REVISIÓN

Biotecnología aplicada al diagnóstico y tratamiento de la osteoporosis. Avances en biofármacos, bioterapias y biomarcadores. Parte 1

Biotechnology applied to the diagnosis and treatment of osteoporosis. Review of biotechnological advances in pharmacy and biochemistry Part 1

Sterin Prync, Aída Edith[1*]; Bagnato, Julieta[1]; Olano, Lucía[1]; Ronchi Rivara, Juan Pablo[1]; Solari Ligo, María Florencia[1]; Torrens, Pierina[1]; Carlucci, Adriana Mónica[1,2]

[1]Instituto Universitario del Hospital Italiano de Buenos Aires, Ciudad Autónoma de Buenos Aires, Argentina.
[2]Departamento Farmacia, Facultad de Farmacia y Bioquímica, Universidad de Buenos Aires. Ciudad Autónoma de Buenos Aires, Argentina.
*Contacto: Sterin Prync, Aída Edith; Potosí 4234, C1199ACL, Ciudad Autónoma de Buenos Aires, Argentina; aida.sterin@hospitalitaliano.org.ar

Resumen Introducción: La osteoporosis es un desorden óseo que incrementa el riesgo a padecer fracturas que constituye un problema de salud pública. Objetivos: Estudiar los avances biotecnológicos en relación con biofármacos, bioterapias y biomarcadores aplicados a la osteporosis. Materiales y Métodos: Se realizó una búsqueda bibliográfica con las palabras clave *osteoporosis, biopharmaceuticals, biotherapies, microbiota, y biomarkers* en *MEDLINE/Pubmed*, *Scielo, Lilacs - BVS* y *Google Scholar*. Se analizaron 53 trabajos científicos en inglés o español, publicados entre 2005 y 2019. Resultados: Los péptidos recombinantes análogos de la hormona paratiroidea son biofármacos aprobados como alternativas a los fármacos tradicionales en la osteoporosis. La microbiota intestinal aparece como una bioterapia en estudio. Se describen distintos tipos de marcadores y biomarcadores y el desarrollo de herramientas como el algoritmo *Fracture Risk Assessment Tool* (FRAX). Conclusiones: La biotecnología bioquímica y farmacéutica tiene una activa e importante participación en alternativas que pueden beneficiar la calidad de vida del paciente y disminuir el problema sanitario de esta compleja patología.

Palabras clave: osteoporosis, biofármacos, bioterapias, microbiota intestinal, biomarcadores.

Abstract Introduction: Osteoporosis is a bone disorder that increases the risk of fractures, and thus constitutes a public health problem. Objectives: To study the biotechnological advances related to biopharmaceuticals, biotherapies and biomarkers applied to osteoporosis. Material and Methods: A bibliographic search was carried out with the key words osteoporosis, biopharmaceuticals, biotherapies, microbiota, and biomarkers in MEDLINE / Pubmed, Scielo, Lilacs VBS and Google Scholar. A total of 53 scientific papers written in English or Spanish and published between 2005 and 2019 were analyzed. Results: Recombinant peptides analogous to parathyroid hormone are approved biopharmaceuticals used as alternatives to traditional drugs. The intestinal microbiota appears as a biotherapy under study. Different types of markers and biomarkers and the development of tools such as the Fracture Risk Assessment Tool (FRAX) algorithm are described. Conclusions: Biochemical-pharmaceutical biotechnology has an active and important participation in alternatives that can benefit the patient's quality of life and reduce the health problem of this complex pathology.

Key words: Osteoporosis, biopharmaceuticals, biotherapies, microbiota, biomarkers

IISSN 1515-6761
ISSN-e 2684-0359
Código bibl.: ByPC
Recibido: 26/11/2021
Aceptado: 30/05/2022

