Texas Heart Institute Journal

Case Reports

Aortic Root Dissection Due to an Automated Fastener Device

Ismael A. Salas De Armas, MD[1]; L. Maximilian Buja, MD[2]; Manish K. Patel, MD[1]; Jayeshkumar Patel, MD[1]; Mehmet H. Akay, MD[1]; Emre Gok, MD[1]; Igor D. Gregoric, MD[1]

[1]Department of Advanced Cardiopulmonary Therapies and Transplantation, The University of Texas Health Science Center at Houston (UTHealth), Houston, Texas
[2]Department of Pathology and Laboratory Medicine, UTHealth, Houston, Texas

Minimally invasive aortic valve replacement through a right thoracotomy is frequently performed in patients with aortic valve disease. The Cor-Knot Device (LSI Solutions) is an automated fastener that secures valve sutures.

This case report is for a patient who developed postcardiotomy shock during a minimally invasive aortic valve surgery. The patient was found to have an aortic root dissection involving 90% of the aortic root circumference, including bilateral coronary ostia. The autopsy revealed that the aortic damage could be explained by a direct aortic intimal tear from the distal tip of the device shaft. The device was most likely not in perfect apposition to the sewing ring because of the restricted angle and space between the ribs. ***(Tex Heart Inst J. 2022;49(6):e207531)***

Citation:
Salas De Armas IA, Buja LM, Patel MK, Patel J, Akay MH, Gok E, Gregoric ID. Aortic root dissection due to an automated fastener device. *Tex Heart Inst J.* 2022;49(6):e207531. doi:10.14503/THIJ-20-7531

Keywords:
Aortic dissection; minimally invasive surgery; heart valve

Corresponding author:
Igor D. Gregoric, MD, Department of Advanced Cardiopulmonary Therapies and Transplantation, The University of Texas Health Science Center at Houston, 6400 Fannin, Suite 2350, Houston, TX 77030

E-mail:
igor.d.gregoric@uth.tmc.edu

Minimally invasive aortic valve replacement through a right thoracotomy has gained acceptance as an effective procedure to address aortic valve disease.[1] During valve surgery, interrupted sutures secure the valve and require 7 to 8 knots. Generally, at least 12 sutures are placed. The Cor-Knot device (LSI Solutions) secures valve sutures during open and minimally invasive surgery. The device replaces the usual hand-tied surgical knots, thereby saving operative time. This is especially helpful in constricted operative fields such as those involving a minimally invasive approach when knot pushers are necessary.[2]

The most common complications related to a minimally invasive valve replacement approach include paravalvular leak, need for a pacemaker, stroke, bleeding, renal failure, and vascular access complications.[3] Aortic root dissection is a rare complication during aortic valve surgery.

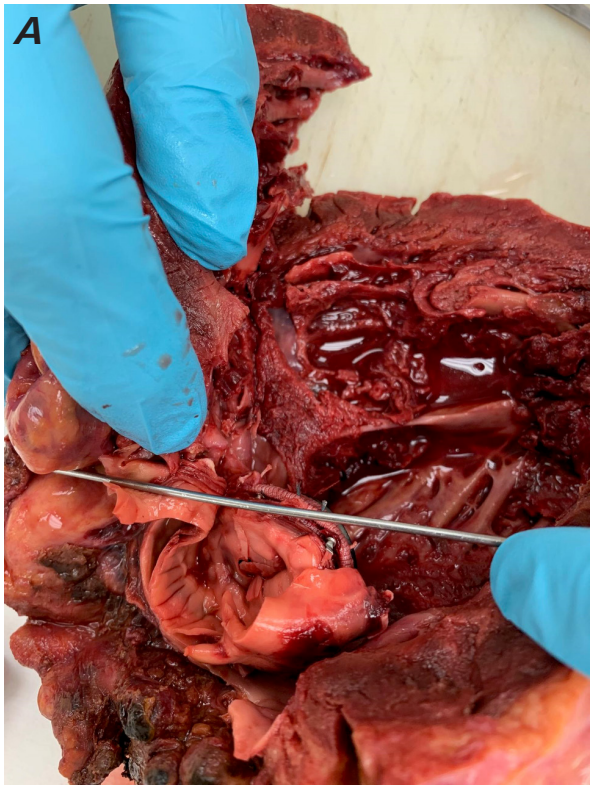
In this report, we described a patient whose autopsy confirmed aortic root dissection with limited flow through the coronary ostium and extensive infarct, which may be related to the application of the automated fastener device (Cor-Knot) using a right thoracotomy approach.

