

ANTİ/HER2 TEDAVİLER İLE İLİŞKİLİ KARDİYOMYOPATİLER

5.

BÖLÜM

Mesut KARATAŞ¹

TRANSTUZUMAB

İnsan epidermal büyüme faktörü reseptörü 2'yi (HER2, ErbB2 olarak da adlandırılır) hedefleyen monoklonal bir antikordur. Tümörleri HER2'Yİ aşırı eksprese eden meme kanseri hastalarının yüzde 15 ila 20'si için transtuzumab tedavisi hem erken hem de ileri hastalığın tedavisinde önemlidir. Bununla birlikte, kullanımı, tipik olarak sol ventrikül ejeksiyon fraksiyonunda asemptomatik bir azalma ve daha az sıklıkla klinik kalp yetmezliği ile kendini gösteren kardiyotoksisite için hafif-orta risk taşımaktadır.

Transtuzumab'ın klinik kullanımından sonra HER2'yi aşırı ekspere eden meme kanserli hastaların tedavisi için transtuzumabın dışında 3 yeni Anti-HER2 ajan geliştirilmiştir.

Bunlardan bir tanesi olan **lapatinib**, bir trozinkinaz inhibitörüdür ve EGFR 1 ve 2 (erb1 ve erb2) reseptörlerinin hücre içi dimerlerinin fosforilasyonunu engeller. Bir diğeri antikor-ilaç konjugatı olan ve **transtuzumab** ile antimitotik bir ajan olan **maytansine'nin** kompozisyonundan oluşan **ado-transtuzumabemtasi-ne(T-DM1)** ve son olarak **Pertuzumab**, HER2'nin ekstrasellüler parçasının alt parçası2(subdomain2)'e bağlanarak HER2'nun HER reseptör ailesinin diğer üeleriyle homo-hetero dimerizasyonunu engeller

Pertuzumab ve T-DM1'in kardiyotoksisitesi hakkındaki bilgilerimiz sınırlı olsa da mevcut bilgiler pertuzumab ve T-DM1'in transtuzumab'a göre daha az kardiyotoksik olduğu yönündedir.

Trastuzumab ve ilgili HER2 hedefli ajanlarla ilgili kardiyotoksisite burada sunulacaktır. Antrasiklinler ve taksanlar da dahil olmak üzere diğer antineoplastik ilaçlara bağlı kardiyotoksisite, kalp yetmezliğinin yönetimi ve trastuzumab ve diğer HER2 hedefli tedavilerin klinik kullanımı ayrı ayrı tartışılmalıdır.

¹ .Uzm Dr., Siyami Ersek Göğüs Kalp Damar, Cerrahisi EAH ORCID iD: 0000-0003-1526-1812

- Adjuvan ilaç alan hastalarda, trastuzumab başlamadan önce bir başlangıç değerlendirmesi ve seri LVEF izlenmesi (trastuzumab'ı başlattıktan 3, 6 ve 12 ay sonra ve bir antrasiklin veya diğer kemoterapiyi başlattıktan 18 ay sonra) kardiyak disfonksiyonu taramak için uygundur.
- Metastatik hastalarda, başlangıç değerlendirmesinden sonra, LVEF semptomların yokluğunda nadiren izlenir
- Trastuzumab ile ilişkili kardiyotoksisite geliştiren hastalar için trastuzumab dozajı için kılavuzlar, LVEF'deki azalma hasta semptomlarına dayanmaktadır
- Trastuzumab ile ilişkili kardiyotoksisite birçok hastada geri dönüşümlüdür ve kalp yetmezliği için standart tedaviye yanıt verir. Birçok hasta devam veya trastuzumab ile tekrar tedaviyi tolere eder
- Trastuzumab, taksanlar, radyasyon tedavisi ve endokrin tedavisi ile güvenli bir şekilde uygulanabilir

