

Bölüm 29

KEMİK METASTAZLARINDA YENİ SİSTEMİK TEDAVİLER

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GİRİŞ

Meme kanseri kadınlarda en sık görülen kanser olup, en sık metastaz yeri kemiktir. Kemiğe metastaz sonucunda ağrı, patolojik kırık, hiperkalsemi, spinal kord basısı gibi iskelet ilişkili olaylar gelişebilmektedir. Bu durum kanser hastalarında önemli morbidite ve morbidite nedeni olup, yaşam kalitesini olumsuz etkilemektedir. Kemik metastazlarına yaklaşım, ağrı kontrolü, iskelet ilişkili olayların önlenmesi ya da minimize edilmesi ve tümör kontrolünün sağlanmasını içermektedir. Bu amaçla analjezikler, cerrahi, radyoterapi, kemiğe yönelik radyonüklit tedaviler ve termal ablasyon yöntemleri uygulanabilmektedir. Sistemik tedavide ise bisfosfonatlar (zoledronik asid, ibandronik asid, pamidronad, vs), RANK ligand inhibitörü (denosumab), Src inhibitörleri (dasatinib, bosutinib, saracatinib), cathepsin-K, kemokin reseptör tip-K ve GPNMB inhibitörleri kullanılmaktadır. Bu bölümde kemik metastazı olan meme kanserinde uygulanan sistemik tedavilerden bahsedilecektir.

Kemik metastazları özellikle akciğer, meme ve prostat kanserlerinde en sık görülen uzak metastaz bölgesidir (1). Osteoklastik ve osteoblastik aktivite artışına bağlı kemik yapım ve yıkımı artmakta ve iskelet ilişkili olaylarla sonuçlanabilmektedir (2, 3).

Evre 4 meme kanseri olan hastaların %65-75'inde kemik metastazları gelişmektedir. Kemik metastazı geliştikten sonra medyan sağkalım 19-25 aydır (4, 5). Kemikte kanser hücreleri kemik formasyonu ve rezorpsiyonunu bozan osteolitik, osteoblastik ve/veya mikst kemik lezyonlarına yol açmaktadırlar.

Kemik metastazlarına yaklaşım hasta ve metastaz ile ilişkili faktörlere dayanmaktadır. Hastalığın yaygınlığı, metastazın yaşam kalitesi üzerine etkisi, hasta-

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viye eklenen klodronat, çalışma girişinde 50 yaşından büyük kadınlarda iskelet ve iskelet dışı metastazsız sağkalımı iyileştirmiştir (her iki durumda da $p < 0.05$). 36 klinik denemeden 22.982 hastayı içeren büyük bir meta-analizde, adjuvan bisfosfonatların menopoz sonrası kadınlarda uzak nüksü önemli ölçüde azalttığını tespit etmiştir (% 18.4'e karşılık % 21.9) (74).

Denosumabın adjuvan kullanımı ile ilgili yapılan D-CARE çalışmasında ise, 67 aylık medyan izlemede, kemik metastazsız sağkalım (HR 0.97, % 95 CI 0.82-1.14, $p = 0.70$), hastaliksız sağkalım (HR 1.04, % 95 CI 0.91-1.19, $p = 0.57$) ve genel sağkalım (HR 1.03, % 95 CI 0.85-1.25) avantajı sağlamadığı görülmüştür (75).

Kuzey Amerika ve Avrupa'da orta-yüksek nüks riski olan meme kanseri hastalarında bisfosfonatların (zoledronat, klodronat veya ibandronat) adjuvan kullanımını önerilmektedir.

