SURGICAL TECHNIQUE

Left atrial appendage resection with cut-and-sew technique

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Left atrial appendage (LAA) is the most common site of thrombus formation inside the heart, especially in cases of atrial fibrillation. Currently, LAA exclusion or resection is considered IIa Class of Recommendation, Level of Evidence C in patients with AF undergoing open chest surgery. There are several techniques to isolate the LAA. External resection by means of cut-and-sew from outside the heart has proven to be the safest one, in terms of less complications, such as reopening, endoleaks, or remnant stump. Here we describe step by step how to resect the LAA from outside the heart by cut-and-sew throughout any open chest cardiac surgery.

Key words: **Atrial fibrillation; Left atrial appendage; Left atrium; Stroke; Thrombus.**

La orejuela izquierda (OI) es el sitio más común de formación de trombos dentro del corazón, especialmente en casos de fibrilación auricular. Actualmente, la exclusión o resección de la OI se considera una Clase de Recomendación IIa, Nivel de evidencia C en pacientes con FA sometidos a cirugía cardiaca abierta. Existen varias técnicas para aislar la OI. La resección externa mediante corte y sutura desde el exterior del corazón ha demostrado ser la más segura, en términos de menos complicaciones, como reapertura, endofugas o muñones remanentes. Aquí describimos paso a paso cómo resecar la OI desde fuera del corazón cortando y suturando durante el curso de cualquier cirugía cardíaca abierta.

Palabras claves: **Fibrilación auricular; Orejuela izquierda; Aurícula izquierda; Embolia; Trombo.**

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It is a very well-known fact that LAA is the most commom site for thrombus formation inside the heart, especially in patients having atrial fibrillation. Broadly speaking, for non-valvular AF the indicence of thrombus formation inside the heart is 19%, out of them 91% are located in the LAA. For valvular AF cases, between 13-15% have any thrombus inside, out of them 57% are found in the LAA [1].

Current guidelines for surgical managenet of atrial fibrillation from STS make clear that LAA elimination (exclusion or resection) is an indication IIa Class of recommendation, Level of evidence C [2]. Nevertheless, based upon findings over several hundreds of patients, Johnson et al. [3] have stated out the removal of the LAA should be performed in all cases undergoing open chest cardiac surgery, regardless having or not AF.

A large number of information about the LAA in cardiac surgery has come to us from the Cox-maze procedure for atrial fibrillation. First described by Jim Cox, LAA resection is part of this surgical technique [4]. As a matter of fact, the maze procedure has shown the lowest postoperative stroke rate in cardiac surgery, with numbers less than 1% [5,6]. García-Villarreal et al. [7] found out the same results working in a series of 27 patients underwent mitral valve surgery plus LAA resection.

A whole arsenal of surgical techniques have been described, all aimed at eliminating LAA, namely, i) external resection by cut-and-sew, ii) external ligation. iii) internal closure, iv) stapler occlusion. Of them all, external resection is the best in terms of fewer complication rates [8].

Having said that and within this framework, I present herein my own technique to eliminate by resection the LAA from outside the heart by means of cut-and-sew throughout any open chest cardiac surgery.

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Firts of all, an adequate planning for the entire operation must be selected. Practically, LAA resection is almost always performed concomitantly along with some mitral valve operation. As a general rule, LAA procedure mut be completed before any valve procedure. Once on cardiopulmonary bypass, the aorta is cross-clamped, and cardioplegic solution released, the atrial approach for mitral valve surgery is per-

