World Journal of Sport Sciences 3 (S): 132-137, 2010
ISSN 2078-4724

Comparison of Take-off Dynamics in the Forward Handspring Followed by Forward Somersault Tuck on the Floor

Ehab Adel Abdel-Baser

Department of Sport Sciences, Faculty of Physical Education for Boys and Girls,
Port Said University, Port Said, Egypt

Abstract: The aim of this study was to identify the mechanical factors of take-off associated with identical performance for both forward handspring (HN.S.) and forward somersault tuck (F.SS.T.) on the floor. The research sample included four women gymnasts of high performance from Somuha Club in Alexandria, Egypt. A video camera filming at a nominal rat of 60 Hz was used to record the performance of the two mentioned skills. Each of (HN.S. and F.SS.T.) was analyzed with the aid of a Simi motion analysis system. The most important results of the two skills tactics revealed that it consists of two essential factors as follows: first, Motion output, which determines the height of the geometric path for center gravity (CG.) through the flight phase. It has a direct effect on the level of motion performance for the pre and post-skill in the kinematic chains. Second, the position factor which is referred to as the composition various body organs take in both the moment of performing the take-off andfinishing in the previous skill, which considers the moment of take off to perform the subsequent skill either by both feet or hands. It can be identified by the amount of body angles and changes that occur in this amount at both kinematic path points during the build.

Key words: Motion analysis · Kinematic chain · Artistic gymnastics

INTRODUCTION

Both forward handspring and backward and forward somersault tucks are basic motor skills, which gymnasts must perform perfectly in artistic gymnastics for both males and females. These skills are usually performed as parts in consecutive movements (motor sentence), in which take-off plays an essential role, within their performance either by hands or feet to achieve the required degree of consistency during the descent at the end of the motor sentence and the success in performing it. Payne and Barker [1] conducted a comparative study for take-off forces in hand flip of backward somersault and tucked backward air twist of standing position in order to realize if the personal judgments and orders of coach can be supported by objective standards of effective forces during the phases of movements starting, through which flight is largely decided by zip-starts. Control and domination during flight start to change in the amount of inertia andwhat are allowed in rules or technical requirements.

The researcher finds out that a comparative study for take-off forces in hand flip of backward somersault and tucked backward air twist of standing position are inappropriate for the nature of their performance during motor sentence on the drill machine in artistic gymnastics for either women or men. In this study, the researcher tries to study these motor skills that performed as parts in a motor consecutive series as the nature of their performance in the motor sentence on a floor exercises apparatus in artistic gymnastics' competitions for women or men.

When (F.SS.T.) and (HN.S.) are taught, coach gives instructions to the male/female player to clarify the difference between Skills. Such as " forward tilt and push by hands, leaving feet forward while seen the floor "struggling" for high-jump and forward before putting the head forward and tucking body (depending on the performance requirements respectively). This study is an attempt done by the researcher to state if personal judgments and orders of the coach can be supported by objective standards of effective forces during the phases of movements release, which are largely decided during

Corresponding Author: Ehab Adel Abdel-Baser, Department of Sport Sciences, Faculty of Physical Education for Boys and Girls, Port Said University, Port Said, Egypt.

Table 1: Descriptive Statistics (n= 4)

Variables	Arithmetic Mean	Standard Deviation	Minimum Range	Maximum Range
Age (year)	11.3	0.96	10.00	12.00
Mass (kg.)	27.8	5.32	20.00	32.00
Height (cm.)	136.8	0.04	129.0	140.0
Score	9.3	1.30	9.25	9.35

the performance of any flight from –and stating of control and domination during flight by changing in the amount of inertia andwhat are allowed in rules or technical requirements. The aim of this study was to get acquainted with the following:

- Dynamics of take-off within performing the Forward Somersault Handspring (HN.S.) followed by Forward somersault tuck on the floor.
- Dynamics of take-off within performing Forward somersault tuck (F.SS.T.) preceded by performing Forward Somersault Handspring (HN.S.) on the floor.