Referencias bibliográficas

1. Raisz LG. Pathogenesis of osteoporosis: Concepts, conflicts, and prospects. J Clin Invest. 2005; 115 (12): 3318–25.
2. Jeremiah MP, Unwin BK, Greenawald MH, Casiano VE. Diagnosis and Management of Osteoporosis. Am Fam Physician. 2015;15;92(4):261–8.
3. Kawamata A, Iihara M, Okamoto T, Obara T. Bone mineral density before and after surgical cure of Cushing's syndrome due to adrenocortical adenoma: Prospective study. World J Surg. 2008; 32(5):890–6.
4. Shahinian VB, Kuo YF, Freeman JL, Goodwin JS. Risk of fracture after androgen deprivation for prostate cancer. N Engl J Med. 2005; 13;352(2):154–64.
5. Cedeno-Veloz B, López-Dóriga Bonnardeauxa P, Duque G. Osteosarcopenia: A narrative review. Revista Espanola de Geriatria y Gerontologia. 2019;54(2): 103-8.
6. Paintin J, Cooper C, Dennison E. Osteosarcopenia. In: Brit J Hosp Med.2018; 79 (5): 253–8
7. Eastell R, Rosen CJ, Black DM, Cheung AM, Murad MH, Shoback D. Pharmacological management of osteoporosis in postmenopausal women: An endocrine society clinical practice guideline. J Clin Endocrinol Metab; 2019; 104: 1595–622.
8. Crandall CJ, Newberry SJ, Diamant A, Lim YW, Gellad WF, Booth MJ, et al. Comparative effectiveness of pharmacologic treatments to prevent fractures: An updated systematic review. Annals of Internal Medicine. American College of Physicians; 2014; 161: 711–23.
9. Ensrud KE, Stock JL, Barrett-Connor E, Grady D, Mosca L, Khaw KT, et al. Effects of raloxifene on fracture risk in postmenopausal women: The raloxifene use for the heart trial. J Bone Miner Res. 2008; 23(1):112–20.
10. Formoso G, Perrone E, Maltoni S, Balduzzi S, Wilkinson J, Basevi V, et al. Short-term and long-term effects of tibolone in postmenopausal women., Cochrane Database of Systematic Reviews. 2016; 10(10).
11. Silverman SL, Christiansen C, Genant HK, Vukicevic S, Zanchetta JR, De Villiers TJ, et al. Efficacy of bazedoxifene in reducing new vertebral fracture risk in postmenopausal women with osteoporosis: Results from a 3-year, randomized, placebo-, and active-controlled clinical trial. J Bone Miner Res 2008;1923–34.
12. Lindsay R, Gallagher JC, Kagan R, Pickar JH, Constantine G. Efficacy of tissue-selective estrogen complex of bazedoxifene/conjugated estrogens for osteoporosis prevention in at-risk postmenopausal women. Fertil Steril 2009; 92(3):1045–52.
13. Neer RM, Arnaud CD, Zanchetta JR, Prince R, Gaich GA, Reginster JY, et al. Effect of parathyroid hormone (1-34) on fractures and bone mineral density in postmenopausal women with osteoporosis. N Engl J Med; 2001;344(19):1434–41.
14. Saag KG, Shane E, Boonen S, Marín F, Donley DW, Taylor KA, et al. Teriparatide or Alendronate in Glucocorticoid-Induced Osteoporosis. N Engl J Med; 2007;357(20):2028–39.
15. Vahle JL, Sato M, Long GG, Young JK, Francis PC, Engelhardt JA, et al. Skeletal changes in rats given daily subcutaneous injections of recombinant human parathyroid hormone (1-34) for 2 years and relevance to human safety. Toxicol Pathol; 2002; 30(3):312–21.
16. Vahle JL, Long GG, Sandusky G, Westmore M, ma YL, Sato M. Bone Neoplasms in F344 Rats Given Teriparatide [rhPTH(1-34)] Are Dependent on Duration of Treatment and Dose. Toxicol Pathol. 2004;32(4):426–38.
17. Andrews EB, Gilsenan AW, Midkiff K, Sherrill B, Wu Y, Mann BH, et al. The US postmarketing surveillance study of adult osteosarcoma and teriparatide: Study design and findings from the first 7 years. J Bone Miner Res; 2012;27(12):2429–37.
