Robotic assisted sleeve lobectomy with the use of barbed sutures

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Abstract: Anastomosis in bronchoplasty using continuous suturing has become widely accepted. However, especially in VATS and robotic assisted thoracic surgery (RATS) it is difficult to maintain a continuous traction of suture over the circumference. In addition, the lack of haptic feedback on the current robotic systems might even further complicate the precise and constant maintenance of traction. Recent reports of using absorbable barbed suture materials in open and VATS surgery were published with promising results. We adopted and standardized the application of barbed sutures (Stratafix, Jonhson & Johnson, USA). There were no intraoperative difficulties such as cutting, loosening or tailing the suture.

Keywords: Robotic sleeve lobectomy; bronchoplasty; absorbable barbed suture; robotic assisted thoracic surgery (RATS)

Received: 19 April 2018; Accepted: 08 May 2018; Published: 04 June 2018.

doi: 10.21037/jovs.2018.05.19

View this article at: http://dx.doi.org/10.21037/jovs.2018.05.19

Introduction

In bronchoplastic operations of the lung, the reconstruction of the airway is usually performed by applying an anastomosis of the bronchus. This is traditionally created in interrupted sutures that are considered to be precise, safe, and reliable (1). However, the placement of interrupted sutures can be complex and time consuming. Usually knots of the back wall of the anastomosis are placed intraluminal whereas the front wall is knotted outside. But especially the intraluminally placed nodes of the inner wall might also lead to a stenosis of the lumen with consecutive accumulation of the secretion (2).

Bronchial anastomosis using continuous suturing has recently become widely accepted, especially in VATS and robotic assisted thoracic surgery (RATS) (3,4). However, the difficulty is to maintain a continuous traction of suture. This is even more difficult in the rigid tissue of the bronchus cartilage. In addition, the lack of haptic feedback on the current robotic systems might further complicate the precise and continuous maintenance of traction or even lead to a bunk of the suture.

Recent reports have demonstrated the usefulness of so-called absorbable barbed sutures in laparoscopic and thoracoscopic surgery (5-7). It is a novel resorbable suture that was originally developed for dermal closure and has a unique barbed structure that prevents loosening of the suture. Based on our own positive experience with this suture in robotic esophageal and bariatric surgery, we have also used this suture in bronchoplastic surgery (8). We report for the first time our clinical experience of robotic assisted sleeve lobectomy with bronchoplasty using barbed continuous sutures.

Surgical technique

The oncological resection is performed in a robotic assisted approach (RATS) as previously described using the DaVinci Si or Xi System (Intuitive Surgery, Sunnyvale, CA, USA) (9). We apply the four-arm technique, where the trocars are placed in the 8th or 9th intercostal space. Systematic hilar and mediastinal lymph node dissection is performed until bronchial reconstruction commenced. After transection of the proximal and distal bronchus, bronchial anastomosis is performed as follows (sample for right upper lobe sleeve resection): we use the large robotic needle driver and

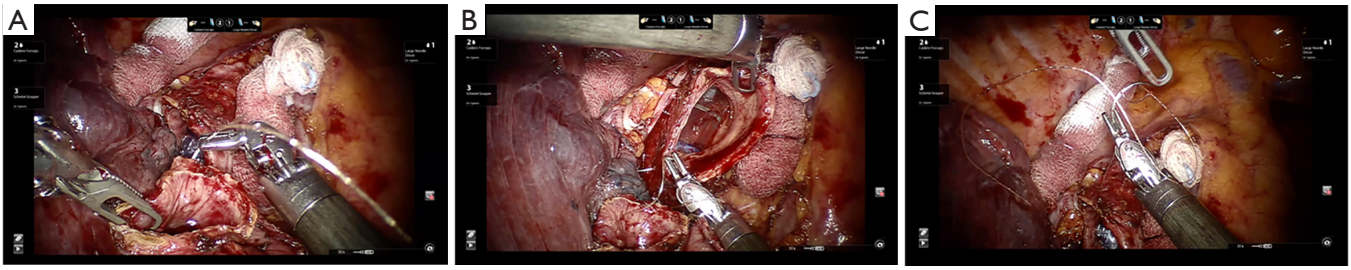

Figure 1 Reconstruction of the airway: right main bronchus and right intermediate bronchus. (A) Start of the anastomosis: outside to inside directed stich at the right intermediate bronchus; (B) inside to outside directed stich at right main bronchus; (C) catching the looping of the suture.

