Medicina Sportiva

Journal of Romanian Sport Medicine Society

Vol. X, No. 3 – 2014 **15.09.2014**

ISSN 1841-0162
***Publisher "Universitaria"*, Craiova, Romania**

Editorial Office Address: University of Craiova, Physical Education and Sports Faculty, Brestei 156, 200177, Craiova, Romania

Site adress:
http://www.medicinasportiva.ro

Technical editor
Eng. Aurora Beldiman (University of Craiova)

Medicina Sportiva (2014), vol. X, no 3, 2357-2363
Journal of Romanian Sports Medicine Society

Nutrition timing in top athletes

Anca Magdalena Munteanu[1], Daniela Manuc[1], Adela Caramoci[2], Mirela Vasilescu[3], Anca Ionescu[2]
[1]*Public Health Department, UMF Carol Davila, Bucharest, Romania*
[2]*Sports Medicine Department, UMF Carol Davila, Bucharest, Romania*
[3]*Kinethoterapy and Sports Medicine Department, University of Craiova, Romania*

Abstract. In the early 2000 timing was introduced as an important nutrition concept in the 21st century, being a must-know for everyone interested in fitness, performance and health. Nutrient timing (NT) is a new system of exercise nutrition that helps improve strength and lean body mass in the shortest time, without changing the exercise program or caloric intake; in any sport discipline, nutrients timing is so necessary to meet exercise performance and to recover from the stress of a workout.
Key words: *diet, nutrient, anabolic effect, training program, periodization*.

Introduction

The exercise nutrition concept originated in the research efforts of solving the "plateau phenomenon" that is the stagnation in muscle growth and strength achievement, despite a hyperproteic diet (1, 2). The research concluded it was not sufficient to use high quality protein to gain lean mass and strength, but to deliver it at precisely the right time and to use other conutrients too (called nutrient "activators"), in order to maximize muscle growth. The NT principle claims: during a muscle's 24 hours growth cycle, there are different periods of contraction, of recovery and of growth, each with specific metabolism (producing glycogen, replenishing it or muscle protein synthesize), so you have to fuel with the right nutrient each of the above periods (3).

The 3 phases of the NT are energy phase, anabolic phase and growth phase.

The energy phase extends during the whole workout, when muscles need enough energy for performing contractions. To meet this goal, timing science shows that 10 min prior to and during workout it is necessary to consume carbohydrates plus proteins, specific amino acids and vitamins. The benefits will be a good spare of glycogen, (improving muscular endurance), blunt the rise in cortisol (reduce muscle damage and limit the immune system suppression) and help preparing the muscle enzymes for a faster muscle recovery following the effort (1, 4, 5).

The anabolic phase extends for the 45 minutes just after the workout, when the muscle has a great capacity of repairing the damaged proteins and to replenish the glycogen stores.

This phase you have to consume carbohydrates, vitamin C and E as antioxidants and some amino acids, to fasten the muscle recovery; research has shown that a ratio of 3:1 carbohydrates to protein is beneficial for enhancing glycogen storage and quicker recovery (6-8).

The growth phase extends from the 45 min after the workout until the next workout; it is the period of increase of contractile proteins and fibers size. It is the time for consuming protein and carbohydrates.

Included into the NT concept is the concept of "*nutrient activation*", for an effective muscle growth: the most important 2 activators are proteins and some amino acids (arginine, glutamine and leucine) and carbohydrates: consuming amino acids and protein (the best is whey protein) during the energy phase, emphases the effect of carbohydrates; consuming carbohydrates in the anabolic phase amplifies the anabolic effect of amino acids and proteins, while the last enhances the glycogen replenishment (9,10).

