Risk factors and injury mechanism in Triathlon

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ABSTRACT

Migliorini S. Risk factors and injury mechanism in Triathlon. *J. Hum. Sport Exerc.* Vol. 6, No. 2, 2011. In the triathlon the combined practice of swimming, cycling and running permits the reduction of overuse injuries compared to the practice of the running alone. Redistribution of stress over several part of the body and correction of muscle imbalance are cited as reasons for the reduction in injuries occurrence. Nonetheless, like other endurance sports, 80-85% of triathlon injuries can be scribed to overuse. From an etiopathogenetic point of view the overuse injuries must be studied in relation to the technical characteristics of the triathlon, to the transitional phases between the disciplines and particularly to the cycle-run transition, to the different load of training that the preparation of the Olympic distance requires compared to the long distance triathlon. Most of the injuries are caused by running and athletes most at risk are former swimmers and cyclists, since they lack of running experience and muscle elasticity. The triathlon cycle-run transition (T2) is a period of particular risk for knee and lower back injury. The knee, the ankle/foot and the lower back are the anatomic site most at risk of injuries. Ileotibial band friction syndrome is common in age groupers whereas Achilles tendon injuries and stress fractures occur more in elite athletes. Previous injuries are correlated with injuries occurrence and the sudden changes in training intensity or volume, hill training and the insufficient development of running technical ability are injuries extrinsic factors. The acute traumatology is due almost exclusively to falls in training and competition in cycling. The episodes of rhabdomiolysis are instead not rare, associated or not to exertional heat/idratation injuries. Injury prevention is based in particular on the learning of the correct technique of the three disciplines, on the right programming of the training sessions, on the study of the overload that the biomechanics of the transition phases between the three sports act on the locomotor apparatus and on the suitability of the technical instruments used. **Key words:** TRIATHLON, OVERUSE INJURIES, PREVENTION

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INTRODUCTION

The triathlon is the most modern among endurance sports. Triathlon made its debut as Olympic sport at the 2000 Sydney Games only 19 years after first being officially recognized by International Olympic Committee. We know much about swimming, cycling and running, but the combined practice of the three disciplines involves particular problems. The alternating of the three disciplines, the different race distances, the weather conditions of some competitions, the training techniques, the better muscular balance, are the causes for which the triathlon may be considered the “frontier” of the endurance sports for studies involving physiology, traumatology, biomechanics and training technique. An understanding of the injuries sustained during triathlon competition and training could inform race day medical coverage, training techniques, risk factor identification, and the development of appropriate intervention strategies specific to the triathlon (Gosling et al., 2010). In this paper I have summarize the current state of the risk factors for injury and I suggest measures to prevent injuries. Particularly attention was made to the relation of injuries with the biomechanical characteristics of this discipline.

Acute Injuries

Acute injuries are relatively rare in the triathlon and most injuries that occur are minor. Contusions/abrasions, blisters, and muscle strains are amongst the most common race injuries (Gosling, 2010). The lower limb muscle strains or foot lacerations occur during water or beach exit in the swim leg or running in transition area. The most serious acute injuries are due to falls during cycling in competition or training. Many falls are consequence of technical errors of the athlete or of accidental factors. The possibility of the triathlete being victim of road accidents cannot be left out, considering that in many races the cycling course is open to traffic. Some injuries could be attributed to mounting and dismounting the bicycle at the start and finish of the cycling leg, especially in young and inexperienced triathletes.

Overuse Injuries

The majority of the literature refers that, as in the other endurance sports, 80-85% of injuries in triathlon are expression of functional overuse (Ireland et al., 1987). Approximately three times as many athletes appear to be affected by overuse as are affected by acute injuries (Massimino et al., 1988; O’Toole et al., 1987; Wilk et al., 1995). One of the reasons for athletes to practice the triathlon is the lower risk of injuries as compared to endurance running. According to Levi et al (1986) the incidence of injuries in triathletes is less than runners but higher than seen in swimmers and cyclists. The redistribution of stress over several parts of the body and correction of muscle imbalance are cited as reasons for the reduction in injury occurrence (O’Toole et al., 1987). The triathlon and the cross-training have surely helped many runners to return to their sport or to have a valid alternative to running. In all of these years we have however noticed that the overload that triathlon creates on the locomotor apparatus is not to be under- estimated. Injury risk was greatest in Elite competitors, in the youngest age categories, and in those competing in the greater distances, especially while running. In the shorter distance triathlon races the incidence of injury (2.3%) was substantially lower than that reported in longher triathlon races. The triathletes at higher injury risk come from swimming and cycling, since they lack of running experience and muscle elasticity (Migliorini, 1991, 2000). An expression of this adaptation period is the high percentage of injuries (51%) that appear in the first year of triathlon practice (Ireland et al., 1987) and the absence of a relationship with the kilometres done in training. Running has been the most commonly reported action associated with injuries in triathletes (Collins et al., 1989) following by cycling and then swimming. Cycle and run training may exert cumulative stress influence on the risk of lower back injury (Massimino et al., 1988). Some authors have suggested that the transition cycle-run (T2) is a period of particular risk for both lower back and knee injury (Migliorini, 1991, 2000; O’Toole et al., 2001; Vleck, 2003). The knee, the ankle/foot and the lower back are the anatomic site most at risk of injuries. The main cause of running injuries can be applied the triathlon: training errors, anatomical factors, biomechanics of swimming, cycling and running, training surfaces, shoes and training equipment, transition (Migliorini, 2000,2003). Overuse injuries may have both intrinsic and extrinsic causes (Table 1).

