

A new mechanical method for pulmonary artery anastomosis



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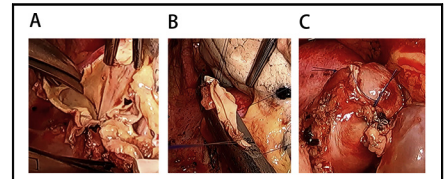
Vascular anastomosis is an essential step for many surgery procedures, especially for cardiovascular surgeries and lung transplantation (LTx). Hand-sewn anastomosis is a reliable and safe method for revascularization and independent of the vessels' size to be anastomosed.¹ It is known as the standard method for vascular anastomosis, although conducting manual suturing quickly and meticulously requires technical expertise and is a time-consuming procedure.² It is also a limitation for the development of minimally invasive surgery. Many studies have confirmed that mechanical anastomosis can reduce the length of the operation compared with hand-sewn.³ However, there is a lack of mechanical assistance for the great vascular anastomosis. This study introduces a new idea to conduct the great vascular mechanical anastomosis through the arterial flap using an endo-stapler.

METHODS

This method was applied in 3 discarded donor lungs and 1 clinical LTx. All donors and their families volunteer to donate organs for clinical treatment or scientific work and have signed the informed consent. Written informed consent was signed from the patient for the procedure and for the publication of the study data. The work was supported by institutional review board (number 2020-030) on May 20, 2020.

TECHNIQUE

Donor's lungs were procured as a standard process. The pulmonary artery should be entirely dissected to further



Mechanical anastomosis of pulmonary artery through the arterial valve using endo-stapler.

CENTRAL MESSAGE

There is a lack of mechanical anastomosis for the great vessel. Mechanical anastomosis by the arterial flap using endo-stapler is an innovative and feasible method for vascular anastomosis.

See Commentaries on pages 188 and 190.

mechanical anastomosis. The discarded donor's pulmonary artery was divided into 2 segments and then was cut longitudinally into 2 arterial flaps about 1 to 2 cm (Figure 1, A). Two guiding sutures were placed at the arterial flaps' commissures to draw both arterial flaps closer and decrease the tension (Figure 1, B). The arterial flaps were aligned with intima-to-intima contact. The mechanical anastomosis was then started from the posterior wall using an endo-stapler (35-mm Vascular Linear Cutter, ECHELON FLEX; Ethicon, Somerville, NJ) followed by the anterior (Figure 1, C). Finally, the arterial flap's commissures were sutured with 4-0 PROLENE (Ethicon) after we completed the mechanical anastomosis. The closure and patency of mechanical anastomoses were tested by water injection experiment with 60 cmH₂O pressure and were almost perfect without a leak. The mean time of mechanical anastomosis (from making arterial flap to completing anastomosis) in vitro was 270 seconds.

The mechanical suture was further applied in the left LTx (as shown in Video 1). The recipient was a 62-year-old male patient who had chronic obstructive pulmonary disease. The anterior wall of the pulmonary artery was easy to perform mechanical anastomosis using an endo-stapler. However,

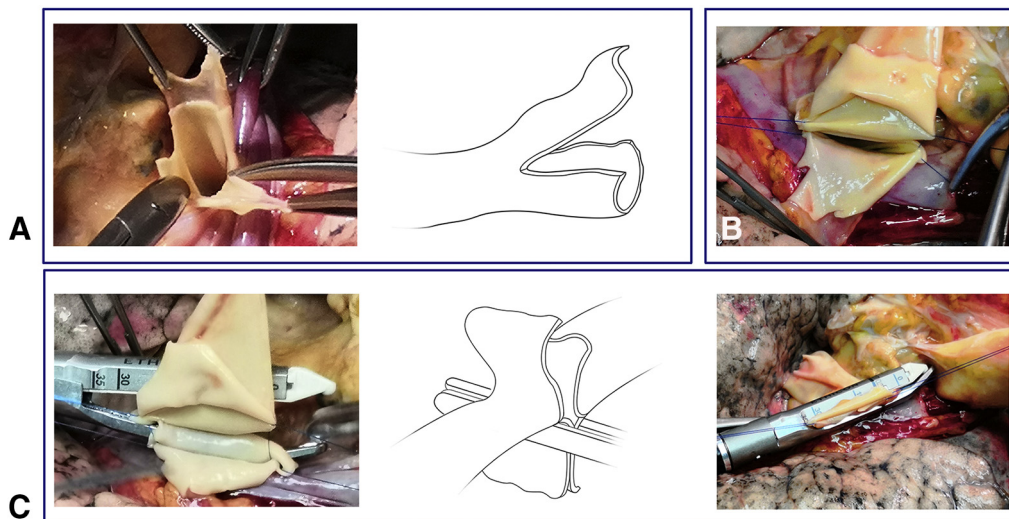


FIGURE 1. Mechanical anastomosis of the pulmonary artery in the discarded donor lung. A, The pulmonary artery was cut longitudinally into 2 arterial flaps about 1-2 cm. *Left*, performed in discarded donor. *Right*, an illustration of the arterial flap. B, Two guiding sutures were placed at the arterial flaps' commissures to draw both arterial flaps closer and decrease the tension. C, In the *left panel*, mechanical anastomosis was performed in the posterior wall using an endo-stapler. In the *right panel*, the anterior wall was anastomosed. In the *middle panel*, an illustration of mechanical anastomosis of the pulmonary artery using endo-stapler.

there was not enough space to use an endo-stapler for the posterior wall after the bronchial anastomosis. The time for pulmonary artery anastomosis was not available. The computed tomography images of the patient in the postoperative first month and sixth month are shown in [Figure 2](#).

