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Translated from the original in spanish

Original article

Proprioceptive kinesiotherapy in the recovery of strength in diabetic patients with *adhesive capsulitis*

Kinesioterapia propioceptiva en la recuperación de la fuerza, en pacientes diabéticos con *capsulitis adhesiva*

Kinesioterapia proprioceptiva na recuperação da força em pacientes diabéticos com *capsulite adesiva*

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ABSTRACT

The shoulder is considered the most mobile and unstable joint of the human body. *Adhesive capsulitis* is a common pathology in the shoulder, with unknown cause, variable course, and controversial treatment, often associated with diabetes mellitus. The rehabilitation of the same traditionally has corresponded to weight-bearing exercises and pendulum movements. Proprioceptive kinesiotherapy is a fundamental pillar during the rehabilitation of this pathology. The objective of this research is to demonstrate the influence of physical proprioceptive exercises in pain relief and muscle strength recovery in patients with *adhesive capsulitis*. An experimental study of explanatory cut, longitudinal, qualitative-quantitative with control group, in a population of 30 patients who received rehabilitative treatment of shoulder, in the Institute of Sports Medicine of Havana, Cuba, during three consecutive months, in the period between January and December 2017 was carried out. Both groups underwent clinical evaluation, clinical history and application of the Constant Scale before and after treatment. Patients in the Experimental Group performed a proprioceptive exercise system and patients in the Control Group performed pendulum exercises. Pain relief was achieved during the first month of treatment in the experimental group, since it presented better results in the recovery of muscle strength than the Control Group between the second and third month of treatment (p=1.000). In conclusion, proprioceptive exercises allow, in a short time, to relieve shoulder pain, as well as to recover muscle strength in patients with adhesive capsulitis.

Keywords: Adhesive capsulitis; Kinesiotherapy; Proprioception; Muscle strength.

RESUMEN

El hombro se considera la articulación más móvil e inestable del cuerpo humano. La *capsulitis adhesiva* es una patología frecuente en el hombro, es de causa desconocida, curso variable, y de tratamiento controversial, frecuentemente asociada a diabetes mellitus. La rehabilitación de la misma, tradicionalmente ha correspondido a ejercicios con peso y movimientos pendulares. La kinesioterapia propioceptiva es pilar fundamental durante la rehabilitación de esta patología. El objetivo de la investigación es demostrar la influencia de los ejercicios físico-propioceptivos en el alivio del dolor y la recuperación de la fuerza muscular, en pacientes con *capsulitis adhesiva*. Se realizó un estudio experimental de corte explicativo, longitudinal, cualitativo-cuantitativo con grupo control, en una población de 30 pacientes que recibieron tratamiento rehabilitador de hombro, en el Instituto de Medicina Deportiva de La Habana, Cuba, durante tres meses consecutivos, en el período comprendido entre enero y diciembre de 2017. A ambos grupos, se les realizó evaluación clínica, historia clínica y aplicación de la Escala de Constant antes y después del tratamiento. Los pacientes del Grupo Experimental realizaron un sistema de ejercicios propioceptivos y los pacientes del Grupo Control realizaron ejercicios pendulares. El alivio del dolor se alcanzó durante el primer mes de tratamiento en el grupo experimental, pues presentó mejores resultados en la recuperación de la fuerza muscular que el Grupo Control entre el segundo y tercer mes de tratamiento (p=1,000). En conclusión, los ejercicios propioceptivos permiten, en poco

tiempo, aliviar el dolor de hombro, así como recuperar la fuerza muscular en pacientes con capsulitis adhesiva.

Palabras clave: Capsulitis adhesiva; Kinesioterapia; Propiocepción; Fuerza muscular.

