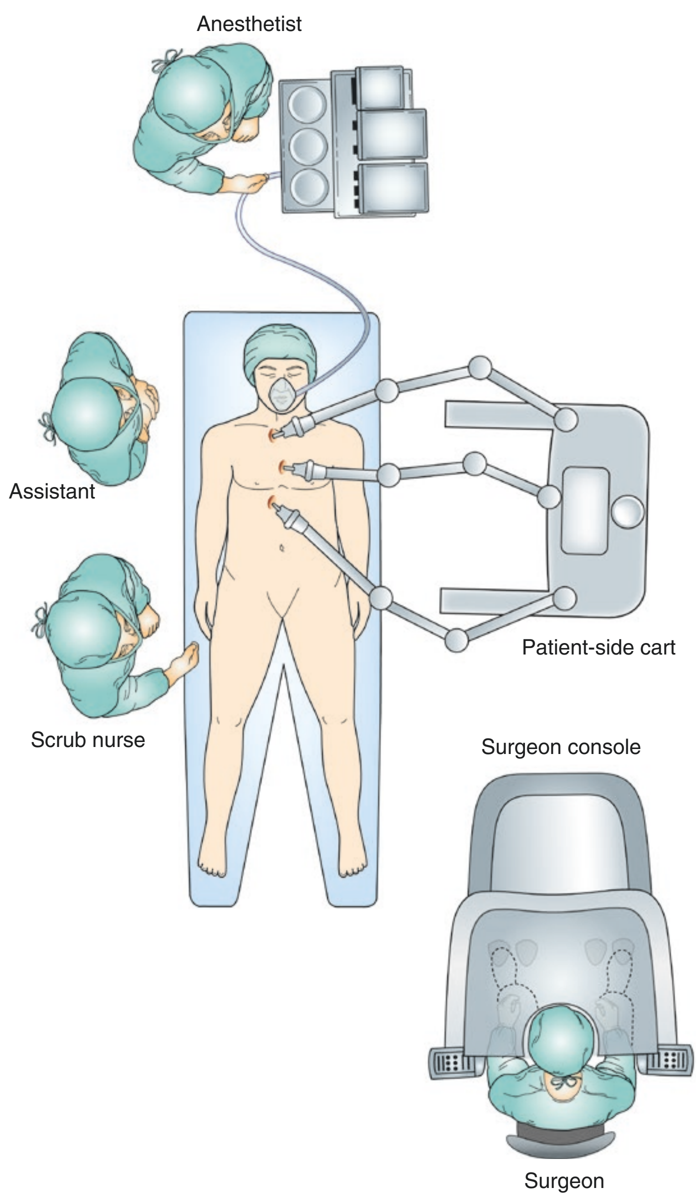

Fig. 8.1 Patient position: camera port (fourth ICS anterior axillary line), Left instrument port (third ICS mid-axillary line) and right instrument port (fifth ICS mid-axillary line)