DISCUSSION

There are 2 main mechanical assist methods for vascular anastomosis, vascular closure staples and ring-pin devices. However, the 2 techniques are both used in microvascular or small artery anastomosis.^{4,5} There is a lack of effective mechanical assist for great arterial anastomosis. In this study, we performed an innovative method for great arterial anastomosis through an arterial flap using an endo-stapler.

The endo-stapler has been usually used in the angioplasty or closure of pulmonary artery in lung cancer

surgery.⁶ These confirmed that vascular suture using an endo-stapler is safe and effective. Mechanical anastomosis using a cutting stapler is often applied in gastrointestinal surgery. The circular stapler was applied to perform the end-to-end gastrointestinal anastomosis.⁷ There is a lack of analogous circular cutting stapler for the end-to-end anastomosis of the pulmonary artery in LTx. Therefore, the arterial flap is designed for mechanical anastomosis using a traditional vascular endo-stapler. In vitro experiment, we found that this technique can complete pulmonary artery anastomosis rapidly and effectively.

We also experienced some unexpected difficulties during the clinical LTx application. First and most, the pulmonary artery's posterior wall is difficult to perform mechanical anastomosis after completing the bronchial anastomosis. Therefore, the pulmonary artery should be processed first to facilitate mechanical anastomosis before the bronchial anastomosis, but which would also make the bronchial anastomosis more difficult inevitably. Although there is not an entirely successful application in this clinical LTx, we believe that the innovative method for the great vascular mechanical anastomosis is valuable to investigate further. Meanwhile, the technique has some limitations, such as the need for enough redundant pulmonary artery and adequate space to pass a stapler. The technique may not be appropriate for patients with thin, diseased pulmonary arteries, or shortened hila, particularly patients with sarcoidosis.

In conclusion, mechanical anastomosis through the arterial flap using an endo-stapler is a likely and suitable strategy for great vascular mechanical anastomosis. It may be



VIDEO 1. The mechanical anastomosis of pulmonary artery (PA) was performed in clinical lung transplantation. Video available at: [https://www.jtcvs.org/article/S2666-2507\(21\)00472-7/fulltext](https://www.jtcvs.org/article/S2666-2507(21)00472-7/fulltext).

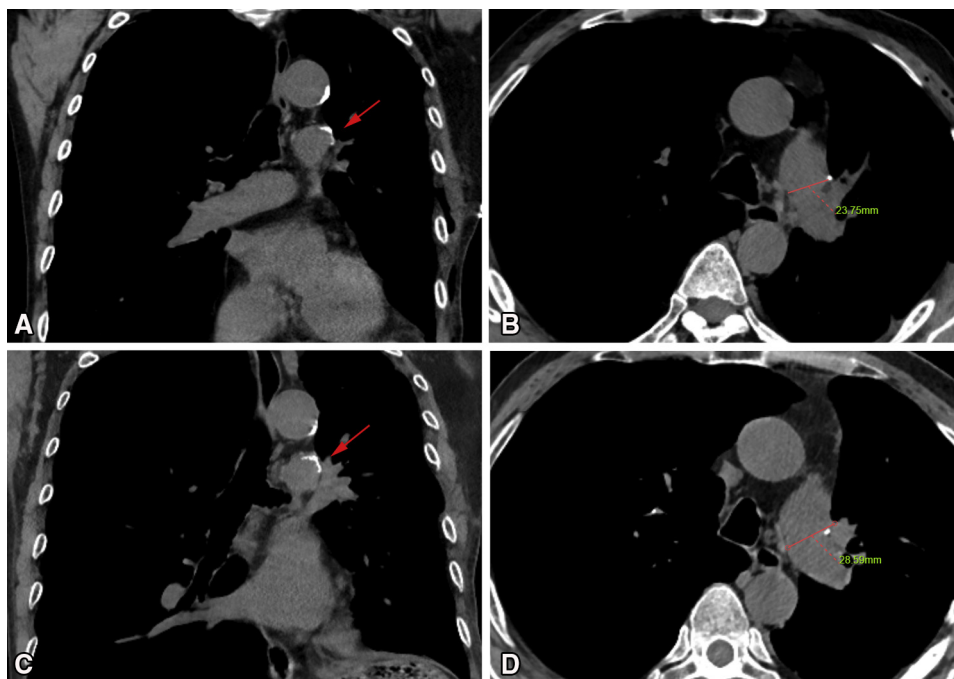


FIGURE 2. CT images of the patient in the postoperative first month and sixth month. A and B, The CT coronal section and cross section in postoperative first month, respectively. The diameter of anastomosis is 23.75 mm. C and D, The CT coronal section and cross section in postoperative sixth month, respectively. The diameter of anastomosis is 28.59 mm. The *red arrow* represents the PA's anterior wall of mechanical anastomosis.

meaningful for the development of cardiovascular surgeries and LTx.

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