In order to maximize the muscle growth, athletes have to consume carbohydrates and amino acids along with the protein drink, during the growth phase.
Arginine, less then 10grams/day, has benefits in synthesis of other amino acids, insulin secretion and blood flow, without side effects. Glutamine, by stimulating protein synthesis and preventing protein breakdown; the richest sources are round steak, chicken breast and thigh, ground beef (11).
Creatine is the most popular muscle building supplement; in a study of 10 weeks creatine supplementation and strength training, resulted a 25% strength and a 60% muscle mass increase (12).
Other substances, such as conjugated linoleic acid CLA, beta-hydroxy-beta metylbutyrate HMB, L-carnitine, ribose and piruvate require more studies in order to evidence their "nutrient activators" effect.

Periodization is an organized approach to training that involves progressive cycling of various aspects of a training program during a specific period of time. It means the division of training cycles throughout the course of the year, where volume, frequency, intensity, time, and type of training are manipulated to meet the demands of the sport.. Most comparative studies have demonstrated the superiority of periodized over non-periodized programs in terms of greater changes in strength, body composition, and motor performance. Periodization has been used by the athletic community since the late 1950s. It is based on the concept of "biological stress" with 2 components: eustress (beneficial muscular strength and growth) and distress (can lead to tissue damage, disease, and death).
Periodization is most widely used in resistance program designed to avoid over-training and to systematically alternate high loads of training with decreased loading phases to improve components of muscular fitness, e.g. strength, strength-speed, and strength-endurance (13,14).
Periodized training deals with three types of cycles: microcycle, mesocycle, and macrocycle. The microcycle is generally up to 7 days. The mesocycle may last from 2 weeks to a few months and can further be classified into preparation, competition, peaking, and transition phases. The macrocycle refers to the overall training period, usually representing a year.
Here are the periodized training models: *traditional* (volume and intensity are systematically manipulated). Training cycle begins with a high-volume, low-intensity profile, then progresses to low volume, high intensity over time), *step wise* (like the traditional model, intensity increases and volume decreases during the training period). Volume is decreased during the training period. Volume is decreased in a stepwise fashion: repetitions are reduced from eight to five, five to three, and so forth, at specific time intervals), *undulating* (training volume and intensity increase and decrease on a regular basis: but they do not follow the traditional pattern of increasing intensity and decreasing volume as the mesocycle progresses), *overreaching* (volume or intensity is increased for a short period of time (one to two weeks), followed by a return to "normal" training. This method is use primarily with advanced strength trained athletes (15.16).
Although there is no single best periodization program that suits everyone due to individual differences such as gender, muscle fiber percentages, and genetics, *undulating periodization* programs have shown particular promise for optimizing muscular fitness benefits (17).
At the beginning of the 21st century, a dietary approach referred to as *nutrient periodization* was launched, and focuses on adjusting the macronutrients to best support exercise periodization techniques. It is supported and driven by the 2005 Dietary Guidelines for Americans. It advocates 45 and 65 percent of their total kilocalories from carbohydrates, 20 to 35 percent from fat, and 10-35 percent from protein, allowing for the dietary individualism that is necessary for meeting specific exercise goals, such as for building muscle and increasing muscular strength (18).
We have to take also into consideration The American Dietetic Association that recommends for athletes: 1.4–1.7g/kg protein, 6-10g/kg carbohydrates, and 20 – 25% fats (19).
Physiologically, the key to gaining muscle mass is to consume more energy than what is expended, while focusing on high-intensity resistance training. So, experts recommend between 1000-3500 excess kilocalories over the course of a week, to gain one pound of muscle, or 44-50kcal/kg body weight/day (1). An athlete's caloric requirements should be based on lean body mass relative weight instead of total bodyweight. Other considerations or nutritional planning will be the time of year, goals, and whether there is a need to lose or gain body fat.

Looking into a nutrition plan at the micro-cycle level. For the athlete seeking to optimize muscle mass, while following the undulating periodization program is recommended that relative macronutrient percentages fluctuate with exercise intensity, to adequately facilitate recovery: a total kilocalories intake ranged 44 to 50 kcal/kg body weight/day; protein intake maintained at 1.7g/kg/day, as the research does not yet support periodization of this nutrient; carbohydrate intake changes from 6-9g/kg/day, depending on the intensity of the associated workout; fat intake adjusts to the carbohydrate and protein intake.