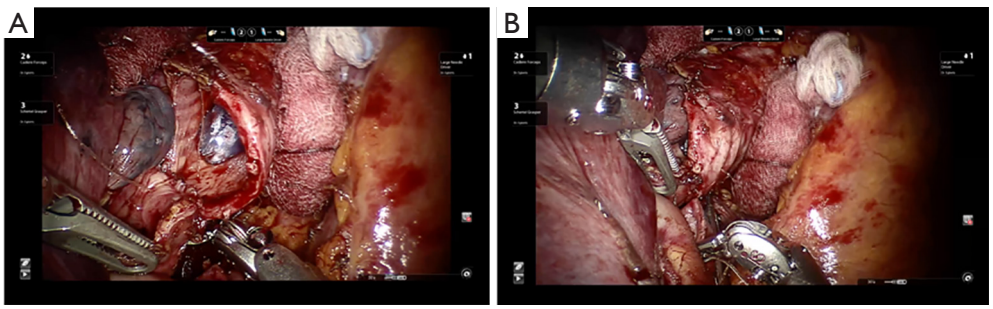

Figure 2 (A) Suturing the back wall (pars membranacea); (B) the anastomosis is semicircular continued through the cartilaginous part).

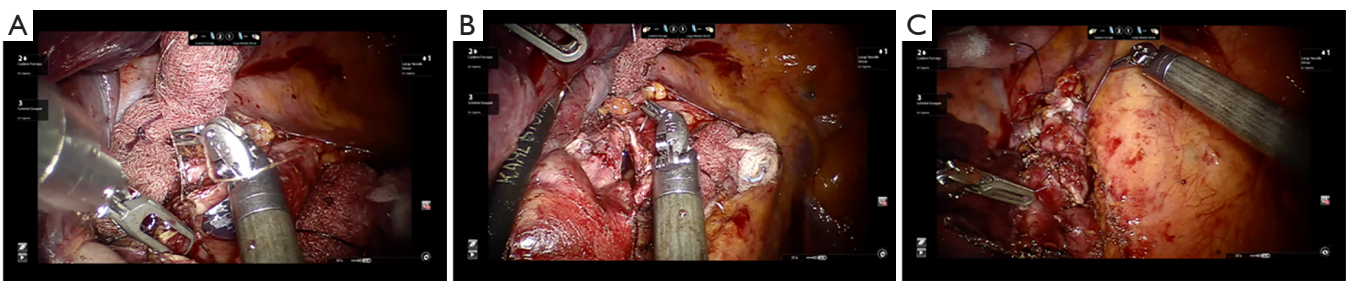

Figure 3 Suture of the front side of the airway. (A) Start with the second suture; (B) suturing the front side; (C) "Z"-Stich for fixation

Cadiere Forceps (Intuitive Surgery, Sunnyvale, CA, USA). For the anastomosis we prefer a monofilament barbed suture (Stratafix 3/0, Ethicon Endosurgery, OH, USA). The first suture is placed on the posterior part of the right bronchus intermedius from out to in to place the knot outside the airway. The corresponding stitch is performed on the right main stem bronchus from in to out, this places the knot in the cartilage of the main stem bronchus close to the membranous part (*Figure 1*). It is important to perform the first stitch in the area of the cartilage to ensure adequate suture retention. The anastomosis is now continued through the cartilaginous part, while slowly bringing the two cut ends together (*Figure 2*). When half of the circumference is completed, a second suture is used (*Figure 3*). This suture begins at the cranial dorsal part of the cartilage to the front side until the first suture is reached. An additional stitch is then placed and locked in the membrane—cartilage junction in the same fashion. Since we did not knot the barbed suture due to its rigidity we placed a single "Z"-Stich with Vicryl 3/0 at the end of bot barbed sutures in order to fixate them in position. The incongruity of both lumens can be well compensated by different seam distances on both sides.

