Orthotopic Heart Transplantation Technique Optimization

Martin Stenlo *

Editorial Office, Surgery: Current Research, Belgium

Corresponding Author*

Martin Stenlo
Editorial Office, Surgery: Current Research, Belgium
E-mail: surggenopen@peerjournal.org

Received: 03-Jan-2023, Manuscript No. SCR-23-20616; **Editor assigned:** 06-Jan-2023, Pre QC No. SCR-23-20616 (PQ); **Reviewed**: 20-Jan-2023, QC No. SCR-23-20616 (Q); **Revised**: 22-Jan-2023, Manuscript No. SCR-23-20616 (R); **Published**: 26-Jan-2023, doi: 10.352482161-1076.22.13(1).429.

Abstract

Orthotopic Heart Transplantation (HTx) implantation methods have developed over time. The use of novel, modified bicaval strategies to reduce warm ischemia has recently become more common in the literature. In our department, HTx was performed on n=238 patients between 2010 and 2022. After looking back, the receivers were separated according to how their anastomoses were made. After releasing the aortic cross-clamp during the reperfusion, anastomoses were sutured either in a biatrial (n=37), bicaval (n=191), or modified bicaval (n=10) way with suturing of the superior cava vein. Biatrial warm ischemia lasted 52min, bicaval warm ischemia lasted 60min, while the modified bicaval approach only lasted 48min (p 0.001). Biatrial (27.0%) and bicaval (28.8%) anastomoses had similar rates of severe Primary Graft Dysfunction (PGD). When using the modified bicaval method, only one patient (10.0%) experienced PGD. Biatrial had a postoperative pacemaker implantation rate of 18.2% compared to bicaval's 3.0% and modified bicaval's(p=0.01). Compared to both biatrial and standard bicaval approaches, the modified bicaval technique allows for a reduction in the critical warm ischemia during HTx. Therefore, bicaval anastomoses are highly advised, ideally in a modified fashion.

Keywords: Heart transplantation • Warm ischemia • Anastomoses • Reperfusion • Cardiac surgery

Introduction

Orthotopic Heart Transplantation (HTx) for end-stage heart failure has undergone a significant evolution in the past few decades in terms of perioperative care and medication. However, little progress has been made in HTx surgical procedures in the interim. The bicaval anastomoses surgical approach is currently the most frequently used for the HTx surgery, followed by the less common biatrial technique. The biatrial anastomoses procedure by Lower and Shumway has been shown to have a higher incidence of tricuspid valve regurgitation and heart rhythm abnormalities necessitating permanent pacemaker insertion in patients than bicaval ones. Contrarily, the bicaval technique necessitates sewing a second anastomosis, extending the graft's warm ischemia. Reduce the warm ischemia since it's an important factor in graft function and postoperative survival, which is why it should be one of the key objectives of every transplant. As a result, reports of bicaval method adjustments have been made. After releasing the aortic cross-clamp using the beating-heart procedure, the superior vena cava, pulmonary artery, and occasionally even the inferior vena cava anastomoses are stitched together. Suturing of the remaining anastomoses following the commencement of donor heart reperfusion, however, may prove more difficult due to the deteriorating exposition, particularly in redo cases and for less experienced surgeons. There is currently scant information in the literature comparing the effectiveness of biatrial, bicaval, and modified bicaval procedures[1].

Materials and Methods

Patients and study design

238 adult patients underwent HTx in our department between 2010 and 2022, and their information was prospectively entered into an institutional database. Regarding the surgical anastomoses approach used in the HTx procedure, these patients were retrospectively analyzed and divided into three study groups. The standard bicaval procedure (bicaval group), which was employed during the whole study period, was used to transplant the majority of patients (n=191) in this study. In contrast, the biatrial Lower and Shumway procedure (biatrial group) was employed until 2021 in n=37 patients. Since its implementation in our practise in 2021, the modified bicaval approach has been applied to n=10 situations (modified bicaval group) [2,3].

