



BÖLÜM 2

Kalp Kapak Hastalıklarında Non İnvazif Stres Testleri ile Tanısal Yaklaşım

Aysel YAĞMUR ¹

GİRİŞ

Kalp kapak hastalıklarının değerlendirilmesinde endikasyona ve testin amacına göre hem dobutamin hem egzersiz ile stres ekokardiyografi (SE) kullanılabilir. Kapak lezyonlarının birçoğunun seyri yavaştır ve hastalar, aktivitelerini sınırlandırdıkları için semptom göstermeyebilirler. Şüpheli semptom öyküsü olan hastalarda egzersiz testi, gerçekten semptomatik olanları belirlemeye yardımcı olur ^{1,2}.

Doğal kapak hastalığında SE için klinik endikasyonlar üçe ayrılabilir: a) asemptomatik ciddi kapak hastalığı, b) semptomlu ciddi olmayan kapak hastalığı ve c) düşük akımlı kapak hastalığı ³⁻⁵. Her durumda testin amacı girişime gerek duyan yani ciddi kapak hastalığı ve semptomları, LV sistolik disfonksiyonu veya diğer hemodinamik sonuçları olan hastaları belirlemektir ^{6,7}. Semptom olup ciddi olmayan kapak hastalığında, testin temel amacı kapak hastalığının gerçekten ciddi olup olmadığını sorgulamak, şiddetini stres kaynaklı değişikliklere veya potansiyel bir dinamik bileşene göre yeniden derecelendirmektir. Düşük akımlı kapak hastalığında testin amacı, stres ile şiddet

parametrelerindeki akıma bağlı değişiklikler sağlayarak, kapak hastalığının gerçekten şiddetli olup olmadığını belirlemektir⁸.

Egzersiz testlerinin iyi eğitilmiş personel tarafından, sürekli EKG ve kan basıncı takibi ile yapılması önemlidir. Egzersiz testi bir koşu bandı ile yapılabilir ancak bu durumda egzersiz görüntüsünden daha ziyade egzersiz sonrası görüntüler alınabilir ve bu da egzersizle ilgili maksimum noktaların daha düşük çıkmasına veya gözden kaçırılmasına neden olabilir. İdeali, stres testinin, test boyunca ve özellikle düşük iş yükünde ve en yüksek eforda bile görüntülemeye izin vermesidir. Bunun için supin bisiklet egzersizi yapılması daha uygundur. Düşük iş yükünde görüntüleme, subklinik sol ventrikül sistolik disfonksiyonunun saptanmasına yardımcı olarak, kontraktıl rezervin ve global longitudinal straindeki değişikliklerin her ikisinin de değerlendirilmesine olanak verir. Ayrıca, düşük iş yükünden kaynaklanan sistolik pulmoner arter basıncındaki artış, ciddi kapak hastalığının hemodinamik sonucu olarak patolojik bir yanıtıdır ve daha yüksek özgüllüğe sahiptir. Dobutamin stres, sol ventrikül ejeksiyon fraksiyonunda azalma ile düşük akımlı, düşük gradiyent-

¹ Uzm. Dr. Aysel YAĞMUR, S.B. S.B.Ü. Dr. Siyami Ersek Göğüs Kalp ve Damar Cerrahisi Eğitim ve Araştırma Hastanesi, Kardiyoloji Bölümü ayselyakici@gmail.com



gelen hemodinamik değişikliklerin değerlendirilmesi, özellikle egzersiz semptomları ile sınırlanan ve aniden daha fazla egzersiz yapamama ile sonuçlanabilen hastalarda değerlidir ¹². Egzersiz akım artışının mitral ve aort kapakları için farklı olduğu bilinmektedir; ortalama mitral orifis alanı egzersizle artarken aort kapağı seviyesindeki atım hacmindeki artışlara aort zaman hız integralindeki artışlar aracılık eder ⁷⁹. Romatizmal mitral kapak hastalığında hem stenoz hem regürjitasyon olabilir ve bu lezyonların rölatif dereceleri egzersiz sırasında değişebilir; bunun tanınması tedavi için önemlidir ⁸⁰. Benzer şekilde, kombine darlık ve yetersizlik olan aort kapak hastalığında, kombinasyonun sonuçları her iki lezyonun toplamı olabilir.

