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ORIGINAL ARTICLE / ÖZGÜN MAKALE

Dilated sinuses of Valsalva subsequent to type A dissection surgery: Is reoperation inevitable?

Tip A diseksiyon cerrahisi sonrasında sinüs Valsalva dilatasyonu: Yeniden ameliyat kaçınılmaz mı?

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ABSTRACT

Background: This study aims to investigate the dilation of sinus valsalva in patients who underwent aortic repair due to type A aortic dissection and to evaluate its progression.

Methods: Between January 2004 and December 2019, a total of 68 patients (50 males, 18 females; mean age: 54.2±10.1 years; range, 30 to 82 years) who underwent root-preserving surgery and followed for at least one year in the outpatient setting were retrospectively analyzed. The patients were divided into two groups according to dilatation during follow-up. Group 1 (n=32) included patients with dilatation and Group 2 (n=36) included patients without dilatation. The sinus of Valsalva diameters were measured using pre- and postoperative computed tomography angiography.

Results: The mean follow-up was 4.9±3.1 (range, 1 to 4) years. Sinus of Valsalva dilatation was observed in 47% of the patients during follow-up. Preoperative sinus of Valsalva diameter was a risk factor for aneurysmatic dilatation. A diameter of ≥4.05 cm was calculated as a cut-off value for developing dilatation requiring reoperation.

Conclusion: Follow-up using postoperative echocardiography or computed tomography angiography is of utmost importance for the assessment of development of sinus of Valsalva dilatation which requires reoperation in patients without intervention to the aortic root.

Keywords: Acute type A aortic dissection, reoperation, sinotubular junction, sinus of Valsalva aneurysm.

ÖZ

Amaç: Bu çalışmada akut tip A aort diseksiyonu nedeniyle aort tamiri yapılan hastalarda sinüs valsalva dilatasyonu araştırıldı ve progresyonu değerlendirildi.

Çalışma planı: Ocak 2004 - Aralık 2019 tarihleri arasında kök koruyucu cerrahi yapılan ve ayaktan en az bir yıl süreyle takip edilen toplam 68 hasta (50 erkek, 18 kadın; ort. yaş: 54.2±10.1 yıl; dağılım, 30-82 yıl) retrospektif olarak incelendi. Hastalar takip sırasında dilatasyona göre iki gruba ayrıldı. Grup 1'de (n=32) dilatasyon gelişen hastalar ve Grup 2'de (n=36) dilatasyon gelişmeyen hastalar yer aldı. Sinüs Valsalva çapları ameliyat öncesi ve ameliyat sonrası bilgisayarlı tomografi anjiyografi ile ölçüldü.

Bulgular: Ortalama takip süresi 4.9±3.1 (dağılım, 1-4) yıl idi. Takip sırasında hastaların %47'sinde sinüs Valsalva dilatasyonu izlendi. Ameliyat öncesi sinüs Valsalva çapı, anevrizma dilatasyonu açısından bir risk faktörü idi. ≥4.05 cm'lik çap, yeniden ameliyat gerektiren dilatasyon gelişimi açısından kesim değeri olarak hesaplandı.

Sonuç: Ameliyat sonrası ekokardiyografi veya bilgisayarlı tomografi anjiyografi ile takip, sinüs Valsalva dilatasyon gelişiminin değerlendirilmesi açısından mühim olup, aort köküne girişim yapılmayan hastalarda yeniden ameliyat gerektirir.

Anahtar sözcükler: Akut tip A aort diseksiyonu, yeniden ameliyat, sinotübüler bileşke, sinüs Valsalva anevrizması.

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Acute aortic dissection (AD) is the separation of the tunica media from the tunica intima and blood surging through the tear. Acute type A AD (ATAAD) occurs in the proximal part of the aorta (ascending aorta or arcus) and may extend proximally to the aortic root and heart or distally to the descending aorta. Management of this life-threatening condition is still a formidable challenge and, in patients with ATAAD treated surgically, the perioperative mortality rate is between 17 and 28%.[1,2]

Dissection surgery has many early and late postoperative complications one of which is the emergence of sinuses of Valsalva (SOV) aneurysm located between the aortic valve annulus and the sinotubular junction at the aortic root.[3] In patients with AD, SOV dilatation emerges as a result of the weakness of the elastic lamina at the junction of the aortic media and due to annular degeneration.[4] If the dilatation approaches an excessive dimension, it may provoke rupture of the SOV, which can be fatal. In detected cases of SOV enlargement, the patient should be promptly referred to a cardiothoracic surgeon for consideration of repair.[5,6]

In the present study, we aimed to investigate the dilated SOV rates in postoperative patients to highlight the importance of following this entity in patients operated for ATAAD and to evaluate its late progression at the time of index operation.

