Ozaki Procedure (Aortic Valve Neocuspidization)

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Currently, the first option in aortic valve pathologies is aortic valve replacement. Taking into account many factors depending on the patient, surgeons decide to use either bioprosthetic or mechanical prosthetic valves, However, despite the advances in prosthetic valve technologies over the years, there is still no prosthetic valve close to the natural aortic valve. One of the major problems in prosthetic valve replacement is that the natural movement dynamics of the aortic annulus is disrupted due to the existing stent of the prosthetic valve, and this brings some anatomical and physiological problems after the procedure. Conditions that overshadow the long-term success of surgery include lifelong use of anticoagulants and increased risk of endocarditis in mechanical prosthetic valves, the smaller effective orifice area of bioprosthetic valves compared to mechanical prosthetic valves of the same size, early degeneration due to increased gradient and the need for additional surgical procedures in patients with narrow aortic annulus.

Ozaki technique is the neocuspidization of the aortic valve performed by using autologous pericardium. The procedure, described by Ozaki et al.[2] in 2011 with the results of 88 patients, is defined as removing the diseased cusps of the native aortic valve, measuring the commissural distance and independently shaping new aortic cusps from the patient's autologous pericardium, which was previously fixed with glutaraldehyde. In the presence of bicuspid or tricuspid aortic valve, various aortic pathologies (aortic stenosis, aortic regurgitation, aortic valve endocarditis) are treated with the Ozaki technique and long-term results are promising. The main advantages of this technique are that it allows anatomical and physiological movement of the aortic annulus and is close to the natural effective orifice area of the valve.

PREPARATION OF AUTOLOGOUS PERICARDIUM

After a standard median sternotomy incision is made, a minimum of 7×8 cm of pericardium must be excised to obtain enough tissue for three leaflets. During excision, care should be taken not to damage the heart, lungs, and phrenic nerve.

The pericardium, whose diaphragmatic side is marked, should be excised without the use of cautery (Photo 11.1). The human pericardium is usually thinner cranially and becomes thicker toward the caudal (diaphragmatic) region. Since the largest leaflet will be exposed to more stress while creating new aortic valve leaflets, the preparation of this leaflet by the diaphragmatic side of the pericardium is important for long-term patency (Figure 11.1). The pericardium in the cranial side is used for the smallest leaflet to obtain better and smoother leaflet movement. The removed pericardium is

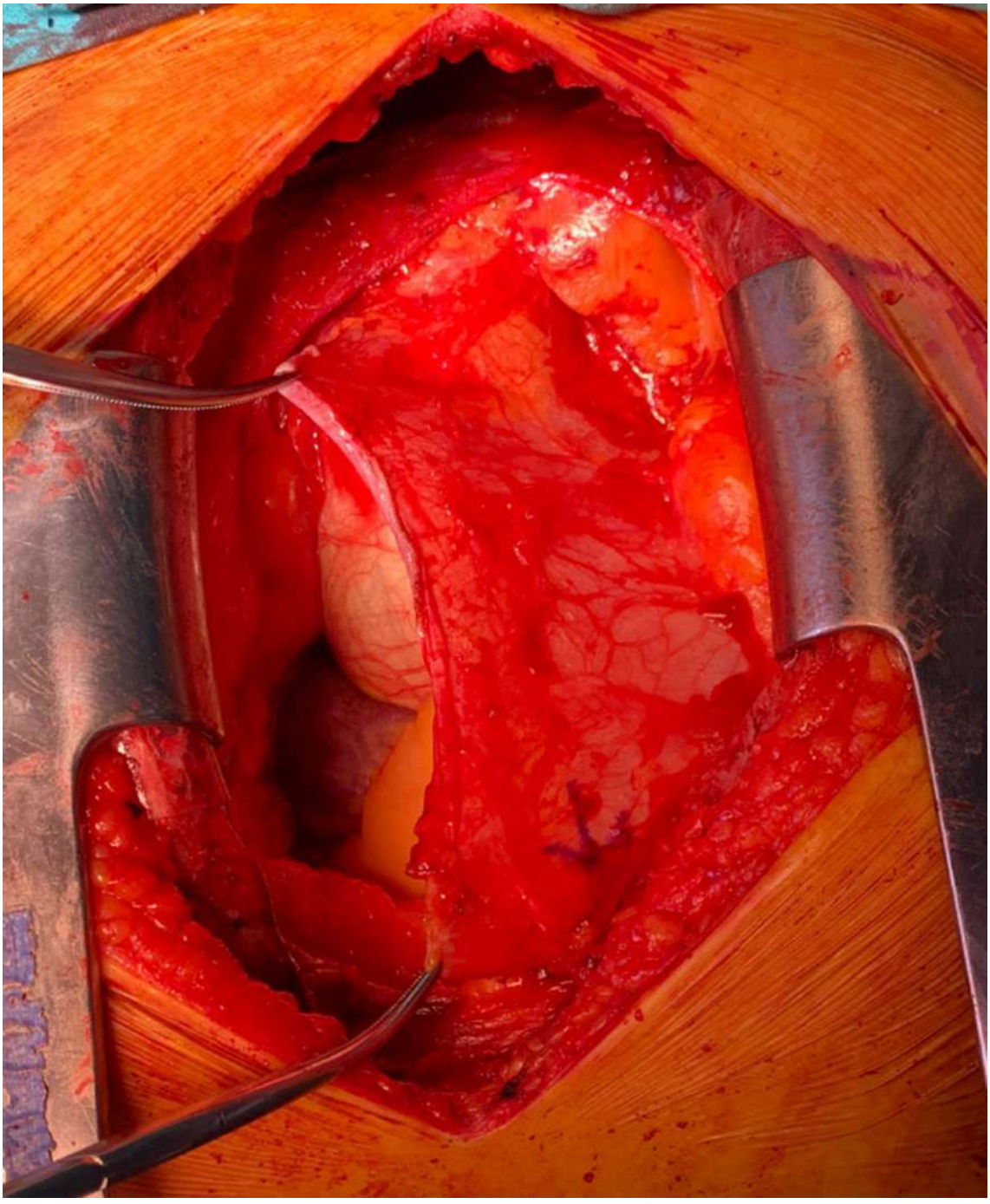

Photo 11.1. Excision of autologous pericardium.

