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ORIGINAL ARTICLE

A Comparative Evaluation of Suture Techniques in Mitral Valve Replacement: Impact on Clinical Outcomes

Mitral Kapak Replasmanında Sütür Tekniklerinin Karşılaştırmalı Değerlendirilmesi: Klinik Sonuçlar Üzerindeki Etkisi

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ABSTRACT

Objective: This study aimed to compare the outcomes of mitral valve replacement (MVR) using the intermittent simple suture technique versus the horizontal matrix suture technique with pledgeted in terms of paravalvular leakage and infective endocarditis.
Materials and Method: A retrospective analysis was conducted on 422 patients who underwent MVR between 2019 and 2023. Patients were divided into two groups based on the suture technique used: group B (simple suture technique) and group P (horizontal matrix suture technique with pledgeted). Propensity score matching was performed to balance the groups, resulting in 62 case pairs for comparative analysis.
Results: There were no intraoperative mortalities, and the duration of cardiopulmonary bypass and cross-clamp time did not significantly differ between the two groups. No significant differences were observed in terms of total hospitalization time, early mortality, cerebrovascular events and arrhythmias. Postoperative echocardiography revealed minimal paravalvular leakage in both groups with non-serious leakage observed in four patients in group B and two patients in group P. The incidence of infective endocarditis was one in group B and two in group P. Hemolysis indicators showed higher mean values in the simple suture technique group although not statistically significant.
Conclusion: The study findings suggest that there is no significant difference in the incidence of paravalvular leak and infective endocarditis between the intermittent simple suture technique and the horizontal matrix suture technique with pledgeted. Both techniques can be safely employed in MVR.

Keywords: Infective endocarditis, Mitral valve replacement, Paravalvular leak, Suture technique

ÖZ

Amaç: Bu çalışmanın amacı mitral kapak replasmanında (MKR) aralıklı basit sütür tekniği ile pledgetli horizontal matriks sütür tekniğinin sonuçlarını paravalvüler kaçak ve enfektif endokardit açısından karşılaştırmaktır.
Gereç ve Yöntem: 2019-2023 yılları arasında MKR uygulanan 422 hasta retrospektif olarak analiz edildi. Hastalar kullanılan sütür tekniğine göre iki gruba ayrıldı: grup B (basit sütür tekniği) ve grup P (pledgetli horizontal matriks sütür tekniği). Grupları dengelemek için eğilim skoru eşleştirmesi yapıldı ve karşılaştırmalı analiz için 62 vaka çifti elde edildi.
Bulgular: İntraoperatif mortalite izlenmedi ve kardiyopulmoner baypas süresi ve kros klemp süresi iki grup arasında anlamlı farklılık göstermedi. Toplam hastanede yatış süresi, hastane içi mortalite, serebrovasküler olaylar ve aritmiler açısından iki grup arasında anlamlı fark gözlenmedi. Ameliyat sonrası ekokardiyografide her iki grupta da minimal paravalvüler kaçak saptandı; B grubunda 4 hastada ve P grubunda 2 hastada ciddi olmayan kaçak gözlendi. Enfektif endokardit insidansı B grubunda 1 ve P grubunda 2 idi. Hemoliz göstergeleri istatistiksel olarak anlamlı olmasa da basit sütür tekniği grubunda daha yüksek ortalama değerler gösterdi.
Sonuç: Bu çalışma, aralıklı basit sütür tekniği ile pledgetli horizontal matriks sütür tekniği arasında paravalvüler kaçak ve enfektif endokardit insidansı açısından anlamlı bir fark olmadığını gösterdi. Her iki teknik de MKR'de güvenle kullanılabilir.

Anahtar Kelimeler: enfektif endokardit, mitral kapak replasmanı, paravalvüler kaçak, sütür tekniği

Introduction

There are multiple suture techniques used in mitral valve replacement (MVR). With or without pledgeted intermittent horizontal matrix suture, intermittent simple suture, and continuous suture techniques are the most commonly used suture methods (1). The choice of suture method is important in terms of paravalvular leakage. Although clinical studies are insufficient to show which suture technique is better, certain inconsistencies also exist. The incidence of paravalvular leak has been reported as 1-4% according to the suture technique (2-5). Paravalvular leak can be seen at a rate of 15% in the early postoperative period after mitral valve replacement (6). Heart failure, hemolytic complications or thromboembolic events can be seen due to paravalvular leak (7). Paravalvular leakage is not only limited to the suture technique. Paravalvular leak is also associated with annular calcifications, infection, valve type and size (1). Although major paravalvular leak is seen in infective endocarditis in the presence of annular calcification, it has been reported that the use of pledgeted also increases the risk of infection (8,9). In our clinic, we use a combination of intermittent simple suture technique and horizontal matrix suture technique with pledgeted. In this study, we aimed to