Study Objectives and Follow-Up Period

All pertinent recipient, donor, and outcome variables were investigated and compared between the research groups in hindsight. The primary endpoint of the study was the length of warm ischemia, which was measured as the time between removing the graft from cold storage and releasing the aortic cross-clamp for reperfusion. Secondary endpoints included the prevalence of postoperative Primary Graft Dysfunction (PGD), perioperative morbidity, postoperative sinus rhythm and pacemaker implantations, as well as 30 days and one-year survival. Postoperative follow-up was routinely conducted every one to three months, lasting a mean of 1062 days for the entire group and a maximum of 4214 days[4,5].

Surgical Procedure and Immuno suppressive Regime

In all instances, heart transplantation was carried out orthotopically. Without the use of a specialised organ preservation technology, donor hearts were kept cool during travel. Patients underwent biatrial, bicaval, or modified bicaval transplantation. Anastomoses were sewn for the biatrial procedure in the following order: Left Atrium (LA), right atrium, Pulmonary Artery (PA), and aorta. The order of the vena cava for the bicaval method was as follows: LA, IVC, SVC, PA, and aorta. The aortic cross-clamp was loosened for the modified bicaval technique after the LA, IVC, and aortic anastomoses, as well as the SVC and PA, were sutured during the reperfusion of the graft in beating-heart procedure. The anastomosis procedure for HTx was selected based on the recipients' anatomical conditions as well as the doctors' preferences. All patients adhered to the same immunosuppressive regimen, which included prednisolone, mycophenolate mofetil, and tacrolimus (target levels: 9 ng/mL-12 ng/mL, 1.5 g/dL-4.0 g/dL, and 9 ng/mL-12 ng/mL, respectively). The majority of the time, the regimen was started right away without any additional induction therapy. Approximately one week after the HTx surgery, a first endomyocardial biopsy was planned to look into probable graft rejection. High-dose prednisolone therapy was used to treat acute graft rejection for at least three days in a row, and immunoabsorption or plasmapheresis, anti-T-lymphocyte IgG, and intravenous IgM-enriched human immunoglobulin were added to the therapy in cases of antibody-mediated rejection.

Discussion

In the current study, we looked at how the anastomoses approach affected the results following HTx. In 238 consecutive cases, we compared the biatrial, bicaval, and a modified bicaval approach for this aim. Biatrial approach was inferior to bicaval technique in terms of postoperative heart rhythm abnormalities necessitating pacemaker implantation, which is in line with the documented literature. Biatrial and bicaval techniques were modified by suturing the pulmonary artery and superior cava vein anastomoses after releasing the aortic cross-clamp, which considerably reduced the warm ischemia. Patients who underwent the modified bicaval procedure also had a statistically

lower incidence of PGD and no postoperative cardiac rhythm problems. The main reason for implementing the modified bicaval approach in our department was to reduce graft ischemia. Transport times have increased and so-called marginal grafts are being accepted more frequently due to the current paucity of donor organs. In the past ten years, numerous innovative graft preservation technologies have been created to guarantee the best graft quality for each patient. These technologies, however, are frequently more expensive and sophisticated than conventional preservation techniques for cold storage. Contrarily, it is more simpler and less expensive to incorporate into daily life a surgical approach that improves the HTx procedure in order to reduce warm ischemia, especially given that warm ischemia is such an important criterion for organ quality.

However, bicaval method is now preferred over biatrial since the danger for heart rhythm abnormalities and tricuspid regurgitation is reduced. However, by using the modified bicaval technique, we were able to minimise the warm ischemia not only by around 275 when compared to the conventional bicaval technique, but more importantly, by about 23% when compared to the biatrial, as shown by the post-hoc studies. As a result, a modified bicaval approach provides the benefits of bicaval anastomoses with relation to heart rhythm problems and tricuspid regurgitation. The most significant finding of our study, simultaneous warm ischemia is significantly more reduced in comparison to biatrial anastomoses, supporting our original idea. PGD is a typical side effect of HTx and carries a significant risk of early mortality. Graft ischemia is just one of the many risk factors for PGD that can be influenced during the actual HTx operation. The International Society for Heart and Lung Transplantation (ISHLT) has characterised severe PGD as having 66 of 238 patients (27.7%) receiving postoperative temporary mechanical support by va-ECMO. We used the same ECMO implantation protocol in all three groups, even though this number might be higher compared to international registry data due to our centre's very lenient policy[6].