KAYNAKLAR

1. Baumgartner H, Hung J, Bermejo J, et al. Echocardiographic assessment of valve stenosis: EAE/ADE recommendations for clinical practice. *Eur J Echocardiogr* 2009;10:1–25.
2. Zoghbi WA, Adams D, Bonow RO, et al. Recommendations for noninvasive evaluation of Doğale Valvular regurgitation: a report from the American Society of Echocardiography. Developed in collaboration with the Society for Cardiovascular Magnetic Resonance. *J Am Soc Echocardiogr* 2017;30:303–71.
3. Garbi M, Chambers J, Vannan MA, Lancellotti P. Valve stress echocardiography: a practical guide for referral, procedure, reporting, and clinical implementation of results from the HAVEC Group. *JACC Cardiovasc Imaging* 2015;8:724–36.
4. Picano E, Pibarot P, Lancellotti P, Monin JL, Bonow RO. The emerging role of exercise testing and stress echocardiography in valvular heart disease. *J Am Coll Cardiol* 2009;54:2251–60.
5. Pierard LA, Lancellotti P. Stress testing in valve disease. *Heart* 2007;93:766–72.
6. Vahanian A, Alfieri O, Andreotti F, Antunes MJ, Baron-Esquvias G, Baumgartner H et al. Guidelines on the management of valvular heart disease. *Eur Heart J* 2012;33:2451–96.
7. Nishimura RA, Otto CM, Bonow RO, Carabello BA, Erwin III JP, Guyton RA et al. 2014 AHA/ACC guideline for the management of patients with valvular heart disease. *J Am Coll Cardiol* 2014;22:e57–185.
8. deFilippi CR, Willett DL, Brickner ME, Appleton CP, Yancy CW, Eichhorn EJ et al. Usefulness of dobutamine echocardiography in distinguishing severe from nonsevere valvular aortic stenosis in patients with depressed left ventricular function and low transvalvular gradient. *Am J Cardiol* 1995;75:191–4.
9. Wu WC, Aziz GF, Sadaniantz A. The use of stress echocardiography in the assessment of mitral valvular disease. *Echocardiography* 2004; 21: 451–8.
10. Carabello BA. Modern management of mitral stenosis. *Circulation* 2005;112:432–7.
11. Baumgartner H, Hung J, Bermejo J, Chambers JB, Evangelista A, Griffin BP et al. Echocardiographic assessment of valve stenosis: EAE/ADE recommendations for clinical practice. *J Am Soc Echocardiogr* 2009;22:1–23.
12. Brochet E, De'taint D, Fondard O, Tazi-Mezalek A, Mes-sika-Zeitoun D, Lung B et al. Early hemodynamic changes versus peak values: what is more useful to predict occurrence of dyspnea during stress echocardiography in patients with asymptomatic mitral stenosis? *J Am Soc Echocardiogr* 2011;24:392–8.
13. Reis G, Motta MS, Barbosa MM, Esteves WA, Souza SE, Bocchi EA. Dobutamine stress echocardiography for noninvasive assessment and risk stratification of patients with rheumatic mitral stenosis. *J Am Coll Cardiol* 2004;43:393–401.
14. Lancellotti P, Troisfontaines P, Toussaint AC et al. Prognostic importance of exercise-induced changes in mitral regurgitation in patients with chronic ischemic left ventricular dysfunction. *Circulation* 2003; 108: 1713–7.
15. Lee R, Haluska B, Leung DY, et al. Functional and prognostic implications of left ventricular contractile reserve in patients with asymptomatic severe mitral regurgitation. *Heart* 2005;91:1407–12.
16. Magne J, Mahjoub H, Dulgheru R, et al. Left ventricular contractile reserve in asymptomatic primary mitral regurgitation. *Eur Heart J* 2014;35:1608–16.
17. Magne J, Lancellotti P, Piérard LA. Exercise-induced changes in degenerative mitral regurgitation. *J Am Coll Cardiol* 2010;56:300–9.
18. Lancellotti P, Magne J. Stress echocardiography in regurgitant valve disease. *Circ Cardiovasc Imaging* 2013;6:840–9.
19. Coisne A, Levy F, Malaquin D, Richardson M, Que'ré JP, Montaigne D et al. Feasibility of Doppler hemodynamic evaluation of primary and secondary mitral regurgitation during exercise echocardiography. *Int J Cardiovasc Imaging* 2015;31:291–9.
20. Magne J, Lancellotti P, Pierard LA. Exercise pulmonary hypertension in asymptomatic degenerative mitral regurgitation. *Circulation* 2010;122:33–41.
21. Magne J, Pibarot P, Sengupta PP, Donal E, Rosenhek R, Lancellotti P. Pulmonary hypertension in valvular disease: a comprehensive review on pathophysiology to therapy from the HAVEC Group. *JACC Cardiovasc Imaging* 2015;8:83–99.
22. Suzuki K, Izumo M, Yoneyama K, Mizukoshi K, Kamijima R, Kou S et al. Influence of exercise-induced pulmonary hypertension on exercise capacity in asymptomatic degenerative mitral regurgitation. *J Cardiol* 2015;66:246–52.
23. Magne J, Donal E, Mahjoub H, Miltner B, Dulgheru R,