Case Report

A 30-year-old male with previous hypertension and diabetes mellitus presented to an outside hospital with dyspnea and was found to have infective endocarditis complicated with aortic insufficiency. The patient underwent a minimally invasive aortic valve replacement through a right thoracotomy, which was converted to a full sternotomy because of cardiogenic shock that required extracorporeal membrane oxygenation (ECMO) placement. The patient was transferred to our hospital. He arrived in multiorgan failure with no pulsatility. The left ventricle was distended, and the patient had pulmonary edema. The electrocardiogram revealed no Q waves; however, some repolarization and ST abnormalities were noted. We placed a left ventricular vent through the right superior pulmonary vein to unload the left ventricle. After maximal support, the multiorgan failure symptoms did not reverse. Care was withdrawn, and the patient expired.

The postmortem investigation showed a hypertrophic heart with a heart weight of 900 g and a left ventricular wall thickness of 2.4 cm. The prosthetic mechanical aortic

valve was in place with Cor-Knot sutures (Fig. 1). An organizing thrombus entirely occluded the mechanical valve on the aortic side. An aortic root intimal dissection with organizing circumferential aortic thrombus was also present (Fig. 1A and Fig. 1B). Histological examination showed that the dissection involved a separation of the intima from the media (Fig. 2A and Fig. 2B). However, neither the transthoracic echocardiogram nor the transesophageal echocardiogram showed any aortic flap that suggested dissection. The aortic root dissection involved 90% of the aortic root circumference, affecting the bilateral coronary ostia. Both the left anterior descending and right coronary artery ostia were also occluded by thrombi (Fig. 2C). Massive premortem thrombi filled the left ventricular cavity. Extensive areas of ischemic changes were identified in the bilateral ventricles.



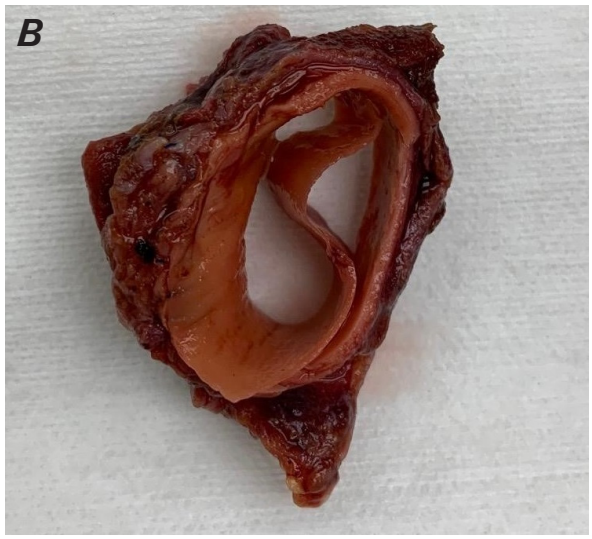


***Fig. 1 A**) Opened left ventricle showing the mechanical prosthetic valve attached with Cor-Knot sutures to the aortic annulus. The dissection flap is in the posterior aorta. The probe points to the occluded left main coronary artery. A thrombus on the surface of the prosthesis has been removed, but the clot in the ventricle is seen. **B**) The aortic root, showing dissection flap.*

