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Outcomes of Nonpledgeted Horizontal Mattress Suture Technique for Mitral Valve Replacement

Gun Jik Kim, M.D., Jong Tae Lee, M.D., Young Ok Lee, M.D., Joon Young Cho, M.D., Tak-Hyuk Oh, M.D.

Background: Most surgeons favor the pledgeted suture technique for heart valve replacements because they believe it decreases the risk of paravalvular leak (PVL). We hypothesized that the use of nonpledgeted rather than pledgeted sutures during mitral valve replacement (MVR) may decrease the incidence of prosthetic valve endocarditis (PVE) and risk of a major PVL. ***Methods:*** We analyzed 263 patients, divided into 175 patients who underwent MVR with nonpledgeted sutures from January 2003 to December 2013 and 88 patients who underwent MVR with pledgeted sutures from January 1995 to December 2001. We compared the occurrence of PVL and PVE between these groups. ***Results:*** In patients who underwent MVR with or without tricuspid valve surgery and/or a Maze operation, PVL occurred in 1.1% of the pledgeted group and 2.9% of the nonpledgeted group. The incidence of PVE was 2.9% in the nonpledgeted group and 1.1% in the pledgeted group. No differences were statistically significant. ***Conclusion:*** We suggest that a nonpledgeted suture technique can be an alternative to the traditional use of pledgeted sutures in most patients who undergo MVR, with no significant difference in the incidence of PVL.

Key words: 1. Mitral valve, replacement
2. Suture techniques
3. Morbidity

INTRODUCTION

Valve repair is the preferred surgical treatment for mitral valvular diseases, regardless of the etiology. However, mitral valve replacement (MVR) should be performed in patients for whom mitral valve repair is not suitable for reasons such as extensive leaflet destruction due to endocarditis or heavy calcification of the leaflets and subvalvular apparatus due to rheumatic disease [1]. Major paravalvular leak (PVL) is a serious complication of valve replacement, most commonly seen after surgery for infective endocarditis and in the presence of annular calcification [2]. Some studies have shown that PVL is associated with the use of a small monofilament suture in a continuous suture technique during valve replacement, whereas the use of pledgets during valve replacement had a protective effect against subsequent PVL [3,4]. Most surgeons favor an everting pledgeted horizontal mattress suture technique during MVR because this technique is thought to decrease the incidence of PVL [1]. Prosthetic valve endocarditis occurring within 12 months of valve replacement is defined as early prosthetic valve endocarditis and is a catastrophic complication of cardiac valve replacements with a high mortality [5]. Early prosthetic valve endocarditis is rarely confined to the leaflets alone, but frequently involves the junction of the sewing ring and annulus [6]. We hypothesized that the use of a nonpledgeted horizontal mattress suture tech-

Department of Thoracic and Cardiovascular Surgery, Kyungpook National University Hospital
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Corresponding author: Jong Tae Lee, Department of Thoracic and Cardiovascular Surgery, Kyungpook National University Hospital, Kyungpook National University College of Medicine, 130 Dongdeok-ro, Jung-gu, Daegu 700-721, Korea
(Tel) 82-53-200-5665 (Fax) 82-53-426-4765 (E-mail) leejt@knu.ac.kr

nique during MVR may decrease the incidence of early prosthetic valve endocarditis by reducing the amount of remaining foreign bodies at the junction of the sewing ring and mitral annulus. We also hypothesized that this technique entails a minimal risk of major PVL, even though the hemodynamic stress during left ventricular systole at the junction of the prosthetic ring and annulus is more intense than that following aortic valve replacement. For the last 10 years, we have been using nonpledgeted sutures as a routine technique during MVR, after a long period of using an everting horizontal mattress suture technique.

In this study, we review 10 years of our experience with nonpledgeted sutures during MVR to assess whether this technique is equivalent to a pledgeted technique with respect to operative mortality, the rate of major PVL, and the rate of prosthetic valve endocarditis. A recent study has shown that the nonpledgeted horizontal mattress suture technique during aortic valve replacement is safe and time efficient [7], but no study concerning the use of a nonpledgeted horizontal mattress suture technique during MVR has previously been published.

METHODS

1) Patients

This study was approved by the institutional review board of Kyungpook National University Hospital. The pledgeted suture technique was the standard in our center until 2002. After a transitional period that spanned almost all of 2002, the nonpledgeted technique became standard.

