

A NOVEL APPROACH TO TIME-MOTION ANALYSIS OF K1 SPORT**Dino Belošević¹, Hrvoje Karninčić¹ and Goran Jelaska²**¹*Faculty of Kinesiology, University of Split, Croatia*²*Department of General Surgery, Virovitica County Hospital, Virovitica, Croatia**Original scientific paper***Abstract**

The aim of this research was to identify technical structure of elite K1 matches and to determine which technical and tactical variables are discriminators within elite kickboxers regarding match success. In accordance with the aim, sample of 8 final K1 tournament matches was used and frequencies of 280 variables (56 techniques from 5 different guards: Stance, Moving forward, Moving backward, Moving left, Moving right). By using Mann Whitney - U test, roundhouse low kick with the front leg to the back leg (Moving forward) ($Z = 1,94$; $p=0,05$) and front hand hook to the head (Moving left) ($Z = 2,10$; $p = 0,04$) were found to be significant discriminators. Results are pointing to the facts that in realization of successful attack decrement of the distance is important goal, while in successful defence, front hand hook can be used for disturbance of opponent's attack. According to the results of this research, recommendation to the trainers would be that while modeling K1 training processes additional attention to the selected specific manifestation of technical and tactical elements which are important for successful realization of elite K1 fights is needed.

Key words: *Kickboxing, K1, technics and tactics, combat sport*

Introduction

Kickboxing is a contact martial art where punches and kicks are allowed and, according to some rules, striking with knees and elbows (Birrner, 1996; Buse & Santana, 2008; Myers, Balmer, Nevill and Al-Nakeeb, 2006). The popularity of kickboxing is rising and there is a high level of preference compared to other martial arts among both male and female respondents (Kudlacek, 2008). Considering its complexity, kickboxing is grouped with other polystructural, acyclical sports (Buse & Santana, 2008). Types of bouts depend on technical abilities of kickboxers directly connected to the motor abilities of athletes, thus the selection and training should focus on harmonizing the characteristics which determine efficiency, whether these are morphological, motor, functional or technical-tactical dimensions. (Blažević, Ljubisavljević & Kačar, 2011; La Bounty, Campbell, Galvan & Antonio, 2011; Machado, Osorio, Silva & Magini, 2010; Ouergui et al. 2014; Ouergui et al. 2015). Aggressiveness and attack-defence characteristics of this sport requiring hitting and blocking strikes with different parts of body and face using techniques in full swing with minimal protective equipment, poses considerable risk from dangerous injuries. This gives additional importance to more detailed defining of technical-tactical structure and to mastering these during training practice in order to reduce the risks at competitions (Gartland, Malik & Lovell, 2005).

Kickboxers must develop the most appropriate techniques which contribute to winning and apply as many defensive and attacking techniques as possible in order to win matches, top kickboxers must have a spectre of motor abilities automatised at training with high efficiency and operationalization at competitions (Krupalja, Kapo, Radjo, Ajnadžić & Simonović, 2011; Ouergui,

Hssin, Franchini, Gmada & Bouhleb, 2013). Technical-tactical analysis of similar martial arts as well as previous researches of technical-tactical structures in kicking martial arts have mostly been conducted incomplete based on the frequency of certain techniques or in the proportion of activities with high and low intensity and inactive time spent in a bout. (Del Vecchio, Hirata & Franchini, 2011; Miarka et al. 2012; Ouergui et al. 2013; Silva, Del Vecchio, Pianço, Takito & Franchini, 2011). There have not been any researches in kicking sports analysing the complete technical structure (all the punches and kicks and all blocks) in a certain fighter and its influence to the final bout result and there are no researches focusing on the analysis of a kickboxer's movement (guard, forward, backward, left and right). In order to make such an analysis, a complete bout from a video footage should be analysed without the loss of elements occurring in an actual bout which can be achieved by using a large number of valid and reliable variables. In accordance with the proposed issues and previous researches, the purpose of this paper is to establish and describe the technical structure of bouts at the final K1 tournament in 2010 and determine and discuss the differences among the techniques with regard to the efficiency in bouts.