fixed on a plate by stretching the edges with the help of sutures, with the rough surface on the upper side (Photo 11.2). The outer surface of the fixed pericardium is cleaned from fat and excess tissue. Before placing the pericardium in the aortic position, it should be treated with glutaraldehyde to reduce the risk of future fibrosis and calcification of the leaflets. Therefore, four containers are set, one has 0.6% glutaraldehyde solution and the other three have 0.9% isotonic solution. The cleaned

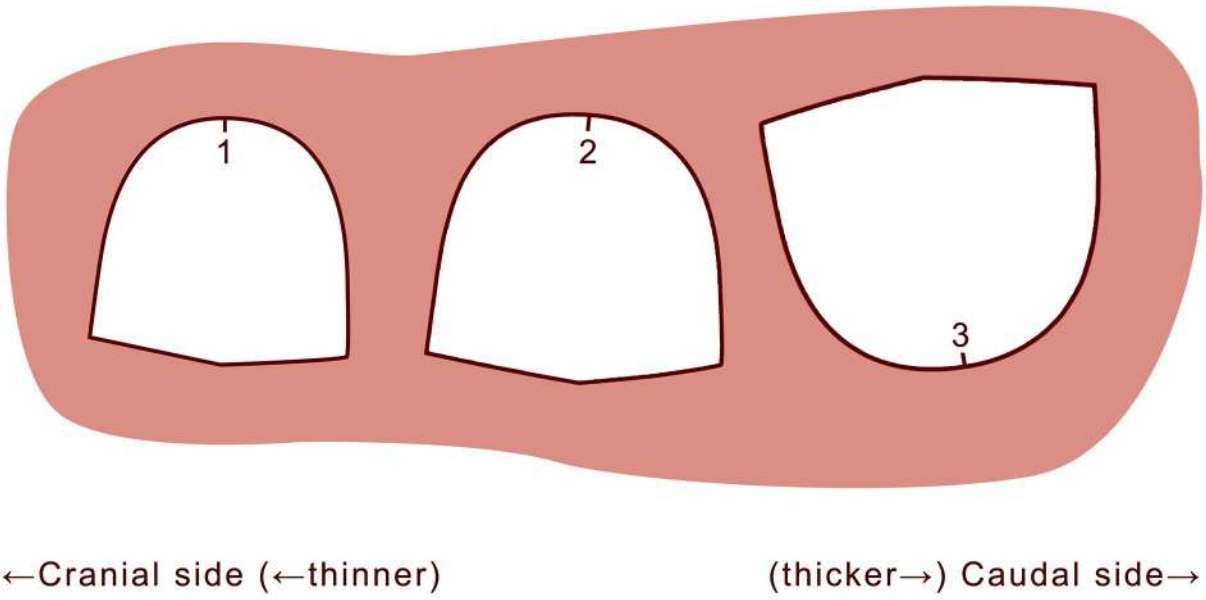

Figure 11.1. Drawing of the leaflets on the pericardium.

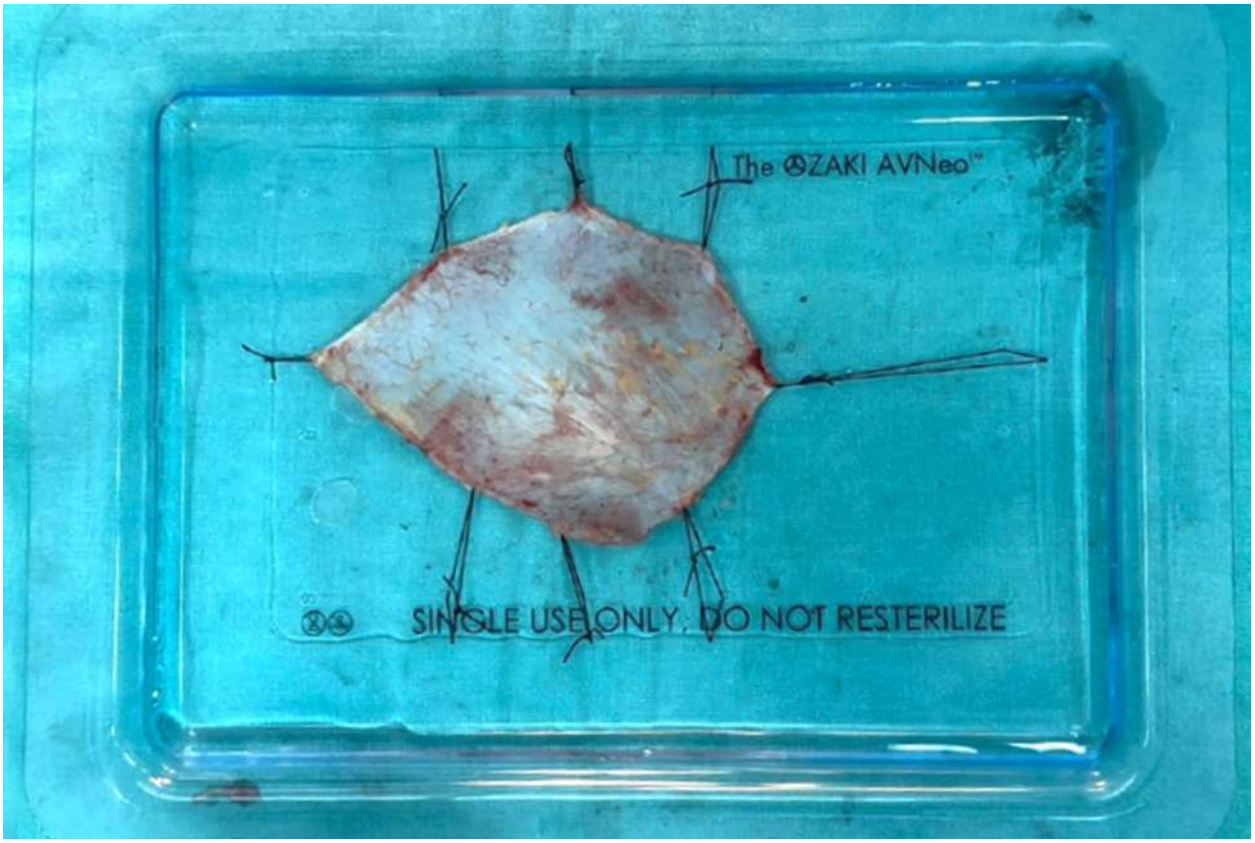

Photo 11.2. Fixing the pericardium on a plate with the rough surface on the upper side by stretching the edges with the help of sutures.

pericardium removed from the fixed plate is kept in 0.6% glutaraldehyde solution for 10 min and, then, rinsed in isotonic solutions separately for 6 min three times each.

