

Babak Vogel/Jan Schröder

# PERSONALISIERTE TRAININGSSTEUERUNG

## Tensiomyografisches Muskelfunktionsmonitoring in der Trainingsroutine: eine Pilot-Kasuistik im Kampfsport

Trainingseinheit	Aufwärmen	Technik	Sparring
T1 Jan 03	15 min	-	60 min bei 50-60 %
T2 Jan 05	15 min	-	60 min bei 50-60 %
<b>1. Trainingsunterbrechung: Muskelkontusionen der Beinstrecker und -beuger Wiedereinstieg in das Training am 12.01.2018</b>			
T3 Jan 15	10 min	50 min	15 min bei 50-60 %
T4 Jan 17	15 min	30 min	30 min bei 70-80 %
<b>2. Trainingsunterbrechung: Supinationstrauma (rechtes Sprunggelenk) Wiedereinstieg in das Training am 28.01.2018</b>			
T5 Jan 31	15 min	45 min	15 min bei 50-60 %
T6 Feb 02	5 min	10 min	60 min bei 50-60 %
T7 Feb 03	20 min	45 min	10 min bei 20-30 %
T8 Feb 05	15 min	60 min	-
<b>3. Trainingsunterbrechung: grippaler Infekt Wiedereinstieg in das Training am 15.02.2018</b>			
T9 Feb 15	15 min	-	60 min bei 70-80 %
T10 Feb 16	15 min	-	60 min bei 50-60 %
T11 Feb 19	15 min	60 min	-
T12 Feb 21	15 min	60 min	-

Tabelle A: Übersicht zu Umfang und Intensität sowie Ausfallzeiten im Training

### Literatur

- Alentorn-Geli, E., Alvarez-Diaz, P., Ramon, S., Marin, M., Steinbacher, G., Boffa, J. J., Cuscó, X., Ballester, J. & Cugat, R. (2015). Assessment of neuromuscular risk factors for anteriorcruciate ligament injury through tensiomyography in male soccer players. *Knee Surgery, Sports Traumatology, Arthroscopy*, 23 (9), 2508-2013.
- Collette, R., Kellmann, M., Ferrauti, A., Meyer, T. & Pfeiffer, M. (2018). Relation between training load and recovery-stress state in high-performance swimming. *Frontiers in Physiology*, 9, 845.
- de Paula Simola, R. A., Harms, N., Raeder, C., Kellmann, M., Meyer, T., Pfeiffer, M. & Ferrauti, A. (2015). Assessment of neuromuscular function after different strength training protocols using tensiomyography. *Journal of Strength and Conditioning Research*, 29 (5), 1339-1348.
- de Paula Simola, R. A., Harms, N., Raeder, C., Kellmann, M., Meyer, T., Pfeiffer, M. & Ferrauti, A. (2016a). Tensiomyography reliability and prediction of changes in muscle force after eccentric strength exercise using muscle mechanical properties. *Sports Technology*, 8, 58-66.
- de Paula Simola, R. A., Raeder, C., Wiewelhove, T., Kellmann, M., Meyer, T., Pfeiffer, M. & Ferrauti, A. (2016b). Muscle mechanical properties of strength and endurance athletes and changes after one week of intensive training. *Journal of Electromyography and Kinesiology*, 30, 73-80.
- Ditroilo, M., Hunter, A. M., Haslam, S. & De Vito, G. (2011). The effectiveness of two novel techniques in establishing the mechanical and contractile responses of biceps femoris. *Physiological Measurement*, 32 (8), 1315-1326.
- Ditroilo, M., Smith, I. J., Fairweather, M. & Hunter, A. M. (2013). Long-term stability of tensiomyography measured under different muscle conditions. *Journal of Electromyography and Kinesiology*, 23 (3), 558-563.
