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Original Article / Özgün Makale

An evaluation of diagnostic sensitivity of transthoracic echocardiography in diagnosis of post-cardiac surgery tamponade

Kalp cerrahisi sonrası kardiyak tamponad tanısında transtorasik ekokardiyografinin tanısal duyarlılığının değerlendirilmesi

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Background: This study aims to evaluate the diagnostic specificity and sensitivity of transthoracic echocardiography (TTE) for the diagnosis of cardiac tamponade after cardiac surgery.

Methods: Of 2,300 patients who underwent open heart surgery between January 2010 and September 2012, 118 (39 males, 79 females; mean age: 55.4±15.2 years; range 19 to 80 years) who required a revision surgery for bleeding and/or cardiac tamponade were retrospectively analyzed. Data of TTE were available in 73 patients. Diagnostic specificity and sensitivity of the TTE and clinical parameters including hypotension, oliguria, and metabolic acidosis were estimated with respect to surgical confirmation. Sensitivity and specifity rates were compared using the Cochrane Q test and McNemar test.

Results: The mean and median time from the first operation were 12.0±11.7 and nine days, respectively (0 to 62 days). Overall mortality occurred in 28 patients (38.4%). Among patients with surgically confirmed tamponade, TTE showed 64.5% sensitivity, whereas hypotension was present in 92.0%, oliguria in 80.6% and metabolic acidosis in 45.1% (p<0.001). Among patients with unconfirmed tamponade, TTE showed 90.9% specificity, whereas hypotension was present in 54.5% patients, oliguria in 81.8% and metabolic acidosis in 45.4% (p=0.07). Specificity rates showed constancy with time, while sensitivity rates tended to increase after seven days.

Conclusion: Transthoracic echocardiography plays an important role in the evaluation of postoperative hemodynamic impairment. However, its high false negativity rate for diagnosis of cardiac tamponade should be kept in mind to prevent further delay in patients with high clinical suspicion.

Key words: Echocardiography; sensitivity; specifity; tamponade.

Amaç: Bu çalışmada transtorasik ekokardiyografinin (TTE) kalp cerrahisi sonrası gelişen kardiyak tamponad tanısındaki tanısal özgüllüğü ve duyarlılığı değerlendirildi.

Çalışma planı: Ocak 2010 ve Eylül 2012 arasında açık kalp cerrahisi yapılan 2300 hastadan kanama veya kardiyak tamponad nedeniyle revizyon cerrahisi gereken 118'i (39 erkek, 79 kadın; ort. yaş 55.4±15.2 yıl; dağılım 19-80 yıl) retrospektif olarak değerlendirildi. Yetmiş üç hastanın TTE verileri mevcuttu. Transtorasik ekokardiyografinin ve hipotansiyon, oligüri ve metabolik asidoz gibi klinik parametrelerin tanısal özgüllüğü ve duyarlılığı cerrahi doğrulama esas alınarak hesaplandı. Özgüllük ve duyarlılık oranları Cochrane Q testi ve McNemar test kullanılarak karşılaştırıldı.

Bulgular: İlk ameliyat sonrası geçen sürenin ortalama ve medyan değerleri sırasıyla 12.0±11.7 ve dokuz gün (0-62 gün) idi. Genel mortalite 28 hastada (%38.4) görüldü. Cerrahi olarak kanıtlanmış tamponad hastalarında, TTE %64.5 duyarlılığa sahip iken %92.0'sinde hipotansiyon, %80.6'sında oligüri ve %45.1'inde metabolik asidoz mevcuttu (p<0.001). Cerrahi olarak tamponad olmadığı doğrulanmış hastalarda, TTE %90.9 özgüllüğe sahip iken, %54.5'inde hipotansiyon, %81.8'inde oligüri ve %45.4'ünde metabolik asidoz mevcuttu (p=0.07). Özgüllük oranları geçen zamanla sabitken duyarlılık oranları yedi günden sonra artma eğilimindeydi.

