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STUDY ON MEASURING AND EVALUATING SHOULDER JOINT FLEXIBILITY IN KARATE PRACTITIONERS USING EMERGING TECHNOLOGIES

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Abstract: *The research aims to highlight new methods of measuring and assessing flexibility using emerging technologies.*
Using Mobee Med equipment as an emerging technology, we can quickly and accurately measure flexibility of the humeral-scapulo joint. The analysis is performed using a compact, sensor-based device, which is also used to conveniently control the software. We can follow the execution of the movement in real time, and we can enter additional relevant information, such as pain data whether or not it exists.
A good flexibility at the level of the humeral-scapulo joint leads to a correct execution of the arm techniques, to a better use of strength and speed.

Key words: *flexibility, joint, technology, equipment, karate.*

1. Introduction

Karate is one of the most popular sports [4]. This is due to the fact that more and more children and adolescents are attracted to martial arts [12]. In karate flexibility plays a very important role because it supports the development of an athlete [7].

Flexibility is an essential quality for an athlete, which is why a high level of flexibility is required to increase efficiency, efficiency and economy of movement, which is generally true in all sports. Flexibility is defined as the range of motion (ROM) of a joint or a series of joints[1]. The measurement of flexibility is currently found in very few reports [9]. The practice of Martial Arts requires a special development of mobility, primarily for the correct execution of basic techniques [5]. Gender plays a very

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important role in flexibility, with girls having a more developed mobility than boys, this difference being preserved throughout their lives [6].

With the popularization of Karate, the methods of developing the flexibility of the body have evolved, the importance of biomotor flexibility being found in all styles of karate[11]. In this evolution a decisive role was played by the training of European, American and Canadian specialists, who adopted the Japanese methods of working with the body and deciphered the mechanisms of performing these exercises [10].

Although Shotokan Karate Do has recently appeared as a university discipline, in mobility at the Faculty of Physical Education and Sport within the "Alexandru I. Cuza University" of Iasi (1996) and at the Faculty of Physical Education and Mountain Sports-Transilvania-Brasov University, we can say that this discipline is also based on a systematic and scientific training[8]. We consider a progress in the university study of martial art Karate Do, the fact that in the course of the discipline Combat is studied the theory of movement and how the body can fully capitalize on its potential for movement. This idea led us to carry out this research.

We aim to highlight some of the emerging technologies for measuring flexibility based on the fact that at the core of these technologies are a series of physical, physiological and biomechanical laws. Checking the devices, equipment and ways to highlight flexibility, in the case of shotokan karate practitioners, is a necessity of the success of the research.

2. Materials and Methods

Mobee Med equipment was used for the study aimed at measuring and evaluating the scapulo-humeral joint.

Place: Superfit Medical Center – Bucharest

Period: January 2021.

The subject of our investigative approach was a sportswoman legitimized at the Kazumi Sports Club within the Romanian Karate Federation, S.K.D.U.N. department.

Collaborators: Director of the Superfit Clinic Bucharest doctor Damian Șerban, physiotherapist Aguciu Mădălin. We chose this modern equipment because it allows us to quickly and accurately measure the mobility of the joints. With over 100 different measurement options, Mobee Med offers a wide selection for almost all joints (except for the fingers and toes joints).

Through different positions (sitting, standing, lying down) one can find the optimal variant for measuring the joint that interests us. Mobee Med will help us record the values obtained from measuring the amplitude of motion. As a digital companion, the system displays the measurements recorded throughout the research period and also makes progress visible.

The analysis is carried out using a compact device, based on sensors, which is also used to conveniently control the software. We can track the execution of the movement in real time and enter additional relevant information, for example data about the pain whether it exists or not. The results are then presented clearly and appropriately for the recipient (coach/athlete). Active-passive and right-left comparisons are

used for evaluation. Impressions of progress throughout the study underscore the success of our research.

Assessment of active flexibility at the level of the scapulo-humeral joint

Shoulder flexion (anterior movement of the arm in the sagittal plane)

1. Reference values (values considered normal by different researchers):
   - 180^0 Mircea Chiriac;
   - 160^0 David J.Magee;
   - 180^0 Tudor Sbenghe;
   - Mobee Med 160^0 active.
2. Initial position (P.I.) – Sitting (orthostatism), arms near the body (in anatomical/ neutral position), palm twisted outwards;
3. Motor action (AM) – Bringing the left arm through forwards upwards;
4. The final position (P.F.) – the athlete in orthostatism will complete the movement reaching with his left arm outstretched near the ear;
5. The plan in which the motor action is carried out – sagittal;
6. Position of the Mobee Med gyroscope – the inner part of the arm;
7. The position of the researcher in relation to the athlete examined – on the same side of the arm.