SONUÇ

Kemik metastazı olan meme kanseri hastalarında amacımız yeterli ağrı kontrolünü düzenlemek, kemik hasarını azaltmak ve işlevi korumak, iskelet ile ilişkili olay riskini en aza indirmek, ve lokal tümör kontrolünü sağlamaktır. Tedavi seçimi hastadaki spesifik semptomlara, metastazın ortaya çıkış şekline, tümörün histolojik tipine, hastanın performans statüsü ve tedavi seçimine göre şekillenmelidir. Yaşam beklentisi düşük olan, patolojik kırık ve/veya spinal kord basısı gibi iskelet ilişkili olayları olmayan hastalarda yalnızca takip yapılabilmektedir. İzole, semptomatik tek kemik metastazlarında lokal tedaviler düşünülmelidir. Litik metastazlarda sistemik tedavide antirezorptif ajanlar bisfosfonatlar ve denosumab kullanılmalıdır. Strontium-89, Samarium-153 ve Radyum 223 ağrı kontrolünde etkinlikleri gösterilmiş ajanlardır.

KAYNAKLAR:

1. Mundy GR. (2002). Metastasis to bone: causes, consequences and therapeutic opportunities. *Nat Rev Cancer*, 2(8), 584.
2. Lowik CW, Boonekamp PM, van de Pluym G *et al.* (1986). Bisphosphonates can reduce osteoclastic bone resorption by two different mechanisms. *Adv. Exp. Med. Biol.* 208, 275-281.
3. Coleman RE. (2006). Clinical features of metastatic bone disease and risk of skeletal morbidity. *Clin Cancer Res*, 12: 6243s.
4. Barzilai O, Laufer I, Yamada Y, et al (2017). Integrating Evidence-Based Medicine for Treatment of Spinal Metastases Into a Decision Framework: Neurologic, Oncologic, Mechanicals Stability, and Systemic Disease. *J Clin Oncol*, 35:2419.
5. Sousa S, Clézardin P. Bone-targeted therapies in cancer-induced bone disease, *Calcif. Tissue Int.* 2018;102, 227-250.
6. Macedo F, Ladeira K, Pinho F, Saraiva N, Bonito N, Pinto L, et al (2017). Bone metastases: an overview, *Oncol. Rev.* 321 (11): 43-49.
7. Terpos E, Ntanasis-Stathopoulos I, Gavriatopoulou M, Dimopoulos MA. (2018). Pathogenesis of bone disease in multiple myeloma: from bench to bedside. *Blood Cancer J.* 8(1),7.

