

# BÖLÜM

# 3

## Antrenmanda Adaptasyon

Mürşit Ceyhun BİRİNCİ<sup>1</sup>

### Antrenmanda Uyum

Beden ve zihnin sürekli ve çeşitli kapsam, sertlikte yüklenmeler altında etkinliğini devam ettirdiği düzenli sürece antrenman denilmektedir. Bir sporcunun antrenman ve yarışma tarafından maruz kalınan iş yüklerine uyum sağlama ve uyum sağlama yeteneği, bir türün yaşadığı çevreye uyum sağlama yeteneği kadar önemlidir. Sporcularda sürekli değişen antrenman ve yüklenme yetersizlikleri yorgunluk, aşırı erişim, aşırı antrenman gibi sınırlayıcı durumlara neden olmaktadır. Bu gibi durumlarda da sporcu antrenman hedeflerine ulaşamamaktadır(1).

Yüksek bir verim düzeyi, sistematik olarak çok iyi bir planlama ve uzun yıllar süren sert bir antrenman sürecinin ürünüdür. Sporcu, bu süreç içerisinde spor dalı gerektirimlerine uygun olacak fizyolojik uyumu oluşturmaya çalışmalıdır. Yüksek verim düzeyi olanaklarının artması antrenman sürecine sağlanan uyum ile sağlanmaktadır. Bu nedenle verim düzeyini artttırıcı uyum olanaklarını artttırmak iyi düzenlenmiş bir antrenman planlamasının amacı olmalıdır(2).

Sporcularda uyum gelişimi arda arda gelen bağlantılı bir sıralamaya bağlı olarak ortaya çıkmaktadır:

---

<sup>1</sup> Dr. Arş. Gör., Ondokuz Mayıs Üniversitesi, Yaşar Doğu Spor Bilimleri Fakültesi  
ceyhun.birinci@hotmail.com

## KAYNAKLAR

1. SELYE, H. The Stress of Life. New York: Mc- Graw-Hill, 1956.
2. COFFEY, V.G., and J.A. HAWLEY. The molecular bases of training adaptation. Sports Med 37:737- 763, 2007.
3. MAUGHAN, R., and M. GLEESON. The Biochemical Basis of Sports Performance. New York: Oxford University Press, 2004.
4. Bompa, T. O. and Haff, G. G. (2017). Dönemleme: Antrenman Kuramı ve Yönetimi (Periodization: Theory and Methodology of Training), 5. Baskı, Çeviri: Tanju Bağırgan, Ankara, Spor Yayınevi ve Kitabevi.
5. MCARDLE, W.D., F.I. KATCH, and V.L. KATCH. Exercise Physiology: Energy, Nutrition, and Human Performance. 6th ed. Baltimore: Lippincott, Williams & Wilkins, 2007.
6. SIFF, M.C., and Y.U. VERKHOSHANSKY. Supertraining. Denver, CO: Supertraining International, 1999.
7. FEBBRAIO, M.A., and J. DANCEY. Skeletal muscle energy metabolism during prolonged, fatiguing exercise. *J Appl Physiol* 87:2341-2347, 1999.
8. JAMURTAS, A.Z., Y. KOUTEDAKIS, V. PASCHALIS, T. TOFAS, C. YFANTI, A. TSIOKANOS, G. KOUKOULIS, D. KOURETAS, and D. LOUPOS. The effects of a single bout of exercise on resting energy expenditure and respiratory exchange ratio. *Eur J Appl Physiol* 92:393-398, 2004.
9. COOPER, K.H. The New Aerobics. New York, NY: M. Evans and Company, 1970.
10. FRY, A.C., and W.J. KRAEMER. Resistance exercise overtraining and overreaching: neuroendocrine responses. *Sports Med* 23:106-129, 1997.
11. FRY, A.C., W.J. KRAEMER, M.H. STONE, B.J. WARREN, S.J. FLECK, J.T. KEARNEY, and S.E. GORDON. Endocrine responses to overreaching before and after 1 year of weightlifting. *Can J Appl Physiol* 19:400-410, 1994.
12. ZATSIORSKY, V.M., and W.J. KRAEMER. Science and Practice of Strength Training. 2nd ed. Champaign, IL: Human Kinetics, 2006.
13. COYLE, E.F. Substrate utilization during exercise in active people. *Am J Clin Nutr* 61:968S-979S, 1995.
14. PAROLIN, M.L., A. CHESLEY, M.P. MATSOS, L.L. SPRIET, N.L. JONES, and G.J. HEIGENHAUSER. Regulation of skeletal muscle glycogen phosphorylase and PDH during maximal intermittent exercise. *Am J Physiol* 277:E890-E900, 1999.
15. TESCH, P.A., L.L. PLOUTZ-SNYDER, L. YSTRÖM, M. CASTRO, and G. DUDLEY. Skeletal muscle glycogen loss evoked by resistance exercise. *J Strength Cond Res* 12:67-73, 1998.
16. GALLIVEN, E.A., A. SINGH, D. MICHELSON, S. BINA, P.W. GOLD, and P.A. DEUSTER. Hormonal and metabolic responses to exercise across time of day and menstrual cycle phase. *J Appl Physiol* 83:1822-1831, 1997.
17. GOTO, K., M. HIGASHIYAMA, N. ISHII, and K. TAKAMATSU. Prior endurance exercise attenuates growth hormone response to subsequent resistance exercise. *Eur J Appl Physiol* 94:333-338, 2005.
18. DAVIS, J.M. Central and peripheral factors in fatigue. *J Sports Sci* 13(Spec No):S49-S53, 1995.
19. GARRANDES, F., S.S. COLSON, M. PENSINI, and P. LEGROS. Time course of mechanical and neuromuscular characteristics of cyclists and triathletes during a fatiguing exercise. *Int J Sports Med* 28:148-156, 2007.
20. GARRANDES, F., S.S. COLSON, M. PENSINI, O. SEYNNES, and P. LEGROS. Neuromuscular fatigue profile in endurance-trained and power-trained athletes. *Med Sci Sports Exerc* 39:149- 158, 2007.
21. BAAR, K. Training for endurance and strength: lessons from cell signaling. *Med Sci Sports*

