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SOME CONSIDERATIONS ABOUT PADELLAR REFLEX. DYNAMICS AND EVALUATION

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Abstract. *The human reflexes, to external stimulus, express the organism capacity of reaction. The testing of human reflexes is part of a set of tests, which the physicians have done, in order to diagnosticate. The padellar reflex test is included in the set we are talking about. In order to obtain the level of padellar reflex it has proposed a measurement method of a cinematic set of parameters. The paper is going to propose two dynamic models for padellar reflex test.*
We try to evaluate the human reflexes quality by the meaning of cinematic set of parameters. In order to obtain the value set of the parameters, there become necessarily an adequate device. So, the paper has to propose a device schema, device able to be connected to a computer data acquisition card. The device has to have two sensors, one for pressure and the other for acceleration measurement. The point is how to place these two sensors relative to the knee joint?

Key words: *bio-mechanics, acceleration measurement, human physiology, measurement device.*

1. THE THEME GENESIS

The human reflexes, are the basic mechanisms of the organism defense. Them represents the capacity of the body fast reaction to the environment stimulus. A good reflex is a measure of the organism functionality. The reflexes state is one of the organism performance parameters. The fast reaction capacity to an external stimulus gives us an essential information concern to the nervous system functionality. The reflexes and the causes which affect them are studied by the Physiology Discipline from Medical Science. The Physiology knowledge concern to reflexes state is affected, in a wrong way, by the

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present evaluation procedure. The present-day procedure gives to the physician only a vague information relate to the reflex stage. There are the physicians and the scientists in the field of medicine who need a new procedure to improve the reflex test.

2. THE PURPOSE OF THE PAPER

The paper intent to propose a new test procedure including a dynamic padellar reflex quantification. The parameter nominate to be quantify is the shank acceleration. The idea of an easy measuring method has decided the selection of which parameter to be used. The procedure of the shank acceleration measuring needs a new acceleration measuring method.

First, the paper attempts to make up a shank mechanical model and an acceleration measuring method dedicated to shank acceleration measurement.

Second, the paper tries to make a draft of a special device that is designed to be bound to the shank. This device should be able to bear two traducers, one for acceleration and the other for pressure measuring.

Third, the paper intent to establish what are the most important parameters that we have to take during the test and finally what are the outcome parameters.

The main targets of the paper as follows:

- an attempt to reveal the essential of the physician padellar reflex test evaluation;
- a try to establish the parameters of the new evaluation;
- a dynamic model of the foot including the knee joint and the quadriceps muscle;
- the reveal of the constants of the human leg bones that come in the dynamic model;
- the establish of the test human groups.

3. A PRELIMINARY LOOK OVER THE PADELLAR REFLEX TEST

The classical test of the padellar reflex is shown in Figure 1 [4], [5]. This procedure excites the reflex arcs using a special hammer. The physician hits the quadriceps muscle tendon by the hammer and observes the level of the shank movement. The evaluation of the reflex depends on the physician practice. The result of the test is drastically distort by the physician practice and by the psychological stage of the patient.

The physician skill concerns the reflex test consists of the following abilities:

- the ability in the psychological preparing of the patient;
- the hit dexterity of the tendon;
- the promptitude of the delay period evaluation;
- the ability of the shank movement evaluation;
- the global evaluation skill of the patient reflex rate;

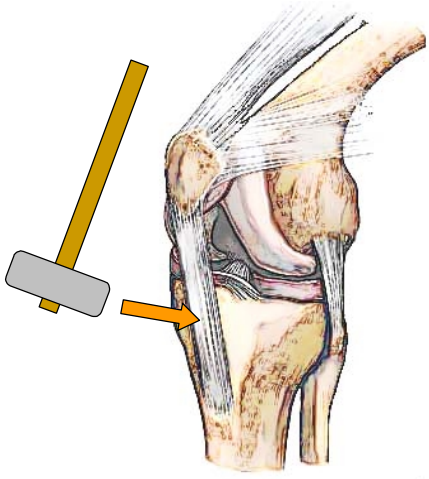

Fig. 1. Classical padellar reflex test

– a good memory and a large experience in the field of physiology discipline;
– a good decision capacity.