Diğer HER2 hedefli ajanlar

- Trastuzumabın aksine, kardiyotoksisite riski, lapatinib, ado-trastuzumab emtansinine (T-DM1) ve pertuzumab gibi diğer insan epidermal büyüme faktörü reseptörü 2 (HER2) hedefli ajanlarla daha az görünmektedir. Bununla birlikte, bu ajanların üçü ile ilgili deneyim sınırlıdır ve tüm ajanlarla potansiyel bir kardiyotoksisite riski vardır.
- Trastuzumab da olduğu gibi LVEF'nin tedavi öncesi bazal değerlendirmesi uygundur. Yine Trastuzumab'da olduğu gibi, metastatik hastalarda, tedavi sırasında semptomların yoksa semptomların yokluğunda LVEF nadiren izlenir.
- Bu ajanlarla tedavi sırasında kardiyotoksisite geliştiren hastalarda doz ayarlaması ile ilgili kılavuzlar mevcuttur

KAYNAKÇA

1. Keefe DL. Trastuzumab-associated cardiotoxicity. *Cancer* 2002; 95:1592.
2. Perez EA, Rodeheffer R. Clinical cardiac tolerability of trastuzumab. *J Clin Oncol* 2004; 22:322.
3. Fiúza M. Cardiotoxicity associated with trastuzumab treatment of HER2+ breast cancer. *Adv Ther* 2009; 26 Suppl 1:S9.
4. Ewer MS, Lippman SM. Type II chemotherapy-related cardiac dysfunction: time to recognize a new entity. *J Clin Oncol* 2005; 23:2900.
5. Henry ML, Niu J, Zhang N, et al. Cardiotoxicity and Cardiac Monitoring Among Chemotherapy-Treated Breast Cancer Patients. *JACC Cardiovasc Imaging* 2018; 11:1084.
6. Advani PP, Ballman KV, Dockett TJ, et al. Long-Term Cardiac Safety Analysis of NCCTG N9831 (Alliance) Adjuvant Trastuzumab Trial. *J Clin Oncol* 2016; 34:581.
7. Bria E, Cuppone F, Fournier M, et al. Cardiotoxicity and incidence of brain metastases after adjuvant trastuzumab for early breast cancer: the dark side of the moon? A meta-analysis of the randomized trials. *Breast Cancer Res Treat* 2008; 109:231.
8. Russell SD, Blackwell KL, Lawrence J, et al. Independent adjudication of symptomatic heart failure with the use of doxorubicin and cyclophosphamide followed by trastuzumab adjuvant therapy: a combined review of cardiac data from the National Surgical Adjuvant breast and

