Editorial

Pre-operative 3D reconstruction—let's first anticipate the surgical procedure

François Montagne^, Clément Dhainaut, Lotfi M. Benhamed

Department of Thoracic Surgery, Hospital of Valenciennes, Valenciennes, France

Correspondence to: François Montagne, MD, MSc. Department of Thoracic Surgery, Hospital of Valenciennes, Avenue Désandrouin CS 50479, 59322 Valenciennes Cedex, France. Email: montagne-f@ch-valenciennes.fr.

Comment on: Lenzini A, Zirafa CC, Ceccarelli I, *et al.* Surgical management of teratoma located in pretracheal retrocaval space: from pre-operative 3D reconstruction to robotic surgery. Video-assist Thorac Surg 2023;8:9.

Keywords: Minimally invasive surgery; robotic-assisted thoracoscopic surgery; preoperative imaging; three-dimensional computed tomography imaging; mediastinal tumor

Received: 19 April 2023; Accepted: 08 June 2023; Published online: 15 June 2023.

doi: 10.21037/vats-23-34

View this article at: https://dx.doi.org/10.21037/vats-23-34

Medical imaging has many distinct applications beyond "just seeing through", thanks to the many technological advances and innovations made since the discoveries of Pierre and Marie Curie.

In their case report, Lenzini *et al.* (1) have reported the important role of medical imaging and in particular three-dimensional (3D) reconstruction of CT images for the surgical management of a teratoma located in the pretracheal and retrocaval space and removed by a robotic approach. This editorial will briefly discuss the advantages of using 3D reconstructions in thoracic surgery, providing some references, but does not constitute an exhaustive review of the literature.

By analyzing the surgical evolutions of these last decades, one word, one qualifier, can be highlighted, "less". Resecting less tissue, with the rise of segmentectomy (2,3) for example, and through a less "disabling" or "traumatic" approach thanks to the development of minimally invasive procedures (4). But, paradoxically, this "less" is permitted because there is "more". More medical shared knowledges (5) and more advanced technologies and surgical tools and devices.

In addition, minimally invasive, or closed-chest, approaches have brought a "barrier" or a "boarder" between the operator's hands and eyes and the patient, and his anatomy. During a conventional open approach, it is still sometimes heard "we'll see when we get there". Moreover, we have the possibility to manipulate, and to analyze progressively by seeing in 3D and from all directions by associating our eyes and our hands the anatomy and its variations. This allows us to better understand it.

In a minimally invasive approach, not all approaches allow us a "global vision", the manipulation of tissues is also more limited and there is this interface, "barrier" or "boarder" between the patient, his tissues, our hands and our eyes. We have "less possibility to see while being there" and the preoperative preparation takes all its meaning.

But how to prepare effectively and to face anatomical variations? Following the example of the aeronautical world, which inspires the various fields of medical and surgical safety, we have seen and reeded the development of the notion of preoperative briefing. But this briefing depends on the available data. Thus, preoperative imaging plays a very important role to be aware of the most accurate knowledge of the individual patient anatomy regarding bronchovascular and mediastinal structures.

We have educated our brain to read flat images, but the representation, the visualization in 3D remains difficult to achieve from these flat images. Moreover, there are many anatomical variations in the lungs and mediastinum

^ ORCID: 0000-0001-8182-2695.

concerning vascularization, bronchial and pulmonary segmentation... Thus, 3D reconstructions allow us to: identify the anatomical landmarks and the anatomical variations; to assess the oncological margins; to define the surgical planning, "to define the plan A"; seems to enhance the safety, the efficiency and preoperative events and short-term outcomes of surgery; and also have educational values.

Many authors have reported the advantages, and the safety benefits of using 3D reconstructions in thoracic surgery for a lung resection or for a mediastinal resection and this can be summarized in a non-exhaustive way as follows:

(I) First, to have a better knowledge of the anatomical landmark and to identify the anatomical variation. Watanabe *et al.* 20 years ago have reported their experience of 3D reconstructions of pulmonary vessels with an angiography CT scan compared to a conventional pulmonary angiography (6). For 10 years 3D reconstructions technology progressively spreads in routine (7,8) for guided lung segmentectomies for example. Moreover, 3D reconstructions increase the spatial representation knowledge of the different anatomical structures, and enhance the safety of the procedure (9-12) .

