Continuous Suture Technique for Isolated Mitral Valve Replacement - A Prospective Postoperative Analysis.

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Abstract— Background- The deleterious effects of cardiopulmonary bypass (CPB) are well known. Techniques to reduce the duration of CPB without compromising patient's safety have been evolving. One such technique is the use of continuous suture technique for mitral valve replacement (MVR). In our study we have analyzed postoperative intensive care unit (ICU) course, morbidity and mortality in patients undergoing isolated MVR with continuous suture technique.Methods- From August 2011 through September 2012, 71 patients underwent isolated MVR with continuous suture technique. The study was prospective, and the database maintained by medical record section and phone contacts with patients. After discharge, patients were followed up clinically on day-7, & 1, 3 and 6 months. Echocardiography was done at 1 & 6 months.The statistical analysis was done using SPSS-15 software. The test used were Chi-square test, Student 't'test and ANOVA (Analysis Of Variance) test. Results- Average CPB time was 50.73+12.48 minutes and mean aortic cross-clamp time was 29.86+8.81 minutes. During ICU course, significant decrease in inotropic support (p=0.004), ventilator time (p=0.037), mediastinal drainage (p<0.001) and shorter ICU stay (p<0.001) were associated with decrease in CPB time. Mediastinal drainage averaged 258.31 ± 172.53 ml whereas 0.94 ± 0.843 units of packed red blood cells were transfused. Incidence of paravalvular leak was 4.2%. There were no incidences of suture breakage or prosthetic valve dehiscence. There was single peri-operative mortality resulting from fatal cerebral thrombo-embolism.Conclusion- Improved post-operative recovery with comparable morbidity and mortality and cost effectiveness mandates use of continuous suture technique for MVR.

Index Terms— Mitral valve replacement, Technique

1 INTRODUCTION

In developing world countries, mitral valve replacement (MVR) is most commonly performed for stenotic and regurgitant lesions of mitral valve as a result of chronic rheumatic heart disease. Approximately 20% of patients with acute rheumatic fever develop varying degrees of acute and chronic rheumatic heart diseases [1], and mitral valve is most commonly affected i.e. in 65-70% of cases [2]. With advancements in cardiac surgery, newer surgical techniques have evolved, aiming for better post-operative results and faster patient recovery. Various suturing techniques for anchoring mechanical prosthetic mitral valve have been developed.

The classical surgical technique described for mitral valve replacement is the interrupted suture technique [3] in this, multiple (10-15), braided, double needle, non- absorbable, pledgeted/non-pledgeted Ethibond 2-0 sutures (Ethicon, Somerville, NJ) are used. Over the years this technique has provided with excellent prosthesis anchorage, lesser incidence of paravalvular leak (PVL) and rare case of prosthesis dehiscence. In contrast, it takes longer time to implant the prosthesis, leading to longer aortic cross-clamp (ACC) time and cardiopulmonary bypass (CPB) time, with its resultant deleterious systemic side effects [4].

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A semi continuous suture technique, ´ *The Hoist technique*', described by Ruchat *et al.* [5] employs use of eight Prolene 2-0 sutures (Ethicon, Somerville, NJ) to anchor the prosthetic valve. They aimed to combine the advantages of interrupted suture technique as well as continuous suture technique.

In continuous suture technique a single, non – pledgeted, non – absorbable, double-needle monofilament Prolene 2-0 suture (Ethicon, Somerville, NJ) with 26mm taper cut needle is used for performing MVR. When access is good, and annular tissues are tough and fibrous, the continuous running suture technique has the advantage of speed [6], [7,[8].

The other suture techniques described in literature but not so commonly used are everted mattress, non-everted mattress, figure of eight, etc [9].

At our institute we routinely perform mitral valve replacement using continuous suture technique. We find this approach to be faster, with significant reduction in CPB time and ACC time, improved & shorter intensive care unit (ICU) stay, comparable morbidity and mortality, and overall very cost effective.

2 MATERIALS AND METHODS

2.1 PATIENTS

Seventy one patients with chronic rheumatic mitral valve disease undergoing isolated mitral valve replacement with prosthetic mechanical valve at department of cardiothoracic and vascular surgery, King George medical university, Lucknow were included in the study. These patients were selected continuously. Patient with concomitant surgeries (aortic valve surgery, coronary artery bypass surgery, etc) and emergency surgeries were excluded from the study. Prospective study of cases was done from August 2011 through September 2012.