RESUMO

O ombro é considerado a articulação mais móvel e instável do corpo humano. A capsulite adesiva é uma patologia comum do ombro, de causa desconhecida, curso variável e tratamento controverso, frequentemente associada ao diabetes mellitus. A reabilitação tem envolvido tradicionalmente exercícios de peso e movimentos pendulares. A Kinesioterapia proprioceptiva é um pilar fundamental durante a reabilitação desta patologia. O objetivo da pesquisa é demonstrar a influência dos exercícios físicos-proprioceptivos no alívio da dor e na recuperação da força muscular em pacientes com capsulite adesiva. Foi realizado um estudo experimental explicativo, longitudinal, qualitativo-quantitativo com um grupo de controle em uma população de 30 pacientes que receberam tratamento de reabilitação do ombro no Instituto de Medicina Esportiva em Havana, Cuba, durante três meses consecutivos, no período de janeiro a dezembro de 2017. Ambos os grupos foram submetidos a avaliação clínica, histórico clínico e aplicação da Escala Constante antes e depois do tratamento. Os pacientes do Grupo Experimental realizaram um sistema de exercícios proprioceptivos e os pacientes do Grupo de Controle realizaram exercícios de pêndulo. O alívio da dor foi alcançado durante o primeiro mês de tratamento no Grupo Experimental, que mostrou melhores resultados na recuperação da força muscular do que no Grupo de Controle entre o segundo e terceiro mês de tratamento (p=1.000). Em conclusão, os exercícios proprioceptivos permitem, em pouco tempo, aliviar a dor no ombro, assim como recuperar a força muscular em pacientes com capsulite adesiva.

Palavras-chave: Capsulite adesiva; Kinesioterapia; Propriocepção; Força muscular.

INTRODUCTION

The shoulder is considered the most mobile joint of the human body, but also the most unstable. It has three degrees of freedom and allows the upper limb to orientate in relation to the three planes of space in disposition to the three axes (Noa Pelier & Vila Gracía, 2019).

In Cuba, shoulder pain is a recurrent reason for consultation in Primary Health Care. It occupies third place in musculoskeletal disease in clinical practice, with about 5 % of general medicine consultations for diseases of the osteomyoarticular system. It causes functional limitation of the affected limb that affects the activities of daily living, affects the patient's quality of life and generates disabilities with the consequent economic impact on the personal, occupational and social spheres (Martín-Piñero, Batista-Herrera, Águedo-Santiesteban, Osorio-Hernández, & Triana-Guerra, 2014; Noa-Pelier & Vila-García, 2019). Among the most common shoulder conditions is frozen shoulder, also known as *adhesive capsulitis*. *Adhesive capsulitis* (AC) is pathology of unknown cause, variable course, unpredictable and controversial treatment.

"It is defined as the progressive loss of passive mobility of the shoulder and is accompanied by diffuse pain that predominates in the anterolateral region of the shoulder" (Serrano-Ardila & Abush-Torton, 2017).

This condition has a frequency of 7 to 20 % among the adult population. Its incidence in the general population ranges from 2 to 5 %, it is more common in women aged 40 to 60 years (Sandoval, Saavedra & Lona, 2016).

AC is frequently associated with Diabetes Mellitus. A meta-analysis was performed in which they stated that diabetics were five times more likely to develop adhesive capsulitis of the shoulder than the general population (HaniZreik *et al.,* 2016) and up to 20 % of patients presenting with this process are diabetics (Manske & Prohaska, 2008).

The treatment indicated for this pathology will depend on how advanced the disease is and it must be individualized. One of the mainstays of treatment is physical therapy with progressive range-of-motion exercises and passive stretching. The most traditional option is weight-bearing exercises and pendulum movements (Castro, Sanchez, Galvez, & Ortiz, 2020).

Kinesiotherapy was used by physicians as a curative means for centuries, particularly for therapeutic purposes, in conditions such as the sequelae of diseases of the locomotor system and until today its effectiveness is recognized. It is, without a doubt, the part of physiotherapy that occupies the most work time of professionals who materialize rehabilitation techniques (Arce-Morera, Hernández-Escalada, & Armas-Montesino, 2016; Paul, Rajkumar, Peter, & Lambert, 2014).

