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Director: Fernando Emilio Valladares Fuente

Email: fernando.valladares@upr.edu.cu

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Original article

Dynamic passive insistence and maximal contraction: Flexibility influence on the karate split

Insistencia pasiva dinámica y contracción máxima: Influencia en la flexibilidad del split en kárate

Insistência passiva dinâmica e contração máxima: Influência na flexibilidade do split no Karate

Edgar Jariff Oña Tacan[1*] https://orcid.org/0000-0002-9942-4174

Daniel Nicolás Chamorro Werz[1] https://orcid.org/0000-0003-4800-7124

Enrique Chávez Cevallos[1] https://orcid.org/0000-0002-2535-3705

[1]University of the Armed Forces ESPE, Quito. Ecuador.

*Corresponding author: ejona32018@gmail.com

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ABSTRACT

The physical capacity of flexibility is related to the possibilities possessed by a joint and muscle group in relation to a given range of motor movement. The capacity is usually determinant in various sports and of vital importance in karate athletes. Therefore, the objective of the research is to compare the dynamic passive insistence method (Mipd in Spanish) and the maximal contraction method (MCM in Spanish), assessing how they affect the flexibility of the coxofemoral joint in karate athletes, determining which method is more effective to increase flexibility in the frontal and lateral split. Experimental research of correlational type, studying 36 karate athletes (14-15 years old, male) divided into 18 subjects for each independent group (experimental and control). The subjects were intervened with an identical training model (five mesocycles), the difference being that the Mipd was applied to the control group and the MCM to the experimental group. For the experimental group, the lateral split test finally obtained a value of □6,6 cm, and the control group □2.72 cm. (+3.89 cm; p=0.002), while, for the experimental group in the frontal split test, a value of □7.72 cm was finally obtained, and the control group □1.06 cm (+6.66 cm; p=0.002). (+6.66 cm; p=0.000). The Mipd increases the level of flexibility, but the MCM is the ideal for an optimal development of coxofemoral flexibility in karate athletes, obtaining better progress in the opening of the legs in frontal and lateral split.

Keywords: Flexibility; Karate; Dynamic passive insistence method; Maximal contraction method; Split.

RESUMEN

La capacidad física de flexibilidad se relaciona con las posibilidades que posee una articulación y grupo muscular en relación con un rango de un movimiento motriz determinado. La capacidad suele ser determinante en diversos deportes y de importancia vital en los karatecas. Por ello, se planteó como objetivo de la investigación comparar el método de insistencia pasiva dinámica (Mipd) y el de contracción maximal (MCM); se valoró además cómo inciden en la flexibilidad de la articulación coxofemoral en karatecas, y determinó qué método es más efectivo para incrementar la flexibilidad en el split frontal y lateral. Se realizó una investigación experimental de corte correlacional, y estudió a 36 karatecas (14-15 años, masculinos) divididos en 18 sujetos para cada grupo independiente (experimental y control). Los sujetos fueron intervenidos con un modelo idéntico de entrenamiento (cinco mesociclos), cuya diferencia radica en que al grupo control se le aplicó el Mipd y al grupo experimental el MCM. Para el grupo experimental, el *test* de split lateral obtuvo finalmente un valor de □6,6 cm., y el grupo de control □2.72 cm. (+3.89 cm.; p=0.002), mientras que, para el grupo experimental en el *test* de split frontal; se obtuvo finalmente el valor de □7.72 cm., y el grupo control □1.06 cm. (+6.66 cm; p=0.000). El Mipd incrementa el nivel de flexibilidad, pero el MCM es el idóneo para un óptimo desarrollo de la flexibilidad coxofemoral en karatekas, obteniéndose mejores progresos en la apertura de las piernas en split frontal y lateral.

Palabras clave: Flexibilidad; Kárate; Método de insistencia pasiva dinámica; método de contracción maximal; Split.

