

## Chapter 9

### EXERCISE IN THE MANAGEMENT OF DIABETIC-RELATED NEUROPATHY

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#### INTRODUCTION

Peripheral neuropathy is the latest microvascular complication of diabetes. Early identification, treatment and preventive interventions of risky feet can prevent negative consequences. It often develops in the feet. It affects the quality of life of the diabetic negatively. It is one of the indicators that diabetes is poorly managed. The long duration of diagnosis and the degree of hyperglycemia is a risk factor for the development of diabetic peripheral neuropathy. In peripheral neuropathy, it causes loss of balance and gait disorders in approximately half of diabetics by causing loss of muscle strength and reflexes, along with impairments in vibration and position sensations in the foot and ankle. It can cause problems in the physical functions of the hands and feet. For this reason, it is important to take safety precautions and exercise for the prevention and regression of neuropathy development and make it a part of neuropathy treatment.

In this section, the epidemiology, pathophysiology, risk factors, physical function losses caused by diabetic peripheral neuropathy, which is common in diabetic patients, the contribution of exercise in neuropathy management, exercise and physical activities recommended for neuropathy, and the education responsibility of health professionals are discussed in a multidimensional manner in line with the current literature.

#### EPIDEMIOLOGY

In diabetic patients, pain, throbbing, sensation, burning and loss of sensation in the toes or fingers may be symptoms of peripheral neuropathy. Peripheral neuropathy can often develop on the hand or feet. Sensory loss in

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fort associated with painful types of neuropathy. Although physical activity does not completely reject peripheral symptoms, it can improve nerve function, decrease muscle strength, and decrease flexibility and loss of function in diabetic patients with diabetes. Often aerobic, balance, stretching exercises are applied for the whole leg and foot, and there are studies that the Buerger-Allen Exercise is beneficial for diabetic neuropathy for the last 2 years. Nurses and physiotherapists who are healthcare professionals have the responsibility of teaching and monitoring diabetic patients with practical training from the moment they are diagnosed to prevent the development of neuropathy in diabetic patients.

## REFERENCES

1. Smith AG SJ. Impaired glucose tolerance and neuropathy. *Neurologist*. 2008;14(1):23-29.
2. Kirkman MS, Briscoe VJ, Clark N et al. Diabetes in older adults. *Diabetes Care*. 2012;35(12):2650-2664.
3. Erbas T, Ertas M, Yucel A, et al. Prevalence of peripheral neuropathy and painful peripheral neuropathy in Turkish diabetic patients. *J Clin Neurophysiol*. 2011;28(1):51-55.
4. Javed S, Alam U, Malik RA. Treating diabetic neuropathy: Present strategies and emerging solutions. *Rev Diabet Stud*. 2015;12(1-2):63-83.
5. Jaiswal M, Divers J, Dabelea D, et al. Prevalence of and risk factors for diabetic peripheral neuropathy in youth with type 1 and type 2 diabetes: Search for diabetes in youth study. *Diabetes Care*. 2017;40(9):1226-1232.
6. Boulton AJM. Management of diabetic peripheral neuropathy. *Clin Diabetes*. 2005;23(1):9-15.
7. Balducci, Stefano, Sacchetti et al. Physical Exercise as therapy for type II diabetes. *Diabetes Metab Res Rev*. 2014;32(30):13-23.
8. Casellini CM VA. Clinical manifestations and current treatment options for diabetic neuropathies. *Endocr Pr*. 2007;13(5):550-566.
9. Bild DE, Selby J V., Sinnock P et al. Lower-extremity amputation in people with diabetes. Epidemiology and prevention. *Diabetes Care*. 1989;12(1):24-31. doi:10.2337/diabetes.12.1.24
10. Alavi A, Sibbald RG, Mayer D, et al. Diabetic foot ulcers: Part I. Pathophysiology and prevention. *J Am Acad Dermatol*. 2014;70(1):1.e1-1.e18.
11. Ziegler D. Treatment of diabetic polyneuropathy update 2006. *Ann N Y Acad Sci*. 2006;1084:250-266. doi:10.1196/annals.1372.008
12. Ziegler D. Treatment of diabetic neuropathy and neuropathic pain: how far have we come? *Diabetes Care*. 2008;31 Suppl 2(2):255-261.
13. Courtemanche R, Teasdale N, Boucher P et al. Gait problems in diabetic neuropathic patients. *Arch Phys Med Rehabil*. 1996;77(9):849-855.
14. Lafond D, Corriveau H, Prince F. Postural Control Mechanisms during Quiet Standing in Patients with Diabetic Sensory Neuropathy. *Diabetes Care*. 2004;27(1):173-178.
15. Ziegler D. Painful diabetic neuropathy: treatment and future aspects. *Diabetes Metab Res Rev*. 2008;(24):52-57.
16. Reiber GE, Lipsky BA, Gibbons GW. The burden of diabetic foot ulcers. *Am J Surg*. 1998;176(2 A):5S-10S.
17. Bacarin TA, Sacco ICN, Hennig EM. Plantar pressure distribution patterns during gait in diabetic neuropathy patients with a history of foot ulcers. *Clinics*. 2009;64(2):113-120.