Methods*Sample*

We use a sample of 8 matches from the professional kickboxing K-1 tournament called Final 16, held in 2010 in Japan where sixteen fighters competed to get to the final tournament. At the mentioned tournament the fighters take part in one fight only and if they win, they are allowed to take part in the final tournament held at another time.

Variables

In this paper, matches under K-1 rules are decomposed in technical-tactical structures described in the 5 followingguards: *Stance* (SM) – a position of a static guard where a fighter keeps a longer or a shorter distance; *Moving forward* (KNAP) - a position in which the fighter ‘wins’ some space by keeping the guard with his leg movements and by moving forward to create an attacking position; *Moving backward* (KNAZ) – a position in which a fighter, by keeping guard with his leg movements, ‘leaves the fight’ in order to form defence or counterattack after the opponent’s attack; *Moving left*(KL) – a position

where a fighter, while keeping the guard by leg movements, moves to the left in order to ‘form the angle’ and win the ring centre to prepare for an attack or uses moving to the left as a defence movement coming on to the opponent’s attack; *Moving right* (KD) – a position where a fighter, by keeping guard with legmovements, moves to the right in order to ‘form the angle’ and win the ring centre to prepare for an attack or uses movements to the right as a defensive movement of coming on to the opponent’s attack. Further on, we defined 56 basic variables coming from 5 described situations and we generated a system consisting of 280 variables.

Table 1. Basic variables of all relevant aspects of the fight

Meanings of a certain variable and its abbreviation has been given in this table:	
V 1: straight punch, jab	V 29: roundhouse low kick with the front leg to the back leg
V 2: straight punch, cross	V 30: roundhouse low kick with the back leg to the front leg
V 3: jab to the body	V 31: roundhouse low kick with the back leg to the back leg
V 4: cross to the body	V 32: roundhouse middle kick with the front leg
V 5: front hand uppercut to the head	V 33: roundhouse middle kick with the back leg
V 6: back hand uppercut to the head	V 34: roundhouse high kick with the front leg
V 7: front hand uppercut to the body	V 35: roundhouse high kick with the back leg
V 8: back hand uppercut to the body	V 36: front leg side kick to the body
V 9: front hand hook to the head	V 37: back leg side kick to the body
V 10: back hand hook to the head	V 38: front leg side kick to the head
V 11: front hook to the body	V 39: back leg side kick to the head
V 12: back hand hook to the body	V 40: turning back kick to the body
V 13: backfist punch	V 41: turning back kick to the head
V 14: spinning backfist	V 42: spinning back heel kick to the head
V 15: hand block from leg kick	V 43: spinning back heel kick to the body
V 16: hand block from punch	V 44: spinning back heel kick to the leg
V 17: hand block from knee kick	V 45: front leg knee kick to the head
V 18: low kick block with front leg	V 46: back leg knee kick to the head
V 19: low kick block with back leg	V 47: front leg knee kick to the body
V 20: middle kick block with front leg	V 48: back leg knee kick to the body
V 21: middle kick block with back leg	V 49: front leg knee kick to the leg
V 22: outside clinching	V 50: back leg knee kick to the leg
V 23: inside clinching	V 51: axe kick with front leg
V 24: front kick with front leg to the head	V 52: axe kick with back leg
V 25: front kick with back leg to the head	V 53: bob and wave to the left
V 26: front kick with front leg to the body	V 54: bob and wave to the right
V 27: front kick with back leg to the body	V 55: left deflection
V 28: roundhouse low kick with the front leg	V 56: right deflection

After several check-ups and discussions with expert professionals dealing with the top kickboxing issues, every defined variable has been unambiguously and clearly determined as a technical aspect included in bouts under K1 rules. The grouping variable was *win/lose* and we had 8 winners and 8 losers out of 16 fighters at the tournament.

Experimental procedure

Two expert judges (one of them being the author of this paper) marked the variable frequencies at the first 3 matches and the same were used to analyse reliability. Considering the fact that K1 is a very complex sport with regard to moving and performing techniques, the measurers were given detailed instructions defining every single variable.