8. D'Oronzo S, Brown J, Coleman R. (2017). The role of biomarkers in the management of bone-homing malignancies, *J. Bone Oncol.* 9,1-9
9. Sceneay J, Smyth MJ, Möller A (2013). The pre-metastatic niche: finding common ground. *Cancer and Metastasis Reviews*, 32(3-4), 449-464.
10. Schneider JG, Amend SR, Weilbaecher KN. (2011). Integrins and bone metastasis: integrating tumor cell and stromal cell interactions. *Bone*, 48(1):54-65.
11. Meng F, Wu G. (2012). The rejuvenated scenario of epithelial–mesenchymal transition (EMT) and cancer metastasis. *Cancer and Metastasis Reviews*, 31(3-4), 455-467.
12. Paget S. (1889). The distribution of secondary growths in cancer of the breast. *The Lancet*, 133(3421), 571-573.
13. Saidak Z, Boudot C, Abdoune R, Petit L, Brazier M, Mentaverri R, et. al (2009). Extracellular calcium promotes the migration of breast cancer cells through the activation of the calcium sensing receptor. *Experimental cell research*, 315(12), 2072-2080.
14. Ha HK, Lee W, Park HJ, Lee SD, Lee JZ, Chung MK. (2011). Clinical significance of CXCL16/CXCR6 expression in patients with prostate cancer. *Molecular medicine reports*, 4(3), 419-424.
15. Lee JH, Kim HN, Kim KO, Jin WJ, Lee S, Kim H et. al (2012). CXCL10 promotes osteolytic bone metastasis by enhancing cancer outgrowth and osteoclastogenesis. *Cancer research*, 72(13), 3175-3186.
16. Khosla S, Bilezikian JP, Dempster DW, Lewiecki EM, Miller PD, Neer RM, et al (2012). Benefits and risks of bisphosphonate therapy for osteoporosis. *J Clin Endocrinol Metab*, 9 (7):2272-2282.
17. Drake MT, Clarke BL, Khosla S. (2008) Bisphosphonates: mechanism of action and role in clinical practice. *Mayo Clin Proc*, 83(9): 1032-1045.
18. Fairney A, Kyd P, Thomas E, Wilson J. (1998). The use of cyclical etidronate in osteoporosis: changes after completion of 3 years treatment. *Br J Rheumatol*, 37(1):51-56.
19. Mkele G. (2013) Bisphosphonates and their use. *S Afr Pharm J*, 80(8):24-26.
20. Naoe M, Ogawa Y, Takeshita K, Morita J, Shichijo T, Fujii K, et. al (2009). Zoledronate stimulates $\gamma\delta$ T cells in prostate cancer patients. *Oncology Research Featuring Preclinical and Clinical Cancer Therapeutics*, 18(10), 493-501.
21. Villa JC, Gianakos A, Lane JM. (2016). Bisphosphonate treatment in osteoporosis: optimal duration of therapy and the incorporation of a drug holiday. *HSS J*, 12(1):66-73.
22. Bartl R, Frisch B. (2nd ed) (2009). Osteoporosis: Diagnosis, Prevention, Therapy. Springer Science & Business Media, 321.
23. Sweetman SC. (36th ed) (2009). Bisphosphonates interaction. Martindale. The Complete Drug Reference. Pharmaceutical Press, London, 3694.
24. Khosla S, Bilezikian JP, Dempster DW, Lewiecki EM, Miller PD, Neer RM, et al (2012). Benefits and risks of bisphosphonate therapy for osteoporosis. *J Clin Endocrinol Metab*, 9 (7):2272-2282.
25. Güven D, Önal A. (2013) Bifosfonatlar ve dış hekimliği. İzmir: Ege Üniversitesi Tıp Fakültesi Farmakoloji Ana Bilim Dalı, p80.
26. TEMD Osteoporoz ve Diğer Metabolik Kemik Hastalıkları Çalışma Grubu. (7. Baskı) (2015) Metabolik Kemik Hastalıkları Tanı ve Tedavi Kılavuzu. Türkiye Endokrinoloji ve Metabolizma Derneği. Ankara, p.97.
27. Abrahamsen B. (2010). Adverse effects of bisphosphonates. *Calcif Tissue Int*, 86(6):421-435.
28. Orhan İ, Sarıca S, Çelik M, Kılıç MA. (2015). Bisphosphonate induced osteonecrosis of the maxilla and mandible: a case report. *KSU Tıp Fak Der*, 10(3):33-36.
29. Soydan SS, Şenel FV, Araz K. (2009). Pathogenesis and treatment of bisphosphonate induced osteonecrosis of the jaws. *Hacettepe Dış Hek Fak Der*, 33(3):61-68.
30. Cosman F, de Beur SJ, LeBoff MS, Lewiecki EM, Tanner B, Randall S, et al (2014). Clinician's guide to prevention and treatment of osteoporosis. *Osteoporos Int*, 25(10):2359-2381.
31. Morgan GJ, Davies FE, Gregory WM, Bell SE, Szubert AJ, Cook G, et. al (2013). Long-term follow-up of MRC Myeloma IX trial: Survival outcomes with bisphosphonate and thalidomide treatment. *Clinical Cancer Research*, 19(21), 6030-6038.
32. Rosen LS, Gordon D, Kaminski M, Howell A, Belch A, Mackey J, et. al (2001). Zoledronic acid versus pamidronate in the treatment of skeletal metastases in patients with breast cancer

