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Left-Side Surgical Approach to Mitral Valve in Dog Cadaver Study

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Abstract : Mitral regurgitation is the most frequent cause of cardiac disability and death in dogs. A wide range of medical and surgical treatments have been used for mitral regurgitation. Surgical treatments for complete correction of mitral regurgitation include valve repair and valve replacement, which have the advantages of eliminating or correcting the primary cause. Surgical treatments approach the mitral valve via right- or left-side thoracotomy. Aortic root exposure is needed for cardiopulmonary bypass. To compare right-side and left-side approaches, 10 dog cadavers were used in this study. Subsequently, the left-side surgical approach was used *in vivo* and in conjunction with cardiopulmonary bypass and cardioplegic arrest. Based on the results, and considering ease of access to the aortic root, valve incision site, and visualization of the surgical field, a left-side approach is recommended.

Key words **:** mitral regurgitation, open heart surgery, left thoracotomy, cardiac approach, dog.

Introduction

Mitral valve insufficiency is a common condition in aging dogs, with an incidence as high as 58% in dogs 9 years old or older (2,12). If mitral regurgitation is severe, it develops into congestive heart failure (CHF) (2). For CHF treatment, medical therapy and surgical procedures are used (4). Medical therapy is used to control the symptoms of CHF, but it is palliative only (2,5). Typically, the disease progresses and results in death, which usually occurs within one year of CHF onset, even with optimal medical treatment (2,11).

Surgical treatment is directed at correcting both the primary mitral valve leaflet abnormality and the secondary annular dilatation (2). Such treatment offers the possibility of prevention or resolution of CHF and improves clinical condition and prognosis (2,10). Surgical options for correction of mitral regurgitation are valve repair and valve replacement (4,10). Mitral valve surgery, which requires stopping the heart and subsequent support of cardiac and pulmonary functions by using a cardiopulmonary bypass (CPB), has been used to treat a variety of cardiac conditions in dogs (10). For CPB placement, cannulation has been used, with arterial cannulation for CPB in the femoral or carotid artery and venous cannulation in the jugular vein or bicaval (direct cannulation of both vena cavae) or cavoatrial locations (2,4,10). Direct cannulation of aorta has also been used (10). To initiate and maintain cardiac arrest, a cold cardioplegic solution is administered via cannula (2,10).

In human medicine, medial sternotomy, mini-sternotomy, and right thoracotomy have been used as surgical treatment approaches (7,8). In veterinary medicine, there are several reports on different surgical approaches. The right thoracotomy, left thoracotomy and median sternotomy have been described (1,11). But, right or left lateral thoracotomies are commonly used because the three-dimensional orientation of the heart with respect to the thorax is fundamentally different in quadrupeds and humans (4). Some reports described the right-side approach, while others have used the left-side approach and been described as preferred in most cases (2,3, 6,9,10). Until now, there is no data to detail evaluate on the left-side approach in dogs. The purpose of this study is to compare left- and right-side approaches to the aortic root and to evaluate incision sites and visualization of surgical fields in dog cadaver. And left-side approach was applied *in vivo*.

Material and Method

Ten beagle dog cadavers (11.3-14.8 kg) underwent surgery. The causes of death are uncertain, but they had no reported cardiovascular disease. Cadaver surgery was performed at 24 hours or more after death. The experimental groups were divided 2 groups with left 4th thoracotomy group (n = 5) and right 4th thoracotomy group (n = 5), respectively. The pericardium was incised parallel to left phrenic nerve and fixed to the chest wall for visibility of the heart (Fig 1). Subsequently, an approach to the aortic root for CPB was attempted. Surrounding fat tissue was retracted caudally to expose the aorta, and a cannula was placed through the aorta (Fig 2). A laboratory-made cannula was used to inject the cardioplegic solution. To expose the mitral valve, a caudodorsal portion of the left auricle was incised. Visualization of the mitral valve by the surgeon was enhanced by standing on the dorsal side of the animal (Fig 3).