With the nutrient periodization approach to training, the suggestion is to allow fat intake to fill in the kilocalories after protein and carbohydrate levels have been established (2,4).

When periodize nutrients, carbohydrate levels during and after intense workouts will be high, so fat intake will be suitably low. When carbohydrate intake is low (prior to moderate or low intensity workouts), it will be the right time for fat intake which will be higher, compensating for the low-fat intake days. In effect, this technique will moderate fat intake while allowing optimal fluctuations of carbohydrate. Fat intake should be periodized in relationship to carbohydrate and protein intake to achieve the best results for building muscle and increasing strength on a periodized exercise program (20).

Of course, lower or higher, fat intake has always to consist of healthful fats, for long-term health benefits. More precisely, for 24 hours following an intense workout, an intake of 9g/kg/day of carbohydrate may be ideal for a correct recovery, possible to extend up to 10-12g/kg/day after endurance training. Further, after the carbohydrate stores have been replenished, high carbohydrate intake is no longer necessary focus and the athlete can focus on the other macronutrients (can raise fats).

During the 24 hours period prior to a moderate or light intensity activity, to build muscle may consider an intake of 6g/kg/day of carbohydrate (21-24). We can notice that, although on a day-to-day basis, macronutrient percentages fall outside the

AMDR* (2002, Acceptable Macronutrient Distribution Range, by the Institute of Medicine Food & Nutrition Board) recommendations, over the course of the week they meet them: fat intake averages ~20%, protein ~14%, and carbohydrate averages between 65-66% (24).

Without this periodization, it could occur chronic elevated protein intake (a common practice for building muscle), that may decrease fat and carbohydrate consumption to levels that hinder performance and ultimately inhibit optimal muscle growth.

Conversely, long time high carbohydrate diets (a necessity for recovery from intense training bouts) may edge out fat and protein, which has an entirely different repercussion, namely altered cholesterol profiles, depressed testosterone levels, and overtraining. This will ultimately lead to the inability to gain muscle mass (25). Chronic low fat diets (<15%) should be avoided because it may make it difficult for an athlete to achieve a high caloric diet, result in overtraining, negatively affect the lipid profile, and/or decrease exercise performance as well reduce fat-soluble vitamin intake. Chronic high fat diets (>35%) should be avoided because they may reduce carbohydrate and protein consumption, decrease long-term performance, and potentially increase the risk for cardiovascular complications (4,18,21,26).

Looking into a nutrition plan at the mesocycle level, may retain some principles: training will occur primarily through four phases, an off - season, preseason, in competition phase, and transition/recovery phase. As each phase requires manipulation of training variables, nutrition should be aligned with the changes in performance requirements during the various phases of periodization. So, the caloric, carbohydrate, fat, and protein requirements will vary depending on the time of year (the above phases) and body composition.

After recovery, the off–season begins. It is the longest period of time of the macrocycle (usually ranges four to six months in length, depending on the sport) and a great time for any athlete to put on muscle mass, improve areas of weakness, and recover from any injuries. During this phase training volume is high in resistance training, and cardiovascular training is minimized. In order to do the nutrition plan for this period, we will consider first whether you are at the ideal weight for your sport. Both weight loss or gain should be done slowly over the four to six months of the off season!

How do we periodize nutrition to correlate with the goals of strength training? We have to answer 2 questions:

1. What should be the needed calorie intake? In order to gain weight the athlete needs to eat more calories than needed, calculated as follows: lean

body mass (in kilograms) x 24 = BMR (it is obvious that lean body mass was calculated after measuring body weight and composition and extract the fat mass from the body weight!); BMRx1.5 (coefficient for high activity level or for gaining weight) = needed calories/day. We start from this caloric intake level and measure body weight at the end of each week!