CANNULATION AND PREPARATION FOR SURGERY

Following classical aortic and venous cannulation, the tissue between the aorta and pulmonary artery is dissected and the aortic root is released. Dissection is performed toward the aortic root and the exit point of the right coronary artery from the aorta is found. Using a ruler, 1.5 cm distal to the right coronary ostium is marked on the aorta. This area indicates the most appropriate aortotomy line for the Ozaki procedure. Under cardiopulmonary bypass, a cross-clamp is placed to the aorta and after hypothermic cardioplegic arrest is achieved, a transverse aortotomy is performed from the previously marked area. The aortic valve is excised. It is important to perform complete decalcification during aortic valve excision, particularly in patients with calcific aortic stenosis since the newly created pericardial leaflets will be sutured to the aortic annulus with a continuous suture technique during Ozaki procedure. Using an aortic retractor to see the aortic annulus more easily will be advantageous in terms of surgery.

DETERMINATION OF LEAFLET SIZES BY MEASURING THE AORTIC ANNULUS AND CREATING LEAFLETS FROM AUTOLOGOUS PERICARDIUM

At the aortic annulus, the distance between the commissures of the resected leaflets is measured using previously standardized sizing apparatus. Measurement of the intercommissural distance is directly related to the success of the procedure. After ensuring that the intercommissural distance is measured correctly while sizing, the midline of the intercommissural distance is marked with the help of the line on the scales (Figure 11.2). This mark is important, as it indicates the midpoint when the autologous leaflet is being sewn to the annulus (it will start to be sewn from this point). The point to be taken into consideration while sizing the leaflets is that if the intercommissural distance does not exactly fit to the small or large sizer, the larger size should be selected. Newly created leaflets are prepared according to a standardized template. Glutaraldehyde-treated pericardium is placed on the plate with its smooth surface facing up. The reason for using

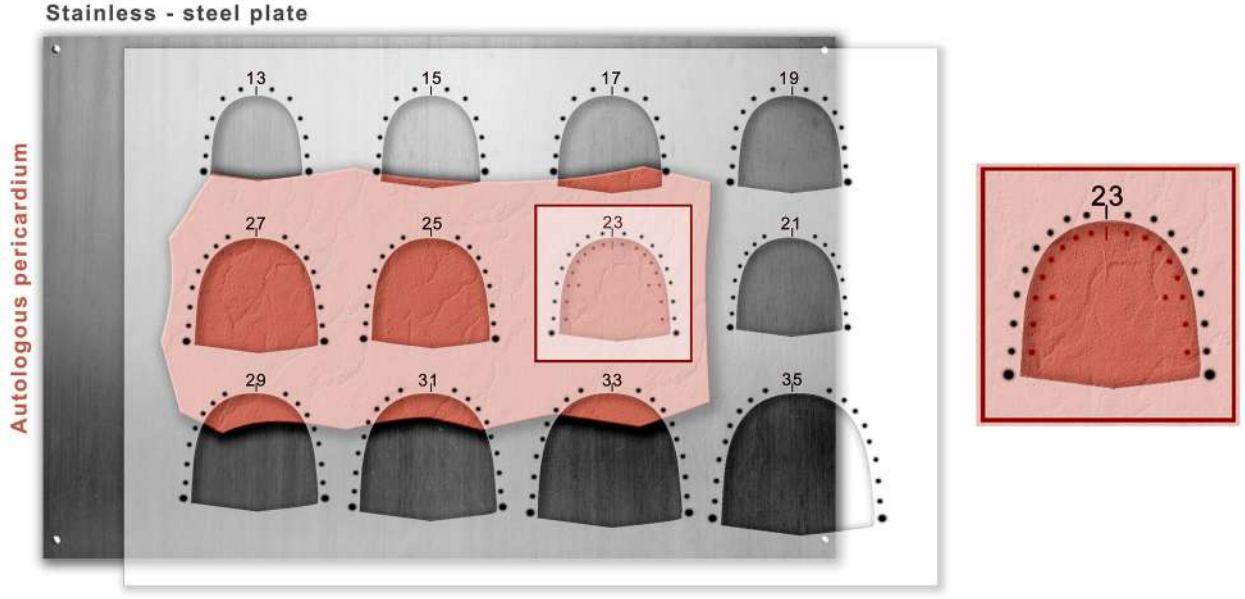

Figure 11.2. Marking guiding points on autologous pericardium with a standardized template.

the pericardium in this way is to reduce platelet aggregation. The guiding template is placed on the autologous pericardium and the guiding points for each suture are marked on it (Photo 11.3). During drawing, care should be taken to ensure that the points are clear, that the first suture point to be passed is drawn longer than the other points, and that the distance between the points is 1.5 mm. The points required to create the commissure wings must also be on both ends of the leaflet, 5 mm away