Proprioception is one of the elements to be considered during the physical rehabilitation process in CA, this is the sense that informs the body of the position of body structures, regulated by the direction and joint range of motion in space, which allows automatic reflex reactions and responses to achieve stability and correct joint functionability (Çelik & Kaya-Mutlu, 2016; Uppal, Evans, & Smith, 2015).

Multiple studies have shown the efficacy of the application of "proprioceptive training" in decreasing injury recurrence, pain relief, gaining joint function and preventing injuries in athletes (Çelik & Kaya-Mutlu, 2016).

Proprioceptive kinesiotherapy is designed to integrate work on postural control, balance, stability, sensory interaction, among others (Abd El-Kader & Al-Jiffri, 2016; Lee, Kim, & Jeon, 2016; Noa-Pelier & Vila-García, 2019).

In the outpatient clinic of Health Promotion, in the Institute of Sports Medicine of Havana, Cuba, there is a high incidence and prevalence of patients with adhesive capsulitis, which referred as personal pathological antecedent (APP) Diabetes Mellitus and the lack of knowledge by specialists on the application of proprioceptive physical exercises as a physical rehabilitation alternative to this type of injury makes unavoidable the need to study the current problem.

The aim of the present research is to demonstrate the influence of the system of physical-propioceptive exercises on pain relief and recovery of muscle strength in diabetic patients with adhesive capsulitis.

MATERIALS AND METHODS

Type of study: experimental, explanatory, longitudinal, qualitative-quantitative with a control group.

Population and sample

From a population of 73 patients with a diagnosis of adhesive capsulitis, 30 diabetic patients who received shoulder rehabilitative treatment, at the Institute of Sports Medicine in Havana, Cuba, were selected for three consecutive months, in the period from January 2017 to December 2017.

Inclusion criteria

- Diabetic patients of both sexes, with diagnosis of adhesive capsulitis, evaluated and diagnosed, clinically and ultrasonographically in the outpatient clinic at the Institute of Sports Medicine in Havana, Cuba.
- Approval of patients to participate in research.

Exclusion criteria

- Other diseases that cause shoulder pain such as: oncoproliferative processes, neurological lesions of the brachial plexus, cervicobrachialgia, cervical first rib syndrome, suprascapular nerve syndrome, long thoracic nerve palsy, coronary heart disease, biliary diseases, diseases of the pulmonary vertex (Pancoast tumor), DSR or shoulder-hand syndrome, polymyalgia rheumatica, muscle diseases: polymyositis and dystrophies, hemophilia, fibromyalgia, polyarthritis, osteoarthritis.
- Non-cooperation of the patients, due to behavioural, psychological or other disorders, which makes it impossible to collect data in the clinical history.

Control group

It was formed by 15 patients with APP of Diabetes Mellitus of different age groups, who went for consultation at the Institute of Sports Medicine in Havana, Cuba, with diagnosis of adhesive capsulitis, to whom the conventional treatment was applied (pendular physical exercises).

Experimental group

It consisted of 15 patients with APP of Diabetes Mellitus of different age groups, who attended the outpatient clinic of Health Promotion at the Institute of Sports Medicine in Havana, Cuba, with a diagnosis of adhesive capsulitis, to whom the proposed battery of physical exercises (System of physical-propioceptive exercises) was applied.

The methodology followed for this research consisted of all diabetic patients who attended the outpatient clinic for health promotion at the Institute of Sports Medicine in Havana, Cuba, with a diagnosis of adhesive capsulitis in the study period from January 2017 to December 2017, who met the inclusion criteria, were given informed consent. Subsequently, the initial clinical evaluation was performed, which consisted of the clinical history by specialized personnel in Sports Medicine and by the author, who collected the clinical and socio-demographic aspects, physical examination with specific exploration maneuvers for the entity under study.

Then, the Constant Scale was applied to both groups of patients and the proprioceptive exercise system was applied to the patients in the Experimental Group, and the pendulum exercises were applied to the patients in the Control Group for three months. Finally, they were re-evaluated with the Constant Scale.

