109 - BIOMECHANICS ANALYSIS OF DIRECT PUNCH: PERFORMANCE VARIABLES.

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INTRODUCTION

The practice of martial arts is present all around the world having many adepts stimulated for the health maintenance or still for the proper self-defense. The martial arts scene is composed for some styles, each one with methods and particular philosophies. The techniques of these styles also are differentiated and this can be observed in kicks, punches, among others movements. The punch techniques are present in practically all the martial arts styles as in the Karate, Taekwondo, Kung Fu, Muay Thai and Boxing.

Although exists similarities in these techniques, there are differences in the method of direct punch execution between the martial arts styles. In boxing, for example, even among the fighters of this modality much diversity can be evidenced. In this multiplicity of methods one perceives that in some Karate styles, the direct punch execution it has an execution with little or many times inexistent trunk rotation on the transversal plan.

Some martial arts styles also exist, as for example, the Boxing and the proper Karate, that carries through this technique with a body rotation on the transversal plan very evidenced [1].

Biomechanics studies can contribute to clarify technical parameters of the executed gestures, as in kicks analyses [2, 3, 4] and direct punch [5], in different martial arts styles.

From these technical differences this research is to investigate on the body rotation influence in the transversal plan in the direct punch performance. This research has as study object one direct punch technique, that in Boxing it is called "direct punch", chosen for being one of the more used techniques in martial arts.

METHOD

Ten martial arts practitioners with an average 15 (±10) years of experience in fights had participated of this research. Also, nine inexperienced individuals in martial arts had participated, this group besides extending the source of data served of comparison and control of eventual results related with technical automatism or execution standards. These two groups of the masculine sort, Brazilian, with average age of 30 years and 78kg of average corporal mass. The Boxing, Karatê, the Muay Thai, the Taekwondo, the Kung Fu, the Capoeira, the Jiu-Jitsu, the Hap Kido, Combat Mix and the Mixed Martial Arts had been martial arts styles practiced by the experienced searched ones, between them national and international champion.

The procedures for the data collection of this research had involved the clarifications of the procedures for the punch execution, the measure of the anthropometrics sizes, the mark of the anatomical points [6, 7, 8], the clothes (swimming suit and gloves of boxe 16-OZ), 7min of previous heating, previous procedures of the punch on the platform familiarization and the simultaneous kinetic and kinematic data acquisition.

Each participant executed 4 punches right-handers on a force plate that served of target. This plate was adjusted the executants chin height that measured the force brandished in each punch (FIGURE 1).

Figure 1: Positioning in front to the target plate illustration.

The punches had been executed with the right arm (dominant) and had broken of a positioning standard (guard position), with the corresponding hand to the member of execution being in contact with the lateral face. In the direct punch execution on the target the hand carried through a rectilinear trajectory objectifying the maximum power. After a 7min heating, the punches had been executed with a 5 seconds interval approximately.

The force plate [9] used in the kinetic analysis is structuralized with strain gauges of electric resistance. This plate has 2N sensitivity level and presents measurement error percentage inferior then 1%. For the conditioning, acquisition and analysis of the signal acquired for the plate, had been used still other equipment: a conditioning plate with entrance 16 canals; an analogic/digital converting board with 16 canal and 60KHz tax of sampling up to entrance; and acquisition and analysis software of signals through microcomputer, called SAD - Data Analysis System 32 bits [10], that also it made possible mathematical and statistical data treatment.

The kinetic data had been acquired with a 2000Hz tax without the use of filters in the processing. In the SAD the reaction forces curves with the target had been acquired (vertical component of the plate).

For kinematics 1 camcorder with 30Hz acquisition frequency was located over the transversal plan f the punch executants. Was carried through a bidimensional analysis frame-the-frame of the collected images for this camera through DgeeMe software version 0.98b..

On the basis of the biacromial anatomical points mark was verified in these images the biacromial angular displacement on the body transversal plan (FIGURE 2). The maximum displacement in the clockwise one was surveyed initially, later in the counter-clockwise direction. Added the displacements hourly and counter-clockwise the angular body displacement in the transversal plan was gotten.