- Exerc 38:1939-1944, 2006.
22. MICHAUT, A., M. POUSSON, G. MILLET, J. BELLEVILLE, and J. VAN HOECKE. Maximal voluntary eccentric, isometric and concentric torque recovery following a concentric isokinetic exercise. Int J Sports Med 24:51-56, 2003.
  23. NICOL, C., J. AVELA, and P.V. KOMI. The stretch-shortening cycle: a model to study naturally occurring neuromuscular fatigue. Sports Med 36:977-999, 2006.
  24. DAVIS, J.M., Z. ZHAO, H.S. STOCK, K.A. MEHL, J. BUGGY, and G.A. HAND. Central nervous system effects of caffeine and adenosine on fatigue. Am J Physiol Regul Integr Comp Physiol 284:R399-R404, 2003.
  25. MACINTOSH, B.R., and D.E. RASSIER. What is fatigue? Can J Appl Physiol 27:42-55, 2002.
  26. HAFF, G.G., M.J. LEHMKUHL, L.B. MCCOY, and M.H. STONE. Carbohydrate supplementation and resistance training. J Strength Cond Res 17:187-196, 2003.
  27. TESCH, P. Muscle fatigue in man: with special reference to lactate accumulation during short term intense exercise. Acta Physiol Scand Suppl 480:1-40, 1980.
  28. WESTERBLAD, H., D.G. ALLEN, and J. LANNERGREN. Muscle fatigue: lactic acid or inorganic phosphate the major cause? News Physiol Sci 17:17-21, 2002.
  29. HIRVONEN, J., S. REHUNEN, H. RUSKO, and M. HARKONEN. Breakdown of high-energy phosphate compounds and lactate accumulation during short supramaximal exercise. Eur J Appl Physiol 56:253-259, 1987.
  30. KARLSSON, J. Lactate in working muscles after prolonged exercise. Acta Physiol Scand 82:123-130, 1971.
  31. AHTIAINEN, J.P., A. PAKARINEN, W.J. KRAEMER, and K. HÄKKINEN. Acute hormonal and neuromuscular responses and recovery to forced vs maximum repetitions multiple resistance exercises. Int J Sports Med 24:410-418, 2003.
  32. GUEZENNEC, Y., L. LEGER, F. LHOSTE, M. AYMONOD, and P.C. PESQUIES. Hormone and metabolite response to weight-lifting training sessions. Int J Sports Med 7:100-105, 1986.
  33. NIEMAN, D.C., and B.K. PEDERSEN. Exercise and immune function: recent developments. Sports Med 27:73-80, 1999.
  34. BURKE, L.M. Nutrition for post-exercise recovery. Aus J Sci Med Sport 29:3-10, 1996.
  35. BURKE, L., and V. DEAKIN. Clinical Sports Nutrition. Roseville, Australia: McGraw-Hill Australia, 2000.
  36. DAL MONTE, A. The functional values of sport. Firenze: Sansoni, 1983.
  37. BURGOMASTER, K.A., G.J. HEIGENHAUSER, and M.J. GIBALA. Effect of short-term sprint interval training on human skeletal muscle carbohydrate metabolism during exercise and time-trial performance. J Appl Physiol 100:2041-2047, 2006.
  38. STEPTO, N.K., D.T. MARTIN, K.E. FALLON, and J.A. HAWLEY. Metabolic demands of intense aerobic interval training in competitive cyclists. Med Sci Sports Exerc 33:303-310, 2001.
  39. HAFF, G.G., A.J. KOCH, J.A. POTTEIGER, K.E. KUPHAL, L.M. MAGEE, S.B. GREEN, and J.J. JAKICIC. Carbohydrate supplementation attenuates muscle glycogen loss during acute bouts of resistance exercise. Int J Sport Nutr Exerc Metab 10:326-339, 2000.
  40. MACDOUGALL, J.D., S. RAY, D.G. SALE, N. MCCARTNEY, P. LEE, and S. GARNER. Muscle substrate utilization and lactate production during weightlifting. Can J Appl Physiol 24:209-215, 1999.
  41. COSTILL, D.L., P.D. GOLLNICK, E.D. JANSSON, B. SALTIN, and E.M. STEIN. Glycogen depletion pattern in human muscle fibres during distance running. Acta Physiol Scand 89:374-383, 1973.
  42. COYLE, E.F. Physical activity as a metabolic stressor. Am J Clin Nutr 72:512S-520S, 2000.
  43. KARLSSON, J., L.O. NORDESJÖ, L. JORFELDT, and B. SALTIN. Muscle lactate, ATP, and CP levels during exercise after physical training in man. J Appl Physiol 33:199-203, 1972.

