Journal of Population Therapeutics & Clinical Pharmacology

RESEARCH ARTICLE
DOI: 10.53555/cdvpss11

Comparative Study Between Semicontinuous and Interrupted Aortic Valve Replacement Regarding Post-Operative Permanent Peacemaker Requirement

Rafeek Fekry Barsoum (MD)[1], Ahmed Labib Dokhan (MD)[2], Mohamed Ahmed El-Hag Aly (MD)[3], Mena Shafik Takla (MSc)[4], Ahmed Hatem Onsi* (MD)[5]

[1,2,3,4,5]Department of Cardiothoracic Surgery, Faculty of Medicine, Menoufia University, Egypt

***Corresponding author:** Ahmed Hatem Onsi,

E-mail: doctoronsi3@gmail.com

ABSTRACT

Background: Aortic valve replacement (AVR) is a well-established, safe treatment that provides significant advantages to patients with valvular disease.

Objectives: to compare the early results of the interrupted and the semicontinuous suture techniques in AVR especially permanent pacemaker (PPM) requirements.

Methods: This prospective study was conducted on 120 patients who underwent AVR between January 2021 and June 2022. The patients were randomly divided into two groups: Group I: 60 patients for AVR using interrupted suture technique. Group II: 60 patients for AVR using semi-continuous suture technique.

Results: In group I, the mean age was 58.50 ± 8.03 years with 40 patients (66.67%) were males. The mean body mass index was 27.26 ± 4.84 Kg/M^2. The preoperative echo: mean LVESD was 4.44 ± 0.76 cm, the mean LVEDD was 5.89 ± 0.66 cm and the mean LVEF was 47.56 ± 8.12 %. While in group II, the mean age was 59.22 ± 7.05 years with 46 patients (76.67%) were males. The mean body mass index was 26.36 ± 4.14 Kg/M^2. The preoperative echo: mean LVESD was 4.19 ± 0.71 cm, the mean LVEDD was 5.69 ± 0.57 cm and the mean LVEF was 45.92 ± 2.61 %.

Conclusions: Semicontinuous suture technique showed significantly better results than interrupted suture technique regarding the mean cardiopulmonary bypass (CPB) time, mean cross clamp time, using of temporary pacemaker, ventilation time, ICU stay and mean total hospital stay.

Keywords: Aortic Valve Replacement, Interrupted, Permanent Pacemaker, Semicontinuous.

INTRODUCTION

As people age, they are more likely to develop aortic valve disease. For aortic valve disorders, the gold standard therapy since 1960 has been surgery. A continuous suture technique (CST) or an interrupted suture technique (IST) might be used for this surgery [1,2]. The effectiveness and results of both techniques have been examined in a number of studies; nonetheless, there is ongoing debate over CST for AVR in the current literature [3,4].

Speed, repeatability, ease of use, and safety are the main benefits of CST over IST. It has been demonstrated that CST dramatically reduces the time needed for cardiac bypass and cross clamp, which ultimately reduces myocardial ischemia damage, operating time, and hospital stay [3]. However, because CST was linked to a higher risk of paravalvular leak, earlier research called into doubt its effectiveness [2].

The design of the sewing ring and stent are two of the many factors that might impact the aortic valve prosthesis' hemodynamic effectiveness. Furthermore, the hemodynamic result of AVR may be impacted by the suture technique. The interrupted everting or non-everting pledged suture is the conventional suture method for AVR. Compared to other suture methods, pledged sutures, which hold the valve prosthesis to the valve annulus, have been demonstrated to provide protection against postoperative paravalvular leak [5, 6].

Tabata and colleagues found that non- everting mattress sutures with pledged reinforcement can compromise the prosthesis's hemodynamic performance, contributing to the transvalvular gradient and leading to pannus development [7]. Ugur and colleagues, on the other hand, discovered no such difference and found no link between the suture method and the effective orifice area [5]. More recently, Haqzad and colleagues discovered that semicontinuous sutures, as opposed to interrupted sutures, allowed for reduced operating times and the use of bigger valves [8].