Table 1. *Factors in lower legs overuse injuries*

Intrinsic	Excessive pronation
	Cavus foot with decreased pronation
	High impact running style
	Varus or valgus knees
	Patellofemoral dysplasia
	Patella infera, patella alta
	Asymmetry of the lower legs
	Hypermobility of joints
Extrinsic	Cold,wind,rain
	Ice,snow, slippery roads
	Poor, old or very new shoes
	Poor training equipment
	Running surface
	Intensive training (too much too soon)
	Poor warm-up procedures
	Lack of stretching
	Insufficient care of muscles

Transition cycle – run T2

The transition from cycling to running is usually the phase of the race in which the greater performance of the elite athletes is seen compared to the middle-level athletes, due to minor muscle fatigue, minor energy expense and for the immediate reorganizing of the correct running mechanics (Millet et al., 2000). With longer biking more time is required to regain the neuromuscular and elastic efficiency indispensable for proper running style (Migliorini, 2000, 2003). A time leg exist after cycling before the running technique can reach it's optimal level. In this phase of the training and of the race the inability to dissipate the load forces of the locomotor apparatus by the lower limbs can favour the transmission of stress to the lumbar-sacral region (Woloshin et al., 1981) and to the knee (Migliorini, 1991, 2000, 2003). The change from concentric muscular contractions to eccentric ones, and from unloaded cycling phase to the load state of running is in fact an extremely delicate phase for the triathlon (Migliorini, 2003). The triathlete is therefore more susceptible to low back pain or knee pain during the first kilometres of running, just after the transition T2. Cycle and run training may exert cumulative stress (Massimino et al., 1988) influence on the risk of lower back injury. In fact, while the running may be the final factor that worsens the injury symptoms, it is likely that the initial cause of the lower back pain is to be found in the cycling phase. Furthermore to maintain a correct aerodynamic cycling position and to have a correct hip flexion necessary to generate an optimal force on the pedals, the lumbar sacral spine is held in a relatively flexed position. The sitting position kept for a long period of time, increases the intradiscal pressure, predisposing for low back pain (Manninen et al., 1996). Obviously pre-existing injuries to the foot and ankle (with further compromise of shock attenuation or gait compromise), just as pre-existing pathologies in the lumbar-sacral region and in the knee, can increase the possibility of low back and knee pain.