- Thebault C et al. Impact of exercise pulmonary hypertension on postoperative outcome in primary mitral regurgitation. *Heart* 2015;101:391–6.
24. Kusunose K, Popovic ZB, Motoki H, Marwick TH. Prognostic significance of exercise-induced right ventricular dysfunction in asymptomatic degenerative mitral regurgitation. *Circ Cardiovasc Imaging* 2013;6:167–76.
25. Haluska BA, Shortt L, Marwick TH. Relationship of ventricular longitudinal function to contractile reserve in patients with mitral regurgitation. *Am Heart J* 2003;146:183–8.
26. Donal E, Masclé S, Brunet A, Thebault C, Corbineau H, Laurent M et al. Prediction of left ventricular ejection fraction 6 months after surgical correction of organic mitral regurgitation: the value of exercise echocardiography and deformation imaging. *Eur Heart J Cardiovasc Imaging* 2012;13:922–30.
27. Lancellotti P, Cosyns B, Zacharakis D, Attena E, Van Camp G, Gach O et al. Importance of left ventricular longitudinal function and functional reserve in patients with degenerative mitral regurgitation: assessment by two-dimensional speckle tracking. *J Am Soc Echocardiogr* 2008;21:1331–6.
28. Paraskevaidis IA, Kyrzopoulos S, Tsiapras D, Iliodromitis EK, Parissis J, Farmakis D et al. The role of left ventricular long-axis contraction in patients with asymptomatic non-ischemic mitral valve regurgitation and normal systolic function. *Int J Cardiol* 2008;124:64–71.
29. Piérard LA, Lancellotti P. The role of ischemic mitral regurgitation in the pathogenesis of acute pulmonary edema. *N Engl J Med* 2004;351:1627–34.
30. Lancellotti P, Lebrun F, Piérard LA. Determinants of exercise-induced changes in mitral regurgitation in patients with coronary artery disease and left ventricular dysfunction. *J Am Coll Cardiol* 2003;42:1921–8.
31. Lancellotti P, Gérard PL, Piérard LA. Long-term outcome of patients with heart failure and dynamic functional mitral regurgitation. *Eur Heart J* 2005;26:1528–32.
32. Lapu-Bula R, Robert A, Van Craeynest D, D'Hondt AM, Gerber BL, Pasquet A et al. Contribution of exercise-induced mitral regurgitation to exercise stroke volume and exercise capacity in patients with left ventricular systolic dysfunction. *Circulation* 2002;106:1342–8.
33. Lancellotti P, Magne J, Dulgheru R, Ancion A, Martinez C, Piérard LA. Clinical significance of exercise pulmonary hypertension in secondary mitral regurgitation. *Am J Cardiol* 2015;115:1454–61.
34. Peteiro J, Bendayan I, Mariñas J et al. Prognostic value of mitral regurgitation assessment during exercise echocardiography in patients with left ventricular dysfunction: a follow-up study of 1.7 +/- 1.5 years. *Eur J Echocardiogr* 2008; 9: 18–25.
35. Lancellotti P, Lebrun F, Piérard LA. Determinants of exercise-induced changes in mitral regurgitation in patients with coronary artery disease and left ventricular dysfunction. *J Am Coll Cardiol* 2003; 42: 1921–8.
36. Leurent G, Donal E, de Place C, et al. Argument for a Doppler echocardiography during exercise in assessing asymptomatic patients with severe aortic stenosis. *Eur J Echocardiogr* 2009;10:69–73.
37. Alborino D, Hoffmann JL, Fournet PC, et al. Value of exercise testing to evaluate the indication for surgery in asymptomatic patients with valvular aortic stenosis. *J Heart Valve Dis* 2002;11:204–9.
38. Amato MC, Moffa PJ, Werner KE, et al. Treatment decision in asymptomatic aortic valve stenosis: role of exercise testing. *Heart* 2001;86:381–6.
39. Donal E, Thebault C, O'Connor K, et al. Impact of aortic stenosis on longitudinal myocardial deformation during exercise. *Eur J Echocardiogr* 2011;12:235–41.
40. Lancellotti P, Karsera D, Tumminello G, et al. Determinants of an abnormal response to exercise in patients with asymptomatic valvular aortic stenosis. *Eur J Echocardiogr* 2008;9:338–43.
41. Lancellotti P, Lebois F, Simon M, et al. Prognostic importance of quantitative exercise Doppler echocardiography in asymptomatic valvular aortic stenosis. *Circulation* 2005;112(9 Suppl):I377–82.
42. Marechaux S, Hachicha Z, Bellouin A, Dumesnil JG, Meimoun P, Pasquet A et al. Usefulness of exercise-stress echocardiography for risk stratification of true asymptomatic patients with aortic valve stenosis. *Eur Heart J* 2010;31:1390–7.
43. Marechaux S, Ennezat PV, LeJemtel TH, Polge AD, de Groote P, Asseman P et al. Left ventricular response to exercise in aortic stenosis: an exercise echocardiographic study. *Echocardiography* 2007;24:955–9.
44. Lancellotti P, Magne J, Donal E, Dulgheru R, Rosca M, Piérard LA. Determinants and prognostic significance of exercise pulmonary hypertension in asymptomatic severe aortic stenosis. *Circulation* 2012;126:851–9.
45. Rafique AM, Biner S, Ray I, et al. Meta-analysis of prognostic value of stress testing in patients with asymptomatic severe aortic stenosis. *Am J Cardiol* 2009;104:972–7.
46. Das P, Rimington H, Chambers J. Exercise testing to stratify risk in aortic stenosis. *Eur Heart J* 2005;26:1309–13.
47. 2021 ESC/EACTS Guidelines for the management of valvular heart disease, *European Heart Journal* (2021) 00, 172 doi:10.1093/eurheartj/ehab395
48. Clavel MA, Ennezat PV, Maréchaux S, et al. Stress echocardiography to assess stenosis severity and predict outcome in patients with paradoxical low-flow, low-gradient aortic stenosis and preserved LVEF. *JACC Cardiovasc Imaging* 2013;6:175–83.
49. Blais C, Burwash IG, Mundigler G, et al. Projected valve area at normal flow rate improves the assessment of stenosis severity in patients with low-flow, low-gradient aortic stenosis: the multicenter TOPAD (Truly or Pseudo-Severe Aortic Stenosis) study. *Circulation* 2006;113:711–21.
50. Cuffe C, Serfaty JM, Cimadevilla C, et al. Measurement of aortic valve calcification using multislice computed tomography: correlation with haemodynamic severity of aortic stenosis and clinical implication for patients with