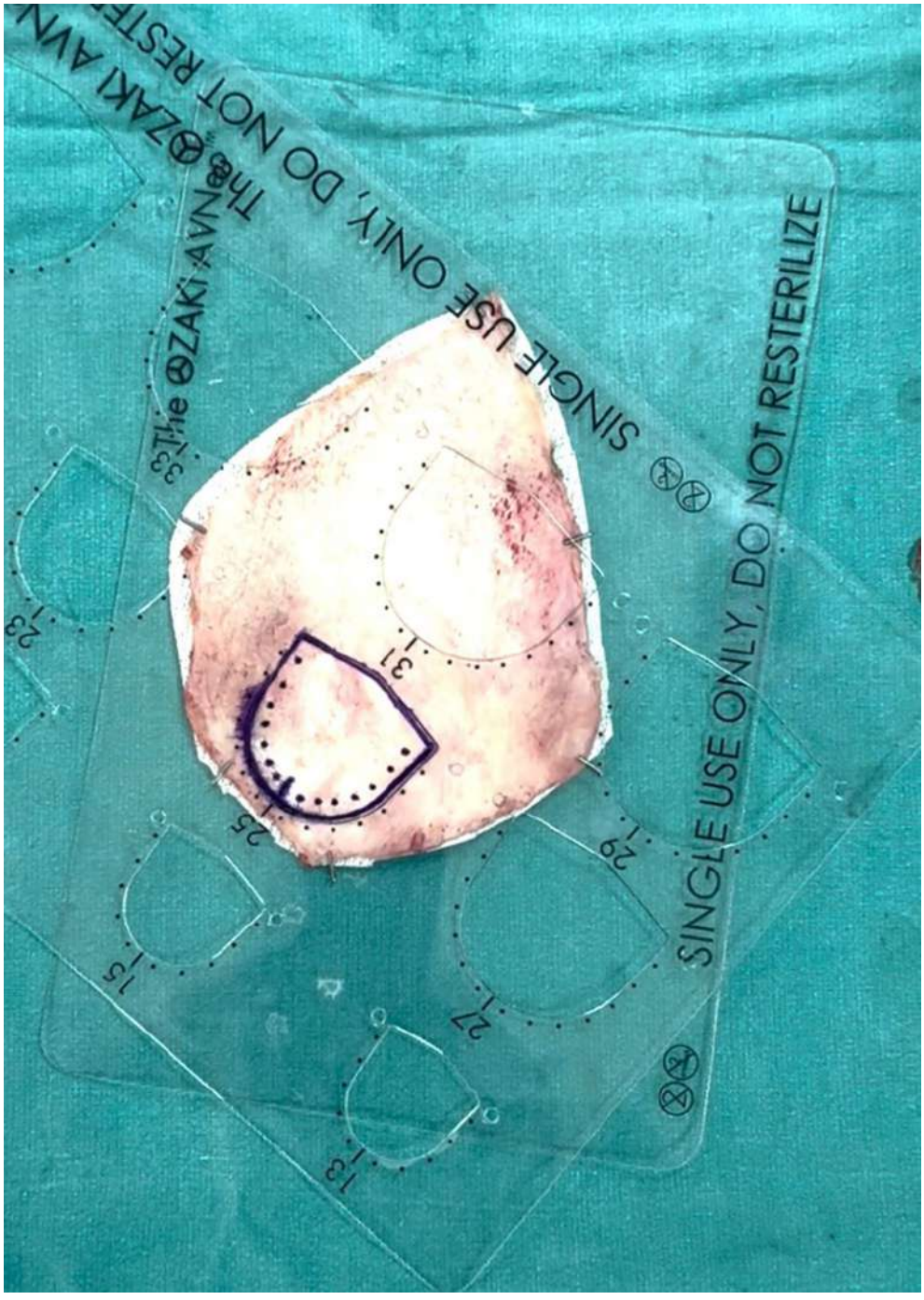

Photo 11.3. Marking guiding points on autologous pericardium with a standardized template.

from the lateral of the last point. While sizing the leaflets, it should be ensured that the largest leaflet is from the pericardium on the diaphragmatic surface. After this stage, each leaflet is cut according to the drawn guide lines and made ready for implantation to the annulus. While the first platelet is sutured to the annulus, the other leaflets prepared in the meantime are placed in a petri dish containing physiological saline (Photo 11.4).

TIPS & PITFALLS

- Inter-commissural distance must be measured accurately.
- Aortic annulus decalcification should be done completely.
- The largest leaflet to be created from pericardium treated with glutaraldehyde should be created from the pericardium in the diaphragmatic region.