18. Jose Luis Lazaro-Martinez, Aragon-Sanchez FJ et al. Foot Biomechanics in Patients with Diabetes Mellitus Doubts Regarding the Relationship Between Neuropathy, Foot Motion, and Deformities. *Am Podiatr Med Assoc*. 2011;101(3):208-214.
19. Andersen H, Gjerstad MD, Jakobsen J. Atrophy of foot muscles: A measure of diabetic neuropathy. *Diabetes Care*. 2004;27(10):2382-2385.
20. H.J. Murray, Youngb MJ. Association Between Callus Formation, High Pressues and Neuropathy in Diabetic Foot Ulceration. *Diabet Med*. 1996;13(July):979-982.
21. Fernando DJS, Masson EA, Veves A et al. Relationship of limited joint mobility to abnormal foot pressures and diabetic foot ulceration. *Diabetes Care*. 1991;14(1):8-11.
22. Mueller MJ, Minor SD, Diamond JE et al. Relationship of foot deformity to ulcer location in patients with diabetes mellitus. *Phys Ther*. 1990;70(6):356-362.
23. Radhika J, Geetha Poomalai, Nalini S et al. Effectiveness of Buerger-Allen Exercise on Lower Extremity Perfusion and Peripheral Neuropathy Symptoms among Patients with Diabetes Mellitus Abstract. *Iran J Nurs Midwifery Res*. 2020;25(4):291-295.
24. Diabetes Control and Complications Trial (DCCT) Research Group. Effect of intensive diabetes treatment on nerve conduction in the Diabetes Control and Complications Trial. *Ann Neurol*. 1995;38:869-80.
25. Richardson JK HE. Peripheral neuropathy: a true risk factor for falls. *J Gerontol A Biol Sci Med Sci*. 1995;50(4):211-215.
26. Crews RT, Yalla SV, Fleischer AE WS. A growing troubling triad: diabetes, aging, and falls. *J Aging Res*. 2013;2013:342650. doi:10.1155/2013/342650
27. Morrison S, Colberg SR, Mariano M et al. Balance training reduces falls risk in older individuals with type 2 diabetes. *Diabetes Care*. 2010;33(4):748-750.
28. Morrison S, Colberg SR, Parson HK VA. Relation between risk of falling and postural sway complexity in diabetes. *Gait Posture*. 2012;35(4):662-668.
29. Dixit S, Maiya A SB. Effect of aerobic exercise on quality of life in population with diabetic peripheral neuropathy in type 2 diabetes: a single blind, randomized controlled trial. *Qual Life Res*. 2014;23(5):1629-1640.
30. Ochoa N GS. Changes in sensory function and force production in adults with type II diabetes. *Muscle Nerve*. 2014;Apr 7.
31. Resnick HE, Stansberry KB HT. Diabetes, peripheral neuropathy, and old age disability. *Muscle Nerve*. 2002;25(1):43-50.
32. Morrison S. Colberg SR. Exercise in individuals with diabetic neuropathy. Lower Extremity Review. November. <https://lermagazine.com/article/exercise-in-individuals-with-diabetic-neuropathy#content>, Erişim tarihi: 16.07.2020. Published 2014.
33. Richardson JK, Thies SB, DeMott TK A-MJ. Gait analysis in a challenging environment differentiates between fallers and nonfallers among older patients with peripheral neuropathy. *Arch Phys Med Rehabil*. 2005;86(8):1539-1544.
34. Alvarsson A, Sandgren B WC. A retrospective analysis of amputation rates in diabetic patients: can lower extremity amputations be further prevented? *Cardiovasc Diabetol*. 2012;11(1):18.
35. Rubin RR, Peyrot M. Quality of life and diabetes. *Diabetes Metab Res Rev*. 1999;15(3):205-218.
36. Callin S, Bennett MI. Assessment of neuropathic pain. *Contin Educ Anaesthesia, Crit Care Pain*. 2008;8(6):210-213.
37. Burkhardt R, Brant AJA, Xpdq HS. Glucose-Responsive Expression of the Human Insulin Promoter in HepG2 Human Hepatoma Cells. *Ann N Y Acad Sci*. 2003;(1005):237-241.
38. Balducci S, Iacobellis G PL. Exercise training can modify the natural history of diabetic peripheral neuropathy. *J Diabetes Complicat*. 2006;20(4):216-223.
39. Ko SU, Stenholm S, Chia CW et al. Gait pattern alterations in older adults associated with type 2 diabetes in the absence of peripheral neuropathy—Results from the Baltimore Longitudinal Study of Aging. *Gait Posture*. 2011;34(4):548-552.