We do not telescope the anastomosis. We perform a leak test under water and cover the anastomosis with either a mediastinal tissue flap or an intercostal muscle flap. Finally, the insertion of a 24 Ch thorax drainages takes place.

Discussion

Sleeve lobectomy is one of the most difficult operations in lung surgery. Mostly this operation is done as an open procedure, only a limited number of medical centers are able to perform VATS sleeve lobectomy. The main reasons are that airway reconstruction with conventional VATS instruments is difficult and inconvenient due to the limited view and particularly a lack of freedom of movement—which is essential for sewing and knots. Therefore, airway reconstructions are often combined with mini-thoracotomies (1,2). The use of a robot outweighs these disadvantages with the enlarged three-dimensional view and angulation of the robot arm (4,10). However, currently available systems also have a significant drawback, such as the lack of haptic feedback. This might be of great importance while sewing fine structures in which continuous tension is required without tearing the suture.

In the past the bronchial anastomosis was sewed in single stich technique. Nowadays bronchial anastomosis is increasingly performed in continuous running suture technique (1,2). The suture material used is usually a monofilament material. Because of the flexibility of these sutures, it is important to maintain continuous tension to avoid leakages. This condition is sometimes limited in the minimally invasive technology. Especially in the RATS technique, with the lack of haptic feedback, there might be the danger that these tensile forces will not be kept constant or too strong and therefore lead to a damage of the tissue or the suture.

The barbed suture Stratafix™ is a knotless tissue control device that was originally developed for soft-tissue approximation (Ethicon, Cincinnati, OH, USA). Anchors are cut into the core of the suture at 2 mm intervals, pointing away from the suture direction. Because each anchor functions to grip the sutured tissue, a stable maintenance of continuous sutures is possible. The suture thread is absorbable but maintains its tensile strength for 6 weeks (11,12). Compared to other spine stitches, the Stratafix™ thread has slightly finer and spiky barbs while, for example, the V-Loc™ (Covidien, New Haven, CT, USA) barbs appear bristling and more rigid. This is due to the manufacturing process, so the Stratafix thread has so-called single angle cut whereas the V-Loc is constructed by dual angle cuts (13).

There are reports of the successful use of the V-Loc in the open or VATS technique for the tracheobronchial reconstruction (7). However, there are no clinical reports of the use of continuous sutures with neither the Stratafix™ suture device in tracheobronchial reconstruction so far, nor any reports of its application with the robot.

We are of the opinion that in fine and delicate tissue, as is the case with the suture of pars membranacea, preferably atraumatic sutures are mandatory. The slightly finer barbs of the Stratafix™ suture give these conditions. However, we would like to point out that it is a purely personal assessment and there are no clinical studies in this regard so far.

The overlapped suture for one or two stitches at the end is important for preventing an anastomosis detachment if the end of the suture is slipped off after surgery. We think it makes sense to place an additional stitch from the end-point that the previous suture is trimmed and appropriately conserved. There are no data regarding the risks of biological reaction or bacterial infection, which could occur more frequently because of the device's barbed structure. Therefore, a number of additional clinical experiences are needed to confirm its safety in bronchial anastomosis.

Acknowledgments

Funding: None.

Footnote

Conflicts of Interest: JHE is paid by Intuitive Surgery™ for proctoring surgical teams. TB received a research grant by Intuitive Surgery™. The other 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. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee(s) and with the Helsinki Declaration (as revised in 2013). Written informed consent was obtained from the patient for publication of this manuscript and any accompanying images.

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doi: 10.21037/jovs.2018.05.19
Cite this article as: Egberts JH, Möller T, Hauser C, Beckmann JH, Schlemminger M, Becker T. Robotic assisted sleeve lobectomy with the use of barbed sutures. J Vis Surg 2018;4:117.