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Research Article

Effects of a Warm-Up Protocol on the General Motor Patterns of Young Tennis Paddle Players

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Abstract

Different authors express the importance of an adequate motor learning in the stages of sports initiation, for this it is necessary to develop adequately the general motor patterns.

Objective: to evaluate the 6-week effect of a warm-up protocol aimed at mobility and stability in a group of young paddle tennis players. The sample consists of 10 children, divided into two groups: Experimental Group (EG) (n=5) and Control Group (CG) (n=5). An initial assessment of the basic functionality was performed by means of a test; Overhead Squat Test (OHST), Hurdle Step Test (HST), Forward Step Down (FSD), Shoulder Mobility Test (SMT), Active Straight Leg Raise (ASLR) and the "L" drill test. A warm-up protocol was then developed for the EG for 6 weeks, two weekly sessions based on mobility and stability. The EG showed significant improvements (p <.05) in the execution of general motor patterns with a significant decrease in the number of compensations (p <.05) and also significantly reduced the time in the "L" probe test (p <.05). It appears that a movement and stability oriented warm-up may improve overall motor patterns in young athletes. However, it is recommended that more studies be conducted in this line to conclude with greater effect.

Keywords: Stability; Mobility; Paddle; Children

Introduction

The development of Fundamental Motor Skills (FMS) should be considered a priority in sports programs [1], as FMS are considered essential building blocks for both the development of movement activities and the specialization of Specific Motor Skills (SMS) [2,3]. In sports initiation programs, coaches are aware of the importance of developing appropriate FMS, because if young athletes begin to develop efficient movement patterns they will be better prepared for more advanced training and skill mastery [4]. On the other hand, if they do not develop the right motor patterns, FMS and progressions in sports specialization, the worst result will be the injury [5]. To prevent this from happening, long-term athletic development experts recommend the work of the basic fundamentals of movement (mobility and stability), correct execution of general motor patterns [6-9], as well as using qualitative and quantitative evaluation techniques on the development of individual FMS [10]. General Motor Patterns (GMP) are the basis of human movement [11]. In other words, FMS are for the development of complex skills and are acquired during infancy in an innate way, as a result of the interaction of human beings and their environment. In addition, they can be modified and disturbed due to interaction with the environment and the proposed task [2].

Therefore, different authors reaffirm that the most important thing in early childhood is learning to move well [9,12] (i.e., the importance of children being skilled in basic movements). For this, it is necessary to work on the quality of movement. This concept consists of developing the coordination and functional movements necessary to lead an adequate life [13]. Starting from this statement and following different theories of the athlete's long-term development [1,14] within the functional movement, in the stage of sport initiation recommend the progressive improvement of mobility and stability with the objective that young athletes can develop properly in later stages [15]. Lack of these components at an early age can lead to increased risk of injury in adults [8] and tissues can be excessively burdened with an increased risk of injury [16].

Paddle tennis is among the sports that are being practiced exponentially by young people. It is one of the most popular racket sports, with more than 4 million players in the world [17-19]. In addition, it is a sport that implements (where it has been shown in high level players) the most numerous attacking strokes, highlighting the service, the volley of right and backhand, and the auction [20]. In fact, participation in racquet sports can reduce reaction time [21].

The importance of the technical actions that are instilled from an early age leads to sessions in stages of formation that are very much aimed at the continuous repetition of actions, which can affect the development of FMS and that in the long run can lead to musculoskeletal injuries [22] given the lack of symmetry and the promotion of unilateralism [23]. However, there are no studies that contemplate the development of the paddle tennis players, from the base of optimal GMP and FMS, to establish adequate SMS. While there are proposals for other modalities, such as that of Mackey coach [24] for rugby teams that say without good body posture there is no quality of movement; no movement quality dissipates energy; without energy, there is no speed or strength (which conditions the technical gesture).

As for GMP, no studies have been found that analyse the effect of interventions focusing on young paddle players. Therefore, the

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objective of this study was to analyze the effects of a warm-up protocol aimed at developing mobility and stability for 6 weeks in adolescent paddle players on their GMP. The hypothesis underlying the present work is that the working group developing the warm-up protocol will improve their motor skills and speed of movement.

Materials and Methods

Experimental design

An experimental design was carried out, where the independent variable was the training program based on quality of movement; and the dependent variables were the level of their motor skills and speed of travel in the change of direction test. The intervention program was only carried out by the Experimental Group (EG), which consisted of developing a warm-up focused on mobility and stability of the athlete. The Control Group (CG) simply warmed up through running and games.