Sonuç: Transtorasik ekokardiyografi ameliyat sonrası hemodinamik bozulmanın değerlendirilmesinde önemli bir role sahiptir. Ancak, testin kardiyak tamponad tanısındaki yüksek yanlış negatiflik oranı, yüksek klinik şüphe varlığında zaman kaybının önlenmesi için akılda tutulmalıdır.

Anahtar sözcükler: Ekokardiyografi; duyarlılık; özgüllük; tamponad.

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Postoperative hemodynamic impairment should be promptly investigated and fixed during the early course of cardiac surgery, and transthoracic echocardiography (TTE) is the most useful modality to elicit the underlying cause, especially in situations where hemodynamic impairment manifests as low cardiac output syndrome (LCOS) accompanied by high central venous pressure levels.[1] A clinical manifestation like this may be the consequence of a variety of overlapping conditions, including anemia, fluid or hematoma compression, and poor ventricular function, but cardiac tamponade comes to mind first, especially when the hemodynamic impairment does not respond to general measures that are undertaken to normalize the patient's blood pressure and cardiac performance.

Transthoracic echocardiography is known to be the gold standard in diagnosing pericardial tamponade that develops during the course of certain diseases.[2] Because cardiac tamponade cannot be totally disproven on the basis of negative clinical and laboratory findings, the use of echocardiography has increasingly become more generalized during the early course of cardiac surgery. Reoperation for revision is inevitable in the presence of positive echocardiographic findings because they are almost always justified during the operation, indicating that TTE is a satisfactory and highly specific diagnostic modality.[3] However, TTE overlooks cardiac tamponade in certain conditions, particularly when the underlying pathology is not the collapsing effect of fluid accumulation around the heart.[4,5] The absence of the usual echocardiographic features of cardiac tamponade that cardiologists are accustomed to seeing during investigations of non-surgical patients indicates no more than the absence of echocardiographic tamponade. Therefore, when the usual echocardiographic findings of tamponade are not present, surgeons must decide whether to continue monitoring the patient and risk further surgical delay.[6]

Although TTE specificity rates ranging from 30-90% have been previously reported,[7-11] these reports lacked the sensitivity rate that could have served as a diagnostic reference to prove or disprove post-cardiac surgery tamponade. In this study, surgical confirmation was considered as the base of reference for calculating both the specificity and sensitivity of TTE in the diagnosis of post-cardiac surgery tamponade, and those rates were compared with a combination of the most commonly observed clinical findings.

PATIENTS AND METHODS

This study was approved by the institutional review board of our hospital, which is a tertiary referral center. Beginning in January 2010, operating room and intensive care registry information became available on a computer database, and the clinical records of 2,300 patients who underwent open heart surgery between January 2010 and September 2012 were then retrospectively evaluated. The registry information, patient counseling charts, and preoperative studies were then systematically reviewed in order to document the patients' demographic and clinical data, and we found that 118 (5.1%) needed revision surgery for bleeding and/or cardiac tamponade. The patients who were operated on because of emergency conditions and those for whom an echocardiographic evaluation was not deemed necessary to prevent further delays were not included to the analysis. Thus, in the end, the TTE data was available for 73 patients.

The normal operative steps used at our institution were performed in these cases, and general anesthesia was provided according to the standardized protocol. In addition, the patients also underwent a midline sternotomy incision and a pericardiotomy. Before the initiation of cardiopulmonary bypass (CPB), systemic heparin (300 IU/kg) was administered and the activated coagulation time (ACT) was maintained for up to 480 seconds. Myocardial protection was achieved with intermittent doses (every 20 minutes) of antegrade normothermic blood cardioplegia combined with retrograde continuous infusion. For the coronary bypass operations, the left internal mammary artery (LIMA) was preferred for the arterial graft for left anterior descending artery (LADA) revascularization, whereas saphenous venous grafts were used for the other revascularization procedures. Depending on the patient's age and their status regarding the use of anticoagulation, either a bioprosthetic or mechanical valve was used for treating valvular diseases when the repair could not be carried out. Ascending aortic replacement was conducted using a Dacron graft, and the aortic root was replaced in the presence of a sinus of Valsalva aneurysm. A combination of procedures, including radiofrequency ablation, tricuspid valve repairment, left atrial size reduction, and intracardiac thrombus evacuation, were performed when required, and the heparin was reversed via the administration of protamine sulphate once the CPB was ceased. Administration of transhexaminic acid was not a part of the standardized protocol, but it was generally applied in the cases that were at high risk for postoperative bleeding. The left pleura was opened,