Ethical considerations

The research is based on the principles of ethics, safeguarding the right of subjects to protect their integrity, registered in the Helsinki Declaration of 1964 and amended by the World Assemblies of Hong Kong in 1983; Edinburgh 2000; Tokyo 2004; Seoul 2008 and Fortaleza, Brazil, 2013, which were taken into account during the development of the same.

The study has a scientific purpose, with no environmental impact and no foreseeable risks. The information obtained will not be used for purposes outside the framework of the research. Information that could physically or emotionally harm the people studied will not be published. The confidentiality of the patients' personal data will be maintained.

Statistical method

Descriptive measures were used for the study variables. A one-factor repeated measures analysis of variance (Anova) was performed to contrast the effect of the variables power and global result in the different moments of measurement.

The Games-Howell *pot-hoc* test was performed (not assuming equal variances, being the homoscedasticity p=0.001 for the Experimental Group and p=0.002 for the Control Group) since there is no homogeneity of variance in the Power variable and the Bonferroni *pot-hoc* test (assuming equal variances, being the homoscedasticity p=0.513 for the Experimental Group and p=0.113 for the Control Group) since there is homogeneity of variance in the global result variable (Table 1).

Table 1. - Homogeneity of variance test for the study variables power and global result

Group	Variables	Levene's statistic	Sig.
Experimental	Power	6,556	0.001
	Overall result	,774	0.513
Control	Power	5,774	0.002
	Overall result	2,080	0.113

Source: Medical history.
Significance level * (p≤0.05).

It is understood for the results of table 1 how there is no homogeneity of variance in the variable power (p=0.001) in the EG and (p=0.002) in the CG, not happening this way in the variable global result (p=0.513) in the EG and (p=0.113) in the CG that does present homogeneity of variance.

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RESULTS

In the sample studied, there was a predominance of patients aged between 50 and 65 years, with the highest incidence of eight patients in the EG and nine in the CG.

Table 2 shows the characterization of the diabetic patients who were part of the research, according to age, time of evolution for both research groups. It can be seen how there is a predominance of 50 to 65 years of age with the highest incidence of patients with 8 GE and 9 GC. All patients presented an evolution time of three to nine months, being in the Freezing Phase (Table 2).

Table 2. - Characterization of Patients with Adhesive Capsulitis

Patients	**Experimental Group GE**		**Control Group GC**	
Age	**40 a 49**	**50 a 65**	**40 a 49**	**50 a 65**
	7	8	6	9
Time of evolution before infiltration	3 a 9 meses (Fase Congelación)			

Source: Medical History.

Figure 1 shows the evolution of the perception of pain during the different moments of measurement, an absolute improvement in pain relief is observed in the EG with respect to the CG. Both treatments were effective, but we can say that the treatment (proprioceptive exercises) relieved the pain faster than the conventional treatment; the difference is found in the point reached at month GE five points (medium pain) GC 0 points (severe pain) (Figure 1).