All of these abilities are necessary for a good qualitative evaluation of reflexes, but not enough to make the test rigorous.

In these circumstances, a new test procedure is both necessary and useful. The new procedure must have a friendly user interface. A data acquisition board, a good computer and a oriented software will satisfy this last request.

4. A PRELIMINARY MECHANICAL MODEL

There is a difficulty to build up an abstract model because we have to decide what details must be eliminate in the abstraction process. Anyway we have to do some simplifying assumptions. The first mechanical model of the knee [1] we propose is shown in Figure 2. The model refers to the knee joint and shank in a specific position requires by the padellar reflex test. The leg complexity comes out of the muscle, bones and tendons complexity. The model conception requires a simplifying assumption set as follows:

a) the femur and tibia are rigid to bending, compression and torsion;
b) the femur-tibia joint is a rigid C_5 couple;
c) quadriceps femoral muscle insertion to tibia is rigid and punctiform;
d) the foot phalanx and tarsal joints are ignored;
e) the vessel and other muscle damper effects are neglected.

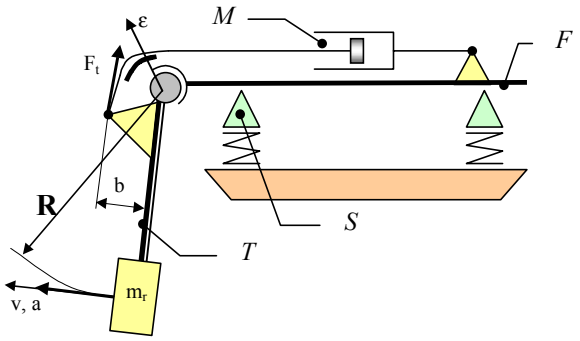

Fig. 2. Padellar reflex test mechanical model

The schema in figure 2 consist of the following elements:

F – femur bar;
T – tibia bar;
M – quadriceps muscle;
F_t – tangent component of the muscle force;
S – elastic dissipative support;
R – shank mass center position;
b – the elevation of the muscle insertion on tibia;
m_r – shank and foot concentrate mass;
v,a,ε – cinematic parameters.

The schema in figure 2 helps us to introduce the equivalent propulsion acceleration. We assign the shank angular acceleration to linear propulsion acceleration concept that is note by a_{le}. The deduction sets of relation are (1) and (2)

$$\left\{\begin{array}{l} M = J * \varepsilon \\ F * b = J * \varepsilon \\ F * b = m_r * R^2 * \varepsilon \\ F * b = m_r * R^2 * a * R \\ a_{le} = F/m_r \end{array}\right\} \Rightarrow a_{le} = (R/b) * R^2 * a \quad (1)$$

$R/b = K_g$ – is one constant of the human leg bones

so: $a_{le} = K_g * R^2 * a$ (2)

The second mechanical model of the knee [1] we propose is shown in Figure 3. This model refers to the knee joint and shank using a bar mechanism in a specific position requires by the padellar reflex test. The leg complexity comes out of the muscle, bones and tendons complexity. The model conception requires a simplifying assumption set as follows:

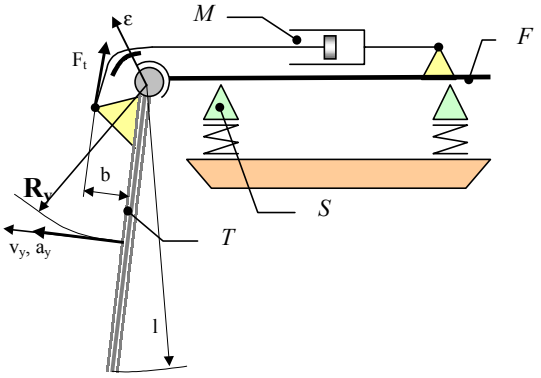

Fig. 3. Padellar reflex test mechanical model with the constant density assumption

The schema in figure 3 consists of the principal elements of the figure 2 schema as follows:

R_y – circle radius of the accelerometer position;
l – shank and foot length;
m – shank and foot mass;
v_y – tangential speed;
a_y – tangential acceleration;
ε – angular acceleration.