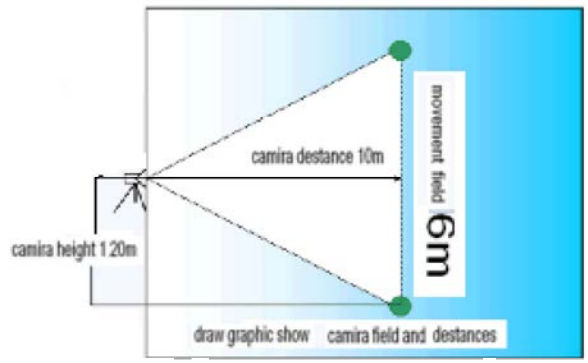


Fig. 1: Camera position within filming

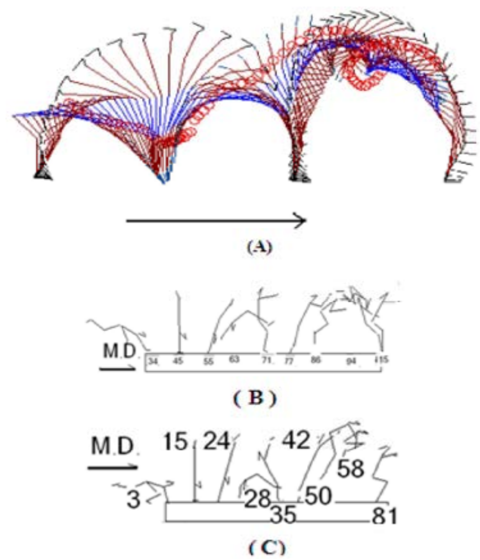


Fig. 2: The diagram of sequence pictures (A), the structure of the motor path for (HN.S.) and (F.SS.T.) for the best performance (B) andthe structure of the motor path for (F.SS.T.) for the worst performance (C).

MATERIALS AND METHODS

Participants: The participants included four female gymnasts in the level of first-class from Somuha Sports Club in Alexandria, Egypt. Table 1 shows the characteristics of participants.

Procedure: Each player performed the kinematic chain, consisting of HS. F.SS.T on the ground, five attempts. Every attempt was filmed by a camera with speed of 60 frame / sec; the best correct attempts were chosen for each player for analysis, which were four attempts.

What has been referred to, by both Abdel-Baser [2,3], was taken into account during the filming process as illustrated in Figure (1). 130 frames were analyzed using Simi Motion program. The Model of Clauser [4] was used to identify X, Y complexes of 21 points defining the configuration of 14 segment model of the human body. The video film was also analyzed using the Simi Analysis program in the Biomechanics Laboratory, Faculty of Physical Education, Mansoura University in Mansoura, Egypt.

RESULTS AND DISCUSSION

Figure 2 illustrates the diagram of the constructive structure for the motor path to perform both the beginning of the kinematic chain which is consisted of the moment of take-off to perform (HN.S.) and (F.SS.T.) on the floor for the best performance. Figures 3-6 also show force curves and their resultant affecting (CG.) female body mass in the direction of both horizontal, vertical forces (Fx, Fy) components within performing the kinematic chain under discussion for the best and worst performance.

Table 2 shows also the differences between gymnast body joints angles on take-off within the performance of kinematic chain performance for both the best and worst one.

Table 2: Body joints angles values at the moment of take-off through kinematic chain components for best performance

The moment of take-off within CG. Path during performance of (HN.S.) and (F.SS.T.).

			Angles joints of			
Performance Phases	Frame	Head Tilt(°)	Shoulder (°)	Thigh (°)	Knees (°)	Ankles (°)
LS.TO	34	30 forward	151	88	95	131
HN.S.	45	33 forward	179	180	180	170
H.TO.	55	45 forward	178	210	180	164
LS.S	71	85 forward	138.5	160	140	155
LS.TO.	77	55 forward	145	170	180	178

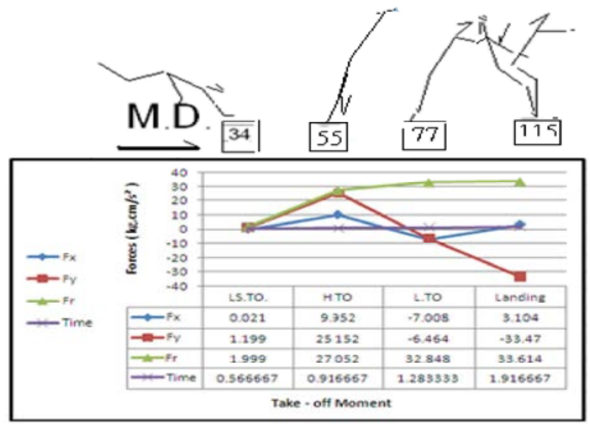


Fig. 3: The values curve of horizontal, vertical forces components and their resultant influent on (CG.) within the moment of Solo take-off foot (LS.TO.), hand take-off (H.TO.) and legs take-off (L.TO) during the performance of kinematic chain movement phases for the best performance.