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RESUMO

A capacidade física de flexibilidade está relacionada com as possibilidades que um grupo articular e muscular possui em relação a uma gama de um determinado movimento motor. A capacidade é normalmente determinante em vários desportos e de importância vital no Karate. Portanto, o objectivo da investigação é comparar o método da insistência passiva dinâmica (Mipd) e o método da contração máxima (MCM), avaliando como afectam a flexibilidade da articulação coxofemoral no karateca, determinando qual o método mais eficaz para aumentar a flexibilidade no split frontal e lateral. Investigação experimental de corte correlacional, estudando 36 karatecas (14-15 anos, masculino) divididas em 18 disciplinas para cada grupo independente (experimental e controlo). Os sujeitos intervieram com um modelo de treino idêntico (cinco mesociclos), sendo a diferença que o grupo de controlo recebeu o Mipd e o grupo experimental o MCM. Para o grupo experimental, o teste de divisão lateral obteve finalmente um valor de □6,6 cm, e o grupo de controlo □2,72 cm. (+3,89 cm; p=0,002), enquanto que, para o grupo experimental no teste de divisão frontal, foi finalmente obtido um valor de □7,72 cm, e o grupo de controlo □1,06 cm (+6,66 cm; p=0,002). (+6,66 cm; p=0,000). O Mipd aumenta o nível de flexibilidade, mas o MCM é o ideal para um desenvolvimento óptimo da flexibilidade coxofemoral nos karatecas, obtendo melhor progresso na abertura das pernas em split frontal e lateral.

Palavras-chave: Flexibilidade; Karate; Método dinâmico de insistência passiva; Método de contração máxima; Split.

INTRODUCTION

Karate as a combat sport has a series of physical factors that are essential in the process of sports training direction; among them: the anaerobic alactic, lactic and aerobic anaerobic energy systems, (Le Roux, Coetzee, Schall, & Van Rensburg, 2016) conditional capacities such as flexibility, strength, speed and endurance, (Spigolon, et al., 2018) and coordinative capacities (orientation, rhythm, balance). Attending to this, flexibility in karate is a fundamental capacity, given the need to preserve or increase the range of motion of the joints, allowing greater elongation and stretching of the muscle, in addition to acting in muscle recovery after intense physical exertion, (Ayala, de Baranda, & Cejudo, 2012; Morales & González , 2015; Massidda, Miyamoto, Beckley, Kikuchi, & Fuku, 2019) influencing the execution of technical movements within the modalities of Kihon (basic movements), in Katas (Forms) and Kumite (Combat). To measure flexibility, there is no specific test in combat sports, and it can be measured statically, dynamically, actively or passively, depending on the work objective in a given sport (Frómeta, Barcia, Montes, Lavandero, & Valdés, 2017; Behm, 2019; Rojas, Natali, López Montalvo, Vallejo Rojas, & Chávez Cevallos, 2019). Flexibility as such is not a universal quality of the human body, this depends on each joint, having different degrees of flexibility depending on what type of flexibility is evaluated. (Marban & Rodríguez, 2009) The greater the flexibility of the lower body, the easier the kicking technique will be to execute from the biomechanical point of view and, (Valdés Cabrera, Quetglas González, Tabares Arévalos, & Ruíz Viladón, 2020; de Moraes Fernandes, Wichi, da Silva, Ladeira, & Ervilha, 2017) therefore, a more effective kick can be given.

Traditional methods for flexibility work include contents which objectives are related to warm-up as a fundamental part of training, currently known as Dynamic Passive Insistence method (Capote Lavandero, *et al.,* 2017). In the traditional warm-up method, stimuli are applied when the body is completely cold, including stimuli of flexibility and

joint mobility, that is, without having previously done a specific warm-up so that the joints and muscle groups are integrally prepared. In this sense, these methods, in addition to forcing the elongation of the muscle, try to reach the maximum opening angle in the joint, to then force the opening, increasing the flexibility in a forced manner; this causes the physiological response of the organism to result in a greater probability of injury to muscles and tendons, directly affecting the joint (Gleim & McHugh, 1997). (Gleim & McHugh, 1997) This effort can generate micro-tears by rapid contraction, produced by the forced elongation of the muscle, which can become, in certain cases, major tears (Ayala, de Baranda, & Cejudo, 2012).

