E-ISSN 2148-9211

CVSI

CARDIOVASCULAR SURGERY *and* INTERVENTIONS

Official Electronic Journal of the Turkish Society of Cardiovascular Surgery

Turkish Society of Cardiovascular Surgery 1988

Volume: 7 / Number: 1 / March 2020

E-ISSN 2148-9211

CARDIOVASCULAR SURGERY AND INTERVENTIONS

Volume 7 - Number 1 - March 2020

Cardiovascular Surgery and Interventions is the official and periodical journal of the Turkish Society of Cardiovascular Surgery. It is published three times a year.

Executive office:
Türk Kalp ve Damar Cerrahisi Derneği
Ataşehir Mah., Ataşehir Bulvarı, 48 Ada,
Mimoza 2/2, K: 2, D: 6,
34758 Ataşehir, İstanbul, Turkey
Tel: +90 216 - 456 14 54
Fax: +90 216 - 456 14 54
e-mail: info@tkdcd.org
URL: http://www.tkdcd.org

Editorial Contact Person
Bilgin Emrecan, MD.
e-mail: bilginemrecan@yahoo.com

Publisher
Bayçınar Tıbbi Yayıncılık ve Reklam Hiz. Tic. Ltd. Şti.
Örnek Mah., Dr. Suphi Ezgi Sok., Saray Apt., No: 11, D: 6,
34704 Ataşehir, İstanbul, Turkey
Tel: +90 216 - 317 41 14
Fax: +90 216 - 317 63 68
e-mail: info@baycinartibbiyayincilik.com

Type of publication: Periodical
Publication date: May 18, 2020

The control of conformity with the journal standards and the typesetting of the articles in this journal, the control of the English abstracts and references and the preparation of the journal for publishing were performed by Bayçınar Medical Publishing.

Contents

Cardiovasc Surg Int 2020;7(1):1-2
http://dx.doi.org/DOI: 10.5606/e-cvsi.2020.815
www.e-cvsi.org

Cardiovascular Surgery and Interventions

Editorial Open Access

Normalization process of cardiac operations in COVID-19 pandemic

Orhan Gökalp

Department of Cardiovascular Surgery, Izmir Katip Çelebi University, Faculty of Medicine, Izmir, Turkey

Received: May 09, 2020 ***Accepted:*** May 11, 2020 ***Published online:*** May 18, 2020

The severe acute respiratory syndrome-coronavirus-2 (SARS-CoV-2; COVID-19), which was first identified in Wuhan province of China in the late December 2019, has infected approximately 3,700,000 individuals worldwide and more than 250,000 deaths have been reported until the first quarter of May 2020.[1] The level of danger for the modern world's healthcare system is revealed, when the possibility of undiagnosed cases, multiple times more than reported numbers, is considered. As a result of this catastrophic scenario, healthcare systems have been reorganized all over the world. The most widely adopted practice is to prioritize COVID-19 patients in all healthcare units and to postpone all diagnose and treatment procedures to a reasonable future date, unless it is urgent or indispensable. The effect of delay in diagnosis and treatment on patients other that those with COVID-19 is a totally different subject of debate on this kind of practice. Nevertheless, we can briefly state that the whole world has to face with this effect of the temporary, but the *de novo* healthcare system.

Among diseases with postponed diagnosis and treatment due to COVID-19 pandemic, cardiovascular diseases are among the most risky conditions to delay. As a matter of fact, cardiovascular surgery clinics all over the world are in an attempt to create a strategy from the very beginning of the pandemic. Some countries have published guidelines one after another, when the others have developed algorithms for this subject.[2-4] A commonly used method is prioritizing and ranking the patients and making patient-based plans.[5,6] In this case, potential problems should be handled during this ranking process. For instance, a patient with coronary artery lesions may have a severe ischemic attack or die while waiting after the decision to delay the operation. As another example, there is no guarantee of a 4.8-cm-abdominal aortic aneurysm not to rupture during the follow-up period, for sure. That is why maximum attention should be paid in determination of priorities. Another strategy in the process of delaying diagnosis and treatment of cardiovascular diseases is to stay in touch with patients via telecommunication tools or face-to-face.[2-6] Moreover, to be proactive during these follow-ups (e.g. to perform an earlier operation for progressive symptoms) may minimize the potential problems caused by this delaying process.

Surely, urgent operations are being performed during this delaying process. Organization of educated healthcare personnel is critical in this point, as cardiovascular surgery is a discipline with lots of technical team and equipment to be used, compared to other surgical specialties. Management of daily working schedule is very difficult, as this team also provides more or less healthcare services, as well. On the other hand, despite using personal protective equipment, there is a risk of infecting the rest of the team or patients, if there is an asymptomatic team member. As a unit with a large number of personnel, cardiovascular surgery operating teams may be insufficient to provide required social distance. Nonetheless, urgent operations will continue to be performed with protective cautions and all these risks to be considered.

How can normalization be practiced in this period? More importantly, when can normalization be started? A vaccine or a mutation to lower the virulence of the virus is required to stop this pandemic and, as we have none of them at the moment, it is obvious

Corresponding author: Orhan Gökalp, MD. İzmir Katip Çelebi Üniversitesi Tıp Fakültesi Kalp ve Damar Cerrahisi Anabilim Dalı, 35620 Çiğli, İzmir, Türkiye. Tel: +90 505 - 216 88 13 e-mail: gokalporhan@yahoo.com

Citation:
Gökalp O. Normalization process of cardiac operations in COVID-19 pandemic. Cardiovasc Surg Int 2020;7(1):1-2.

that normalization will get started without these items. Undoubtedly, local and universal COVID-19 numbers should be taken into consideration in decision of when to start normalization process. The most serious guideline is from the Canadian Cardiovascular Society, when publications from the beginning of the pandemic are studied.[2] According to this guideline, normalization for cardiovascular operations should be held in three phases. In the first phase, a 0 to 25%-increase in capacity and urgent/emergent cases should be focused on and, when it comes to prioritized out-of-hospital patients, it recommends to select patients who are less likely to require prolonged intensive care unit and hospital length of stay. In the second phase, 25 to 50% increase in capacity and to maintain in-patient urgent/emergent services while broadening the inclusion of appropriately prioritized out-of-hospital patients are recommended. Examples of these prioritized patients are the ones with severe symptomatic aortic stenosis, left main coronary artery disease, a cardiac tumor with high-risk features for obstruction or embolism, and aortic aneurysm disease with high-risk features such as rapid growth. In the last phase, it recommends a start to return to normal outpatient services. While practicing these recommendations, it should be kept in mind that there may be fluctuations in pandemics and this process should be managed in a dynamic manner.

Another important issue is to rule out COVID-19 before the operation for both considering survival of the patient and protection of personnel. The risk of COVID-19 spread from an intubated patient with COVID-19 in the operation room is very high whether he/she has been diagnosed or not. On the other hand, very high mortality ratios have been, unfortunately, reported on elective cases with COVID-19. Even in studies with small cohorts, the mortality was reported as 20%, regardless of the operation type.[7] Considering such outcomes, preoperative polymerase chain reaction (PCR) test may be useful for elective patients. Patients who are symptomatic and have a negative PCR result can be also confirmed by computed tomography for COVID-19. In the light of these data, we use PCR test right before the operation for the prioritized patients, and the operation is performed as soon as it is resulted, as there will be a risk of COVID-19 infection, even one day is lost after the test result.

In conclusion, clinical trials will provide us an insight and shed light into the strategies for both management of urgent/emergent operations, when the virus spread is at the top and normalization process are right or wrong. Irrespective of the results, it should be always remembered that healthcare systems all over the globe, for the first time, provide healthcare, while simultaneously fighting against such a challenging outbreak with widespread transmission.

Declaration of conflicting interests

The authors declared no conflicts of interest with respect to the authorship and/or publication of this article.

Funding

The authors received no financial support for the research and/or authorship of this article.

REFERENCES

1. World Health Organization. Coronavirus disease (COVID19) Pandemic. Available at: https://www.who.int/emergencies/diseases/novel-coronavirus-2019 [Accessed: May 8, 2020]
2. Hassan A, Arora RC, Lother SA, Adams C, Bouchard D, Cook R, et al. Ramping Up the Delivery of Cardiac Surgery During the COVID-19 Pandemic: A Guidance Statement from the Canadian Society of Cardiac Surgeons. Can J Cardiol 2020:S0828-282X(20)30415-3.
3. Mavioğlu HL, Ünal EU, Aşkın G, Küçüker ŞA, Özatik MA. Perioperative planning for cardiovascular operations in the COVID-19 pandemic. Turk Gogus Kalp Dama 2020;28:236-43.
4. Barros L, Rivetti LA, Furlanetto BH, Teixeira EM, Welikow A. COVID-19: General guidelines for cardiovascular surgeons (standard guidelines - subject to change). Braz J Cardiovasc Surg 2020;35:I-III.
5. Ünal EU, Mavioğlu HL, İscan HZ. Vascular surgery in the COVID-19 pandemic. J Vasc Surg 2020:S0741-5214(20)31077-6.
6. Bashir M, Moughal S. Cardiovascular Disease and Surgery Amid COVID-19 Pandemic. J Vasc Surg 2020:S0741-5214(20)31076-4.
7. Lei S, Jiang F, Su W, Chen C, Chen J, Mei W, et al. Clinical characteristics and outcomes of patients undergoing surgeries during the incubation period of COVID-19 infection. EClinicalMedicine 2020:100331.

Cardiovasc Surg Int 2020;7(1):3-7
http://dx.doi.org/DOI: 10.5606/e-cvsi.2020.778
www.e-cvsi.org

Cardiovascular Surgery and Interventions

Original Article Open Access

Comparison of the metabolic effects of eplerenone and spironolactone via plasma galectin-3 level in patients with heart failure

Hakan Göçer[1], Ahmet Barış Durukan[2], Mustafa Ünal[3]

[1]Department of Cardiology, Medical Park Uşak Hospital, Uşak, Turkey
[2]Department of Cardiovascular Surgery, Medical Park Uşak Hospital, Uşak, Turkey
[3]Department of Cardiovascular Surgery, Bicard Clinic, Bishkek, Kyrgyzstan

Received: April 06, 2020 ***Accepted:*** April 14, 2020 ***Published online:*** May 18, 2020

ABSTRACT

Objectives: This study aims to compare the metabolic effect of eplerenone and spironolactone, mineralocorticoid receptor blockers, in patients with heart failure via galectin-3 plasma level.

Patients and methods: Between March 2018 and July 2018, 20 heart failure patients (12 males, 8 females; mean age 65.2±7.6 years; range, 58 to 73 years) diagnosed based on clinical parameters and echocardiographic findings were randomized (1:1) to either spironolactone (25 mg/day) or eplerenone (50 mg/day). All patients were also given standard heart failure treatment. We measured plasma levels of galectin-3 with biochemically. Galectin-3 levels were compared before the study and four months after both spironolactone and eplerenone treatment.

Results: The mean ejection fraction of the patients was 25.0±4.6% in the eplerenone group and 25.0±4.7% in the spironolactone group. Demographic and hemodynamic characteristics of the patients were comparable between the groups. In both groups, plasma galectin-3 levels were not significantly different prior to initiation of mineralocorticoid receptor antagonist therapy (p=0.307). In patients receiving eplerenone, the mean plasma galectin-3 levels decreased from 898.6±23.4 to 99.7±7.9 four months after the treatment (p=0.0004). In the spironolactone group, galectin-3 levels prior to and after treatment did not change significantly (p=0.201).

Conclusion: Galectin-3 concentration, which is an emerging marker of cardiac fibrosis, statistically decreased in the eplerenone group rather than spironolactone group. Based on this finding, we can speculate that eplerenone is more effective than spironolactone in preventing fibrosis and inflammation in patients with heart failure.

Keywords: Eplerenone, fibrosis, Galectin-3, heart failure, spironolactone.

Heart failure (HF) is a common and highly morbid cardiovascular disorder associated with perturbations in cardiac structure and function. The incidence of HF has been gradually increasing in recent years. For individuals aged >40 years, the lifetime risk for developing HF has been estimated to be approximately 20%.[1,2] The incidence of HF is the highest in population aged >65 years, which has been rapidly growing, ensuring an epidemic of HF that is expected to continue to grow as the population ages.[1,2] According to Boon et al.,[3] the prevalence of HF rises from approximately 1% among patients aged 50 to 59 years to 5 to 10% among those aged 80 to 89 years.

Galectin-3, a member of the galactic family, is a 30 kDa protein. It is an emerging marker of cardiac fibrosis, which is an outcome of HF.[4-6] There is increasing evidence in consensus with the use of plasma galectin-3 as a diagnostic and prognostic biomarker for HF.[6]

Mineralocorticoid receptor antagonists (MRAs), represented by the non-selective agents spironolactone[7] and selective eplerenone[8,9] have been shown to improve survival in patients with symptomatic chronic HF and acute myocardial infarction associated with left ventricular (LV) systolic dysfunction. These clinical benefits have been related to the improvement of LV remodeling and the reduction of cardiac fibrosis.[10,11] Activation of mineralocorticoid receptor promotes myocardial fibrosis, inflammation, cardiomyocyte death, and LV hypertrophy,[12] although the molecular

Corresponding author: Ahmet Barış Durukan, MD. Medical Park Uşak Hastanesi Kalp ve Damar Cerrahisi Bölümü, 64200 Uşak, Türkiye.
Tel: +90 532 - 227 38 14 e-mail: barisdurukan@yahoo.com

Citation:
Göçer H, Durukan AB, Ünal M. Comparison of the metabolic effects of eplerenone and spironolactone via plasma galectin-3 level in patients with heart failure. Cardiovasc Surg Int 2020;7(1):3-7.

mechanisms which specifically underlie their clinical benefits have not been completely elucidated, yet. In addition, spironolactone and eplerenone differ in their molecular structure, pharmacodynamics, and pleiotropic effects;[13,14] however, meaningful differences between the two agents are not clearly present, and clinical practice guidelines do not discriminate between agents while recommending the use of an MRA in this setting.[15,16]

In the present study, we, therefore, aimed to evaluate the differences of plasma galectin-3 levels in patients receiving either eplerenone or spironolactone for the treatment of HF and to assess the effectiveness of these treatments.

PATIENTS AND METHODS

In this prospective study, all patients were selected based on echocardiographic and clinical findings. Eligibility criteria were as follows: having the New York Heart Association (NYHA) functional Class III symptoms, an LV ejection fraction (LVEF) of <30%, and receiving treatment with an angiotensin-converting enzyme (ACE) inhibitor or an angiotensin-receptor blocker and a beta-blocker, furosemide, digoxin (unless contraindicated) at the recommended dose or maximal tolerated dose. Exclusion criteria were renal failure, non-cardiac fluid overload, thyroid disorders, hepatic disorders, or atrial fibrillation. Finally, a total of 20 HF patients (12 males, 8 females; mean age 65.2±7.6 years; range, 58 to 73 years) were included between March 2018 and July 2018. A written informed consent was obtained from each patient. The study protocol was approved by the Ethics Committee of Bicard Clinic of Bishkek, Kyrgyzstan. The study was conducted in accordance with the principles of the Declaration of Helsinki.

The patients were randomized (1:1) to either spironolactone (25 mg/day) or eplerenone (50 mg/day). Ten patients received eplerenone 50 mg/day (Group 1), while the other 10 patients received spironolactone 25 mg/day for four months (Group 2). Blood samples were aseptically collected from each patient at the beginning of treatment and after four months, and plasma was eventually separated for the measurement of plasma galectin-3 using the galectin-3 assay (BG Medicine (BG Medicine Inc., Waltham, MA, USA). This assay quantitatively measures the concentration of human galectin-3 levels in ethylenediaminetetraacetic acid plasma. It has a high sensitivity (lower limit of detection, 1.13 ng/mL) and exhibits no cross-reactivity with collagens or other members of the galectin family. Commonly used HF medications such as ACE inhibitors, beta-blockers, furosemide, acetylsalicylic acid, warfarin, coumarins, and digoxin do not show interference with this assay.[7]

Statistical analysis

Statistical analysis was performed using the IBM SPSS version 22.0 software (IBM Corp., Armonk, NY, USA). Descriptive data were expressed in mean ± standard error of the mean (SEM), median (min-max), or number and frequency. Univariate analysis was performed using the Student's t-test. Categorical data were compared using the chi-square test. A linear regression analysis was used to identify the relationship between continuous variables. A p value of <0.05 was considered statistically significant.

Table 1
Demographic and hemodynamic characteristics of patients

	Eplerenone Group (n=10)	Spironolactone Group (n=10)	
	Mean±SD	Mean±SD	p
Age (year)	65.7±7.7	64.6±7.6	>0.05
Left ventricular ejection fraction (%)	25±4.6	25±4.7	>0.05
Duration of heart failure (year)	5.8±3.4	5.7±3.6	>0.05
Blood pressure systolic (mmHg)	123±17	120±15	>0.05
Blood pressure diastolic (mmHg)	75±10	74±8	>0.05
Plasma galectin-3 level (pg/mL) (before treatment)	898.6±23.4	864.4±28.5	>0.05

SD: Standard deviation.

Table 2
Comparison of Galectin-3 levels

	Before treatment galectin-3 (pg/mL)	After treatment galectin-3 (pg/mL)	
	Mean±SD	Mean±SD	*p*
Group 1 (Eplerenone)	898.6±23.4	99.7±7.9	0.0004
Group 2 (Spironolactone)	864.4±28.5	798±25	0.201
p-value	>0.05	0.001	

SD: Standard deviation.