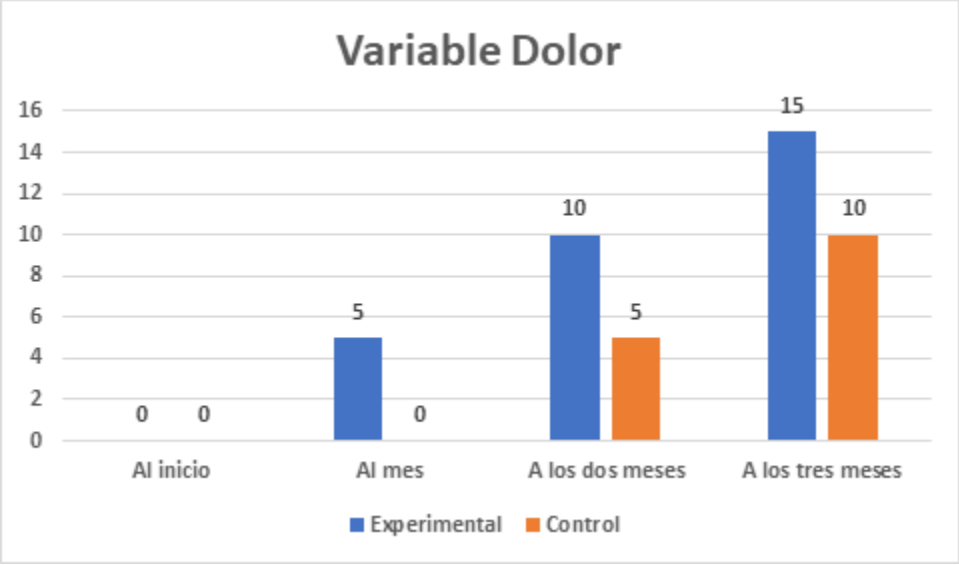

Fig. 1. - Pain variable
Source: Medical History.

Table 3 shows the Descriptive Measures and Pot-Hoc Games-Howell Test for the variable Power (muscular strength) in both evaluated groups. There is evidence of decreased power capacity in the GE and GC in the initial evaluation (p=1.000) not significant, which affirms unfavorable disabling condition in muscle development and strength for the shoulder joint. The group had a marked increase in subsequent measurements, which shows a tendency to a faster joint functionality. The homogeneity in the results tends to improve as treatment time elapses, as reflected by the coefficient of variation. The GE presented better results in power than the CG between the second and third month of treatment (p=1.000). Both groups at the end achieved very significant results in the development of muscle strength, which favored lifting heavier weights (Table 3).

Table 3. - Descriptive measures and Pot-Hoc Games-Howell test. Variable Power

Momento	Media	Desviación típica	Coeficiente de variación	Valor mínimo	Valor máximo	Prueba Games-Howell (p=0.05)
Grupo Experimental						
Inicial	1,60	0,502	31,4	1,10	2,74	1.000
Al mes	12,50	2,702	21,6	6,69	18,69	0.000
A los dos meses	18,08	2,461	13,6	13,36	21,32	0.000
A los tres meses	22,07	2,535	11,4	18,16	24,98	0.000
Grupo Control						
Inicial	1,00	0,423	42,3	0,33	1,58	1.000
Al mes	12,50	2,702	21,6	6,69	18,69	0.000
A los dos meses	15,75	3,077	19,5	10,36	20,32	0.000
A los tres meses	20,18	2,530	12,5	17,17	24,23	0.000

Source: Medical history.

Table 4 shows the Descriptive Measures and Pot-Hoc Bonferroni Test for the overall outcome variable; where in both groups there were considerable improvements. In the groups, a marked increase in the points achieved is observed, which shows a tendency towards a faster functional independence for the shoulder joint. In both groups, the homogeneity in the results tends to improve as the treatment time elapses, as reflected by the coefficient of variation. The GE presented better results than the GC in all the moments of measurement (p=1.000) and (p=0.000). At the end, both groups achieved very significant results in the development of muscle strength, which favored joint functionality that allowed them to be ready to perform the different activities of daily life (Table 4).

Table 4. - Descriptive measures and Pot-Hoc Bonferroni test. Overall outcome variable

Momento	Media	Desviación típica	Coeficiente de variación	Valor mínimo	Valor máximo	Prueba Bonferroni (p=0.05)
Grupo Experimental						
Inicial	27,47	6,664	24.2	18	41	1.000
Al mes	54,47	9,273	17.0	40	66	0.000
A los dos meses	76,67	8,217	10.7	59	88	0.000
A los tres meses	84,53	7,405	8.7	68	95	0.000
Grupo Control						
Inicial	23,67	7,432	31.3	10	38	1.000

Al mes	50,67	9,656	19.0	33	66	0.000
A los dos meses	68,80	7,203	10.4	55	78	0.000
A los tres meses	79,60	5,435	6.8	68	87	0.000

Source: Medical history.

DISCUSSION

According to the literature, adhesive capsulitis occurs in 5.3 % of the population (Le, Lee, Nazarian, & Rodriguez, 2017). Although there are no data from the Cuban population for the development of the research, 43 % of the total population with adhesive capsulitis who attended the service of the Institute of Sports Medicine of Havana in a period of three months was selected. In this study, all patients presented ages between 40 and 65 years, predominantly the age group of 50 to 65 years; these values correspond to what was observed by Lamplot and Colbs in which they relate an incidence of ages between a range of 40 to 65 years of age (Lamplot, Lillegraven, & Brophy, 2018).