Based on the above, the traditional methods, from the physiological point of view, are not the most appropriate because they cause muscle injuries, although it is a method prioritized in many sports; (Eras, *et al.,* 2020) while the maximal contraction method could be the ideal for flexibility work, achieving additional improvements by the physiological response that this method has in the body (Fox, Bowers, & Foss, 1998; Kapandji, 2010). This method produces a maximal contraction at the maximum opening angle of the joint, being the response of the organism to that contraction a relaxation of the antagonist muscle, but being at the maximum angle of the joint, that relaxation response translates into an increase of flexibility in the joint. This is a product of muscle elongation as a physiological response. (Fox, Bowers, & Foss, 1998). Additionally, the maximal contraction method has outlets in sciences such as physiotherapy, contributing in muscle relaxation when cramps occur. This method helps in the recovery of micro-tears and enhancing joint mobility in advanced ages (Kapandji, 2010; Mercedes, Álvarez, Guallichico, Chávez, & Romero, 2017).

Flexibility is a physical capacity marked by the age of the subject, being a significant factor to train it from early ages, (Ma & Qu, 2017). Training flexibility in Karate involves dividing the physical stimulus into general and specific preparation. Within the general one, flexibility should be applied in the most general joints that act in the integral movement, enhancing joint amplitude, muscle strength and injury prevention. Within the specific one, the specialized musculature is stimulated in each technical movement specific to the sport, overlapping the demands of the same (Marban & Rodriguez, 2009).

The coxofemoral joint within Karate is one of the most important for motor success, as it is continuously used with techniques that require a large angular opening of the legs (Kata and Kumite) (Molinaro, Taborri, Montecchiani, & Rossi, 2020; Nickytha, Fitri, & Sultoni, 2019). Therefore, many stimuli and work time are focused on such articulation to enhance it, among them the intensive application of stimuli based on flexibility stands out. Therefore, having an excellent flexibility, both in the frontal and lateral Split, allows improving the specific and general sports performance.

However, regardless of the advantages and limitations that usually have different models of sports training, not always the most appropriate training method is the one that allows to achieve maximum athletic performance, (Calero., 2019; Morales., 2018) so doubts arise about which of the two methods of flexibility training better enhances the physical capacity mentioned.

In this sense, the purpose of the present study is to compare the method of Dynamic Passive Insistence and the method of maximal contraction, assessing how they affect the flexibility of the coxofemoral joint in karate athletes, determining which method is more effective to increase flexibility in the frontal and lateral Split.

MATERIALS AND METHODS

A correlational experimental research was conducted at the Academia Formativa Fortaleza Karate Club, carried out at the headquarters (Chillogallo) and at the branch (Ciudadela Ibarra). All athletes were considered healthy, without any additional training regimen to the rest, they did not present previous pathologies or injuries that prevented the application of the study.

Thirty six athletes were studied in total (14-15 years old; Male), where 18 subjects train in the matrix of the Fortaleza Club (experimental group) and the other 18 athletes train in the branch of the same club (Control group); all athletes train the capacity of flexibility three times a week during five mesocycles, in addition to their respective competitions. The sports training models applied to both independent groups were identical, except for the physical stimuli related to the capacity of flexibility, where the control group was applied the method of Dynamic Passive Insistence (Mipd) and the experimental group, the method of Maximal Contraction (MCM).

The application of the Dynamic Passive Insistence method consisted of reaching the maximum extension angle of the coxofemoral joint and then forcing this maximum angle between 3 to 4°, maintaining this opening for ten seconds. Subsequently, the patient rested for 20 seconds to perform the same procedure again. For the control group, four series of five repetitions were performed.

The application of the maximal contraction method consisted of reaching the maximum extension angle of the coxofemoral joint, without forcing the increase of this angle. In order to accomplish this method, an external force (subject performing counter force to prevent flexion of the joint) must be used to prevent flexion of the joint so that at this point the subject performs a contraction. With this, it is intended to seek a maximal contraction of the muscle, with the intention of flexing the joint.

This contraction is performed for ten seconds; after this operation, a relaxation of the muscle is performed for ten seconds. For the experimental group, four sets of five repetitions were performed.

To check the results in both training methods, the following performance evaluation tests (test) are applied, checking the amplitude of the coxofemoral joint:

1. *Lateral split test:* it is performed using a reference point called zero point, where the right foot is placed and the lateral split is performed until the subject to be studied can separate his legs laterally. For the evaluation, there is a numerical scale in centimeters that goes from the zero point (which has zero centimeters as reference) and is measured up to the maximum opening point.