44. KARLSSON, J., and B. OLLANDER. Muscle metabolites with exhaustive static exercise of different duration. *Acta Physiol Scand* 86:309-314, 1972.
45. BALOG, E.M., B.R. FRUEN, P.K. KANE, and C.F. LOUIS. Mechanisms of P(i) regulation of the skeletal muscle SR Ca(2+) release channel. *Am J Physiol Cell Physiol* 278:C601-611, 2000.
46. DAHLSTEDT, A.J., A. KATZ, B. WIERINGA, and H. WESTERBLAD. Is creatine kinase responsible for fatigue? Studies of isolated skeletal muscle deficient in creatine kinase. *FASEB J* 14:982-990, 2000.
47. KJAER, M., B. KIENS, M. HARGREAVES, and E.A. RICHTER. Influence of active muscle mass on glucose homeostasis during exercise in humans. *J Appl Physiol* 71:552-557, 1991.
48. SUH, S.H., I.Y. PAIK, and K. JACOBS. Regulation of blood glucose homeostasis during prolonged exercise. *Mol Cells* 23:272-279, 2007.
49. CLOSE, G.L., T. ASHTON, A. MCARDLE, and D.P. MACLAREN. The emerging role of free radicals in delayed onset muscle soreness and contraction- induced muscle injury. *Comp Biochem Physiol* 142:257-266, 2005.
50. GARCIA-LOPEZ, D., J.A. DE PAZ, R. JIMENEZJIMENEZ, G. BRESCIANI, F. DE SOUZA-TEIXEIRA, J.A. HERRERO, I. ALVEAR-ORDENES, and J. GONZALEZ-GALLEG. Early explosive force reduction associated with exercise-induced muscle damage. *J Physiol Biochem* 62:163-169, 2006.
51. MACINTYRE, D.L., S. SORICHTER, J. MAIR, A. BERG, and D.C. MCKENZIE. Markers of inflammation and myofibrillar proteins following eccentric exercise in humans. *Eur J Appl Physiol* 84:180-186, 2001.
52. HARRIS, R.C., R.H. EDWARDS, E. HULTMAN, L.O. NORDESJO, B. NYLIND, and K. SAHLIN. The time course of phosphorylcreatine resynthesis during recovery of the quadriceps muscle in man. *Pflugers Arch* 367:137-142, 1976.
53. HULTMAN, E., and H. SJØHOLM. Biochemical causes of fatigue. In: *Human Muscle Power*. N.L. Jones, ed. Champaign, IL: Human Kinetics, 1986, pp. 343-363.
54. ABERNETHY, P.J., J. JURIMAE, P.A. LOGAN, A.W. TAYLOR, and R.E. THAYER. Acute and chronic response of skeletal muscle to resistance exercise. *Sports Med* 17:22-38, 1994.
55. ABERNETHY, P.J., R. THAYER, and A.W. TAYLOR. Acute and chronic responses of skeletal muscle to endurance and sprint exercise: a review. *Sports Med* 10:365-389, 1990.
56. COYLE, E.F. Timing and method of increased carbohydrate intake to cope with heavy training, competition and recovery. *J Sports Sci* 9(Spec No):29-51, discussion 51-22, 1991.
57. COSTILL, D.L., D.D. PASCOE, W.J. FINK, R.A. ROBERGS, S.I. BARR, and D. PEARSON. Impaired muscle glycogen resynthesis after eccentric exercise. *J Appl Physiol* 69:46-50, 1990.
58. COSTILL, D.L., W.M. SHERMAN, W.J. FINK, C. MARESH, M. WITTEN, and J.M. MILLER. The role of dietary carbohydrates in muscle glycogen resynthesis after strenuous running. *Am J Clin Nutr* 34:1831-1836, 1981.357.
59. LAFORGIA, J., R.T. WITHERS, and C.J. GORE. Effects of exercise intensity and duration on the excess post-exercise oxygen consumption. *J Sports Sci* 24:1247-1264, 2006.
60. BURLESON, M.A., Jr., H.S. O'BRYANT, M.H. STONE, M.A. COLLINS, and T. TRIPLETT-MCBRIDE. Effect of weight training exercise and treadmill exercise on post- exercise oxygen consumption. *Med Sci Sports Exerc* 30:518-522, 1998.
61. MCMILLAN, J.L., M.H. STONE, J. SARTIN, R. KEITH, D. MARPLE, C. BROWN, and R.D. LEWIS. 20-hour physiological responses to a single weight-training session. *J Strength Cond Res* 7:9- 21, 1993.
62. MELBY, C., C. SCHOLL, G. EDWARDS, and R. BULLOUGH. Effect of acute resistance exercise on postexercise energy expenditure and resting metabolic rate. *J Appl Physiol* 75:1847-1853, 1993.
63. MACDOUGALL, J.D., M.J. GIBALA, M.A. TARNOPOLSKY, J.R. MACDONALD, S.A. INTERISANO, and K.E. YARASHESKI. The time course for elevated muscle protein