- or osteolytic lesions of multiple myeloma: a phase III, double-blind, comparative trial. *Cancer journal (Sudbury, Mass.)*, 7(5), 377-387.
33. Rosen LS, Gordon D, Kaminski M, Howell A, Belch A, Mackey J, et. al (2003). Long-term efficacy and safety of zoledronic acid compared with pamidronate disodium in the treatment of skeletal complications in patients with advanced multiple myeloma or breast carcinoma: a randomized, double-blind, multicenter, comparative trial. *Cancer: Interdisciplinary International Journal of the American Cancer Society*, 98(8), 1735-1744.
 34. Rosen LS, Gordon D, Tchekmedyan NS, Yanagihara R, Hirsh V, Krzakowski M, et. al (2004). Long-term efficacy and safety of zoledronic acid in the treatment of skeletal metastases in patients with nonsmall cell lung carcinoma and other solid tumors: a randomized, Phase III, double-blind, placebo-controlled trial. *Cancer*, 100(12), 2613-2621.
 35. Coleman R, Body JJ, Aapro M, Hadji P, Herrstedt J. (2014). Bone health in cancer patients: ESMO Clinical Practice Guidelines. *Annals of Oncology*, 2:124-137.
 36. Hortobagyi GN, Van Poznak C, Harker WG, Gradishar WJ, Chew H, Dakhil SR, et. al (2017). Continued treatment effect of zoledronic acid dosing every 12 vs 4 weeks in women with breast cancer metastatic to bone: the OPTIMIZE-2 randomized clinical trial. *JAMA oncology*, 3(7), 906-912.
 37. Stopeck AT, Fizazi K, Body JJ, Brown JE, Carducci M, Diel I, et. al (2016). Safety of long-term denosumab therapy: results from the open label extension phase of two phase 3 studies in patients with metastatic breast and prostate cancer. *Supportive Care in Cancer*, 24(1), 447-455.
 38. Raje N, Terpos E, Willenbacher W, Shimizu K, García-Sanz R, Durie B, et. al (2018). Denosumab versus zoledronic acid in bone disease treatment of newly diagnosed multiple myeloma: an international, double-blind, double-dummy, randomised, controlled, phase 3 study. *The Lancet Oncology*, 19(3), 370-381.
 39. O'Carrigan B, Wong MH, Willson ML, Stockler MR, Pavlakis N, Goodwin A. (2017). Bisphosphonates and other bone agents for breast cancer. *Cochrane database of systematic reviews*, (10).
 40. Rucci N, Recchia I, Angelucci A, Alamanou M, Del Fattore A, Fortunati D, et. al (2006). Inhibition of protein kinase c-Src reduces the incidence of breast cancer metastases and increases survival in mice: implications for therapy. *Journal of Pharmacology and Experimental Therapeutics*, 318(1), 161-172.
 41. Zhang XHF, Wang Q, Gerald W, Hudis CA, Norton L, Smid M, et. al (2009). Latent bone metastasis in breast cancer tied to Src-dependent survival signals. *Cancer cell*, 16(1), 67-78.
 42. Mitri Z, Nanda R, Blackwell K, Costelloe CM, Hood I, Wei C, et. al (2016). TBCRC-010: phase I/II study of dasatinib in combination with zoledronic acid for the treatment of breast cancer bone metastasis. *Clinical Cancer Research*, 22(23), 5706-5712.
 43. Schott AF, Barlow WE, Van Poznak CH, Hayes DF, Moinpour CM, Lew DL, et. al. (2016). Phase II studies of two different schedules of dasatinib in bone metastasis predominant metastatic breast cancer: SWOG S0622. *Breast cancer research and treatment*, 159(1), 87-95.
 44. Le Gall C, Bellahcene A, Bonnelye E, Gasser JA, Castronovo V, Green J, et al (2007). A cathepsin K inhibitor reduces breast cancer-induced osteolysis and skeletal tumor burden. *Cancer Research*, 67(20), 9894-9902.
 45. Jensen AB, Wynne C, Ramirez G, He W, Song Y, Berd Y, et. al (2010). The cathepsin K inhibitor odanacatib suppresses bone resorption in women with breast cancer and established bone metastases: results of a 4-week, double-blind, randomized, controlled trial. *Clinical breast cancer*, 10(6), 452-458.
 46. McCubrey JA, Davis NM, Abrams SL, Montalto G, Cervello M, Libra M, et al (2014). Targeting breast cancer initiating cells: advances in breast cancer research and therapy. *Adv Biol Regul*, 56: 81-107.
 47. Hurvitz SA, Andre F, Jiang Z, Shao Z, Mano MS, Neciosup SP, et. al (2015). Combination of everolimus with trastuzumab plus paclitaxel as first-line treatment for patients with HER2-po-