We retrospectively reviewed 591 cases of MVR, with or without other concomitant procedures, from January 1995 to December 2013. From January 2003 to December 2013, the frequency with which we used the nonpledgeted horizontal mattress suture technique increased and ultimately was used in 383 cases over this period (Fig. 1). For this study, we excluded 328 cases that required reoperation, involved patients aged less than 18 years, had no postoperative follow-up, or had combined MVR with aortic valve replacement, aortic valve repair, or aortic root surgery. Thus, we analyzed a total of 263 patients who were classified into two groups. The P group was composed of patients whose surgeries were performed using a pledgeted suture technique from January 1995 to December 2001, and the N group was composed of patients whose surgeries were performed using a nonpledgeted technique from January 2003 to December 2013.

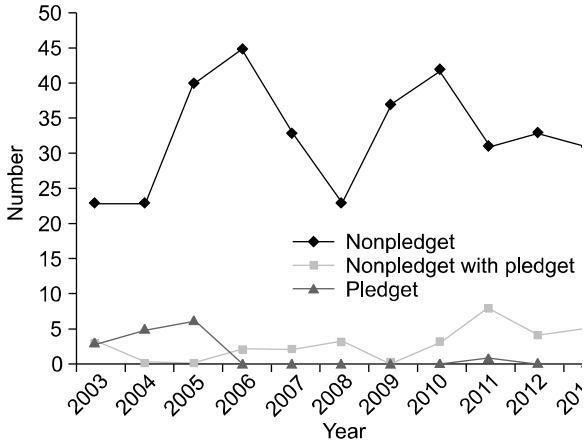

Fig. 1. The number of nonpledgeted sutures gradually increased over this period, albeit with some fluctuations. The simultaneous use of both nonpledgeted and pledgeted sutures remained rare, and pledgeted sutures have been rarely used since 2006.

The patients' demographic characteristics, preoperative variables, operative features, and postoperative outcomes were evaluated. We followed standard guidelines from the Society of Thoracic Surgeons to describe all preoperative and operative variables as well as postoperative mortality and morbidity. Operative mortality included patient deaths occurring before hospital discharge or within 30 days after the operation. The instances of PVL requiring subsequent reoperation for symptoms of congestive heart failure or significant hemolysis were defined as major PVL. Any infections on the mitral prosthesis that required antibiotic therapies for infective endocarditis or reoperation were classified as cases of prosthetic valve endocarditis. The incidence of major PVL was evaluated immediately after MVR using transesophageal echocardiography in the operation room, and transthoracic echocardiography was used to detect major PVL during the postoperative period.

2) Operative technique

After a median sternotomy, transesophageal echocardiography was performed to assess the diseased mitral valve and other lesions in the heart or ascending aorta. After cardiopulmonary bypass was established, the aorta was cross-clamped and the heart was arrested by infusing cardioplegic

solution in the aortic root: Custodiol HTK solution (Kohler Chemie GmbH, Alsbach-Hahnlein, Germany) in the N group and blood cardioplegic solution in the P group. A wide incision in the left atrium was made parallel to the interatrial groove to expose the mitral valve. The anterior mitral leaflet was then excised, sparing the posterior leaflet and its chordae to preserve ventriculoannular continuity. The annulus was properly measured to select an appropriately sized prosthesis. In the N group, 14 to 18 2-0 Ti-Cron sutures (Covidien Syneture, Mansfield, MA, USA) without pledgets were placed in a horizontal mattress fashion from the left atrial side of the annulus to the ventricular side of the annulus. In the P group, 2-0 Ethibond sutures (Ethicon Inc., Somerville, NJ, USA) with pledgets were placed in a similar fashion. After the prosthesis was put in place, the left atrial incision was closed by running non-absorbable polypropylene sutures in two layers, and a vent catheter was placed in the left ventricle for deairing. After deairing, the aortic cross-clamp was then removed. Transesophageal echocardiography was used to verify adequate deairing and to assess the prosthesis for competence and the presence of a PVL. The patient was then weaned from cardiopulmonary bypass, pacing wires and drainage tubes were placed, and the wound was closed layer by layer in the usual surgical fashion.

3) Data collection and statistical analysis

The medical records of the patients included in this study were reviewed. The mean follow-up period was 96.8±76.6 months in the N group and 196.1±129.9 months in the P group. Continuous variables were reported as mean±standard deviation and range. Statistical analyses were performed using Student t-tests and chi-square tests. Moreover, Mann-Whitney U-tests were used to analyze differences in the scores between the groups. All p-values less than 0.05 were considered statistically significant. All statistical analyses were performed using IBM SPSS ver. 20.0 (IBM Co., Armonk, NY, USA).