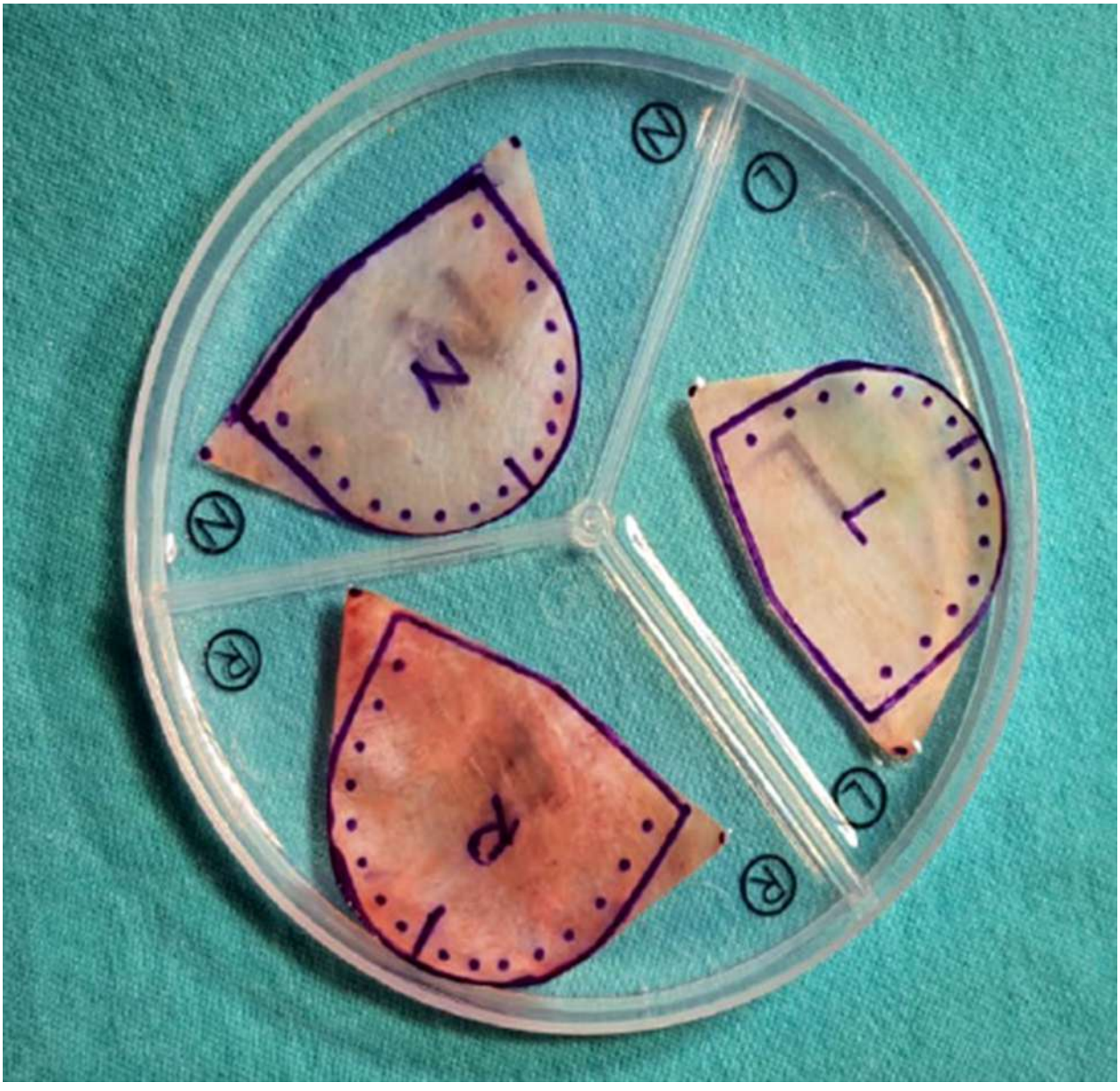

Photo 11.4. Prepared leaflets placed in a Petri dish.

SUTURING THE LEAFLETS TO THE AORTIC ANNULUS

To implant the leaflets to the annulus six 13 mm, 90 cm, 4-0 polypropylene sutures with 1/2 circle needle are required. To create the commissures, three 17 mm, 90 cm, 4-0 polypropylene sutures with 1/2 circle needle are required. Three 5×10 mm pledgets are required to fix the sutures to the aortic wall at the commissural line. Since the implantation of leaflets into the annulus is difficult surgically, it is recommended to start with the right coronary leaflet first. The smooth and marked surface of the leaflet should be the ventricle side. The first suture is passed through the midpoint of the leaflet and the midpoint of the annulus previously marked (Figure 11.3, Photo 11.5). The leaflet is moved into the ventricle, the suture is tied with three knots and suturing to the annulus is done with the continuous technique. While applying the continuous suture technique, the needle must pass through the aortic annulus in an inverted manner for subannular placement of the leaflet. For the first three to four sutures on the annulus side, the distance between two sutures should be one-third of the distance between the points marked on the leaflet, giving the apex of the leaflet a bird's nest shape. Subsequent sutures, on the annulus side and on the leaflet, should be crossed at a one-to-one distance (Figure 11.4). For a better connection point support at the commissural line, the last suture on the annulus should be passed through the aorta at a larger width than the others. After the last suture is passed through the leaflet, it is passed from the aorta from inside out, 2.5 mm below the upper part of the commissure. While the leaflets are implanted to the aortic annulus, suturing the non-coronary leaflet after the right coronary leaflet would provide a more comfortable field of view during the implantation of the left coronary leaflet.

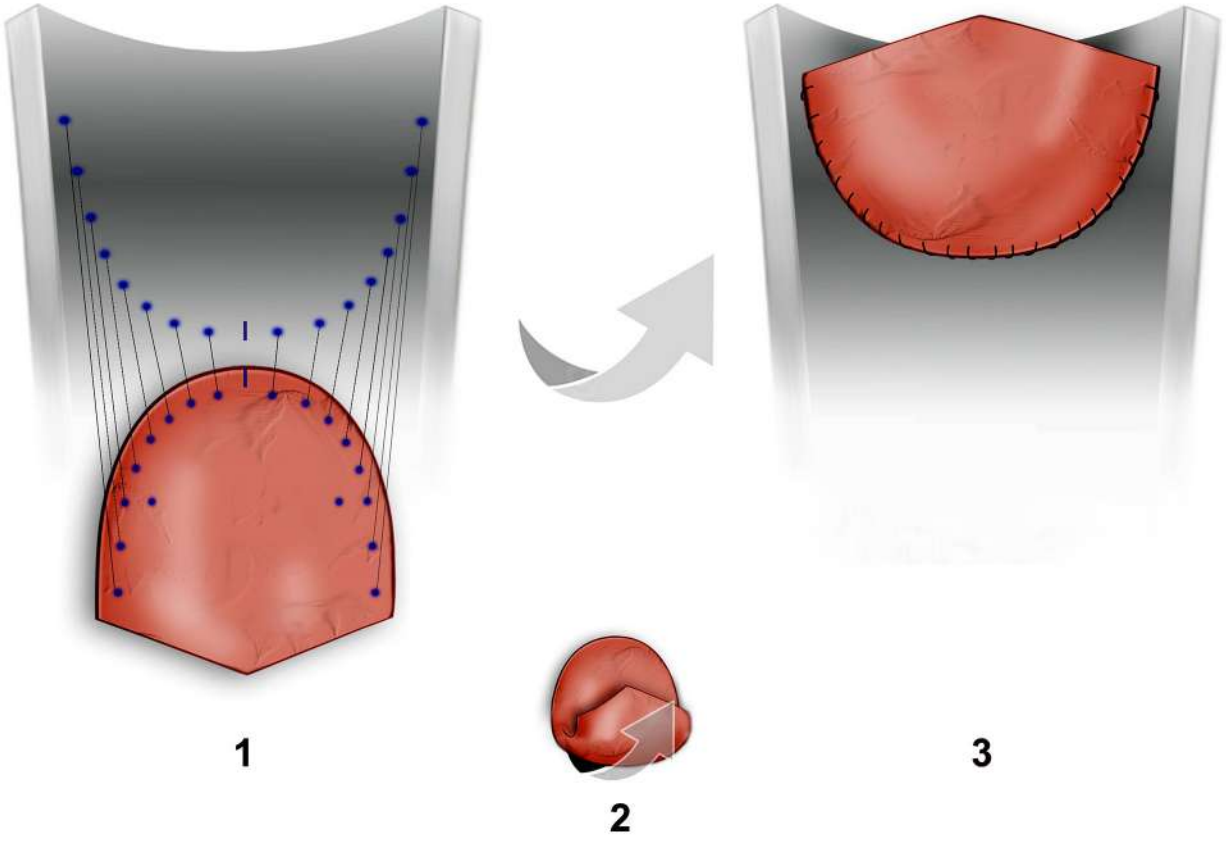

Figure 11.3. Planning of the suture points.