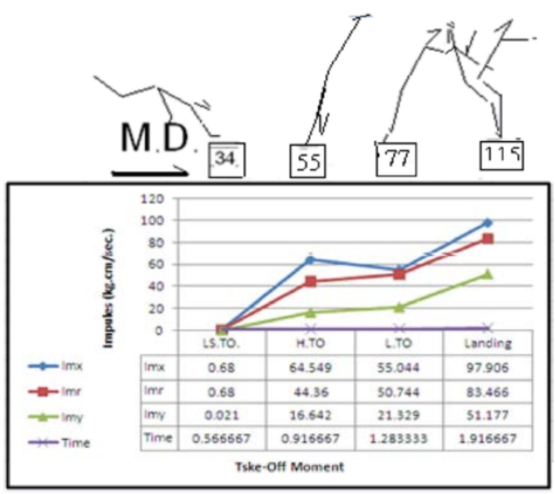


Fig. 4: The values curve of horizontal, vertical Impulses components andtheir resultant influent on (CG.) within the moment of (LS.TO.), (H.TO.) and(L.TO) during the performance of kinematic chain movement phases for the best performance

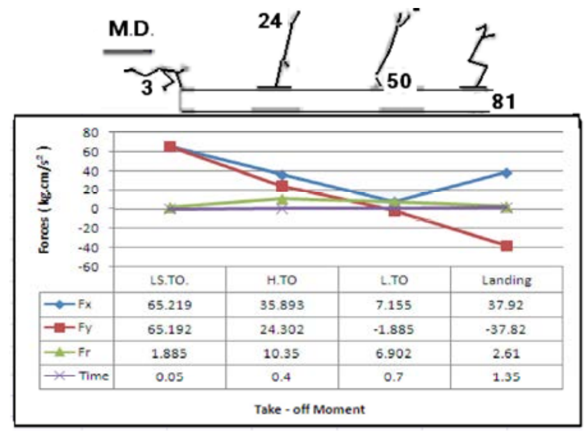
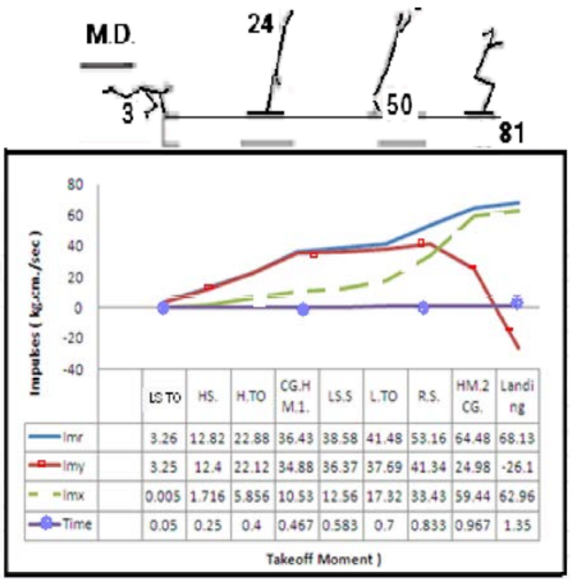


Fig. 5: The values curve of horizontal, vertical impulses components andtheir resultant influent on (CG.) within the moment of (LS.TO.), (H.TO.) and (L.TO) during the performance of kinematic chain movement phases for the worst performance

Sequence Pictures of the (HN.S.) and (F.SS.T.) performance on the floor showed that the kinematic chain started from (HN.S.) Figure (3) of the image (3) and ended at the image (115) in standing position on the floor. This means that the goal of the kinematic chain consisting of (HN.S. and F.SS.T.) may be done according to the specifications of International Gymnastics Federation Men`s Technical Committee [5] of the terms of linking motor skills, which indicates that the tactic of both motor skills forming kinematic chain consists of two major factors:

- Motor Output, which determines the height of the geometric path of (CG.) within the flight phases anddirectly affects the degree of motor performances for the pre and post-skill in the kinematic chain.
- A position factor, which is the composition various body organs take in the moment of take-off and finishing within performing the previous skill,



	LS TO	HS.	H.TO	CG.H M.1.	LS.S	L.TO	R.S.	HM.2 CG.	Landing
Imr	3.26	12.82	22.88	36.43	38.58	41.48	53.16	64.48	68.13
Imy	3.25	12.4	22.12	34.88	36.37	37.69	41.34	24.98	-26.1
Imx	0.005	1.716	5.856	10.53	12.56	17.32	33.43	59.44	62.96
Time	0.05	0.25	0.4	0.467	0.583	0.7	0.833	0.967	1.35

Fig. 6: The values curve of horizontal, vertical Impulses volume components and their resultant influent on (CG.) within moment (LS.TO.), (H.TO.) and (L.TO) during the performance of kinematic chain movement phases for the worst performance

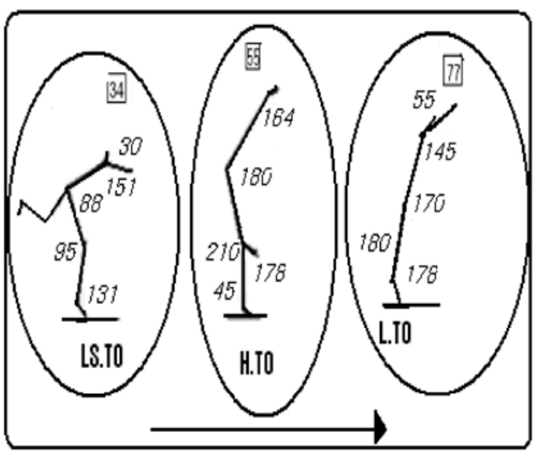


Fig. 7: Characteristics of the body shape at the starting moment during the phases of kinematics chain performance

which considers the moment of take-off to perform the subsequent skill either by feet or hands. It can be identified by the amount of body angles and changes that occur to it in the amount of kinematic path points during the build.

- Curves of the force and Impulses during take-off in (HN.S.), (The beginning of the kinematic path under discussion) for the best performance Figures (3, 4) indicates that both force and Impulses influencing on (CG.) increased at the moment of beginning take-off at the image (34) andthe moment of time (0.5670 sec.) even in the image (63) and the moment of time (1.050sec.) where the amount in the vertical component was respectively (9.216 kg.cm/s², 39.410 kg. cm/s). While its equivalent respectively decreased at the image (71) to the amount of (2.55 kg. cm/s², 2.958 kg. cm/s) and the resultant Impulses reached (15.330 kg. cm/s², 44.63 kg. cm/s). This means that the gymnast successfully converted the exerted impulses and force trendily and amount at the moment of take-off beginning during the performance of (HN.S.). The researcher explains this result under what was noted [6-8]. If take-off was done by solo foot to perform (HN.S.); gymnast must utilize of the amount of acquired movements during the moment of take-off at the beginning of the performance it by back tilt to move (CG.) in front of the support base (feet) with the amount that permitted her to start with the distribution of force and impulse acquired towards both horizontal and vertical components; with taking into consideration that vertical component surpassed the horizontal one in order to ensure obtaining the appropriate flight curve to complete (HN.S.).