Shoulder extension (posterior movement of the arm in the sagittal plane)

1. Reference values (values considered normal by different researchers):
   450 Mircea Chiriac;
   50^0-60^0 David J.Magee;
   50^0-60^0 active, 90^0 passive-Tudor Sbenghe.
   Mobee Med 50^0 active.
2. Initial position (P.I.) – Sitting (orthostatism), arms near the body (in anatomical/ neutral position), palm twisted outwards;
3. Motor action (AM) – Bringing the left arm backwards;
4. The final position (P.F.) – the athlete in orthostatism will complete the movement reaching with his left arm stretched back to the limit of movement;
5. The plan in which the motor action is carried out – sagittal;
6. Position of the Mobee Med gyroscope – the inner part of the arm;
7. The position of the researcher in relation to the athlete examined – on the same side of the arm.

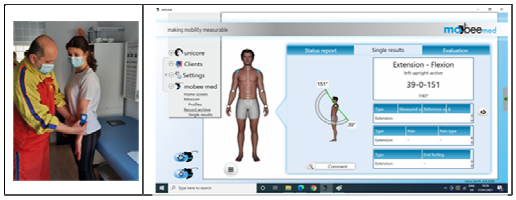

Fig. 1. *Flexion and shoulder extension*

Horizontal adduction of the shoulder (the movement of approaching the arm to the opposite shoulder, keeping the shoulder flexion of 90^0)

1. Reference values (values considered normal by different researchers):
   - 135^0-140^0 Mircea Chiriac (from dorsal lying);
   - 130^0- David J.Magee (from supine lying);
   - Mobee Med 140^0 (from orthostatism) active.
2. Initial position (P.I.) – Sitting (orthostatism), left arm stretched laterally (in abduction position 90^0), palm facing forward;
3. Motor action (AM) – Bringing the left arm through forward and to the right;

4.The final position (P.F.) – the athlete in orthostatism will complete the movement reaching with his left arm outstretched and to the right to the limit of movement;
5.The plan in which the motor action is carried out – transversally;
6.Position of the Mobee Med gyroscope – the outer part of the arm;
7.The position of the researcher in relation to the athlete examined – on the same side of the arm.

Horizontal abduction of the shoulder (movement of the arm away from the midline of the trunk in the transverse plane)

1.Reference values (values considered normal by different researchers):
- 130^0 David J.Magee (from sitting with his arm outstretched forward;
- Mobee Med 60^0 active (from sitting with the arm outstretched sideways).
2.Initial position (P.I.) – Sitting (orthostatism), left arm stretched laterally (in abduction position 90^0), palm facing forward;
3.Motor action (AM) – Ducting the left arm stretched backwards;
4.The final position (P.F.) – the athlete in orthostatism will complete the movement reaching with his left arm stretched back to the limit of movement;
5.The plan in which the motor action is carried out – transversally;
6.Position of the Mobee Med gyroscope – the outer part of the arm;
7.The position of the researcher in relation to the athlete examined – on the same side of the arm.

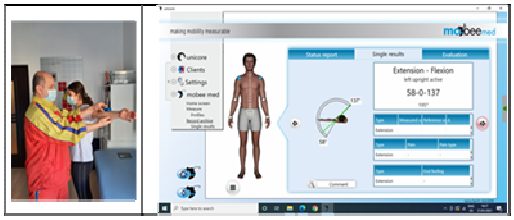

Fig. 2. *Horizontal addition and abduction of the shoulder*

External rotation of the shoulder (movement around a vertical axis)

1.Reference values (values considered normal by different researchers):
- 80^0-90^0 Mircea Chiriac;
- 80^0-90^0 David J.Magee;
- Mobee Med 90^0 active.
2.Initial position (P.I.) – Sitting (orthostatism) with the left arm in flexion and abduction of 90^0, palm facing the ground;
3.Motor action (AM) – Bringing the left forearm through forward up;
4.The final position (P.F.) – the athlete in orthostatism will complete the movement reaching with his fingertips upwards, keeping the flexion of 90^0, up to the limit of movement;
5.The plan in which the motor action is carried out – sagittal;
6.Position of the Mobee Med gyroscope – the outer part of the forearm;
7.The position of the researcher towards the examined athlete – before the tested member.

Internal rotation of the shoulder (movement around a vertical axis, spindle that will pass through the middle of the humeral head)

1.Reference values (values considered normal by different researchers):
- 80^0-90^0 Mircea Chiriac;
- 60^0-100^0 David J.Magee;
- Mobee Med 95^0 active.