- sitive advanced breast cancer (BOLERO-1): a phase 3, randomised, double-blind, multicentre trial. *The Lancet Oncology*, 16(7), 816-829.
48. Gnant M, Baselga J, Rugo HS, Noguchi S, Burris HA, Piccart M, et. al (2013). Effect of everolimus on bone marker levels and progressive disease in bone in BOLERO-2. *Journal of the National Cancer Institute*, 105(9), 654-663.
 49. Ande SR, Chen J, Maddika S. (2009). The ubiquitin pathway: An emerging drug target in cancer therapy. *Eur J Pharmacol*, 625:199-205.
 50. Moreau P, Richardson PG, Cavo M, Orłowski RZ, San Miguel JF, Palumbo A, Harousseau JL. (2012). Proteasome inhibitors in multiple myeloma: 10 years later. *Blood*, 120: 947-59.
 51. Agyin JK, Santhamma B, Nair HB, Roy SS, Tekmal RR. (2009). BU-32: a novel proteasome inhibitor for breast cancer. *Breast Cancer Res*, 11: R74.
 52. Accardi F, Toscan D, Bolzoni M, Dalla Palma B, Aversa F, Giuliani N. (2015). Mechanism of action of bortezomib and the new proteasome inhibitors on myeloma cells and the bone microenvironment: impact on myeloma-induced alterations of bone remodeling. *BioMed research international*, 2015, 172458.
 53. Bellido T, Ali AA, Gubrij I, Plotkin LI, Fu Q, O'Brien CA, et. al (2005). Chronic elevation of parathyroid hormone in mice reduces expression of sclerostin by osteocytes: a novel mechanism for hormonal control of osteoblastogenesis. *Endocrinology*, 146(11), 4577-4583.
 54. Swami S, Johnson J, Bettinson LA, Kimura T, Zhu H, Albertelli MA, et. al (2017). Prevention of breast cancer skeletal metastases with parathyroid hormone. *JCI insight*, 2(17).
 55. Baron R, Kneissel M. (2013). WNT signaling in bone homeostasis and disease: from human mutations to treatments. *Nat Med*, 19(2):179-192.
 56. Hesse E, Schröder S, Brandt D, Pamperin J, Saito H, Taipaleenmäki H. (2019). Sclerostin inhibition alleviates breast cancer-induced bone metastases and muscle weakness. *JCI insight*, 4(9).
 57. Pinzone JJ, Hall BM, Thudi NK, Vonau M, Qiang YW, Rosol TJ, Shaughnessy JD. (2009). The role of Dickkopf-1 in bone development, homeostasis, and disease. *Blood*, 113(3), 517-525.
 58. Sato H, Suzuki H, Toyota M, Nojima M, Maruyama R, Sasaki S, Sonoda T. (2007). Frequent epigenetic inactivation of DICKKOPF family genes in human gastrointestinal tumors. *Carcinogenesis*, 28(12), 2459-2466.
 59. Eda H, Santo L, Wein MN, Hu DZ, Cirstea DD, Nemani N, Kronenberg HM. (2016). Regulation of sclerostin expression in multiple myeloma by Dkk-1: a potential therapeutic strategy for myeloma bone disease. *Journal of Bone and Mineral Research*, 31(6), 1225-1234.
 60. Wakefield LM, Hill CS. (2013). Beyond TGFbeta: roles of other TGFbeta superfamily members in cancer. *Nat Rev Cancer*, 13:328-341.
 61. Kalli M, Mpekris F, Wong CK, Panagi M, Ozturk S, Thiagalingam S, Papageorgis P, et. al (2019). Activin A signaling regulates IL13Ra2 expression to promote breast cancer metastasis. *Frontiers in oncology*, 9.
 62. Chantry AD, Heath D, Mulivor AW, Pearsall S, Baud'huin M, Coulton L, et. al (2010). Inhibiting activin-A signaling stimulates bone formation and prevents cancer-induced bone destruction in vivo. *Journal of Bone and Mineral Research*, 25(12), 2633-2646.
 63. Li JK, Yu L, Shen Y, Zhou LS, Wang YC, Zhang, JH. (2008). Inhibition of CXCR4 activity with AMD3100 decreases invasion of human colorectal cancer cells in vitro. *World journal of gastroenterology: WJG*, 14(15), 2308-2313.
 64. Saleh MN, Bendell JC, Rose A, Siegel P, Hart LL, Sirpal S, et. al (2010). Correlation of GPNMB expression with outcome in breast cancer (BC) patients treated with the antibody-drug conjugate (ADC), CDX-011 (CR011-vcMMAE). *Journal of Clinical Oncology*, 28(15_suppl), 1095-1095.
 65. Kähkönen TE, Tuomela JM, Grönroos TJ, Halleen JM, Ivaska KK, Härkönen PL. (2019). Dovitinib dilactate reduces tumor growth and tumor-induced bone changes in an experimental breast cancer bone growth model. *Journal of Bone Oncology*, 100232.
 66. Pang X, Gong K, Zhang X, Wu S, Cui Y, Qian BZ. (2019). Osteopontin as a Multifaceted Driver of Bone Metastasis and Drug Resistance. *Pharmacological research*.

