Continuous Suture Technique for Aortic Valve Replacement: Technical Considerations and Controversies

Sotiris C. Stamou, MD, PhD¹ Ellie A. Moeller, BS¹ Marcos A. Nores, MD¹

¹Department of Thoracic and Cardiovascular Surgery, JFK Medical Center, Atlantis, Florida

Address for correspondence Sotiris C. Stamou, MD, PhD,
180 JFK Dr, Suite 320, Atlantis, FL 33462
(e-mail: Sotiris.stamou@hcahealthcare.com).

Int J Angiol 2019;28:64–68.

Abstract

Keywords

- aortic valve replacement
- continuous suture technique

Continuous suture technique (CST) for aortic valve replacement (AVR) is a simple, secure, and fast surgical technique that has been shown to significantly decrease cross clamp time and cardiac bypass time, ultimately resulting in decreased myocardial ischemic injury, operation time, and hospital stay. However, previous studies have reported increased risk of periprosthetic regurgitation with CST for AVR. We describe our technique for AVR using CST in 100 patients with low complication rate and no perioperative paravalvular aortic insufficiency.

Surgical aortic valve replacement (AVR) improves symptoms and prolongs survival in patients with senile calcific aortic valve stenosis, the most common valvulopathy in elderly patients.^{1,2} This procedure can be performed using either a continuous (CST) or interrupted suture technique (IST).^{1,2} Several studies have compared the efficacy and long-term outcomes of both techniques, although there is still controversy on CST for AVR in the recent literature.^{3,4}

The primary advantages of CST over IST are its speed, reproducibility, simplicity, and safety; CST has been shown to significantly decrease cross clamp time and cardiac bypass time, ultimately resulting in decreased myocardial ischemic injury, operation time, and hospital stay.³ However, previous studies questioned the efficacy of CST, since it was associated with increased risk of paravalvular leak (PVL).² The primary objective of our study was to describe the CST technique for surgical AVR, employed in 90 patients.

Patients and Methods

Study Design and Conduct

This is a retrospective cohort study of prospectively collected data from consecutive patients who underwent AVR with CST, by the senior author (MN), at JFK Medical Center ($n = 100$). Early PVL is defined as PVL identified intraoperatively and is diagnosed by transesophageal echocardiography. In our series, no patients exhibited early PVL. Additionally, in our series no

patients were diagnosed or required reoperation for PVL. Study approval was obtained from the Western Institutional Review Board. Patient confidentiality was maintained at all times, consistent with the Health Insurance Portability and Accountability Act of 1996 regulations.

Surgical Technique

After median sternotomy, cardiopulmonary bypass was initiated via aortic and right atrial cannulation. An aortic root vent was placed. The aorta was cross-clamped and a dose of 1 L del Nido cardioplegia was administered in antegrade fashion. A left ventricular vent was placed via the right superior pulmonary vein. In patients with aortic insufficiency, del Nido cardioplegic solution was administered directly into the coronary ostia. The field is flooded with CO₂. An oblique aortotomy was performed toward the nadir of the noncoronary sinus. Three 4–0 Ethibond retraction sutures were placed above each of the aortic commissure. These sutures were placed on tension and attached to the chest wall so as to bring the aortic annulus into full view and optimize the exposure. The aortic valve was resected and the annulus completely decalcified. An appropriate valve prosthesis was selected. Three polypropylene sutures (3–0), 48 inches in length with needles at each end, were used. We started at the junction of the right and left commissure in a “counter clock-wise” direction toward the left noncoronary commissural junction. The needle was passed from the ventricular side of the annulus, toward the aortic side, and then through the sewing

Fig. 1 Intraoperative photograph shows the prosthesis being held firmly ~3 mm above the aortic annulus during suturing. Equidistant spacing of the sutures is important. Distance between sutures was kept at a 3 mm on the cuff of the prosthesis.

cuff of the prosthetic valve from top to bottom (► **Fig. 1**). The stitches were spaced ~3 mm apart to assure good coaptation. This process was repeated in each remaining non- and right coronary cusp. Once the sewing cuff for the right coronary leaflet was completed, we used rubber-tipped hemostats to hold this needle and the needle of the second suture together. At this point, a loop of 0 silk suture was placed around the polypropylene suture in the middle of the nadir of each sinuses subsequently. This silk “pulley” loop was held by a hemostat to be used to adjust tension on the suture line. The prosthetic valve was then lowered to the annulus as one pulls on the stitches and the “pulley” stitch simultaneously (► **Fig. 2**). At that time, the tension of the stitch is adjusted by carefully pulling the stitches from within the valve with the assistance of a “nerve-hook,” making sure there is appropriate coaptation of the sewing ring of the valve prosthesis and the left ventricular outflow tract tissue. We like to start the process from the nadir of each segment and