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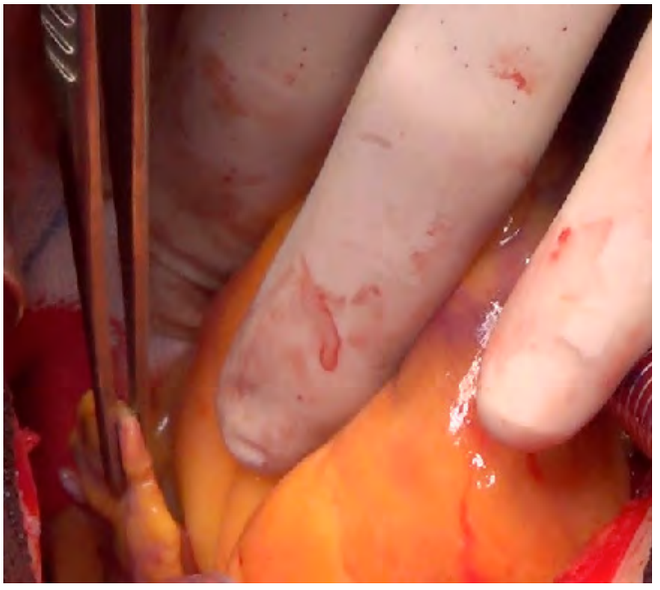

Figure 1. Exposure of the left atrial appendage

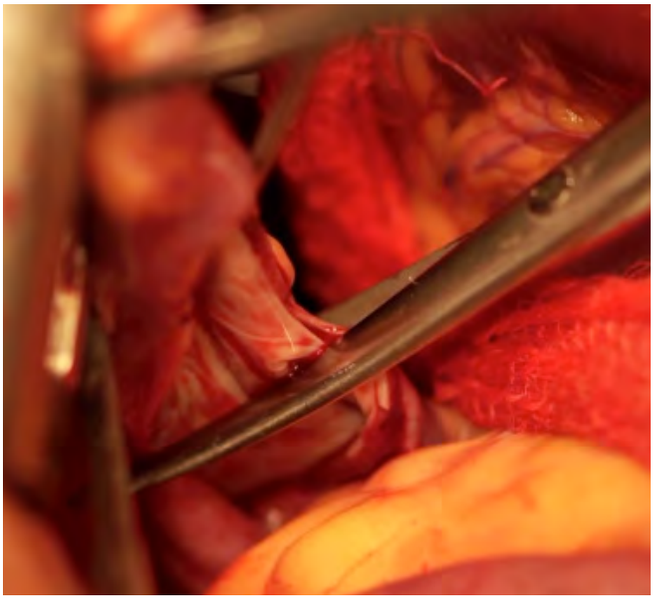

Figure 2. Cutting the left atrial appendage

formed. Thus, a full left-sided cavity decompression can be achieved. At this point, mitral valve is left temporary behind, and the technique follows on the LAA. For this purpose, the heart is dislocated forward from the pericardium, twisting it. LAA is now exposed on the left side of the operative field (**Fig. 1**). For a more complete exposure, one assitant's hand can help by pushing the heart off toward the right side. Alternatively, the "hands-free approach" described by García-Villarreal can be handy and extremely useful here [9].

Next step is implemented by cutting with scissors over the base of the LAA. The cut must be done at 1 cm far from the atrial surface. In other words, no more than 1 cm must be left in order to get a secure closure (**Fig. 2**). On the other hand, particular care must be paid to keep from leaving a stump with more than 1 cm in height. It may be the origin of some thrombus formation, as acting as a "cul-de-sac" or remnant stump. As the tissue in this area around the LAA is highly thinned and friable and the circumflexe coronary