2. Initial position (P.I.) – Sitting (orthostatism) with the left arm in flexion and abduction of 90^0, palm facing the ground;
3. Motor action (AM) – Bringing down the left forearm;
4. The final position (P.F.) – the athlete in orthostatism will complete the movement reaching with his fingertips down, keeping the flexion of 90^0, up to the limit of movement;
5. The plan in which the motor action is carried out – sagittal;
6. Position of the Mobee Med gyroscope – the outer part of the forearm;
7. The position of the researcher towards the examined athlete – before the tested member.

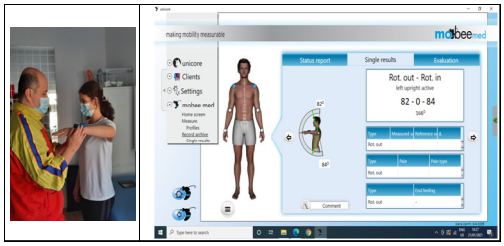

Fig. 3. *Internal and external rotation*

3. Presentation of the Results of Scientific Research

Flexion and extension measurement Table 1

Shoulder flexion in the sagittal plane			Shoulder extension in the sagittal plane		
left.	right.	Reference values	left.	right.	Reference values
151	154	160	39	43	50

Measurement of horizontal abduction and adduction Table 2

Horizontal Abduction (Ext.in the transverse plane)			Horizontal Adduction (Flex.. in the transverse plane)		
left.	right.	Reference values	left.	right.	Reference values
58	59	60	137	139	140

Measurement of external and internal rotation Table 3

External rotation			Internal rotation		
left.	right.	Reference values	left.	right.	Reference values
82	84	90	85	88	95

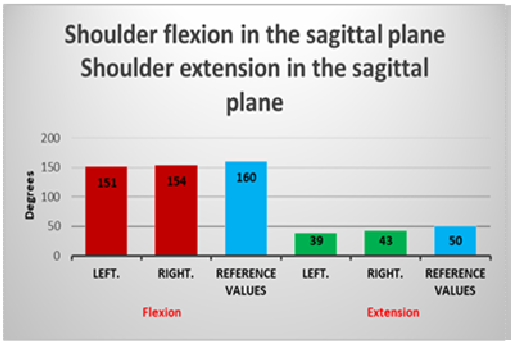

Fig. 4. *Flexion-Extension*

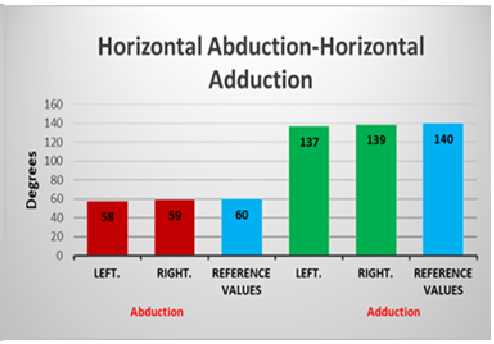

Fig. 5. *Abduction—Horizontal adduction*

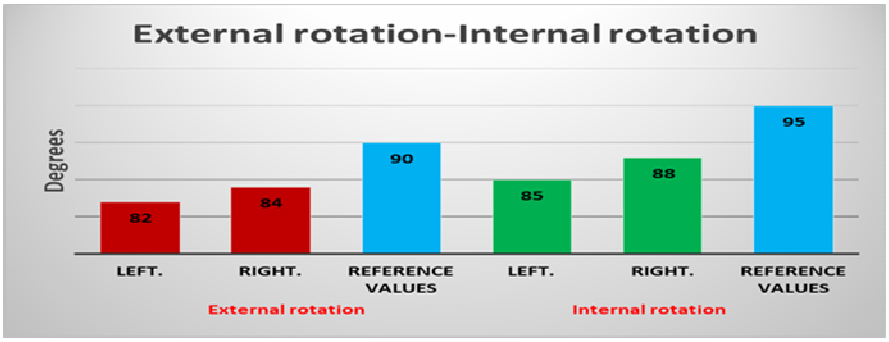

Fig. 6. *Entern-internal rotation at the level of the scapulo-humeral joint*

From a bone perspective this joint consists of humerus, clavicle and shoulder blade.

The humerus, the arm bone, shows a tuberosity (humeral head) that will enter a part of the shoulder blade called the glen. The glena is very well rounded and will take over the humeral head which will form one of the largest and most complex movements found in a joint of the human body. We have in all planes the motion and the combination of these planes in a motion called circumduction.

At the level of this joint we find the ligaments between the acromion and the coracoid process, between the acromion and the clavicle that will provide stability in the fixed structures of the scapular belt. And as a soft tissue we also find the tendinous inserts of the muscles. Beyond the bone structure, the tendons-muscles and what exactly gives stability to the bone structure, we must also remember the capsule that comes to cover both bone ends. The humeral head and glena are coated with a cartilage called hyaline cartilage, the most slippery of the cartilage types. In motion that capsule will secrete synovial fluid. This liquid is a more viscous substance that will form a lubrication film between the two bony ends (the humerus and the glena) wallpapered in cartilage. If from the start this hyaline cartilage is very slippery and we also have synovial fluid, it is practically very difficult to destroy or affect this cartilage just by simply moving in the mobility parameters.