As it is raised by some authors, there is a predominance of female gender of capsulitis, in 70 % cases (Le *et al.,* 2017) and in the non-dominant limb, it is manifested between 40 and 50 % of cases bilaterally (Le *et al.,* 2017). However, in our investigation, there were no differences between sex or shoulder of the dominant upper limb and no patient had bilateral involvement.

The evolution times are variable in the literature. In stage 1 or pre-adhesive, patients complain of shoulder pain, predominantly at night; in arthroscopy there is evidence of synovitis without adhesions or contractures. In stage two, also called proliferative or freezing, which occurs between 10 and 36 weeks, patients begin to develop stiffness, in arthroscopy synovitis is observed again with loss of axillary recess, suggestive of early formation of adhesions and capsular contracture. Stage three maturation or stiffness which manifests from four to 12 months is characterized by a profound global loss of arches of motion and pain at the extremities (Chi, Kim, Long, Morrison, & Zoga, 2017; Yip *et al.,* 2018).

This second phase (freezing phase) is characterized by stiffness and limited mobility. Subjects complain of restriction in performing activities of daily living; although pain is present, it is of lesser intensity. On physical examination, limitation in abduction and rotations is evident, there is muscle atrophy due to disuse. This phase has an average duration between four and twelve months (Serrano-Ardila & Abush-Torton, 2017).

Considering the time of evolution, all patients in the present investigation were in the freezing phase, with evolution of AC from three months to nine months (36 weeks). Pain, stiffness and decreased muscle strength were predominant in the clinical picture of the patients. This symptomatology coincided with that reported in the international literature.

Conservative treatment aims to restore movement, decrease pain and the duration of symptoms. There is evidence that physical therapy through early mobilization offers good results, as well as stretching or muscle strengthening programs (Le *et al.,* 2017; Santa-María-Gasca, Aguirre-Rodríguez, Valdés-Montor, Mejía-Terrazas, & Valero-

González, 2020). Joint stiffness should be treated with stretching exercises. Home exercise programs are as effective as physiotherapist-led rehabilitation protocols. In any case, physiotherapy programs should be applied in a gentle, tolerable and non-painful manner (Itoi *et al.,* 2016). Generally, all the techniques used (mobilizations, deep massage, therapeutic exercises and even placebo) produce pain reduction. However, no study has shown statistically significant differences between groups of treatments compared. It is recommended to start strengthening exercises as soon as pain and active shoulder movements allow (Serrano-Ardila & Abush-Torton, 2017).

A non-randomized clinical test (Hotta, Santos, McQuade, & de Oliveira, 2018), compared neuromuscular training and strengthening of the periscapular musculature for eight weeks with an untreated control group. Muscle strength increased in, middle trapezius, lower trapezius and serratus in the treated group. Functionality improved only in the intervention group ($p<0.01$). The treated group decreased 3.7 points ($p<0.01$).

In the present investigation, the muscle strength of all the muscle groups of the shoulder girdle improved in both groups of patients. The GE presented better results in the increase of muscle strength than the CG, between the second and third month of treatment ($p=1.000$). It also improved the global result of the patients in the Experimental Group, according to the Constant Scale score, increasing active joint mobility and functional independence for the affected shoulder joint.

CONCLUSIONS

Proprioceptive kinesiotherapy is an important tool to achieve the recovery of strength in patients with adhesive capsulitis, from the second month of rehabilitation treatment. Proprioceptive exercises allow pain relief during the first month of treatment, achieving total resolution of pain after three months in patients with this diagnosis.

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Bárbara Yumila Noa Pelier: Conception of the idea, literature search and review, compilation of information resulting from the instruments applied, drafting of the original (first version), authorship coordinator.

José Manuel Vila García: statistic análisis, preparation of tables, graphs, and images.

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