Subjects

The sample consisted of 10 young paddle tennis players (8 boys and 2 girls), which were divided into 2 groups of 5 intentional players (according to the schedule of sessions). The CG (n=5) consisted of 4 boys and 1 girl (10±1.41 years; 1.62±0.89 years of practice; 1.47±0.05 m; 37.61 ± 4.03 kg), and the EG (n=5) consisted of 4 boys and 1 girl (11.60±1.51 years; 2.43±0.89 years of practice; 1.58±0.13 m; 45.22±7.15 kg) The inclusion criteria were no injury in the last year, paddle tennis practice for more than 1 year, and 2 paddle tennis sessions per week. Exclusion criteria included injury in the last year or during the intervention phase and missing sessions during the 8 weeks of the study.

Subjects and their parents were reunited one week prior to the study to be informed. All of them participated voluntarily and their parents signed the informed consent, which was reviewed and approved by the ethics committee of the local institution.

Instrumentation

A scale, model PS1023 (Italy), was used for determination of body weight, and a wall height meter, Adults Soehnle (Germany), was used measurement of height. For the functional assessment, a GoPro Hero Session video camera (San Mateo, California) and an aerobic step 10 cm high was used. For the travel speed test ("L drill test"), cones and a stopwatch were used.

The intervention program

The intervention program for the EG lasted 6 weeks, with two sessions per week. They worked on mobility and stability-oriented warm-up of 15 minutes (30 minutes per week), which consisted of 4 phases:

Self-Myofascial Release (SMR) with one paddle ball per person, massaging the soles of the feet, inner rotating hip muscles, passing the ball in an ascending direction, outer rotating hip muscles, and in descending direction. The execution time is 30 seconds to 1 minute per body area.

Dynamic mobility, which was centered on the ankle, hip, thorax and shoulders.

Activation of the deep and superficial musculature of the trunk, gluteal musculature, and humeroscapular musculature; like, for example: glute bridge, dynamics dead bug and alphabet row exercises.

Neural activation through rapid response exercises

The numbers of series and repetitions to be carried out in the first week were one series of 6 repetitions. During the rest of the weeks, one series of 8 repetitions of each exercise was done. On the other hand, the CG warmed up during those 6 weeks for 15 minutes with a running in different directions and games with the ball and the shovel. The rest of the session 45 min, both the EG and CG carried out the same paddle training sessions (i.e., right kick, backhand, volleys, back wall, side wall, and backhand). The program was supervised by two certified coaches (Sports Science) with over 5 years of experience.

Data collection

Data were collected at two points in time: one week before 6 weeks of intervention and the following week after 6 weeks of intervention. Both groups performed the same procedure. All tests took place inside a paddle tennis court in the sports center where the intervention was carried out. The tests that make up the functional evaluation were carried out in accordance with the test proposal for a basic functional evaluation [25], with the objective of observing the quality of execution in different fundamental motor patterns. In this order: Overhead Squat Test (OHST), Hurdle Step Test (HST), Forward Step Down (FSD), Shoulder Mobility Test (SMT), and Active Straight Leg Raise (ASLR). The evaluator's indications for the OHST realization were: separate your feet (bare feet) to shoulder width; raise your arms upwards, as if you want to touch the ceiling; when I say "ready, set, go", slowly lower your butt to the floor. The evaluator's indications for the HST were: go up one step (10-20 cm) and join the bare feet; cross your arms over your chest; when I say "ready, set, go", raise the right knee as much as you can without falling and keep it up until I tell you. The evaluator's indications for the FSD were: go up one step (10-20 cm) and join the bare feet together; cross your arms over your chest; when I say "ready, set, go", wear your right heel as much as you can do down and forward without falling. For the SMT, the indications were: separate your arms and place your big toe inside the others; when I say "ready, set, go", put your right arm over your head and your left arm underneath until both wrists meet in your back. And the indications for the ASLR were: lie on your back with legs outstretched, when I say "ready, set, go", raise your right leg fully extended as much as you can. Of all the tests, 3 repetitions were made and video recorded from the frontal, sagittal and transverse planes. Afterwards, the videos were reviewed to extract the data. The points for correct execution and points for the number of compensations made from each test was extracted, following the study of Nessler [26]. The observation criteria for each test can be seen below.

OHST: eversion or inversion of the ankle, internal or external rotation of the foot, varosity or valgosity of th knee, pelvic rotation or tilt, asymmetric load distribution, loss of pelvic lumbar dissociation, lumbar hyperlordosis, dorsal kyphosis, and fall of the arms in front.