and a chest tube was inserted into the left thoracic cavity whenever the IMA was harvested.

An echocardiographic evaluation was always performed with a senior cardiologist or resident in attendance. In our review of the patient records, the most frequently observed positive echocardiographic criteria sought for verification of cardiac tamponade were the following: *(i)* accumulation of fluid around the heart by describing its location (i.e. posterior, right ventricular side, lateral, or anterior); *(ii)* diastolic chamber collapse, *(iii)* a plethored inferior vena cava and the presence of any chamber compression; *(iv)* alterations in the mitral or tricuspid inflow; and *(v)* loculated or entrapped fluid in a certain localization. The echocardiographic diagnosis was established by the presence of more than one of these criteria in an individual patient.

During the data analysis, 85% of the patients had proven tamponade, which was defined as achieving a benefit from the surgical evacuation of fluid and/or a hematoma collected around the heart, whereas in 15%, no tamponade was found. In addition, sensitivity was defined as the percentage ratio of true positives to the sum of true positives and false negatives, and specificity was defined as the percentage ratio of true negatives to the sum of true negatives and false positives. In addition, clinical tamponade was characterized as the simultaneous presence of hypotension, oliguria, and elevated lactate levels of >1.5 mg/dl with or without elevated central venous pressure and an altered heart rate. The diagnostic specificity and sensitivity of the TTE and those of the clinical findings were calculated with respect to surgical confirmation.

Statistical analysis

All statistical analyses were performed using the SPSS version 16.0 (SPSS Inc. Chicago, IL, USA) software package. Visual histograms and the Kolmogorov-Smirnov and Shapiro-Wilk's tests were used to determine normal distribution. Continuous parameters were represented as mean ± standard deviation (SD) while categorical data was represented as numbers and percentages. The percentages of the echocardiographic and clinical parameters that were positive among the patients with proven tamponade (sensitivity) and negative among the patients without tamponade (specificity) were compared using the Cochrane's Q and McNemar's tests. In order to report the independent predictors of in-hospital mortality, variables that had a p value <0.15 in the univariate analysis were also included in the multivariate binominal logistic regression analysis. In addition, the appropriateness of the model was tested using the Akaike information criterion (AIC), and a p value ≤0.05 was considered to be statistically significant.

RESULTS

The baseline characteristics are shown in Table 1. Low-molecular-weight heparin treatment was given preoperatively to 31 patients (42.5) while nine (13.3%) received heparin, 13 (17.8%) were given aspirin, and seven (53.8%) were administered warfarin. The mean and median times from the first operation were 12.0±11.7 and nine days, respectively (range 0 to 62 days). Additionally, a second revision operation was required after the first revision in five patients. with two having a reoccurrence of hemodynamic impairment and radiographic signs of mediastinal enlargement. In the other three, the sternum had been left open without wiring, and the skin was primarily closed. They underwent the revision operation to remove the sponges that had been intentionally left inside to provide compression for ongoing non-surgical bleeding (median time from first revision 3 days; range 1-11 days). The preoperative and operative details are given in Tables 2 and 3.