RESULTS

The mean LVEF of the patients was 25.0±4.6% in the eplerenone group and 25.0±4.7% in the spironolactone group. Demographic and hemodynamic characteristics of the patients including baseline galectin-3 levels were comparable between the groups (Table 1).

In both groups, plasma galectin-3 levels were not significantly different prior to initiation of MRA treatment (p=0.307). In patients receiving eplerenone, the mean plasma galectin-3 levels significantly decreased from 898.6±23.4 to 99.7±7.9 four months after the treatment (p=0.0004). In the spironolactone group, however, galectin-3 levels prior to and after treatment did not change significantly (p=0.201). In patients receiving eplerenone, the mean plasma galectin-3 level was statistically significantly lower than the patients receiving spironolactone four months after the treatment (99.7±7.9 pg/mL vs. 798±25 pg/mL; p=0.001) (Table 2).

DISCUSSION

Biomarkers such as galectin-3 which reflect ongoing remodeling may provide complementary information regarding the natriuretic peptides used in the management of chronic HF with regard to risk stratification for future adverse cardiac events including death, myocardial infarction, and need for heart transplantation.[10] Plasma galectin-3 measurement is cost-effective, readily available, easily interpretable, and suitable for low-income individuals similar to those included in our study.

The physiological importance of spironolactone is indirect regulation of blood volume and blood pressure by sodium retention. However, spironolactone also plays an essential role in the pathogenesis of HF.[17] By antagonizing spironolactone, MRAs can prevent the pathophysiological effects of sodium retention, cardiac hypertrophy, and cardiac fibrosis.[12]

Currently, the success of several MRAs has been already established in HF. First, the Randomized Aldactone Evaluation Study (RALES) trial determined the efficacy of co-therapy with spironolactone in patients with severe HF (LVEF ≤35%) compared to placebo.[18] The primary efficacy end-point was all-cause mortality and secondary endpoints included cardiovascular death and hospitalization and change in the NYHA class. Spironolactone treatment proved to be successful in reducing the risk for all-cause mortality (30% risk reduction) and prespecified secondary outcomes, compared to placebo, regardless of age. Second, The Eplerenone in Patients with Heart Failure Due to Systolic Dysfunction Complicating Acute Myocardial Infarction (EPHESUS) trial investigators investigated the efficacy of eplerenone treatment in addition to optimal treatment in a multi-center, double-blind, randomized trial in patients with LV dysfunction (LVEF ≤40%) after acute myocardial infarction. Treatment with eplerenone led to a reduction of overall mortality (by 15%) and to a reduction of cardiovascular death and hospitalization (by 13%) compared to placebo. The Effect of Eplerenone versus Placebo on Cardiovascular Mortality and Heart Failure Hospitalization in Subjects with NYHA Class II Chronic Systolic Heart Failure (EMPHASIS-HF) trial also investigated the effectiveness of eplerenone in patients with systolic HF (LVEF ≤35%) and mild HF symptoms.[19,20]

In the present study, plasma galectin-3 concentration in clinical groups were identical at the beginning of treatment. Upon randomization, in the eplerenone group, plasma galectin significantly decreased after four months than in patients receiving spironolactone.

In the patients receiving spironolactone, plasma galectin-3 level did not significantly change. Although eplerenone and spironolactone have the same effect on the treatment of HF,[21,22] they have different molecular structures, pharmacodynamics, and pleiotropic effects.[16] Clinical practice guidelines do not specifically discriminate between these two agents for the use of an MRA in this setting.[21,22] There may be slight differences in the MRAs' metabolic activities. We can detect these differences via new emerging biochemical markers, such as galectin-3. In our study, we showed that, there was a significant difference in reducing galectin-3 levels in favor of the eplerenone group. Eplerenone treatment differs from spironolactone in this setting. Although there is no clear discrimination in the clinical practice guidelines so far, we can obtain new data with metabolic studies to clarify the difference of these agents.

The main limitation of our study is its limited sample size. In addition, we were unable to test clinical outcomes. Nevertheless, this study provides evidence regarding the superiority of eplerenone to spironolactone in reducing galectin-3 levels.

In conclusion, our study findings indicate that the metabolic effects of eplerenone are different from those of spironolactone and eplerenone may be superior to spironolactone in the way of metabolic aspect in patients with HF. Additional large-scale studies are still needed to clarify the relationship of eplerenone treatment and plasma galectin-3 levels in adjusting HF treatment.

Declaration of conflicting interests

The authors declared no conflicts of interest with respect to the authorship and/or publication of this article.

Funding

The authors received no financial support for the research and/or authorship of this article.

REFERENCES

1. Frank J. Congestive heart failure and brain natriuretic peptide. PSA Consult 2002;14:4-5.
2. Lloyd-Jones DM. The risk of congestive heart failure: sobering lessons from the Framingham Heart Study. Curr Cardiol Rep 2001;3:184-90.
3. Boon NA, Fox KAA, Bloomfield P, Bradbury A. Cardiovascular disease. In: Haslett C, Chilvers ER, Boon NA, Colledge NR, editors. Davidson's Principles and Practice of Medicine. 19th ed. Edinburgh: Churchill Livingstone; 2002. p. 381-5.
4. Milting H, Ellinghaus P, Seewald M, Cakar H, Bohms B, Kassner A, et al. Plasma biomarkers of myocardial fibrosis and remodeling in terminal heart failure patients supported by mechanical circulatory support devices. J Heart Lung Transplant 2008;27:589-96.
5. Dickstein K, Cohen-Solal A, Filippatos G, McMurray JJ, Ponikowski P, Poole-Wilson PA, et al. ESC Guidelines for the diagnosis and treatment of acute and chronic heart failure 2008: the Task Force for the Diagnosis and Treatment of Acute and Chronic Heart Failure 2008 of the European Society of Cardiology. Developed in collaboration with the Heart Failure Association of the ESC (HFA) and endorsed by the European Society of Intensive Care Medicine (ESICM). Eur Heart J 2008;29:2388-442.
6. de Boer RA, Voors AA, Muntendam P, van Gilst WH, van Veldhuisen DJ. Galectin-3: a novel mediator of heart failure development and progression. Eur J Heart Fail 2009;11:811-7.
7. Yang RY, Rabinovich GA, Liu FT. Galectins: structure, function and therapeutic potential. Expert Rev Mol Med 2008;10:e17.
8. Chen K, Jiang RJ, Wang CQ, Yin ZF, Fan YQ, Cao JT, et al. Predictive value of plasma galectin-3 in patients with chronic heart failure. Eur Rev Med Pharmacol Sci 2013;17:1005-11.
9. Suarez G, Meyerrose G. Heart failure and galectin 3. Ann Transl Med 2014;2:86.
10. Coburn E, Frishman W. Comprehensive review of the prognostic value of galectin-3 in heart failure. Cardiol Rev 2014;22:171-5.
11. Wedel H, McMurray JJ, Lindberg M, Wikstrand J, Cleland JG, Cornel JH, et al. Predictors of fatal and non-fatal outcomes in the Controlled Rosuvastatin Multinational Trial in Heart Failure (CORONA): incremental value of apolipoprotein A-1, high-sensitivity C-reactive peptide and N-terminal pro B-type natriuretic peptide. Eur J Heart Fail 2009;11:281-91.
12. Pitt B, Zannad F, Remme WJ, Cody R, Castaigne A, Perez A, et al. The effect of spironolactone on morbidity and mortality in patients with severe heart failure. Randomized Aldactone Evaluation Study Investigators. N Engl J Med 1999;341:709-17.
13. Pitt B, Remme W, Zannad F, Neaton J, Martinez F, Roniker B, et al. Eplerenone, a selective aldosterone blocker, in patients with left ventricular dysfunction after myocardial infarction. N Engl J Med 2003;348:1309-21.
14. Zannad F, McMurray JJ, Krum H, van Veldhuisen DJ, Swedberg K, Shi H, et al. Eplerenone in patients with systolic heart failure and mild symptoms. N Engl J Med 2011;364:11-21.
15. Zannad F, Alla F, Dousset B, Perez A, Pitt B. Limitation of excessive extracellular matrix turnover may contribute to survival benefit of spironolactone therapy in patients with congestive heart failure: insights from the randomized aldactone evaluation study (RALES). Rales Investigators. Circulation 2000;102:2700-6.

16. Tsutamoto T, Wada A, Maeda K, Mabuchi N, Hayashi M, Tsutsui T, et al. Effect of spironolactone on plasma brain natriuretic peptide and left ventricular remodeling in patients with congestive heart failure. J Am Coll Cardiol 2001;37:1228-33.
17. Weber KT. Aldosterone in congestive heart failure. N Engl J Med 2001;345:1689-97.
18. Zannad F, McMurray JJ, Drexler H, Krum H, van Veldhuisen DJ, Swedberg K, et al. Rationale and design of the Eplerenone in Mild Patients Hospitalization And SurvIval Study in Heart Failure (EMPHASIS-HF). Eur J Heart Fail 2010;12:617-22.
19. Edelmann F, Wachter R, Schmidt AG, Kraigher-Krainer E, Colantonio C, Kamke W, et al. Effect of spironolactone on diastolic function and exercise capacity in patients with heart failure with preserved ejection fraction: the Aldo-DHF randomized controlled trial. JAMA 2013;309:781-91.
20. Pitt B, Pfeffer MA, Assmann SF, Boineau R, Anand IS, Claggett B, et al. Spironolactone for heart failure with preserved ejection fraction. N Engl J Med 2014;370:1383-92.
21. Iqbal J, Parviz Y, Pitt B, Newell-Price J, Al-Mohammad A, Zannad F. Selection of a mineralocorticoid receptor antagonist for patients with hypertension or heart failure. Eur J Heart Fail 2014;16:143-50.
22. McMurray JJ, Adamopoulos S, Anker SD, Auricchio A, Böhm M, Dickstein K, et al. ESC Guidelines for the diagnosis and treatment of acute and chronic heart failure 2012: The Task Force for the Diagnosis and Treatment of Acute and Chronic Heart Failure 2012 of the European Society of Cardiology. Developed in collaboration with the Heart Failure Association (HFA) of the ESC. Eur Heart J 2012;33:1787-847.

Cardiovasc Surg Int 2020;7(1):8-13
http://dx.doi.org/DOI: 10.5606/e-cvsi.2020.760
www.e-cvsi.org

Cardiovascular Surgery and Interventions

Original Article Open Access

Effects of systemic inflammatory response on coronary artery bypass grafting

Nihan Yeşilkaya[1], Orhan Gökalp[1], Hasan İner[1], Yüksel Beşir[1], Hüseyin Durmaz[2], Yaşar Gökkurt[2], İhsan Peker[2], Levent Yılık[1], Ali Gürbüz[1]

[1]Department of Cardiovascular Surgery, Izmir Katip Çelebi University Faculty of Medicine, Izmir, Turkey
[2]Department of Cardiovascular Surgery, Izmir Katip Çelebi University Atatürk Research and Training Hospital, Izmir, Turkey

Received: September 10, 2016 ***Accepted:*** November 08, 2016 ***Published online:*** May 18, 2017

ABSTRACT

Objectives: In this study, we aimed to investigate the effects of systemic inflammatory response syndrome (SIRS) on postoperative results of coronary artery bypass grafting (CABG).

Patients and methods: Between April 2016 and April 2018, a total of 287 patients (203 males, 84 females; mean age 62.5 years; range, 21 to 89 years) who underwent CABG were retrospectively analyzed. Data were collected from the medical records. The diagnosis of SIRS was made according to the criteria used by Boehme.

Results: In total, 83.9% of the patients had postoperative SIRS. Univariate analysis revealed that the predictive factors of SIRS were age, preoperative EuroSCORE, on-pump surgery, and preoperative low hemoglobin levels. However, age was detected as the only predictive factor in the multivariate analysis. The diagnosis of SIRS did not affect hospital mortality, neurological complications or length of hospital stay, whereas it prolonged the weaning period and length of intensive care unit stay.

Conclusion: Our study results show that SIRS has no significant effect on mortality and neurological complications in CABG patients. On the other hand, special attention should be given to the inflammatory response, as it prolongs the weaning period and length of intensive care unit stay.

Keywords: Cardiopulmonary bypass, coronary artery bypass grafting, systemic inflammatory response syndrome.

Coronary artery bypass grafting (CABG) is the conventional therapy of coronary artery disease. This procedure became widespread after Gibbon started to use cardiopulmonary bypass (CPB) machines in 1953.[1] Blood contact with non-endothelial surface triggers systemic inflammation through the secretion of mediators. Systemic inflammation during and after cardiac surgery, more particularly in CABG procedures, is related to the secretion of a large number of mediators and to the activation of certain natural defense mechanisms.[1]

Inflammation is one of the basic parameters that affects postoperative results.[2] The magnitude of the inflammatory reaction varies, although the persistence of any degree of inflammation may be considered potentially harmful to the cardiac patient.[3] In addition, systemic inflammatory response syndrome (SIRS) can lead to pulmonary, renal, gastrointestinal, myocardial, and central nervous system dysfunction as well as coagulopathy, vasoconstriction, increased interstitial fluid, fever, leukocytosis, hemolysis, and an increased susceptibility to infections.[3,4] When CPB is avoided (e.g., off-pump CABG [OPCAB]), however, evidence suggests that activation of inflammation still occurs, but is slightly delayed with respect to on-pump bypass.[4] In the present study, we aimed to evaluate the effects of SIRS on the postoperative results of CABG.

PATIENTS AND METHODS

Between April 2016 and April 2018, a total of 287 patients (203 males, 84 females; mean age 62.5 years; range, 21 to 89 years who underwent CABG were retrospectively analyzed. Medical data including pre-, intra-, and postoperative data of the patients

Corresponding author: Nihan Yeşilkaya, MD. İzmir Katip Çelebi Üniversitesi Tıp Fakültesi Kalp ve Damar Cerrahisi Anabilim Dalı 35620 Çiğli, İzmir, Türkiye. Tel: +90 539 - 643 46 47 e-mail: nihankarakas@gmail.com

Citation:
Yeşilkaya N, Gökalp O, İner H, Beşir Y, Durmaz H, Gökkurt Y, et al. Effects of systemic inflammatory response on coronary artery bypass grafting. Cardiovasc Surg Int 2020;7(1):8-13.

were obtained from the hospital archive department. Patients who underwent emergent surgery or who had concomitant peripheral artery intervention, valve repair/replacement or carotid endarterectomy were excluded. A written informed consent was obtained from each patient. The study protocol was approved by the Izmir Katip Çelebi University Faculty of Medicine Ethics Commitee of Retrospective Studies. The study was conducted in accordance with the principles of the Declaration of Helsinki.

The patients were divided into two groups according to the SIRS status: the SIRS-positive group (n=241) and SIRS-negative group (n=46). The two groups were compared in terms of pre-, intra, and postoperative parameters. The diagnosis of SIRS was made according to the criteria used by Boehme.[5] According to these criteria, at least two of the followings were required: fever >38°C or <36°C, heart rate >90 bpm, respiratory rate >20 bpm or partial pressure of carbon dioxide (pCO_2) <32 mmHg, leucocyte >12×10^3/μL^{-1} or <4×10^3/μL^{-1}.

Statistical analysis

Statistical analysis was performed using the IBM SPSS version 22.0 software (IBM Corp., Armonk, NY, USA). Descriptive data were expressed in mean ± standard deviation (SD), median (min-max) or number and frequency. Categorical data were compared using the Pearson's chi-square and Fisher's exact tests. The Mann-Whitney U test was used for the comparison of the study groups. The correlation between SIRS and demographic and clinical characteristics of the patients was analyzed using univariate and multivariate regression analyses. A *p* value of <0.05 was considered statistically significant.

RESULTS

In terms of preoperative parameters, the mean age and EuroSCORE were higher and the mean preoperative hemoglobin levels were lower in the SIRS group (p<0.001 and p=0.009, respectively). However, there were no statistically significant differences in the other preoperative parameters (Table 1).

Table 1
Pre- and intraoperative data

	SIRS+ (n=241)			SIRS- (n=46)			
	n	%	Mean±SD	n	%	Mean±SD	*p*
Age (year)			64.5±15.9			52.3±16.3	<0.001
Gender							0.114
Female	75	31.1		9	19.6		
Diabetes mellitus	81	33.6		11	23.9		0.197
COPD	13	5.4		2	4.3		0.999
Smoking	100	41.5		21	45.7		0.601
Chronic renal failure	8	3.3		3	6.5		0.392
Hypertension	141	58.5		21	45.7		0.107
Redo surgery	2	0.8		1	2.2		0.410
EuroSCORE			4.1±2.3			2.8±2.4	0.001
Ejection fraction			48.5±11.9			49.7±11.2	0.542
Preoperative hemoglobin			12.3±1.6			13.0±1.8	0.009
Body surface area			1.8±0.2			1.8±0.2	0.177
On-pump surgery	199	82.6		28	60.9		0.001
Intraaortic balloon pump	34	14.1		1	2.2		0.026
CBP time (min)			83.8±31.4			77.4±46.1	0.054
Cross-clamp time (min)			44.3±18.9			43.0±34.0	0.099

SIRS: Systemic inflammatory response syndrome; SD: Standard deviation; COPD: Chronic obstructive pulmonary disease; CPB: Cardiopulmonary bypass.