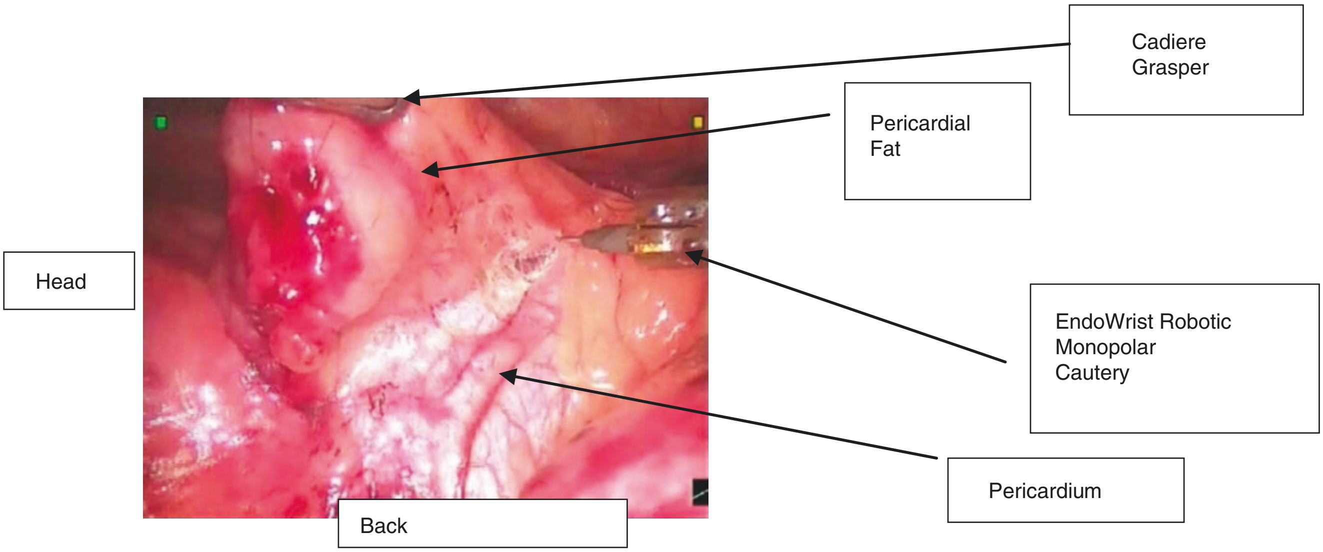

Fig. 8.2 Room set-up for right-sided approach thymectomy

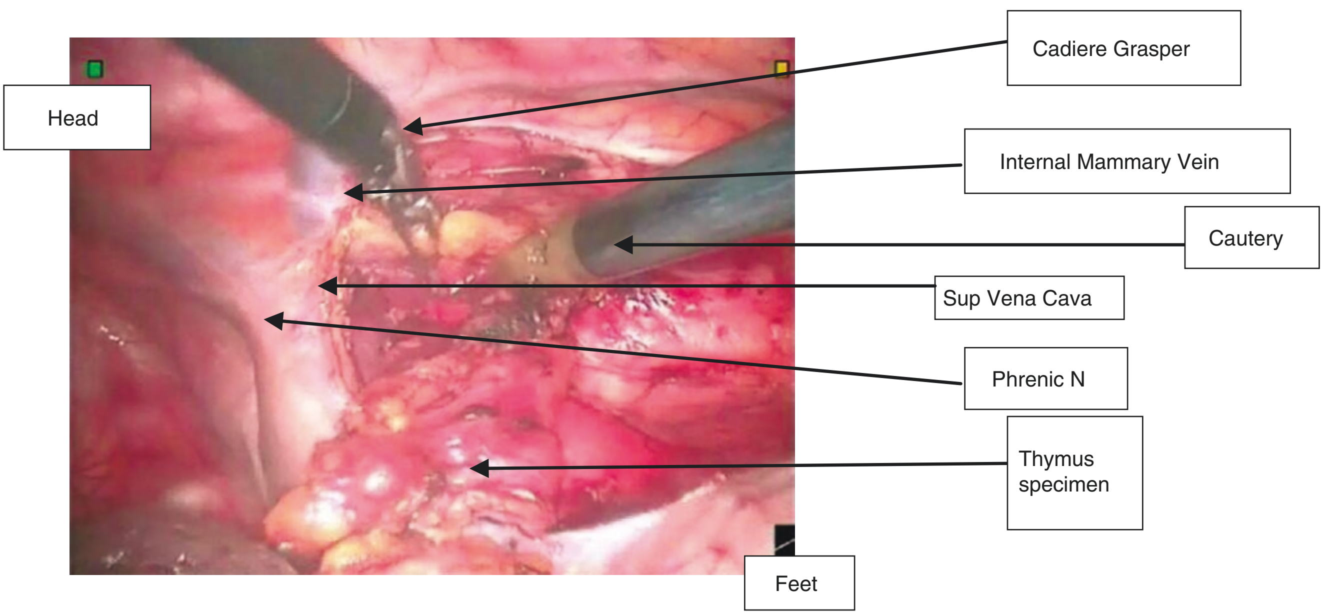

Fig. 8.3 Initiation of right-sided approach thymectomy. Lower mediastinal dissection: Dissection of the right inferior horn (RIH) of the thymus from the diaphragm and the pericardium anterior to the right phrenic nerve (PN)

port-inserted endoscope. There is no need to use the fourth arm of the robot to perform a thymectomy. The right lung is then deflated and CO_2 insufflation is started at 10 mmHg through the camera port.