18. Miller PD, Hattersley G, Riis BJ, Williams GC, Lau E, Russo LA, et al. Effect of abaloparatide vs placebo on newvertebral fractures in postmenopausalwomen with osteoporosis a randomized clinical trial. JAMA 2016; 316(7):722–33.
19. Lamy O, Gonzalez Rodriguez E, Stoll D, Aubry-Rozier B, Livio F, Wu J, et al. Denosumab versus Zoledronic Acid for Men with Osteoporosis: A Review of Clinical Effectiveness and Guidelines. Eur J Endocrinol [Internet]. 2018 ;107(1):R31–45.
20. Smith MR, Egerdie B, Toriz NH, Feldman R, Tammela TLJ, Saad F, et al. Denosumab in men receiving androgen-deprivation therapy for prostate cancer. N Engl J Med . 2009 Aug 20;361(8):745–55.
21. Yatsonsky D, Pan K, Shendge VB, Liu J, Ebraheim NA. Linkage of microbiota and osteoporosis: A mini literature review.World J Orthop; 2019; 18 (10): 123–7.
22. Abboud M, Papandreou D. Gut microbiome, probiotics and bone: An updated mini review. Maced J Med Sci. 2019; 7:478–81.
23. Li JY, Chassaing B, Tyagi AM, Vaccaro C, Luo T, Adams J, et al. Sex steroid deficiency-associated bone loss is microbiota dependent and prevented by probiotics. J Clin Invest 2016; 1;126(6):2049–63.
24. Collins KH, Paul HA, Reimer RA, Seerattan RA, Hart DA, Herzog W. Relationship between inflammation, the gut microbiota, and metabolic osteoarthritis development: Studies in a rat model. Osteoarthr Cartil. 2015; 1 ;23(11):1989–98.
25. Yan J, Herzog JW, Tsang K, Brennan CA, Bower MA, Garrett WS, et al. Gut microbiota induce IGF-1 and promote bone formation and growth. Proc Natl Acad Sci U S A. 2016; 22;113(47):E7554–63
26. Thompson DD, Simmons HA, Pirie CM, Ke HZ. FDA Guidelines and animal models for osteoporosis. Bone. 1995 Oct 17(4 Suppl):125S-133S.
27. DeLuca HF. Evolution of our understanding of vitamin D. In: Nutrition Reviews 2008; S73-87.
28. Van de Wiele T, Vanhaecke L, Boeckaert C, Peru K, Headley J, Verstraete W, et al. Human colon microbiota transform polycyclic aromatic hydrocarbons to estrogenic metabolites. Environ Health Perspect. 2005;113(1):6–10.
29. Al Saedi A, Hassan EB, Duque G. The diagnostic role of fat in osteosarcopenia. J Lab Precis Med.2019; (4): 7-15
30. Bermeo S, Gunaratnam K, Duque G. Fat and bone interactions. Curr Osteoporos Rep 2014. 12: p. 235–42.
31. Singh L, Tyagi S, Myers D, Duque G. Good, Bad, or Ugly: the Biological Roles of Bone Marrow Fat. Vol. 16, Curr Osteoporos Rep; 2018. 16: 130–7.
32. Verma S, Rajaratnam JH, Denton J, Hoyland JA, Byers RJ. Adipocytic proportion of bone marrow is inversely related to bone formation in osteoporosis. J Clin Pathol. 2002;55(9):693–8.
33. Kanis JA, Johnell O, Oden A, Johansson H, McCloskey E. FRAXTM and the assessment of fracture probability in men and women from the UK. Osteoporos Int; 2008;19(4):385–97.
34. Hu HH, Chen J, Shen W. Segmentation and quantification of adipose tissue by magnetic resonance imaging. Vol. 29, Magnetic Resonance Materials in Physics, Biology and Medicine (MAGMA). 2016; 29(2):259-76. .
35. Ogawa M, Lester R, Akima H, Gorgey AS. Quantification of intermuscular and intramuscular adipose tissue using magnetic resonance imaging after neurodegenerative disorders. Vol. 12, Neural Regen Res; 2017. 12(12):2100-2105.
36. Kanis JA, Harvey NC, McCloskey E, Bruyère O, Veronese N, Lorentzon M, et al. Algorithm for the management of patients at low, high and very high risk of osteoporotic fractures. Osteoporos Int 2020; 31(1):1–12.
37. Kanis JA, Johnell O, Oden A, Johansson H, McCloskey E. FRAXTM and the assessment of fracture probability in men and women from the UK. Osteoporos Int 2008 ;19(4):385–97.