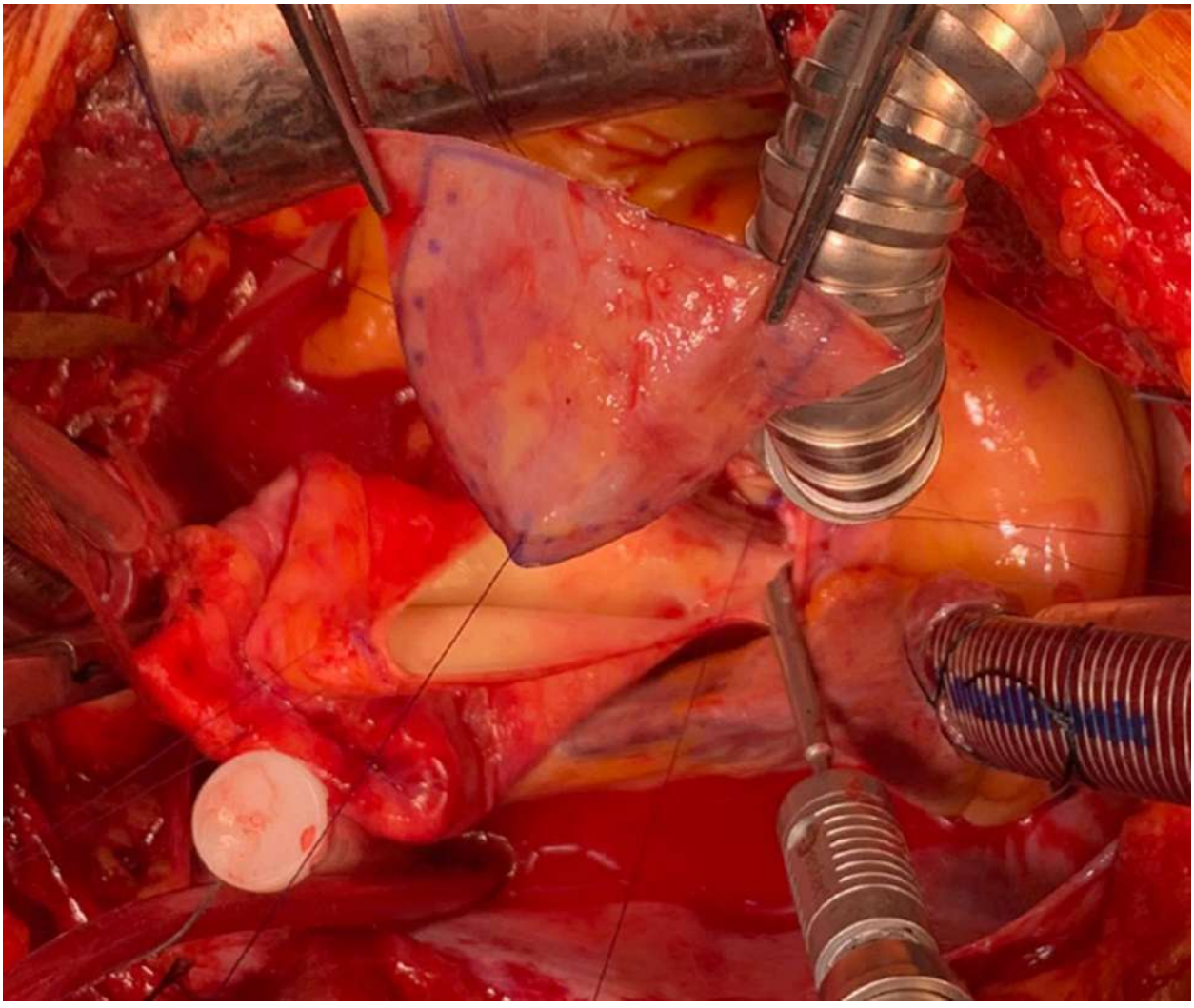

Photo 11.5. Passing the sutures for leaflet implantation.

After all the leaflets are implanted, the creation of the commissures starts. To create the commissure, the needle is passed from the outside to the inside through the free edge of the leaflet and the middle point of the previous suture, and is passed from the inside to the outside through the same area of the opposite leaflet and is taken out of the aorta 2.5 mm above the extreme point of the commissure. The other end of the needle is passed through the outer corner of the first leaflet and taken out of the aorta. Currently, there are four suture materials outside the aorta in the area where the commissure line is located. To stabilize the commissure, these sutures are passed through a 5×10 mm pledgets and the upper and lower sutures are tied to each other (Figure 11.5). This method is performed on all commissures and the neocuspidization procedure is completed. After the procedure is completed, the aortic valve should visually appear as a "windmill" from above, as an indication of good neocuspidization (Figure 11.6). Later the aortotomy line is closed with 4/0 prolene sutures. Before decannulation, the aortic valve competence should be checked with transesophageal echocardiography.