Cadiere forceps are used through the left port in all except the first case in the series, where a Debakey forceps with Endowrist action was used. Electrocautery blades with Endowrist action were used via the right port, acting as a dissecting instrument. The right inferior pole of the thymus is first dissected off the right pericardium and diaphragm (Fig. 8.3), continuing cranially along the anterior border of the phrenic nerve and the superior vena cava up to the level of the right internal mammary vein (Fig. 8.4). The retrosternal plane is developed with dissection of the mediastinal fat and tissue at the anterior mediastinum. The dissection is continued over the retrosternal space until the left mediastinal pleura and left inferior horn are identified (Fig. 8.5). After further dissection the innominate vein is then exposed by mobilizing the lower part of the thymus upwards (Fig. 8.6a). Thymic veins from the innominate vein are clipped and cut

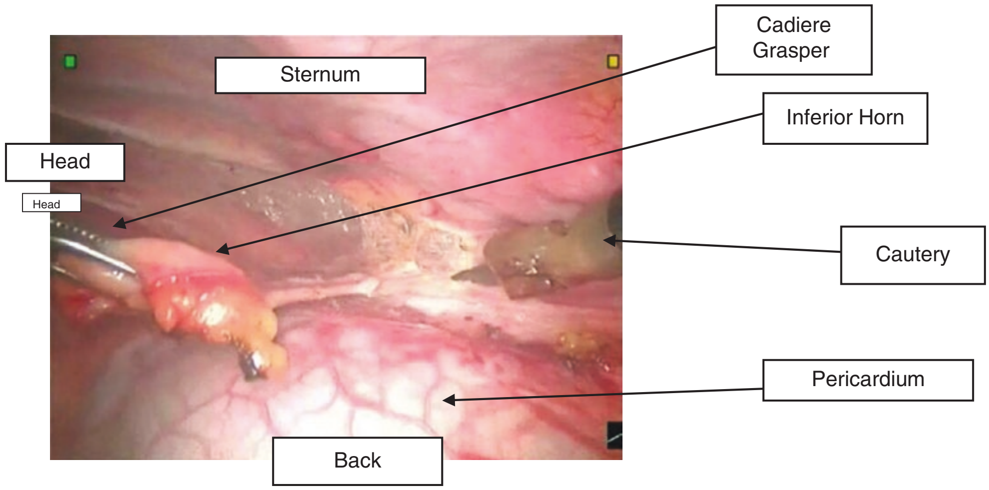

Fig. 8.4 Right-sided aspect of thymectomy completed

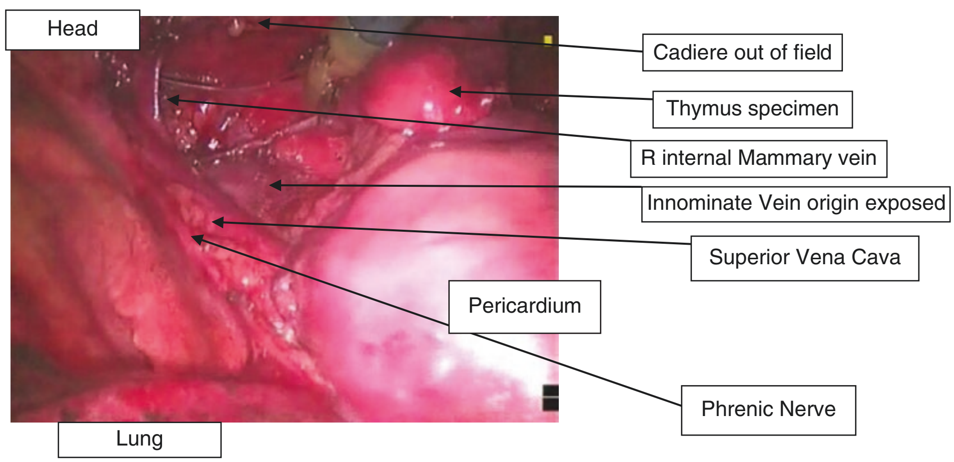

Fig. 8.5 Dissection of the left inferior horn

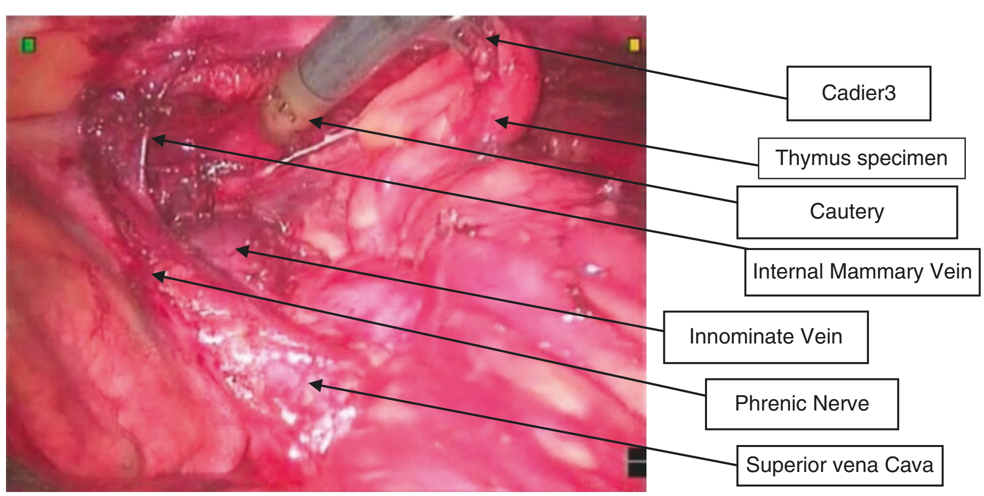

Fig. 8.6 (**a**, **b**) Exposure of the innominate vein by lifting the thymus cephalad. Upper mediastinum. The thymus was dissected from the innominate vein with venous thymic tributaries and left upper horn of thymus can be mobilized. The right internal mammary vein is preserved

using a robotic clip applicator and scissors with Endowrist action via the right assess port. Change of instruments during the surgery is facilitated by the scrub nurse and the assistant, sitting on the right of the patient. The right superior horn was dissected and freed from the innominate vein. The left upper horn could be dissected and excised in a similar manner and detached from the thyroid gland by blunt dissection (Fig. 8.6b).

The excised specimen was placed in a "Zip-lock" bag and delivered through the inferior port/camera port after the trochars were removed. A 24 Fr chest tube is inserted through the most inferior port after hemostasis and wounds are closed in layers. All patients are extubated in the operating room and transferred to the intensive care unit for observation overnight.

Table 8.1 Patient characteristics

Age	21–53 (mean: 41)
Sex M:F ratio	1:3
Osserman Class	
I	2
IIa	3
IIb	5
III	2
IV	0