One recognized consequence of AVR is conduction problems, which are believed to occur as a result of an operation near the AV node or bundle of hiss, which may cause damage to the conduction system [9]. Numerous conduction issues might arise, such as total heart block or a better-tolerated right or left bundle branch block [10]. This often occurs when the conduction pathway is damaged following the removal of calcium from the right fibrous trigone or membranous septum, or when sutures are inserted through this region to install a replacement valve [11].

Permanent pacemaker (PPM) insertion, with a reported frequency of 3%-8.5% following solitary AVR, remains a significant complication of aortic valve surgery [12,13,14]. PPM implantation affects hospital stay, rehospitalization rate, expenditures, and potentially long-term death rates [14, 15]. The aim of the study is to compare the early results of the conventional interrupted and the semi-continuous suture techniques in AVR especially PPM requirements.

PATIENTS AND METHODS

This prospective study was conducted after the approval of the Ethics committee of the Faculty of Medicine, Menoufia University. This study was conducted on 120 patients who underwent AVR between January 2021 and June 2022 in Menoufia University Hospital.

The patients were randomly divided into two groups: Group I: included 60 patients for AVR using interrupted suture technique. Group II: included 60 patients for AVR using semi-continuous suture technique.

Patients with previous cardiac surgery, any degree of heart block pre-operative, any other combined valve or coronary lesion requiring surgery, any procedure other than aortic valve procedure, and patient with chronic kidney or liver or lung disease were excluded from the study.

All patients were subjected to: Preoperative assessment included: full history taking, physical examination, laboratory assessment (routine laboratory investigation including complete blood picture, liver function, kidney function and blood sugar), plain chest radiography, electrocardiography and transthoracic echocardiography. Intra-operative assessment included: cross clamp time, CPB time, size of prosthesis, intra-operative complications and temporary pacemaker requirement. Postoperative assessment included: ICU data, inotropic support, time of ventilation, postoperative complications and PPM requirement.

All surgeries were conducted by median sternotomy with CPB and mild hypothermia. CPB was performed with a two-stage single venous cannula and a straight-tip ascending aortic cannula. Cardioplegia was administered by an antegrade aortic root cardioplegia, which might be selective or non-selective. Warm blood cardioplegia was utilized to stop and protect the heart. The warm cardioplegia was delivered by syringe pump. The valve was implanted either by interrupted or semi-continuous suture techniques.

Statistical analysis:

Microsoft Excel was used to code, input, and analyze the data. SPSS version 22 was used for statistical analysis. Standard techniques were used in the study to report and analyze the data. Mean ± SD was used to represent regularly distributed continuous data, whereas median and range were used to describe non-normally distributed data. Outcome percentages were presented as absolute percentages. Employing Chi-square to compare frequencies and t-tests to assess mean correlations. A p-value of less than 0.05 indicated statistical significance.

RESULTS

Regarding the demographic data and the pre-operative echo data, there was not any significant statistical difference between both groups (Tables 1 & 2).

Table (1): Comparison between both groups regarding demographic and clinical characteristics:

	Group I (n=60)	**Group II (n=60)**	**P value**
Age (years)	58.50 ± 8.03	59.22 ± 7.05	0.634
Male Gender	40(66.67%)	46(76.67%)	0.224
Weight (Kg)	77.26 ± 11.06	78.40 ± 9.55	0.582
Height (M)	169.94 ± 7.63	172.38 ± 8.55	0.135
BMI (Kg/M^2)	27.26 ± 4.84	26.36 ± 4.14	0.320
Smoking	29(48.33%)	27(45.00%)	0.714
DM	30(50%)	28(46.67%)	0.715
Hypertension	31(51.67%)	25(41.67%)	0.272
NYHA Classification **II** **III** **IV**	 32(53.33%) 20(33.33%) 8(13.33%)	 37(61.67%) 16(26.67%) 7(11.67%)	0.646

BMI; Body mass index, DM; Diabetes mellitus, NYHA; New York Heart Association.