(II) Then those 3D reconstructions allow us to define the resectability of the lesion and for lung segmentectomy to define the oncological margins, so the oncological effectiveness of the segmentectomy and to define the intersegmental plane (7,8,12-14).

(III) With 3D reconstructions, the surgical procedure can be planned before the surgery. Anatomical landmarks are known, anatomical variations are highlighted and surgical margins are anticipated. Then the resections steps can be defined, this is the "plan A" the surgical scenario (7,15-17). When the "plan B" is the scenario when a complication occurs. 3D reconstructions are one of the devices that we used for multimodal segmentectomy (18-20).

(IV) Moreover, when you have this "plan A" guided by the most effective knowledge of the specific anatomical landmark of the patient, the surgery was reported as most efficient, in a shorter operative time (21-24), with a better lymph node dissection (23,25) and a lower conversion rate (24,25). Nevertheless, the good short-term outcomes already described after a minimally invasive thoracic approach are not yet significantly improved (11,21-25).

(V) One of the hearts of our specialty is to share and educate our youngest residents and fellows and 3D reconstructions plays an important role, by providing many advantages. First, providing a 3D approach of the specific anatomical landmark of the patient, to discuss the oncological margins for infa-lobar resections, so to discuss oncological issues, then to identify the planning, the scenario of the resection and discuss what complication can occurred at each step for example. Moreover, 3D reconstructions can be integrated in simulation-based training programs (17).

Let us always have in mind to bring the best, to our patients, the best quality of care, by adopting the technique adapted to their pathology and recognized by the medical and surgical community. As briefly reported, 3D reconstructions play an important in our specialty, for thoracic cancer surgery. Providing the best knowledge of the specific anatomical landmarks, it allows us to define the best surgical approach, to perform the best surgical resection with a better lymph node assessment and better oncological margins respecting oncological guidelines, in a safer way. Moreover, this device has many educational values to finally improve the health of everyone.

Acknowledgments

Funding: None.

Footnote

Provenance and Peer Review: This article was commissioned by the editorial office, *Video-Assisted Thoracic Surgery*. The article did not undergo external peer review.

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://vats.amegroups.org/article/view/10.21037/vats-23-34/coif). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