RESULTS

1) Patient demographics and operative characteristics

A total of 263 patients (88 pledgeted, 175 nonpledgeted) underwent MVR with or without tricuspid valve surgery and/or a Maze operation. In comparing the N and P group, patients in the N group were older than those in the P group (57.5±11.6 years vs. 48.8±10.8 years, p=0.000). In addition, there were significantly more rheumatic patients in the P group and more patients with degenerative diseases in the N group (Table 1). There were more patients with hypertension, diabetes mellitus, and major adverse cardiac and cerebrovascular events in the N group. The type of implanted artificial valve was more often mechanical in the P group, but more frequently a bioprosthesis in the N group. The aortic cross-clamp time and cardiopulmonary bypass time were similar in the two groups (Table 1).

2) Outcome

The operative mortality appeared to be lower in the N group, but the difference was statistically insignificant (p=0.06). Prosthetic valve endocarditis, major PVL, and the need for reoperation occurred with similar frequencies in both groups (Table 2). The causes of postoperative re-exploration were excessive postoperative bleeding in 12 cases, mediastinal hematoma in two cases, and left atrial rupture in one case. Major PVL occurred in five patients in the N group and one patient in the P group (2.9% vs. 1.1%, p=0.38). Delayed PVL developed in three patients in the N group (1.7%).

DISCUSSION

This study suggests that the nonpledgeted suture technique can be used as safely as the conventional pledgeted suture technique, with clinically indistinguishable results in terms of operative mortality and the incidence of major PVL and prosthetic valve endocarditis.

Mitral prostheses can be inserted using different suture techniques including interrupted sutures, continuous sutures, pledgeted horizontal mattress sutures, and nonpledgeted horizontal mattress sutures [1]. Major PVL after MVR is a rare but serious complication that usually leads to reoperation [8]. According to previous studies on the relationship of suture techniques with materials and the incidence of major PVL, the use of pledgets for valve replacement had a protective effect against subsequent PVL, whereas the use of a small monofilament suture with a continuous suture technique dur-

Table 1. Preoperative and operative variables for patients undergoing mitral valve replacement, with or without tricuspid valve surgery and Maze operation, comparing nonpledgeted versus pledgeted suture procedures (n=263)

Variable	Pledgeted (n=88)	Nonpledgeted (n=175)	p-value
Preoperative			
Age (yr)	48.8±10.8	57.5±11.6	0.000
Sex (female)	68 (77.3)	113 (64.6)	0.036
Hypertension	4 (5.8)	41 (23.4)	0.001
Major adverse cardiac and cerebrovascular event	12 (17.4)	55 (31.4)	0.027
Diabetes mellitus	3 (4.3)	28 (16.0)	0.014
Atrial fibrillation	62 (70.5)	110 (62.9)	0.222
New York Heart Association class			0.206
I–II	13 (15.1)	38 (21.7)	
III–IV	73 (84.9)	137 (78.3)	
Etiology			0.007
Rheumatic	60 (67.4)	81 (46.6)	
Degenerative	15 (16.9)	44 (25.1)	
Prosthetic valve failure	9 (10.1)	29 (16.7)	
Infective endocarditis	4 (4.5)	21 (12.0)	
Renal failure	2 (2.9)	11 (6.3)	
Left ventricular ejection fraction severe dysfunction (<30%)	2 (2.8)	7 (4.0)	0.641
Dominance of mitral disease			0.050
Mitral stenosis	57 (68.7)	96 (55.8)	
Mitral regurgitation	26 (31.3)	76 (44.2)	
Operative			
Prosthesis type			0.000
Bioprosthesis	7 (8.0)	111 (63.4)	
Mechanical prosthesis	81 (92.0)	64 (36.6)	
Valve size (mm)			0.057
25	4 (4.5)	0	
27	36 (40.9)	72 (41.1)	
29	39 (44.3)	81 (46.3)	
31	7 (8.0)	20 (11.4)	
33	2 (2.3)	2 (1.1)	
Aortic cross-clamp time (min)	76.0±29.9	79.0±25.0	0.426
Cardiopulmonary bypass time (min)	123.0±52.4	120.6±43.0	0.714

Values are presented as mean±standard deviation or number (%).