40. Kanade RV, van Deursen RWM, Harding K PP. Walking performance in people with diabetic neuropathy: benefits and threats. *Diabetologia*. 2006;49(8):1747-1754.
41. LeMaster J, Reiber GE, Smith DG et al. Daily weight-bearing activity does not increase the risk of diabetic foot ulcers. *Med Sci Sport Exerc*. 2003;35(7):1093-1099.
42. LeMaster JW, Mueller MJ, Reiber GE et al. Effect of weight-bearing activity on foot ulcer incidence in people with diabetic peripheral neuropathy: feet first randomized controlled trial. *Phys Ther*. 2008;88(11):1385-1398.
43. Singh N, Armstrong DG LB. Preventing foot ulcers in patients with diabetes. *JAMA*. 2005;293(2):217-228.
44. Colberg SR, Sigal RJ, Fernhall B et al. Exercise and type 2 diabetes: The American College of Sports Medicine and the American Diabetes Association: joint position statement. *Diabetes Care*. 2010;33(12):e147-e167. doi:10.2337/dc10-9990
45. Bus SA, Valk GD, van Deursen RW et al. The effectiveness of footwear and offloading interventions to prevent and heal foot ulcers and reduce plantar pressure in diabetes: a systematic review. *Diabetes Metab Res Rev*. 2008;24(S1):S162-S180.
46. Rizzo L, Tedeschi A, Fallani E et al. Custom-made orthosis and shoes in a structured follow-up program reduces the incidence of neuropathic ulcers in high-risk diabetic foot patients. *Int J Low Extrem Wounds*. 2012;11(1):59-64.
47. Ulbrecht JS, Hurley T, Mauer DT CP. Prevention of recurrent foot ulcers with plantar pressure-based in-shoe orthoses: The CareFUL prevention multicenter randomized controlled trial. *Diabetes Care*. 2014;37(7):1982-1989.
48. The foundation for peripheral neuropathy <https://www.foundationforpn.org/living-well/lifestyle/exercise-and-physical-therapy/> Erişim Tarihi: 27.07.2020
49. Kruse RL, LeMaster JW MR. Fall and balance outcomes after an intervention to promote leg strength, balance, and walking in people with diabetic peripheral neuropathy: “Feet First” randomized controlled trial. *Phys Ther*. 2010;90(11):1568-1579.
50. Francia P, Gulisano M, Anichini R et al. Diabetic Foot and Exercise Therapy: Step by Step The Role of Rigid Posture and Biomechanics Treatment. *Curr Diabetes Rev*. 2014;10:86-99.
51. El-Wishy A, Elsayed E. Effect of proprioceptive training program on balance in patients with diabetic neuropathy: A controlled randomized study. *Bull. Fac. Phy. Ther*. 2012; 17(2): 1-8.
52. Richerson S RK. Does tai chi improve plantar sensory ability? A pilot study. *Diabetes Technol Ther*. 2007;9(3):276-286.
53. Rojhani-Shirazi, Z., Barzintaj, F., & Salimifard MR. Comparison the effects of two types of therapeutic exercises Frenkele vs. Swiss ball on the clinical balance measures in patients with type II diabetic neuropathy. *Diabetes Metab Syndr*. 2017;11:29-32.
54. Dhasaradharaman K, Suganthirababu P, Mohanraj K. Effect of proprioceptive and flexibility exercise program along with resisted training on anxiety and depression with diabetic neuropathy. *Indian J Public Heal Res Dev*. 2018;9(10):101-105.
55. Bus SA, Lavery LA, Monteiro-Soares M, et al. Guidelines on the prevention of foot ulcers in persons with diabetes (IWGDF 2019 update). *Diabetes Metab Res Rev*. 2020;36(S1):1-18.
56. Dixit S, Maiya AG, Shastry BA. Effect of aerobic exercise on peripheral nerve functions of population with diabetic peripheral neuropathy in type 2 diabetes: A single blind, parallel group randomized controlled trial. *J Diabetes Complications*. 2014;28(3):332-339.
57. Matos M, Mendes R, Silva AB, Sousa N. Physical activity and exercise on diabetic foot related outcomes: A systematic review. *Diabetes Res Clin Pract*. 2018;139:81-90.
58. Li H, Shen Z, Lu Y et al. Muscle NT-3 levels increased by exercise training contribute to the improvement in caudal nerve conduction velocity in diabetic rats. *Mol Med Rep*. 2012;6(1):69-74.
59. Bethany Barone Gibbs, PhDa, Devon A. Dobrosielski, Andrew D et al. The effect of exercise training on ankle-brachial index in type 2 diabetes. *Atherosclerosis*. 2013;230(1):125-130.