- low ejection fraction. *Heart* 2011;97:721–6.
51. Dulgheru R, Magne J, Davin L, et al. Left ventricular regional function and maximal exercise capacity in aortic stenosis. *Eur Heart J Cardiovasc Imaging* 2016;17:217–24.
52. Monin JL, Quere JP, Monchi M, Petit H, Baleynaud S, Chauvel C et al. Low-gradient aortic stenosis: operative risk stratification and predictors for long-term outcome: a multicenter study using dobutamine stress hemodynamics. *Circulation* 2003;108: 319 – 24.
53. Clavel MA, Burwash IG, Mundigler G, Dumesnil JG, Baumgartner H, Bergler-Klein J et al. Validation of conventional and simplified methods to calculate projected valve area at normal flow rate in patients with low flow, low gradient aortic stenosis: the multicenter TOPAD (True or Pseudo Severe Aortic Stenosis) study. *J Am Soc Echocardiogr* 2010;23:380–6.
54. Tribouilloy C, Levy F, Rusinaru D, Gue'ret P, Petit-Eisenmann H, Baleynaud S et al. Outcome after aortic valve replacement for low-flow/low-gradient aortic stenosis without contractile reserve on dobutamine stress echocardiography. *J Am Coll Cardiol* 2009;53:1865–73.
55. Quere JP, Monin JL, Levy F, Petit H, Baleynaud S, Chauvel C et al. Influence of pre-operative left ventricular contractile reserve on postoperative ejection fraction in low-gradient aortic stenosis. *Circulation* 2006;113:1738–44.
56. Bartko PE, Heinze G, Graf S, Clavel MA, Khorsand A, Bergler-Klein J et al. Two-dimensional strain for the assessment of left ventricular function in low flow-low gradient aortic stenosis, relationship to hemodynamics and outcome: A substudy of the multicenter TOPAD study. *Circ Cardiovasc Imaging* 2012;6:268–76.
57. Dahou A, Bartko PE, Capoulade R, Clavel MA, Mundigler G, Grondin S et al. Usefulness of global left ventricular longitudinal strain for risk stratification in low ejection fraction, low-gradient aortic stenosis: results from the multicenter true or pseudo-severe aortic stenosis study. *Circ Cardiovasc Imaging* 2015;8:e002117.
58. Clavel MA, Burwash IG, Mundigler G, Dumesnil JG, Baumgartner H, Bergler-Klein J et al. Validation of conventional and simplified methods to calculate projected valve area at normal flow rate in patients with low flow, low gradient aortic stenosis: the multicenter TOPAD (True or Pseudo Severe Aortic Stenosis) study. *J Am Soc Echocardiogr* 2010;23:380–6.
59. Pibarot P, Dumesnil JG. Aortic stenosis suspected to be severe despite low gradients. *Circ Cardiovasc Imaging* 2014;7:545–51.
60. Bonow RO, Lakatos E, Maron BJ, Epstein SE. Serial long-term assessment of the do'gal history of asymptomatic patients with chronic aortic regurgitation and normal left ventricular systolic function. *Circulation* 1991;84:1625–35.
61. Wahi S, Haluska B, Pasquet A, et al. Exercise echocardiography predicts development of left ventricular dysfunction in medically and surgically treated patients with asymptomatic severe aortic regurgitation. *Heart* 2000;84:606–14.