Table (2): Comparison between both groups regarding pre-operative echocardiogram:

		Group I (n=60)	**Group II (n=60)**	**P value**
LVESD (cm)		4.44 ± 0.76	4.19 ± 0.71	0.092
LVEDD (cm)		5.89 ± 0.66	5.69 ± 0.57	0.108
LVEF (%)		47.56 ± 8.12	45.92 ± 2.61	0.177
LA (cm)		4.28 ± 0.31	4.12 ± 0.52	0.064
Aortic annulus (cm)		2.59 ± 0.38	2.71 ± 0.52	0.190
Aortic valve lesion	**AR** **AS**	32(53.33%) 28(46.67%)	36(60.00%) 24(40.00%)	0.461

LVESD; left ventricular end systolic diameter, LVEDD; left ventricular end diastolic diameter, LVEF; left ventricular ejection fraction, LA; left atrium, AR; aortic regurge, AS: aortic stenosis

Regarding the intra-operative data, there were significant statistical differences between both groups regarding the surgical prosthetic position, using of Teflon pledges, CPB time, aortic cross

clamp time and requirement of temporary pacemaker (P <0.001,<0.001, <0.001, <0.001 & =0.047, respectively) (Table 3).

Table (3): Comparison between both groups regarding intra-operative data:

		Group I (n=60)	Group II (n=60)	P value
Cardioplegia approach	**Selective** **Non-selective**	32(53.33%) 28(46.67%)	36(60.00%) 24(40.00%)	0.461
Surgical position	**Supra-annular** **Intra-annular**	34(56.67%) 26(43.33%)	0(0%) 60(100.00%)	<0.001*
Using of Teflon pledged		37(61.67%)	0(0%)	<0.001*
CPB time (min)		112.30 ± 24.01	73.12 ± 12.94	<0.001*
Aortic cross clamp time (min)		85.82 ± 20.48	48.98 ± 10.21	<0.001*
Use of inotropic drugs		51(85.00%)	46(76.67%)	0.246
Size of prosthesis	**19** **21** **23** **25**	19(31.67%) 12(20.00%) 16(26.67%) 13(21.67%)	19(31.67%) 14(23.33%) 10(16.67%) 17(28.33%)	0.557
Temporary pacemaker		8(13.33%)	2(3.33%)	0.047*

*Significant.

Regarding the ICU data, there were significant statistical differences between both groups regarding ventilation time and ICU stay (P=0.017 & <0.001, respectively) (Table 4).

Table (4): Comparison between both groups regarding ICU data:

		Group I (n=60)	Group II (n=60)	P value
Ventilation time (hours)		11.48 ± 5.91	8.94 ± 4.49	0.017*
Blood loss volume (ml)		393.30 ± 262.83	346.02 ± 232.29	0.342
Re-exploration		2(3.33%)	1(1.67%)	0.558
Stroke		1(1.67%)	1(1.67%)	1.000
Renal impairment		0(0%)	1(1.67%)	0.315
Pneumonia		3(5.00%)	1(1.67%)	0.309
Brady-arrhythmia	**Sinus brady**	1 (1.67%)	2(3.3%)	0.558
	1st degree HB	1(1.67%)	1(1.67%)	1.000
	Mobitz type I	0(0%)	1(1.67%)	0.315
	Mobitz type II	2(3.3%)	0(0%)	0.508
	CHB	3(5.00%)	1(1.67%)	0.309
	Total	7(11.67%)	5(8.33%)	0.543
Tachy-arrhythmia (AF)		2(3.33%)	3(5.00%)	0.647
Permanent peacemaker		2 (3.33%)	0(0%)	0.153
Mortality		2(3.33%)	1(1.67%)	0.558
ICU stay (days)		3.62 ± 1.51	2.78 ± 0.64	<0.001*

* Significant, Brady; bradycardia, HB; heart block, CHB; complete heart block, AF; atrial fibrillation, ICU; intensive care unit.

Regarding the post-operative data, there was a significant statistical difference between both groups regarding mean total hospital stay (P<0.001) (Table 5).

Table (5): Comparison between the survivals from both groups regarding post-operative data:

	Group I (n=58)	**Group II (n=59)**	**P value**
NYHA Classification			
I	19(32.75%)	22(37.28%)	
II	29 (50.00%)	25(42.37%)	0.585
III	9(15.51%)	12(20.33%)	
IV	1(1.72%)	0(0%)	
LVESD (cm)	5.12 ± 0.55	4.96 ± 0.49	0.099
LVEDD (cm)	5.93 ± 0.51	5.77 ± 0.46	0.077
LVEF (%)	45.44 ± 2.15	46.18 ± 2.39	0.081
Wound infection	3(5.17%)	2(3.38%)	0.633
Total hospital stay (days)	9.28 ± 2.34	7.80 ± 2.24	<0.001*

*Significant, NYHA; New York heart association, LVESD; left ventricle end systolic diameter, LVEDD; left ventricle end diastolic diameter, LVEF; left ventricular ejection fraction.