60. Eraydin S, Avsar G. The Effect of Foot Exercises on Wound Healing in Type 2 Diabetic Patients with a Foot Ulcer: A Randomized Control Study. *J Wound, Ostomy Cont Nurs.* 2018;45(2):123-130.
61. Goldsmith JR, Lidtke RH, Shott S. The effects of range-of-motion therapy on the plantar pressures of patients with diabetes mellitus. *J Am Podiatr Med Assoc.* 2002;92(9):483-490. doi:10.7547/87507315-92-9-483
62. Monteiro RL, Sartor CD, Ferreira JSSP et al. Protocol for evaluating the effects of a foot-ankle therapeutic exercise program on daily activity, foot-ankle functionality, and biomechanics in people with diabetic polyneuropathy: A randomized controlled trial. *BMC Musculoskelet Disord.* 2018;19(1):1-12.
63. Tudpor K, Traithip W. Fall Prevention by Short-Foot Exercise in Diabetic Patients. *Indian J Physiother Occup Ther - An Int J.* 2019;13(2):69.
64. Reid SL, Pitcher CA, Williams SA, et al. Does muscle size matter? the relationship between muscle size and strength in children with cerebral palsy. *Disabil Rehabil.* 2015;37(7):579-584.
65. Turan Y. Diyabetik Ayak Ülserlerinde Fizik Tedavi Ve Rehabilitasyon. <http://www.turktibbirehabilitasyon.org/diyabetik-ayak-ulserlerinde-fizik-tedavi-rehabilitasyon/> Erişim Tarihi: 27.07.2020
66. Sathya K, Karthi R. A Study to Assess the Effectiveness of Buerger Allen Exercise to Prevent Risk of Diabetic Foot by Improving Lower Extremity Perfusion among Clients With Type-2 Diabetes Mellitus in Selected Hospitals at Villupuram District , Tamilnadu. *Int J Res Rev.* 2019;6(March):83-88.
67. American Diabetes Association (ADA). Microvascular Complications and Foot Care: Standards of Medical Care in Diabetes2020 *Diabetes Care* 2020;43(Suppl. 1):S135–S151 |