- synthesis following heavy resistance exercise. *Can J Appl Physiol* 20:480-486, 1995.
- 64. LEBON, V., S. DUFOUR, K.F. PETERSEN, J. REN, B.M. JUCKER, L.A. SLEZAK, G.W. CLINE, D.L. ROTHMAN, and G.I. SHULMAN. Effect of triiodothyronine on mitochondrial energy coupling in human skeletal muscle. *J Clin Invest* 108:733-737, 2001.
  - 65. CHESLEY, A., J.D. MACDOUGALL, M.A. TARNOPOLSKY, S.A. ATKINSON, and K. SMITH. Changes in human muscle protein synthesis after resistance exercise. *J Appl Physiol* 73:1383-1388, 1992.
  - 66. ZAINUDDIN, Z., P. SACCO, M. NEWTON, and K. NOSAKA. Light concentric exercise has a temporarily analgesic effect on delayed-onset muscle soreness, but no effect on recovery from eccentric exercise. *Appl Physiol Nutr Metab* 31:126-134, 2006.
  - 67. GILLAM, G.M. Effects of frequency of weight training on muscle strength enhancement. *J Sports Med* 21:432-436, 1981.
  - 68. PETERSON, M.D., M.R. RHEA, and B.A. ALVAR. Applications of the dose-response for muscular strength development: a review of meta-analytic efficacy and reliability for designing training prescription. *J Strength Cond Res* 19:950-958, 2005.
  - 69. FRY, A.C. The role of training intensity in resistance exercise overtraining and overreaching. In: *Overtraining in Sport*. R.B. Kreider, A.C. Fry, and M.L. O'Toole, eds. Champaign, IL: Human Kinetics, 1998, pp. 107-127.
  - 70. FRY, A.C., W.J. KRAEMER, F. VAN BORSELEN, J.M. LYNCH, J.L. MARSIT, E.P. ROY, N.T. TRIPPLETT, and H.G. KNUTTGEN. Performance decrements with high-intensity resistance exercise overtraining. *Med Sci Sports Exerc* 26:1165-1173, 1994.
  - 71. FRY, A.C., B.K. SCHILLING, L.W. WEISS, and L.Z. CHIU. Beta<sub>2</sub>-Adrenergic receptor downregulation and performance decrements during high-intensity resistance exercise overtraining. *J Appl Physiol* 101:1664-1672, 2006.
  - 72. IZQUIERDO, M., J. IBANEZ, J.J. GONZALEZ-BADILLO, K. HÄKKINEN, N.A. RATAMESS, W.J. KRAEMER, D.N. FRENCH, J. ESLAVA, A. ALTADILL, X. ASIAIN, and E.M. GOROSTIAGA. Differential effects of strength training leading to failure versus not to failure on hormonal responses, strength, and muscle power gains. *J Appl Physiol* 100:1647-1656, 2006.