If the athlete does not gain weight in the first week, then we add 250–500 additional calories *a* week, until we notice the needed weight.

2. How shall we be structuring these calories? Remember the athlete is in the off-season and wants to gain weight. So the carbohydrates daily intake =lean body mass (kg) x 6g/kg; protein daily intake = lean body mass (kg) x 1.4-1.6g/kg; fat daily intake = 20% of the caloric daily intake calculated above (1,19).

After 20–26 weeks of strength and conditioning, it is time to get ready for another competitive season. All this time, bodyweight should be done weekly, and body fat should be done at the end of each month.

Training season

Calories should be adjusted up to an activity level of 1.5, since the athlete is training harder. But if carrying excess body fat, then we would start at a 1.3 activity level. Carbohydrates should be higher (increase at 8 grams/kg), protein higher too (slightly increase at 1.5 – 1.7), and fat calories about the same. It is important to pay closer attention to fluids and micronutrients. A multivitamin supplement may also be recommended (27).

Going into more detailed recommendation, during the preparatory cycle, daily carbohydrate intake should range from 3–7g/kg. Athletes who are not training with high volume or intensity should begin at the lower end, while those training more than two hours per day should begin in the middle of the range. Daily protein intake should range from 1.2–2.5g/kg.

For athletes seeking weight loss, the higher end of the range is recommended (2.0–2.2g/kg) to improve satiety (through a blood sugar stabilizing effect) and better utilize the thermal effect of food. For those interested in maintaining weight, a moderate protein intake (1.2– 1.7g/kg) can be recommended.

Daily fat intake should be relatively low, ranging from 0.8 – 1.3g/kg (28). Again we say fat is a necessary component in the nutrition plan and should not be neglected. However, the proper sources of fat should be a focal area: use sources of monounsaturated (omega 9) and polyunsaturated (omega-3 and 6) fats, while minimize the intake of saturated and trans fats, the last, avoidable.

There are no definitive daily hydration guidelines that are supported by research; in practice, urine color should be pale yellow and individual should be urinating every 2 – 3 hours to ensure a positive hydration status (29)!

Power athletes – should eat smaller, frequent meals, with continuous hydration along the day; once a caloric intake that sustain weight is achieved, extra energy intake is needed (about 500cal/day, 55-25-20% G-P-L) to support muscle gain, simultaneous to a continuously challenging resistance training routine. Monitoring weight (weekly) and body composition (monthly) is vital!

For *endurance athlete* **-** never loss more than 450-900g/week, therefore begin a nutrition regime with enough time to rich the goals appropriately. A too rapid weight loss means muscle and water loss too, altering performance (30). They should eat a minimum of 6-8 servings of fruit and vegetables per day and choose high fiber foods; this is the time when they should experiment new energy supplements and rehydration standard solutions, to choose the most suitable products for each athlete body in the upcoming stages; try to find out what nutritional products will be used at the races they will be competing in the upcoming season and try those (31)!

Competition Cycle

If the athlete has followed the periodized nutrition plan and assessments, he/she should be at an optimal fuel level and body composition. It is detrimental to be on a low calorie diet during the in season, and he/she should be at the highest level of carbohydrates and caloric requirements. It is important that meals are structured before and after practice. It is also important that meals are structured before and after competitive events. Carbohydrates are the key during in season, along with adequate calories (27). Energy expenditure will change as athlete's progress into the competition cycle. The physical goals require a shift to higher intensity training and usually include improving strength, power and speed. This change in energy expenditure will facilitate a needed nutritional change. Daily carbohydrate requirements will likely increase depending on the level of exercise that an athlete performs. If the

exercise duration and intensity increase significantly from the previous training cycle, carbohydrate intake should also increase to support the higher physical demands. Carbohydrate intake should range from 5 – 12g/kg. Daily protein intake should range from 1.4–2.0g/kg. Since a higher amount of carbohydrates may be consumed, protein intake may decrease slightly. For endurance athletes, focusing more on cardiovascular exercise with light strength training, daily protein requirements can be met with a range of 1.2 – 1.7g/kg. For athletes focused more on strength and power training, with lean muscle mass gains as a goal, daily protein intake can remain around the 1.7 – 2.0g/kg (21, 23, 30).