Data processing methods

The system of variables underwent a detailed preliminary expert validity assessment by 6 K1 experts and based on their observations, some details of the variable systems were corrected.

Reliability of the applied measuring procedure has been examined in two different ways. Firstly, we examined the judges’ reliability to assess guards (stance, moving forward, moving backward, moving left, moving right) by using Cohen Kappa coefficient calculated on the contingency table 5x5. Secondly, by examining the significance of the differences among the proportions, we examined the reliability to notice the appearance of certain variables within a certain guard.

In every observed movement guard, we calculated frequency percentage for 5 most frequent variables. Considering the non-parametric data structure, and with the purpose of establishing the differences between winners and losers, we used Mann Whitney – U test and we examined the difference in the first 20 most frequent variables, for each previously mentioned guard. Type one error was set at 5%. All calculations were performed at University of Split, Faculty of Kinesiology, by using data analysis software system Statistica 12 (StatSoft., Tulsa, OK, USA).

Results

The results of reliability analysis clearly reveal a considerable reliability of the judge assessment of guards (Cohen Kappa = 0.890) as well as reliability in observing appearance of certain variables within a certain guard. To be more precise, for each of the 20 most frequent variables within a certain observed guard, we observed the differences significance among proportions among

the expert judges and we identified no statistical significance ($p > 0.05$). Table 1 displays technical structure considering the movement of a fighter in the bouts at the final K1 tournament 2010.

Statistically significant difference with regard to the win/lose grouping variable was found in front hand hook to the head moving left variable (V_9) and roundhouse low kick with the front leg to the back leg moving forward variable (V_29).

Table 2. Technical and tactical structure due to the movement of fighters

<i>Moving forward</i>		<i>Moving backward</i>	
Front hand straight punch	40%	Hand block from punch	53%
Back hand straight punch	20%	Front hand straight punch	19%
Back hand hook to the head	19%	Back hand hook to the head	11%
Roundhouse lowkick with the back leg to the front leg	12%	Hand block from leg kick	11%
Hand block from punch	9%	Roundhouse lowkick with the back leg to the front leg	6%
<i>Moving left</i>		<i>Moving right</i>	
Front hand straight punch	46%	Hand block from punch	29%
Roundhouse lowkick with the back leg to the front leg	24%	Hand block from leg kick	24%
Front hand hook to the head	11%	Back hand hook to the head	19%
Hand block from leg kick	11%	Front hand straight punch	15%
Outside clinching	8%	Inside clinching	13%
<i>Stance</i>		<i>Total structure</i>	
Front hand straight punch	30%	Stance	44%
Hand block from punch	22%	Moving forward	32%
Back hand hook to the head	19%	Moving to the left	12%
Front hand hook to the head	15%	Moving to the right	8%
Roundhouse lowkick with the back leg to the front leg	14%	Moving backward	4%

Table 3. Statistical significance of differences by using Mann Whitney U test in 20 most frequent variables considering the win/lose group. variable

Stance		Moving forward		Moving backward		Moving left		Moving right	
Variable	p	Variable	p	Variable	p	Variable	p	Variable	p
V 1	0.79	V 1	0.43	V 1	0.87	V 1	0.16	V 1	0.56
V 2	1.00	V 2	0.92	V 2	0.67	V 2	0.92	V 2	0.40
V 6	0.96	V 6	0.71	V 6	0.40	V 6	1.00	V 6	0.67
V 9	0.67	V 9	0.71	V 9	0.67	V 9	0.04	V 9	0.21
V 10	0.60	V 10	0.14	V 10	0.64	V 10	0.14	V 10	0.40
V 11	0.49	V 11	0.79	V 11	0.67	V 11	0.67	V 11	1.00
V 15	0.08	V 15	0.60	V 15	1.00	V 15	0.21	V 15	0.67
V 16	0.40	V 16	0.92	V 16	0.60	V 16	0.67	V 16	1.00
V 17	0.29	V 17	0.67	V 17	0.75	V 17	0.67	V 17	1.00
V 18	0.40	V 18	0.75	V 18	0.46	V 18	0.96	V 18	0.40
V 22	0.92	V 22	0.37	V 22	0.87	V 22	0.71	V 22	0.67
V 23	0.87	V 23	0.79	V 23	1.00	V 23	0.67	V 23	1.00
V 26	0.75	V 26	0.27	V 26	0.37	V 26	0.87	V 26	0.40
V 28	0.87	V 28	0.23	V 28	0.67	V 28	1.00	V 28	0.67
V 29	0.60	V 29	0.05	V 29	0.40	V 29	0.53	V 29	0.32
V 30	0.46	V 30	0.46	V 30	0.09	V 30	1.00	V 30	0.40
V 32	0.32	V 32	0.67	V 32	1.00	V 32	0.67	V 32	0.96
V 33	0.32	V 33	0.92	V 33	1.00	V 33	0.40	V 33	1.00
V 55	0.12	V 55	0.67	V 55	0.40	V 55	1.00	V 55	0.67
V 56	0.71	V 56	0.43	V 56	0.87	V 56	0.16	V 56	0.56