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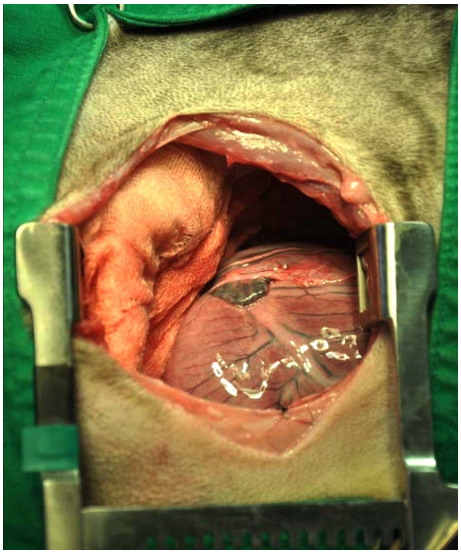

Fig 1. View of left-side approach via left 4th thoracotomy. Left side is cranial, top side is dorsal.

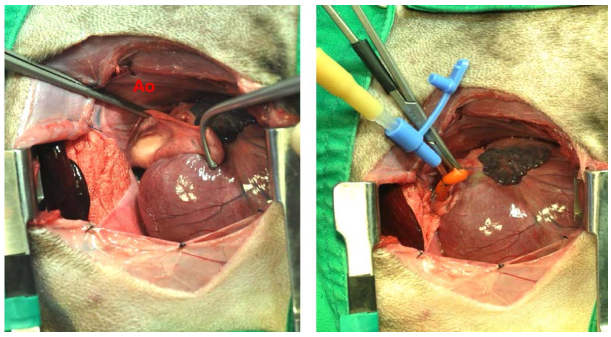

Fig 2. Aortic root (Ao) was exposed and laboratory-made cannula was placed. Left sides of images are cranial and top sides of images are dorsal.

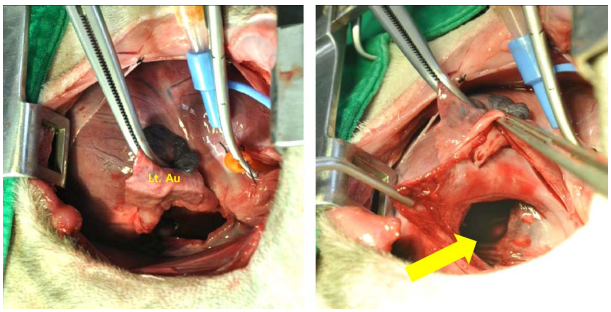

Fig 3. Mitral valve (arrow) has been exposed. Right sides of images are cranial, Bottom sides of images are dorsal.
Lt.Au : left auricle.

For comparison, a right 4th thoracotomy was performed. To approach the aortic root, the right auricular appendage was retroflected carefully (Fig 4). At the connection of the cranial vena cava and the auricular appendage, care should be taken to avoid traction and tearing. Blood vessel and heart tissue should be separated in order to expose the incision site located

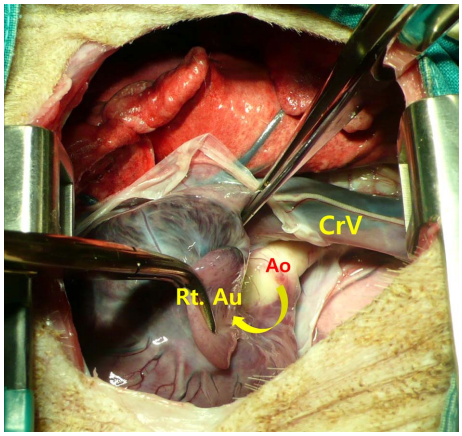

Fig 4. View of right-side approach via right thoracotomy. Right side of image is cranial. Top side of image is dorsal.
Rt.Au: right auricle. Ao: aorta. CrVC: cranial vena cava.