A subanalysis of the 28 patients who died in the hospital after the revision operation revealed that the deaths occurred within one to 35 days postoperatively (median 6.5 days). The most common clinical scenarios encountered in the non-survivors were the following: *(i)* a persistent state of low cardiac output (n=17; 60.7%); *(ii)* acute renal failure accompanied by metabolic acidosis and/or anuria (n=26; 92.8%); *(iii)* pneumonia and/or respiratory failure (n=7; 25.0%); arrhythmia (n=10; 35.7%); neurological impairment/ failure to wake up from a coma (n=3; 4.1%); and sepsis/ multiorgan failure (n=9; 32.1%). When stratified by the time the death occurred, LCOS was predominant within the first week following the revision (n=15) versus two afterwards (p=0.03), whereas multiorgan failure occurred in four patients within the first week and five afterwards (p=0.06). Furthermore, pneumonia was seen in two patients within the first week and five afterwards (p=0.009). The mortality rates were also similar between the patients with proven tamponade and those without (38.7% vs. 36.4%, respectively; p>0.05), and the multivariate logistic regression analysis showed that older age and early reoperation (<7 days) were independent predictors of in-hospital mortality (Table 4 and 5).

Transthoracic echocardiography revealed pericardial effusion in 58 patients (75.8% of the patients with proven tamponade and 100% of those without (p=0.10).

Table 1. Baseline characteristics

Variable	n	%	Mean±SD
Age (years)			55.5±15.2
Gender			
Male	39	53.4	
Diabetes mellitus	23	31.5	
Hypertension	41	56.2	
Chronic pulmonary disease	13	17.8	
Renal failure	6	8.2	
Myocardial infarction	8	11.0	
Operations			
Coronary artery bypass grafting	18	24.7	
Valve replacement/repair	17	23.3	
Ascending aortic replacement	6	8.2	
Reoperation	6	8.2	
Combined	26	35.6	
Ejection fraction			57.4±11.2
Operative details			
Cross-clamp time (min)			91.4±49.3
Cardiopulmonary bypass time (min)			128.5±58.0
Hypothermia (°C)			29.3±2.6
Postoperative data			
Time to extubation (hours/n=65)			15.6±13.2
Amount of bleeding (ml/24 hour)			589.9±364.2
Need to inotropes	46	63.0	
New onset renal failure (n=67)	24	32.9	

SD: Standard deviation.

Moreover, 41 patients (56%) had positive TTE findings for cardiac tamponade. Of these, 30 (73.1%) had an accumulation of fluid around the heart, 41 (100%) had diastolic chamber collapse, 38 (92.6%) had a plethored inferior vena cava, 40 had (97.5%) altered mitral or tricuspid inflow, and 19 (46.3%) had loculated or entrapped fluid in a certain localization. All of these patients were taken straight to the operating room. Reoperation was necessary for the other 32 patients (44%) either because hemodynamic impairment persisted despite appropriate nonaggressive treatment or a localized pericardial effusion was the cause of chamber compression. During the reoperation, cardiac tamponade was verified in 62 patients (85%) but was not found in 11 others (15%). Among those with tamponade (i.e., true positives + false negative), the TTE showed 64.5% sensitivity, whereas the positive findings of those patients with clinically verified tamponade showed 92.0% sensitivity. Among the patients without tamponade (i.e., false positives + true negatives), the TTE showed 90.9% specificity, whereas the clinically verified tamponade showed 54.5% specificity (p=0.07) (Table 6). The specificity rates of both the TTE and clinical tamponade were consistent over time, but the sensitivity rates of both measures tended to increase as time passed (80.6% for clinical tamponade vs. 50.0% for echocardiographic tamponade before postoperative day seven (p=0.03) and 89.2% vs. 62.2%, respectively (p=0.06) after postoperative day seven).

Table 2. Data of the patients immediately before the revision operation

Variable	n	%
Clinical and laboratory parameters		
Hypotension	48	65.8
Re-intubation in intensive care unit	32	43.8
Tachycardia	47	64.4
Cardiopulmonary resuscitation	18	24.7
Electrolyte disturbances	37	50.7
Elevated lactate	46	63.0
pH <7.30	37	50.7

DISCUSSION

In this study, we determined that TTE had a high false negativity rate (22 of 62 of the patients with proven tamponade) with post-cardiac surgery tamponade.