Table 2. Postoperative morbidity and mortality for patients undergoing mitral valve replacement, with or without tricuspid valve surgery and Maze operation (n=263)

Variable	Pledgeted (n=88)	Nonpledgeted (n=175)	p-value
Acute renal failure	1 (1.4)	7 (4.0)	0.314
Reoperation for bleeding	1 (1.4)	15 (8.6)	0.043
Low cardiac output syndrome	7 (10.1)	7 (4.0)	0.063
Arrhythmias	11 (15.9)	29 (16.6)	0.905
Stroke	9 (13.0)	10 (5.7)	0.054
Prosthetic valve endocarditis	1 (1.1)	5 (2.9)	0.368
Major paravalvular leak	1 (1.1)	5 (2.9)	0.378
Reoperation for paravalvular leak	0	3 (1.7)	0.217
Early mortality	5 (7.4)	4 (2.3)	0.060

Values are presented as number (%).

ing valve replacement was strongly associated with developing a PVL [3,4]. Pledgeted horizontal mattress sutures with large braided suture materials have long been used as a standard suture technique for MVR [1]. One study has demonstrated that the use of a nonpledgeted horizontal mattress suture technique during aortic valve replacement did not increase the rate of PVL in comparison with the use of a pledgeted suture technique [7]. In the present study, a major PVL occurred in 1.1% of patients in the P group and 2.9% of patients in the N group, which was a non-significant difference.

Prosthetic valve endocarditis is another serious complication of valve replacement, associated with subsequent operative interventions and a high mortality rate [8]. Infections in mechanical valves generally involve the sewing ring or the adherent thrombi around the annulus, leading to PVLs, ring abscesses, and invasive infection [9]. Infections in bioprostheses occur in the junction of the sewing ring and annulus less frequently than in the mechanical valves, but once the junction of the sewing ring and annulus become infected, the pathogenesis is the same as for mechanical valves [10,11]. For some time, St. Jude Medical, Inc. (Minneapolis, MN, USA) manufactured a mechanical valve with a silver-coated sewing ring to reduce prosthetic valve endocarditis, based on studies documenting the safety and efficacy of silver for antimicrobial protection [12]. However, the manufacturers soon withdrew this valve from the market because it led to an increased risk of PVL requiring reoperation [12]. Few studies have investigated ways of reducing prosthetic valve endocarditis by improving suture techniques or materials. Early prosthetic valve endocarditis by definition occurs within 12 months of valve replacement; it frequently involves the junction of the sewing ring and annulus, leading to valve dehiscence and paravalvular abscesses [13]. Before endothelialization occurs on the sewing ring, suture threads, and pledgets, it is easier for microorganisms in the bloodstream to adhere to the surface of these components or to invade blood clots that are in contact with them. This kind of infection occurs less frequently after endothelialization is completed [9]. We hypothesized that a nonpledgeted suture technique during valve replacement would result in a lower incidence of early prosthetic valve endocarditis compared with the pledgeted suture technique. Dhasmana et al. [3], comparing continuous 2-0, continuous 1-0, and pledgeted mattress sutures, reported that the incidence of prosthetic valve endocarditis was not affected by the suture technique used during MVR. Our study showed that prosthetic valve endocarditis occurred in 1.1% and 2.9% of patients in the N and P groups, respectively, which was a non-significant difference. When the sutures are placed on the mitral annulus after the anterior mitral leaflet is excised, the nonpledgeted mattress suture technique eliminates the surgical steps of properly positioning the pledgets and removing the pledgets left buried in the annulus if valve surgery is performed again. It also allows a clear view of the space between stitches, facilitating the efficient insertion of the next stitch. A clinical study of aortic valve replacement has demonstrated that the nonpledgeted technique resulted in significantly shorter aortic cross-clamp and cardiopulmonary bypass times than the pledgeted technique [6]. In our study, the two techniques showed no statistically significant differences in the aortic cross-clamp time and cardiopulmonary bypass time.

1) Limitations

The limitations of this study include the small sample size, poorly matched patient demographic characteristics, and different follow-up times between the two groups.

2) Conclusion

We suggest that the nonpledgeted horizontal mattress suture technique might be used as safely as the traditional pledgeted suture technique during MVR, with no significant increase in the incidence of PVL. Further studies are necessary to determine whether these clinical outcomes can be reduplicated in a larger, prospectively followed patient population.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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