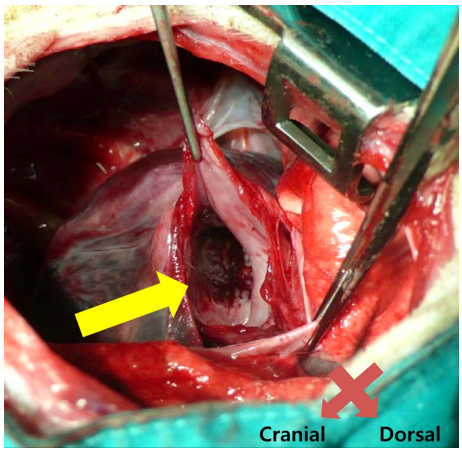

Fig 5. Mitral valve (arrow) is exposed.

between the interatrial groove and the right pulmonary vein. Following left atrium incision, the mitral valve is exposed (Fig 5). For clinical trials *in vivo*, the left approach was applied to have mitral valve surgeries and other cardiac repairs in over 20 dogs. All dogs were positioned in right recumbency for a left 4th thoracotomy. After thoracotomy, the pericardium was retracted to expose the left atrium & ventricle. Before the incision of left atrium, cardioplegic catheter was placed at the aortic root to induce cardioplegia. And then, mitral valve was exposed through the left atrium incision.

Results

By using the left-side approach, access to the aortic root was established more easily on sight than that from the right-side approach because of the anatomical structure. In addition, from the left-side approach, the mitral valve was safely accessed and visualized through an incision. Right-side approach includes potential pitfalls that causes damage to blood vessels and heart structure. *In vivo*, aortic root, incision site and mitral valve exposure were easily accomplished.

Discussion

For direct cardioplegic cannulation, an aortic root approach was used. For such cannulation, right thoracotomy, left thoracotomy, or median sternotomy may be used (2,10,11). The experience gained from the cadaver investigations lead to the conclusion that, in terms of aortic root access for direct cardioplegic cannulation, the right-side approach is more difficult than that from the left-side approach. When using the right-side approach, right auricular appendage retroflection was needed. Also, the right-side approach required greater care to avoid traction and tearing. Thus, compared to the right-side approach, the left-side approach was deemed less difficult. In the left-side approach, caudal retraction of periaortic fat was needed, but tearing of fat can be avoided if care is taken to avoid excessive retraction. Importantly, the right-side approach requires manipulation of the right auricular appendage while the left-side approach does not require manipulation of a heart structure. Thus, the left-side approach is easier than the right-side approach.

Furthermore, in terms of left atrium incision site access, the left-side approach is preferred because the right-side incision site from a right-side approach is located dorsal to the right atrium and interatrial groove, ventral to the pulmonary veins, and within the pericardial space (2). Thus, to achieve exposure, the right-side approach requires blunt dissection between vessels and heart. In contrast, the left-side approach does not need blunt dissection. Thus, the risk for damage to vessel and heart structure is lower via the left-side approach than the right-side approach. Consequently, in terms of incision site safety, the left-side approach is safer than that from the right side.

In terms of mitral valve exposure, the left-side approach is similar to that from the right side. Both approaches can provide sufficient visibility of the surgical field, but the left-side approach is easier and safer.

In addition, we applied the left-side approach to dogs *in vivo* and found it to be safe, straightforward, and reproducible with good visualization *in vivo*. However, because direct cannulation can obstruct visualization of the surgical field in small dogs, cannulation of peripheral vessels is preferred over direct cannulation of the aorta (10).

A limitation of current study was cadaver numbers and using just one breed Beagle because of the various sizes of another breed. Further study should be needed to have more specific cadaver with cardiac diseases in various breeds.

Conclusion

The left-side approach was found to be easier than the right-side approach for accessing the aortic root. Moreover, incision risk was lower when using the left-side approach, and it provided a sufficient field of view to perform surgical procedures related to the mitral valve. Therefore, we recommend a left-side approach when performing procedures on mitral valves under CPB in canine patients.

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