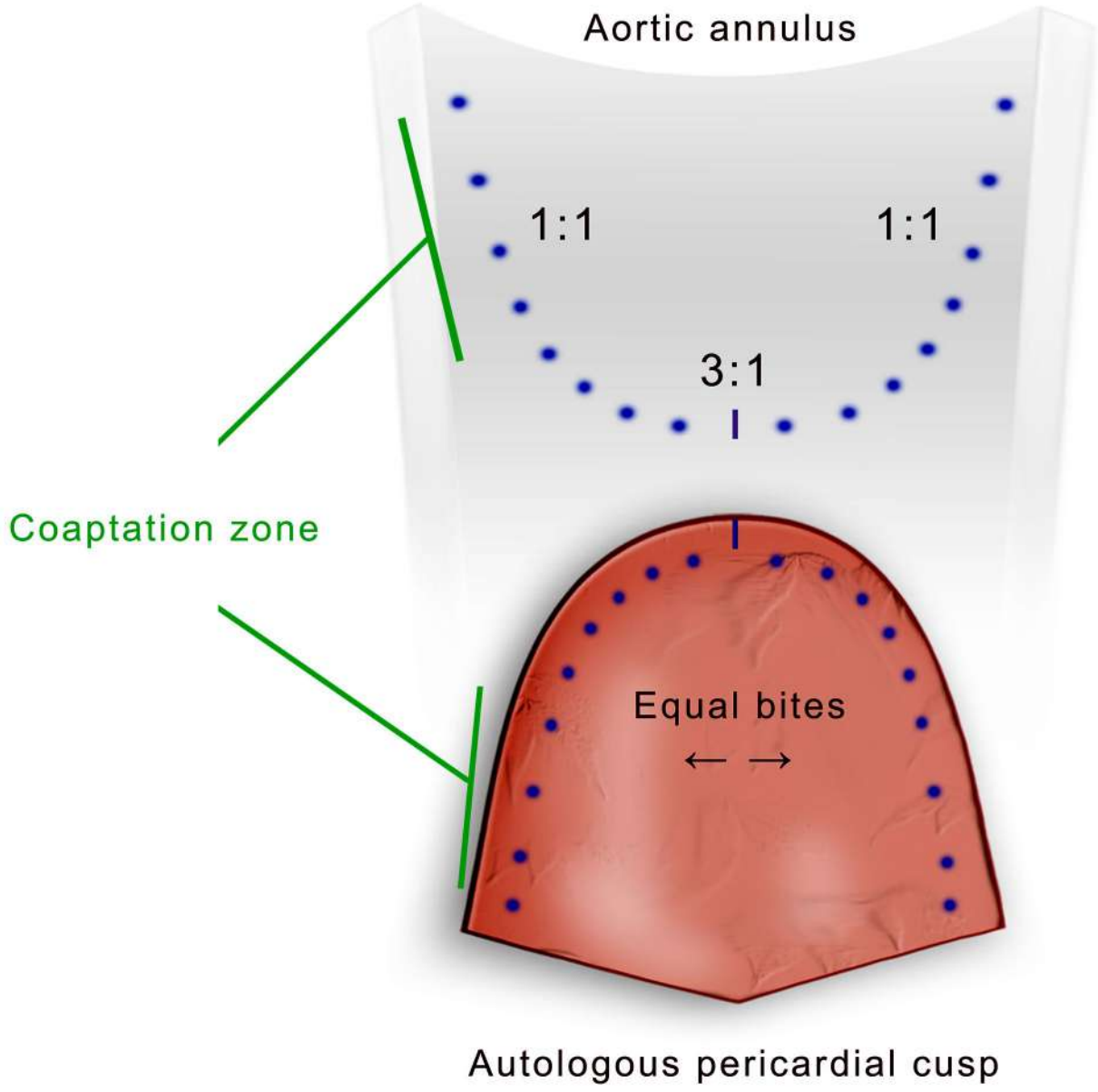

Figure 11.4. Technique of suturing newly created aortic leaflets to the aortic annulus.

TIPS & PITFALLS

- It is recommended to start implanting leaflets from the right coronary leaflet.
- The smooth and marked surface of the prepared leaflet should remain on the ventricular side.
- Leaflet should be placed subannularly.
- Care should be taken to ensure that the commissures created are in the same plane.

TRICUSPIDIZATION PROCEDURE

The Ozaki technique, which consists of an independent replacement or reconstruction of three

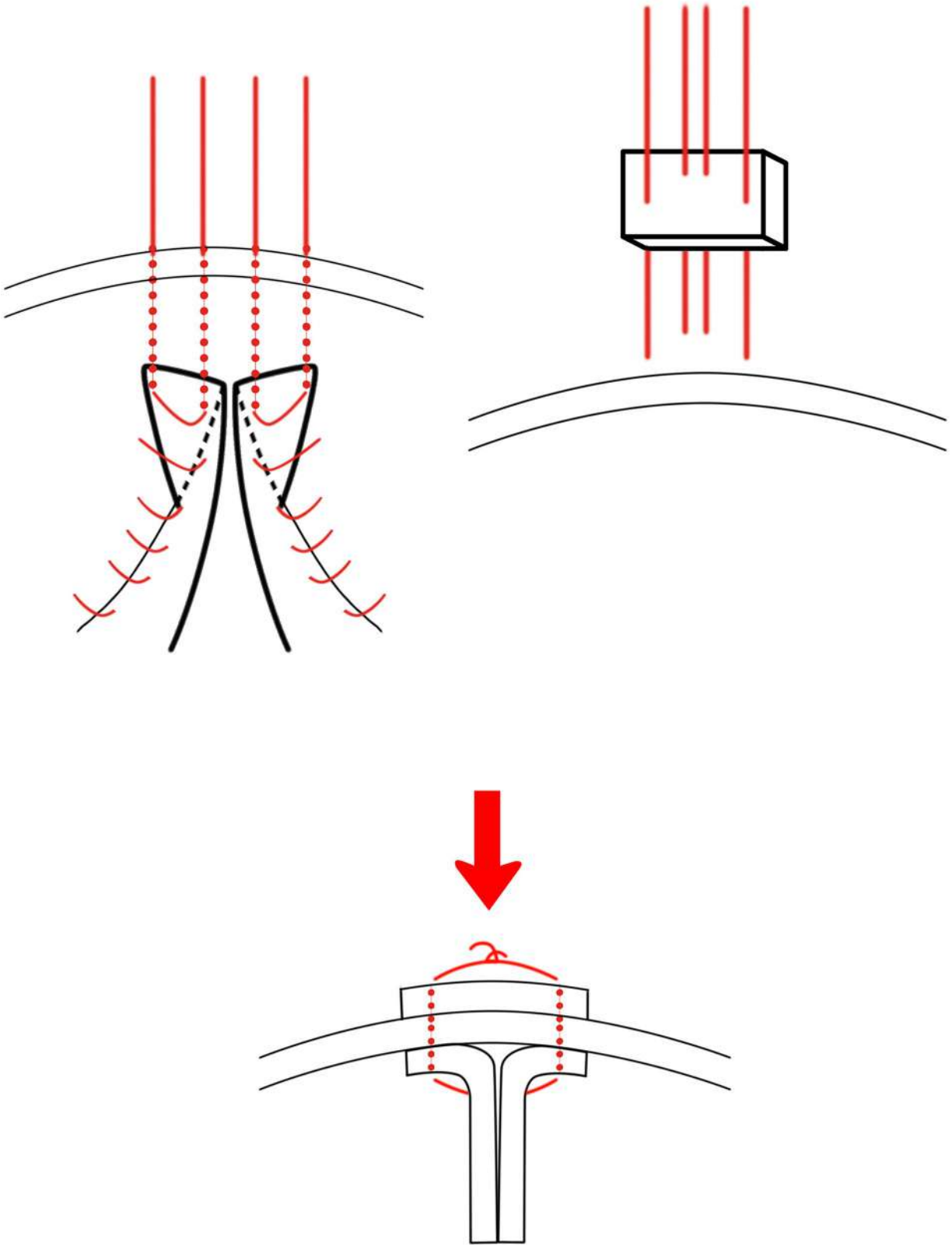

Figure 11.5. Creation of the commissures.