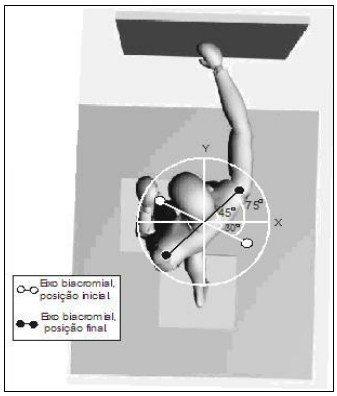

Figure 2: Example of measurement in the Biacromial angular displacement in the longitudinal axle.

RESULTS AND DISCUSSION

The kinetic data of the target plate present the force peaks magnitudes generated by the four punches of each subject, these magnitudes had been also normalized by the body weight of each individual (Table I). To facilitate the kinetic variable comparative analysis, the measured forces in the punches had been normalized by the body weight, being normalization the kinetic values division for the body weight of each individual [11, 12], express in times number of the body weight (BW).\

ble 1: Table 1: Maximum peaks force on the target plate in Newton and normalized by the body weight [N(BW)],

Individuals	Weight	1º	2º	3º	4º	**Media**
1 (e)	770	2979 *(3,9)*	[*]	2056 *(2,7)*	3242 *(4,2)*	**2759 *(3,6)***
2 (e)	816	3113 *(3,8)*	2327 *(2,9)*	2105 *(2,6)*	2746 *(3,4)*	**2573 *(3,2)***
3 (e)	831	3074 *(3,7)*	3338 *(4,0)*	4016 *(4,8)*	3240 *(3,9)*	**3417 *(4,1)***
4 (e)	814	2191 *(2,7)*	2203 *(2,7)*	2317 *(2,8)*	2732 *(3,4)*	**2361 *(2,9)***
5 (e)	675	[*]	3913 *(5,8)*	3073 *(4,6)*	3913 *(5,8)*	**3633 *(5,4)***
6 (e)	1127	4603 *(4,1)*	4921 *(4,4)*	5375 *(4,8)*	5712 *(5,1)*	**5153 *(4,6)***
7 (e)	616	1839 *(3,0)*	2176 *(3,5)*	2259 *(3,7)*	2234 *(3,6)*	**2127 *(3,5)***
8 (e)	611	1834 *(3,0)*	2200 *(3,6)*	[*]	2043 *(3,3)*	**2026 *(3,3)***
9 (e)	784	3718 *(4,7)*	3001 *(3,8)*	3181 *(4,1)*	2849 *(3,6)*	**3187 *(4,1)***
10 (e)	706	3230 *(4,6)*	3157 *(4,5)*	3147 *(4,5)*	3884 *(5,5)*	**3354 *(4,8)***
1 (i)	613	1128 *(1,8)*	1377 *(2,2)*	1377 *(2,2)*	1421 *(2,3)*	**1325 *(2,2)***
2 (i)	730	2328 *(3,2)*	1894 *(2,6)*	1777 *(2,4)*	2035 *(2,8)*	**2008 *(2,8)***
3 (i)	869	3330 *(3,8)*	3462 *(4,0)*	3169 *(3,6)*	3613 *(4,2)*	**3394 *(3,9)***
4 (i)	910	2670 *(2,9)*	2612 *(2,9)*	1650 *(1,8)*	1918 *(2,1)*	**2213 *(2,4)***
5 (i)	928	2233 *(2,4)*	2507 *(2,7)*	2868 *(3,1)*	2849 *(3,1)*	**2614 *(2,8)***
6 (i)	927	2910 *(3,1)*	2798 *(3,0)*	3638 *(3,9)*	4438 *(4,8)*	**3446 *(3,7)***
7 (i)	621	1381 *(2,2)*	1703 *(2,7)*	2035 *(3,3)*	2079 *(3,3)*	**1800 *(2,9)***
8 (i)	754	2789 *(3,7)*	2525 *(3,3)*	2603 *(3,5)*	[*]	**2639 *(3,5)***
9 (i)	591	2109 *(3,6)*	2128 *(3,6)*	1664 *(2,8)*	2196 (3,7)	**2024 *(3,4)***
Média	**773**	**2637 *(3,4)***	**2680 *(3,5)***	**2684 *(3,5)***	**2953 *(3,8)***	**2740 *(3.5)***
S	141	853 *(1,1)*	854 *(1,1)*	998 *(1,3)*	1064 *(1,4)*	**878 *(1.1)***
V (%)	18,2	32,4	31,9	37,2	36,1	**32,1**

Not processed data; ( ) Reaction force normalized for the body weight;; (e) experienced; (i) inexperienced.