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compare the results of patients who underwent mitral valve replacement with the intermittent simple suture technique and the horizontal matrix suture technique with pledgeted.

Material and Methods

All patients over the age of 18 who underwent MVR between 2019 and 2023 were scanned in the hospital database. This study was approved by Ankara City Hospital Clinical Researches Ethics Committee (Approval Number: E1-22-.2603 Date: 15/06/2022). Retrospectively, 982 patients were screened, and patients who had additional procedures, patients who were operated on for infective endocarditis, and patients under the age of 18, except for those who had simultaneous tricuspid valve intervention, were excluded from the study. Consequently, 422 patients were included in the study. These patients were divided into two groups as simple suture technique or horizontal matrix suture technique with pledgeted during mitral valve replacement.

Demographic information, comorbidities, preoperative postoperative echocardiographic findings, blood test results, reason for mitral valve intervention, presence of postoperative infective endocarditis, intensive care follow-up, intensive care and hospitalization times, complications due to valve replacement and mortality of the patients in the two groups were recorded. Mortality was considered when it occurred during the hospitalization period or within the first 30 days after the operation. Major paravalvular leak was defined by the appearance of signs of severe hemolysis or heart failure.

Operative Technique

After median sternotomy, cardiopulmonary bypass was established by performing aorto bicaval cannulation. Cardiac arrest was achieved by administering antegrade and retrograde Del Nido cardioplegia from the aortic root after aortic cross-clamp. The left atrium and the right atrium were separated from each other through the Waterstone groove and a left atriotomy was performed parallel to the interatrial groove. The anterior leaflet of the mitral valve was excised. If possible, the posterior leaflet and chordae were preserved to ensure ventriculo-annular continuity. In all operations, St. Jude Medical mechanical valve (St. Jude Medical, Inc., St. Paul, Minn.) was used. Appropriate valve size was selected. With the horizontal matrix suture technique (pledget remaining on the atrial face), Ethibond Excel (Ethicon, Somerville, 2-0 pledgeted, NJ, USA) suture was used. Simple intermittent suture technique and 2-0 non-pledgeted Ethibond (Ethicon, Somerville, NJ, USA) sutures were used in other patients. After the prosthesis was seated and the sutures were tied, the left atriotomy was closed with a monofilament 2-0 prolene suture (Ethicon, Somerville, NJ, USA). Air was removed from the left ventricle by transseptal method using a 16G gray intracath (Bıçakcılar, İstanbul, TR). Then aortic cross-clamp was removed. The patient was weaned from cardiopulmonary bypass. After the epicardial pacing wire and drains were placed, the layers were closed in routine fashion.

Data and statistical analysis

Propensity score matching (PSM) was performed to reduce selection bias due to the retrospective nature of the study. Propensity scores were calculated using logistic regression analysis with age, gender, comorbidities, mitral valve lesion grade as covariates. Using the caliper matching method, the patient pairs were matched in propensity scores at a ratio of 1:1 using nearest neighbor within a caliper width of 0.2. As a result of this matching, 62 case pairs were created.

The distribution of continuous variables was analyzed with the Kolmogorov-Smirnov test. Normally distributed continuous variables were given as mean ± standard deviation and non-normally distributed as median (range). Categorical variables were indicated as numbers and percentages. In the comparison of two groups, "independent sample t-test" or "Mann-Whitney-U test" were used for continuous variables. For categorical variables, "chi-square test" or "Fisher exact test" were used. A p value below 0.05 were considered significant. SPSS package program (SPSS for Windows 15.0, Chicago, IL, USA) were used for all statistical analysis.