Daily fat intake should be moderate, ranging from 1.0 – 1.5g/kg. As was the case in the preparatory cycle, healthy fats should be the abundant fat consumed by individuals. It is important to understand the exercise load that an athlete follows as this will largely dictate the amount of fat consumed each day. If an athlete is training at least 2 – 3 times per day with high energy expenditure, more daily fat may be necessary to remain in energy balance.

Hydration should be a high priority during this time due to the increase in sweating from higher exercise duration and/or intensity. One thing that is often forgotten by athletes is the importance of daily hydration prior to workouts. It is imperative that athletes develop the habit of drinking enough fluids and eating enough high water content foods such as fruits and vegetables to improve their hydration status throughout the day to have proper fluid stores for their training session. They might become dehydrated during exercise as a result of improper daily hydration practices. If an athlete is dehydrated before exercise, there is not much they can do to prevent further dehydration during exercise and thus their training session will be compromised (28).

For endurance athletes - specifically formulated supplements nutrition products dedicated for the long period of training and carbohydrates-protein mixes for recovery are recommended; they rise significantly the daily energy intake from food, but it is no danger of weight gain because they are burned because of the intensity and duration of training (30). Going into details, from built to peak, these athletes should use the energy bars, gels and sports drinks that were tested and worked well for them during the base cycle; eat often, snacking is beneficial in this cycle; supplement the salt intake (salt tablets). If they race longer distances, a lower fiber diet, to decrease bowel movements during a race. Fruit juice is a great choice since there is no fiber and brings some vitamins and minerals; drink a minimum of 12-14 glasses of non-caffeinated fluid per day; if they are training for a full Ironman distance, add extra salt to the diet (up to one teaspoon of extra salt, if pre-existing health conditions allow).

Preparation for the race means having developed the above pre-race eating routine with specific foods and beverages and specific timing of foods, then maintain with it the entire season: try to eat every couple of hours inside the range of hungry; eat small breakfast; hydration using sports drink. A special attention should be payed to carbo-loading two nights before the race and continue to snack on high carbohydrate foods the day before a race.

The endurance athletes should be told it is not at all advisable to try anything new, especially on race day or to carbo-load only the night before a race, or to drink too much water (hyponatremia danger) (7).

For power athletes - should reduce energy intake, in order to lose body fat, but maintain muscle mass gained in preseason. So, a week before competition they should decrease energy intake, and increase carbohydrate to protein ratio, so that the glycogen is optimal loaded for the competition day. Beside fat loss, another strategy of highlighting the muscles is manipulating, but only for some days, the fluids and
sodium intakes. Restricting sodium and hydration levels for a long period, blood potassium and phosphorus levels would increase dangerously the risk of heart failure (30).

Transition or recovery is that time immediate after the season is over (two weeks to a month). It is time when athletes should rest, and have little to no structure diet and training. The transition cycle typically has a significant reduction in training. Athletes may still exercise during the transition cycle, but do so less frequently and without much structure. It is recommended to continue to stay active, doing things other than the chosen sport.

This is normally the time of the year where most nutritional mistakes are made due to this somehow abrupt change in energy expenditure. They expend less, and if don't have good nutrition knowledge; they could continue to intake at comparable energy levels with that during the previous cycle! Bodyweight is not allowed to drift 2.5-5kg from playing weight (27).