Table 3. Reoperation data (n=73)

Variable	n	%	Mean±SD	Range
Amount of fluid evacuated (ml)			858.6±403.3	
Hematoma evacuation	7	9.6		
Time to extubation (hours)	45		13.4±18.9	
Amount of bleeding (ml)			488.4±693.9	
Intensive care unit stay (days)	45		3.6±2.9	1 to 13 days
Mortality in TTE available patients*	28	38.4		
Overall mortality of reoperation for revision*	30	25.4		

SD: Standard deviation; TTE: Transthoracic echocardiography; * In-hospital mortality.

However, it is noteworthy that these negative results were misleading, especially within the early course after the operation. In contrast, because the positive findings of tamponade via echocardiography had been surgically proven in the majority of patients, the number of cases with false positivity was extremely low (1 of 41 patients with echocardiographic tamponade). This was satisfactorily specific for the diagnosis, especially when the echocardiography was consulted after the first postoperative week. Overall, these findings suggest that the data provided by a negative TTE is not as reliable as those provided by a positive TTE for the diagnosis of post-cardiac surgery tamponade. Our study primarily focused on those patients who underwent a reoperation for cardiac tamponade, and those who underwent urgent revision surgery were excluded. Furthermore, it was not our objective to determine which patients with an identifiable amount of pericardial effusion on echocardiography eventually had cardiac tamponade.

Our retrospective review of the clinical records revealed that hypotension, oliguria, and elevated lactate levels were present simultaneously in 62 of the patients (i.e., those with clinical tamponade), 57 of whom were proven to have cardiac tamponade during the operation. It is clear that our findings did not lead directly to the diagnosis of cardiac tamponade, and as a general rule, this should be differentiated from other causes of LCOS before a reoperation. However, although our clinical suspicions could not be quantified, the clinical records revealed that low cardiac output was somehow persistent and unresponsive to the initial measures that had been undertaken to improve cardiac hemodynamics. In addition, because almost half of our patients (44%) underwent revision surgery

Table 4. Univariate predictors of survival after reoperation for cardiac tamponade

Variable	Survivors (n=45)			Non-survivors (n=28)			
	n	%	Mean±SD	n	%	Mean±SD	*p*
Age (years)			49.3±15.5			65.3±8.0	>0.001
Gender							
Male	26	57.8		13	46.4		0.34
Diabetes mellitus	11	24.4		12	42.9		0.10
Renal failure	2	4.4		2	7.1		0.63
Myocardial infarction	3	6.7		5	17.9		0.24
Low molecular weight heparin	20	44.4		11	39.3		0.66
Aspirin	8	17.8		5	17.9		0.99
Clopidrogel	10	22.2		7	25.0		0.78
Coumadin	3	6.7		4	14.3		0.41
Heparin	5	11.1		4	14.3		0.72
Combined	12	26.7		15	53.6		0.02
Ejection fraction			59.3±9.9			54.3±12.5	0.08
Cross-clamp time (min)			86.2±39.7			99.1±61.7	0.61
Cardiopulmonary bypass time (min)			116.2±42.8			148.3±73.0	0.07
Hypothermia (°C)			29.8±2.2			28.5±13.1	0.16
Reoperation <7 days	16	35.6		20	71.4		0.03

SD: Standard deviation.