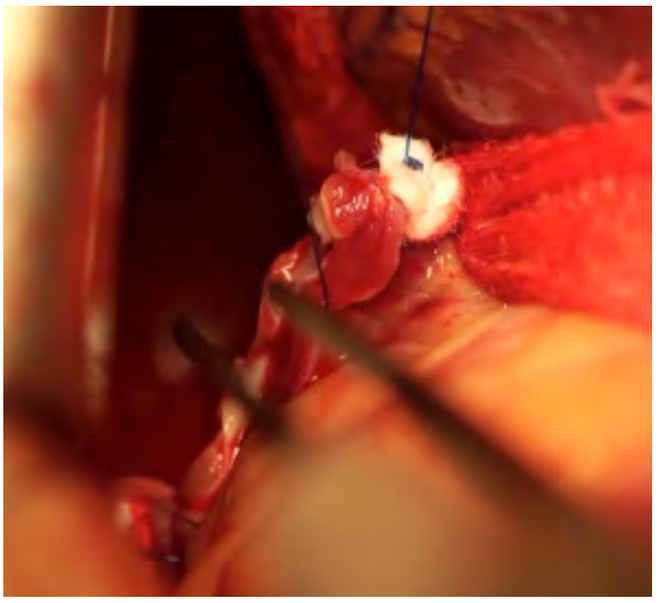

Figure 3. Closure line on the base of the left atrial appendage

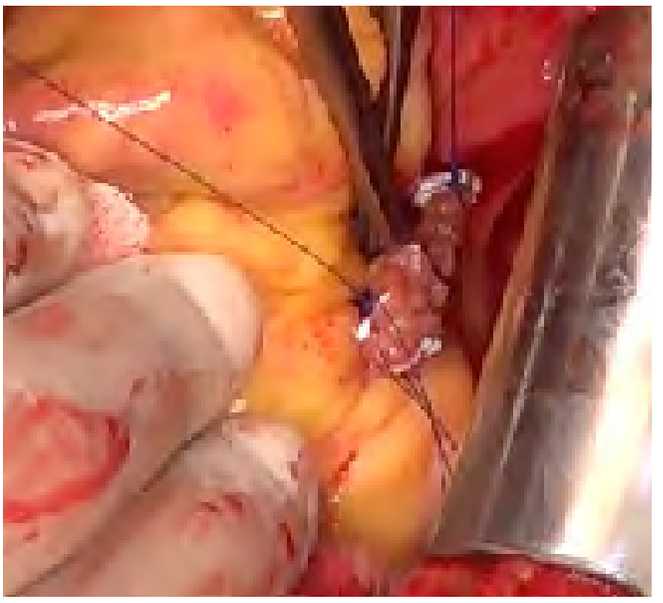

Figure 4. Final aspect of the closure line

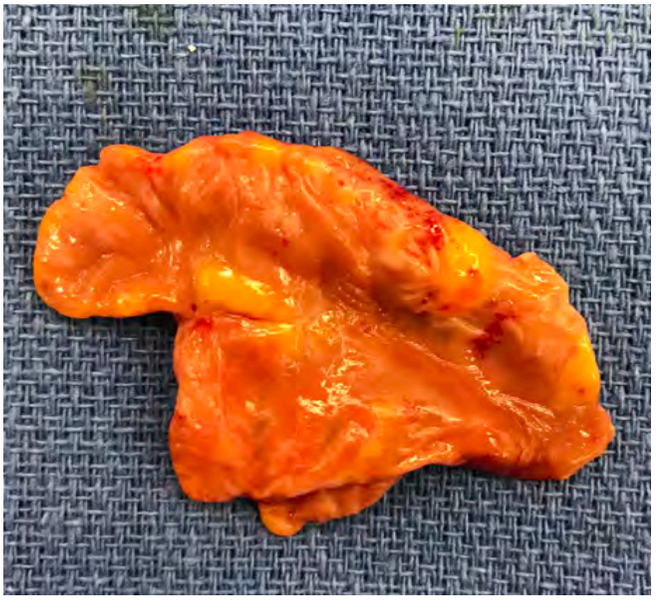

Figure 5. Left atrial appendage once resected

artery runs off along very close this area, closure line must be done precisely, as it is so difficult to see the line later. The sutures must take adequate bites. Closure line is performed with a continuous suture technique using 3/0 polypropilene. It is begun as a pledgetted matress suture at the end close to the pulmonary veins, carrying down until reaching the other end. Each stitch must be placed deep enough, but not that deep, so the circumflexe artery remains out of the risk to be involved or pulled off (**Fig. 3**). A final overview over the worked area is done (**Fig. 4**). Keep in mind that one must keep from dislocating again the heart once aortic cross-clamp has been removed. Special care on the hemostasis is taken because the risk of ventricular rupture may be higher than usual once the left ventricle contains a rigid prosthesis. LAA is removed out of the heart (**Fig. 5**).