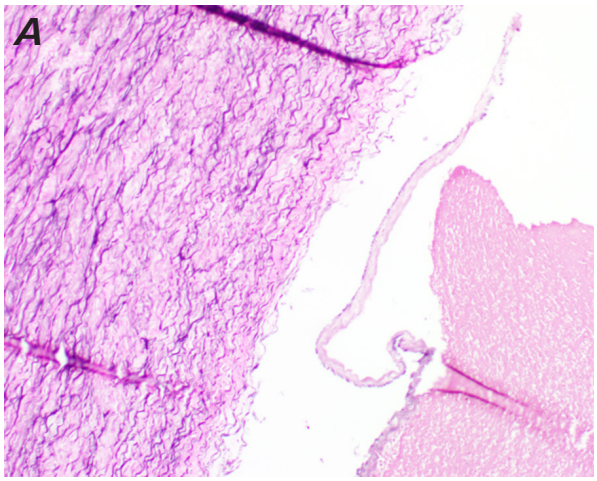
Discussion

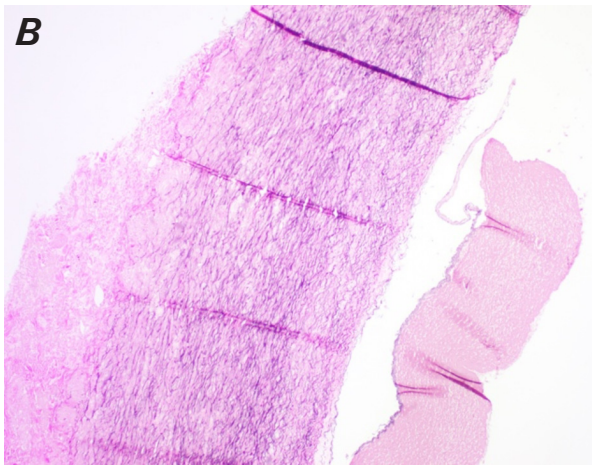
There have been reports about the potential benefit of minimally invasive valve surgery; however, limited working space for exposure and implantation represents a disadvantage in cardiac surgery. To overcome practical issues, surgeons using a minimally invasive approach for aortic valve replacement are work with sutureless valves[4] or automated fastener devices,[5] among other techniques. The latest reports have shown shorter operative times with automated fastener devices than those with hand-tied knots or knot pushers.[2]

Nevertheless, specific adverse events related to the Cor-Knot device, including leaflet perforations[6] and delayed metallic embolization, have been published.[7] To the best of the authors' knowledge, there are no reports of aortic root dissection with this device.

Acute aortic dissection is an infrequent and devastating complication during aortic valve surgery, especially if undetected intraoperatively. In the autopsy, the initial aortic tear appeared directly above the titanium fastener (Fig. 1). This resulted in a dissection lifting the intima from the media (Fig. 2). This damage could be explained by a direct tear from the distal tip of the device shaft, which may not have been in perfect apposition (perpendicular orientation) to the sewing ring owing to the restricted space between the ribs (Fig. 3). It is also possible that the metallic fastener produced repetitive trauma on the aortic wall, causing disruption. However, another mechanism for aortic wall tear damage could be aortic wall manipulation resulting from instrument use during annular measurement, placement of annular sutures, and valve positioning, although these seem to be less likely. Although the dissection was not directly observed in the procedure, the pathology report strongly supports the theory that the device was the cause of the dissection. The pathogenesis of the dissection appears to be related to aortic root trauma secondary to either the distal tip of the shaft from the Cor-Knot device or aortic trauma from the fastener metal clip.

The aortic dissection likely compromised the coronary flow, which explains the postcardiotomy syndrome and the need for ECMO. Patients with a mechanical valve requiring ECMO constitute a unique situation.





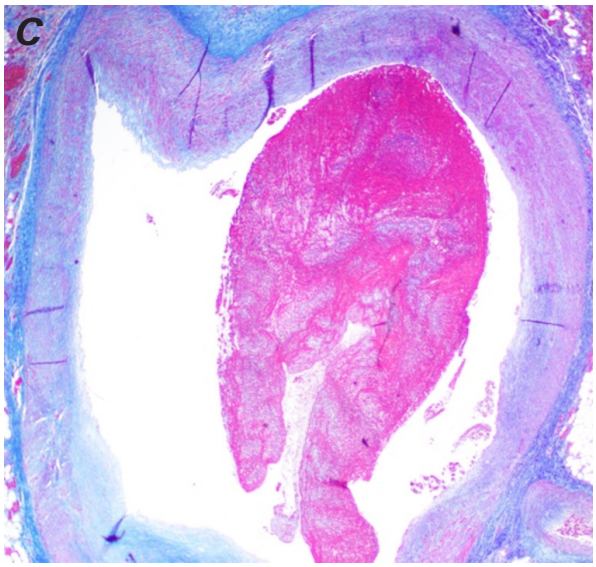


Fig. 2 *Histological findings.* ***A****) The dissection is at a plane between the thin intima and the media; there is a superimposed thrombus (elastic tissue stain, low magnification with ×4 lens).* ***B****) A closer view of the dissection plane (elastic tissue stain, medium magnification with ×10 lens).* ***C****) The proximal coronary artery with thrombus (trichrome stain, low magnification with ×2 lens).*