With the improved bicaval method, just one patient in ten experienced severe PGD. On the other hand, almost three out of every ten patients who underwent biatrial or bicaval surgery required postoperative brief ECMO therapy. In our sample, the modified bicaval method led to a relative risk decrease for PGD of roughly 65% while taking into account the multifactorial genesis of PGD as a potential confounder[7].

According to the research, patients who undergo surgery using the biatrial approach as opposed to the bicaval technique had a higher incidence of postoperative heart rhythm abnormalities and tricuspid regurgitation. Similar benefits were seen in our sample for cardiac rhythm problems. We gave up on the biatrial method as a result. Since then, patients have either had bicaval transplants or bicaval transplants with modifications. Concerns about the biatrial approach relate mostly to the relatively high rate of postoperative pacemaker implantation and the concomitant risk for pacemaker lead infections and endocarditis of the graft[8].

In the realm of HTx surgery, modifications to the bicaval approach are frequent and not new. The number of sutured anastomoses and changes to the anastomosis lines before releasing the aortic cross-clamp have both been documented in the literature. However, the majority of these studies are case reports. Contrarily, numerous sizable research contrast the bicaval and biatrial approaches. These studies, however, don't generally distinguish between traditional and modified bicaval methods. As a result, there is still a paucity of evidence comparing biatrial, bicaval, and modified bicaval procedures. Additionally, because there have been so many distinct ways that the bicaval technique has been modified, the term "modified bicaval technique" itself may be deceptive because it encompasses a variety of alterations. In our work, we utilised the phrase to indicate how, during the reperfusion of the graft using the beating-heart approach, the LA, IVC, and aortic anastomoses, as well as the SVC and PA, were sutured. In comparison to 30 patients treated with the standard bicaval procedure, 28 patients were treated using the same modified technique. Although the authors observed rather extended warm ischemia-around 80 minutes for the control group and about 62 minutes for the modified group-their findings show that ischemia and graft function are generally on the same trend as in our study[9].

Other groups suture the IVC, SVC, and PA during reperfusion and release the cross-clamp after the LA and aortic anastomoses. This alteration may further reduce the warm ischemia of the transplant, but it may also make surgery more difficult. To further enhance the surgical procedure, a systematic comparison of these two procedures with the standard bicaval one is also lacking and should be addressed in the future[10].

The results' validity is constrained by the retrospective and single centre approach. Group sizes were uneven and unmatched, despite the fact that preoperative recipient donor donor factors were comparable between the three groups. Additionally, a variety of surgeons with varying levels of competence performed operations on the study patients who were reported, and only the standard bicaval technique was used for anastomose. A multicentric randomised experiment would be required to eliminate these biases. Despite this, we were able to present fresh information and support the data that already existed to show that the modified bicaval approach improved the outcomes for patients receiving HTx. Future plans include a follow-up report with a higher percentage of patients who underwent the modified bicaval procedure and a longer follow-up period that enables multivariate analyses.

Conclusion

In comparison to both biatrial and conventional bicaval approaches, the modified bicaval technique allows for a reduction in the critical warm ischemia during HTx. The modified bicaval method is particularly beneficial for cases with lengthy transit times because the risk for postoperative PGD rises with the graft's overall ischemia time. We were able to provide encouraging findings for a perioperative outcome, notably decreased incidence of PGD and increased short-term survival using the modified bicaval approach, despite the fact that the results are only preliminary. Patients with biatrial anastomoses required permanent pacemaker installation after HTx considerably more frequently than those using the bicaval method. Therefore, bicaval anastomoses are highly advised, ideally in a modified fashion.

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Cite this article: Stenlo M. Orthotopic Heart Transplantation Technique Optimization. Surg Curr Res. 2022, 13 (1), 429.