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Gait – pathology or phisiology

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Introduction

A man's gait is the most natural locomotion, an automated motor act. Like handwriting or fingerprints, the gait can tell about a person's mood, about his state of health. In addition, the gait may be a sign of some kind of diseases. It is said that the gait is unique, like a handwriting. No wonder O. Balzac called the gait of a person - the character's personality.

Individual features of the gait consist of the size of the steps, speed, position of the body and head, the commonwealth of the movements of the hands. To take a step, a lot of effort is needed: in the hip, knee, ankle joints, the joints of the foot and even the hands. Need to work the muscles of the legs and arms, the muscles of the chest and the lumbar. Strictly coordinates this complex motor process by the central nervous system. The act of the gait also involves the organs of vision and hearing.[1,2]

The tasks of the gait, as an important locomotive function of a person are:

1. Safe linear forward movement of the body.

2. Hold the vertical balance, preventing falling during movement.

3. Security of energy, use of the minimum amount of energy due to its redistribution during the cycle of the step.

All of the above points suggests that gaits studies are important for evaluating the patient's functional capabilities. Despite clinical significance and widespread prevalence, gait disturbances have not been the subject of special study until recently.[3] All these factors determined the timelines of this study.

The **purpose of our scientific work** was to study some mechanisms of formation of human gait, to study some electromyographyc (EMG) and biomechanical features of gait in pathological conditions and volunteers. The gait of a person is a peculiar kind of two-legged movement, in which the support for one leg cyclically changes the bi-axial period, and then the support to the other leg. Gait is figuratively described as "controlled fall". At each new step, the person bend over and begins to fall, which is hampered by the advanced leg. After it touches the earth, the weight of the body is transferred to it, the knee bends, and erects, returning the body to its original position. That is why many authors represent gait as model of the "inverted pendulum" (Figure 1).

Here's how in the simplified version the first step is formed: the central nervous system sends a pre-formed sequence of commands to the muscles. At the spinal level, only the simplest coordinating reactions proceed, however, the spinal cord can perform quite large functions, up to the "spin pitch" in animals (so-called spinal automatism). Such qualities of motion as smoothness, accuracy are realized with the participation of the cerebellum and extrapyramidal system by regulating the temporal, velocity and spatial characteristics of motion. It becomes clear that gait disturbances may accompany with motor disorders that arise in diseases of any system, takes part in the formation of an act of walking - muscles, peripheral nerves, spinal roots, pyramidal tracts, cerebellum, extrapyramidal formations, as well as an axial skeleton and auditory and visual analyzers.[1]

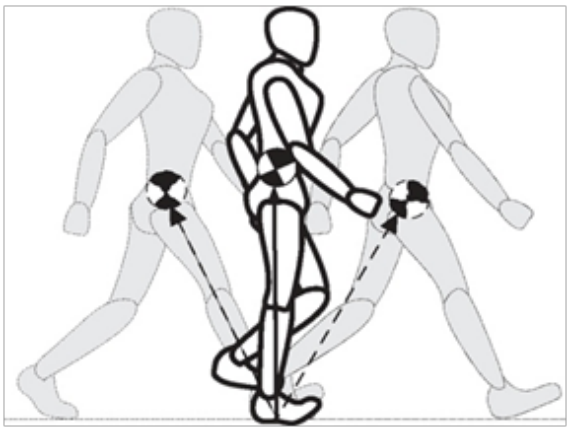

Figure 1 Walking – "inverted pendulum".

The gait disorder is a very valuable diagnostic indicator. Shambling walk together with lowered shoulders and head, trembling hands – are the symptoms of Parkinson's disease. Parkinson's disease affects the area of the extrapyramidal system, which is called a black substance, where a neurotransmitter, dopamine, is produced, whose function is to smoothly transfer impulses to ensure normal movements. In patients with Parkinson's disease reduces the production of dopamine, disturbs the normal transmission of nerve impulses and appear the main symptoms of parkinsonism (Figure 2).

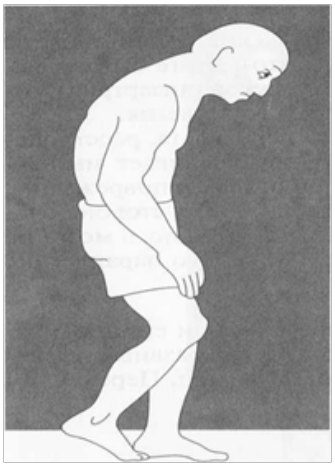

Figure 2 Typical pose for patients with parkinsonism.

