BIOMECHANICAL CORRECTIONS OF DYSMETRIES AND PARAMORPHISMS IN CYCLING

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INTRODUCTION

Cycling is an aerobic sport which favors the articular movement of the inferior limbs and distributes the body-weight on five points (handle bar, saddle, pedals). Therefore orthopedists as well as physiotherapists suggest it for the re-education of patients affected by trauma at the inferior limbs or after surgery.

This sport is recommanded for those sportsmen, who should better not practice other gravitational sports being affected by dysmetries, hypotrophies and paramorphisms of the inferior limbs or of the spine.

The goal of the biomechanical doctor is to research and evaluate statically and dynamically the physical and postural anomalies which might cause a muscular-tendinous pathology and to correct the station of the inferior limbs in respect to the pedals by technical devices in order to improve the shift of the muscular energy.

METHOD

Fundamental steps applied in chronological order :

- survey and relation between the main anatomical measures (trunk, inferior and superior limbs) ;
- measurement of the circumference of thigh and calf ;
- orthopedical and postural examination in order to trace possible dysmetries of the limbs or asymmetries of the rachis and of the pelvis ;
- examination of the articular mobility of hips and spine ;
- plantoscopic examination.

In this way, the morpho-functional characteristics and the muscular typology (brevilineal, longilineal, sprinter, long-distance racing cyclist) have been pointed out. It is then possible to proceed with the dynamic examination on the mechanical vehicle (previously measured).

Check of the anatomical position of the cleat.

Examination of the dynamic deformation of the foot-wear, the wear of the cleat and the prints of the pedal on the sole.

RESULTS

In cycling the joining point between foot, shoe and pedal and the working angles of the various body segments are fundamental for the biomechanical performance of the pedal revolution (transformation of the muscle contraction energy in movement of the vehicle). Nowadays, the use of shoes in synthetic material and of clipless pedals is very widespread. The shoe's stiff sole is blocked on the pedal and does not allow the necessary adjustments in case of paramorphisms of the foot or of the inferior limb. In order to overcome the problems of the knee's station (dynamic knock-knee) or of the foot (flat-foot, hollow-foot or hallux valgus) thicknesses (which are called "supinatory cuneus) of 0,6-1 mm are used and positioned on the internal side of the shoe between the sole and the cleat.

In the clinical cases described in the present study various biomechanical techniques have been adopted in order to improve the muscular efficiency and to avoid pathologies deriving from wrong positioning. The adopted techniques in the various cases are : use of crank-arms of different lengths, thicknesses of 1-2 mm between shoe and pedal, differentiation in anterior-posterior position of the cleats in both shoes, supinatory cuneus, plantar prothesis.

CLINICAL CASES

First case : **D.H.** , a 46 year old racer cyclist, longilineal type, has asymmetries in the pelvis with a consequent compensatory dorsal-lumbar scoliotic curve. The inferior limbs present a slight valgus of the knee and varus of the left heel. The muscular circumferences of the inferior limbs are symmetric. On the mechanical vehicle a notable dynamic knees valgus comes to evidence, the knees rubbing against the frame.

The tecnical goal to be reached was to improve the station of the knees and to balance the pelvis and the spine. These biomechanical improvements have been obtained by positioning under the right shoe a thickness of 1,5 mm between the cleat and the sole together with a supinatory cuneus of 1 mm. In the left shoe I put a supinatory cuneus of 1 mm. The dynamic consequences of these devices were the reduction of the dynamic valgus of the knees and the balance of the pelvis and the spine.

These changes in the station improved the shift of the muscular energy and this cyclist has obtained notable athletic results specially in time trial (Italian champion in time trial climb and on road 91 and Italian champion in time trial 92).

It is difficult to quantify these improvements, a metabolic and stroboscopic study effected by a research center would be necessary. With the use of these technical devices (supinatory cuneus) we assume an improvement of the proprioceptive sensation of the metatarsal heads.

Another factor which might contribute to the positive action of the supinatory cuneus in cycling is the working distance in this sport. While in ambulation the inferior limbs (tibial malleolus) are at a distance of 5-6 cm, in cycling the mechanical vehicle forces the malleolus to keep a minimum distance of 15-16 cm (Q factor). This enlarqment of the support basis causes a natural dynamic valgus of the antefoot and consequently of the knee. In coincidence with foot paramorphisms the supinatory cuneus has a stabilizing effect on the pedal revolution.

Second case : Z.A., a 44 year old recreational cyclist, normotype. During his childhood he suffered from a virus, infection of poliomyelitis. The orthopedical examination points out an evident residual hypotrophy of the right calf (circumference 27 cm) compared with the left one (circumference 34 cm). Furthermore there is a slight claudication in ambulation. Dynamically on the mechanical vehicle there is a slight fall of the right heel caused by the hypotrophy of the right calf and above all a marked dynamic knee varus which reduces the muscular performance of the correspondent limb. The consequence of all this is the dynamical disarray of the spine. In order to improve the muscular performance of this cyclist it is necessary to avoid the fall of the heel and the dynamic varus of the right knee. By applying a supinatory cuneus under the right shoe, by differentiating the cleats in the two shoes (moving back the foot in respect to the pedal) and by rising the saddle in position of slight equinism of the foot, a dynamic reduction of the preceding defects has been obtained.

The most important data which I found is the positive action of the supinatory cuneus which in this clinical case corrrected the knee varus and in the preceding case the knee valgus.

Third case : F.Z., a 17 year old junior racer cyclist, suffers from back ache caused by stress. The postural examination reveals a pelvic asymmetry and a shorten leg (-1,5 cm). In order to balance this defect the coach applied a thickness of 1 cm under the hyposomic limb. Dynamically there is evidence of a notable axial deviation of the spine towards the limb previously supplied with the thickness, all this probably cause of the back ache from stress, The reduction of the axial deviation and the disappearing of the symptomatoloqy has been obtained by reducing the thickness to 2 mm and differrentiating the position of the cleats (12 cm on the left, 11,7 cm on the right). This clinical case shows the negative effect on the station of consistent thicknesses applied between shoe and pedal. Normally with the modern pedals the convolution effected by the pushing point of the foot (first metarsal head) is made oval and eccentric in respect to the bottom bracket. Adding another thickness to the pedal (1 cm) causes a further eccentricity to the pedal revolution. The distance of the foot in the superior stalling point reaches 21,5 cm and in the inferior stallinq point 12,5 cm. The dynamic consequence is the different angular speed in the pushing phase of the two limbs with an effect of unilateral unbalance of the pelvis and of the spine.

CONCLUSIONS

In modern cycling the new equipments (clipless pedals, stiff soles) together with preexisting paramorphisms cause an increase of the muscular-tendinous pathologies. The goal of this study is to observe and to adjust the human morphology to the bicycle by means of biomechanical devices. Furthermore it is opportune for the research centers to study with adequate instruments these new phenomena in order to allow recreational and racer cyclists to correctly practice this sport.

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