Discussion

Observing the total number of performed techniques (Table 1), the largest number of techniques was performed from stance, 44% and from moving forward 32%. Techniques in these movements are considered to be attacking and the results where kickboxers are engaged more in attacking than in defending techniques were confirmed by a research they conducted (Ouergui et al., 2013). All other movements together make as much as 24%. From the stance, the following techniques are relatively equally performed: straight punch, defence from hand techniques, front hand and back hand hook and roundhouse

lowkicks with the back leg to the front leg. In moving forward, the domineering techniques are: front straight punch (40%), followed by back straight punch (20%) while back hand hook, roundhouse lowkick with back leg to the front leg and hand technique blocks are performed in 40% of cases. These results match the results from the researches on top karate fighters which reveal a rising tendency towards using hand techniques as opposed to leg techniques. The usage of uppercut is definitely decreasing and since it has not achieved a sufficient frequency not even in this research, it was not additionally analysed (Tabben et al., 2015). Considering movements backward as it is logical, the domineering hand techniques

are hand blocks with 53% and front straight punch with 19% serving more to obstruct the opponent's attack in this case. While moving backwards, when body gravity is set on 'heels', kicks are not sufficiently forceful and their attacking effect is significantly weaker than in a defending one in this situation. Applying force and speed in punches has proven to be crucial in other researches on kicking sports (Artioli, Gualano & Franchini, 2009) therefore techniques from these positions are considered defensive. In moving backwards, other techniques applied are back hand hook, hand blocks from kicks and roundhouse low kick with the back leg to the front leg at 28%. Moving left is obviously a defensive move, but it is dominated by techniques used to obstruct the opponent's attack. Front straight punch is most frequent technique with 46%, followed by roundhouse lowkick with the back leg to the front leg with 24% and front hand hook, kick blocks and outside clinching as exclusively defensive techniques. While moving right which is also a defensive move unlike moving left, the dominating techniques are hand blocks preventing punches with 29% and hand blocks preventing kicks with 24%, followed by back hand hook and front straight punch as a purely defensive technique. Other researches on kicking sports also prove that to achieve efficiency in sport, one must apply as many techniques as possible on body parts which are destructive for opponents and thus enable advantage in scoring (El Ashker, 2011). In table 1 we can see that roundhouse lowkick with the front leg to the back leg moving forward ($Z = 1.94$; $p=0.05$) and front hand hook moving left ($Z = 2.10$; $p = 0.04$) statistically significantly differ considering the grouping efficiency variable. Roundhouse lowkick with the front leg to the back leg moving forward variable differs from other frequent techniques performed when moving forward by the fact that the distance between fighters when performing this kick is small. One must be near the opponent to perform a kick to the back leg, and from this precise distance other hand techniques can be quality performed which can be crucial for the final outcome of the bout. While attacking (in moving forward), the winners have more frequently performed roundhouse lowkick with the front leg to the back leg, and at the same time in defence when moving left (avoiding) they performed front hand hook. This is logical since a kickboxer, when moving left, obstructs the opponent's attack with continuous front hand hook and prevents him from scoring easily. By moving left in defence, the kickboxer goes for the opponent's right hand, usually the dominant one, and risks a single punch with the dominant arm, but in this way also avoids preparation techniques with left hand which are followed by a strong punch with the right hand. These results match the research on technical-tactical structure in kickboxing which led to the conclusion that variables important for efficiency in a match are kicks on the opponent's leg and hooks (Ouerqui et al. 2013). Out of all most frequent variables in moving (in all directions and from stance), only these two variables significantly