Results

A total of 422 patients were included, and MVR was performed in 62 patients with the simple suture technique (group B) and in 360 patients with horizontal matrix suture with pledgeted (group P). Propensity Score Matching (PSM) method, which balances the past basic characteristics of the two comparison groups, was applied with caliper matching. Two groups of 62 patients were obtained. After balancing the baseline data of the two groups, a total of 62 case pairs were obtained. A comparative analysis of baseline data of the two groups found no statistically significant differences (Table1).

Mitral valve replacement was successfully performed in both groups, and no intraoperative mortality was observed. There was no statistically significant difference in the duration of cardiopulmonary bypass and cross-clamp time between the two groups ($p>0.05$). There was no significant difference between the two groups in terms of total hospitalization time, early mortality, cerebrovascular event and arrhythmia (Table 2).

Postoperative control echocardiography (ECO) was performed one month later. In the ECO controls, the leakage from the suture margin and the paravalvular leakage that did not cause any hemodynamic impairment was evaluated as minimal. Non-serious paravalvular leakage was seen in four patients who underwent MVR with the simple suture technique. Infective endocarditis was seen in one patient. Non-serious paravalvular leak was observed in two patients, and infective endocarditis was observed in two patients in whom horizontal matrix technique with pledgeted suture was used. LDH and indirect

bilirubin values indicating hemolysis were recorded in postoperative blood tests. It was observed that the mean of both values was higher in patients who used the simple suture technique, but it was not statistically significant (Table 3).

Table 1: Demographic information of the patients, preoperative rhythm, functional classification, etiology, mitral regurgitation, mitral stenosis, cross clamp and cardiopulmonary bypass time. Group B: Simple spaced suture group, non pledgeted, P group: Horizontal matrix suture group with pledgeted.

Variables	Group B (n=62)	Group P (n=62)	P value
Age	55.3±15.4	54.8±15.2	>0.05
Female	37 (59.7%)	37 (59.7%)	>0.05
Hypertension	22 (35.5%)	20 (32.2%)	>0.05
Diabetes Mellitus	13 (21%)	15 (24.2%)	>0.05
Smoking	14 (22.6%)	17 (27.4%)	>0.05
COPD	7 (11.3%)	6 (9.6%)	>0.05
CVO	10 (16.1%)	9 (14.5%)	>0.05
Atherosclerotic Heart Disease	14 (22.6%)	14 (22.6%)	>0.05
CKD	8 (12.9%)	7 (11.2%)	>0.05
Rhythm			
AF	29 (46.8%)	32 (51.6%)	>0.05
NSR	33 (53.2%)	30 (48.3%)	>0.05
NYHA			
I-II	14 (22.6%)	15 (%24.1)	>0.05
III-IV	48 (77.3%)	47 (%75.8)	>0.05
Etiology			
Rheumatic	35 (56.5%)	38 (61.2%)	>0.05
Degenerative	23 (37.1%)	20 (32.2%)	>0.05
Ischemic	2 (3.2%)	1 (1.6%)	>0.05
Flail	2 (3.2%)	3 (4.8%)	>0.05
Mitral regurgitation	36 (58.1%)	32 (51.6%)	>0.05
Mitral stenosis	26 (41.9%)	30 (48.3%)	>0.05
X-clamp time (min)	60.1±61.6	66.2±63.6	0.16
CPB time(min)	100.3±37.6	109.5±39.4	0.22

COPD: Chronic obstructive pulmonary disease, VVO: cerebrovascular accident, CKD: Chronic Kidney Disease, AF: Atrial Fibrillation, NSR: Normal Sinus Rhythm, NYHA: New York Heart Association, CPB: Cardiopulmonary Bypass

Table 2: Early postoperative follow-up of patients

Variables	Group B (n=62)	Group P (n=62)	P value
Mechanical ventilation time (hours)	5.4±1.2	5.6±1.4	>0.05
Total drainage (ml)	430±160	460±180	>0.05
Blood product replacement (unit)	1.7±0.3	1.6±0.4	>0.05
Reexploration	1 (1.6%)	2 (3.2%)	>0.05
ICU staying (day)	1.8±1.1	1.7±0.9	>0.05
Hospitalization (day)	5.5±2.1	5.8±2.4	>0.05
Early term mortality	-	-	-
CVO	1 (1.6%)	1 (1.6%)	>0.05
Arrhythmia	2 (3.2%)	2 (3.2%)	>0.05

Table 3: Postoperative echocardiography and laboratory results. LDH: Lactate dehydrogenase enzyme