Now, the operation continues on the mitral valve or any other cardiac procedure. It is advisable a brief and sligthy sight with no twisting the heart on the worked area on the LAA while rewarming progresses, and the reminder of the operation is completed as usual.

COMMENT

The relationship between LAA and stroke is not a new problem. Cumulative experience in patients with AF indicates LAA is mainly the source for thrombus formation inside the heart [1]. Definitely, it is undeniable fact that the LAA removal reduces the stroke rate in patients having AF. Friedman et al. [10] found that by analyzing 10,524 adult cardiac patients undergoing surgery, out of them 3,892 (37%) underwent surgical exclusion of the LAA. Surgical exclusion of the LAA group compared with the group of no-touching the LAA makes very clear that the first one is associated with a lower risk of stroke among patients with no oral anticoagulation (unadjusted rate, 4.2% vs 6%; adjusted HR, 0.26; 95% CI, 0.17-0.40; $p < 0.001$). In a similar way, Yao et al. [11] studied 75,782 patients who underwent cardiac surgery, out of them 4,374 (5.8%) underwent concomitant LAA surgical occlusion. A reduced risk of stroke (1.14 vs 1.59 events per 100 person-years; HR, 0.73; 95% CI, 0.56-0.96; $p = 0.03$) was observed in this group.

Also, in the case of some authors, it has been categorically proposed that LAA should be removed in any case for open chest cardiac surgery regardless the type of cardiac rhythm [3]. In a more comprehensive and strategic way, new guidelines for surgical ablation for AF coming from STS, they stressed that the LAA elimination in patients with AF is a IIa Class of Recommendation, Level of Evidence C [12].

Getting back on the main issue herein in this article, LAA can be removed in several ways, namely, i) excision, ii) suture exclusion, and iii) stapler exclusion. Of course, each of them with arguments for and against [8]. However, surgical excision has demostrated to be the best in terms of inherent complications such as endoleaks or any remnant stump. In an article by Kanderian et al. [13], 5.8% showed patent LAA (excision, 0%; suture exclusion, 8%; stapler exclusion, 17%), remnant LAA, 20% (excision, 27%; suture exclusion, 8%; stapler exclusion, 58%), excluded LAA with persistent flow, 34% (excision, 0%; suture exclusion, 61%; stapler exclusion, 25%), and a successful LAA closure, 40% (excision, 73%; suture exclusion 23%; stapler exclusion, 0%). Moreover, 60 % of patients with suture exclusion of the LAA had persistent flow into the appendage documented by color Doppler from the LA and the LAA, and 58% of those with stapler exclusion had a persistent LAA stump >1 cm [13]. LAA partially closed is more likely to contribute to exacerbating thrombosis because of blood stasis higher than normal.

Working on this context, it is abundantly clear that surgical resection by means of cut-and-sew is the safest technique in order to resect the LAA. This is the preferred author's technique having performed more than 150 cases with such technique.

Particular attention must be paid on two extremely important items. First, incomplete surgical LAA closure may promote rather than reduce the risk of stroke, acting as an independent predictor of stroke or systemic embolism. The smaller the neck diameter, the higher the stroke rate. In this setting, after analyzing 72 cases, Aryana et al. [14] found that the annualized stroke and systemic embolization risk were 6.5%, increasing up to 14.4% while not receiving oral anticoagulation, and 19.0 % in those cases with neck diameter ≤5.0 mm, per 100 patient-years of follow-up. Noteworthy, stroke risk was 5-fold higher than expected [14]. Second, we must not fall into the error to leave any remnant stump. Remnant LAA is defined as a residual stump >1 cm in maximum length after closure. Theoretically, this increases the likelihood in producing any thrombus formation [8].