During the transition cycle, daily carbohydrate intake should decrease to 3 – 4g/kg. Even if an athlete is exercising up to 6 – 7 times per week, this new carbohydrate range will still provide enough energy for the muscles and brain to fuel exercise and sustain cognitive function.

Daily protein intake should range from 1.5 – 2.3g/kg. A slightly higher protein intake will improve the satiety response and will contribute to a higher thermogenic contribution to energy expenditure. The upper end is recommended if the athlete has a hypertrophy producing strength training program during this time, while for those engaging in lighter cardiovascular and strength training activities, the lower range can be used as long as satiety is maintained.

Daily fat intake may decrease slightly but, in general, should remain moderate, ranging from 1.0 – 1.2g/kg. Increasing hydration is still important as it is year-round but decreased, in comparison to the specific active periods (21).

During post season – the power athletes have the time to increase desired visual effects, including a little more dehydration. They have to forget about protein supplements, amino acids and creatine and come bake to healthy food, such as fruits, vegetables, whole grain products, lean meat and fish, low-medium fat diary. So, an energy intake that allow a desired body weight and body composition, as well is recommended for this period, structured 55-25-20 as % carbs, proteins and fat (31). The endurance athletes, should forget the energy bars, gels and sports drinks for a while; should re-introduce whole foods from all of the food groups; allow eating at restaurants, eating forbidden foods the rest of the year, for nutritional but mostly psychological balance, yet pay an extra attention to overeat, and overweight, in comparison to a power athlete (31).

Finally, some nutrition principles the athletes should apply year –round. Eat different foods, within a decent volume, not over 2-2.5kg; the rest has to be provided by supplements, that is within small volumes! At least half of the daily intake of fruits and vegetables should be fresh, in order to provide natural sources of vitamins. Pay a special attention to the fat sources quality: more polyunsaturated (fish, even fat fish) and monounsaturated (nuts, fresh, virgin oils, avocados, olives) fats rather than saturated fats (high-fat meats, butter, lard, some oils, processed foods such as cookies and chips). Consume a high-glycemic index carbohydrate source combined with a lean protein within the first 15 minutes after training or a race: a sports drink with a cup of low fat yogurt, watermelon and chocolate milk, a lean meat sandwich; the athletes should let their nutritionist or sports medicine specialist conduct their nutrient supplementation: proteins, carbohydrates, omega 3, 6, 9 fatty acids, vitamins and minerals; salt intake and hydration has to be under the nutritionist or medical control; not at last, all athletes should continuously benefit of an effective food and nutrition basic training, to allow them to react as an well informed food products consumer, with supplementary special nutritional needs.

References

1. Moore P (2006). Nutrition for Intermittent, High Intensity Sports. *NSCA Southeast Regional Conference*; Boone, NC.
2. Lambert CP, Frank LL, Evan WJ (2004). Macronutrient considerations for the sport of bodybuilding. *Sports Medicine*; 34(5), 317-327.
3. Ivy JL (2002). Exercise physiology and adaptations to training. *Handbook of Exercise in Diabetes*; 23-62.
4. American College of Sports Medicine, American Dietetic Association, and Dietitians of Canada (2000). Joint Position Statement: Nutrition and athletic performance. *Med and Science in Sports and Exercise;* 32: 2130-2145.
5. Venkatraman JT, Pendergast DR, (2002). Effect of Dietary Intake on Immune Function in Athletes. *Sports Medicine*; 32(5):323-37.
6. Sacheck JM, Blewry JB (2001). Role of vitamine E and oxidative stress in exercise, *Nutrition*; 17: 809-14.
7. Seebohar B (2004). Nutrition periodization for endurance athletes: Taking Traditional Sports Nutrition to the Next Level.
8. Gibala MJ (2004). The role of protein in promoting recovery from exercise. *Gatorade Sports Science Institute* Sports Science News.
9. Ivy J, Portman R (2004). *Nutrient timing-the future of sports nutrition.* North Bergen, NJ: Basic Health Publications.
10. Miller SL, Tipton KD, Chinkes DL, et al. (2003). Independent and combined effects of amino acids and glucose after resistance exercise, *Medicine and Science in Sports and Exercise*; 35: 449-455.
11. Varnier M, Leese GP, Thompson J, et al. (1995). Stimulatory effect of glutamine on glycogen accumulation in human skeletal muscle. *Am J PH;* 269: E309-E315.
12. Vandenberghe K, Goris M, VanHecke P, et al. (1997). Long term creatine intake is beneficial to muscle performance during resistance training. *J Appl Ph*; 83:2055-63.