Table 2
Postoperative data

	SIRS+ (n=241)			SIRS- (n=46)			
	n	%	Mean±SD	n	%	Mean±SD	*p*
Drainage (mL)			585.4±420.8			512.0±238.3	0.510
Blood transfusion (IU)			2.6±2.8			2±1.2	0.791
Revision surgery	25	10.4		5	10.9		0.999
Weaning (h)			13.7±9.4			9.2±3.8	<0.001
ICU length of stay (day)			3.4±2.8			2.5±1.1	0.004
Hospital stay (days)			7.4±4.0			7.6±3.8	0.388
Mortality	22	9.2		2	4.3		0.390
Neurologic complications	6	2.5		0	0		0.594

SIRS: Systemic inflammatory response syndrome; SD: Standard deviation; ICU: Intensive care unit.

In terms of intraoperative data, the use of on-pump surgery and intra-aortic balloon pump (IABP) was statistically significantly higher in the SIRS group (p=0.001 and p=0.026, respectively). On the other hand, there were no statistically significant differences in the cross-clamp and CPB time (Table 1).

In terms of postoperative data, the length of intensive care unit stay and the weaning period were statistically longer in the SIRS group (p<0.001 and p=0.004, respectively). However, there were no statistically significant differences in the incidence of postoperative neurological complications and mortality rates between the groups (Table 2).

Table 3
Univariate logistic regression analysis for predictors of SIRS

	B	SE	Wald	*p*
Age	0.043	0.010	19.105	<0.001
Gender	-0.619	0.397	2.434	0.119
Diabetes mellitus	0.477	0.372	1.646	0.200
COPD	0.227	0.777	0.085	0.771
Smoking	-0.169	0.324	0.274	0.601
Chronic renal failure	-0.709	0.697	1.035	0.309
Hypertension	0.518	0.324	2.562	0.109
Redo surgery	-0.972	1.235	0.620	0.431
EuroSCORE	0.265	0.077	11.858	0.001
Ejection fraction	-0.008	0.014	0.359	0.549
Preoperative hemoglobin	-0.243	0.100	5.871	0.015
Body Surface Area	-0.963	0.860	1.256	0.262
Off-pump CABG	-1.051	0.350	8.997	0.003
On-pump CABG	1.114	0.347	10.329	0.001
CPB time (min)	0.007	0.007	0.939	0.332
Cross-clamp time (min)	0.003	0.010	0.096	0.757

SIRS: systemic inflammatory response syndrome; *B*: Unstandardized beta; SE: Standard error; COPD: Chronic obstructive pulmonary disease; CABG: Coronary artery bypass grafting; CPB: Cardiopulmonary bypass.

Table 4
Multivariate logistic regression analysis for predictors of SIRS

	B	SE	Wald	*p*
Age	0.032	0.012	6.899	0.009
EuroSCORE	0.087	0.091	0.911	0.340
Preoperative hemoglobin	-0.093	0.103	0.818	0.366
Off-pump CABG	0.505	1.199	0.177	0.674
On-pump CABG	1.485	1.180	1.583	0.208
Constant	-0.563	1.912	0.087	0.768

SIRS: systemic inflammatory response syndrome; *B*: Unstandardized beta; SE: Standard error; CABG: Coronary artery bypass grafting.

Table 5
Univariate regression analysis

Dependent variable	Independent variable	*B*	SE	Wald	*p*
Mortality	SIRS	0.802	0.757	1.123	0.289
Neurologic complication		17.535	5926.129	0.000	0.998

B: Unstandardized beta; SE: Standard error; SIRS: Systemic inflammatory response syndrome.

Table 6
Single linear regression analysis

Dependent variable	Independent variable	*B*	SE	β	t	*p*
Weaning period (h)	SIRS	4.500	1.449	0.190	3.105	0.002
Hospital stay (day)		-0.265	0.651	-0.026	-0.408	0.684
ICU stay (day)		0.975	0.423	0.135	2.306	0.022

B: Unstandardized beta; SE: Standard error; SIRS: Systemic inflammatory response syndrome; ICU: Intensive care unit.

Univariate regression analysis was carried out to identify possible variables for SIRS. The analysis revealed that age, EuroSCORE, preoperative low hemoglobin level, and on-pump surgery positively affected SIRS (p<0.001, p=0.001, p=0.015, and p=0.001, respectively). On the contrary, off-pump CABG adversely affected SIRS (p=0.003). The remaining variables were not found to be significant predictors of SIRS (Table 3). Factors which were statistically significant in the univariate analysis were included in the multivariate analysis. Accordingly, age was the only factor which had a significant effect on SIRS prediction (p=0.009) (Table 4). A regression analysis was performed to identify whether SIRS had an effect on the postoperative results, and SIRS was found to have no significant effect on neurological complications or mortality (p=0.998 and p=0.289, respectively) (Table 5). A single linear regression analysis revealed that the length of ICU stay and the weaning period were longer in the patients with SIRS (p=0.022 and p=0.002, respectively) (Table 6).

DISCUSSION

As one of the most common operations, particularly after the introduction of CBP machine, CABG surgery is subject to much interest, as it may lead to prolonged weaning times, increased renal dysfunction, stroke, deep sternal infections, and death.[6] These results are thought to be related to systemic inflammation, which is most probably caused by CBP machines.[7,8] Nevertheless, systemic inflammation which occurs after CABG procedures

is affected by many factors other than CPB machines. Tissue damage, endotoxemia, and contact of blood with non-endothelial surfaces are the main known triggers of SIRS.[9,10]

There are two major ways to investigate SIRS both in cardiac surgery and other fields. One is through the use of laboratory parameters such as tumor necrosis factor or interleukins. The other way is with clinical criteria such as hypotension, hyperthermia, leukocytosis.[5,11] Unfortunately, according to the global studies, the number of patients who develop SIRS after cardiac surgery cannot be neglected. In the study of Sasse et al.,[12] the postoperative SIRS ratio was 39% among the patients undergoing cardiac surgery, including pediatric cases. In another study, MacCallum et al.[13] reported that the postoperative SIRS ratio was 96.2% using clinical parameters for patients in an adult cardiothoracic ICU.[13] We used the same method in our study and the postoperative SIRS ratio was found to be 83.9%.

Although previous studies have investigated the risk factors of SIRS in many settings, only a few have evaluated the risk factors of SIRS after CABG procedures. However, as a major factor affecting postoperative outcomes of patients undergoing CABG, many studies regarding the causes of SIRS and related precautions for its avoidance SIRS are expected. One of these studies was by Ferraris et al.,[14] which revealed a relation between the intraoperative blood use and SIRS. According to their study, intraoperative blood use led to negative changes in the immune system and induced SIRS. The authors also reported that other factors which caused SIRS were low preoperative functional capacity, liver dysfunction, chronic obstructive pulmonary disease, male sex, preoperative steroid therapy, preoperative dialysis history, and age above 74 years. In another study, Sinning et al.[15] investigated the postoperative effects of SIRS on patients undergoing transaortic valve implantation. Their results showed that risk factors for SIRS were the amount of contrast agents used, major bleeding, major vascular trauma, and blood transfusion. In a similar study by Lindmann et al.,[16] 747 patients who underwent aortic valve implantation or transaortic valve implantation were included to investigate the relationship between SIRS and mortality. The authors found that the predictors of SIRS were high preoperative hemoglobin and leucocyte count, cerebrovascular disease, and preoperative dialysis history. Another study examining SIRS in pediatric patients undergoing cardiac surgery in the postoperative period revealed that predictors of SIRS were age, low weight, CPB time, and cross-clamp time.[9] In a study by Güvener et al.,[17] 246 pediatric patients were retrospectively evaluated to identify the effects of SIRS on the postoperative results. The study revealed that predictors of SIRS were CPB time, low weight (<10 kg), and right-to-left shunt before surgery. In the present study, preoperative EuroSCORE, on-pump CABG, and IABP use were found to be SIRS predictors. In contrary to aforementioned studies, CPB time was not found to be among the SIRS predictors. Another factor different from other studies was hemoglobin level, as such we found that low hemoglobin levels, but not high hemoglobin levels, were the predictor of SIRS.

Although it is well-known that SIRS is one of the main reasons for adverse postoperative outcomes after cardiac interventions, only a few studies have addressed into this problem. In one of these studies made by Sinning et al.,[15] 152 patients who underwent transcatheter aortic valve implantation (TAVI) were evaluated to question the effects of SIRS on the postoperative results. According to this study, SIRS affected early postoperative results and postoperative first-year mortality rates; however, it had no effect on postoperative stroke. Güvener et al.[17] also evaluated the effects of SIRS on postoperative results of pediatric cardiac operations and SIRS was found to be a strong predictor of postoperative mortality. As mentioned above, Lindmann et al.[16] evaluated 747 patients undergoing postoperative TAVI in terms of SIRS predictors. Clinical parameters were used in their study and the patients with SIRS had a longer ICU length of stay, more frequent ICU admission, longer hospitalization period, and higher acute renal failure incidence. The authors also found that SIRS had no significant effect on postoperative stroke and mortality in the early postoperative period. Subgroup analysis revealed that SIRS was a predictor of mortality in cardiac patients with diabetes in the postoperative period. In another study, Soares et al.[9] evaluated 101 patients who underwent open heart surgery. It was shown that SIRS prolonged the weaning period and the length of ICU and hospital stay. The authors also reported that SIRS had no significant effect on mortality. Our results are consistent with previous studies. According to the present study, SIRS prolonged the weaning period and the length

of ICU stay; however, it did not increase neurological outcomes or mortality.

The main limitations of the present study are its retrospective design and the evaluation of clinical parameters only, but not proinflammatory markers. Nevertheless, our study is one of the rare studies which address into the relationship between SIRS and CABG.

In conclusion, the relationship between SIRS and CABG outcomes is still an obscure subject to be elucidated. In our study, mean age and EuroSCORE were higher and preoperative hemoglobin levels were lower in patients with SIRS. On-pump surgery and IABP use were also significantly higher in the SIRS group, while the length of ICU stay and the weaning period were significantly longer in the SIRS group. Based on these results, we can speculate that age is the only factor which has a significant effect on SIRS prediction. Although SIRS seems not to have an evident effect on neurological complications or mortality, it may prolong the length of ICU stay and the weaning period. Further prospective, large-scale, randomized-controlled studies are needed to confirm these findings.

Declaration of conflicting interests

The authors declared no conflicts of interest with respect to the authorship and/or publication of this article.

Funding

The authors received no financial support for the research and/or authorship of this article.

REFERENCES

1. Stoney WS. Evolution of cardiopulmonary bypass. Circulation 2009;119:2844-53.
2. Asimakopoulos G. Systemic inflammation and cardiac surgery: an update. Perfusion 2001;16:353-60.
3. Brix-Christensen V. The systemic inflammatory response after cardiac surgery with cardiopulmonary bypass in children. Acta Anaesthesiol Scand 2001;45:671-9.
4. Boyle EM Jr, Pohlman TH, Johnson MC, Verrier ED. Endothelial cell injury in cardiovascular surgery: the systemic inflammatory response. Ann Thorac Surg 1997;63:277-84.
5. Boehme AK, Hays AN, Kicielinski KP, Arora K, Kapoor N, Lyerly MJ, et al. Systemic Inflammatory Response Syndrome and Outcomes in Intracerebral Hemorrhage. Neurocrit Care 2016;25:133-40.
6. Shahian DM, O'Brien SM, Filardo G, Ferraris VA, Haan CK, Rich JB, et al. The Society of Thoracic Surgeons 2008 cardiac surgery risk models: part 1--coronary artery bypass grafting surgery. Ann Thorac Surg 2009;88:S2-22.
7. Brewer R, Theurer PF, Cogan CM, Bell GF, Prager RL, Paone G; Membership of the Michigan Society of Thoracic and Cardiovascular Surgeons. Morbidity but not mortality is decreased after off-pump coronary artery bypass surgery. Ann Thorac Surg 2014;97:831-6.
8. Bicer M, Senturk T, Yanar M, Tutuncu A, Oral AY, Ulukaya E, et al. Effects of off-pump versus on-pump coronary artery bypass grafting: apoptosis, inflammation, and oxidative stress. Heart Surg Forum 2014;17:E271-6.
9. Soares LC, Ribas D, Spring R, Silva JM, Miyague NI. Clinical profile of systemic inflammatory response after pediatric cardiac surgery with cardiopulmonary bypass. Arq Bras Cardiol 2010;94:127-33.
10. Laffey JG, Boylan JF, Cheng DC. The systemic inflammatory response to cardiac surgery: implications for the anesthesiologist. Anesthesiology 2002;97:215-52.
11. Downing SW, Edmunds LH Jr. Release of vasoactive substances during cardiopulmonary bypass. Ann Thorac Surg 1992;54:1236-43.
12. Sasse M, Dziuba F, Jack T, Köditz H, Kaussen T, Bertram H, Beerbaum P, Boehne M. In-line Filtration Decreases Systemic Inflammatory Response Syndrome, Renal and Hematologic Dysfunction in Pediatric Cardiac Intensive Care Patients. Pediatr Cardiol 2015;36:1270-8.
13. MacCallum NS, Finney SJ, Gordon SE, Quinlan GJ, Evans TW. Modified criteria for the systemic inflammatory response syndrome improves their utility following cardiac surgery. Chest 2014;145:1197-203.
14. Ferraris VA, Ballert EQ, Mahan A. The relationship between intraoperative blood transfusion and postoperative systemic inflammatory response syndrome. Am J Surg 2013;205:457-65.
15. Sinning JM, Scheer AC, Adenauer V, Ghanem A, Hammerstingl C, Schueler R, Müller C, Vasa-Nicotera M, Grube E, Nickenig G, Werner N. Systemic inflammatory response syndrome predicts increased mortality in patients after transcatheter aortic valve implantation. Eur Heart J 2012;33:1459-68.
16. Lindman BR, Goldstein JS, Nassif ME, Zajarias A, Novak E, Tibrewala A, et al. Systemic inflammatory response syndrome after transcatheter or surgical aortic valve replacement. Heart 2015;101:537-45.
17. Güvener M, Korun O, Demirtürk OS. Risk factors for systemic inflammatory response after congenital cardiac surgery. J Card Surg 2015;30:92-6.

Cardiovasc Surg Int 2020;7(1):14-19
http://dx.doi.org/DOI: 10.5606/e-cvsi.2020.758
www.e-cvsi.org

Cardiovascular Surgery and Interventions

Original Article Open Access

In which conditions should we insert an intra-aortic balloon pump? In the operating room or intensive care unit?

Hasan İner, Nihan Yeşilkaya, Orhan Gökalp, Yüksel Beşir, Levent Yılık, Ali Gürbüz

Department of Cardiovascular Surgery, Katip Çelebi University Faculty of Medicine, Izmir, Turkey

Received: January 02, 2020 ***Accepted:*** March 17, 2020 ***Published online:*** May 18, 2020

ABSTRACT

Objectives: In this study, we aimed to evaluate complications of intra-aortic balloon pump catheters inserted percutaneously in the operating room versus in the intensive care unit setting.

Patients and methods: Between January 2013 and January 2016, a total of 71 patients (54 males, 17 females; mean age 63.0 years, range, 41 to 84 years) who underwent percutaneous intra-aortic balloon pump insertion in the operating room or in the intensive care unit were retrospectively reviewed. The patients were divided into two groups as Group 1 (n=48) consisting of the patients with intra-aortic balloon pump inserted in the operating room and Group 2 (n=23) consisting of those who underwent intra-aortic balloon pump in the intensive care unit. Both groups were compared in terms of pre- and post-procedural data and the effects of intra-aortic balloon pump insertion performed in the intensive care unit and operating room settings on reproductive pathology results of the catheters were assessed.

Results: The mean pre- and post-procedural platelet counts were significantly higher in Group 2 than Group 1. After the procedure, the incidence of growth only was higher in the cultures collected from the tips of the catheters inserted in the intensive care unit.

Conclusion: Insertion of intra-aortic balloon pump catheters in the operating room is more secure than the catheters inserted in the intensive care unit in terms of catheter infections. Therefore, in patients who are scheduled for intra-aortic balloon pump support in the intensive care unit setting, this procedure should be considered to be performed under operating room conditions, if the mobility of the patient is ensured.

Keywords: Complication, infection, intra-aortic balloon pump.

Although cardiogenic shock following cardiac surgery is less than 1%, it is associated with a high rate of mortality.[1] Low blood outflow and ischemia in organs can be prevented with mechanical support where dramatic responses to pharmacological therapy cannot be obtained during this critical period.[2]

Intra-aortic balloon pump (IABP) support is the first invasive treatment option in cases of post-cardiotomy syndrome in which low outflow syndrome or cardiogenic shock predominate. These pumps are inserted percutaneously or surgically during the pre-, intra-, or postoperative period in the intensive care unit (ICU) or operating room (OR) setting. The rate of complication may vary depending on the surgically or percutaneously insertion of IABP in OR or ICU setting.

In the present study, we aimed to evaluate complications of IABP catheters inserted percutaneously in the OR versus in the ICU setting.