62. Kusunose K, Agarwal S, Marwick TH, et al. Decision making in asymptomatic aortic regurgitation in the era of guidelines: incremental values of resting and exercise cardiac dysfunction. *Circ Cardiovasc Imaging* 2014;7:352–62.
63. Vinereanu D, Ionescu AA, Fraser AG. Assessment of left ventricular long axis contraction can detect early myocardial dysfunction in asymptomatic patients with severe aortic regurgitation. *Heart* 2001;85:30–6.
64. Pibarot P, Dumesnil JG. Prosthetic heart valves: selection of the optimal prosthesis and long-term management. *Circulation* 2009;119:1034–48.
65. Pibarot P, Dumesnil JG. Valve prosthesis-patient mismatch, 1978 to 2011: from original concept to compelling evidence. *J Am Coll Cardiol* 2012;60:1136–9.
66. Zoghbi WA, Chambers JB, Dumesnil JG, Foster E, Gottdiener JS, Grayburn PA et al. Recommendations for evaluation of prosthetic valves with echocardiography and Doppler ultrasound. *J Am Soc Echocardiogr* 2009;22:975–1014.
67. Lancellotti P, Pibarot P, Chambers JB, Edvardsen T, Delgado V, Dulgheru R et al. Recommendations for the imaging assessment of prosthetic heart valves. *Eur Heart J Cardiovasc Imag* 2016;17:589–90.
68. Pibarot P, Dumesnil JG, Jobin J, Cartier P, Honos G, Durand LG. Hemodynamic and physical performance during maximal exercise in patients with an aortic bioprosthetic valve. Comparison of stentless versus stented bioprostheses. *J Am Coll Cardiol* 1999;34:1609–17.
69. Pibarot P, Dumesnil JG, Jobin J, Lemieux M, Honos G, Durand LG. Usefulness of the indexed effective orifice area at rest in predicting an increase in gradient during maximum exercise in patients with a bioprosthesis in the aortic valve position. *Am J Cardiol* 1999;83:542–6.
70. Tatineni S, Barner HB, Pearson AC, Halbe D, Woodruff R, Labovitz AJ. Rest and exercise evaluation of St. Jude medical and Medtronic hall prostheses. Influence of primary lesion, valvular type, valvular size, and left ventricular function. *Circulation* 1989;80(Suppl. I):I.16– 23.
71. van den Brink RB, Verheul HA, Visser CA, Koelemay MJW, Dunning AJ. Value of exercise Doppler echocardiography in patients with prosthetic or bioprosthetic cardiac valves. *Am J Cardiol* 1992;69:367–72.
72. Magne J, Se'ne'chal M, Mathieu P, Dumesnil JG, Dagenais F, Pibarot P. Restrictive annuloplasty for ischemic mitral regurgitation may induce functional mitral stenosis. *J Am Coll Cardiol* 2008;51:1692–701.
73. Kubota K, Otsuji Y, Ueno T, Koriyama C, Levine RA, Sakata R et al. Functional mitral stenosis after surgical annuloplasty for ischemic mitral regurgitation: importance of subvalvular tethering in the mechanism and dynamic deterioration during exertion. *J Thorac Cardiovasc Surg* 2010;140:617–23.
74. Kainuma S, Taniguchi K, Daimon T, Sakaguchi T, Funatsu T, Kondoh H et al. Does stringent restrictive annuloplasty for functional mitral regurgitation cause functional mitral stenosis and pulmonary hypertension? *Circulation* 2011;124(11 Suppl.):S97 – 106.