The reaction forces peaks with the target of the 72 punches executed had reached 2952N. A bigger magnitude direct punch was 6E-4º, reaching a force of 5711N and lesser magnitude punch was a punch it 1I-1º, reaching one of 1127N force.

From the normalization, it was verified that direct punch reaches in average 3,5BW, having arrived to reach in punch 5E-2º and 4º, 5,8BW of the executants. As expected, the experienced group searched presented a general average of the punches force modules (4BW) superior to the general average of the inexperienced group (3BW).

In it direct punch the angular body displacement on the transversal plan is related with the impulse of the corporal mass on the target. As the impulse is a product of the force that is related with the time [11, 12], a bigger displacement allows an application of force for more time, or either, it can provide a greater corporal impulse. The angular displacements in the transversal plan of the punches can be observed in Table II.

Table 2: Biacromial angular displacement in the transversal plan [º].

Individuals	1º	2º	3º	4º	**Média**
1 (e)	45º	90º	60º	115º	**78º**
2 (e)	95º	45º	45º	125º	**78º**
3 (e)	90º	90º	90º	130º	**100º**
4 (e)	45º	50º	50º	125º	**68º**
5 (e)	90º	45º	90º	130º	**89º**
6 (e)	50º	115º	140º	80º	**96º**
7 (e)	50º	45º	70º	70º	**59º**
8 (e)	95º	95º	55º	70º	**79º**
9 (e)	90º	100º	80º	95º	**91º**
10 (e)	80º	105º	110º	90º	**96º**
1 (i)	45º	20º	55º	70º	**48º**
2 (i)	65º	65º	65º	90º	**71º**
3 (i)	90º	65º	60º	55º	**68º**
4 (i)	65º	65º	95º	80º	**76º**
5 (i)	65º	55º	50º	60º	**58º**
6 (i)	75º	95º	100º	105º	**94º**
7 (i)	50º	35º	65º	55º	**51º**
8 (i)	60º	60º	60º	60º	**60º**
9 (i)	40º	60º	50º	55º	**51º**
Média	**69º**	**69º**	**74º**	**89º**	**74º**
s	19º	27º	25º	27º	17º
CV (%)	27,5	39,1	33,8	30,3	22,7

(e) experienced; (i) inexperienced.

Comparing the biacromiais angular displacements with the punches magnitudes normalized for the body weight, it was verified that 50% of the bigger punches magnitude possess a biacromial angular displacement average of 85° in the transversal plan. Among 50% of the lower punches magnitude the average of biacromial angular displacement was of 64°.

One also evidenced that between the 10 bigger punches magnitude normalized, the biacromial angular displacement was of 94°. And among the 10 lower punches magnitude, the biacromial angular displacement was of 58°.

CONCLUSION

Considering the reaction force magnitude with the target as one of the main evidences of direct punch performance is verified, through the data of this research, that this is optimized by the body displacement on the transversal plan. And with this, the body displacement on the transversal plan is an evidence as an direct punch performance variable.

With these results it is made possible improvement of this biomechanics variable performance, as for example, the training of the responsible muscular groups for the body angular displacement in the transversal plan. And still, in general way, to favor the pedagogical interference in the punch techniques education.

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BIOMECHANICS ANALYSIS OF DIRECT PUNCH: PERFORMANCE VARIABLES.

ABSTRACT

This work describes the direct punch biomechanics, verifying the influence of the rotation of the body in the transverse plan in the performance of this technique on a fixed target. This research had 10 practitioners of martial arts, with 15,3±10,5 years of experience, and 9 inexperienced individuals in fights. In these two groups the age average was 30 years and 78 the average corporal mass in kg. The collection of data was carried through with a force platform that served of target and measured the force of reaction of the punches. Also a camcorder (30Hz) located in the transverse plan of the executants of the punches was used and, through the pictures of image of this camera had been surveyed the angles of biacromial corporal displacement in the transverse plan. Each participant executed 4 direct punches on the fixed platform of force. Between the executed punches, the forces of reaction with the target of bigger magnitude, normalized for the corporal weight, were related with the biggest angular displacements of the body in the transverse plan. With this it was verified that the corporal displacement in the transverse plan is presented as a determinative biomechanics variable in the performance of direct punch.

