Left atrial appendage amputation using a modified appendage clip: an experimental canine study

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To the Editor: Atrial fibrillation (AF) is one of the most common cardiac arrhythmias observed in the general population. The main cause of stroke associated with AF is the formation of thrombosis in the left atrial appendage (LAA) and falling off from it. More than 90% of the formation of thrombosis in the left atrial appendage population. The main cause of stroke associated with AF is common cardiac arrhythmias observed in the general population.

A total of 24 healthy male and female Labrador Retrievers (Shanghai Jiagan Biotechnology Co., Ltd.), with a mean weight of 34.5 ± 3.1 kg were used in the present study. All dogs were implanted with a modified LAAC. Before the start of the study, the time points for study termination were set as 7 days (n = 6), 60 days (n = 6), 90 days (n = 6), and 180 (n = 6) days. The animals were randomly assigned to different time point groups. All the animals underwent transesophageal echocardiography (TEE) both before clip placement, and the anatomy of the LAA and the position of the LAAC were evaluated before sacrifice. The animal studies were carried out with the review and approval of the animal care and use committee of Mid-Link Technology Testing Co., Ltd. (Tianjin, China).

The LAAC system comprises a clamp and conveying system and is pre-loaded on a disposable delivery system. After general anesthesia and intubation, the dogs were placed in a supine position. A 2 to 3 cm parasternal incision was made in the left 4th intercostal space. A PHILIPS EPIQ 7C echocardiography instrument (Philips Healthcare, Best, The Netherlands) with a 2.0 to 7.0 MHz frequency conversion probe was used. Two-dimensional (2D) TEE, three-dimensional (3D) TEE, and Doppler echocardiography were performed to determine the shape, size, and location of the LAA and the blood flow before and after implantation. While manually stabilizing the heart and exposing the LAA, a suitably sized clip was selected and lowered onto the LAA and deployed at its base. Care was taken to orient the clip parallel to the base of the appendage and not to impinge upon the circumflex coronary or pulmonary artery. One dog was randomly selected from each group for observation to confirm the circulatory exclusion of the LAA by cutting a 5-mm incision at the LAA distal. The defect was subsequently oversewn layer-by-layer with a 7-0 prolene suture.

During the surgery, it was easy and convenient to deliver the LAAC on beating hearts in the dog with an average delivery time of 4.17 ± 2.90 min. In all cases, there were no significant differences in the 2D TEE parameters, such as end-systolic left atrial anteroposterior-diameter, end-diastolic volume, stroke volume, and ejection fraction. 3D Doppler echocardiography revealed no communication between the LAA and left atrium, and no residual blood flow in the LAA immediately after implantation. The left pulmonary vein showed neither stenosis nor obstruction after implantation [Figure 1]. All dogs survived the study without major post-operative complications, including related bleeding, incomplete exclusion, atrial tears, myocardial ischemia, and pericardial tamponade. There were no statistical differences among the groups in hemodynamics, as reflected by systolic blood pressure and diastolic blood pressure, before and after the implantation.

Local inflammatory cell infiltration was observed in cardiac tissues around the LAAC, and there was mild endothelial cell proliferation at the inner side of the atrial opening in the 7-day group. Endothelial cell proliferation...
was increased to form a complete layer at the inner surface, whereas the inflammatory responses decreased around the clipping site in the 60-day group. The endothelial layer was thickened, and only slight inflammatory responses were observed in the 90-day group. In the 180-day group, little inflammatory cell infiltration was noted, and there was a continuous endothelial layer at the inner surface of the atrial opening. At each time point, there was no intracardiac thrombosis, and there was no residual shunt in the appendage. LAA hyperemia and swelling were noted in the 7-day group, and LAA atrophy was observed in the 60-, 90-, and 180-day groups. There was an increasing tendency of fibrosis in residual LAA tissue between the clamping arms from day 7 to 180 after LAAC implantation. Furthermore, hematoxylin-eosin staining showed no inflammatory reaction in tissues from the rest of the left atrium, right atrium, left ventricle, or right ventricle, suggesting that LAA amputation had little impact on adjacent structures.

Three general approaches have been devised to exclude LAA: (1) a surgical approach directed at amputation or ligation of the LAA, (2) a percutaneous endovascular strategy that allows deployment of a device inside the LAA to occlude this structure, and, more recently, (3) a percutaneous epicardial ligation technique aimed at externally excluding the LAA. These surgical techniques make it difficult to guarantee ligation with a smooth surface, with no sag and creases. Percutaneous LAA transcatheter occlusion significantly demands the anatomy of the LAA orifice, and it is closely related to the shape of the occluder device.[2] Previous studies revealed that cardiac tamponade is one of the most severe post-operative complications of percutaneous atrial septal puncture, and incomplete LAA closure and ligation face thrombosis are commonly observed after surgical exclusion of the LAA.[3]

Our device used in experimental dogs did not fall off, shift, deform, or crack. There were no major operational complications such as thickening and deformation of the left atrial wall, formation of local hematoma and compression of important peripheral anatomical structures, cardiac tamponade, and hemodynamic instability. Moreover, cardiac function was not affected during or after implantation.

Our results showed that easy, reliable, and safe exclusion of the LAA could be achieved using the modified LAAC. Further investigations are still required, such as larger
sample size experiments with longer follow-up time and implantations of the device in diseased rather than normal animal models.

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**Conflicts of interest**

None.

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