75. Chan KL, Chen SY, Chan V, Hay K, Mesana T, Lam BK. Functional significance of elevated mitral gradients after repair for degenerative mitral regurgitation. *Circ Cardiovasc Imaging* 2013;6:1041–7.
76. Bertrand PB, Verbrugge FH, Verhaert D, Smeets CJ, Grieten L, Mullens W et al. Mitral valve area during exercise after restrictive mitral valve annuloplasty: importance of diastolic anterior leaflet tethering. *J Am Coll Cardiol* 2015;65:452–61.
77. Bertrand PB, Gutermann H, Smeets CJ, Van Kerrebroeck C, Verhaert D, Vandervoort P et al. Functional impact of transmitral gradients at rest and during exercise after restrictive annuloplasty for ischemic mitral regurgitation. *J Thorac Cardiovasc Surg* 2014;148:183–7.
78. Unger P, Rosenhek R, Dedobbeleer C, Berrebi A, Lancellotti P. Management of multiple valve disease. *Heart* 2011;97:272 – 7.
79. Rassi A, Crawford MH, Richards KL, Miller JF. Differing mechanisms of exercise flow augmentation at the mitral and aortic valves. *Circulation* 1988;77:543–51.
80. TischlerMD, BattleRW, SahaM, NiggelJ, LeWinterMM. Observations suggesting a high incidence of exercise-induced severe mitral regurgitation in patients with mild rheumatic mitral valve disease at rest. *J Am Coll Cardiol* 1994;25:128–33.