PATIENTS AND METHODS

Between January 2013 and January 2016, a total of 71 patients (54 males, 17 females; mean age 63.0 years, range, 41 to 84 years) who underwent percutaneous IABP insertion in the OR or in the ICU were retrospectively reviewed. Data were retrieved from the hospital registry system. The indication of IABP insertion was post-cardiotomy cardiogenic shock. Exclusion criteria were as follows: patients with contamination suspicion while taking catheter tip samples for culture. A written informed consent was obtained from each patient. The study protocol was

Corresponding author: Hasan İner, MD. Katip Çelebi Üniversitesi Tıp Fakültesi Kalp ve Damar Cerrahisi Anabilim Dalı, 35620 Çiğli, İzmir, Turkey.
Tel: +90 553 - 132 51 10 e-mail: hasan_iner@hotmail.com

Citation:
İner H, Yeşilkaya N, Gökalp O, Beşir Y, Yılık L, Gürbüz A. In which conditions should we insert an intra-aortic balloon pump? In the operating room or intensive care unit?. Cardiovasc Surg Int 2020;7(1):14-19.

approved by the Katip Çelebi University Faculty of Medicine Ethics Committee. The study was conducted in accordance with the principles of the Declaration of Helsinki.

The study population consisted of patients under medical follow-up in the ICU as candidates for open heart surgery and undergoing open heart surgery. The patients were divided into two groups as Group 1 (n=48) consisting of the patients with IABP inserted in the OR and Group 2 (n=23) consisting of those who underwent IABP in the ICU. Data including baseline demographic and clinical characteristics of the patients, and intra- and postoperative findings were recorded. Both groups were compared in terms of complications and microbiological growth pathologies of the tips of the balloon catheters.

The patients were diagnosed with systemic inflammatory response syndrome (SIRS) in the postoperative period based on the 2001 SCCM/ESICM/ACCP/ATS/SIS International Sepsis Definitions Conference criteria. Accordingly, the presence of at least two of the following data was considered as SIRS: body temperature >38°C or <36°C, pulse >90/min, respiratory rate >20/min or partial pressure of carbon dioxide <32 mmHg, and leukocyte count >12,000 μL^{-1} or <4,000 μL^{-1}.[4]

The IABP catheters were removed under aseptic conditions in patients who did not require clinical IABP support and the catheter tips were sent to the

Table 1
Pre- and intraoperative data of study population

	Group 1 (n=48)				Group 2 (n=23)				
	n	%	Mean±SD	Median	n	%	Mean±SD	Median	*p*
Age (year)			63.1±9.8	62.5			64.4±8.2	65.0	0.588*
Gender									0.138**
Male	39	81.3			15	65.2			
Female	9	18.8			8	34.8			
Diabetes mellitus	20	41.7			10	43.5			0.885**
COPD	12	25			13	43.7			0.009**
Smoking	34	70.8			16	69.6			0.913**
Hypertension	38	79.2			19	82.6			0.733**
Cerebrovascular events	3	6.3			1	4.3			0.745**
Peripheral arterial disease	16	33.3			8	34.8			0.904**
Ejection fraction			47.1±12.5	50			46.5±13.5	45	0.920†
EuroSCORE			5.5±2.2	6			5.7±2.7	5.5	0.867†
Body surface area			1.8±0.2	1.8			1.79±0.2	1.8	0.197†
Preoperative Hb (g/dL)			12.9±2.2	12.9			11.8±1.9	11.4	0.062†
Postoperative Hb (g/dL)			9.6±1.6	9.3			9.4±1.6	9.1	0.540†
Preoperative WBC ($\times 10^3$)			7.7±2.9	7.8			8.7±4.0	8.5	0.217†
Postoperative WBC ($\times 10^3$) (K/uL)			15.8±5.7	16.0			18.8±5.6	19.6	0.049†
Pre-IABP PLT ($\times 10^3$) (K/uL)			235±74.3	227.5			251.6±86.2	249.0	0.531†
Post-IABP PLT ($\times 10^3$) (K/uL)			101.3±62.9	92.0			135.4±85.1	115.0	0.045†
Preoperative creatinine (mg/dL)			1.0±0.3	0.9			1.3±0.7	1.0	0.366†
Postoperative creatinine (mg/dL)			1.8±0.9	1.6			2.2±1.2	2.1	0.353†
Cross-clamping time (min.)			117.9±66.3	105.0			100.2±37.1	94.5	0.446†
CPB time (min.)			59.6±31.0	51.0			53.0±29.6	55.0	0.758†

SD: Standard deviation; * T test; ** Chi square (Fischer test); † Mann-Whitney U test; COPD: Chronic obstructive pulmonary disease; Hb: Hemoglobin; WBC: White blood cell; PLT: Platelet; IABP: Intra-aortic balloon pump; CPB: Cardiopulmonary bypass.

microbiology laboratory to compare microbiological growth pathologies in sterile conditions. The same procedure was also applied to the IABP catheters of patients who died. Culture results were obtained under monitoring.

Statistical analysis

Statistical analysis was performed using the IBM SPSS version 22.0 software (IBM Corp., Armonk, NY, USA). Descriptive data were expressed in mean ± standard deviation (SD), median (min-max), or number and frequency. The distribution of the variables was measured using the Kolmogorov-Smirnov test. The independent sample t-test and Mann-Whitney U test were used in the analysis of quantitative independent data. The chi-square test was used to analyze qualitative independent data, and the Fisher's test was used, when the chi-square test conditions were not met. A p value of <0.05 was considered statistically significant.

RESULTS

There was no significant difference in the baseline demographic and clinical characteristics including age, gender, body surface area, ejection fraction, rate of smoking, incidence of hypertension, diabetes mellitus, cerebrovascular events, and peripheral artery disease between the groups (p>0.05). In Group 2, however, the incidence of chronic obstructive pulmonary disease (COPD) was significantly higher than Group 1 (p<0.05) (Table 1). Of the patients included in the study, 19 (39.6%) in Group 1 and 13 (56.5%) in Group 2 died, indicating no statistically significant difference between the groups (Table 1).

According to the results of laboratory tests, the mean platelet count and leukocyte count were significantly higher after the termination of IABP in the patients who underwent IABP insertion in the ICU than the patients who received IABP in the OR (p<0.05). No significant difference was found in the other laboratory test results between Group 1 and Group 2 (Table 1).

There was no significant difference in the intraoperative data between the groups (Table 1). However, after the termination of IABP, the culture positivity rate was found to be significantly higher in the patients who underwent insertion in the ICU compared to those who received IABP in the OR (p<0.05) (Table 2). Although there was a significant difference in the culture results, the positivity of SIRS, the use of antibiotics and high body temperature (>38°C) did not differ between the groups. There was also no significant difference in the duration of mechanical ventilation and ICU stay between Group 1 and 2.

DISCUSSION

Intra-aortic balloon pump is the most commonly used device which is easy to access, easy to implement, inexpensive, and still the most widely used device which increases myocardial supply and demand balance, by improving myocardial performance.[5] However, several complications may be seen due

Table 2
Postoperative data after the termination of IABP

	Group 1 (n=48)			Group 2 (n=23)			
	n	%	Mean±SD	n	%	Mean±SD	p
Culture outcome (+)	11	22.9		11	47.8		0.034
Patients using antibiotics	29	60.4		11	47.8		0.317
Temperature >38°C	29	60.4		13	56.5		0.755
SIRS (+)	32	66.7		19	82.6		0.162
IABP complication (+)	4	8.3		1	4.3		1.000
Duration of extubation (h)			32.9±44.7			29.9±19.8	0.192
Duration of intensive care (h)			12.4±12.9			9.8±9.7	0.416
Mortality	19	39.6		13	56.5		0.179

IABP: Intra-aortic balloon pump; SD: Standard deviation; SIRS: Systemic inflammatory response syndrome.

to its widespread use. These complications include vascular complications, balloon-related complications, and infections. Vascular complications include lower extremity ischemia, peripheral thrombosis and embolism, vasospasm which may result from local vascular damage during insertion of the catheter, hematoma, pseudoaneurysm, arteriovenous fistula, major vessel injury with mechanical effect of the catheter, aortic dissection, spinal cord ischemia, and malperfusion of visceral organs. Balloon-related complications include dislocation or migration of the balloon, balloon rupture which may lead to gas embolization, anemia, and thrombocytopenia resulting from trauma to erythrocytes and platelets with mechanical effect. In addition, IABP catheter-related local wound infections and systemic infections among the rare complications which should be kept in mind.[6,8-12] In the literature, IABP complications are similar to those reported in our study population. Among the patients with IABP inserted in the OR, critical leg ischemia was observed in two patients and retroperitoneal hematoma due to vascular trauma in one patient. In addition, local wound infection was observed in one patient in each group, and was taken under control with antibiotherapy without any need for surgical debridement.

In the vast majority of patients with IABP inserted, laboratory investigations yield abnormalities.[13,14] Inflation and deflation in the balloon catheter with the mechanical effect cause trauma to platelets and erythrocytes. This situation manifests as thrombocytopenia and anemia. Studies conducted by Bream-Rouwenhorst et al.[14] and McCabe et al.[13] demonstrated that the most common side effect of IABP was thrombocytopenia, which was reported in 47 to 82% of patients. Similar results were also obtained in our study. Thrombocytopenia was observed in 85.7% of the patients 24 hours after the procedure. Furthermore, when the patients who received IABP in the OR and those who received IABP in the ICU were compared, the relative decrease in the platelet counts was statistically significantly higher in the in patients undergoing IABP in the OR setting ($p<0.005$). This difference, undoubtedly, is largely due to the exposure of cardiopulmonary bypass during open heart surgery. In addition, nine patients (18.7%) in Group 1 underwent mediastinal re-exploration due to bleeding revision and eight (88.9%) of these patients had thrombocytopenia. Therefore, it should be kept in mind that thrombocytopenia may cause redo surgery and an increased amount of blood transfusion due to postoperative bleeding in patients undergoing open heart surgery and it may further complicate the clinical picture of patient.

When used at an early stage and timely in an appropriate location and in a proper way, IABP assists both the patient and the surgical team. Therefore, mortality and morbidities, length of stay in the ICU, duration of mechanical ventilation, and location and timing of IABP application have been repeatedly investigated and the discrepancies among the studies have been a subject of many clinical studies. In a study, Torchiana et al.[15] classified the location of IABP insertion as medical intensive care, surgical intensive care, and OR and included these locations in the multivariate analysis for mortality predictors. The authors reported that early decision for IABP insertion and performing percutaneous IABP insertion in the preoperative ICU setting reduced mortality. In parallel with this finding, Christenson et al.[16] and Metz et al.[17] also found more promising results in terms of mortality, duration of mechanical ventilation, and length of stay in the ICU in patients with IABP inserted preoperatively in the ICU. In our study, the mean length of stay in the ICU in the patients with IABP inserted was found to be 7.5 days in Group 1 and 7 days in Group 2, indicating no statistically significant difference. Also, there was no statistically significant difference in the total duration of mechanical ventilation between the groups. The rate of mortality was found to be 39.6% in Group 1 and 56.5% in Group 2.

Nosocomial infections seen in patients followed with IABP are rarely associated with the IABP catheter alone. Since patients subjected to IABP support usually have more than one monitoring lines in addition to the balloon pump, it should be kept in mind that the presence of these lines is an additional factor in the frequency of fever and bacteremia. Review of the literature reveals the increased incidence of nosocomial infections in patients with IABP insertion.[10,11] In the studies by Beckman et al.[12] and McCabe et al.[13] evaluating the complications of IABP, the incidence of local wound site infection was found to be 2.2 to 5%. In a study by Pawar et al.[18] including 136 patients with IABPs inserted, the most common systemic infection resulted from the respiratory system and this was attributed to the increased incidence of atelectasis and superinfection in patients who were unable to be mobilized while under the support of IABP. In another

study by Goldberg et al.[19] with 101 patients comparing percutaneous and surgical techniques, the rates of local (2%) and systemic (4%) infections were found to be higher in patients undergoing the surgical method. In many studies conducted, it has been demonstrated that the frequency of infections associated with IABP was directly proportional to the duration of IABP therapy and it has been suggested that the IABP catheter as well as all invasive lines should be removed as soon as possible to avoid this complication. In our study, local wound infection was observed in the femoral region where the IABP catheter was applied in one patient in each group, and this was controlled with proper antibiotherapy without any need for surgical debridement. Although no significant difference was found between the groups in terms of fever and the use of antibiotics, pathogens were isolated in the catheter tips sent to the laboratory in 11 patients (22.9%) from Group 1 and 11 patients (47.8%) from Group 2, which was found to be statistically significant (p=0.034). It is clear that the main reason for this result is the sterile environment provided by the operative conditions in the patients where the insertion was performed in the OR. Although IABP catheters were inserted in the ICU conditions under aseptic conditions, the results indicate that these efforts are not as reliable as those of the OR conditions.

The limitations of this study are its retrospective design and small sample size. On the other hand, the fact that makes our study valuable is the microbiological assessment of pathological growth in the samples collected from the catheter tips after termination of IABP therapy which was performed using the same technique in the ICU or in the OR after the termination of IABP treatment. To the best of our knowledge, this is the first study in this regard in the literature.

In conclusion, in our study, complications of intra-aortic balloon pump application, which has been increasingly used due to the ease of use and relatively low cost in low cardiac output syndrome, were examined in great detail. However, it is noteworthy that significant differences were found in the outcomes of catheter cultures, although strict asepsis was followed in our intensive care unit and the experience of the team which performed the insertion procedures and undertook care of the patients. Therefore, to reduce infective complications of intra-aortic balloon pump, all intra-aortic balloon pump catheters can be considered to be inserted in the operating rooms setting. Nonetheless, further large-scale, prospective, randomized-controlled studies are warranted to gain a better understanding on this topic.

Declaration of conflicting interests

The authors declared no conflicts of interest with respect to the authorship and/or publication of this article.

Funding

The authors received no financial support for the research and/or authorship of this article.

REFERENCES

1. Li CL, Wang H, Jia M, Ma N, Meng X, Hou XT. The early dynamic behavior of lactate is linked to mortality in postcardiotomy patients with extracorporeal membrane oxygenation support: A retrospective observational study. J Thorac Cardiovasc Surg 2015;149:1445-50.
2. Koprivanac M, Kelava M, Soltesz E, Smedira N, Kapadia S, Brzezinski A, et al. Advances in temporary mechanical support for treatment of cardiogenic shock. Expert Rev Med Devices 2015;12:689-702.
3. Güler A, Kadan M, Cingöz F, Arslan Z, İyisoy A, Güler L. Postkardiyotomi sendromunda impella ventrikül destek cihazı kullanımı. Pam Tıp Derg 2011;4:112-5.
4. Boehme AK, Hays AN, Kicielinski KP, Arora K, Kapoor N, Lyerly MJ, Gadpaille A, Shiue H, Albright K, Miller D, Elkind MS, Harrigan MR. Systemic Inflammatory Response Syndrome and Outcomes in Intracerebral Hemorrhage. Neurocrit Care 2016;25:133-40.
5. Küçükaksu DS, Şener E, Taşdemir O. Kalp Transplantasyonuna Mekanik Sistemlerle Köprüleme: Hasta ve Cihaz Seçimi. Türk Gö¬ğüs Kalp Damar Cer Derg 2002;10:190-200.
6. Ferguson JJ 3rd, Cohen M, Freedman RJ Jr, Stone GW, Miller MF, Joseph DL, et al. The current practice of intra-aortic balloon counterpulsation: results from the Benchmark Registry. J Am Coll Cardiol 2001;38:1456-62.
7. Alderman JD, Gabliani GI, McCabe CH, Brewer CC, Lorell BH, Pasternak RC, et al. Incidence and management of limb ischemia with percutaneous wire-guided intraaortic balloon catheters. J Am Coll Cardiol 1987;9:524-30.
8. Lazar HL, Bao Y, Rivers S, Treanor PR, Shemin RJ. Decreased incidence of arterial thrombosis using heparin-bonded intraaortic balloons. Ann Thorac Surg 1999;67:446-9.
9. Kogan A, Preisman S, Sternik L, Orlov B, Spiegelstein D, Hod H, et al. Heparin-free management of intra-aortic balloon pump after cardiac surgery. J Card Surg 2012;27:434-7.
10. Olsen MA, Lock-Buckley P, Hopkins D, Polish LB, Sundt TM, Fraser VJ. The risk factors for deep and superficial chest surgical-site infections after coronary artery bypass graft surgery are different. J Thorac Cardiovasc Surg 2002;124:136-45.

11. Aksnes J, Abdelnoor M, Berge V, Fjeld NB. Risk factors of septicemia and perioperative myocardial infarction in a cohort of patients supported with intra-aortic balloon pump (IABP) in the course of open heart surgery. Eur J Cardiothorac Surg 1993;7:153-7.
12. Beckman CB, Geha AS, Hammond GL, Baue AE. Results and complications of intraaortic balloon counterpulsation. Ann Thorac Surg 1977;24:550-9.
13. McCabe JC, Abel RM, Subramanian VA, Guy WA Jr. Complications of intra-aortic balloon insertion and counterpulsation. Circulation 1978;57:769-73.
14. Bream-Rouwenhorst HR, Hobbs RA, Horwitz PA. Thrombocytopenia in patients treated with heparin, combination antiplatelet therapy, and intra-aortic balloon pump counterpulsation. J Interv Cardiol 2008;21:350-6.
15. Torchiana DF, Hirsch G, Buckley MJ, Hahn C, Allyn JW, Akins CW, et al. Intraaortic balloon pumping for cardiac support: trends in practice and outcome, 1968 to 1995. J Thorac Cardiovasc Surg 1997;113:758-64.
16. Christenson JT, Badel P, Simonet F, Schmuziger M. Preoperative intraaortic balloon pump enhances cardiac performance and improves the outcome of redo CABG. Ann Thorac Surg 1997;64:1237-44.
17. Metz D, Stiller M, Silber RE, Kroll H, Hofmann HS, Diez C. Prophylaktische intraaortale Ballongegenpulsation bei herzchirurgischen Hochrisikopatienten Prophylactic intraaortic balloon pumping in high-risk cardiac surgery patients. Med Klin Intensivmed Notfmed 2011;106:125-31.
18. Pawar M, Mehta Y, Ansari A, Nair R, Trehan N. Nosocomial infections and balloon counterpulsation: risk factors and outcome. Asian Cardiovasc Thorac Ann 2005;13:316-20.
19. Goldberg MJ, Rubenfire M, Kantrowitz A, Goodman G, Freed PS, Hallen L, et al. Intraaortic balloon pump insertion: a randomized study comparing percutaneous and surgical techniques. J Am Coll Cardiol 1987;9:515-23.