Patient's demographic data, pre-operative echocardiography, blood investigations, intra operative findings, ICU course were recorded. Clinical follow up was done in outdoor patient department on day 7 and at 1, 3, and 6 months. Follow-up echocardiography was done at 1 month and 6 month. We used standard textbook references for categorization of various patient disease parameters [3], [10].

2.2 Operative Technique

Out of 71 patients, 53 patients underwent MVR with bi-leaflet mechanical prosthetic valves and 18 patients with monoleaflet mechanical prosthetic valves. Standard aseptic precautions were employed, median sternotomy done. Cardiopulmonary bypass instituted, antegrade cold blood hyperkalemic cardioplegia administered. Posterior mitral leaflet was preserved in 34 patients and both anterior and posterior mitral leaflet were preserved in 21 patients. Thorough annular de-calcification was done in 16 patients with annular calcification and no leaflet tissue/chordae were preserved in these patients. Single Prolene 2-0 (Ethicon, Somerville, NJ) double armed suture with taper cut 26mm needle was used to anchor the mechanical prosthetic valve at mitral annulus. The first suture bite was taken at 2 o'clock position at mitral annulus and prosthetic valve was fixed in ante-anatomic position using continuous suturing technique (Fig 1, Fig 2) Thorough retrograde and antegrade de-airing was done and patient weaned of cardiopulmonary bypass [3,[11].

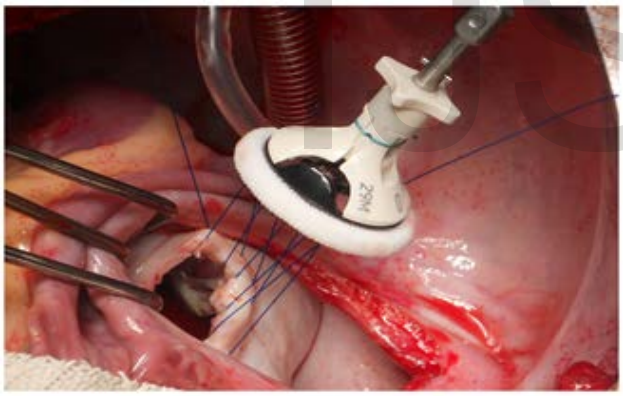

Fig 1: Parachuting of the valve prosthesis

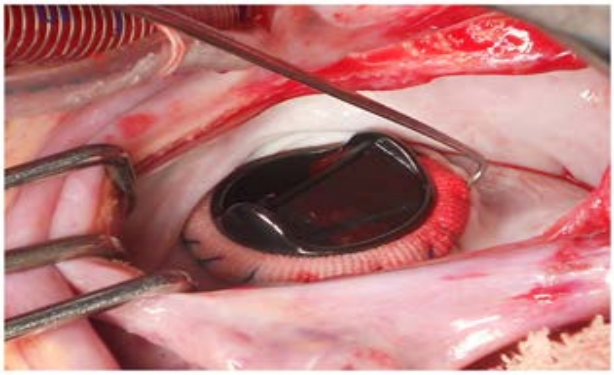

Fig 2: Valve prostehsis implanted at the mitral annulus

2.3 Statistical Analysis

The statistical analysis was done using SPSS (Statistical Package for Social Sciences) Version 15.0 statistical Analysis Software. The values were represented in Number (%) and Mean ± Standard Deviation. Chi square test was used for non-continuous variables. To test the significance of two means the Student't' test was used. The ANOVA (Analysis Of Variance) test was used to compare the within group and between group variances amongst the study groups *i.e.* the three different sealers. ANOVA provided "F" ratio, where a higher "F" value depicted a higher inter-group difference.

3 Results

A total of 71 patients were included in the study. Table 1 depicts the demographic data of the patients. The average age of the patients was 33.51 years ± 11.61 years and consisted of 35 (49.3%) females and 36 (50.7%) males. Seven (9.8%) patients had undergone prior mitral valve surgery (BMV-6, CMV-1). Atrial fibrillation was present in 26.8% patients and left atrial clot was reported in four (5.6%) patients.. Most of the patients were in NYHA class III (67.61%). Mild to moderate left ventricular dysfunction was present in 18.3% and 8.4% patients respectively, whereas majority of patients (73.2 %) had normal left ventricular ejection fraction. Sixteen patients (22.5 %) had presence of annular calcification.