Fig. 2 Intraoperative photograph illustrates the three silk “pulley” traction sutures. Traction is placed on the three silk “pulley” loop sutures to bring the prosthesis into the annulus of the aortic valve. Then, two strings of each forceps are pulled individually, and the loops at the nadir are tightened.

continue toward each commissure. Once each segment was tightened, the two extremes of the different segments were tied together. Any discrepancy in the spacing was noticed by careful examination of the placement from within the left ventricular outflow tract side. An occasional pledgeted 2–0 Ethibond suture was used to correct the discrepancy. Finally, the aortotomy was closed with a double layer of 4–0 polypropylene suture. The patient is weaned off cardiopulmonary bypass, once the heart is deaired and sinus rhythm is restored.

Results

Preoperative Characteristics

From February 2016 to December 2017, 100 patients underwent AVR using CST. Patient preoperative characteristics are presented in ► **Table 1**. The majority were female (65%) and had hypertension (83%). Indications included aortic stenosis ($n = 77$), aortic insufficiency ($n = 13$), and aortic valve endocarditis ($n = 3$). Other indications included radiation valve disease ($n = 1$), bioprosthetic aortic valve severe PVL status post AVR at another facility ($n = 1$), subaortic membrane ($n = 1$), and aortic valve bioprosthetic degeneration ($n = 4$).

Operative Characteristics

Operative patient characteristics are presented in ► **Table 2**. Valve size was expressed in millimeters (mm) in 93 patients (93%). The most commonly deployed valve size was 23 mm ($n = 33$), followed by 25 mm ($n = 27$). Median cross clamp time was 68 minutes (IQR, interquartile range, 54–85.5) and median cardiopulmonary bypass time was 79 minutes (IQR, 34–79). Majority of patients underwent AVR with CST without concomitant procedures (65%).

Postoperative Characteristics

Postoperative patient characteristics are presented in ► **Table 3**. In our series, no patients exhibited early PVL (0%). Additionally, no patients in our series were diagnosed with or required reoperation for PVL (0%). Early postoperative complications included atrial fibrillation (31%) and cardiac arrest (4%). Two patients required reoperation for bleeding complications and no patients required reoperation

Table 1 Preoperative characteristics ($n = 100$)

Age (years)	70 (62–79)
Females	65 (65%)
Prior cardiac surgery	13 (13%)
COPD	24 (24%)
Diabetes	36 (36%)
Hemodialysis	5 (5%)
Congestive heart failure	14 (14%)
Hypertension	83 (83%)
Prior myocardial infarction	9 (9%)
Previous cerebrovascular accident	5 (5%)

Abbreviation: COPD, chronic obstructive pulmonary disease. Values expressed as n (%) or median.

Table 2 Operative patient characteristics (*n* = 100)

Bioprosthesis size	
19 mm	3 (3%)
21 mm	18 (18%)
23 mm	33 (33%)
25 mm	27 (27%)
27 mm	9 (9%)
29 mm	3 (3%)
Cross clamp time (minutes)	68 (54–85.5)
CPB time (minutes)	79 (34–97)
Concurrent procedure	
CABG	30 (30%)
Maze procedure	9 (9%)

Abbreviations: CABG, coronary artery bypass graft; CPB, cardiopulmonary bypass.

Values expressed as *n* (%) or median (IQR, interquartile range).

Table 3 Postoperative outcomes

Atrial fibrillation	31 (31%)
Cardiac arrest	4 (4%)
Reoperation	2 (2%)
Bleeding complication	2 (2%)
Valve dysfunction	0 (0%)
Blood transfusion	56 (56%)
ICU stay, hours	49 (32.8–84.2)
Prolonged ventilation (> 24 hours)	13 (13%)
Hospital length of stay, days	7 (1–11)
Readmission	16 (16%)
Paravalvular leak	
None	100 (100)
Operative mortality	2 (2%)

Abbreviation: ICU, intensive care unit.

Values expressed as *n* (%) or median (IQR, interquartile range).

for valvular dysfunction. Operative mortality (death within 30 days or in-hospital mortality) was 2%.