- Bowel Project B-31 and the North Central Cancer Treatment Group N9831 clinical trials. *J Clin Oncol* 2010; 28:3416.
9. Romond EH, Perez EA, Bryant J, et al. Trastuzumab plus adjuvant chemotherapy for operable HER2-positive breast cancer. *N Engl J Med* 2005; 353:1673.
 10. Perez EA, Suman VJ, Davidson NE, et al. Cardiac safety analysis of doxorubicin and cyclophosphamide followed by paclitaxel with or without trastuzumab in the North Central Cancer Treatment Group N9831 adjuvant breast cancer trial. *J Clin Oncol* 2008; 26:1231.
 11. Smith I, Procter M, Gelber RD, et al. 2-year follow-up of trastuzumab after adjuvant chemotherapy in HER2-positive breast cancer: a randomised controlled trial. *Lancet* 2007; 369:29.
 12. Slamon D, Eiermann W, Robert N, et al. Adjuvant trastuzumab in HER2-positive breast cancer. *N Engl J Med* 2011; 365:1273.
 13. Perez EA, Romond EH, Suman VJ, et al. Four-year follow-up of trastuzumab plus adjuvant chemotherapy for operable human epidermal growth factor receptor 2-positive breast cancer: joint analysis of data from NCCTG N9831 and NSABP B-31. *J Clin Oncol* 2011; 29:3366.
 14. Perez EA, Suman VJ, Davidson NE, et al. Sequential versus concurrent trastuzumab in adjuvant chemotherapy for breast cancer. *J Clin Oncol* 2011; 29:4491.
 15. de Azambuja E, Procter MJ, van Veldhuisen DJ, et al. Trastuzumab-associated cardiac events at 8 years of median follow-up in the Herceptin Adjuvant trial (BIG 1-01). *J Clin Oncol* 2014; 32:2159.
 16. Gianni L, Eiermann W, Semiglazov V, et al. Neoadjuvant chemotherapy with trastuzumab followed by adjuvant trastuzumab versus neoadjuvant chemotherapy alone, in patients with HER2-positive locally advanced breast cancer (the NOAH trial): a randomised controlled superiority trial with a parallel HER2-negative cohort. *Lancet* 2010; 375:377.
 17. Buzdar AU, Ibrahim NK, Francis D, et al. Significantly higher pathologic complete remission rate after neoadjuvant therapy with trastuzumab, paclitaxel, and epirubicin chemotherapy: results of a randomized trial in human epidermal growth factor receptor 2-positive operable breast cancer. *J Clin Oncol* 2005; 23:3676.
 18. Spielmann M, Roché H, Delozier T, et al. Trastuzumab for patients with axillary-node-positive breast cancer: results of the FNCLCC-PACS 04 trial. *J Clin Oncol* 2009; 27:6129.
 19. Moja L, Tagliabue L, Balduzzi S, et al. Trastuzumab containing regimens for early breast cancer. *Cochrane Database Syst Rev* 2012; :CD006243.
 20. Dang C, Guo H, Najita J, et al. Cardiac Outcomes of Patients Receiving Adjuvant Weekly Paclitaxel and Trastuzumab for Node-Negative, ERBB2-Positive Breast Cancer. *JAMA Oncol* 2016; 2:29.
 21. Slamon DJ, Leyland-Jones B, Shak S, et al. Use of chemotherapy plus a monoclonal antibody against HER2 for metastatic breast cancer that overexpresses HER2. *N Engl J Med* 2001; 344:783.
 22. Seidman A, Hudis C, Pierri MK, et al. Cardiac dysfunction in the trastuzumab clinical trials experience. *J Clin Oncol* 2002; 20:1215.
 23. Ewer SM, Ewer MS. Cardiotoxicity profile of trastuzumab. *Drug Saf* 2008; 31:459.
 24. Rastogi P, Jeong J, Geyer CE, et al. Five-year update of cardiac dysfunction on NSABP B-31, a randomized trial of sequential doxorubicin/cyclophosphamide (AC)-paclitaxel (T) versus AC-T with trastuzumab (H). *J Clin Oncol* 2007; 25S: ASCO #LBA513.
 25. Suter TM, Procter M, van Veldhuisen DJ, et al. Trastuzumab-associated cardiac adverse effects in the herceptin adjuvant trial. *J Clin Oncol* 2007; 25:3859.
 26. Bowles EJ, Wellman R, Feigelson HS, et al. Risk of heart failure in breast cancer patients after anthracycline and trastuzumab treatment: a retrospective cohort study. *J Natl Cancer Inst* 2012; 104:1293.
 27. Guenancia C, Lefebvre A, Cardinale D, et al. Obesity As a Risk Factor for Anthracyclines and Trastuzumab Cardiotoxicity in Breast Cancer: A Systematic Review and Meta-Analysis. *J Clin Oncol* 2016; 34:3157.