Cardiovasc Surg Int 2020;7(1):20-29
http://dx.doi.org/DOI: 10.5606/e-cvsi.2020.754
www.e-cvsi.org

Cardiovascular Surgery and Interventions

Original Article Open Access

Comparison of early treatment outcomes after aortic valve replacement with sutureless, bioprosthetic, and mechanical valves: Our single-center experience with 140 patients

Gökhan İlhan[1], Şahin Bozok[2], Mustafa Çağdaş Çayır[3], Nebiye Tüfekçi[4], Şeref Alp Küçüker[5]

[1]Department of Cardiovascular Surgery, Muğla Sıtkı Koçman University, Training and Research Hospital, Muğla, Turkey
[2]Department of Cardiovascular Surgery, Uşak University Faculty of Medicine, Uşak, Turkey
[3]Department of Cardiovascular Surgery, Pamukkale University Faculty of Medicine, Denizli, Turkey
[4]Department of Cardiovascular Surgery, Yıldırım Beyazıt University, Yenimahalle Training and Research Hospital, Ankara, Turkey
[5]Department of Cardiovascular Surgery, Ankara City Hospital, Ankara, Turkey

Received: December 20, 2019 ***Accepted:*** March 09, 2020 ***Published online:*** May 18, 2020

ABSTRACT

Objectives: The aim of the present study was to comparatively assess the perioperative findings and early therapeutic outcomes in patients who underwent aortic valve replacement (AVR) with sutureless, bioprosthetic, and mechanical valves.

Patients and methods: This prospective cohort included a total of 140 patients (78 males, 62 females; mean age 68.5 years range, 36 to 82 years) who underwent AVR in the cardiovascular surgery department of a tertiary care center between January 2013 and September 2016. The patients were divided into three groups according to the valve implanted: sutureless (Group 1, n=48), bioprosthetic (Group 2, n=44), and mechanical (Group 3, n=48) valve groups. Baseline demographic and clinical characteristics, comorbidities, pre- and postoperative echocardiographic findings, hemodynamic parameters, additional interventions, complications, and early therapeutic outcomes were recorded in three patient groups.

Results: Ejection fraction was significantly lower (p=0.026) and the New York Heart Association functional class was significantly higher (p=0.002) in the sutureless valve group. Duration of operation, cross-clamp time, and duration of cardiopulmonary bypass were significantly shorter in the sutureless valve group (p<0.001 for all). Duration of intubation, the amount of erythrocyte suspension transfusion and drainage, and the length of hospitalization and intensive care unit stay were shorter in the sutureless valve group (p<0.001). Comparison of pre- and postoperative echocardiographic findings within each group revealed that maximum and mean aortic gradients were improved in three groups after the operation. However, there was no statistically significant difference in ejection fraction and pulmonary arterial pressure postoperatively among the groups.

Conclusion: Based on our study findings, we conclude that selection of the valves before AVR procedure must be made according to the characteristics of the patient including comorbidities and hemodynamic profile.

Keywords: Aortic valve, bioprosthesis, sutureless, transcatheter aortic valve replacement.

Increased life expectancy of the overall population led to an increase in the prevalence of patients with valvular heart disease suitable for aortic valve replacement (AVR). Surgical replacement of the aortic valve constitutes the most effective mode of treatment in patients with severe symptomatic aortic stenosis.[1,2] Replacement of the valve not only improves the systolic and diastolic functions of the left ventricle, but also leads to improved clinical outcomes.[3-5]

The increased incidence of aortic stenosis is currently associated with substantial co-morbidities. Aortic valve replacement has been popularized to avoid risks related to aortic stenosis. For this purpose, various techniques and alternative options have been developed for aortic valve surgery. The seek for minimally invasive methods with reduction of surgical trauma, as well as increased cost-efficacy has been sustained. In addition to the mechanical valve and bioprosthetic valves, sutureless valves have been introduced to eliminate the risks associated with the placement of sutures and to reduce cross-clamp and cardiopulmonary bypass (CPB) duration.[4,6] The use

Corresponding author: Şahin Bozok, MD. Uşak Üniversitesi Tıp Fakültesi Kalp ve Damar Cerrahisi Anabilim Dalı, 64000 Uşak, Turkey.
Tel: +90 533 - 236 24 42 e-mail: sahinboz@yahoo.com

Citation:
İlhan G, Bozok Ş, Çayır MÇ, Tüfekçi N, Küçüker ŞA. Comparison of early treatment outcomes after aortic valve replacement with sutureless, bioprosthetic, and mechanical valves: Our single-center experience with 140 patients. Cardiovasc Surg Int 2020;7(1):20-29.

of different valve materials may provide advantages such as enhancement of complex cardiac procedures, maintenance of sufficient hemodynamic parameters, and a decrease in paravalvular leak.[6]

The choice of the appropriate valve prosthesis in patients with severe and symptomatic aortic stenosis is still under debate. The therapeutic policy should be based on the growth potential which restricts the number of interventions. Mechanical prostheses have superior durability over tissue prostheses, particularly in adolescents; however, they lack the growth potential.[7]

Aortic valve replacement using bioprosthetic materials is the method of choice in elderly. This modality yields satisfactory hemodynamic outcomes and postoperative durability devoid of complications attributed to warfarin.[2] Nevertheless, additional data are still necessary to compare and document the therapeutic efficacy of AVR procedures with different valves.[6]

Selection of the appropriate valve may improve the quality of life with acceptable safety and avoidance of complications such as pacemaker implantation, paravalvular leaks, and increased neurological events.[8]

In the present study, we aimed to comparatively assess the hemodynamic variables, perioperative findings, and early therapeutic outcomes in aortic stenosis patients who underwent AVR with sutureless, bioprosthetic, or mechanical valves.

PATIENTS AND METHODS

This prospective cohort was conducted in the Cardiovascular Surgery Department of Recep Tayyip Erdoğan University, Training and Research Hospital between January 2013 and September 2016. A total of 140 patients (78 males, 62 females; mean age 68.5 years range, 36 to 82 years) who underwent AVR for aortic stenosis were included. All patients were operated by a single surgical team. Inclusion criteria were as follows: having a scheduled surgical valve replacement with severe and symptomatic aortic valve disease, and New York Heart Association (NYHA) functional Class ≥2. The study was conducted in accordance with the principles of the Declaration of Helsinki.

The patients were divided into three groups according to the valve implanted: sutureless (Group 1, n=48), bioprosthetic (Group 2, n=44), and mechanical (Group 3, n=48) valve groups. Data including baseline demographic and clinical characteristics, comorbidities, pre- and postoperative echocardiographic findings, hemodynamic parameters, additional interventions, complications, and early therapeutic outcomes were recorded in three groups. The selection of the valves was made according to the optimal effective orifice area regarding the body surface area for every patient. The types and sizes of valves used in three groups of our series are listed in Table 1. The Enable® (Medtronic Inc., MN, USA), Perceval S® (SorinBiomedica Cardio Srl, Sallugia, Italy), Edwards Intuity® (Edwards Lifesccience Inc., CA, USA), St. Jude mechanical valve® (St. Jude Medical Inc., MN, USA), Vascutek® (Vascutek, Scotland, UK), and ATS mechanical valves (Medtronic Inc., MN, USA) were the valves mainly preferred in the current series. Sutureless valves were particularly popularized in patients with a high operative risk and candidates for additional surgical procedures.

All operations were carried out by a single cardiovascular surgeon in our tertiary care center. After induction of general anesthesia and orotracheal intubation, patients were kept on CPB following a thorough sternotomy. For myocardial protection, antegrade and retrograde administration of cold crystalloid cardioplegic solution (Plegisol®, Abbott Laboratories, Abbott Park, IL, USA) was performed during induction. Maintenance of this regimen was provided with the retrograde administration of cold blood cardioplegic doses every 20 min.

The patients were maintained on conventional CPB circuit with a roller pump. Antegrade potassium chloride-added Calafiore solution (Politecnico di Torino, Italy) was administered for myocardial protection. When necessary, it was repeated during the intervention through the left and right coronary artery orifices.

Surgical procedures for AVR with different types of valves were performed as described in the current literature.[3-5] Transesophageal echocardiography was implemented to assess the structural and functional cardiac parameters before AVR and at discharge.

Baseline characteristics (age, gender), body surface area, smoking habit, history of hypertension, diabetes mellitus, cerebrovascular disease, carotid artery disease, chronic obstructive pulmonary disease, and renal failure were noted. Pre- and postoperative

Table 1
The types and sizes of valves used in sutureless, bioprosthetic, and mechanical valve groups

Valve types								
Sutureless (n=48)			Bioprosthetic (n=44)			Mechanical (n=48)		
Type	Size (mm)	n	Type	Size (mm)	n	Type	Size (mm)	n
Edwards Intuity®	21	14	Carpentier Edwards® supraannular valve (Labcor)	19	2	St. Jude® Aortic mechanical HP	19	1
	23	12		23	6		21	2
Sorin Perceval S®	S (21)	8		25	1		23	3
	M (23)	8	Sorin Mitroflow® aortic bioprosthetic valve	19	2		25	4
	L (25)	3		21	8	St. Jude Aortic Regent® mechanical valve	21	5
Enable®	23	2		23	7		23	7
	25	1		25	1		25	1
			Carpentier Edwards® perimount bioprosthesis	19	2	ATS® mechanical valve	22	7
				21	6		24	7
				23	5	Sorin Bileaflet® mechanical valve	21	3
			St. Jude® Aortic Epic valve	25	1		23	6
			St. Jude® Aortic Trifecta bioprosthesis	19	1		25	1
			Vascutek Aspire® bioprosthetic valve	21	1		27	1

hemodynamic variables, and intraoperative findings were recorded and compared among the groups. Postoperative alterations in echocardiographic and other hemodynamic indicators following surgery were also investigated six months after AVR. The mean and maximum aortic gradient, thicknesses of the interventricular septum and posterior wall, ejection fraction, presences of mitral, aortic and tricuspid insufficiency, pulmonary arterial pressure, left ventricular end systolic and diastolic diameters, aortic root diameter, and ascending aorta diameter on echocardiography were recorded before and after the operation. The NYHA and EuroSCORE results were comparatively analyzed. Intraoperative parameters evaluated included operation time, cross-clamp time, coronary artery bypass grafting (CABG), ascending aorta surgery, root enlargement procedure, intubation time, inotropic agent use, amount of drainage and erythrocyte suspension transfusion, and length of intensive care unit stay and hospitalization.

Statistical analysis

Statistical analysis was performed using the IBM SPSS version 20.0 software (IBM Corp., Armonk, NY, USA). Descriptive data were expressed in mean ± standard deviation (SD), median (min-max) or number and frequency. Normality of distribution for variables was tested using the Shapiro-Wilk test. Parametric tests were used for variables with normal distribution, while variables without a normal distribution were evaluated with non-parametric tests. Analysis of variance (ANOVA) (post-hoc Tamhane) and Kruskal-Wallis tests were used for the analysis of data. The Bonferroni-corrected Mann-Whitney U test was carried out to examine the origin of difference among the groups. A paired t-test and Wilcoxon test were performed to compare the parameters within each group before and after surgery. A p value of <0.05 was considered statistically significant with 95% confidence interval (CI).

Table 2
Baseline demographic and clinical characteristics of study population

Variable	Groups: Sutureless Mean±SD	Bioprosthetic Mean±SD	Mechanical Mean±SD	KW χ^2	*p*
Age (year)	76.3±2.8	73.6±2.7	55.7±9.7*	55.83	<0.0001
Body surface area	1.8±0.3	1.7±0.7	1.8±0.7	2.30	0.316
Ejection fraction (%)	52.4±12.0	57.1±11.1	61.1±6.7	7.34	0.026*
New York Heart Association	3.4±0.5	2.6±0.6	2.7±0.7	12.77	0.002*
EuroSCORE	9.7±2.2	7.2±2.4	3.9±1.6	32.11	<0.0001*

SD: Standard deviation; * Statistically significant; KW χ^2: Kruskal Wallis χ^2; ANOVA has been used for age, while other variables were tested with Kruskal Wallis χ^2.

RESULTS

Table 2 demonstrates a comparison of baseline descriptive and clinical parameters in our series. The patients receiving mechanical valve during AVR were significantly younger than the other groups (p<0.001). Ejection fraction of the patients in the sutureless vale group was significantly lower than the patients who had a mechanical valve during AVR (p=0.026). The NYHA class for sutureless valve group was significantly higher than the other groups (p=0.002). In addition, all three groups had significantly different EuroSCORE results. Accordingly, the sutureless valve group had the highest scores, whereas the mechanical valve group had the lowest EuroSCORE results.

Perioperative data are presented in Table 3. Accordingly, duration of operation, cross-clamp time, and duration of CPB were significantly shorter in the sutureless valve group (p<0.001 for all). Similarly, duration of intubation, amounts of erythrocyte suspension transfusion and drainage, and the length of hospitalization and intensive care unit stay were shorter in the sutureless valve group (p<0.001).

Echocardiographic findings obtained pre- and postoperatively are summarized in Tables 4 and 5. Additional procedures performed in three groups are shown in Table 6. Comparison of pre- and postoperative echocardiographic findings within each group revealed that the maximum and mean aortic

Table 3
Perioperative data of study population

Variable	Groups: Sutureless Mean±SD	Bioprosthetic Mean±SD	Mechanical Mean±SD	KW χ^2	*p*
Duration of operation (minutes)	172.9±30.6	242.9±13.8	235.6±29.6	24.60	<0.0001*
Cardiopulmonary bypass time (minutes)	79.2±21.1	148.4±10.4	139.8±28.9	29.31	<0.0001*
Cross-clamp time (minutes)	57.8±19.9	94.8±11.4	91.6±17.1	20.64	<0.0001*
Intubation time (hours)	6.2±2.2	9.6±3.4	9.4±2.3	14.56	0.001*
Drainage (mL)	496.4±284.5	861.1±410.4	752.8±320.1	9.92	0.007*
Erythrocyte suspension (unit)	2.36±1.2	4.2±2.0	4.3±1.36	14.94	0.001*
Length of intensive care unit stay (days)	2.3±0.6	3.2±0.9	3.2±1.2	10.45	0.005*
Length of hospital stay (days)	7.7±0.9	11.2±2.0	10.6±2.0	24.29	<0.0001*

SD: Standard deviation; * Statistically significant; KW χ^2: Kruskal Wallis χ^2.

Table 4
Echocardiographic findings before AVR in three valve groups

Variable	Groups: Sutureless Mean±SD	Bioprosthetic Mean±SD	Mechanical Mean±SD	KW χ^2	p
Maximum aortic gradient (mmHg)	80.4±21.3	76.8±10.4	85.6±30.2	0.71	0.495
Mean aortic gradient (mmHg)	48.4±12.0	47.1±8.1	54.1±18.2	2.66	0.264
Interventricular septum (mm)	13.4±1.4	13.8±1.6	14.3±1.7	1.51	0.470
Posterior wall (mm)	11.9±1.2	12.4±1.3	12.9±1.1	5.72	0.057
Ejection fraction (%)	52.4±12.0	57.1±11.1	61.1±6.7	7.34	0.026*
Pulmonary arterial pressure (mmHg)	36.6±6.0	36.6±11.0	35.2±12.5	2.01	0.366
Left ventricular end diastolic diameter (mm)	48.8±4.8	49.8±8.9	49.5±6.1	0.09§	0.913
Left ventricular end systolic diameter (mm)	31.4±4.6	35.6±8.0	33.2±4.7	3.15	0.207
Root of aorta	29.6±1.6	31.6±4.3	30.1±3.2	1.51§	0.231
LA (left atrium)	44.3±5.7	41.3±3.4	43.2±3.7	3.30	0.192
Ascending aorta	37.2±2.0	40.4±7.3	38.8±7.5	2.02	0.365

SD: Standard deviation; * Statistically significant; § Analyzed with ANOVA; KW χ^2: Kruskal Wallis χ^2.

gradients were improved in all three groups after the operation (Table 7). Similarly, a posterior wall and interventricular septal thicknesses significantly decreased following AVR. However, no statistically significant changes were observed in ejection fraction and pulmonary arterial pressure postoperatively. Recovery of the left ventricular end systolic diameter was evident in only Group 2.