Table 1: Patient Demographics

S.No.	Variable	Mean Sd
1.	Age	33.5 ± 11.61
2.	Gender(Male)	50.7 %
3.	BMI	18.84 ± 4.37
4.	Type Of Lesion MS MR MS+MR	 19 29 23
5.	Severity Of Lesion MS (Severe) MR (Severe)	 54.93% 60.50%
6.	Nyha Class ≤ III IV	 67.61 % 33.39 %
7.	Rhthym AF	19 Patients
8.	PREVIOUS PROCEDURE (BMV/ CMV)	9.86%
9.	LV DYSFUNCTION EF≤ 44%	6 Patients
10.	LA Clot	4 Patients
11.	LA Area Giant LA (>40 Cm2)	45 ± 14.14 47 Patients
12.	Annular Calcification	16 Patients

Average Cardiopulmonary Bypass time was 50.73 ± 12.48 minutes. We had divided CPB time in range of twenty minutes each, corresponding to the length of action of hyperkalemic cardioplegia we had administered. (Fig 3).

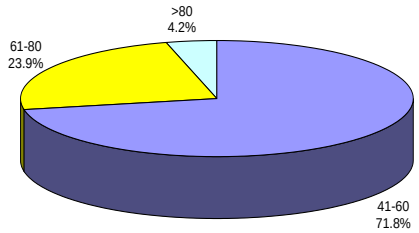

Fig 3: Distribution of cases according to Cardiopulmonary Bypass Time (minutes)

Shorter cardiopulmonary bypass time was found to have significant correlation to lesser inotropic support (p=0.004), shorter ventilatory time (p=0.037), lower mediastinal drainage (p<0.001), lesser blood units (Packed red blood cells) transfusion (p<0.001) and shorter ICU stay (p<0.001) as shown in table 2.

Table 2: ICU parameters in relation to and CPB Time

CPB Time (in minutes)	40-60 (n=51)		61-80 (n=17)		>80 (n=3)		F	'p'
	Mean	SD	Mean	SD	Mean	SD		
Inotropic requirement (hours)	6.58	7.10	10.59	11.51	22.67	11.72	5.943	0.004
Ventilatory time (hours)	7.15	6.19	8.25	6.51	17.67	16.26	3.454	0.037
Mediastinal Drain (first24 hours)	235.88	164.11	264.12	105.60	973.33	900.07	16.679	<0.001
Blood Transfusion Units(PRBC)	0.80	0.75	1.06	0.66	2.67	1.53	8.685	<0.001
ICU Stay (days)	1.64	0.40	2.11	0.59	3.33	1.15	8.710	<0.001

Average Aortic Cross Clamp time (ACC) was 29.86±8.81 minutes**.** During ICU Course, first 24 hours mediastinal drainage showed a statistically significant co-relation to shorter aortic cross-clamp time (p=0.002) (TABLE-3).

Table 3: ICU parameters in relation to Aortic Cross clamp Time

Aortic Cross clamp Time	21-40 minutes (n=62)		Time >40 minutes (n=9)		't'	'p'
	Mean	SD	Mean	SD		
Inotropic requirement (hours)	8.01	8.72	9.67	11.77	-0.509	0.612
Ventilatory time (hours)	7.64	6.49	9.33	10.28	-0.674	0.503
Mediastinal Drain (first 24 hours)	238.71	156.41	515.56	569.39	-3.189	0.002
Blood Transfusion Units(PRBC)	0.89	0.73	1.33	1.41	-1.497	0.139
ICU Stay (days)	2.19	0.47	2.44	0.88	-1.310	0.195

Inotropic support was required for 6.58 ± 7.1 hours when CPB time was 40-60 minutes, while in cases with CPB time more than 80 minutes, the inotropic requirement drastically increased to 22.67 ± 11.72 hours. All the patients were shifted from operation theatre to ICU on ventilatory support. In ICU, the average ventilatory support required was 7.84 hours, in comparison to prolonged ventilator support of 17.67 ± 16.26 hours required for patients with CPB time more than 80 minutes. Mediastinal drainage in first 24 hours averaged 258.31 ± 172.53 ml. This was in contrast to 973.33 ± 900.07 ml mediastinal drainage of patients in whom CPB time was more than 80 minutes and mediastinal drainage of 515.56 ± 569.39ml with aortic cross clamp time of more than 40 minutes. On average patients required 0.94 ± 0.843 units of packed red blood cells (PRBC) transfusion during first 24 hours. (Fig 4).