By closing, LAA resection can be safely performed increasing the scope in avoiding the stroke rate, especially in patients with AF. For the moment, LAA resection is considered to be a concomitant procedure alongside any primary open chest cardiac surgery.

Naturally, given the feasibility in reproducibility, LAA resection can be indicated in any case having AF, despite the primary procedure. Perhaps, after all arguments collected over the years of experience, LAA removal might be indicated

as a primary procedure, as long as certain conditions are met, such as mini-invasive or thoracoscopic approach.

As a final point, resection of the LAA is preferable over all other options in cardiac surgery.

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REFERENCES

1. Blackshear JL, Oddel JA. Appendage obliteration to reduce stroke in cardiac surgical patients with atrial fibrillation. Ann Thorac Surg 1996; 61: 755-9.
2. Badhwar V, Rankin S, Damiano Jr RJ, Gillinov MA, Bakaeen FG, Edgerton JR, et al. The Society of Thoracic Surgeons 2017 Clinical practice guidelines for the surgical treatment of atrial fibrillation. Ann Thorac Surg. 2017;103:329-41.
3. Johnson WD, Ganjoob AK, Stonec CD, Srivyasa RC, Howard M. The left atrial appendage: our most lethal human attachment! Surgical implications. Eur J Cardiothorac Surg 2000; 17: 718-22.
4. Cox JL. The surgical treatment of atrial fibrillation. IV. Surgical technique. J Thorac Cardiovasc Surg 1991;101:584-92.
5. Ad N, Cox JL. Stroke prevention as an indication for the Maze procedure in the treatment of atrial fibrillation. Semin Thorac Cardiovasc Surg 2000; 12:56-62.
6. Cox JL, Ad N, Palazzo T. Impact of the maze procedure on the stroke rate in patients with atrial fibrillation. J Thorac Cardiovasc Surg 1999;118:833-40.
7. García-Villarreal OA, Heredia-Delgado JA. Left atrial appendage in rheumatic mitral valve disease: The main source of embolism in atrial fibrillation. Arch Cardiol Mex 2017; 87(4). http://dx.doi.org/10.1016/j.acmx.2016.11.00.
8. Garcia-Villarreal OA. Surgical closure of the left atrial appendage. Basal considerations before attempting with occluder devices. J Surg Open Access 2017;3(2): doi http://dx.doi. org/10.16966/2470-0991.144.
9. García-Villarreal OA. Hands-free approach for the left atrial appendage in Cox maze IV. Asian Cardiovasc Thorac Ann 2014;22:1141-3.
10. Friedman DJ, Piccini JP, Wang T, et al. Association between left atrial appendage occlusion and readmission for thromboembolism among patients with atrial fibrillation undergoing concomitant cardiac surgery. JAMA 2018; 319: 365-74.
11. Yao X, Gersh BJ, Holmes DR Jr, et al. Association of surgical left atrial appendage occlusion with subsequent stroke and mortality among patients undergoing cardiac surgery. JAMA 2018; 319: 2116-26.
12. Badhwar V, Rankin S, Damiano Jr RJ, Gillinov MA, Bakaeen FG, Edgerton JR, et al. The Society of Thoracic Surgeons 2017 Clinical practice guidelines for the surgical treatment of atrial fibrillation. Ann Thorac Surg. 2017;103:329-41.
13. Kanderian AS, Gillinov AM, Petterson GB, Blackstone E, Klein AL. Success of surgical left atrial appendage closure. Assessment by transesophageal echocardiography. J Am Coll Cardiol 2008; 52: 924-9.
14. Aryana A, Singh SK, Singh SM, et al. Association between incomplete surgical ligation of left atrial appendage and stroke and systemic embolization. Heart Rhythm 2015; 12: 1431-7.