Word-key: Biomechanics; Direct punch; Martial Arts.

ANALYSE BIOMÉCANIQUE DE LA FRAPPE DIRECT: VARIABLES DE LA PERFORMANCE.

RÉSUMÉ

Ce travail décrit les frappes biomécaniques directs, vérifiant l'influence de la rotation du corps dans le plan transverse lors de l'exécution de cette technique sur un montage blanc. Pendant cette recherche nous avons fait participé 10 pratiquants d'arts martiaux de 15,3±10,5 d'expérience, et 9 individus inexpérimentés aux combats. Dans ces deux groupes la moyenne d'âge était de 30 ans et la masse corporelle moyenne de 78 kilogrammes. La collecte des données a été effectué à l'aide d'une plateforme de force qui a servi de cible pour mesurer la force d'impacte des coups et la force de réaction des appuis. En outre, un appareil-photo numerique (30Hz) situé dans le plan transvers filmait l'exécutant, pour examiner les angles du déplacement corporel biacromial. Chaque participant a exécuté 4 coups directs sur la plateforme de force blanche. Entre les coups exécutés, les forces d'impact sur la cible sont d'une plus grande amplitude par rapport au poids corporel. Ils ont été relié aux plus grands écarts angulaires dans le plan transvers. Grâce a cela on a pû vérifié que le déplacement corporel dans le plan transvers ne

présent aucune variable biomécanique déterminent dans l'exécution de une frappe directe.
Mot-clef : Biomécanique; Frappe directe; Arts martiaux.

ANÁLISE BIOMECÁNICA DEL GOLPE DIRECTO: VARIABLES DE LA PERFORMANCE.

RESUMEN

Este trabajo relata la biomecánica golpe directo, verificando la influencia de la rotación en el plano transversal en la performance de ésta técnica sobre un blanco fijo. Esta pesquisa conto con la participación de 10 practicantes de lucha marcial, com 15,3 ± 10,5 años de experiencia, y 9 individuos sin experiencia en luchas. En estos dos grupos la edad media fué 30 años y la média de masa corporal 78 kg. La colecta de información fué realizada en una plataforma de fuerza que servia de blanco y media la fuerza de reacción del golpe. También se utilizó una filmadora (30Hz) posicionada en el plano transversal del ejecutante del golpe y, a través de los cuadros de los imágenes de la filmadora, se verificaron los ángulos del deslocamiento corporal biocromial en el plano transversal. Cada participante ejecutó 4 golpes directos sobre la plataforma de la fuerza blanco. Entre los golpes ejecutados, las fuerzas de reacción con el blanco de magnitud más grande, normalizadas por el peso corporal, estaban relacionadas con el mayor deslocamiento angular del cuerpo en el plano transversal. Con esto se verificó que el deslocamiento corporal en el plano transversal se muestra como una variable biomecánica determinante de la performance del golpe directo.
Palabras-clave: Biomecánica; Golpe Directo; Lucha.

ANÁLISE BIOMECÂNICA DO SOCO DIRETO: VARIÁVEIS DA PERFORMANCE.

RESUMO

Este trabalho descreve a biomecânica soco direto, verificando a influência da rotação do corpo no plano transverso na performance desta técnica sobre um alvo fixo. Esta pesquisa teve 10 praticantes de lutas marciais, com 15,310,5 anos de experiência, e 9 indivíduos inexperientes em lutas. Nestes dois grupos a média de idade foi 30 anos e a massa corporal média de 78 Kg. A coleta de dados foi realizada com uma plataforma de força que servia de alvo e media a força de reação do soco. Também foi utilizada uma câmera de vídeo (30Hz) posicionada no plano transverso do executante do soco e, através dos quadros de imagem desta câmera foram aferidos os ângulos de deslocamento corporal biacromial no plano transverso. Cada participante executou 4 socos direto sobre a plataforma de força alvo. Entre os socos executados, as forças de reação com o alvo de maior magnitude, normalizadas pelo peso corporal, estavam relacionadas com os maiores deslocamentos angulares do corpo no plano transverso. Com isto verificou-se que o deslocamento corporal no plano transverso apresenta-se como uma variável biomecânica determinante da na performance do soco direto.
Palavras-chave: Biomecânica; Soco direto; Artes marciais.