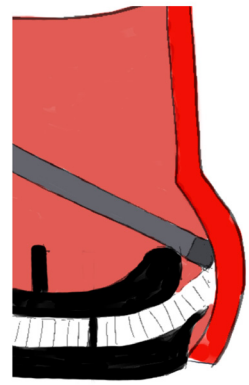


Fig. 3 *The angle between the distal shaft of the Cor-Knot device and the sewing ring is not perpendicular and could cause intimal damage.*

Extracorporeal membrane oxygenation increases the afterload; consequently, the left ventricle is often unable to generate enough intraventricular pressure to overcome the aortic pressure. Thus, the aortic mechanical valve remains closed and increases the chances of thrombus formation and ventricular distention due to continuous pulmonary vein return. This explains the organizing thrombus occluding the mechanical valve found during the autopsy. The ventricular distention can increase the wall's tension. The subsequent increase in myocardial oxygen consumption can lead to myocardial ischemia and pulmonary edema.

Conclusion

The objective of this case report is to raise awareness regarding this mortal complication. When visualization is obfuscated, it is imperative that caution be used. Aortic dissection with coronary involvement should always be considered as an acute complication during open-heart surgery, especially in patients with cardiogenic shock.

The authors believe the minimally invasive approach may have contributed to the dissection. The manufacturer recommends placing the distal tip of the device shaft on the prosthetic sewing ring, and this apposition must be achieved. However, using the Cor-Knot device via the minimally invasive approach may limit the visualization of the placement of the device's tip, especially during a small right thoracotomy where proper angulation of this device is limited. Awareness among surgeons about the importance of always obtaining complete visualization of the shaft and sewing ring and the perpendicular apposition between them at all times is vital. Automated fasteners improve operative times, but caution during application should be used. If the surgical approach obscures direct visualization, alternative methods are advised.

Acknowledgments

The authors would like to thank Dr Biswajit Kar for his contributions to the case and manuscript. Thanks are also extended to Drs Jessica Moody and Michelle Sauer for editorial assistance.

Published: 30 November 2022

Conflict of Interest Disclosures: The authors received educational/travel support or attended catered events; the activity does not present a conflict of interest.

Funding/Support: None.

References

1. Phan K, Xie A, Di Eusanio M, Yan TD. A meta-analysis of minimally invasive versus conventional sternotomy for aortic valve replacement. *Ann Thorac Surg*. 2014;98(4):1499-1511. doi:10.1016/j.athoracsur.2014.05.060
2. Grapow MT, Mytsyk M, Fassl J, et al. Automated fastener versus manually tied knots in minimally invasive mitral valve repair: impact on operation time and short- term results. *J Cardiothorac Surg*. 2015;10:146. doi:10.1186/s13019-015-0344-4
3. Glauber M, Ferrarini M, Miceli A. Minimally invasive aortic valve surgery: state of the art and future directions. *Ann Cardiothorac Surg*. 2015;4(1):26-32. doi:10.3978/j.issn.2225-319X.2015.01.01
4. Glauber M, Miceli A. Minimally invasive aortic valve replacement with sutureless valve is the appropriate treatment option for high-risk patients and the "real alternative" to transcatheter aortic valve implantation. *J Thorac Cardiovasc Surg*. 2016;151(3):610-613. doi:10.1016/j.jtcvs.2015.10.028
5. Beute TJ, Oram MD, Schiller TM, et al. Use of an automated suture fastening device in minimally invasive aortic valve replacement. *Ann Thorac Surg*. 2018;106(1):58-62. doi:10.1016/j.athoracsur.2018.01.073
6. Brescia AA, Bolling SF, Patel HJ. Valvular regurgitation after implantation of prostheses secured with Cor-Knot automated fasteners. *Ann Thorac Surg*. 2017;103(6):e491-e492. doi:10.1016/j.athoracsur.2016.11.035
7. Garrett HE Jr. Delayed metallic embolization of a Cor-Knot fastener. *Thorac Cardiovasc Surg Rep*. 2017;6(1):e40-e41. doi:10.1055/s-0037-1612613