differ with regard to efficiency and we can say that the first one is characteristic of attack and the second one of defence. Based on the obtained results we can claim there are statistically significant differences among techniques with regard to efficiency in a bout from moving forward and there are statistically significant differences among techniques with regard to efficiency in a bout from moving left. On the other hand, we cannot say there are statistically significant differences among techniques with regard to efficiency in a bout from a stance, significant differences among techniques with regard to efficiency in a bout from moving backward and significant differences in techniques with regard to efficiency in a bout from moving right. Punches and kicks with the highest frequency in a bout, front and back straight punch and other similar ones, have not significantly differed winners from losers, although this was expected, but since we did not mark the effect of the punch, (score-miss or the power of the punch), thus these variables were proved insignificant. The importance and the existence of the techniques performed with reduced intensity are considered a very important indirect issue (Silva et al. 2011). Such techniques were used to prepare for performing strong and significant punches and this is why the frequency is so high although they did not have any significant effect on the match outcome. Potential limits of this research may be a large number of variables applied on a relatively small sample describing a complex structure of a bout. Furthermore, there are some variabilities in the results since both right-handed and left-handed kickboxers take part in bouts, thus the front-back hand and leg structures are mutually intertwined in some cases, e.g. front hand can be either left or right. Additionally, there are situations when a fighter changes his guard during a bout and this leads to result mixing. These situations are not relatively common and should not affect the result validity. In further researches there should be a scale to assess the effect of punches and kicks, we should increase the number of entities and leave out variables with 0 frequency so this would lead us to a better insight into the structure state of bouts at K1 tournaments.

Conclusion

The research revealed that in attack the distance should be reduced while the opponent's attacks are stopped by front hooks. Such tactics helped fighters to win this tournament. This kind of analysis could not have been conducted without the new way of marking and technical-tactical structure processing. By this analysis we evidently obtain a deeper structure which cannot be revealed by usual observing. This technology has some space for improvement and further researches should follow the road towards better and clearer variables defining since they make the total structure of this sport. Further development and software availability should be enabled in these kinds of analysis.

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NOVI PRISTUP ANALIZI KRETANJA U K1 SPORTU

Sažetak

Cilj ovoga istraživanja bio je utvrditi tehničku strukturu elitnih K1 borbi, te utvrditi tehničko taktičke varijable koje diskriminiraju elitne kickboksere obzirom na uspjeh u borbi. Korišten je uzorak od 8 borbi finalnog K1 turnira a bilježene su frekvencije 280 tehničkih varijabli (56 tehnika iz 5 vrsta kretanja: stav u mjestu, kretanje naprijed, kretanje natrag, kretanje lijevo i kretanje desno). Korištenjem Mann Whitney - U testa identificirano je da su niski kružni udarac prednjom nogom na zadnju nogu iz kretanja prema naprijed ($Z = 1,94$; $p=0,05$) i kroše u glavu prednjom rukom iz kretanja u lijevu stranu ($Z = 2,10$; $p = 0,04$) varijable koje diskriminiraju pobjednike od poraženih. Rezultati ukazuju je da je u uspješnom napadu važno smanjiti distancu a u uspješnoj obrani prednjim krošeima ometati napad protivnika. Istraživanje može pomoći trenerima da pri modeliranju trenažnog procesa obrate dodatnu pozornost na odabrane specifične manifestacije tehničko-taktičkih elemenata koji su važni za uspješnu realizaciju elitnih K1 borbi.

Ključne riječi: Kickboxing, K1, tehnika i taktika, borilački sport

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