



From video-assisted thoracoscopic surgery to the uniportal subxiphoid robotic approach

Diego Gonzalez-Rivas^{1,2}

¹Uniportal VATS Training Program, Shanghai Pulmonary Hospital, Shanghai 200000, China; ²Minimally Invasive Thoracic Surgery Unit (UCTMI) and Coruña University Hospital, Coruña, Spain

Correspondence to: Diego Gonzalez-Rivas, MD, FECTS. Director Uniportal VATS Training Program, Shanghai Pulmonary Hospital, Shanghai 200000, China; Minimally Invasive Thoracic Surgery Unit (UCTMI) and Coruña University Hospital, Coruña, Spain. Email: Diego.Gonzalez.Rivas@sergas.es.

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“Our future in surgery lies not in blood and guts, but in bits and bites”. —Colonel Richard Satava, pioneer of robotic telesurgery 2000

Developments in minimally invasive thoracic surgery begun one century ago by the hand of Hans Christian Jacobaeus. Diagnostic procedures, such as pleural biopsies, were performed mainly by pulmonologists and thanks to the introduction of the video-assisted surgical scope in 1991, the minimally invasive technique applications expanded to include major anatomic resections among other thoracic procedures. Since then, these techniques have evolved and improved all around the world.

The initial practice of three port technique in a ‘baseball diamond’ pattern was modified to suit surgical needs, and gradually developed into ‘next generation’ less invasive approaches, such as the double port video-assisted thoracoscopic surgery (VATS). Thereafter the logical progression of reducing the number of incisions ended with the single port VATS approach. In the last decade, this technique generated considerable interest within the field of minimally invasive thoracic surgery due to several reasons. Because this approach is less invasive, the uniportal technique has emerged as an innovative technique, applicable to a large variety of thoracic diseases, from easy diagnostic procedures to the most complex resections for lung cancer, including bronchial, vascular sleeves or even carinal resections.

There are many studies that show that the intercostal, uniportal approach can reduce the surgical trauma when compared with multiport thoracoscopic surgery. However, the risk of possible injury to the intercostal nerve and the

consequent acute and, or chronic pain cannot be completely ruled out. Avoiding the incision through the intercostal space could be a potential advantage to reduce postoperative pain and to improve the postoperative course of patients.

Recent innovations in single-incision approach include the use of subxiphoid and subcostal approach for major anatomic pulmonary resections. The subxiphoid and subcostal approach has been used during the last two decades initially for different minor thoracic procedures such as pericardial window, thymectomies, pulmonary metastasectomy and bilateral resections.

In 2013, Liu CC, with previous experience in uniportal transthoracic surgery, reported the first case of thoracoscopic lobectomy with mediastinal lymph node sampling through a single subxiphoid incision in a patient with lung cancer. Since then the technique has been refined and improved in only few centers around the world with the largest experience at the Shanghai Pulmonary Hospital. The volume of surgery at this center includes the largest number of subxiphoid and subcostal cases reported in the world. These include upper and lower lobectomies, pneumonectomies and all kind of segmentectomies.

One of the most important advantages of the subxiphoid approach is that it can reach both sides of the chest through a single incision. This is very useful for bilateral resections, anterior mediastinal resections and thymectomies. However, the access through the subxiphoid space has several limitations. One of the most important is the handling of major bleeding. When an emergent conversion to open surgery is necessary, an extension of the subxiphoid incision is unlikely to be useful and an additional chest incision or

even thoracotomy should be performed.

In addition, a radical lymph node dissection is very difficult to achieve via subxiphoid approach and there is limited access to posterior anatomy, so the upper posterior and lower anatomic segmentectomies are really challenging. From the xiphoid to the hilum, there is an oblique and longer distance than transthoracically so the instrument fighting problem during uniportal surgery will be even more challenging than through the transthoracic approach. The manipulation of instruments over the beating heart is also inconvenient, especially during left side procedures where extra care must be taken to avoid cardiac problems during surgery. The use of a sternal retractor improves the access and particularly reduces compression of the heart. The subcostal approach on the left side diminishes a bit the heat compression and could improve also the view.

So, the question that arises is how can we solve these subxiphoid limitations.

Parallel to the development of thoracoscopic approaches, a new concept of surgery was born almost 20 years ago—robotic surgery. Since the first robotic resection was reported in 2002, the popularity of this approach is slowly gaining clinical and research interest all over the world. Like other minimally invasive techniques, the robotic system offers the advantages of reduced postoperative pain, faster recovery and decreased hospital stay compared to open surgery. Most of the robotic platforms include a system with several arms so a minimum number of 3 to 4 incisions are always performed.

Supporters of robotic surgery claim several advantages over VATS, such as improved three-dimensional visualization, better ergonomics and more degrees of freedom of motion. However, to date, not one single study has shown clear advantages of the robot over VATS approaches. Therefore, the superiority of multiportal robotics cannot be demonstrated yet, especially when compared with the uniportal approach which is cheaper, faster and less invasive.

So why not try to apply the robotic technology through the subxiphoid approach?

We have now reached the moment when the subxiphoid approach and robotic surgery converge to develop a system that allows greater maneuverability and precision as well as avoidance of acute or chronic pain due to intercostal nerve damage. The robotic surgery allows a greater range of instrumentation so the areas that were previously limited through the subxiphoid space (posterior segments and subcarinal and paratracheal space) are now accessible thanks

to the advanced movement of the robot and the use of angulated cameras.

A couple of years ago we started a project with an important robotic company to develop this concept into thoracic surgery. After the visit of the engineers to our Uniportal VATS training program at Shanghai Pulmonary Hospital we followed with visits to the factory to improve this new robotic thoracic platform. A robotic system that accesses the chest through the subxiphoid space

We could say now that the future of the subxiphoid approach is promising with the recent development of the uniportal robotic equipment designed to minimize the surgical access trauma. We used a 2.5-cm diameter insertable arm which opens up within the operating cavity into a steerable 3D camera and three effector arms for tissue handling and suturing. The initial anatomic thoracic procedures we performed with this system in the cadaveric model were excellent showing feasibility of all kind of lobectomies and thymectomies. One of the advantages of this new platform could be the visualization of the subcarinal and paratracheal space to accomplish extensive lymph node dissection.

We are now waiting for studies to document the applicability in patients and compare clinical outcomes of the subxiphoid robotic technology versus the transthoracic and subxiphoid uniportal thoracoscopic approaches, in order to show clear benefits for this new exciting system. Once again, we are facing a new revolution in thoracic surgery that will definitely change the way we treat lung cancer and other thoracic surgical diseases.

“It is very difficult to slow down. The practice of medicine is like the heart muscle contraction—it’s all or none” —Alexis Carrel (1873–1944).

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