Analyzing from a muscular perspective, when we talk about external rotation, we highlight three muscles: the supraspinous muscle, the infraspinous muscle and the small round muscle. The supraspinous muscle that is in the ditch of the shoulder blade passes through this canal under the acromio-clavicle and attaches to the humerus. When it contracts, a rotation and abduction in the slightly anterior or lateral plane is performed.

As for the internal rotation, most of this movement will be comprised by the subscapular (which opens like a fan on the internal side – the part inside the shoulder blade facing the ribs) and by the humerus, and at the time when it tightens it internally rotates the shoulder or humerus.

From figure 3 we can see that the athlete examined both in the case of external rotation and in the case of internal rotation presents on both sides angular values below the reference values indicated by the Mobee Med equipment: external rotation 82^0 stg-84^0 dr. compared to 90^0 reference value and internal rotation 85^0 stg-88^0 dr compared to 95^0 reference value. In the case of external rotation, the mobility deficit, generated by the subspinous muscles, posterior deltoid

and small round, is on the left side of 80, and on the right side by 60. In internal rotation the large, large dorsal and large round muscles recorded a deficit of 100 on the left side and 70 degrees on the right side.

When our subject performs flexion movement at the level of the scapulo-humeral joint (Figure No. 1. raising the outstretched arm upwards), the main muscles involved will be the brachial biceps, the coracobrahial and the anterior deltoid, and the accessory muscles involved will be the subscapular and the anterior deltoid. In extension, the accessory muscles are subspinous and small round, and the main muscles involved in the motricity of the joint are deltoid, large round, large dorsal and long head of the brachial triceps.

From figure 1 it can be seen that in the case of both flexion and extension, angular values were recorded below the reference values proposed by the manufacturers of the Mobee Med. In flexion 151^0 stg-154^0 dr compared to 160^0 reference value, and in extension 39^0 stg-43^0 dr compared to 50^0 reference value Mobee Med. The flexion mobility deficit is 9^0 stg-6^0 dr, and with regard to the extension 11^0 stg-7^0 dr, because in both actions (flexion-extension) the main muscles and the accessory muscles show little flexibility. For the design of the shoulder, adduction in the horizontal plane (Figure 2) a major involvement in the realization of the movement is held by the pectoral muscle (large pectoral and small pectoralis).

From Figure 2 we can see that the data obtained in the case of horizontal abduction and adduction are very close to the reference values: horizontal abduction 58^0 stg-59^0 dr-60^0 reference value; horizontal adduction 137^0 stg-139^0 dr-140^0 value equipment Mobee Med. We identify a somewhat better flexibility at the level of the posterior deltoid muscles, subspinous, small round, large round, rhomboids in the case of horizontal abduction performed by the tested athlete. And in terms of horizontal adduction, a mobility deficit of 3^0 stg. and only 1^0 dr. generated by the large pectoralis is observed. The deficit in the case of horizontal abduction is only 2^0 stg and 1^0 for the right side.

4. Conclusions

The use at this stage of emerging technologies (laboratory equipment) has provided us with reliable data in relation to the possibility of tracking the progress of the scapulo-humeral joint. We consider it necessary to transition from the classical means and methods of measuring and assessing flexibility to the use of emerging technologies as classical instruments in certain contexts present considerable limits. One such example would be the goniometer. According to Balint&Diaconu, et al, (2007) despite the fact that they are very comfortable can generate numerous errors in the assessment of angular values, especially if the calibration was not correctly performed [3]. Avramescu (2006) argued that a great disadvantage of the goniometer is that he appreciates the angular value of the amplitude of motion only in one plane, while the joint actions are performed simultaneously in several planes [2]. At the level of the knee joint flexion is accompanied by an internal rotation and extension by an external rotation of the lower leg, and this disability can be overlooked when the assessment is made using the goniometer. For other bone segments the result of actions combined in several planes can not be overlooked. Eversion and inversion movements, for example, are impossible to measure with the goniometer because it is necessary to

measure the amplitude of motion at the level of the ankle in three directions.

These limits are practically canceled with the help of the Mobee Med equipment selected at this preliminary stage. Representing a sensitive technology with 3 sensors allows for implausible accuracy of measuring the amplitude of movements at the joints of the body in the three planes. The accuracy in measurement, the instantaneous exposure of the measured angular values, the automatic comparison of these values with the values of the normative range justify the use of Mobee Med as an emerging tool for measuring flexibility at the macro level in the karate halls.

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