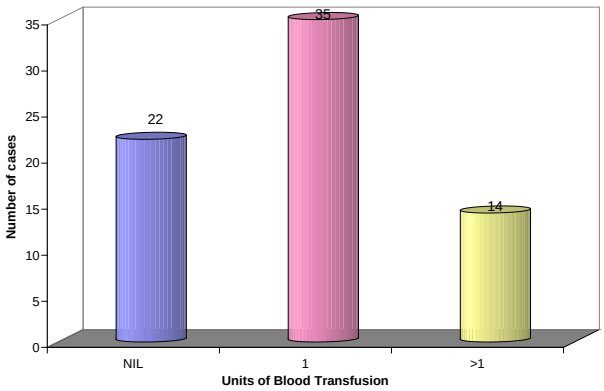

Fig 4: Postoperative blood transfusions.

The total incidence of paravalvular leak (PVL) in our study was 4.2% i.e. 3 patients. Sixteen (22.5%) patients had annular

calcification and two patients (12.5%) out of sixteen patients with annular calcification developed para valvular leak. No significant correlation between annular calcification and incidence of paravalvular leak was found (p=0.062) (TABLE-4).

Table 4: Association of Paravalvular Leak (PVL) with Annular Calcification

Annular Calcification	PVL	
	Present	**Absent**
Present (n=16)	2	14
Absent (n=55)	1	54
Total	3	68

These paravalvular leaks were mild, causing no hemodynamic or hematological derangements, and were treated conservatively none requiring re-operation. There was no incident of prosthetic valve endocarditis, suture breakage or prosthetic valve dehiscence or re-operation.

4 Discussion

The search for ideal valvular prosthesis as postulated by Harken [12] and at the same time surgical techniques aimed to decrease the morbidity and mortality for implanting these prosthetic valves in human heart have undergone tremendous improvements[13],[14] . The various suturing techniques for mitral valve replacement have been debated for long and has been subject to numerous studies and analysis [15], [16]

The continuous suture technique for mitral valve replacement has been subjected to criticism for the following reasons: (1) suture breakage can have devastating results[5] , (2) adequate operative exposure of mitral annulus is sometimes difficult to obtain and (3) paravalvular leak, a known complication after MVR, has been reported to have higher incidence with continuous suture technique [11],[17],[18]. On the other hand continuous suture technique can be advantageous as it simplifies the operative procedure, shortens the cardiopulmonary bypass time, may diminish thrombo-embolic events by reducing the number of suture knots [6] and decreases incidence of prosthetic valve endocarditis by avoiding use of porous pledgets which may harbor bacteria [19]. Furthermore, there is significant reduction in cost to the patient resulting from (1) decrease in cost of surgical disposables i.e. of suture material (USD 8.00 for single Prolene 2-0 suture vs. USD 160.00 for Ethibond 2-0 suture pack for interrupted sutures), (2) from decrease in number of blood units transfused, (3) from shorter ICU stay days and shorter hospital stay, which is very important considering the poor socio-economic status of the patient in developing countries.

Cardiopulmonary bypass is associated with an acute phase reaction of protease cascades, leucocyte, and platelet activation that result in systemic inflammation and may lead to tissue injury. This manifests as subclinical organ dysfunction which produces a clinical adverse effect in patients with limited functional reserve and in those who generate excessive inflammatory response [20],[21],[22] . The various adverse cardiac [23], pulmonary [24], renal [25] and neuro-cognitive [26] side effects are well documented in literature. It is known that shorter the blood- foreign body contact, lesser the inflammatory reaction and faster the patient recovery in post operative period. In our study average cardiopulmonary bypass time time was 50.73±12.48 minutes and mean aortic cross clamp time was 29.86±8.81 minutes. Englberger L. *et al.* [9] who used interrupted sutures for isolated MVR reported an average cardiopulmonary bypass time of 86.7±39.0 minutes and aortic cross clamp time of 63.2±30.3 minutes. A meta-analysis done by Cheng,et al, reported overall cardiopulmonary bypass time of 111 minutes and aortic cross clamp time of of 74 ± 36 minutes with conventional mitral valve surgery [27]. Hellgreen *et al.* [28] found that CPB time on average >180 minutes and aortic cross clamp time >150 minutes increased the risk for early mortality. We found that shorter CPB time was associated with significant lesser inotropic support (p=0.004), shorter ventilatory time (p=0.037), lower mediastinal drainage (p<0.001), lesser units of blood transfusion (PRBC) (p<0.001) and shorter ICU stay (p<0.001). Decrease in aortic cross clamp time resulted in significant (p=0.002) decrease in mediastinal drain in these patients.