In case of pushing by hands during the performance of (HN.S.), from image (45) to image (55) (figure 4), both force and push force in vertical and horizontal components would respectively increase to (25.152 kg. cm/s², 9.935 kg. cm/s, 39.41 kg. cm/s², 9.696 kg. cm/s). The starting angle is (°94.10) which indicates player's success in directing the force of arms during pushing hands up. The researcher also explains this result in light of what was referred by previous studies [3,6,9] of the necessity for a strong take-off on the hands after take-off solo phase and hands-on land to give the chance to transmit (CG.) forward out of the support base for decentralized push to complete (HN.S.) and reaching the imbrications phase mode to the end (HN.S.) and the beginning (F.SS.T.), some upgrading from image (71) to image (77). Figures 3, 4 occurred where force and impulses respectively increased in the horizontal component of the amount (7.010kg. cm/s², 21.320 kg. cm/s) opposite to decrease in force in the vertical component of the amount (-6.470 kg. cm/s²) and increased impulse in the vertical component to amount (50.740 kg. cm/s). This indicates a shift of forces in the horizontal component to vertical force component in the moment of release the performance of (F.SS.T.) to obtain the preparation to perform appropriate flight of (F.SS.T.) indicates the gymnast success in directing exerted force at the moment of release (F.SS.T.). This is confirmed by the gymnast starting at (°90.80). Researcher informs that the moment of pushing hands during the performance of (HN.S.). The angle speed was (255.6 m/s) and(560.8 m/s) within performing (F.SS.T.). The researcher explains these differences in estimating the angular velocity within performing both (HN.S.) and (F.SS.T.) where the inertia strength of (F.SS.T.) during flight is less than the equivalent of (HN.S.).

Table 2 shows the values of body joints angles at the moment of (LS.TO), (H.TO.) and(LS.S) within the performance of kinematic chain components. Researcher also notes that there are differences among the values of the body joints angles, but these differences related to the nature of performing both skills. In case of (HN.S.), it requires to be performed the head of athlete slant forward to allow (CG.) being out of the support base in order to obtain an appropriate decentralize pushing to complete the flight curve of (HN.S.). Body forwards with counterclockwise and landing on the feet. While body joints angles values differ in (F.SS.T.), the angle of tilt head forward increased and the angle of joint shoulders also did. The angle of release becomes greater (82.32° forward) to get high flight curve allows to complete the performance (F.SS.T.).

CONCLUSION

Based on collecting data methods andthe limitations and hypotheses of the study, several conclusions were derived by researcher:

The Structure of Kinematic Chain: The kinematic chain consists of (HN.S.) and (F.SS.T.) on the floor. Geometric path of (CG) is divided while performing kinematic chain into the following components:

- Beginning (HN.S.).
- (H.TO.).
- The end of (HN.S.) and the beginning of (F.SS.T.).

Tactics of Both Motor Skills Forming the Kinematic Chain Consist of Two Major Factors:

- Motor output, which determines the height of the geometric path of (CG.) to the performance phase anddirectly affects the points of performances for the pre and post-skill in kinematic chain.
- The position factor, which is the composition different body organs take at the moment of take-off and finishing in the previous skill and the moment of within the performance which considers the moment of take-off to perform subsequent skill either by feet or hands. It can be identified by the amount of body angles and changes that occur to it in the amount of kinetic path points during the build.

The Dynamic Characteristics of Kinematic Chain Components:

- Take-off in (HN.S.).
- Take-off time solo foot (0.18 sec. by 9.380%) of the total time of performance (HN.S.).
- Hands impulse time (0.17 sec. by 8.85%) of the total time of performance (HN.S.).
- The release angle (°94.10).
- The formal characteristics of a body moment of release.

Abbreviations

Variables	Symbols
Solo take-off foot	L.S.TO.
Hand take-off	H.TO.
Hand release angle	h.ə
Preflight	PF.
Legs take-off	L.TO.
Legs release angle	L.a.
Post flight	PSF.
Forward Somersault Tuck	FSST.
Landing	La.
Mass center gravity	CG.
Horizontal Forces component influent on CG.	Fx
Vertical Forces component influent on CG.	Fy
Resultant Forces influent on CG.	Fr
Horizontal Impulses component influent on CG.	Imx
Vertical Impulses component influent on CG.	Imy
Resultant Impulses influent on CG.	Imr
Horizontal Angular velocity component influent on CG.	$^{\omega}x$
Vertical Angular velocity component influent on CG.	y^{ω}
Resultant Angular Velocity influent on CG.	ω_R
Performance Evaluation points	PP.
Height maximum CG. Preflight	CG.HM.1
Height maximum CG. Post flight	CG.HM.2
Hand Support	HS.
Legs Support	LS.S
Start Rotation	R.S.
Solo Foot Time Take-off	T_1
Feet Time Take-off	T_2
Hand Support Time	T3
Hand Spring Forward	HN.S
International Gymnastics Federation Women	FIG.
Movement Direction	MD.

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