Table 5
Echocardiographic findings six months after AVR in three valve groups

Variable	Groups: Sutureless Mean±SD	Bioprosthetic Mean±SD	Mechanical Mean±SD	KW χ^2	p
Maximum aortic gradient (mmHg)	19.8±5.9	23.9±9.5	23.4±10.1	1.57	0.455
Mean aortic gradient (mmHg)	10.8±3.5	12.2±4.6	12.6±5.6	0.89	0.640
Interventricular septum (mm)	11.9±1.3	12.7±0.9	12.3±1.5	2.58	0.275
Posterior wall (mm)	10.8±0.9	11.2±0.9	11.3±1.2	2.14	0.343
Ejection fraction (%)	58.8±6.7	56.7±9.3	60.4±3.2	2.35	0.308
Pulmonary arterial pressure (mmHg)	35.6±10.4	34.1±11.3	32.3±5.6	1.95	0.377
Left ventricular end diastolic diameter (mm)	45.7±3.8	45.6±3.7	46.8±4.4	0.89	0.642
Left ventricular end systolic diameter (mm)	29.3±3.7	30.1±4.7	31.4±5.1	2.48	0.289
Root of aorta	28.5±2.6	30.4±4.1	28.1±2.5	3.45	0.068
LA (left atrium)	42.7±4.2	42.5±5.7	42.9±4.4	0.17	0.938
Ascending aorta	35.7±4.0	38.8±4.8	35.6±3.4	4.02	0.056

SD: Standard deviation; * Statistically significant; § Analyzed with ANOVA; KW χ^2: Kruskal Wallis χ^2.

Table 6
Additional procedures performed in sutureless, bioprosthetic, and mechanical valve groups

	Valve type		
	Sutureless	Bioprosthetic	Mechanical
Additional procedure	n	n	n
Coronary artery bypass grafting	16	11	12
Mitral ring annuloplasty + coronary artery bypass grafting	0	1	2
Ascending aorta graft replacement + coronary artery bypass grafting	1	1	2
Ascending aorta graft replacement	3	0	3
Bentall procedure	0	1	4
Root enlargement procedure	0	1	2
Tricuspid ring annuloplasty	0	1	2
Tricuspid ring annuloplasty + atrial septal defect closure	1	0	0

DISCUSSION

Stenosis of the aortic valve is the most common cardiac valve disease in developed countries affecting approximately 3% of elderly patients. In parallel with the growth of the aging population, aortic stenosis becomes a more remarkable morbidity. Since more elderly patients are recruited as candidates for AVR, morbidities and concomitant risk factors should be considered before the choice of the operative technique.[9-14]

Muneretto et al.[15] suggested that the use of transcatheter AVR in patients with an intermediate-to-high-risk profile was linked with a significantly higher incidence of perioperative complications and decreased survival at short and mid-term compared to conventional surgery and sutureless valve implantation. In this perspective, the choice of the appropriate valve for every patient is a key point in planning the surgical management of symptomatic aortic stenosis.

The primary aim of the present study was to determine and compare early therapeutic outcomes after AVR with sutureless, bioprosthetic, and mechanical valves. Our study results demonstrated that AVR maintained its position as the mainstay of treatment in patients with severe and symptomatic aortic stenosis. Improvement in cardiac functions is reflected in echocardiographic findings such as mean and maximum aortic gradient, as well as the thickness of the posterior wall and interventricular septum. However, early postoperative data did not yield any noteworthy alterations regarding ejection fraction and pulmonary arterial pressure. Hence, more accurate conclusions require further analyses of long-term therapeutic results.

Perioperative data in our series showed that durations of operation and cross-clamp and the length of hospitalization and intensive care unit stay were shorter in Group 1. However, these favorable results for sutureless valves may be associated with the characteristics of patients and comorbidities. Cost-efficacy and the establishment of treatment strategy on an individualized basis for every patient are other key points to be considered. Although the initial ejection fractions of patients in the sutureless valve group were lower than the other groups, this difference disappeared after AVR procedure. Based on these findings, it can be speculated that sutureless valves may result in more obvious beneficial effects in the short-term.

Good clinical and hemodynamic outcomes have been accomplished with AVR procedures with sutureless, bioprosthetic, and mechanical valves. On the other hand, determination of specific patient selection criteria and the establishment of guidelines is mandatory for optimizing treatment outcomes. Aortic valve replacement using bioprostheses is more preferential in elderly, whereas conventional AVR in this population has an operative mortality ranging between 4 to 10%.[16] Mataraci et al.[4] reported that there was no mortality during hospital stay in the sutureless valve group. Whether root enlargement procedure increases mortality is still under debate.[17,18] In our study, we observed that additional procedures were accompanied with substantial morbidity compared to AVR procedures alone.

Table 7
Intra- and inter-group comparison of pre- and postoperative echocardiographic findings

	Group		
	Sutureless	Bioprosthesis	Mechanical
Variable	Mean±SD	Mean±SD	Mean±SD
Maximum aortic gradient (mmHg)			
Preoperative	80.4±21.3	76.8±10.4	85.6±30.2
Postoperative	19.8±5.9	23.9±9.5	23.4±10.1
p-value	**0.001**	**<0.0001**	**<0.0001**
Mean aortic gradient (mmHg)			
Preoperative	48.4±12.0	47.1±8.1	54.1±18.2
Postoperative	10.8±3.5	12.2±4.6	12.6±5.6
p-value	**0.001**	**<0.0001**	**<0.0001**
Interventricular septum (mm)			
Preoperative	13.4±1.4	13.8±1.6	14.3±1.7
Postoperative	11.9±1.3	12.2±0.9	12.3±1.5
p-value	**0.034**	**0.042**	**0.005**
Posterior wall (mm)			
Preoperative	11.9±1.2	12.4±1.3	12.9±1.1
Postoperative	10.8±0.9	11.2±0.9	11.3±1.2
p-value	**0.032**	**0.012**	**0.005**
Ejection fraction (%)			
Preoperative	52.4±12.0	57.1±11.1	61.1±6.7
Postoperative	58.8±6.7	56.7±9.3	60.4±3.2
p-value	0.198	0.796	0.300
Pulmonary arterial pressure (mmHg)			
Preoperative	36.6±6.0	36.6±11.0	35.2±12.5
Postoperative	35.6±10.4	34.1±11.3	32.3±5.6
p-value	0.398	0.295	0.850
Left ventricular end diastolic diameter (mm)			
Preoperative	48.8±4.8	49.8±8.9	49.5±6.1
Postoperative	45.7±3.8	45.6±3.7	46.8±4.4
p-value	**0.044**	0.072	0.229
Left ventricular end systolic diameter (mm)			
Preoperative	31.4±4.6	35.6±8.0	33.2±4.7
Postoperative	29.3±3.7	30.1±4.7	31.4±5.1
p-value	0.064	0.010	0.319
Root of aorta			
Preoperative	29.6±1.6	31.6±4.3	30.1±3.2
Postoperative	28.5±2.6	30.4±4.1	28.1±2.5
p-value	0.084†	0.446†	0.090†
Left atrium			
Preoperative	44.3±5.7	41.3±3.4	43.2±3.7
Postoperative	42.7±4.2	42.5±5.7	42.9±4.4
p-value	0.196	0.342	0.451
Ascending aorta			
Preoperative	37.2±2.0	40.4±7.3	38.8±7.5
Postoperative	35.7±4.0	38.8±4.8	35.6±3.4
p-value	0.056	0.556	0.254

SD: Standard deviation; † Analyzed with paired t-test; all of the other variables were tested with Wilcoxon test. Statistically significant differences are shown in bold.

Table 8
Comorbidities and postoperative complications in three valve groups

Complication	Time	Group Sutureless	Cause	Group Bioprosthetic	Cause	Group Mechanical	Cause
Mortality	In hospital	0		1	Low output	2	LCO, CVO
	Postoperative 1st month	1	CRF, CVO	1	CVO	0	
	Postoperative 6th month	0		2	CVO, other causes	2	CRF, CVO
Neurological complication	In hospital	0		1	TIA	1	TIA
	Postoperative 1st month	1		1	CVO	1	CVO
	Postoperative 6th month	0		1	CVO	1	CVO
Paravalvular leak	In hospital	0		0		0	
	Postoperative 1st month	0		1 (mild)		0	
	Postoperative 6th month	1 (mild)		2 (mild)		0	
Central leak	In hospital	0		1 (mild)		1 (mild)	
	Postoperative 1st month	0		1 (mild)		1 (mild)	
	Postoperative 6th month	0		1 (mild)		2 (mild)	
AV complete block / Permanent pacemaker	In hospital	0		1		1	
	Postoperative 1st month	0		1		0	
	Postoperative 6th month	0		0		0	
Infective endocarditis	In hospital	0		0		0	
	Postoperative 1st month	0		0		0	
	Postoperative 6th month	0		0		0	
Valve dehiscence	In hospital	0		0		0	
	Postoperative 1st month	0		0		0	
	Postoperative 6th month	0		0		0	
Valve dysfunction	In hospital	0		0		0	
	Postoperative 1st month	0		0		0	
	Postoperative 6th month	0		0		0	
Valve migration	In hospital	0		0		0	
	Postoperative 1st month	0		0		0	
	Postoperative 6th month	0		0		0	
Reoperation		2*	Bleeding	2†	Bleeding	2§	Bleeding
		0	Valve dehiscence	0	Valve dehiscence	0	Valve dehiscence
		0	Infective endocarditis	0	Infective endocarditis	0	Infective endocarditis
		0	Valve dysfunction	0	Valve dysfunction	0	Valve dysfunction

Additional procedures in patients who underwent reoperation included * CABG, † CABG and supracoronary ascending aorta replacement, and § CABG and CABG + ascending aorta replacement; LCO: Left coronary artery occlusion; CVO: Cerebrovascular occlusion; CRF: Chronic renal failure; TIA: Transient ischemic attack; CABG: Coronary artery bypass grafting.

In the current study, we presented our short-term experience with three different valve types. Although our data were insufficient for statistical analysis, complications including mortality, neurological hazards, central and paravalvular leak, and valve dehiscence and migration were evaluated. Interestingly, mortality and need for reoperation after AVR were more frequent in the patients who underwent additional surgical procedures such as CABG and root enlargement procedure (Table 8). Dhareshwar et al.[18] also proposed that root enlargement procedure was a contributor to mortality in the univariate analysis; however, multivariate analysis results did not support this hypothesis.

The improvement in the mean and maximum aortic gradients after surgery was consistent with the report by Borger et al.[19] In parallel with the report of Pollari et al.,[20] we also observed that sutureless valve interventions were associated with decreased operative and cross-clamp time and shorter duration of

hospitalization and intensive care unit stay. Therefore, this option can be of choice in elderly patients who require additional procedures.[3-5] Furthermore, reduction of operative time and cross-clamp time may avoid side effects such as hemolysis, oxidative stress, and hemolysis, thereby, improving the rates of morbidity and mortality.[21]

Among complications encountered after AVR, paravalvular leakage deserves a particular attention. It has been suggested that insufficient sizing or inappropriate decalcification of the annulus may be responsible for this problem. Even if it may be time-consuming, the prosthesis must be positioned properly and accurately.[22] Root enlargement procedures are supposed not to amplify the surgical risk; however, they should be omitted in elderly patients with severely calcified aortic walls.[23]

Sutureless valves have been manufactured to facilitate valve procedures, although they constitute a technical challenge, and a learning curve is required. Considering that sutureless procedures are not completely devoid of risks, treatment strategy must be tailored on an individualized basis for every candidate of AVR. Increased awareness on complications and close follow-up after surgery are crucial to achieve reduced rates of morbidity and mortality.

Nonetheless, this study has some limitations including the lack of long-term results and data restricted to the experience of a single institution. Many unidentified risk factors may have been considered during decision-making process of clinicians. Procedure-related costs constitute another important aspect of AVR interventions. Moreover, we were unable to perform a cost-efficacy analysis among the treatment methods. Differences among the groups regarding baseline characteristics such as age, ejection fraction, NYHA class, and EuroSCORE mandate a more cautious interpretation of our data. The effects of social, environmental, and genetic factors can be deemed other limitations before extrapolation of our results to larger populations.

In conclusion, AVR procedures are the mainstay of treatment for severe and symptomatic aortic stenosis. Selection of sutureless, bioprosthetic, and mechanical valves must be made according to the characteristics of the patient including comorbidities and hemodynamic profile. Further prospective, multi-center trials on larger series are warranted to determine the safety, efficacy, durability, advantages and disadvantages of each valve type.

Declaration of conflicting interests

The authors declared no conflicts of interest with respect to the authorship and/or publication of this article.

Funding

The authors received no financial support for the research and/or authorship of this article.

REFERENCES

1. Eichstaedt HC, Easo J, Härle T, Dapunt OE. Early single-center experience in sutureless aortic valve implantation in 120 patients. J Thorac Cardiovasc Surg 2014;147:370-5.
2. Altintas G, Diken AI, Hanedan O, Yurdakok O, Ozyalcin S, Kucuker SA, et al. The Sorin Freedom SOLO stentless tissue valve: early outcomes after aortic valve replacement. Tex Heart Inst J 2013;40:50-5.
3. Ihsan Parlar A, Onur Hanedan M, Mataraci I, Ali Yuruk M, Sayar U, Kemal Arslan A, et al. Immediate Outcomes of Aortic Valve Replacement with Sutureless versus Stentless Bioprosthesis. J Heart Valve Dis 2016;25:21-7.
4. Mataracı İ, Hanedan MO, Sayar U, Yürük MA, Özer T, Arslan AK, et al. Early outcomes of the sutureless aortic valves versus conventional stented bioprosthetic valves. Turk Gogus Kalp Dama 2016;24:240-7.
5. Göde S, Aksu T, Kadiroğulları E, Demirel A, Başgöze S, Erkanlı K, et al. Early- and mid-term results of sutureless aortic valve replacement in high-risk patients: our single-center experience. Turk Gogus Kalp Dama 2016;24:446-53.
6. Di Eusanio M, Phan K. Sutureless aortic valve replacement. Ann Cardiothorac Surg 2015;4:123-30.
7. Xu Z, Shi Q, Mei J, Tan Y. Long-term outcomes after mechanical aortic valve replacement with aortic root enlargement in adolescents. J Card Surg 2017;32:133-7.
8. Zahn R, Gerckens U, Grube E, Linke A, Sievert H, Eggebrecht H, et al. Transcatheter aortic valve implantation: first results from a multi-centre real-world registry. Eur Heart J. 2011 Jan;32(2):198-204.
9. Vahanian A, Otto CM. Risk stratification of patients with aortic stenosis. Eur Heart J 2010;31:416-23.
10. Bozok Ş, Kestelli M, Şahin A, Kara H, Güneş T, Özpak B, et al. Surgical Method for Facilitation of Aortic Valve Replacement: Intraoperative Application of External Pressure for Increasing the Transverse Axis of Aortic Annulus. World Journal of Cardiovascular Surgery 2015;5:108-13.
11. Brown JM, O'Brien SM, Wu C, Sikora JA, Griffith BP, Gammie JS. Isolated aortic valve replacement in North America comprising 108,687 patients in 10 years: changes in risks, valve types, and outcomes in the Society of Thoracic Surgeons National Database. J Thorac Cardiovasc Surg 2009;137:82-90.
12. Leon MB, Smith CR, Mack M, Miller DC, Moses JW, Svensson LG, et al. Transcatheter aortic-valve implantation for aortic stenosis in patients who cannot undergo surgery. N Engl J Med 2010;363:1597-607.

13. Kapadia SR, Tuzcu EM, Makkar RR, Svensson LG, Agarwal S, Kodali S, et al. Long-term outcomes of inoperable patients with aortic stenosis randomly assigned to transcatheter aortic valve replacement or standard therapy. Circulation 2014;130:1483-92.
14. Cosgrove DM 3rd, Sabik JF. Minimally invasive approach for aortic valve operations. Ann Thorac Surg 1996;62:596-7.
15. Muneretto C, Alfieri O, Cesana BM, Bisleri G, De Bonis M, Di Bartolomeo R, et al. A comparison of conventional surgery, transcatheter aortic valve replacement, and sutureless valves in "real-world" patients with aortic stenosis and intermediate- to high-risk profile. J Thorac Cardiovasc Surg 2015;150:1570-7.
16. Di Eusanio M, Fortuna D, De Palma R, Dell'Amore A, Lamarra M, Contini GA, et al. Aortic valve replacement: results and predictors of mortality from a contemporary series of 2256 patients. J Thorac Cardiovasc Surg 2011;141:940-7.
17. St Rammos K, Ketikoglou DG, Koullias GJ, Tsomkopoulos SG, Rammos CK, Argyrakis NP. The Nicks-Nunez posterior enlargement in the small aortic annulus: immediate-intermediate results. Interact Cardiovasc Thorac Surg 2006;5:749-53.
18. Dhareshwar J, Sundt TM 3rd, Dearani JA, Schaff HV, Cook DJ, Orszulak TA. Aortic root enlargement: what are the operative risks? J Thorac Cardiovasc Surg 2007;134:916-24.
19. Borger MA, Carson SM, Ivanov J, Rao V, Scully HE, Feindel CM, et al. Stentless aortic valves are hemodynamically superior to stented valves during mid-term follow-up: a large retrospective study. Ann Thorac Surg 2005;80:2180-5.
20. Pollari F, Santarpino G, Dell'Aquila AM, Gazdag L, Alnahas H, Vogt F, et al. Better short-term outcome by using sutureless valves: a propensity-matched score analysis. Ann Thorac Surg 2014;98:611-6.
21. Zakkar M, Guida G, Suleiman MS, Angelini GD. Cardiopulmonary bypass and oxidative stress. Oxid Med Cell Longev 2015;2015:189863.
22. Folliguet TA, Laborde F, Zannis K, Ghorayeb G, Haverich A, Shrestha M. Sutureless perceval aortic valve replacement: results of two European centers. Ann Thorac Surg 2012;93:1483-8.
23. Coutinho GF, Correia PM, Paupério G, de Oliveira F, Antunes MJ. Aortic root enlargement does not increase the surgical risk and short-term patient outcome? Eur J Cardiothorac Surg 2011;40:441-7.