Twenty-two percent of patients with paravalvular leaks are reported to be diagnosed in the first week after mitral valve replacement, and another 52% are diagnosed within the first postoperative year [29]. An incidence of 4.2% of paravalvular leak was observed in our study. Ionescu *et al.*,[30] in their prospective study using transesophageal echocardiography reported paravalvular leak to be significantly higher in patients who had undergone mitral valve replacement with continuous sutures vs. interrupted sutures (36 of 88 *i.e.* 41% vs. 2 of 28 *i.e.* 7%). Nair SK *et al.* [18] reported 15% incidence of paraprosthetic regurgitation whereas, Beddermann *et al.* [31] reported incidence of paravalvular leak to range from 3-15% using continuous suture technique. An experimental study of micro vascular patency using continuous suture technique done by Hamilton et al. showed no deleterious effect of continuous suture on microvascular growth at mitral annulus [32]. Gisueppe *et al* [33] reported an incidence of 34% of paravalvular leak in patients who had significant annular calcification. In our study, the incidence of PVL in patients with annular calcification was found to be 12.5 % with no significant statistical correlation between annular calcification and paravalvular leak (p=0.062). This may be attributed to the fact that we aim to thoroughly remove all annular calcification possible before suturing the prosthetic valve at the annulus. Paravalvular leaks lead to turbulent blood flow resulting in hemolysis, decreased hematocrit value and congestive cardiac failure, necessitating blood transfusions. Surgical intervention to repair the leak improves symptoms of congestive heart failure and is an independent predictor of long-term survival when compared with medical therapy [34], [35]. In our study, the PVL's were mild with no resultant hemodynamic instability or hematological derangement, none requiring any re-operation.

We found an average first 24 hours mediastinal drain to be around 258.31±172.53 ml .Spegar *et al.* [36] reported chest drain

to be 460±90 ml in first 24 hrs following mitral valve replacement with interrupted suture technique. Kochamba et *al* [37] reported a twenty four hour mediastinal drainage to be 997±112 ml after valve replacement with average 65 minutes of CPB time. A meta-analysis found chest tube drainage of 871 ± 771 with conventional mitral valve surgery with average CPB time of 111 mins [27].

The average requirement for blood transfusion (PRBC) was 0.94 ± 0.843 units per case. Meta- analysis study of Cheng et al. reported overall units of red blood cells transfusion of 3.5 ± 2.9 U in patients who underwent conventional mitral valve surgery [27] with longer CPB time.

Although six patients in the post operative period had hyper-pyrexia, none of these was significant enough as all of them responded well to a course of oral antibiotics and anti-pyretic. None of these patients had a positive blood culture or any evidence of prosthetic valve endocarditis. Cooley DA [19] reportedly found continuous suture technique to be more secure than interrupted suture technique. We had zero incidence of valve dehiscence, there were no clot or vegetation on valve, no prosthetic infection with both valves having good leaflet motion in our study.There was single mortality (1.4%) which resulted from fatal cerebral thrombo-embolism in patient who was in atrial fibrillation and was found to have left atrial clot preoperatively. These are very much comparable to mortality rate reported in various other studies, mostly below 5% [38], [39].

5 Conclusion

Mitral Valve Replacement with continuous suture technique is safe and very cost effective surgical technique with no significant increase in morbidity or mortality. Rather shorter cardiopulmonary bypass time and shorter aortic cross clamp time leads to improved and shorter ICU course, better post operative hematological parameters, reduced blood transfusion requirement and shorter hospital stay. Cost to the patient was immensely reduced along with better and faster post operative recovery mandating routine use of this technique.

6 Acknowledgment

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