Sixth International Joint Meeting on THORACIC SURGERY
Barcelona - 20th, 21st and 22nd November 2024
Auditorio Foment del Treball Nacional. Barcelona (Spain)

11th International Meeting on General Thoracic Surgery
10th International Workshop on Surgical Exploration of the Mediastinum and Systematic Nodal Dissection
5th Meeting of the Thoracic Oncology, Thoracic Surgery, Techniques & Transplant, Respiratory Nursing and Respiratory Physiotherapy Areas of the Spanish Society of Pneumology and Thoracic Surgery (SEPAR)
3rd Joint Meeting of the Spanish Society of Thoracic Surgery (SECT)
30th Congress of the "Asociación Iberoamericana de Cirugía Torácica" AIACT
10th International Workshop on Surgical Exploration of the Mediastinum and Systematic Nodal Dissection

ROBOTIC THYMECTOMY

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Thymectomy (Thx) is indicated for mediastinal lesions, especially thymoma, and for the majority of patients with myasthenia gravis (MG). Several concerns have determined median sternotomy as the gold standard technique for Thx: ensuring adequate radicality for oncological reasons in thymoma cases and completeness of thymectomy, including all of the possible microscopic ectopic thymic tissue in the mediastinum with MG patients. Therefore, the concept of combining true minimal invasion with maximal exposure via VATS, while ideal for MG, has been limited in the past by criticism

The development of robotic surgical techniques has created convincing opportunities, making robotic Thx a driving force in robotic thoracic surgery [1].Special challenges in Thx include: the main left thymic lobe located with the left phrenic nerve inside, thymic growth extending to the entrance of the left pulmonary veins, anatomical variations such as one or both upper thymic poles situated below the innominate vein (between the aortic arch and the innominate vein), a large amount of mediastinal tissue due to age and/or higher BMI, large thymomas, and young children with MG.

The wristed instrument tips, true 3D vision, tremor filtration, precise positioning, tremendous magnification, and ergonomic comfort for the surgeon are key technical advantages of the robotic surgical technique in addressing these specific challenges in Thx [2]. Over time, robotic Thx has incorporated various technical modifications, such as unilateral left- or right-sided approaches, bilateral robotic Thx, the 4-trocar technique with a subxiphoid trocar, subxiphoid robotic Thx, and robotic Thx with sternal lift-up. Additionally, there have been ongoing refinements in operative technique.

Robotic Thx using a unilateral left-sided approach can be performed as a 10- to 12-step procedure. Patient positioning and the placement of the three trocars are strategically reproducible points. The initial visual exploration reveals possible anatomical variations, which are almost always found on the left side of the thymic gland. The most meticulous dissection in this area is best achieved directly from the left side.

Over 22 years, the single-center experience at Charité in Berlin includes more than 1,200 robotic Thx cases, with a current annual frequency of 100 procedures. Robotic Thx has evolved directly from thoracoscopic Thx. Since the MGTX trial in 2016 established level 1 evidence for the efficacy of Thx in managing MG, two clinical questions remain regarding surgical approach: Is minimally invasive Thx adequate or even superior to median sternotomy, and which minimally invasive technique best addresses all potential challenges of Thx? [3]

Secondly, clinical investigations should clarify the role of Thx for MG subgroups not included in the MGTX study. The robotic unilateral left-sided approach has shown superiority over non-robotic VATS in improving MG outcomes for a mixed, non-selected MG cohort [4]. Moreover, the left-sided robotic approach demonstrated greater improvement for MG compared to the right-sided technique in a multi-institutional international study [5].