HST and FSD: eversion or inversion of the ankle, internal or external rotation of the support foot, valgus or varus of the knee support, internal or external rotation of the hip in the air, pelvic rotation or inclination, movement of the thorax, loss of lumbopelvic dissociation, excess lumbar lordosis and dorsal kyphosis.

SMT: winged shoulder blades, excess lordosis and cervical rectification.

ASLR: external or internal rotation of the immobile foot, knee flexion of the hip in flexion, loss of pelvic lumbar dissociation, lumbar flexion, extension or flexion of the thorax and cervical flexion or extension.

In this way, weak points or compensations of movement have been detected as great predictors of future injuries [16]. For this purpose, the % Global Injury Risk (GIR) was calculated based on the total compensation number (sum of the compensations for each test) Following the proposal of Hernández-García, et al., [25]:

% GIR = (nº compensations OHS + nº compensations HST + nº compensations FSD + nº compensations SMT + nº compensations ASLR) × 100 / 75

The number 75 corresponds to the maximum number of possible compensations.

For the "L drill test", subjects performed 3 repetitions and scored the best runtime in seconds.

Data analysis

The SPSS statistical package version 21.0 for Windows was used. A descriptive analysis of the data shown as mean and standard deviation was performed. The Wilcoxon test was used to assess the effect of the intervention within the individual groups; and the Mann Whitney U test was used for comparison between groups at the pre-intervention and post-intervention stages and to compare the difference value between the two groups. Significance was stated at $p < 0.05$.

Results

In Table 1, the effects of the motion quality training program on the basic functional assessment tests and the L cone drill test in the EG can be seen.

As can be seen in Table 1, the experimental group after the intervention program shows statistically significant differences in the number of OHST compensations, the compensation with significant changes has been "Arms fall to the front" (p=0.46). The number of compensations in the HST after the operation has also decreased, the most significant variables being: "external rotation of the left foot" (p=0.046) and "internal rotation of the hip in flexion" performing the test with both legs (p=0.046). In the FSD test, the scores for execution have increased significantly, due to the improvement of the variable: "stable pelvis" on both sides (p=0.046); and at the same time the number of compensations have decreased, the most significant being "chest movement" on both sides (p=0.046) and "heel lifts" when they do so by supporting the right leg (p=0.046). In the ASLR, the number of compensations has also decreased significantly, specifically the variable: "external rotation of the support leg" on both sides (p=0.046). The execution time of the "L cone drill" speed test was also significantly reduced after the intervention in the experimental group. After having completed the intervention program for 6 weeks, significant changes appeared ($p < 0.05$), decreasing the % of the risk of injury according to the number of compensations from 56% to 10.9%.

In Table 2, the results of the basic functional assessment before and after the intervention program in the CG are shown.

However, in the control group after the intervention period, there was a significant decrease in the total execution values (p<0.05), and a significant increase in the time obtained in the "L cone drill" speed test (p<0.05). The GIR did not change between the initial and final assessment.

Table 1: Evaluation of the effects of the intervention on the Functional Tests and the L Cone Drill test in the Experimental Group (EG).

Variable	Pre	Post	Value P
Execution OHST	2.20±1.48	3.40±0.89	p=0.063
Compensation OHST	8.00±1.22	2.20±1.78	p=0.039
Execution HST	2.60±1.34	6.40±1.34	p=0.078
Compensation HST	9.80±4.71	0.40±0.89	p=0.043
Execution FSD	3.20±1.78	7.20±1.09	p=0.041
Compensation FSD	15.60±3.91	4.00±3.91	p=0.043
Execution SMT	5.60±2.60	7.00±1.73	p=0.141
Compensation SMT	4.20±1.09	1.60±1.67	p=0.059
Execution ASLR	1.40±0.89	1.60±0.89	p=0.317
Compensation ASLR	4.20±2.28	0.00±0.00	p=0.042
Execution Total	15.00±4.06	25.60±3.50	p=0.042
Compensation Total	41.80±9.41	8.20±4.49	p=0.043
Test L Cone Drill	10.39±0.82	10.17±0.70	p=0.043

OHST: Overhead Squat Test; HST: Hurdle Step Test; FSD: Forward Step Down; SMT: Shoulder Mobility Test; ASLR: Activate Straight Leg Raise

Table 2: Evaluation of the effects of the intervention on the Functional Tests and the L Cone Drill test in the Experimental Group (EC).