28. Halyard MY, Pisansky TM, Dueck AC, et al. Radiotherapy and adjuvant trastuzumab in operable breast cancer: tolerability and adverse event data from the NCCTG Phase III Trial N9831. *J Clin Oncol* 2009; 27:2638.
29. Romond EH, Jeong JH, Rastogi P, et al. Seven-year follow-up assessment of cardiac function in NSABP B-31, a randomized trial comparing doxorubicin and cyclophosphamide followed by paclitaxel (ACP) with ACP plus trastuzumab as adjuvant therapy for patients with node-positive, human epidermal growth factor receptor 2-positive breast cancer. *J Clin Oncol* 2012; 30:3792.
30. Serrano C, Cortés J, De Mattos-Arruda L, et al. Trastuzumab-related cardiotoxicity in the elderly: a role for cardiovascular risk factors. *Ann Oncol* 2012; 23:897.
31. Procter M, Suter TM, de Azambuja E, et al. Longer-term assessment of trastuzumab-related cardiac adverse events in the Herceptin Adjuvant (HERA) trial. *J Clin Oncol* 2010; 28:3422.
32. Piccart-Gebhart MJ, Procter M, Leyland-Jones B, et al. Trastuzumab after adjuvant chemotherapy in HER2-positive breast cancer. *N Engl J Med* 2005; 353:1659.
33. Levine MN. Trastuzumab cardiac side effects: only time will tell. *J Clin Oncol* 2005; 23:7775.
34. Ezaz G, Long JB, Gross CP, Chen J. Risk prediction model for heart failure and cardiomyopathy after adjuvant trastuzumab therapy for breast cancer. *J Am Heart Assoc* 2014; 3:e000472.
35. Ewer MS, Vooletich MT, Durand JB, et al. Reversibility of trastuzumab-related cardiotoxicity: new insights based on clinical course and response to medical treatment. *J Clin Oncol* 2005; 23:7820.
36. Guarneri V, Lenihan DJ, Valero V, et al. Long-term cardiac tolerability of trastuzumab in metastatic breast cancer: the M.D. Anderson Cancer Center experience. *J Clin Oncol* 2006; 24:4107.
37. Eiger D, Pondé NF, Agbor-Tarh D, et al. Long-term cardiac outcomes of patients with HER2-positive breast cancer treated in the adjuvant lapatinib and/or trastuzumab Treatment Optimization Trial. *Br J Cancer* 2020; 122:1453.
38. Tripathy D, Seidman A, Keefe D, et al. Effect of cardiac dysfunction on treatment outcomes in women receiving trastuzumab for HER2-overexpressing metastatic breast cancer. *Clin Breast Cancer* 2004; 5:293.
39. Mayer EL, Lin NU. Long term follow-up of national surgical adjuvant breast and bowel project trial B-31: how well can we predict cardiac toxicity with trastuzumab? *J Clin Oncol* 2012; 30:3769.
40. Fox KF. The evaluation of left ventricular function for patients being considered for, or receiving Trastuzumab (Herceptin) therapy. *Br J Cancer* 2006; 95:1454.
41. Guglin M, Krischer J, Tamura R, et al. Randomized Trial of Lisinopril Versus Carvedilol to Prevent Trastuzumab Cardiotoxicity in Patients With Breast Cancer. *J Am Coll Cardiol* 2019; 73:2859.
42. Goldhar HA, Yan AT, Ko DT, et al. The Temporal Risk of Heart Failure Associated With Adjuvant Trastuzumab in Breast Cancer Patients: A Population Study. *J Natl Cancer Inst* 2016; 108.
43. Cardinale D, Colombo A, Torrisi R, et al. Trastuzumab-induced cardiotoxicity: clinical and prognostic implications of troponin I evaluation. *J Clin Oncol* 2010; 28:3910.
44. Ewer MS, Ewer SM. Troponin I provides insight into cardiotoxicity and the anthracycline-trastuzumab interaction. *J Clin Oncol* 2010; 28:3901.
45. Zardavas D, Suter TM, Van Veldhuisen DJ, et al. Role of Troponins I and T and N-Terminal Prohormone of Brain Natriuretic Peptide in Monitoring Cardiac Safety of Patients With Early-Stage Human Epidermal Growth Factor Receptor 2-Positive Breast Cancer Receiving Trastuzumab: A Herceptin Adjuvant Study Cardiac Marker Substudy. *J Clin Oncol* 2017; 35:878.
46. Bianchi G, Albanell J, Eiermann W, et al. Pilot trial of trastuzumab starting with or after the doxorubicin component of a doxorubicin plus paclitaxel regimen for women with HER2-positive advanced breast cancer. *Clin Cancer Res* 2003; 9:5944.
47. Semiglazov V, Gianni L, Manikhas GM, et al. Neoadjuvant trastuzumab in locally advanced breast cancer (NOAH): Antitumour and safety analysis. *J Clin Oncol* 2007; 25S: ASCO #532.