13. Hoffman JR (2002). Periodized Training for the Strength/Power Athlete. *NSCA's Performance Training Journal;* 1(9): 8-11.
14. Fleck SJ (1999). Periodized strength training: A critical review. *Journal of Strength and Conditioning Research;* 13: 82-89.
15. Stone MH, O'Bryant HS, Schilling BK, Johnson RL, Pierce KC, Haff GG, Stone M (1999). Periodization: Effects of manipulating volume and intensity. Part 2. *Strength and Conditioning Journal;* 21(3): 54-60.
16. Stone MH, O'Bryant HS, Schilling BK, Johnson RL, Pierce KC, Haff GG, and Stone, M (1999). Periodization: Effects of manipulating volume and intensity. Part 1. *Strength and Conditioning Journal;* 21(3): 54-60.
17. Frankel CC, Kravitz L (2000). Periodization: Latest Studies and Practical Applications. *IDEA Personal Trainer;* 11(1): 15-16.
18. U.S. Department of Health and Human Services (HHS) and the U.S. Department of Agriculture (USDA) (2005). Dietary Guidelines for Americans 2005. *www.healthierus.gov/dietaryguidelines*.
19. American Dietetic Association, Dieticians of Canada, and the American College of Sports Medicine (2000). Nutrition and athletic performance. *Medicine & Science in Sports & Exercise;* 32(12): 2130 – 2145.
20. Block P, Kravitz L, (2006). Tailoring Nutrient Intake to Exercise Goals. *IDEA Fitness Journal;*3(8):48-55.
21. Rodriquez NR, DiMarco NM and Langley (2009). S. Position of the American Dietetic Association, Dietitians of Canada, and the American College of Sports Medicine: Nutrition and athletic performance. *J Am Diet Assoc;* 109(3): 509 – 527.
22. Manore M, Thompson J, (2000). *Sport nutrition for health and performance*. Human Kinetics
23. Burke LM, Cox GR, Culmmings NK, Desbrow B, (2001). Guidelines for daily carbohydrate intake: do athletes achieve them? *Sports Med*; 31: 267 – 299.
24. National Academic of Sciences. Institute of Medicine. Dietary Reference Intakes for Energy, Carbohydrate, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids2002. <http://www. iom.edu/Object.File/Master/4/154/0.pdf>
25. Tipton K.D, Wolfe RR. (2004). Protein and amino acids for athletes. *Journal of Sports Sciences;* 22: 65-79.
26. Dreon DM, Fernstrom HA, Williams PT, & Krauss RM (1999). A very low-fat diet is not associated with improved lipoprotein profiles in men with a predominance of large low-density lipoproteins. *American Journal of Clinical Nutrition;* 69: 411-418.
27. Gaines R (2006). Periodized Nutrition for Strength and Power Athletic Performance**,** *NSCA's Performance Training Journal*, 5(6): 18-20.
28. Seebohar B **(**2009). *Nutrition Periodization for Athletes and Metabolic Efficiency for Endurance Athletes*. NSCA Sports Nutrition Summit. Colorado Springs, Colorado.
29. Burke LM and Hawley JA. (2006). Fat and carbohydrate for exercise*. Curr Opin Clin Nutr Metab Care*; 9(4): 476 – 481.
30. Ilana Katz (2007). Nutrition periodization for endurance and power athletes, *http://www. theoptimalathlete.com/ NutritionPeriodization.pdf*
31. Seebohar B, Nutrition Periodization: How to Structure your Eating Throughout the Year. *http://www.trinewbies.com/tnowellness.asp*

