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Valve-sparing aortic root replacement. Which technique is better? A challenge that we must take

Reemplazo de la raíz aórtica con preservación de la válvula. ¿Cuál técnica es mejor? Un desafío que debemos asumir

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Life is like riding a bicycle: to maintain balance, you must keep moving.
Albert Einstein

Since the 1960s the procedure introduced by Dr. Bentall and Dr. DeBono has been the gold standard surgery for aortic root aneurysms; but, after the introduction of valve-sparing operations in the 1990s, they have generated increasing interest for the treatment of root aneurysm with pliable bicuspid or tricuspid aortic cusps; however, medical evidence for repairing the aortic valve rather than replacing it remains low.[1]

The two main techniques are the Yacoub procedure (remodeling) and the David procedure (reimplantation). The possibility to preserve the aortic valve (AV), restore its function and replace the dilated part of ascending aorta has become a game-changing concept in approach to aortic root and/or regurgitant AV.[2] The most important point is that the patient will be free of the risks inherent in the presence of an aortic prosthesis.

Aortic valve-sparing procedures should mimic the physiological behavior of the aortic root to restore proper valve coaptation through (1) resuspension of the cusp effective height, (2) reduction of the dilated root diameters (aortic annular base and sinotubular junction), and (3) preservation of root dynamics with vortices (sinuses of Valsalva) and expansibility (interleaflet triangles).[3-5]

Both procedures are of the same age and have been reproduced by many centers, this has generated various results and there has been a constant debate over which of the two above mentioned techniques is superior; the remodeling technique provides physiologic cusp movement within the three reconstructed neo-sinuses, thus preserving root expansibility through the interleaflet triangles, but it does not address annular base dilation.[6,7]

On the other hand, the reimplantation procedure as an inclusion technique performs a subvalvular annuloplasty through the proximal suture of the graft but withdraws the sinuses of Valsalva and includes the interleaflet triangles

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within the noncompliant prosthesis, thus impairing root dynamics.[7]

Exists studies that compare the hydrodynamics of remodelling versus reimplantation on porcine roots in vitro with significantly smoother valve movement in remodelling configuration, which could eventually lead to slower valve degeneration.[8] This is one of the observed phenomena that have shown that remodeling is more physiological, remembering that it not only gives a normal displacement of the cusps, but it also allows the natural movement of the annulus during cardiac contraction.

Last year has been performed a similar comparison including remodelling, reimplantation and reimplantation into Valsalva graft, they found that this graft provided the most similar characteristics to the native root in terms of energy loss and valve opening.[9]

Recently a meta-analysis of fifteen studies met eligibility criteria, comprising 3044 patients (1991 in the reimplantation group and 2018 in the remodeling group). They found that patients who underwent valve-sparing aortic root surgery with remodeling had a higher risk of all-cause death Landmark analysis (with 4 years as the landmark time point) demonstrated that survival was lower in patients who underwent remodeling in the first 4 years. Beyond the 4-year time point, no difference in survival was observed. The risk for need of aortic valve and/or root reintervention was higher in patients undergoing remodeling.

They did not find statistically significant coefficients for the covariates of age, female sex, connective tissue disorders, bicuspid aortic valve, aortic dissection, coronary bypass surgery, total arch replacement, or annular stabilization, which means that these covariates did not modulate the effects observed in their pooled analyses. They concluded that the reimplantation is associated with better overall survival and lower risk of need for reintervention over time compared with remodeling. Regarding overall survival, they observed a time-varying effect that favored the reimplantation technique up to 4 years of follow-up, but not beyond this time point.[10]

Despite this meta-analysis comprising observational studies, the 15 studies yielded many patients that allows a good comparison of both techniques and the results obtained have statistical weight. However, the comparison of the techniques was carried out in patients who underwent remodeling without modification of the aortic annulus reinforcement. In 2006, Lansac et al. published the use of an expandable ring placed in the external part of the aortic root, this was after they observed that in young patients, after remodeling, the dilation of the ring was not controllable and is the cause of late aortic insufficiency.[11]

In 2016, Schäfers et al. suggested an external PTFE suture surrounding the ring;[12] This is more reproducible, less need for deep dissection of the aortic root and less risk of late injuries due to the presence of material in that region, in addition if there is a relevant height discrepancy between the basal plane and the aorto-ventricular junction, external dissection sufficient to place an external annuloplasty device will be difficult.