Table 5. Multivariate predictors of survival after reoperation for cardiac tamponade

Variable	OR	95% CI	*p*
Age (years)	1.140	1.06-1.22	<0.001
Reoperation <7 days	3.936	1.11-13.95	0.03
Cardiopulmonary bypass time	1.011	1.00-1.023	0.05

OR: Operating room; CI: Confidence interval.

despite having no clear evidence of echocardiographic tamponade, some may doubt our methods. Moreover, the fact that cardiac tamponade was not found in five of the 62 patients who underwent this surgery on the basis of clinical suspicion may lead to further doubt regarding whether the reoperation was necessary. We acknowledge that four of these five patients had no evidence of echocardiographic tamponade and received no benefits from the reoperation. However, a majority of the patients with clinical suspicion (57 of 62 patients) were proven to have cardiac tamponade during this procedure when the echocardiography had failed to establish a preoperative diagnosis in nearly half of them (n=22). This discrepancy between the TTE findings and surgical findings may be related to the poor TTE view through all of the echocardiographic windows when the cause for the tamponade was the rapid formation of a hematoma around the heart. These results suggest that when cardiac tamponade is the most likely source of LCOS, a reoperation might be justified, even for patients for whom there is no echocardiographic evidence to support the suspicion. Thus, we believe that the advantages of a reoperation outweigh the disadvantages.

In previous studies, reexploration for bleeding or tamponade took place at a rate of between 0.9% and 8.4% for patients who underwent cardiac surgery.[1,3,8,9,12-15] Furthermore, the mortality rate after reoperation ranged from 3.5-37.5%, depending on the patient characteristics along with the inclusion and exclusion criteria. In our study, mortality occurred in 28 patients (38.3%) with LCOS, with respiratory pathologies being the most frequent causes. In a recent study, Čanádyová et al.[14] reported a similar mortality (37.5%) rate, but their study did not exclude patients who underwent a reoperation for bleeding during the early postoperative hours. Thus, in contrast to our findings, the survival rate was higher in patients who were reopened up to 12 hours after the initial operation. Because the median time interval between the first operation and revision was seven days in our study, we considered this to be the cut-off point between early and late revision in order to create a balanced distribution of patients. Consistent with previous studies, we found that older age was significantly associated with mortality, and early reoperation was also more common among non-survivors.

In a large prospective study, Pepi and Muratori[16] found that 500 of 780 (64%) patients had pericardial effusion in the postoperative period when those who underwent early reoperation were excluded. All of the patients were monitored whether the pericardial effusions increased in size or not; however, cardiac tamponade developed in less than 2% (n=15) of the patients during the follow-up period. One remarkable finding of the Pepi et al.[16] study was that more than half of the pericardial effusions were loculated in that series. In addition, the authors suggested that decreased transvalvular flow velocities, as viewed on echocardiographic Doppler imaging, were more reliable than those seen on echocardiography. Our retrospective review of clinical reports revealed that

Table 6. Specifity and sensitivity of transthoracic echocardiography and clinical parameters for diagnosis of post-cardiac surgery tamponade

	Tamponade proven	Tamponade disproven	Sensitivity (Tp/Tp+Fn)		Specifity (Tn/Tn+Fp)	
Echocardiographic tamponade						
+	Tp: 40 (16)	Fp: 1 (0)	64.5%	p<0.001	90.9%	p=0.12
–	Fn: 22 (8)	Tn: 10 (4)				
Clinical tamponade						
+	Tp: 57 (23)	Fp: 5 (3)	91.9%		54.5%	
–	Fn: 5 (1)	Tn: 6 (1)				

Tp: Tamponade proven; Fp: False positive; Fn: False negative; Tn: True negative.

decreased flow velocity through mitral and tricuspid valves was suggestive of echocardiographic tamponade in the presence of commonly observed positive findings for cardiac tamponade. However, these findings were not taken into consideration as the sole features of cardiac tamponade, especially when a considerable amount of fluid or a hematoma were not present in the echocardiography.