48. Joensuu H, Bono P, Kataja V, et al. Fluorouracil, epirubicin, and cyclophosphamide with either docetaxel or vinorelbine, with or without trastuzumab, as adjuvant treatments of breast cancer: final results of the FinHer Trial. *J Clin Oncol* 2009; 27:5685.
49. Geyer CE, Forster J, Lindquist D, et al. Lapatinib plus capecitabine for HER2-positive advanced breast cancer. *N Engl J Med* 2006; 355:2733.
50. Perez EA, Koehler M, Byrne J, et al. Cardiac safety of lapatinib: pooled analysis of 3689 patients enrolled in clinical trials. *Mayo Clin Proc* 2008; 83:679.
51. Blackwell KL, Burstein HJ, Storniolo AM, et al. Randomized study of Lapatinib alone or in combination with trastuzumab in women with ErbB2-positive, trastuzumab-refractory metastatic breast cancer. *J Clin Oncol* 2010; 28:1124.
52. Valachis A, Nearchou A, Polyzos NP, Lind P. Cardiac toxicity in breast cancer patients treated with dual HER2 blockade. *Int J Cancer* 2013; 133:2245.
53. Lapatinib tablets. United States Prescribing Information. US National Library of Medicine. <http://dailymed.nlm.nih.gov/dailymed/lookup.cfm?setid=63319b01-cad6-4d0a-c39b-938fa951a808> (Accessed on February 05, 2013).
54. Pondé N, Ameye L, Lambertini M, et al. Trastuzumab emtansine (T-DM1)-associated cardiotoxicity: Pooled analysis in advanced HER2-positive breast cancer. *Eur J Cancer* 2020; 126:65.
55. Verma S, Miles D, Gianni L, et al. Trastuzumab emtansine for HER2-positive advanced breast cancer. *N Engl J Med* 2012; 367:1783.
56. Hurvitz SA, Dirix L, Kocsis J, et al. Phase II randomized study of trastuzumab emtansine versus trastuzumab plus docetaxel in patients with human epidermal growth factor receptor 2-positive metastatic breast cancer. *J Clin Oncol* 2013; 31:1157.
57. Krop IE, Suter TM, Dang CT, et al. Feasibility and cardiac safety of trastuzumab emtansine after anthracycline-based chemotherapy as (neo)adjuvant therapy for human epidermal growth factor receptor 2-positive early-stage breast cancer. *J Clin Oncol* 2015; 33:1136.
58. Ado-trastuzumab emtansine, for injection. United States Prescribing Information. US National Library of Medicine. http://www.accessdata.fda.gov/drugsatfda_docs/label/2013/125427lbl.pdf?et_cid=31141095&et_rid=463638624&linkid=http%3a%2f%2fwww.accessdata.fda.gov%2fdrugsatfda_docs%2flabel%2f2013%2f125427lbl.pdf (Accessed on February 25, 2013).
59. Baselga J, Gelmon KA, Verma S, et al. Phase II trial of pertuzumab and trastuzumab in patients with human epidermal growth factor receptor 2-positive metastatic breast cancer that progressed during prior trastuzumab therapy. *J Clin Oncol* 2010; 28:1138.
60. Swain SM, Ewer MS, Cortés J, et al. Cardiac tolerability of pertuzumab plus trastuzumab plus docetaxel in patients with HER2-positive metastatic breast cancer in CLEOPATRA: a randomized, double-blind, placebo-controlled phase III study. *Oncologist* 2013; 18:257.
61. Modi S, Saura C, Yamashita T, et al. Trastuzumab Deruxtecan in Previously Treated HER2-Positive Breast Cancer. *N Engl J Med* 2020; 382:610.
62. Fam-trastuzumab deruxtecan-nxki, for injection. United States Prescribing Information. US National Library of Medicine. https://www.accessdata.fda.gov/drugsatfda_docs/label/2019/761139s000lbl.pdf (Accessed on January 28, 2020).
63. Hudis CA. Trastuzumab--mechanism of action and use in clinical practice. *N Engl J Med* 2007; 357:39.
64. Mackey JR, Kaufman B, Clemens M, et al. Trastuzumab prolongs progression-free survival in hormone-dependent and HER2-positive metastatic breast cancer (abstract). Data presented at the 29th annual San Antonio Breast Cancer Symposium, December 14, 2006.
65. Cote GM, Sawyer DB, Chabner BA. ERBB2 inhibition and heart failure. *N Engl J Med* 2012; 367:2150.
66. Lee KF, Simon H, Chen H, et al. Requirement for neuregulin receptor erbB2 in neural and cardiac development. *Nature* 1995; 378:394.
67. Erickson SL, O'Shea KS, Ghaboosi N, et al. ErbB3 is required for normal cerebellar and cardiac development: a comparison with ErbB2- and heregulin-deficient mice. *Development* 1997; 124:4999.