It considered that the mass is uniform distributed on the foot length.

The schema in figure 3 helps us to refine the equivalent propulsion acceleration. We assign again the shank angular acceleration to linear propulsion acceleration concept that is also note by a_{le}. The deduction sets of relation are (3) and (4)

$$\left\{\begin{array}{l} M = J * \varepsilon \\ F * b = J * \varepsilon \\ F * b = (m * l^2/3) * \varepsilon \\ F * b = (m * l^2/3) * a_y * R_y \\ a_{le} = F/m \end{array}\right\} \Longrightarrow a_{le} = R_y * l^2 * a_y/3b \quad (3)$$

$l^2/3b = K_l$ – is another constant of the human leg bones

so: $a_{le} = K_l * R_y * a_y$ (4)

The (4) relation using is constrain by the K_l constant statute. It could be separate tree cases that determine the (4) relation using:

Case 1 - K_l is an universal constant of human species. In this case we need a device that bear the acceleration transducer at a constant ray R_y. The range of R_y could be in a usual domain of values.

Case 2 - K_l is a common constant of human species because it takes different values for different age classes, race classes, and so on. In this case the device must be settable to different values of the ray R_y. The ray R_y value will be set in accordance with the class the patient belongs to.

Case 3 - K_l is not a constant of human species because it takes random values for any people. This is the most general case. The device must be tunable in accordance with any patient.

5. A MEASURING SYSTEM STRUCTURE

The System Schema follows the virtual instrumentation principle [2]. This modern principle requests a computer, a specialized software, a set of transducers and a set of specific devices. The System Schema is shown in Figure 4 and consists as follows [3]:

1. printer;
2. PC computer;
3. data acquisition board ;
4. special cables and connectors;
5. special hammer for reflex stimulus;
6. device body;
7. connectors;
8. accelerometer;
9. pressure transducer;
10. reference joint for the transducers position.

The device body has to do an important function, to establish the traducer position relative to the knee joint. The two device schema are shown in Figure 5 and Figure 6.

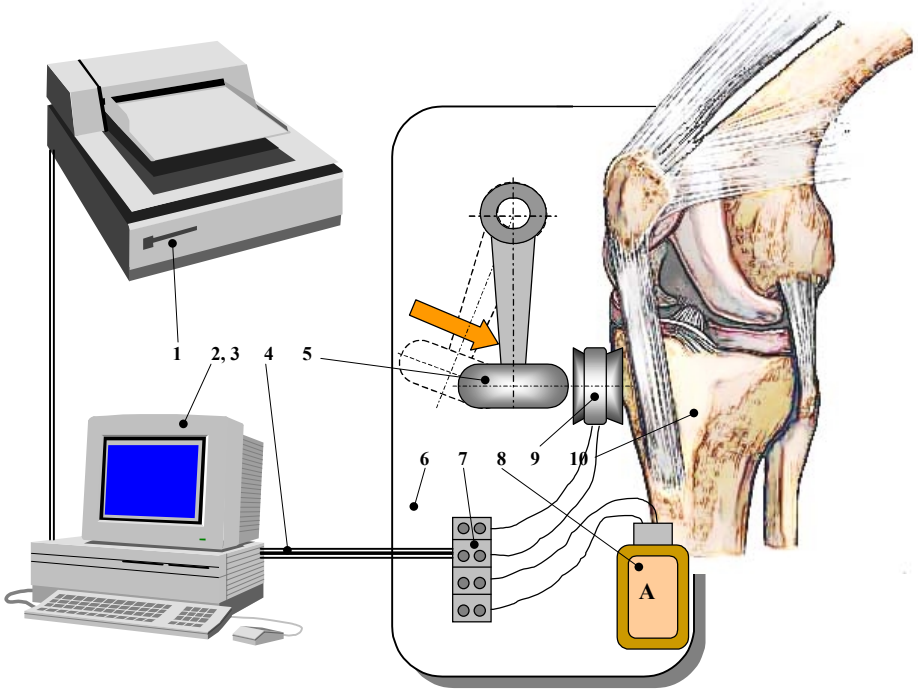

Fig. 4.