67. Boumans MJ, Houbiers JG, Verschuere P, Ishikura H, Westhovens R, Brouwer E, et. al. (2012). Safety, tolerability, pharmacokinetics, pharmacodynamics and efficacy of the monoclonal antibody ASK8007 blocking osteopontin in patients with rheumatoid arthritis: a randomised, placebo controlled, proof-of-concept study, *Ann. Rheum. Dis.* 71:(2),180-185.
68. Park D, Park CW, Choi Y, Lin J, Seo DH, Kim HS, et. al (2016). A novel small-molecule PPI inhibitor targeting integrin $\alpha\beta3$ -osteopontin interface blocks bone resorption in vitro and prevents bone loss in mice. *Biomaterials*, 98, 131-142.
69. Desai B, Rogers MJ, Chellaiah MA. (2007). Mechanisms of osteopontin and CD44 as metastatic principles in prostate cancer cells. *Molecular cancer*, 6(1), 18.
70. Turner PG, O'Sullivan JM. (2015). 223Ra and other bone-targeting radiopharmaceuticals—the translation of radiation biology into clinical practice. *The British journal of radiology*, 88(1050), 20140752.
71. Parker CC, Coleman RE, Sartor O, Vogelzang NJ, Bottomley D, Heinrich D, et. al (2018). Three-year safety of radium-223 dichloride in patients with castration-resistant prostate cancer and symptomatic bone metastases from phase 3 randomized alpharadin in symptomatic prostate cancer trial. *European urology*, 73(3), 427-435.
72. Gnant M, Mlineritsch B, Stoeger H, Luschin-Ebengreuth G, Heck D, Menzel C, et al. (2011). Adjuvant endocrine therapy plus zoledronic acid in premenopausal women with early-stage breast cancer: 62-month follow-up from the ABCSG-12 randomised trial. *Lancet Oncol* 12: 631–641.
73. Coleman RE., Thorpe HC, Cameron D, Dodwell D, Burkinshaw R, Keane M, et. al (2010). Abstract S4-5: Adjuvant Treatment with Zoledronic Acid in Stage II/III Breast Cancer. The AZURE Trial (BIG 01/04).
74. Paterson AH, Anderson SJ, Lembersky BC, Fehrenbacher L, Falkson CI, King KM, et. al (2012). Oral clodronate for adjuvant treatment of operable breast cancer (National Surgical Adjuvant Breast and Bowel Project protocol B-34): a multicentre, placebo-controlled, randomised trial. *Lancet Oncol*, 13(7), 734-742.
75. Coleman RE, Finkelstein D, Barrios CH, Martin M, Iwata H, Glaspy JA, et. al (2018). Adjuvant denosumab in early breast cancer: First results from the international multicenter randomized phase III placebo controlled D-CARE study.