2. *Frontal split test*: it is performed using a reference point called zero point, in which the instep is placed together with the left knee to the floor. In this case, the toes are at the reference point and the frontal split is performed up to the point where the subject can open his legs frontally. For the evaluation, there is a numerical scale in centimeters that goes from the zero point (which has as reference zero centimeters) and is measured up to the maximum point of opening.

For the present research, only the final data collected at the end of the fifth training mesocycle will be shown, evidencing the amplitude (A) or increase in centimeters with respect to the first test applied in the first mesocycle. For the evaluation of the functional tests, the following instruments were used:

1. Measuring tape.
2. Tape for marking points.
3. Lenovo I7 computer.
4. Statistical processing software (Microsoft Office 2016, SPSS v25).

When applying the Shapiro-Wilk Test on the data obtained with the Lateral Split test, a normal distribution of the data is evidenced, applying the t-test for independent samples ($p \leq 0.05$), while the Shapiro-Wilk test evidenced the non-existence of a normal distribution of the data in the Frontal Split test, applying the non-parametric Mann-Whitney U test ($p \leq 0.05$).

RESULTS

Table 1 shows the results obtained by the karateka belonging to the two independent groups (Table 1).

Table 1. - Results in the flexibility tests in both independent groups

No	Edad	Grupo Experimental		Grupo Control	
		A: Split Lateral	*A: Split Frontal*	*A: Split Lateral*	*A: Split Frontal*
1	*14*	11	5	*8*	*0*
2	*14*	9	3	*7*	3
3	*14*	7	4	*3*	8
4	*14*	8	3	*4*	1
5	*14*	7	8	*-1*	-1
6	*14*	4	4	*7*	1
7	*14*	4	2	*5*	3
8	*14*	7	4	*6*	0
9	*14*	14	59	*-1*	2
10	*14*	9	3	*3*	-2
11	*15*	7	0	*4*	0
12	*15*	4	11	*4*	-2
13	*15*	4	8	*-2*	0
14	*15*	11	9	*-1*	3
15	*15*	0	5	*1*	-5
16	*15*	5	5	*3*	6
17	*15*	8	0	*-2*	0
18	*15*	0	6	*1*	2
□	14,44	6,61	7,72	2,72	1,06
M_e	14	7	4,5	3	0,5

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The mean or average improvement in the lateral split (experimental group) was □6,61 cm, while in the control group it reached □2.72 cm. (+3.89 cm.), the differences evidenced in the means, in both independent groups, denote a difference in favor of the maximal contraction method (experimental group), being significantly different (p=0.002).

In the case of the data obtained with the frontal split test, the mean obtained in the experimental group was □7.72 cm. and in the control group □1.06 cm. (+6.66 cm.). As in the previous test, the experimental group where the maximal contraction method was applied obtained a better average range (24.50) than the control group (12.50), evidenced by the Mann-Whitney U test, which is significantly different (p=0.000).

Visually, Figures 1 and 2 show the trend lines in both independent groups, with the Experimental Group having the greatest increase in flexibility in the frontal (Figure 1) and lateral (Figure 2) splits compared to the control group.