Variable	Pre	Post	Value P
Execution OHST	2.60±0.89	1.40±1.34	p=0.193
Compensation OHST	8.8±3.42	9.60±1.67	p=0.334
Execution HST	2.60±1.67	3.60±2.50	p=0.182
Compensation HST	8.40±4.03	9.20±4.14	p=0.581
Execution FSD	4.60±2.40	3.00±2.44	p=0.101
Compensation FSD	12.80±2.77	13.20±2.58	p=1.000
Execution SMT	4.00±1.41	3.80±1.48	p=0.313
Compensation SMT	5.60±0.89	6.00±0.00	p=0.311
Execution ASLR	1.20±1.09	1.00±1.00	p=0.315
Compensation ASLR	5.20±2.28	6.20±1.48	p=0.182
Execution Total	15.00±5.33	12.80±5.54	p=0.042
Compensation Total	40.80±10.44	40.80±10.44	p=1.000
Test L Cone Drill	10.14±0.72	10.62±0.57	p=0.043

OHST: Overhead Squat Test; HST: Hurdle Step Test; FSD: Forward Step Down; SMT: Shoulder Mobility Test; ASLR: Activate Straight Leg Raise

Table 3 shows the differences between the data obtained in the initial assessment and the final assessment, for comparison between groups. The data indicate that there are statistically significant differences between groups due to the effect of the intervention, mainly in the number of compensations for the tests performed on standing: OHST, HST, FSD (p<0.05), in the number of points per FSD execution and in the "L cone Drill" speed test (p=0.08).

Discussion

As far as the authors know, one of the strengths of this study is that it is the first to carry out a warming protocol oriented to mobility

Table 3: Comparison of the difference value between pre- and post-intervention in both groups (EG *vs* CG).

	Pre-post difference EG	Pre-post difference CvG	p
Execution OHST	-3.80±2.94	-1.00±1.41	0.151
Compensation OHST	5.80±1.09	-0.80±1.78	0.008
Execution HST	-3.80±2.94	-1.00±1.41	0.151
Compensation HST	9.40±4.56	-0.80±3.27	0.016
Execution FSD	-4.00±2.00	1.60±1.81	0.008
Compensation FSD	11.60±3.04	-0.40±4.72	0.008
Execution SMT	-1.40±1.94	0.20±0.44	0.222
Compensation SMT	2.60±1.94	-0.40±0.89	0.032
Execution ASLR	-0.20±0.44	0.20±0.44	0.421
Compensation ASLR	-0.20±0.44	0.20±0.44	0.421
Execution Total	-10.60±4.33	2.20±0.83	0.008
Compensation Total	33.60±6.80	0.00±0.00	0.008
Test L Cone Drill	0.22±0.14	-0.48±0.45	0.008

OHST: Overhead Squat Test; HST: Hurdle Step Test; FSD: Forward Step Down; SMT: Shoulder Mobility Test; ASLR: Activate Straight Leg Raise

and stability in an adolescent population. Since functionality tests can predict different aspects of future subject performance [16], it is important to highlight the importance of this study for planning an activity such as paddle tennis. The age of the subjects is around 10 years, a sensitive age for correcting possible weaknesses in GMP and FMS, so that specific skills have a good basis for their development [14]. As for the basic functional assessment tests used, tests already existed for other batteries; and they have been used to obtain more information on the execution of the movement, not only by extracting quantitative but also qualitative data as recommended [11]. In this way, weak points or movement compensations have been detected as major predictors of future injuries [16].

The first striking aspect is that the subjects show (in EG and CG) compensations mainly in the ankle, hip and thorax joints in the initial evaluation (Tables 1 and 2); besides observing numerous compensations on the monopodal stability with both legs (Tables 1 and 2). Motor skills that young people should develop appropriately between the ages of 4 and 6, and then develop the FMS [9] (e.g., shooting), where the athlete hits the ball with a single-path support.

After the intervention phase, the functionality of the CG shows a statistically significant decrease in the number of points per execution and a significant increase in time in the “L cone drill” test. These results are to be expected since the warm-ups carried out in the paddle sessions of this study were very oriented to the development of specific skills and the technical development of this sport through play. This is contrary to the recommendation for children between the ages of 8 and 12, since it should be highlighted in the improvement of FMS, with progressive programs [5], because if it does not master a basic skill performed at low intensity (test) these failures will amplify them in more complex and intense movements. In addition, taking into account that in individual sports such as paddle tennis, early specialization leads to higher rates of overuse injuries [27].