Cardiovasc Surg Int 2020;7(1):30-32
http://dx.doi.org/DOI: 10.5606/e-cvsi.2020.771
www.e-cvsi.org

Cardiovascular Surgery and Interventions

How to do it? Open Access

Off-pump coronary artery surgery with clamshell incision

Mehmet Ali Şahin, Erkan Kuralay

Department of Cardiovascular Surgery, A Life Hospital, Ankara, Turkey

Received: February 11, 2020 ***Accepted:*** May 05, 2020 ***Published online:*** May 18, 2020

ABSTRACT

The clamshell incision is a type of incision which provides excellent exposure to the thoracic and cardiac structures. Herein, we report a case of laryngeal cancer with previous tracheostomy who underwent off-pump coronary artery bypass surgery using the saphenous vein graft via the clamshell incision The postoperative course was uneventful and the patient was discharged on postoperative Day 10 with recovery.

Keywords: Clamshell, coronary artery bypass grafting, off-pump, tracheostomy.

Cardiac surgery procedures with a median sternotomy may cause severe complications such as wound infections, sternal osteomyelitis, and mediastinitis in patients with tracheostomy or cervical esophagostomy.[1,2] In addition, severe bleeding and tracheal injury may develop due to dense adhesion behind the sternal notch during the median sternotomy.[3] It seems possible avoiding all these complications during cardiac surgery by the clamshell incision.[4] Both on-pump and off-pump cardiac surgeries can be safely performed using the clamshell incision with an acceptable complication rate.[5]

Herein, we report a case of laryngeal cancer with previous tracheostomy and a tracheal stoma who underwent off-pump coronary artery bypass surgery (CABG) using the saphenous vein graft via the clamshell incision.

SURGICAL TECHNIQUE

An 81-year-old male patient who had total laryngectomy, radical neck dissection, and tracheostomy 15 years ago was admitted to our department with severe unstable angina symptoms. On electrocardiography, ST-elevation on V1-V6 and coronary T waves were observed. Two-vessel disease was detected on coronary angiography with 90% stenosis in the left anterior descending (LAD) artery at the first diagonal artery bifurcation and 99% stenosis in the right posterior descendent artery. We planned CABG to alleviate unstable angina due to unsuitable coronary anatomy for interventional cardiac procedures. A written informed consent was obtained from the patient.

We placed an 8F endotracheal tube into the tracheal stoma (Figure 1a). The incision was done from the right anterior axillary line to the left anterior axillary line (Figure 1b). Both thoracotomies were done in the fourth intercostal space. Both the internal thoracic artery and veins were ligated on both sides. Retractors were placed (Figure 1c) and the pericardium was opened. The saphenous vein was harvested and heparinization was done using 2 mg/kg. The first diagonal artery, followed by LAD artery bypass and posterior descending artery anastomosis were done using the Octopus® (Medtronic Inc., CA, USA) stabilizer. Proximal anastomosis of the diagonal artery and posterior descending artery grafts were, then, done to the ascending aorta. Proximal anastomosis of the LAD artery graft was carried out on the diagonal artery graft in an end-to-side fashion (Figure 1d, e). Protamine was given for bleeding control. Procaine solution was infiltrated to both intercostal spaces for the management of postoperative pain. Both

Corresponding author: Erkan Kuralay, MD. A Life Hastanesi Kalp ve Damar Cerrahisi Bölümü, 06790 Etimesgut, Ankara, Türkiye.
Tel: +90 533 - 230 96 56 e-mail: erkankuralay@gmail.com

Citation:
Şahin MA, Kuralay E. Off-pump coronary artery surgery with clamshell incision. Cardiovasc Surg Int 2020;7(1):30-32.

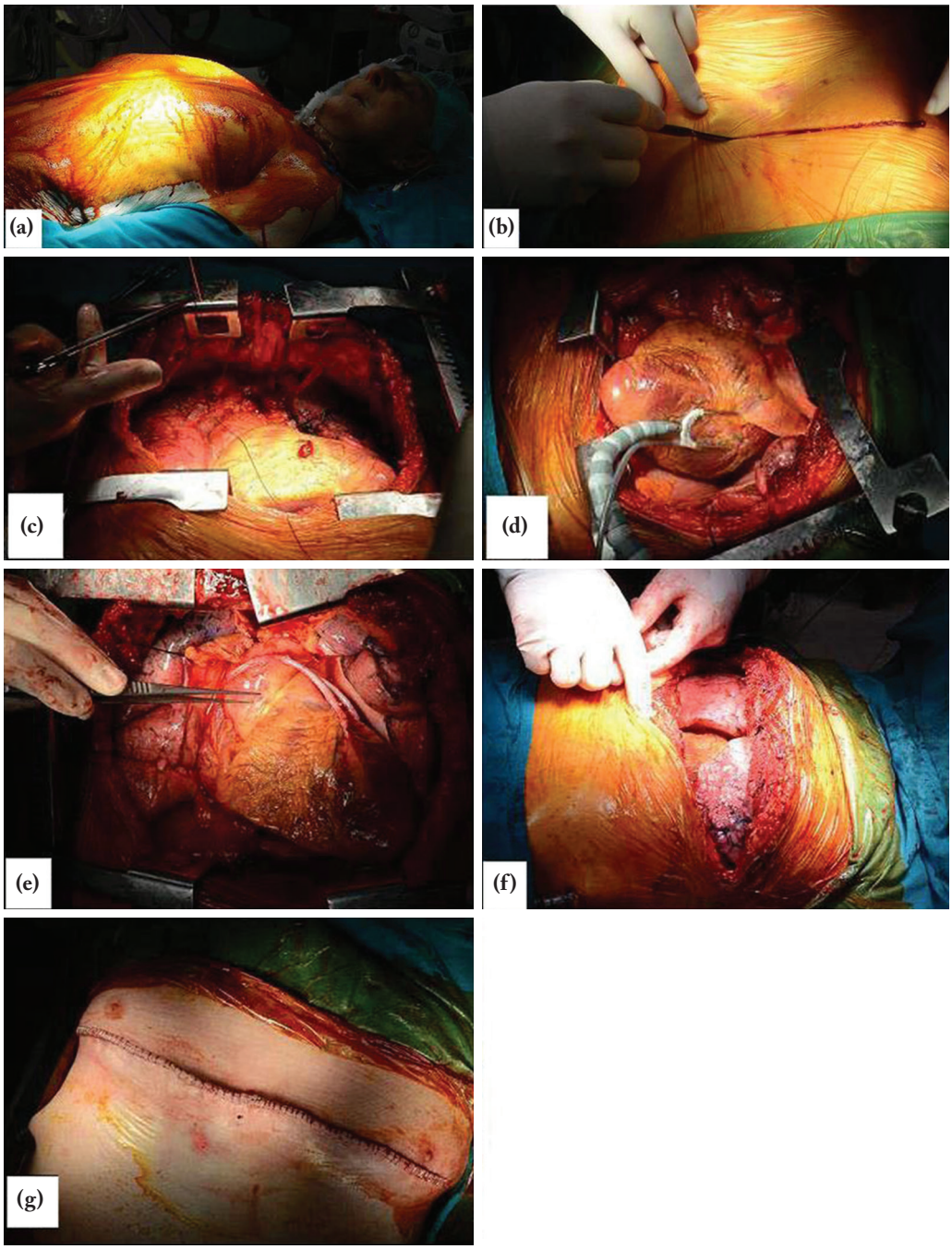

Figure 1. Operative steps of coronary artery bypass grafting via clamshell incision. **(a)** An 81-year-old male patient intubated through a tracheostomy stoma. **(b)** A transverse submammary incision was performed from right anterior axillary line to left anterior axillary line. We entered to both pleurae from fourth intercostal space. **(c)** Two retractors were placed in both sides of chest and pericardium was opened. **(d)** The first diagonal artery and posterior descendent arteries were bypassed with saphenous veins. **(e)** A side clamp was placed to ascending aorta, and proximal anastomosis of diagonal artery and posterior descending artery grafts were performed. Proximal anastomosis of saphenous vein of left anterior descending artery graft was performed to diagonal artery graft. **(f)** Both lungs were forcefully expanded and sternum was, then, approached with sternal wire. Both sides of thoracotomy were closed. **(g)** Skin closure was done by stapler suture and the patient was transferred to intensive care unit.

thoracotomies were, then, closed (Figure 1f, g). The patient was extubated at 18th postoperative hours. Atrial fibrillation on the first postoperative day was controlled by amiodarone infusion. The patient was discharged on postoperative Day 10 uneventfully.

DISCUSSION

Classical median sternotomy may be dangerous in patients with previous tracheostomy or cervical esophagostomy. Postoperative mediastinitis and sternal osteomyelitis may develop, leading to death eventually.[4] Uncontrollable bleeding from the retrosternal area beneath the sternal notch may be troublesome. Bains et al.[6] used the clamshell incision in oncologic surgery. Lung transplantations and comprehensive thymoma surgeries were safely performed using the clamshell incision.

The clamshell incision for cardiac surgery has been used for the last three decades. This approach was routinely used in CABG with additional aortic arch surgery patients.[5] In particular, aortic arch and descendent aorta surgery can be performed with the clamshell incision in a single-stage operation. Ascending aorta cannulation and cross-clamping can be easily done with this incision and it can be used for cosmetic reasons, as well. The left internal thoracic artery can be harvested by the clamshell incision to ensure a safe CABG for the patients. Postoperative bleeding problems were reported in several studies.[1-5] Total sternotomy with a low skin incision may be used in many cases due to cosmetic reason. Dissection of the upper part of sternum may cause bleeding in chronic tracheostomy patients. Lower partial sternotomy can be also used in on-pump CABG. Off-pump CABG with multivessel disease may cause some troublesome complications due to the limited exposure of the ascending aorta with lower partial sternotomy. Left thoracotomy is also another option for tracheostomy patients, while the right coronary system cannot be safely exposed with this approach.

In conclusion, we believe that off-pump CABG with the clamshell incision may additionally reduce bleeding problems. The clamshell incision may be in the surgeons' armamentarium for selected patients to perform a safe cardiac surgery.

Declaration of conflicting interests

The authors declared no conflicts of interest with respect to the authorship and/or publication of this article.

Funding

The authors received no financial support for the research and/or authorship of this article.

REFERENCES

1. Curtis JJ, Clark NC, McKenney CA, Walls JT, Schmaltz RA, Demmy TL, et al. Tracheostomy: a risk factor for mediastinitis after cardiac operation. Ann Thorac Surg 2001;72:731-4.
2. Fansa I, Bakuy V, Mavitaş B. Trakeostomisi bulunan bir hastada koroner arter bypass cerrahisi. Bidder Tıp Bilimleri Dergisi 2009;1:29-30.
3. Kaiser LR, Salerno TA. Coronary artery bypass in patients with total laryngectomy. Ann Thorac Surg 1985;39:481-2.
4. Legarra JJ, Sarralde JA, López Coronado JL, Trenor AM. Surgical approach for cardiac surgery in a patient with tracheostoma. Eur J Cardiothorac Surg 1998;14:338-9.
5. Eng JB. Combined repair of aortic arch aneurysm and coronary artery bypass grafting via a modified clamshell incision. Med J Malaysia 2007;62:177-8.
6. Bains MS, Ginsberg RJ, Jones WG 2nd, McCormack PM, Rusch VW, Burt ME, et al. The clamshell incision: an improved approach to bilateral pulmonary and mediastinal tumor. Ann Thorac Surg 1994;58:30-2.

Cardiovasc Surg Int 2020;7(1):33-38
http://dx.doi.org/DOI: 10.5606/e-cvsi.2020.770
www.e-cvsi.org

Cardiovascular Surgery and Interventions

Letter to the Editor Open Access

Outcomes of the Istanbul Symposium on minimally invasive and robotic cardiac surgery

Burak Onan

Department of Cardiovascular Surgery, University of Health Sciences Turkey, Istanbul Mehmet Akif Ersoy Thoracic and Cardiovascular Surgery Training and Research Hospital, Istanbul, Turkey

Received: February 04, 2020 ***Accepted:*** April 28, 2020 ***Published online:*** May 18, 2020

The Turkish Society of Cardiovascular Surgery (TSCVS) has been actively engaged in organizing congresses, school programs for education, local meetings, and symposiums on thoracic and cardiovascular surgery since 1988. The main goals of all these programs are to educate new generations, to share growing experience with other colleagues, and to promote the best health care to patients with cardiovascular disease. The most final of these symposiums took place at Istanbul Mehmet Akif Ersoy Thoracic and Cardiovascular Surgery Hospital (IMAEH) on the date of December 20th, 2019. The symposium hosted different aspects and experiences on minimally invasive and robotic cardiac surgery in adult patients. The conference lasted for one day and cardiac surgeons, adult cardiologists, nurses, technicians, and perfusionists attended the meeting. Twelve researchers from different hospitals shared their experiences. After scientific sessions, a wet-lab panel was held on robotic cardiac surgery, including simulation training on the daVinci robotic surgical system.

At the Istanbul Symposium on minimally invasive and robotic cardiac surgery by our society, the welcoming messages were given by the chief physicians of the Department of Cardiovascular Surgery of IMAEH, Assoc. Prof. Burak Onan, MD and Prof. Vedat Erentuğ, MD. Then, Baris Timur, MD and Aylin Demirel, MD presented their brief speeches to introduce the experimental animal laboratory of the hospital for animal research and life support systems. The chief of the hospital, Mehmet Erturk, MD presented a welcome speech. Prof. Mehmet Ali Özatik, MD, who is the president of the TSCVS, welcomed the attendees and presented a short lecture on the current status of minimally invasive and robotic cardiac surgery in Turkey (Figures 1 and 2).

FIRST PANEL: INTRODUCTION TO MINIMALLY INVASIVE AND ROBOTIC CARDIAC SURGERY

The first speech of this section was about the history and future of minimally invasive cardiac surgery in the world, as well as in Turkey. Prof. Belhhan Akpinar, MD offered an inspiring lecture to the attendees. Of note, he is a mentor and one of the pioneers of minimally invasive cardiac surgery in Turkey. Akpinar and his colleagues performed the initial series of port-access cardiac surgery in 2001, as well as the first robotic cardiac procedures in Turkey in 2004.[1,2] He adapted the surgical technique of endoscopic mitral valve surgery (by Vanerman, MD in OLV clinic from Belgium) to his colleagues and fellows. Since then, more than 762 port-access endoscopic cardiac operations were performed in his carrier. In his lecture, he summarized that the number of minimally invasive and robotic cardiac procedures in Turkey has dramatically increased after 2010 and more than 1,300 robotic surgeries have been performed in our country since 2013. Next generation robotic devices and innovations in this field were also mentioned by Akpinar, MD.

In addition, Assoc. Prof. Burak Onan, MD shared preferences of the IMAEH for patient selection in minimally invasive cardiac surgery and his experiences during the learning curve period. Onan and his

Corresponding author: Burak Onan, MD. Türkiye SBÜ Mehmet Akif Ersoy Göğüs Kalp Damar Cerrahisi Eğitim Araştırma Hastanesi Kalp ve Damar Cerrahisi Kliniği, 34303 Küçükçekmece, İstanbul, Turkey.
Tel: +90 553 - 622 38 78 e-mail: burakonan@hotmail.com

Citation:
Onan B. Outcomes of the Istanbul Symposium on minimally invasive and robotic cardiac surgery. Cardiovasc Surg Int 2020;7(1):33-38.

Figure 1. The speech of Prof. Mehmet Ali Özatik, MD at Istanbul symposium.

Figure 2. The Istanbul Symposium on minimally invasive and robotic cardiac surgery.

colleagues performed more than 550 robotic cardiac procedures since 2013. He is also experienced with minimally invasive port-access procedures in terms of patient selection and technical details. He gave a lecture about the details of preoperative patient selection in the learning curve period. He also noted that the procedures were totally different, and the surgeons should have a considerable experience in conventional techniques and peripheral cannulation before starting mini-operations. The initial cases should be selected among patients without associated comorbidities and patients should have simple and isolated pathologies, such as atrial septal defect or mitral valve replacement. Also, the selection of an ideal patient initially and the mentorship during the learning curve period are both beneficial for the volunteers.

Unal Aydın, MD from the IMAEH shared his and his colleagues' experiences and protocol on step-by-step surgical set-up for robotic cardiac surgery. Since 2013, more than 100 patients in each year underwent robotic procedures and almost 70% of these cases were mitral valve repair or replacement and atrial septal defect closure procedures. The mortality rate for robotic procedures was less than 2% based on their experiences for mitral procedures. The steps included endotracheal intubation, jugular vein and femoral vessel cannulation, port placement, docking, cardioplegia method, and cardiopulmonary bypass period. Aydin, MD noted that each of these surgical steps should be performed uneventfully for a successful and excellent outcome of a robotic operation. For instance, jugular vein or femoral cannulations should be done without any complication under transesophageal echocardiography guidance, or port placement should be done in the proper position to prevent technical failure and unexpected events. The choice of cannulas and surgical instruments should be also selected appropriately.