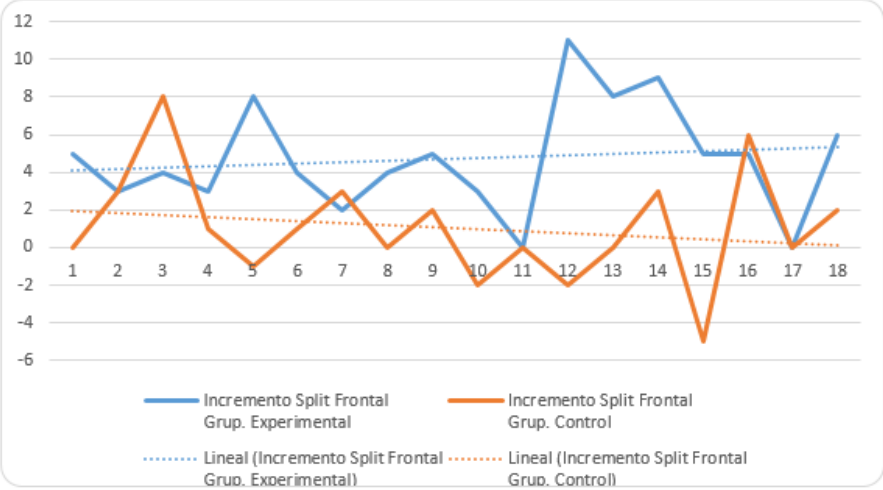

Fig. 1. - Graphical comparison of the frontal split in both independent groups

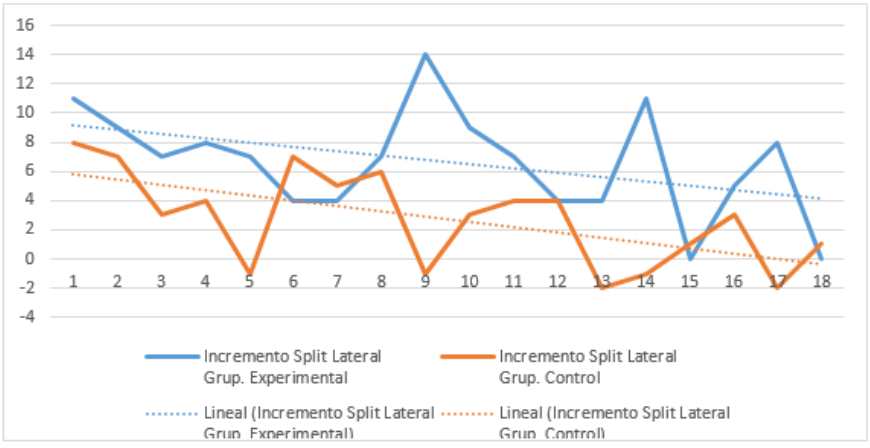

Fig. 2. - Graphical comparison of the lateral split in both independent groups

DISCUSSION

For the present research, primarily it was detected that in the dynamic passive insistence method some athletes increased their flexibility and in other cases, some athletes decreased their flexibility, given that, when performing pressure and forcing the joints and muscles involved in the frontal and lateral split; these tend to contract due to the stress or pressure they are subjected to by the sports instructor or by the other teammate who actively supports the stretching. The contraction of the muscles reaches such a point that prevents a better development of flexibility, in addition, with this method, it can damage and expose athletes to sports injuries (Gleim & McHugh, 1997; Bernal, 2009).

As for the maximal contraction method (MCM), better results were obtained in the two splits since, without exception, all the athletes increased their amplitude in the frontal and lateral split and, therefore, flexibility improved significantly, obtaining an outstanding case that increased its amplitude by 14 cm. in relation to the preliminary measurements. In the application of the MCM method, the decrease in flexibility is not detected as in previous studies; this happens because the method consists of having the opening to the maximum angle of the legs, without forcing the increase of that angle; an external force must be used to avoid flexion of the joint and as an effect, muscle relaxation is obtained, which improves flexibility to a greater extent (Fox, Bowers, & Foss, 1998).

While it is true that the increase in flexibility also depends on age and gender, (Gallego, Sanchez, Vacas, & Zagalaz, 2016); then, flexibility in athletes will have a faster development the younger they are and slower with increasing age. Regarding this last idea, it would be useful to apply the present research in other age ranges to establish the pertinent comparisons, demonstrating whether there are significant variations, depending on the gender and age of the subject.

On the other hand, there are cases in which athletes with younger age have a maximum level of flexibility, because they have a complete opening of the legs; in these cases, using the method of maximal contraction, they only maintain their muscular elasticity in a general sense, which allows them to maintain optimal conditions for the correct performance of the positions and technical gestures of Karate-Do.

CONCLUSSIONS

In conclusion, it is stated that, although the dynamic passive insistence method increases the level of flexibility, it was determined that the maximal contraction method is the ideal one for an optimal development of coxofemoral flexibility in Karatekas, obtaining better progress in the opening of the legs in frontal and lateral split.

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Conflict of interests:
The authors declare not to have any interest conflicts.

Authors' contribution:
Edgar Jariff Oña Tacan: Project management, drafting, statistics, interpretation of results, implementation of the proposal, corresponding author.

Daniel Nicolás Chamorro Werz: Drafting, statistics, interpretation of the results, implementation of the proposal, background search.

Enrique Chávez Cevallos: Methodological advice.