Overuse Injuries of tendons

The most injuries occur to the lower extremities and ileotibial band syndrome (ITBS) is common in age groupers (Migliorini, 2000, 2003) whereas Achilles tendon problems may occur in Elite Athletes (Vleck et al., 1998; Vleck, 2003; Shaw et al., 2004). ITBS is an overuse injuries caused by repetitive friction of the ileotibial band and underlying burse or lateral synovial recess across the lateral femoral epicondyle. The friction occurs at or slighty less than 30° of knee flexion. The posterior edge of ITB impinges against the lateral epicondyle just after foot strike in the gait cycle. The triathletes that have sporting background in swimming normally tend to have very little hip abductor (gluteus medius) and the triathletes fatigued after cycling fraction, are prone to increased thigh adduction and internal rotation at midstance, leading to increased valgus vector at the knee. This situation increase the tension on the ITB, making it more prone to inpingment on the lateral epicondyle of the femur, expecially during foot contact, when maximal deceleration absorbs ground reaction forces (Migliorini, 1997, 2003). The transition cycle-run increase the stress on the ITB. ITBS related training errors are sudden increases in training distance or intensity, hills, running on steeply cambered roads (Migliorini, 2000, 2003, 2009). Triathletes that have sporting backgrounds in cycling tend to be too tight in hip flexors, tensor fasciae latae and ITB. In this type of injury we must consider also the combination of anatomical variant of the inferior extremities with an improper use of race bicycle or only the use of inadeguate frame. For example varus knee or external tibial rotation of greather than 20° place a significant stress on distal ITB when riding with internally rotate cleats. Abnormal lateral knee stress is most often the result of incorrect cleat pedal alignements, of excessive height of the saddle or too far-back saddle. About 4800 times at hour at 80 rpm the ITB fibres suffer a repeated abrasion on the lateral epicondyle of the femur when riding. The high impact running style, the intensive training (too much too soon), the hill running, may favour ITBS. Also injuries typical of middle-distance runners are encountered (peritendonitis and insertional Achilles tendinophaty, sural triceps strain, plantar fasciitis). This is not surprising considering that in order to run the final 10 km with performance of international level it is necessary to carry out training sessions that, for what regards work quality, are ever more similar to those carried out by middle-distance runners. A few triathletes suffer of trochanteric syndrome, particularly if they have lived bicycle falls with pelvis and hip traumas (Migliorini et al., 1999). The development of a trochanteric bursitis is not rare, with an associated degeneration of the tendons that insert onto trochanter and excessive tension of the ileo-tibial tract of tensor fasciae latae.

Miscellaneous injuries

Expression of poor adaptation to the running are injuries such as the medial-tibial stress syndrome, the tibialis anterior syndrome, the hamstring syndrome, the patellofemoral pain syndrome, tarsal tunnel syndrome, and the stress fractures of tibia, fibula, neck of the femur, and of the foot (talus ,calcaneus, tarsal navicular, metatarsal). It is necessary to be very careful in evaluating groin pain, expecially in female athletes, because there is a concrete possibility to have an ischio-pubic branch stress fracture or a femoral neck stress fracture.

Thermal injuries

Most injuries that occurred over the course of the triathlon were minor, however race organizers and medical directors should be prepared for worst case scenarios. In Ironman events the dehydratation and exhaustion (58-72%) were reported to be much higher than trauma/orthopaedic complaints (13-22%) (Hiller et al., 1987). Training and competition in hot climates can cause great problems for athletes. Heat injury may occur in three forms particularly with extreme heat and humidity: heat cramps, heat exhaustion and heat stroke. Exercise- associated collapse (EAC) is the most common reason that athletes are treated in the medical tent following a triathlon event. Collapse in endurance event can be attributed to a myriad of factors including exhaustion, hyperthermia, hypothermia, postural hypotension, and dehydratation, and as such, race medical staff should be preparated to provide medical assistance for post exercise collapse regardless of the environmental conditions (Gosling et al., 2010). Hypothermia affects cardiovascular, respiratory, CNS and neuromuscular systems, and occurs when core body temperature decreses enough to affect body functions. Water immersion and exposure to wind are common antecedent factors. To prevent the cold injuries the ITU competition rules decide the water temperature limits to use the wetsuits and the water temperature limits to short or to cancel the swim race. Rhabdomyolysis is frequent after a triathlon race. The variations in CPK are however less after an Olympic triathlon race compared to those registered after the marathon (Kohler et al., 1987; Migliorini et al., 1991). Iwane (1984) instead compared the responses of Ironman with those of the marathon, evidencing levels of CPK increased 11.9 times after the long distance triathlon and only twice after the marathon. The association of exertional rhabdomiolysis with the dehydratation /hyperthermia by exhaustion or heat-stroke may cause in some case an acute renal failure that often requires the carryng out of a dialysis and in a few cases may bring to the death. Fortunately only 5-7% of all rhabdomyolisis cases turn into a renal failure. Until now in Italy we have encountered only one episode of acute renal failure after a duathlon race (run/cycle/run) resolved in a few days with dialysis.

Conclusion and general prevention principles

Acute and overuse injuries are frequent in triathlon. Only the correct comprehension of overuse on the locomotor apparatus and a continued and qualified medical and technical assistance permit to Elite athlete to the higher performance levels in a sport discipline that is extremely complex from a physiologic, biomechanic and traumatological standpoint. To reduce the frequency of triathlon injuries it is important to development of technical ability in swimming, cycling and running and the avoidance of intensive training (too much too soon). To decrease injuries and diseases in elite athlete is important to perform a periodic health evaluation PHE (Ljungqvist et al 2009). Anyway some of the lower leg pains cannot be prevented totally, because modern athletic training includes such vast training quantities that the locomotor system will be on the upper limit of its tolerance. Adaptation will not continue forever (Orava, 1999).

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