Variables	Group B (n=62)	Group P (n=62)	P value
Paravalvular leak	4 (6.4%)	2 (3.2%)	>0.05
Infective endocarditis	1 (1.6%)	2 (3.2%)	>0.05
LDH (U/L)	579.7±252.4	501.4±248.1	>0.05
Indirect bilirubin (mg/dL)	0.71±0.47	0.61±0.42	>0.05

Discussion

Paravalvular leak is one of the events that can be seen after mitral valve replacement and increase mortality and morbidity. (8) Reoperation is inevitable when severe paravalvular leak is seen. (10) The causes of paravalvular leak can be divided into two; factors belonging to the patient and factors related to the surgical technique. The presence of infection and annular calcification can be considered as the patient's own factor. Those associated with the surgical technique; it can be counted as the valve size suitable for the annulus and the suture technique (1).

Various methods are used as suture techniques when performing MVR. Simple intermittent suture technique, continuous suture technique, 8-figure suture technique, horizontal matrix with pledgeted and horizontal matrix suture technique without pledgeted can be used. When the suture technique was compared, it was observed that there was 8% paravalvular leakage in the continuous suture technique (3,11). While Kirsh et al. (12) recommended horizontal matrix sutures with supra-annular pledgeted, Fishman et al. (13) suggested the combination of a non-pledgeted horizontal matrix and intermittent simple suture technique. In our study, paravalvular leakage was observed at a rate of 6.4% in the simple suture technique, and none of these leaks were serious. It was seen in 3.2% of the suture technique with pledget, and the difference was not statistically significant.

In an in-vitro study, the force to cause valve dehiscence with the difference in suture technique was investigated, and it was reported that the suture technique with the highest strength was the horizontal matrix suture with sub-annular pledget, the strength of the simple intermittent suture technique was relatively low among the investigated techniques, and this difference was statistically significant ($p < 0.01$) (14). It is thought that the strength is increased by providing a balanced distribution of force by expanding the surface area with the use of pledget. In our study, although less paravalvular leakage was observed in the pledgeted group, however, this difference was not statistically significant.

One of the complications that may develop after valve replacement is infective endocarditis. Infection usually originates from a thrombus that develops in the seal of the valve or around the annulus. In addition

to the prosthetic material used, it has been reported that the use of sutures and pledget may increase the possibility of infection. This situation is seen more rarely after reendothelialization (15). In our study, it was hypothesized that less endocarditis could be seen in the suture technique that did not use pledget, and less infective endocarditis was observed in the group without pledget in the results, but this difference was not statistically significant. Dhasmana et al. (2) conducted an investigation to determine whether there were differences in the incidence of infective endocarditis based on various suture techniques. Their findings indicated that there was no statistically significant difference when comparing the continuous 1-0 prolene, continuous 2-0 prolene, and matrix suture techniques with pledget.

In studies focused on the aortic valve, a comparison was made between the simple intermittent suture technique and the pledgeted suture technique. It was reported that the cross-clamp time was shorter in the simple intermittent suture technique (16). However, our study did not find a statistically significant difference in cross-clamping time between the two suture techniques.

Limitations

One limitation of our study is its retrospective nature, which may introduce inherent biases and limitations in data collection and analysis. Although the differences between the two groups were tried to be reduced by applying propensity score matching, there were differences and the sample size was small when the two groups were considered. More reliable results can be obtained with higher patient numbers.

Conclusion

When comparing the simple intermittent suturing technique with the horizontal matrix suture technique with pledget, our findings revealed no statistically significant difference in the incidence of paravalvular leak and infective endocarditis. These results suggest that both techniques can be employed safely. However, it is important to note that our study's scope was limited, and further investigations are warranted to ascertain whether these clinical outcomes can be replicated within a larger, prospectively followed patient population.

Ethical Approval

Ankara City Hospital Clinical Researches Ethics Committee, Ref No. E1-22-.2603 Date: 15/06/2022, has approved the study.

Conflict of Interest

Authors declared no conflict of interest.

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Authors' Contributions

Conception: SM, SH, GD, Materials: SM, AY, Data Collection and/or Processing: AY, Analysis and/or Interpretation: AY, SH, Literature Review: GD, Writer: SM, Critical Review: SM, BK

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