- Eccles, R. (2005). Understanding the symptoms of the common cold and influenza. *The Lancet Infectious Diseases*, 5 (11), 718-725.
- García-Manso, J. M., Rodríguez-Matoso, D., Sarmiento, S., de Saa, Y., Vaamonde, D., Rodríguez-Ruiz, D. & Da Silva-Grigoletto, M. E. (2012). Effect of high-load and high-volume resistance exercise on the tensiomyographic twitch response of biceps brachii. *Journal of Electromyography and Kinesiology*, 22 (4), 612-619.
- Hecksteden, A., Skorski, S., Schwindling, S., Hammes, D., Pfeiffer, M., Kellmann, M., Ferrauti, A. & Meyer, T. (2016). Blood-borne markers of fatigue and recovery in competitive athletes. Results from a simulated training camp. *PloS ONE*, 11 (2), e0148810.
- Hitzschke, B., Wiewelhove, T., Raeder, C., Ferrauti, A., Meyer, T., Pfeiffer, M., Kellmann, M. & Kölling, S. (2017). Evaluation of psychological measures for the assessment of recovery and stress during a shock-microcycle in strength and high-intensity interval training. *Performance Enhancement & Health*, 5 (4), 147-157.
- Hunter, A., Galloway, S., Smith, I., Tallent, J., Ditroilo, M., Fairweather, M. & Howatson, G. (2012). Assessment of eccentric-induced muscle damage of the elbow flexors by tensiomyography. *Journal of Electromyography and Kinesiology*, 22 (3), 334-341.
- Klavara, P. (2000). Vertical jump tests: a critical review. *Strength and Conditioning Journal*, 22 (5), 70-74.
- Košiček, A. (2014). TMG-S1 Muscular Measuring Device. User Manual (Version 3.5). Ljubljana, Slovenia.
- Leard, J. S., Cirillo, M. A., Katsnelson, E., Kimiatek, D. A., Miller, T. W., Trebincevic, K. & Garbalosa, J. C. (2007). Validity of two alternative systems for measuring vertical jump height. *Journal of Strength and Conditioning Research*, 21 (4), 1296-1299.
- Lohr, C., Braumann, K.-M., Reer, R., Schröder, J. & Schmidt, T. (2018). Reliability of tensiomyography and myotonometry in detecting mechanical and contractile characteristics of the lumbar erector spinae in healthy volunteers. *European Journal of Applied Physiology*, 118 (7), 1349-1359.
- Loturco, I., Pereira, L. A., Kobal, R., Kitamura, K., Ramírez-Campillo, R., Zanetti, V., Cal Abad, C. C. & Nakamura, F. Y. (2016). Muscle contraction velocity: a suitable approach to analyze the functional adaptations in elite soccer players. *Journal of Sports Science and Medicine*, 15, 483-491.
- Macgregor, L. J., Ditroilo, M., Smith, I. J., Fairweather, M. M. & Hunter, A. M. (2016). Reduced radial displacement of the gastrocnemius medialis muscle after electrically elicited fatigue. *Journal of Sport Rehabilitation*, 25, 241-247.
- Macgregor, L. J., Hunter, A. M., Orizio, C., Fairweather, M. M. & Ditroilo, M. (2018). Assessment of skeletal muscle contractile properties by radial displacement: the case for tensiomyography. *Sports Medicine*, 48 (7), 1607-1620.
- Markovic, G., Dizdar, D., Jukic, I. & Cardinale, M. (2004). Reliability and factorial validity of squat