Then, Ersin Kadirogullari, MD from the IMAEH gave a lecture on perfusion and myocardial protection strategies. Accordingly, all members of the operation should be aware of the work and minimally invasive procedures need a teamwork, as all we know. Peripheral cannulation is a major step for establishing of cardiopulmonary bypass in minimally invasive cardiac surgery.[3] Technically, Kadirogullari, MD suggested that jugular vein cannulations could be done using 17F cannulas. Femoral venous cannulas should be the appropriate size rather than selecting a larger size and venous drainage during cardiopulmonary bypass can be augmented with suction devices with experienced perfusionists. Specifically, positive pressures may cause air embolization, whereas higher negative suction (more than -50 mmHg) may cause collapse of the venous system. Therefore, he recommended the use of alert systems and adjustment of safe range between +5 and -100 mmHg. He also mentioned the risk of aortic dissection during peripheral cardiopulmonary bypass and warned young surgeons about the necessity of safe arterial cannulation techniques. Cardioplegia techniques and solutions (isothermic blood, Custodiol® or del Nido®) were also reviewed. The safe periods are up to 90 to 120 min with Custodiol® solution and up to 60 min with del Nido® solution. He summarized that there was no ideal technique in minimally invasive procedures and the most important aspect was the communication and teamwork.

SECOND PANEL: ROBOTIC CARDIAC SURGERY

Opening of the second panel began with presentation of Kerem Oral, MD from Florence Nightingale Hospital on robot-assisted minimally invasive direct coronary artery bypass (MIDCAB). His clinic has a great experience in robotically enhanced procedures.[4] The author presented the technical details of harvesting the left internal thoracic artery with the use of the daVinci system. Then, operative details were presented with a live-in-box demonstration. He also presented his and his colleagues' clinical experience in robotically enhanced MIDCAB procedures between 2004 and 2018. A total of 286 patients operated and four of them were totally endoscopic bypass grafting cases. In the other cases, 197 patients had a single left internal thoracic artery-to-left anterior descending artery bypass grafting. Eighty-four patients had two-vessel coronary artery bypass grafting (CABG). Conversion was needed in only seven cases. He also recommended robotic MIDCAB as an alternative to a sternotomy incision in patients with comorbidities in terms of a hybrid approach. He summarized that the patency rate of robotic MIDCAB procedures could be comparable to conventional operations.

Subsequently, Assoc. Prof. Burak Onan, MD from the IMAEH made a speech on robotic mitral valve surgery. He stated that the difference of robotic surgery from the other minimally invasive techniques was the easy instrumentation and enhanced three-dimensional (3D) surgical view of robotic systems. Also, he mentioned the other advantages such as

a better exposure of the subvalvular apparatus and improved cosmetic results. Based on a brief literature review, he stated that operative risks and mortality of robotic procedures were similar to conventional procedures.[5-7] Onan, MD also noted that this approach could a safe alternative to sternotomy and the other techniques. In addition, he stated that mitral repair procedures could be done successfully, and the use of robotic technique was feasible and safe. The conversion rate can be decreased with a proper port placement after a learning curve period of 30 or 50 procedures. Robotic surgery is still evolving, and new devices are available soon which makes this approach an alternative for all patients. However, the cost issue is still a major problem in developing countries.

Prof. Sahin Senay, MD from Acıbadem University, Faculty of Medicine continued with robotic approach to intracardiac pathologies and shared his experiences on robotic cardiac surgery. Prof. Senay, MD is the current Editor-in-chief of The Turkish Journal of Thoracic and Cardiovascular Surgery and is a member of the Editorial Board of the International Society of Minimally Invasive Cardiac Surgery. He has a great experience in technical and philosophical details of minimally invasive and robotic cardiac surgery. In the symposium, he gave a great lecture on the feasibility of robotic procedures including valve repair, complex repair, intracardiac tumor resection, and atrial septal defect closures. He also summarized technical pitfalls and surgical approaches to intracardiac robotic procedures with the aid of video presentations.

Prof. Cengiz Bolcal, MD from Ankara Gulhane Training and Research Hospital continued with his experiences in reoperations using robotic surgery system. Technically, robotic reoperations can be done in patients with mitral and tricuspid valve pathologies. These patients may have a previous mitral valve replacement, repair, or CABG through a sternotomy incision. He noted that the procedures could be done on a beating heart, as well as on cardiac arrest under cardiopulmonary bypass, if aortic clamping was possible. The author stated that beating-heart technique could be preferred to ventricular fibrillation in terms of better myocardial protection. Prof. Bolcal, MD also provided technical details of deairing maneuvers to prevent systemic air embolization: both the left atrium and ventricle should be drained continuously during the procedure and left ventricular suction should be kept in its place through the mitral prosthesis, until the closure of the left atriotomy. Carbon dioxide insufflation is also mandatory. With this technique, Prof. Bolcal, MD and his colleagues uneventfully operated 14 patients so far, including 12 mitral valve procedures and two right atrial tumor excisions.

THIRD PANEL: AORTIC, MITRAL, AND MIDCAB

Opening of the third panel was assured by Prof. Ertan Sagbas, MD from Florence Nightingale Hospital who presented robot-assisted MIDCAB endoscopic port-access mitral valve surgery. Prof. Sagbas, MD is also one of the pioneers of minimally invasive endoscopic heart surgery in Turkey. He noted that the first truly video endoscopic port-access operation in their clinic was an atrial septal defect closure operation in 2002. The first robotic operation of Turkey was performed in 2004 by the team of Prof. Akpinar, MD. Port-access technique can be used for mitral and tricuspid valve pathologies, atrial septal defect closure, and myxoma excision. Prof. Sagbas, MD also commented on mitral valve repair techniques including resection and respect philosophy. During the last decade, he preferred neo-chordae implantation for mitral repair and, with this technique, his success rate was above 95%. He summarized that endoscopic port-access approach to mitral valve procedures was safe, effective, and durable with favorable long-term results.

The second lecture was delivered by Assoc. Prof. Mehmet Kaya, MD from the IMAEH on minimally invasive aortic surgery through a mini-sternotomy incision. He presented technical pitfalls and tips for a successful minimally invasive aortic surgery. He stated that aneurysms of the aortic root, ascending aorta, and even aortic arch could be treated through a mini-sternotomy incision. He summarized the details of these procedures with a video lecture on this topic.

Prof. Serkan Durdu, MD continued with minimally invasive aortic valve replacement through lateral mini-thoracotomy. He noted that this approach could be an alternative to sternotomy or J-sternotomy incision in patients with preoperative comorbidities.[8,9] However, he noted that surgical experience was mandatory. Operative steps and details were presented, and his and his colleagues' experiences were shared with the attendees. He also presented their clinical experiences previously.[6]

From January 2013 through March 2018, 13 patients with severe aortic stenosis involving bicuspid aortic valve underwent aortic valve replacement in their center. The mean age was 72.8±2.3 years ranging from 70 to 77, and 53.8% of the patients were males. Minimally invasive approach through right anterior thoracotomy from the third intercostal space was performed in all patients. There was no in-hospital mortality. He suggested that this approach was a technically feasible and safe procedure in patients with severe aortic stenosis.

Prof. Cem Alhan, MD from Acıbadem Hospital gave a great lecture on the surgical approach to transcatheter aortic valve implantation (TAVI). He encouraged the attendees to play an active role in minimally invasive procedures, TAVI, and surgical options. The long-term durability of TAVI valves and surgical options were discussed. He noted that the results of the PARTNER 2 trial found that the five-year outcomes for patients with an intermediate operative risk having surgical aortic valve replacement were significantly better than for those having the TAVI procedure. This means that for every 100 patients dying within five years of having the TAVI procedure, 75 would have died having had surgery. Also, the cost analysis of TAVI was discussed. He summarized that TAVI could be an alternative for patients who had a high operative risk, as well as for patients with advanced age (above 80 years) and poor two-year survival. He also noted that no literature evidence was present currently on the application of TAVI to young adults. Thus, he recommended that surgical aortic valve replacement was a reasonable choice for all patients in terms of favorable long-term results and reasonable cost.

Prof. Baris Caynak, MD presented a novel technique for minimal invasive cardiac surgery, entitled "multi-vessel MIDCAB through mini-thoracotomy". This experience for coronary revascularization has not been presented in Turkey previously. In this technique, multi-vessel CABG procedures can be performed without making a sternotomy incision. Instead, a 6 to 8-cm mini-thoracotomy incision is used. Prof. Caynak, MD suggested that this approach could be preferred for all patients who were candidates for CABG. He also noted that age, sex, body mass index, ejection fraction, and number of anastomoses or localization of the lesions were not a contraindication for this procedure. Technical details were presented in a live-in-a-box presentation. The left internal thoracic artery was harvested with the help of a specially designed chest retractor through mini-thoracotomy incision and coronary anastomoses were done under cardiopulmonary bypass and cardiac arrest. Using this technique, Prof. Caynak, MD performed 62 procedures and 189 coronary anastomoses without any mortality. In 49 patients, the right coronary system was vascularized together with the left coronary system. The mean lengths of intensive care unit and hospital stay were 1.2±0.6 days and 5.3±22.7 days, respectively. He concluded that this technique could be feasible, safe, and alternative to a sternotomy incision for all patients.

LAB PANEL

In this section, Assoc. Prof. Burak Onan, MD, Ünal Aydın, MD and Ersin Kadirogullari, MD shared their experiences on robotic surgery. In the operating room, small groups studied on robotic simulation and manipulations, and had some technical and theoretical information about the daVinci system and robotic operations. Meanwhile, the attendees had the opportunity of using 3D endoscopic visualization and instrumentation.

COMMENTS

Prof. Aydin Aytac, MD, who was a great mentor and pioneer of cardiac surgery in Turkey, presented a valuable manuscript that shed light on the history of cardiovascular surgery in our country.[7] According to this report, the initial cardiac procedures were closed by mitral commissurotomy which were performed in 1953 and 1954 by Prof. Nihat Dorken, MD and Prof. Fahri Arel, MD in Istanbul and Dr. Orhan Mumin and Prof. Hilmi Akın, MD in Ankara. The first cardiac surgery series were performed by Prof. Aytac, MD in Hacettepe University, Pediatric Hospital after June 1962. Since then, many pediatric and adult cardiac procedures were successfully done using cardiopulmonary bypass. As the new surgical devices and innovations of minimally invasive techniques have been developed, the number of patients undergoing minimally invasive procedures has increased tremendously since late 1990s. Mitral valve procedures, closure of intracardiac defects, excision of tumors, and ablation surgeries have been done frequently. In particular, during the last two decades, cardiac surgical procedures which utilize mini-incisions and robotic systems have been

performed widely in Turkey. The community and young cardiac surgeons are highly interested in innovations and novel techniques. Complex cardiac procedures and even reoperations can be performed through exceedingly small access points in robotic surgery.

In conclusion, minimally invasive and robotic cardiac surgery can be successfully performed for aortic, mitral, coronary artery, and intracardiac pathologies. The choice of surgical incision and technique depends on the access routes or surgical incisions according to surgeon's preferences and experience. Nevertheless, a learning curve period and mentorship would be beneficial for young generations and those who are willing to start a new program of minimally invasive cardiac surgery. In the future, no one knows exactly how cardiac surgery would progress with innovations; however, the surgeons are expected to be adapted to changes in this field.

Declaration of conflicting interests

The authors declared no conflicts of interest with respect to the authorship and/or publication of this article.

Funding

The authors received no financial support for the research and/or authorship of this article.

REFERENCES

1. Sağbaş E, Sanisoğlu İ, Güden M, Çaynak B, Akpınar B. Robotically enhanced totally endoscopic coronary artery bypass surgery in three cases. Turk Gogus Kalp Dama 2008;16:254-6.
2. Akpinar B, Guden M, Sagbas E, Sanisoglu I, Ozbek U, Caynak B, et al. Combined radiofrequency modified maze and mitral valve procedure through a port access approach: early and mid-term results. Eur J Cardiothorac Surg 2003;24:223-30.
3. Onan B, Aydın Ü, Kadiroğulları E, Erkanlı K. An alternative peripheral arterial cannulation in minimally invasive and robotic cardiac surgery. Cardiovasc Surg Int 2016;3:91-3.
4. Ezelsoy M, Caynak B, Bayram M, Oral K, Bayramoglu Z, Sagbas E, et al. The Comparison between Minimally Invasive Coronary Bypass Grafting Surgery and Conventional Bypass Grafting Surgery in Proximal LAD Lesion. Heart Surg Forum 2015;18:E042-6.
5. Onan B, Aydin U, Kadirogullari E, Onan IS, Sen O, Kahraman Z. Robotic repair of partial anomalous pulmonary venous connection: the initial experience and technical details. J Robot Surg 2020;14:101-7.
6. Onan B, Aydin U, Kadirogullari E, Onan IS, Sen O. Totally Endoscopic Robotic-Assisted Cardiac Surgery in Children. Artif Organs 2019;43:342-9.
7. Onan B. Coronary revascularization in robotic cardiac surgery. Cardiovasc Surg Int 2018;5:48-59.
8. Durdu MS, Gumus F, Ozcinar E, Cakici M, Bermede O, Dincer I, et al. Sutureless Valve Replacement Through a Right Anterior Mini-thoracotomy in Elderly Patients With Stenotic Bicuspid Aortic Valve. Semin Thorac Cardiovasc Surg 2019;31:458-64.
9. İnan MB, Özçınar E, Dikmen Yaman N, Durdu S, Aral A, Şırlak M, et al. Right anterior thoracotomy approach for isolated aortic valve replacement with sutured aortic valve prosthesis. Cardiovasc Surg Int 2016;3:31-3.
10. Aytaç A. Dünyada ve Türkiye'de kalp cerrahisi. Turk Gogus Kalp Dama 1991;1:8-12.

Cardiovasc Surg Int 2020;7(1):39
http://dx.doi.org/DOI: 10.5606/e-cvsi.2020.779
www.e-cvsi.org

Cardiovascular Surgery and Interventions

Letter to the Editor Open Access

ACE-gene polymorphism, particularly "D/I", may play a role in the occurrence of COVID-19 pneumonia in hypertensive elderly patients

Hakan Göçer[1], Ahmet Barış Durukan[2]

[1]Department of Cardiology, Medical Park Uşak Hospital, Uşak, Turkey
[2]Department of Cardiovascular Surgery, Medical Park Uşak Hospital, Uşak, Turkey

Received: April 07, 2020 ***Accepted:*** April 12, 2020 ***Published online:*** May 18, 2020

Renin-angiotensin-aldosterone system has an important role in the pathophysiology of high blood pressure.[1] Also, angiotensin II and bradykinin are vasoactive molecules with multiple acute and chronic effects on the cardiovascular system.[1,2] As stated in recent reports, COVID-19 pneumonia more frequently occurs in COVID-19-positive hypertensive elderly.[2] To the best our knowledge, COVID-19 pneumonia has a grave prognosis in hypertensive and elderly patients. Angiotensin-converting enzyme (ACE) genotype has been blamed for this course, and although the interaction between COVID-19 and ACE receptors interaction has been well defined, ACE genotype polymorphism has not been fully elucidated, yet.[3] In this infection, many researches and reports have shown the effect of ACE insertion deletion (I/D) gene polymorphism on risk, prognosis, and reaction to treatment of many diseases such as hypertension, heart failure, myocardial infarction, diabetes, diabetic nephropathy, and cancer.[3] It is well-known that ACE gene is located on chromosome 17 and polymorphism consists of three types within the intron 16 (DD, ID, II) and depends on heredity, ethnicity, and geographical considerations.[4] Furthermore, D/I type has been found more frequently in hypertension, diabetes, and myocardial infarction.[4] Prognosis is more grave in this genotype polymorphism. Our suggestion is that D/I type ACE gene polymorphism should be a research of interest for predicting prognosis and propensity of COVID-19 infection in hypertensive elderly patients.

Declaration of conflicting interests

The authors declared no conflicts of interest with respect to the authorship and/or publication of this article.

Funding

The authors received no financial support for the research and/or authorship of this article.

REFERENCES

1. Sun P, Lu X, Xu C, Wang Y, Sun W, Xi J. CD-sACE2 inclusion compounds: An effective treatment for coronavirus disease 2019 (COVID-19). J Med Virol 2020. [Epub ahead of print
2. South AM, Diz DI, Chappell MC. COVID-19, ACE2, and the cardiovascular consequences. Am J Physiol Heart Circ Physiol 2020;318:H1084-H90.
3. Thomson G. COVID-19: Social distancing, ACE 2 receptors, protease inhibitors and beyond? Int J Clin Pract 2020:e13503.
4. Prasad A, Narayanan S, Waclawiw MA, Epstein N, Quyyumi AA. The insertion/deletion polymorphism of the angiotensin-converting enzyme gene determines coronary vascular tone and nitric oxide activity. J Am Coll Cardiol 2000;36:1579-86.

Corresponding author: Ahmet Barış Durukan, MD. Medical Park Uşak Hastanesi Kalp ve Damar Cerrahisi Bölümü, 64200 Uşak, Türkiye.
Tel: +90 532 - 227 38 14 e-mail: barisdurukan@yahoo.com

Citation:
Göçer H, Durukan AB. ACE-gene polymorphism, particularly "D/I", may play a role in the occurrence of COVID-19 pneumonia in hypertensive elderly patients. Cardiovasc Surg Int 2020;7(1):39.