References

1. Lenzini A, Zirafa CC, Ceccarelli I, et al. Surgical management of teratoma located in pretracheal retrocaval space: from pre-operative 3D reconstruction to robotic surgery. Video-assist Thorac Surg 2023;8:9.
2. Saji H, Okada M, Tsuboi M, et al. Segmentectomy versus lobectomy in small-sized peripheral non-small-cell lung cancer (JCOG0802/WJOG4607L): a multicentre, open-label, phase 3, randomised, controlled, non-inferiority trial. Lancet 2022;399:1607-17.
3. Altorki N, Wang X, Kozono D, et al. Lobar or Sublobar Resection for Peripheral Stage IA Non-Small-Cell Lung Cancer. N Engl J Med 2023;388:489-98.
4. Montagne F, Guisier F, Venissac N, et al. The Role of Surgery in Lung Cancer Treatment: Present Indications and Future Perspectives-State of the Art. Cancers (Basel) 2021;13:3711.
5. Flanagin A, Curfman G, Bibbins-Domingo K. Data Sharing and the Growth of Medical Knowledge. JAMA 2022;328:2398-9.
6. Watanabe S, Arai K, Watanabe T, et al. Use of three-dimensional computed tomographic angiography of pulmonary vessels for lung resections. Ann Thorac Surg 2003;75:388-92; discussion 392.
7. Iwano S, Yokoi K, Taniguchi T, et al. Planning of segmentectomy using three-dimensional computed tomography angiography with a virtual safety margin: technique and initial experience. Lung Cancer 2013;81:410-5.
8. Shimizu K, Nakano T, Kamiyoshihara M, et al. Segmentectomy guided by three-dimensional computed tomography angiography and bronchography. Interact Cardiovasc Thorac Surg 2012;15:194-6.
9. Shiina N, Kaga K, Hida Y, et al. Variations of pulmonary vein drainage critical for lung resection assessed by three-dimensional computed tomography angiography. Thorac Cancer 2018;9:584-8.
10. Cui Z, Ding C, Li C, et al. Preoperative evaluation of the segmental artery by three-dimensional image reconstruction vs. thin-section multi-detector computed tomography. J Thorac Dis 2020;12:4196-204.
11. Fourdrain A, De Dominicis F, Blanchard C, et al. Three-dimensional CT angiography of anatomic variations in the pulmonary arterial tree. Surg Radiol Anat 2018;40:45-53.
12. Vervoorn MT, Wulfse M, Mohamed Hoesein FAA, et al. Application of three-dimensional computed tomography imaging and reconstructive techniques in lung surgery: A mini-review. Front Surg 2022;9:1079857.
13. Nex G, Schiavone M, De Palma A, et al. How to identify intersegmental planes in performing sublobar anatomical resections. J Thorac Dis 2020;12:3369-75.
14. Nakazawa S, Hanawa R, Nagashima T, et al. Segmentectomy Guided by 3D Images Reconstructed from Non-enhanced Computed Tomography Data. Ann Thorac Surg 2020;111:e301-4.
15. Sato M. All things are created twice: the importance of planning and reproduction in sublobar lung resection. J Thorac Dis 2018;10:S3200-2.
16. Le Moal J, Peillon C, Dacher JN, et al. Three-dimensional computed tomography reconstruction for operative planning in robotic segmentectomy: a pilot study. J Thorac Dis 2018;10:196-201.
17. Sardari Nia P, Olsthoorn JR, Heuts S, et al. Interactive 3D Reconstruction of Pulmonary Anatomy for Preoperative Planning, Virtual Simulation, and Intraoperative Guiding in Video-Assisted Thoracoscopic Lung Surgery. Innovations (Phila) 2019;14:17-26.
18. Sarsam M, Baste JM, Lachkar S. Multidisciplinary approach to minimally invasive lung segmentectomy. J Vis Surg 2020;6:50.
19. Baste JM, Soldea V, Lachkar S, et al. Development of a precision multimodal surgical navigation system for lung robotic segmentectomy. J Thorac Dis 2018;10:S1195-204.
20. Montagne F, Chaari Z, Bottet B, et al. Long-Term Survival Following Minimally Invasive Lung Cancer Surgery: Comparing Robotic-Assisted and Video-Assisted Surgery. Cancers (Basel) 2022;14:2611.
21. Hamada A, Oizumi H, Kato H, et al. Outcome of thoracoscopic anatomical sublobar resection under 3-dimensional computed tomography simulation. Surg Endosc 2022;36:2312-20.
22. Wang X, Wang Q, Zhang X, et al. Application of three-dimensional (3D) reconstruction in the treatment of video-assisted thoracoscopic complex segmentectomy of the lower lung lobe: A retrospective study. Front Surg 2022;9:968199.
23. Wu X, Li T, Zhang C, et al. Comparison of Perioperative Outcomes Between Precise and Routine Segmentectomy

for Patients With Early-Stage Lung Cancer Presenting as Ground-Glass Opacities: A Propensity Score-Matched Study. Front Oncol 2021;11:661821.
24. Chen Y, Zhang J, Chen Q, et al. Three-dimensional printing technology for localised thoracoscopic segmental resection for lung cancer: a quasi-randomised clinical trial. World J Surg Oncol 2020;18:223.
25. Zhu XY, Yao FR, Xu C, et al. Utility of preoperative three-dimensional CT bronchography and angiography in uniportal video-assisted thoracoscopic anatomical lobectomy: a retrospective propensity score-matched analysis. Ann Transl Med 2021;9:480.

doi: 10.21037/vats-23-34
Cite this article as: Montagne F, Dhainaut C, Benhamed LM. Pre-operative 3D reconstruction—let's first anticipate the surgical procedure. Video-assist Thorac Surg 2023;8:13.