PATIENTS AND METHODS

This single-center, retrospective study was conducted at Dr. Siyami Ersek Training and Research Hospital, Department of Cardiovascular Surgery between January 2004 and December 2019. We identified all patients who were operated due to ATAAD in our clinic. A total of 68 patients (50 males, 18 females; mean age: 54.2±10.1 years; range, 30 to 82 years) who underwent root-preserving surgery and followed for at least one year in the outpatient setting were included. Patients with collagen tissue disease, endocarditis, operative mortality, and who had root replantation surgery were excluded. Patients who were lost-to-follow-up within one-year of the operation were also excluded. Perioperative mortality was defined as mortality within two months of surgery. Late mortality was defined as mortality later than two months of surgery.

The patients were divided into two groups according to the development of SOV dilatation during follow-up. Group 1 (n=32) included patients with SOV dilatation and Group 2 (n=36) included patients without SOV dilatation. Root-preserving techniques consisted of supracoronary graft interposition without commissural resuspension. Demographic features, comorbidities, and dissection lengths were recorded. The diameter of SOV was measured by pre- and postoperative computed tomography (CT) angiography and both groups were compared. The radiologists measured the widest segment in the middle of the SOV on the transverse section using two-dimensional CT angiography. The planes crossed the widest parts of the examined aortic segments. Postoperative CT angiography scanning times varied between 1 and 12 years.

Statistical analysis

Statistical analysis was performed using the GraphPad Prism version 9.0 software (GraphPad Software Inc., San Diego, CA, USA). Continuous data were expressed in mean ± standard deviation (SD), while categorical data were expressed in number and frequency. Categorical data were compared between the groups using the chi-square, chi-squared with Yates' correction, and Fisher exact tests. Continuous data were compared using the independent t-test. Predictors of aneurysmatic dilatation in SOV (i.e., age, sex, CT angiography control time, and preoperative SOV diameter) were analyzed using multiple regression analysis. A cut-off value of preoperative SOV diameter for developing aneurysmatic dilatation was calculated using the receiver operating characteristic (ROC) analysis. A p value of <0.05 was considered statistically significant.

RESULTS

All patients underwent surgery without intervention to the aortic root. The mean follow-up was 4.9±3.1 (range, 1 to 4) years. Two patients had bicuspid aortic valve.

All patients continued their cardiovascular follow-up at our outpatient clinic for at least one year. The overall mean SOV diameter was 4.44±0.91 (range, 2.9 to 7.9) cm. Thirty-two of the patients (47.06%) developed SOV dilatation with a sinus diameter of more than 4.5 cm during follow-up. The mean SOV diameter of this group was 5.23±0.61 cm. Thirty-six patients (52.94%) had a normal SOV diameter and the mean SOV diameter of this group was 3.74±0.43 cm. Nineteen patients in Group 1 and 23 patients in Group 2 were followed for less than five years. There was no significant difference in the demographic features, comorbidities, length of the dissection, and hospitalization times between the groups ($p>0.05$) (Table 1).

In Group 1, 24 patients (35.29%) had a SOV diameter greater than 5 cm, while nine patients

Table 1. Descriptive data of patients with or without postoperative SOV dilatation after root-preserving surgery

	Total (n=68)			SOV dilatation (+) (n=32)			SOV dilatation (–) (n=36)			
	n	%	Mean±SD	n	%	Mean±SD	n	%	Mean±SD	*p*
Age (year)			54.2±10.1			53.2±9.9			55.1±10.4	0.4538
Sex										0.5930
Female	18	26.47		7	21.88		11	30.56		
Male	50	73.53		25	78.12		25	69.44		
Hypertension	53	77.94		27	84.38		26	72.22		0.3610
Diabetes mellitus	13	19.12		7	21.88		6	16.67		0.8132
Dissection ends before iliac level	44	64.71		20			24			0.9166
Dissection ends after iliac level	24	35.29		12			12			
Mean follow-up time			4.90±3.09			5.38±3.08			4.47±2.92	0.215
ICU stay (day)			4.79±4.28			4.34±3.39			5.19±4.95	0.4176
Hospital stay (day)			16.63±12			17±10.04			16.31±13.64	0.8149
Preoperative SOV diameter (cm)			3.83±0.53			4.33±0.18			3.39±0.27	**<0.0001**
Follow-up SOV diameter (cm)			4.48±0.50			5.23±0.61			3.74±0.43	**<0.0001**

SD: Standard deviation; SOV: Sinus of Valsalva; ICU: Intensive care unit.

Table 2. Multivariate analysis results

	Standardized coefficients-Beta	t	Sig.
Age	-0.048	-1.080	0.284
Sex	-0.020	-0.429	0.669
Hypertension	-0.032	-0.523	0.812
Computed tomography time (year)	-0.016	-0.351	0.727
Preoperative SOV diameter (cm)	0.928	20.474	**<0.001**

SOV: Sinus of valsalva; Adjusted R square: 0.872; Regression df:4 Residual df:63.

(11.77%) had a SOV diameter greater than 5.5 cm (Figure 1). The maximum measured SOV diameter was 7.2 cm. Patients who did not undergo procedures for the aortic root during the first operation due to a small SOV diameter were expected to experience a SOV dilatation above the aneurysmatic limits in the future.