- and countermovement jump tests. *Journal of Strength and Conditioning Research*, 18 (3), 551-555.
- Meyer, T., Ferrauti, A., Kellmann, M. & Pfeiffer, M. (2016). Regenerationsmanagement im Spitzensport. *REGman – Ergebnisse und Handlungsempfehlungen*. Köln: Sportverlag Strauß.
- Meyer, T., Skorski, S., Pfeiffer, M., Kellmann, M., Ferrauti, A. & Hecksteden, A. (2018). Regenerationsmanagement im Sport. Ergebnisse eines Verbundprojekts im Auftrag des Bundesinstituts für Sportwissenschaft. *Sportphysio*, 6, 24-32.
- Mueller-Wohlfahrt, H.-W., Haensel, L., Mithoefer, K., Ekstrand, J., English, B., McNally, S., Orchard, J., van Dijk, C. N., Kerkhoffs, G. M., Schamasch, P., Blottner, D., Swaerd, L., Goedhart, E. & Ueblacker, P. (2013). Terminology and classification of muscle injuries in sport: The Munich consensus statement. *British Journal of Sports Medicine*, 47, 342-350.
- Mullix, J., Warner, M. & Stokes, M. (2012). Testing muscle tone and mechanical properties of rectus femoris and biceps femoris using a novel hand held MyotonPRO device: relative ratios and reliability. *Working Papers in Health Sciences*, 1 (1), 1-8.
- Orchard, J., Marsden, J., Lord, S. & Garlick, D. (1997). Preseason hamstring muscle weakness associated with hamstring muscle injury in Australian footballers. *The American Journal of Sports Medicine*, 25 (1), 81-85.
- Padulo, J., Tiloca, A., Powell, D., Granatelli, G., Bianco, A. & Paoli, A. (2013). EMG amplitude of the biceps femoris during jumping compared to landing movements. *SpringerPlus*, 2, 520.
- Raeder, C., Wiewelhove, T., de Paula Simola, R., Kellmann, M., Meyer, T., Pfeiffer, M. & Ferrauti, A. (2016). Assessment of fatigue and recovery in male and female athletes following six days of intensified strength training. *Journal of Strength and Conditioning Research*, 30 (12), 3412-3427.
- Reiss, M. & Reiss, G. (2000). Studies on Motorial Asymmetries. *Fortschritte der Neurologie – Psychiatrie*, 68 (2), 70-79.
- Rodríguez-Mataso, D., García-Manso, J. M., Sarmiento, S., De Saa, Y., Vaamonde, D., Rodríguez-Ruiz, D. & Da Silva-Grigoletto, M. E. (2012). Assessment of muscle response as a control tool in the area of physical activity, health, and sports. *Andaluza Journal of Sports Medicine*, 5, 28-40.
- Rodríguez-Ruiz, D., Rodríguez-Mataso, D., Quiroga, M. E., Sarmiento, S., García-Manso, J. M. & Da Silva-Grigoletto, M.E. (2012). Study of mechanical characteristics of the knee extensor and flexor musculature of volleyball players. *European Journal of Sport Science*, 12 (5), 399-407.
- Rusu, L., Cosma, G., Cernăianu, S., Marin, M., Rusu, P., Ciocanescu, D. & Neferu, F. (2013). Tensiomyography method used for neuromuscular assessment of muscle training. *Journal of Neuroengineering and Rehabilitation*, 10, 67.
- Saw, A. E., Main, L. C. & Gastin, P. B. (2016). Monitoring the athlete training response: subjective self-reported measures trump commonly used objective measures: a systematic review. *British Journal of Sports Medicine*, 50 (5), 281-291.
- Schröder, J., Vogel, B., Liedtke, G., Hollander, K. & Braumann, K.-M. (2018). Trainingsbegleitendes Monitoring des Muskelfunktionsstatus. Ist die Tensiomyographie im Feld praxistauglich? *Leistungssport*, 48 (3), 37-42.
- Valenčič, V. & Knež, N. (1997). Measuring of skeletal muscles dynamic properties. *Artificial Organs*, 21 (3), 240-242.
- Valenčič, V., Knež, N. & Simunic, B. (2001). Tensiomyography: Detection of skeletal muscle response by means of radial muscle belly displacement. *Biomedical Engineering* 1, 1-10.
- van der Harst, J. J., Gokeler, A. & Hof, A. L. (2007). Leg kinematics and kinetics in landing from a single-leg hop for distance. A comparison between dominant and non-dominant leg. *Clinical Biomechanics* (Bristol, Avon), 22 (6), 674-680.
- Weidner, T. G. & Sevier, T. L. (1996). Sport, Exercise and the Common Cold. *Journal of Athletic Training*, 31 (2), 154-159.
- Weir, J. P. (2005). Quantifying test-retest reliability using the intraclass correlation coefficient and the SEM. *Journal of Strength and Conditioning Research*, 19 (1), 231-240.
- Wiewelhove, T., Raeder, C., Meyer, T., Kellmann, M., Pfeiffer, M. & Ferrauti, A. (2015). Markers for routine assessment of fatigue and recovery in male and female team sport athletes during high-intensity interval training. *PLoS ONE*, 10 (10), e0139801. Download unter <https://journals.plos.org/plos-one/article?id=10.1371/journal.pone.0139801>.
- Wiewelhove, T., Raeder, C., de Paula Simola, R. A., Schneider, C., Döweling, A. & Ferrauti, A. (2017). Tensiomyographic markers are not sensitive for monitoring muscle fatigue in elite youth athletes: a pilot study. *Frontiers in Physiology*, 8, 406.
- Wilson, G. J., Wood, G. A. & Elliott, B. C. (1991). The relationship between stiffness of the musculature and static flexibility: an alternative explanation for the occurrence of muscular injury. *International Journal of Sports Medicine*, 12 (4), 403-407.
- Wilson, H. V., Johnson, M. I. & Francis, P. (2018). Repeated stimulation, inter-stimulus interval and inter-electrode distance alters muscle contractile properties as measured by tensiomyography. *PLoS ONE*, 13 (2), e0191965. Download unter <https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0191965>.
- World Medical Association (Hrsg.). (2013). *WMA Declaration of Helsinki – Ethical Principles for Medical Research Involving Human Subjects*. Download unter <https://www.wma.net/wp-content/uploads/2016/11/DoH-Oct2013-JAMA.pdf>.

### Korrespondenzadresse

Babak Vogel, Universität Hamburg, Fakultät für Psychologie und Bewegungswissenschaft, Turmweg 2, 20148 Hamburg  
E-Mail: Babakv1990@yahoo.de