Regarding follow-up data, there wasn't any statistically significant difference between both groups (Table 6).

Table (6): Comparison between the survivals from both groups regarding 6-months follow-up data:

	Group I (n=58)	**Group II (n=59)**	**P value**
NYHA Classification			
I	28(48.27%)	21(35.59%)	
II	17(29.31%)	21(35.59%)	0.377
III	13(22.41%)	17(28.81%)	
LVESD (cm)	4.15 ± 0.43	4.08 ± 0.21	0.264
LVEDD (cm)	5.72 ± 0.33	5.63 ± 0.24	0.093
LVEF (%)	49.73 ± 3.24	48.85 ± 2.93	0.126

NYHA; New York heart association, LVESD; left ventricle end systolic diameter, LVEDD; left ventricle end diastolic diameter, LVEF; left ventricular ejection fraction.

DISCUSSION

One of the most popular cardiac surgery procedures carried out globally is surgical AVR. All prosthetic valve replacements can benefit from the semi-continuous suture technique, although it is particularly appropriate for those with tiny left atriums and small aortic annuli, as well as those of rheumatic origin (as the tissue more thick than degenerative which did not need support with pledges). It is straightforward, requires little time for valve installation, has minimal postoperative problems, and is particularly appropriate for patients in underdeveloped nations [16]. The fact that the CST technique does not involve the use of thrombogenic material (no pledges or braided suture knots) for valve replacement is one of its benefits over the IST procedure [1].

Placing pledges at the ventricular side in the IST group may expose the annular margins into the valve opening, which might diminish the area of the mechanical or bioprosthetic valve or interfere with the leaflet movement. On the other hand, the CST technique buries the annular tissue in the CST line, preventing it from being exposed to the prosthetic valve opening [1].

According to one research, the CST technique has the benefit of allowing for the placement of a prosthesis that is one size bigger than the greatest size that can be used with the IST procedure [2]. This is because the full removal of the valve and the loosening of the constricted

annulus enlarges the aortic annulus to some extent. Better hemodynamic performance is the outcome of this [17]. We did not, however, see this benefit in our investigation.

Endocarditis of the prosthetic valve is an uncommon but dangerous post-operative complication. Using the CST technique instead of pledges or braided sutures may lower the incidence of post-operative prosthetic endocarditis [2].

There has been considerable debate concerning the increased risk of paravalvular leak with the CST method for AVR. **Hjelms et al.** [18] found an 8.8% incidence of para-valvular leak in 80 patients having AVR using the CST procedure. They came to the conclusion that patients with pure aortic insufficiency were not suitable candidates for the CST method because the rate of paravalvular leak was as high as 26% in these patients. According to a recent study with a 10-year follow-up after AVR, the CST group had a 12% incidence of moderate to severe paravalvular leak, whereas the IST group had a 0% incidence [1].

In our study, there was no incidence of early post-operative paravalvular in both groups. Also, **Laks et al.** [19] showed that the CST technique had a para-valvular leak rate of just 2.3%, which is equivalent to the IST technique. **Dhasmana et al.** [20] found that periprosthetic leakage without endocarditis was independent to suture method (interrupted vs continuous), but was associated to suture size and annular calcification. They emphasized the necessity of thorough annular decalcification and the use of a lower suture size.

In our study, the mean age of group I was 58.50 ± 8.03 years and the mean age of group II was 59.22±7.05 years. In the literature, the mean age was older ranged between 71-74 years [3, 21, 22]. As the main etiology of AVR is rheumatic fever in Egypt while it is degenerative in western countries.

In our study, the intra-operative data of group I revealed that the mean CPB time was 112.30±24.01 minutes and the mean cross clamp time was 85.82±20.48 minutes. Temporary pacemakers were required in 8 patients (13.33%). While in group II, the mean CPB time was 73.12±12.94 minutes and the mean cross clamp time was 48.98±10.21 minutes. Temporary pacemakers were required in 2 patients (3.33%). There were significant statistical differences between both groups regarding mean CPB time, mean cross clamp time and using of temporary pacemaker ($P < 0.001$, < 0.001 & $= 0.047$, respectively).