Corresponding author
Anca Magdalena Munteanu
Public Health Department, UMF Carol Davila, Bucharest, Romania
E-mail: *anca_mun@yahoo.com*

Received: May 20, 2014
Accepted: August 24, 2014

Medicina Sportiva (2014), vol. X, no 3, 2364-2368
Journal of Romanian Sports Medicine Society

Sport related injuries of the nerves in the knee region

Costin Dan[1,2], Ispas Al T[3], Mirela Vasilescu[4], Laura Stroică[2] , Fabian Klein[5], Ardeleanu Valeriu[6]
[1]*Emergency Hospital of Alexandria,* [2]*Romanian Handball Federation, Romania*
[3] *Anatomy Department, University of Medicine and Pharmacy Carol Davila, Bucharest, Romania*
[4] *Kinethoterapy and Sports Medicine Department, University of Craiova, Romania*
[5] *UMF Carol Davila, Bucharest, Romania*
[6] *Faculty of Medicine and Pharmacy, Lower Danube University of Galati, Romania*

Abstract. Although peripheral nerve lesions are quite rare in sport injuries, they can be a career ending cause and have a serious impact on the general quality of life of the former sportsman. Therefore, it is imperative that nerve lesions be diagnosed promptly, allowing early intervention prior to irreversible loss of nerve function. That's why sports medicine physicians must have a deep knowledge of peripheral nerve anatomy and physiology in order to diagnose the level of injury accurately and provide appropriate treatment and prognostic information to the patient.
Key words: *knee injuries, nerve lesions, compression, traction, laceration.*

Introduction

Nerves can be injured through a variety of mechanisms. The lesions can be acute or chronic. The main mechanism involved in sport injuries of the nerves is compression followed by ischemia (1). Pressure seems to be the responsible agent of injury with chronic entrapment of nerves, although ischemia may also play a small role.

Acute nerve injury may cause damage when applying high pressure for a short period of time (e.g., nerve injury from a fracture). In addition, a rapid reversible physiologic nerve impairment can occur when a high pression is applied to the nerve for a small period of time (e g. cross-legged sitting, causing numbness and paresthesia). This condition is mostly caused by ischemia. In the 6 hours interval, the restoration of nerve function is complete. After more than 8 hours of ischemia, the nerve lesion is irreversible, due to the axonal infarction. An acute compression may be caused by an ill-fitting equipment (2).

Chronic nerve injuries cause lesions by small or moderate compression for a long period of time or moderate pressure applied constantly on the same region, the last one being a condition which defines a professional sportsman.

Chronic compression may be done by an abnormal muscular band, or tendon or by a bony prominence which dimensions or development were exaggerated by sport practice (2--4).

Another nerve injury mechanism, quite frequent in sports, is traction. The elasticity of the nerves is due to the collagenous endoneurium, which allows a nerve to stretch 10-20% without significant structural or functional damage. When the nerve is stretched beyond his stretching capacity (elongation between 30 and 70%), injuries occur (1, 5, 6).

Not only the value of the tensile force applied is important, but also the rate of application which affects the degree of injury. Specialists report that a slow stretch applied for several years can elongate a nerve without functional impairment. But if a strong stretching force is applied acutely, complete transection may occur (5, 7, 8).

A rare mechanism of nerve lesions involved in sport injuries is laceration, in which the nerve continuity may be preserved or, more serious, the transection is complete and the two nerve fragments are apart from each other.

Transection is followed by apoptosis and cell death. The sensitive neurons are more susceptible to death than the motor ones. Cellular loss in the sensitive ganglia from the dorsal root of the spinal nerves may reach up to 50%.