68. Gassmann M, Casagrande F, Orioli D, et al. Aberrant neural and cardiac development in mice lacking the ErbB4 neuregulin receptor. *Nature* 1995; 378:390.
 69. Crone SA, Zhao YY, Fan L, et al. ErbB2 is essential in the prevention of dilated cardiomyopathy. *Nat Med* 2002; 8:459.
 70. García-Rivello H, Taranda J, Said M, et al. Dilated cardiomyopathy in Erb-b4-deficient ventricular muscle. *Am J Physiol Heart Circ Physiol* 2005; 289:H1153.
 71. Ozcelik C, Erdmann B, Pilz B, et al. Conditional mutation of the ErbB2 (HER2) receptor in cardiomyocytes leads to dilated cardiomyopathy. *Proc Natl Acad Sci U S A* 2002; 99:8880.
 72. Liu FF, Stone JR, Schuldt AJ, et al. Heterozygous knockout of neuregulin-1 gene in mice exacerbates doxorubicin-induced heart failure. *Am J Physiol Heart Circ Physiol* 2005; 289:H660.
 73. Perik PJ, de Vries EG, Gietema JA, et al. Serum HER2 levels are increased in patients with chronic heart failure. *Eur J Heart Fail* 2007; 9:173.
 74. Chien KR. Herceptin and the heart--a molecular modifier of cardiac failure. *N Engl J Med* 2006; 354:789.
 75. de Korte MA, de Vries EG, Lub-de Hooge MN, et al. 111Indium-trastuzumab visualises myocardial human epidermal growth factor receptor 2 expression shortly after anthracycline treatment but not during heart failure: a clue to uncover the mechanisms of trastuzumab-related cardiotoxicity. *Eur J Cancer* 2007; 43:2046.
 76. Fedele C, Riccio G, Malara AE, et al. Mechanisms of cardiotoxicity associated with ErbB2 inhibitors. *Breast Cancer Res Treat* 2012; 134:595.
 77. Fuller SJ, Sivarajah K, Sugden PH. ErbB receptors, their ligands, and the consequences of their activation and inhibition in the myocardium. *J Mol Cell Cardiol* 2008; 44:831.
 78. Bersell K, Arab S, Haring B, Kühn B. Neuregulin1/ErbB4 signaling induces cardiomyocyte proliferation and repair of heart injury. *Cell* 2009; 138:257.
- De Keulenaer GW, Doggen K, Lemmens K. The vulnerability of the heart as a pluricellular paracrine organ: lessons from unexpected triggers of heart failure in targeted ErbB2 anticancer therapy. *Circ Res* 2010; 106:35.