In the literature, the mean CPB time ranged between 71-89 minutes and the mean cross clamp time ranged between 47-66 minutes in continuous suture group. While in interrupted suture group, the mean CPB time ranged between 81 - 94 minutes and the mean cross clamp time ranged between 60-69 minutes in CST group [1, 8, 21]. These results coincided with our results regarding higher CPB and cross clamp times in interrupted suture technique.

In our study, the mortality rate was 3.33% in group I and 1.67% in group II. The mortality rate did not differ statistically significantly between the two groups. The mortality rate ranged between 1.7 - 3.9% in continuous suture group and 2.9 -3% in interrupted suture group [8, 21].

The most reliable finding associated with PPM implantation was the presence of conduction anomalies on the preoperative ECG. Compared to normal preoperative ECG readings, preoperative left and right bundle branch blocks have been shown to increase the risk of needing a PPM by up to four times. So, we excluded all degrees of heart block in our study. The incidence of PPM implantation was closely correlated with the open-surgical suture technique used to anchor the prosthesis, in addition to the previously established risk factor of an underlying rhythm problem [23]. There were 704 participants in the participants undergoing Aortic Bio valve

Implantation (CAREAVR) experiment, with a median follow-up of 4.7 years. The New York Heart Association class before surgery was greater for patients who needed PPMs [26].

In early study, **Totaro et al.** [25] found that the continuous suture technique enhanced the necessity for postoperative pacemaker placement following AVR. However, in our study, there was a higher incidence of PPM insertion in group I than group II (3.33% vs 0%) but it was statistically insignificant. In the recent study, there was no statistically significant difference between continuous suture and interrupted suture techniques regarding PPM requirement [21].

The current study had certain limitations that should be noted. Early results may not adequately reflect the situation. As a result, longer-term follow-up studies with bigger sample sizes are needed. Also, one of the limitations of our study that the operations were performed by multiple surgeons.

CONCLUSION

Semicontinuous suture technique showed significantly better results than interrupted suture technique regarding the mean CPB time, mean cross clamp time, using of temporary pacemaker, ventilation time, ICU stay and mean total hospital stay. There was a larger necessity for PPM in patients who had AVR with the interrupted suture technique, but it was not statistically significant. The semicontinuous technique was discovered to be a safer and more dependable way of AVR.

Financial support and sponsorship: Nil

Conflict of Interest: Nil

REFERENCES

1. Choi JB, Kim JH, Park HK. Aortic valve replacement using continuous suture technique in patientswith aortic valve disease. Korean J Thorac Cardiovasc Surg. 2013; 46(04):249–255.
2. Nair SK, Bhatnagar G, Valencia O, Chandrasekaran V. Effect of valve suture technique on incidence of paraprosthetic regurgitation and 10-year survival. Ann Thorac Surg. 2010; 88:747–748.
3. Kitamura T, Edwards J, Miyaji K. Continuous suture technique for aortic valve replacement shortens cross-clamp and bypass times. Tex Heart Inst J. 2017; 44(06):390–394.
4. Qicai H, Zili C, Zhengfu H. Continuous-suture technique in aortic valve replacement. J Card Surg. 2006; 21(02):178–181.
5. Ugur M, Byrne JG, Bavaria JE. Suture technique does not affect hemodynamic performance of the small supraannular Trifecta bioprosthesis. J Thorac Cardiovasc Surg. 2014; 148:1347-1351.
6. Englberger L, Schaff HV, Jamieson WR. Importance of implant technique on risk of major paravalvular leak (PVL) after St. Jude mechanical heart valve replacement: a report from the Artificial Valve Endocarditis Reduction Trial (AVERT). Eur J Cardiothoracic Surg. 2005; 28:838-843.
7. Tabata M, Shibayama K, Watanabe H. Simple interrupted suturing increases valve performance after aortic valve replacement with a small supra-annular bioprosthesis. J Thorac Cardiovasc Surg. 2014; 147:321-325.
8. Haqzad Y, Loubani M, Chaudhry M. Multicentre, propensity-matched study to evaluate long-term impact of implantation technique in isolated aortic valve replacement on mortality and incidence of redo surgery. Interact Cardiovasc Thorac Surg. 2016; 22:599-605.