The postoperative clinical and echocardiographic features of cardiac tamponade differ from those observed in non-surgical patients.[17] From the classical point of view, hypotension, narrowed pulse pressure, tachycardia, low mixed venous oxygen saturation, and elevation of venous pressures are nonspecific and may be present as the result of either tamponade or ventricular dysfunction.[18] In a recent large, retrospective cohort study, Holm et al.[19] found that reoperations for bleeding occurred significantly more often in patients with lower mixed venous oxygen saturations than in those with normal levels (5.6% vs. 2.5%, respectively; p=0.0005), indicating that this measurement could possibly be used in the diagnosis of cardiac tamponade. Larose et al.[20] reported that a proper diagnosis was delayed in up to 80% of patients with cardiac tamponade and that the delayed diagnosis was associated with adverse outcomes. In support of this finding, another study by Kuvin et al.[21] found that the mean time to diagnosis was 10±1 days after open heart surgery.[21] Besides the known determinants of postoperative cardiac tamponade, such as the amount of the fluid collected around the heart and its accumulation rate, the hypovolemic status of the patients may also aid in the diagnosis well before these clinical signs are apparent. This so called low pressure cardiac tamponade may develop with diastolic pressures as low as 3-6 mmHg.[1,22] Although pulsus paradoxus is also an important key for diagnosing cardiac tamponade in non-surgical patients, it loses its significance in the postoperative setting. Positive pressure ventilation is another factor which prevents pulsus paradoxus from occurring as a manifestation of ventricular interdependence. Moreover, when there is a tendency toward postoperative bleeding, the typical signs and symptoms may not be present unless the hemodynamic status becomes severely compromised.[1] Furthermore, the absence of fluid accumulation during echocardiographic evaluations may be deceiving, especially when the clinical picture is atypical, and this may cause further delays in the diagnosis.[4]

A number of previous studies have focused on trying to determine to what extent echocardiographic evaluations provide reliable information in the diagnosis of postoperative cardiac tamponade. For example, Price et al.[9] seem to have been the first to analytically describe the limited capability of echocardiography in the diagnosis of this condition. In their study, they divided the patients into two groups according to the time of revision and reported that there were no classic echocardiographic features of tamponade in up to 80% of the patients within the first 72 hours. Similar to our findings, that study based their diagnostic confirmation on surgical reexploration. Although a 60% false negativity rate may be deduced from their findings, their report did not compare the sensitivity and specificity rates.

Some authors have advocated the use of TEE when the clinical symptoms and TTE findings are atypical.[5] In addition, it has been suggested that TEE provides more valuable information in cases of localized tamponade and that it may reveal some additional findings that cannot be seen via TTE.[23,24] This may be supported by the results of İmren et al.[13] in which TTE had a 60% false negativity rate (almost the same as the findings of our study and those of Price et al.[9]). However, they based their diagnostic confirmation on the results of TEE results since their surgical results were highly concordant with the TEE findings. On the other hand, in the series by ten Tusscher et al.,[8] TEE was reported to have been falsely negative in four of the 13 patients in which a clot was revealed via a rethoracotomy. Because TEE was not a part of the diagnostic evaluation of our patients, our study cannot conclude anything about its potential diagnostic role. Additionally, although the loss of R wave progression in electrocardiograms is known to be another important finding of acute tamponade, we cannot report its accuracy in our study because not all of the patients had electrocardiogram tracings taken at predetermined regular appointed times. In our study, TTE evaluation was not dependent on the participation of the same cardiologist but was performed by a different cardiologist at random times. Therefore, the possibility of interindividual discrepancy is among the limitations of this study. Additionally, our study also was comprised of a low number of patients and did not include long-term follow-up data.

Conclusion

Transthoracic echocardiography still remains the most efficient modality for diagnosing post-cardiac surgery tamponade, and it plays a direct role in the decision- making process in cases involving hemodynamic instability early after cardiac surgery. Our results were also consistent with the classic point

of view that states that TTE findings should never be used as the only parameters for diagnosing tamponade after cardiac surgery. Instead, they should be combined with the clinical results to come to a definitive decision on how to proceed. Furthermore, we believe that revision surgery should not be delayed when there is high clinical suspicion because of the relatively lower sensitivity of TTE related to the diagnosis compared with the clinical parameters.

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