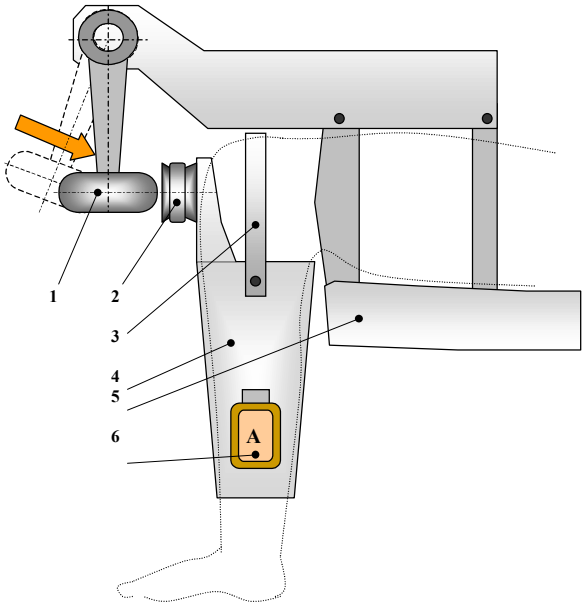

Fig. 5.

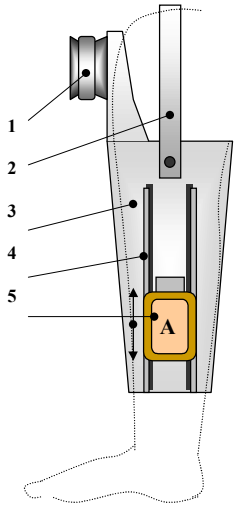

Fig. 6.

6. CONCLUSION

The muscles of the mammals fulfil a propulsion function. They convert the chemical energy of the body in motion and warm. The efficiency of the energy conversions characterizes the muscle energetic quality. But the effort capacity and the retrieval capacity of the muscle are very important qualities.

The muscles belong of the reflex arcs. The muscle capacity, from this point of view, can be evaluate by period of response to an external impulse. The other parameter is the amplitude of the movement.

The padellar reflex value express the general state of the pair muscle nerve. Thus it is important to express it as a propulsion parameter.

The evaluation of the reflex must be done by a general procedure. The generality of the evaluation procedure could be establish only by statistic experiment.

The paper make the first move on the direction of reflex study. This one should be follows by a large experiment in this field of research.

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NEKA RAZMATRANJA O USLOVNIM REFLEKSIMA, DINAMICI I EVALUACIJI

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Ljudski refleksi na spoljne stimulanse predstavljaju sposobnost organizma da reaguje. Testiranje ljudskih refleksa je deo serije testova koje su neki lekari uradili da bi dali dijagnozu. I sam test o uslovnim refleksima je deo ovih testova. Da bi se dostigao nivo uslovnih refleksa predloženo je da se koristi monitor na kome bi se prikazao niz parametara. U ovom radu su predstavljena dva dinamička modela za test o uslovnim refleksima. Pokušaćemo da procenimo kvalitet ljudskih refleksa na osnovu značenja niza parametara koji su predstavljeni na monitoru. Ovaj rad treba da predstavi šemu tog uređaja koji je povezan sa senzorima i sa podacima u kompjuteru. Uređaj mora da ima dva senzora, jedan za pritisak i drugi za merenje ubrzanja. Problem je u tome kako postaviti ova dva senzora da budu blizu zgloba kolena.

Ključne reči: *biomehanika, merenje ubrzanja, ljudska fiziologija, uređaj za merenje.*