The improved radicality or completeness of thymic tissue harvesting from the left side, given the broader anatomical distribution and variations of the thymic gland on this side, may help explain these results. Video demonstrations of specific mediastinal dissection steps highlight the advantages of direct surgical

action at the main anatomical challenges of the thymus. The right phrenic nerve bundle can be safely visualized and preserved by performing mediastinal dissection along landmarks at the entry point of the right mammary vein into the venous confluence [6].
Robotic Thx has proven to be an effective approach for juvenile MG, particularly in young children as small as 4 years old and weighing as little as 15 kg, with significantly better treatment outcomes compared to non-surgical comprehensive MG treatment in this subgroup [7]. Given the very low perioperative morbidity and extensive dissection, including both cardiophrenic fat pads, robotic Thx may also be suitable for additional MG subgroups.
In seronegative MG (snMG), robotic Thx is part of a comprehensive scientific investigation, with outcomes appearing more favorable than with non-surgical treatment. Robotic Thx has shown particular benefit in late-onset MG (LOMG); for a cohort diagnosed with MG after age 60, perioperative morbidity was very low, with a significant reduction in postoperative immunosuppressive therapy [8]. In MG patients with higher BMI, achieving radical Thx may be challenging, but the technological advantages of robotic Thx provide the most effective solution. Even for the rare indication of re-Thx after previous (incomplete) Thx the robotic operation technique worked perfectly [9].
Mediastinal tumors, particularly thymomas, may co-occur with MG or be discovered incidentally. The traditional view that median sternotomy is necessary for thymoma patients was cautiously challenged and successfully revised through initial multi-institutional retrospective studies [10,11]. Over time, extensive research has continued to demonstrate the unique dissection quality of robotic surgery, which is advantageous for the oncological management of thymoma. A large study further confirmed that even larger thymomas (>5 cm) can be effectively addressed with a modified robotic Thx technique [12].
Robotic Thx has gained worldwide acceptance and is likely to become the preferred technique for Thx in most institutions with dedicated Thx programs.

Reference

[1] Rückert JC, Ismail M, Swierzy M, Sobel H, Rogalla P, Meisel A, Wernecke KD, Rückert RI, Müller JM. Thoracoscopic thymectomy with the da Vinci robotic system for myasthenia gravis. Ann N Y Acad Sci. 2008;1132:329-35. doi: 10.1196/annals.1405.013. PMID: 18567884.
[2] Ismail M, Swierzy M, Rückert JC. State of the art of robotic thymectomy. World J Surg. 2013 Dec;37(12):2740-6. doi: 10.1007/s00268-013-2250-z. PMID: 24154574.
[3] Wolfe, Gil I., et al. "Randomized trial of thymectomy in myasthenia gravis." New England Journal of Medicine 375.6 (2016): 511-522.
[4] Rückert JC, Swierzy M, Ismail M. Comparison of robotic and nonrobotic thoracoscopic thymectomy: a cohort study. J Thorac Cardiovasc Surg. 2011 Mar;141(3):673-7. doi: 10.1016/j.jtcvs.2010.11.042. PMID: 21335125.
[5] Wilshire, Candice L., et al. "Minimally invasive thymectomy for myasthenia gravis favours left-sided approach and low severity class." European Journal of Cardio-Thoracic Surgery 60.4 (2021): 898-905.
[6] Thymectomy in Myasthenia Gravis, An Issue of Thoracic Surgery Clinics (Volume 29-2) (The Clinics: Surgery, Volume 29-2).
[7] Li, Zhongmin, et al. "Outcomes of juvenile myasthenia gravis: a comparison of robotic thymectomy with medication treatment." The Annals of Thoracic Surgery 113.1 (2022): 295-301.
[8] Li, Feng, et al. "Results of robotic thymectomy performed in myasthenia gravis patients older than 60 years at onset." The Annals of Thoracic Surgery 108.3 (2019): 912-919.
[9] Li, Feng, et al. "Robotic-extended rethymectomy for refractory myasthenia gravis: a case series." Seminars in thoracic and cardiovascular surgery. Vol. 32. No. 3. WB Saunders, 2020.
[10] Marulli, Giuseppe, et al. "Robot-aided thoracoscopic thymectomy for early-stage thymoma: a multicenter European study." The Journal of Thoracic and Cardiovascular Surgery 144.5 (2012): 1125-1132.
[11] Marulli, Giuseppe, et al. "Multi-institutional European experience of robotic thymectomy for thymoma." Annals of cardiothoracic surgery 5.1 (2016): 18.).
[12] Huang, Luyu, et al. "Robotic-assisted extended thymectomy for large resectable thymoma: 21 years' experience." The Journal of Thoracic and Cardiovascular Surgery (2024).