If a person has suffered from stroke, localized in the internal capsule, then during walking it falls on one side and makes a characteristic movement: the arm is pressed against the body, the foot is set aside (Figure 3).

Figure 3 Pose Wernicke-Mann

A swinging "goose gait" is observed at congenital bilateral dislocations of the hip joints and myopathy, diseases in which pathological changes occur directly in the muscles or joints.[4]

"Peroneal gait" occurs when appear paresis of the extensor muscles of the foot, when there is the injury of the fibular muscles and / or the injury to the fibular nerve, which innervates this muscles group. The patient raises his leg high, throws it forward and drops sharply (Figure 4).

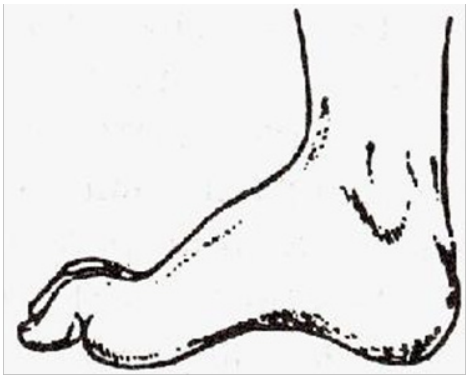

Figure 4 Footstep in patient with "peroneal gait".

All examinations were conducted in Sytenko Institute of spine and joints pathology NAMS of Ukraine. The studies were performed in 4 patients with Parkinson's disease, 5 patients suffering from ischemic stroke, 4 patients with peroneal nerve neuropathy, and 2 patients with myopathy. The comparison group involved 7 healthy volunteers.

There were recorded a high-frequency, high-amplitude curves during muscle contraction in healthy volunteers (Figure 5).

There were recorded "firing" of spindle-shaped escalation of the potentials amplitude and subsequent decrease in patients with Parkinson's disease (Figure 6).

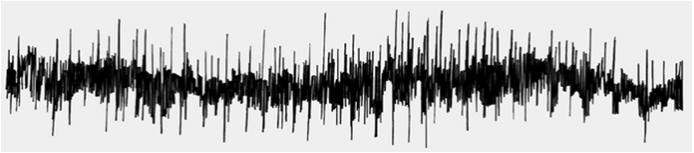

Figure 5 Healthy volunteers EMG.

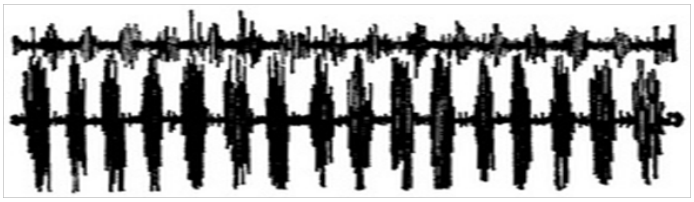

Figure 6 EMG in patient with Parkinson's disease.

In patients with myopathy, we recorded that the amplitude and duration of potentials were reduced. In our view, this was due to decrease of the number of normal muscle fibers that can be active. There were recorded the singular potentials irregular in amplitude and frequency singular potentials in patients with peroneal nerve neuropathy (Figure 7). Generally, all electromyograms were characterized by low amplitude activity. In one patient, we recorded "full bioelectric activities absence", talked about the death of most nerve fibers and the depression of bioelectric activity of the muscles.

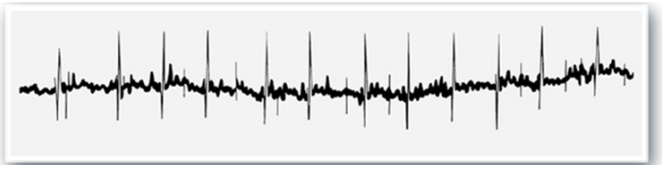

Figure 7 EMG in patient with peroneal nerve neuropathy.

Based on the data obtained, in all of the patients we observed, we recorded EMG data which evidence pathological process. So, electromyography examination allowed to objectify the level of changes in the process of neuromuscular transmission in various diseases. The design of the movement plan, like as its implementation, is carried out by the center controlling the posture (the motor part of the cerebral cortex), using the previous planning experience and sense of the body position. There is the possibility of "pre-programming" of motion due to direct connections between the cerebral cortex and the vestibular system. It is considered as the basis for maintaining balance and posture.