There are many studies and modifications to the remodeling technique, good long-term results have been achieved. Lansac introduced the term: CAVIAAR technique (Conservative Aortic Valve surgery for Aortic Insufficiency and Aneurysm of the Aortic Root), a standardized and physiologic-driven approach to aortic valve repair. By combining key elements of established remodeling techniques. CAVIAAR effectively addresses both aortic root aneurysm and valve insufficiency, through: (1) a physiologic reconstruction of the aortic root according to the remodeling technique; (2) resuspension of the cusp effective height; and (3) external placement of an expansible subvalvular aortic ring annuloplasty.[13]

After 5 years, they published the early experience with CAVIAAR technique versus mechanical Bentall in 261 consecutive patients with aortic root aneurysm who were enrolled in multicentric prospective cohort (131 in the BENTALL group, 130 in the REPAIR group) in 20 centers. The main end point was composite criterion including mortality; reoperation; thromboembolic, hemorrhagic, or infectious events; and heart failure. Secondary endpoints were major adverse valve-related events. The mean age was 56.1 years, and the valve was bicuspid in 115 patients (44.7%). The median preoperative aortic insufficiency grade was 2.0 (1.0-3.0) in the REPAIR group and 3.0 (2.0-3.0) in the BENTALL group. Thirty-day mortality was 3.8% (n = 5) in both groups (p = 1.00). Despite a learning curve and longer cross clamp times for valve repair (147.7 vs 99.8 minutes, $p < 0.0001$), the 2 groups did not differ significantly for the main criterion or 30-day mortality, with a trend toward more frequent major adverse valve-related events in the BENTALL group. At discharge, 121 patients (96.8%) in the REPAIR group had grade 0 or 1 aortic insufficiency. With their results, they concluded that a new standardized approach to valve repair, combining an expansible aortic annuloplasty ring with the remodeling technique, presented similar 30-day results to mechanical BENTALL with a trend toward reducing major adverse valve-related events.[14]

This year has been published a retrospective international multicentre study of patients undergoing remodelling or reimplantation.[15] The aim was to compare AV reimplantation (David procedure) and aortic root remodelling including basal ring annuloplasty (Yacoub procedure) regarding the longer-term freedom from AV perioperative outcomes were analyzed along with longer-term freedom from AV reoperation/reintervention and other major valve-related events.

One hundred and twelve pairs were selected and further compared. In the remodeling, they did not find a statistically significant difference in perioperative outcomes between the matched groups. Patients after remodelling had significantly higher reintervention risk than after reimplantation over the median follow-up of 6 years ($p = 0.016$). The remodelling technique, need for decalcification and degree of immediate postoperative AV regurgitation ($p < 0.001$) were defined as independent risk factors for later AV reintervention. After exclusion of patients with worse than mild AV regurgitation immediately after repair, both techniques functioned comparably ($p = 0.089$) AV reimplantation was associated with better valve function in longer-term postoperatively than remodelling. But, if optimal immediate repair outcome was achieved, both techniques provided comparable AV function. The debate will continue because many centers continue to develop valve-sparing surgery; some more remodeled, others reimplanted. The interesting thing should be that smaller centers start an aortic root surgery program where we can have a complete treatment arsenal and individualize the patient. The techniques exist but each patient is different and therefore, the correct path is which patient is for each technique.

In 2021, David et al.[16] published their last report of reimplantation; a total of 465 patients who had reimplantation of aortic valve from 1989 to 2018 were followed prospectively with periodic clinical and echocardiographic assessments. Mean follow-up was 10 ± 6 years and 98% complete. At 20 years, 69.1% of patients were alive and free from aortic valve reoperation, and the cumulative probability of aortic valve reoperation with death as a competing risk was 6.0%, and the cumulative probability of developing moderate or severe AI was 10.2%. Only time per 1-year interval was associated with the development of postoperative. As we can see, over 30 years the percentage of reintervention for valve insufficiency has been very low. Initial reports mentioned up to 11% over 10 years.

In Mexico, the first report of valve-sparing aortic root replacement was in 2018 by García-Villarreal et al.[17] They present a case of aortic root aneurysm successfully repaired with the David V technique. Three years later we published a series of 14 cases of patients with aneurysm of the aortic root and/or ascending aorta with some degree of aortic valve insufficiency, successfully undergoing valve reimplantation with the David I technique, the initial results have been successful, and after 10 years we do not have reintervention.[18]

While it is true, there are many surgeons in Mexico who perform aortic root surgery, but, this only two reports of cases in our country, reflects that we do not have well-established aortic root surgery programs.

As is already known, both aortic valve preservation procedures have the main advantage of avoiding the risks inherent to valve prostheses (endocarditis, thrombosis, bleeding); that is why cardiac surgeons must have the ability to develop and indicate them according to each patient. Remodeling is more physiological than reimplantation, however, reimplantation has greater durability, therefore, in young patients and/or patients with collagenopathy, it seems to be the best option.[2]

There may be fear of failure and the need for early reinterventions and/or prolonged surgical times in non-successful cases that are converted to Bentall. The learning curve may be long, but we must start and gain the necessary experience. Let's get our minds and hands going.

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