Age, sex, CT angiography control time, and preoperative SOV diameter were analyzed in the multiple regression analysis to identify the risk factors for the development of aneurysmatic SOV dilatation postoperatively (Table 2). Accordingly, age and sex were not found to be correlated with the presence of SOV dilatation. Development of SOV dilatation was not correlated with the CT angiography time after the operation, either. The mean CT angiography control time interval after index AD surgery was 5.37±3.08 years in Group 1 and 4.47±2.92 years in Group 2. On the other hand, there was a significant relationship between postoperative dilatation and preoperative SOV diameters. The wider preoperative SOV diameter was associated with a higher risk for aneurysmatic dilatation. In the ROC curve for preoperative diameter values, we determined a cut-off value of 4.05 cm for

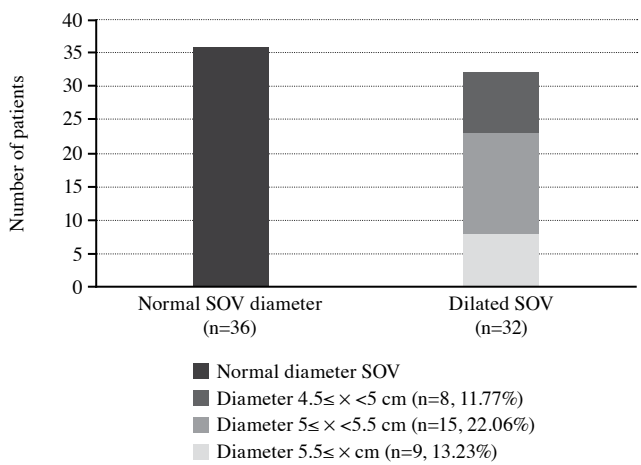

Figure 1. Distribution of sinuses of Valsalva diameters.
SOV: Sinus of Valsalva.

developing critical dilatation which would require reoperation in the future with a >95% specifity and sensitivity (p<0.0001).

DISCUSSION

The aortic root is comprised of the sinotubular junction, SOV, the aortic annulus, and leaflets. The SOV ensures that the coronary artery blood flow is maintained throughout the cardiac systole and its normal diameter is less than 4.0 cm for men and 3.6 cm for women.[7] While performing ATAAD surgery, if significant SOV dilatation exists, root replacement techniques are added to standard aortic replacement procedures. As a prevalent trend, extensive surgery is avoided to refrain from perioperative high mortality and morbidity.[8] However, incorporating proximal root interventions in cases with dissections that extend close to the sinotubular junction may be promising for preventing patients from reoperations. Indeed, the surgeon has to face a more challenging approach in such cases.

Previous studies have demonstrated that a greater SOV diameter and the number of commissural detachments are significant risk factors for aortic-related death or aortic root-related reoperations.[9] Our results supported this finding, with the development of SOV dilatation beyond the aneurysmatic limit being more frequent in patients whose SOV was wider preoperatively. We constructed a ROC curve for preoperative diameter values and found that 4.05 cm was a cut-off value for developing critical dilatation which would require reoperation in the future. This value can be crucial in regards to choosing the type of operation in AD patients. Further studies designed for this purpose are necessary to arrive at this conclusion.

A multi-center study from four cardiac surgery centers in Italy reported the results of implanting a Dacron® Valsalva graft for valve-sparing aortic root replacement.[10] In this study, the mean follow-up was 4.5 years and the authors concluded that the use of a Valsalva graft could be performed with satisfactory perioperative and mid-term results. Only 11% of patients required reoperation due to the aortic valve insufficiency and the freedom from aortic valve reoperation rate was 91%. In a recent study including a very large cohort of patients, the SOV of a diameter greater than 4.5 cm was found to be a risk factor for proximal aortic reoperation.[11] In addition, root replacement was associated with smaller SOV diameters during follow-up.

Non-standardized clinical or scanning control times and evaluating CT angiographies by different radiologists are the main limitations to the present study. In addition, we identified a cut-off value to predict postoperative SOV dilatation, regardless of the body mass index (BMI) and body surface area (BSA) of the patients. However, BMI and, particularly BSA, can influence the normal aortic sizes as reported in recent studies.[12,13] The aortic sizes with respect to the BMI or BSA were unable to be analyzed, as the BMI and BSA data were not available.

In conclusion, follow-up using postoperative echocardiography or computed tomography angiography is of utmost importance for the assessment of development of sinus of Valsalva dilatation which requires reoperation in patients without intervention to the aortic root. In patients with a sinus of valsalva greater than 4.05 cm in diameter at the time of index operation, replacement of the aortic root, such as the Bentall or David procedures, may be considered.

Ethics Committee Approval: The study protocol was approved by the Health Sciences University Dr Siyami Ersek Haydarpaşa Training and Research Hospitals Ethics Committee (date: 01.11.2022, no: E-28001928-604.01.01). The study was conducted in accordance with the principles of the Declaration of Helsinki.

Patient Consent for Publication: A written informed consent was obtained from each patient.

Data Sharing Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

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