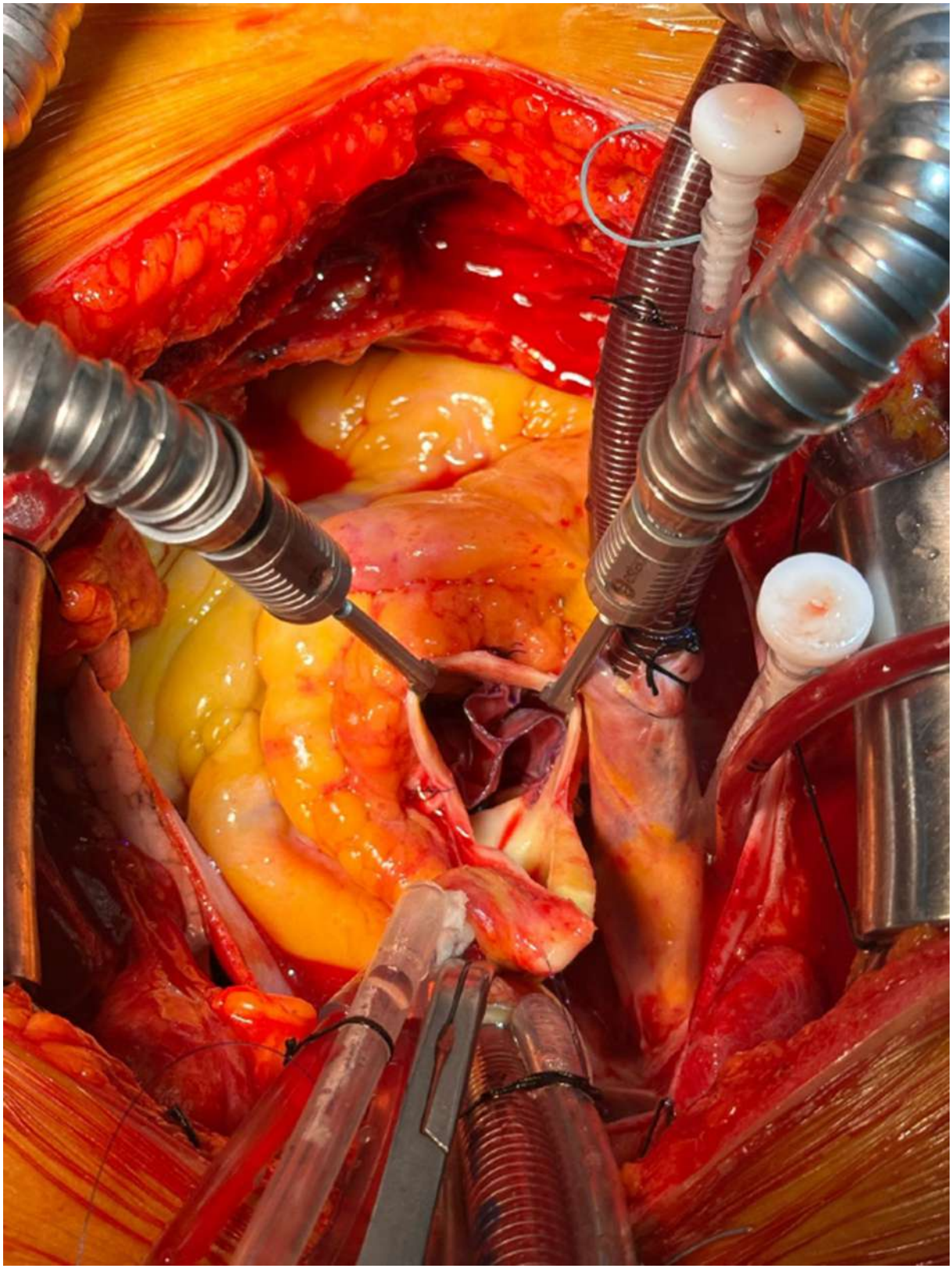

Photo 11.6. 'Windmill' appearance on the aortic valve after the Ozaki procedure.

aortic leaflets using autologous pericardium, has also been successfully applied as a reconstruction technique in congenital quadricuspid, bicuspid, and unicuspid aortic valves. Measurement and implantation of the leaflets in congenital valve pathologies, is not performed over the existing commissures. It is necessary to create a neocomissure on the annulus and this modification is called the tricuspidization procedure of the Ozaki technique. In congenital aortic valve disorders, particularly in patients with advanced calcific aortic stenosis, the pathology may have developed on the basis of a bicuspid valve and the tricuspid valve morphology may have changed. To achieve a successful aortic valve reconstruction, newly created pericardial leaflets may have equal area on the coaptation surface. If there are three commissures but there is a difference of more than two sizes between the measurements, or if there are no three separate commissures, one or two new commissures must be created to reconstruct the three leaflets. To do this, the new commissure line is determined by measuring the aortic annulus with a standardized sizing apparatus. According to the new commissure, leaflets are prepared according to a standardized template as previously stated. Finally, implantation of the leaflets is achieved by using a 13 mm, 90 cm, 4.0 polypropylene suture with a1/2 circle needle as described above, based on the natural commissure, and the newly created commissure. Commissure lines are created as described above. Since the newly created commissures in the tricuspidization procedure do not have a natural commissural line, the pericardium remaining on both sides of the leaflets forming the commissure line is fixed to the aortic wall using a 4×6 mm pericardial pledget. This suture should be done to increase the stability of the commissures which are exposed to high diastolic aortic pressure, as the unnatural commissural line is lack of the fibrous structure.

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