Osserman Classification: I Occular MG: Involvement of extra ocular muscles, with diplopia or ptosis; IIa Mild generalised MG: occular symptoms are associate to slow involvement of bulbar and skeletal muscles; IIb Moderately generalised MG: Progressive onset of symptoms with significant manifestation of weakness; III Acute MG: Rapid onset (6 months) of severe bulbar and skeletal muscles with important weakness. Respiratory muscles involved; IV Late severe MG: progressive in severity for 2 or more years

8.4 Outcomes

From April 2006 to Nov 2009, 12 patients with myasthenia gravis underwent right-sided thoracoscopic thymectomy using the da Vinci Robotic system (Table 8.1) [14]. Nine were females and 3 were male, aged 21–53 years old. MG was diagnosed using clinical criteria and positive results: the Tensilon test, circulating acetylcholine receptor antibodies, or electromyography. All patients had pre-operative computed tomography (CT) performed. Two patients had a pre-operative diagnosis of a small thymoma (less than 2 cm), while the other ten patients had normal-sized thymus on CT scan.

Twelve robotic-assisted complete thymectomy procedures were performed with no conversion to other approaches (Table 8.2) [15]. Operative time ranges from 100 to 200 min (mean time 140 min), with a trend of decreasing operative time with accumulating experience. The operative time was longer for patients with thymoma (200 and 170 min, respectively) since that involved resection of a relatively bulky thymic gland with exploration of the left pleural space via the right side. There were no intra-operative or post-operative complications. Nearly all chest drains were removed on post-operative day 1 and the mean hospital stay was 4.0 days only. The excised specimens showed thymic hyperplasia except for two patients with type B1 thymoma. The follow-up period ranges from 2 to 44 months. Early post-operative evaluations showed 1 patient had complete remission in symptoms (DeFillipi class 1), eleven patients became asymptomatic or less symptomatic with decreasing medication requirement (DeFillipi class 2 and 3).

Table 8.2 Outcomes

Operative time (min)	100–200 (mean 140)
Intra-operative blood loss (mL)	10–100 (mean 40)
Chest drain removal (days)	1–3 (mean 2)
Hospital stay (days)	3–6 (mean 4)
Follow-up (months)	2–44 (mean 21)
DeFilippi Class on follow-up	
1	1
2	7
3	4
4	0

DeFilippi Postop Classification: 1 Complete remission. No medication; 2 Asymptomatic, decreased medication; 3 Improved, decreased symptoms or decreased medication; 4 No change; 5 Worsening symptoms

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