However, if there are significant changes in the GD (Table 1), such as shoulder mobility and chest stability, as shown by the variable: “The arms fall forward” (p=0.46). Monopodal tests (HST and FSD) also show significant improvements, improving compensations such as “external rotation of the left foot” (p=0.046) and “internal rotation of the hip in flexion” by testing with both legs (p=0.046)”; as well as showing better values for “stable pelvis” on both sides (p=0.046), “chest movement” on both sides (p=0.046) and “heel lift” when supporting the right leg (p=0.046). These data can be attributed for two reasons: on the one hand, the effect of the mean age of the EG, as it is higher than that of the CG; and on the other hand, they suggest that the proposed warming protocol on mobility and stability has mainly improved the stability of the chest with the arms upwards, ankle mobility and the balance between external and internal hip rotators in both bipodal and monopodal support. This improvement is of vital importance for a sport such as paddle tennis, in which, given the dimensions of the court (20 × 10) according to the Spanish Paddle Tennis Federation, 35% of the total time of a match is being played and in which there are around 9 strokes per point [20]. In addition, changes of direction will be continuous and frequent. For changes in direction, adequate dorsiflexion, hip stability and central strength are needed [28]. These elements will provide athletes with the dynamic stability essential to developing efficient multidirectional skills [29].

On the other hand, no statistically significant differences have been found in the SMT in the EG. Perhaps, the proposed warm-up work for the subjects was not sufficient to provoke adaptations at the shoulder joint level or maybe the protocol has focused more on improving the lower extremities, and not so much the upper extremities, as on other sports [30]. However, it is recommended that more exercises for the development of shoulder mobility be included in the warm-up phases of paddle players. From an early age, teenagers who play racquet sports increase the strength of their shoulders but worsen mobility by decreasing internal rotation and increasing external rotation, causing the rotators to become unbalanced [31].

However, the improvement in the thoracic stability variables in OHST and FSD appear to show an improvement in central and thoracic stability in arm movements, so necessary in paddle tennis. Coinciding with several studies that indicate that improved stability is of vital importance in the sports field, both to integrate and maintain stability in the change of passive and active movements [32-34] and for the transmission of strength from the ground to the arms [35]. In addition, there are studies that indicate the importance of right and back volleyball strokes in paddle tennis, which are characterized by continuous rotation of the entire body [20,36]. In the stages of sports initiation, these findings are important not only for rowing athletes, but also for other modalities [37].

This study appears to show that warming protocols based on mobility and stability improve fundamental movement patterns, especially if chest, shoulder, hip, and ankle mobility and core stability are included. In fact, a decrease in GIR (% Global Risk of Injury) has been observed in young players of EG, from 55.73% to 10.9%. As some authors cite, improved stability of the foot (base of support), hip movement, and stability are factors that decrease the risk of ACL injury so typical in athletes in sports with change of direction, such as paddle tennis [26,38,39].

In both groups, there are significant changes in the “L cone drill” (Table 3). Mainly, he notes that the change in the AG is an increase over time. Although this study has a low number of subjects, it could be thought that the fact of training technical-tactical aspects of paddle throughout the 6 weeks, in which there are specific movements of this sport, could have a greater transference in this test. This would require a more detailed analysis of the contents of the specific training programming. In the EG, the differences show a significant improvement (Table 3) which may be due to improved mobility in the ankle and hip joints, as well as improved core stability. Because these are improvements in the fundamentals of motion, they have a direct implication with this test by causing a more efficient execution of this test. Referring mainly to the development of the core that can improve the performance of young athletes [40]. Although these data should be taken with caution, they show that adequate warm-up to complement the specificity of the sport can not only improve overall motor patterns and avoid the risk of injury, but also help to improve sports-specific skills. However, as a limitation of the study, the number of the sample as well as the age differences should be highlighted.

Conclusion

In conclusion, it should be noted that the warming protocol proposed to the EG results in improvements in its functionality and overall speed compared to the QA. Thus, it can be said that after this intervention the number of compensations has been reduced (and, therefore, the RLG has decreased), at the same time as improvements in their sports performance have been obtained. For all these reasons, it is important to stress the importance and necessity of the role of mobility and stability in training for the improvement of general motor skills.

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Author Contributions

Conceptualization, RHG; Formal analysis, GTL; Investigation, DM; Methodology, DM; Project administration, RHG; Resources,; Writing – original draft, RHG; Writing – review & editing, GTL.

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