Discussion

A CST provides several advantages for AVR compared with the IST. CST is more hemostatic than the IST, provided equal and precise spacing of sutures is applied; thus, the incidence of PVL is lower. Moreover, the CST uses monofilament suture, removing the suture interstices encountered in braided suture material employed in the IST which may harbor bacteria or fibrin clot.⁵ There are only three knots in the continuous technique; thus, the chances for thrombus formation and embolism at the knot are reduced, compared with the IST. Furthermore, CST avoids use of pledgeted material; thus, a slightly larger prosthesis might be accommodated in the aortic annulus. In our experience, CST provides excellent exposure of the aortic annulus, allows more uniform approximation of the annulus to the sewing ring of the prosthesis, and an improved overall appearance of valve placement when complete. Finally, it is easier to exchange the prosthesis should reoperation be required as the continuous suture needs only be divided at one point in each sinus and the prosthesis lifted away from the annulus by blunt or sharp dissection.⁵

Previous authors have showed continuous suturing is associated with significantly shorter cross-clamp time than that of interrupted suturing (► **Table 4**).³ The CST, although comparatively faster than interrupted suturing, has been associated with a higher incidence of PVL.² There has been some controversy regarding the increased incidence of perivalvular leak with the CST for AVR. Hjelms et al⁶ reported that the incidence of perivalvular leak was 8.8% in 80 patients undergoing AVR with the CST. Because the incidence of PVL was as high as 26% among patients with pure aortic insufficiency, the authors recommended against CST in patients with pure aortic insufficiency. In a recent study² with a 10-year follow-up after AVR, the incidence of moderate-to-severe PVL was 12% in the CST group, while the incidence was 0% in the IST group. However, other authors reported that the incidence of PVL with the CST was comparable to that of the IST. Dhasmana et al⁷ reported that PVL was unrelated to the suture technique (CST vs IST), but

Table 4 Studies on IST for AVR

Study	Advantages	Limitations
Stamou et al (this paper)	Cohort study of 90 patients with successful outcomes. Provides in-depth description of continuous suture technique	Does not compare CST with IST
Kitamura et al ³	Retrospective study of 60 patients who underwent AVR with CST or IST. Compares postoperative outcomes	Small sample size, no long-term outcome or PVL reported
Qicai et al ⁴	Retrospective study of 103 patients who underwent AVR with CST with some modification or IST. Compares postoperative outcomes for up to 35 months	Does not provide comprehensive description of either technique
Hjelms et al ⁶	Retrospective study of 80 patients who underwent AVR with CST or IST. Compares postoperative outcomes	Procedural era minimizes significance of outcomes

Abbreviations: AVR, aortic valve replacement; CST, continuous suture technique; IST, interrupted suture technique; PVL, paravalvular leak.

was related to suture size and annular calcification. They suggested the importance of meticulous annular decalcification and the use of a suture of smaller size, as in our experience. Furthermore, the CST allows avoidance of pledgets in patients with endocarditis, thus preventing recurrence. It also allows implantation of relatively larger prosthesis as compared with the IST.

Limitations

Our study's retrospective, observational design has inherent limitations. As this investigation was conducted at a single, high-volume tertiary facility, it is vulnerable to referral bias that may affect its generalizability. Among the strengths of this study are the prospective entry of all data elements into a cardiac surgical research database with strict definitions and careful selection of patients for AVR.

Conclusions

This study shows excellent outcomes for patients undergoing AVR with the outlined CST. Our series demonstrate that CST may be employed without postoperative PVL and allows the implant of larger aortic valve prostheses.

Disclaimer

This research was supported (in whole or in part) by HCA Healthcare and/or an HCA Healthcare affiliated entity.

The views expressed in this publication represent those of the author(s) and do not necessarily represent the official views of HCA Healthcare or any of its affiliated entities.

Conflict of Interest

None declared.

References

- 1 Choi JB, Kim JH, Park HK, et al. Aortic valve replacement using continuous suture technique in patients with 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* 2015;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, et al. Continuous-suture technique in aortic valve replacement. *J Card Surg* 2006;21(02):178–181
- 5 Doty DB, Nelson RM. Aortic valve replacement: continuous-suture technique. *J Card Surg* 1986;1(04):379–382
- 6 Hjelms E, Vilhelmsen R, Rygg IH. Continuous suture technique in prosthetic aortic valve replacement. *J Cardiovasc Surg (Torino)* 1982;23(02):145–148
- 7 Dhasmana JP, Blackstone EH, Kirklin JW, Kouchoukos NT. Factors associated with periprosthetic leakage following primary mitral valve replacement: with special consideration of the suture technique. *Ann Thorac Surg* 1983;35(02):170–178