The least energy-consuming is the "convenient type" of standing and walking, in which the projection of the common center of mass locate behind the shoulder and knee joints and in front of the hip joint. The vertical posture, biomechanically and ergonomically ideal, provides physiological curves of the spine, normal values of spine-pelvic balance parameters (the relationship between the waist, lumbar vertebrae and the head of the femur), the neutral position of the main joints of the lower extremities.[3] The vertebral-pelvic balance is the state of the sum of all the bends of the spine, in which, in the standing position (according to X-ray data), the line drawn through the center of the vertebral body C7 and the center of the disk L5-S1, parallel to the slope line, and which is necessary for the optimal function of the spine (Figure 8).

The PI value is the constant for the subject, determines other pelvic parameters and is the major parameter in the regulation of the spinal centering in the formation of the human gait. That's why we decided

to determine this parameter in the patients. PI (pelvis incidence) is the angle between the line connecting the middle of the upper surface of the sacrum (O) with the center of the head of the femur (F) and the perpendicular to the upper surface of the sacrum, restored at the point O[4,5] (Figure 9).

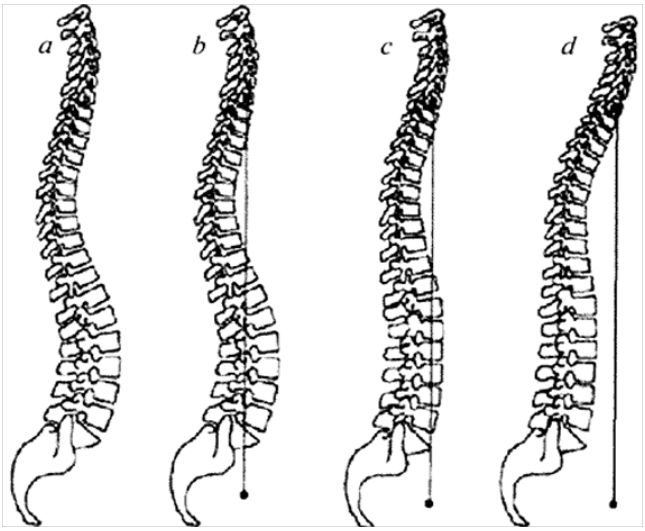

Figure 8 Vertebral-pelvic balance. a) b) – normal ; c) d) – dysbalance

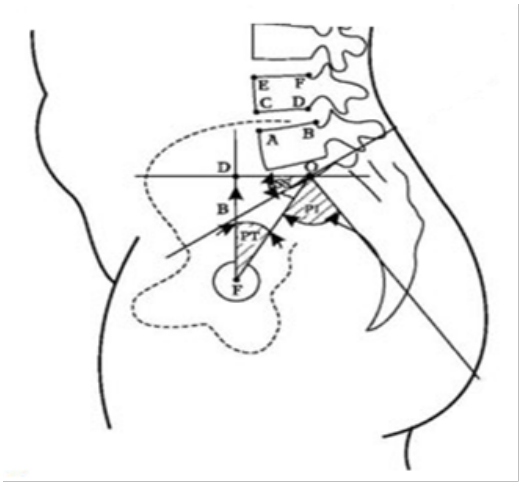

Figure 9 Measuring the parameters of the vertebral - pelvic balance (PI value).

The parameter PI is anatomical and in patients it varies depending on the observation group, and depends on the pathological condition:

a. PI (50.1 °) - patients with peroneal nerve neuropathy and volunteers

b. PI (less than 35 °) - patients with stroke

c. PI (between 35 ° and 50.1 °) patients with myopathy and Parkinson's disease.

What can explain such variations of PI in our patients? In the vertical position, the vertebral-pelvic balance is regulated by the neuromuscular system, which minimizes the work of the muscles to maintain a vertical posture. Therefore, it is logical to assume that the violations in the system of neuromuscular transmission also change the parameters of the vertebral-pelvic balance. So, the PI score may also be important in the diagnosis in patients with gait abnormalities.

Conclusion

The person's gait - being individual and absolutely unique, testify both to health, and about a possible pathology. The type of pathological gait depends on which of the links of the locomotor chain has suffered: corticospinal tract, extrapyramidal system, musculoskeletal system, etc. In setting the correct diagnosis in the presence of a pathological gait, the main place belongs to the clinical examination, as well as electromyography and biomechanical examinations.

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