9. Ghannam M, Cunnane R, Menees D. Atrioventricular conduction in patients undergoing pacemaker implant following self-expandable transcatheter aortic valve replacement. Pacing Clin Electrophysiol. 2019; 42(7):980–8.
10. Sultan I, Bianco V, Yazji I, Kilic A. Hemiarch Reconstruction Versus Clamped Aortic Anastomosis for Concomitant Ascending Aortic Aneurysm. Ann Thorac Surg. 2018; 106(3):750–6.
11. Koechlin L, Macius E, Kaufmann J. Aortic root and ascending aorta dimensions in acute aortic dissection. Perfusion. 2019; 35(2):131–7.
12. Nardi P, Pellegrino A, Scafuri A. Permanent pacemaker implantation after isolated aortic valve replacement: incidence, risk factors and surgical technical aspects. J Cardiovasc Med (Hagerstown). 2010; 11: 14–19.
13. Dawkins S, Hobson AR, Kalra PR, Tang AT, Monro JL and Dawkins KD. Permanent pacemaker implantation after isolated aortic valve replacement: incidence, indications, and predictors. Ann Thorac Surg. 2008; 85: 108–112.
14. Robich MP, Schiltz NK, Johnston DR. Risk factors and outcomes of patients requiring a permanent pacemaker after aortic valve replacement in the United States. J Card Surg. 2016; 31: 476–485.
15. Nazif TM, Dizon JM, Hahn RT. Predictors and clinical outcomes of permanent pacemaker implantation after transcatheter aortic valve replacement: the PARTNER (Placement of AoRtic TraNscathetER Valves) trial and registry. JACC Cardiovasc Interv. 2015; 8: 60–69.
16. Vollenbroich R, Sakiri E, Roost E. Clinical outcomes in high-risk patients with a severe aortic stenosis: a seven-year follow-up analysis. Swiss Med Wkly. 2019; 24:149:w20013.
17. D'Onofrio A, Mazzucco A, Valfre C, et al. Left ventricular remodeling, hemodynamics and early clinical outcomes after aortic valve replacement with the Pericarbon Freedom stentless bioprosthesis: results from the Italian Prospective Multicenter Trial. J Heart Valve Dis. 2011; 20:531-9.
18. Hjelms E, Vilhelmsen R, Rygg IH. Continuous suture technique in prosthetic aortic valve replacement. J Cardiovasc Surg (Torino). 1982; 23:145-8.
19. Laks H, Pearl JM, Barthel SW, et al. Aortic valve replacement using a continuous suture technique. J Card Surg. 1993; 8:459-65.
20. Dhasmana JP, Blackstone EH, Kirklin JW, et al. Factors associated with periprosthetic leakage following primary mitral valve replacement: with special consideration of the suture technique. Ann Thorac Surg. 1983; 35:170-8.
21. Arabkhani B, Gonthier S, Lorenz V, et al. Continuous or interrupted pledgeted suture technique in stented bioprosthetic aortic valve replacement: a comparison of in-hospital outcomes. J Cardiothorac Surg. 2021; 19(1):174.
22. Niclauss L, Delay D, Pfister R, et al. Low pacemaker incidence with continuous-sutured valves: a retrospective analysis. Asian Cardiovasc Thorac Ann. 2017; 25(5):350-356.
23. Limongelli G. Risk factors for pacemaker implantation following aortic valve replacement: a single centre experience. Heart. 2003; 89(8):901–4.
24. Wollersheim LW, Li WW, Bouma BJ, Repossini A, van der Meulen J, de Mol BA. Aortic Valve Replacement with the Stentless Freedom SOLO Bioprosthesis: A Systematic Review. Ann Thorac Surg. 2015; 100(4):1496–504.
25. Totaro P, Calamai G, Montesi G, Barzaghi C, Vaccari M. Continuous suture technique and impairment of the atrioventricular conduction after aortic valve replacement. J Card Surg. 2000; 15(6):418-423.