ORIGINAL ARTICLE

The body balance variability of judo athletes during a contest

Authors' Contribution:
A Study Design
B Data Collection
C Statistical Analysis
D Manuscript Preparation
E Funds Collection

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Abstract

Background and Study Aim: One important aspect to know with accuracy and with influence in a judo contest is the balance response that it has on athletes. The purpose was to know the variability in body balance during the successive bouts of a judo contest and possible loss percentages in this ability.

Material and Methods: Twenty-two men performed five 5-minute bouts with 15 minutes of passive rest. Immediately after each bout, in rest time, balance abilities indicators were tested in a Sway test: centre or pressures (COP), ellipse of area (EA), Sway long (SL) and mean velocity (MV) in dominant (D), non-dominant (ND) and both legs (B). To compare baseline test data and successive bouts, ANOVA was used.

Results: ANOVA revealed significant differences in EAD (ellipse of area dominant leg) $p = 0.05$, SLND (Sway long no dominant leg) $p<0.001$, SL2 (Sway long both legs) $p = 0.009$, MVND (mean velocity no dominant leg) $p = 0.01$ and MVD (mean velocity dominant leg) $p = 0.003$. In percentages, some decreases of 51.24% in EAD, 44.92% in SLND, 24.48% in SLB, 62.10% in MVND, 27.18% in MVD and 48.86% in MV2 (mean velocity both legs) were found. Fifteen minutes of rest-time was not enough for recovery the baseline levels in body balance abilities.

Conclusions: The balance ability is modified during a judo contest. There is an important loss that affects to assessment of dominant, no dominant and mean values to both legs. Due to the fact that there are a high variability of situations that occurs in judo and individuals adaptations postural to aim a high performance, there is not a proportional loss in balance that in others capacities.

Key words: martial arts • performance • recovery time • Sway test

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INTRODUCTION

It is well known the necessity to obtain with precision the specific demands of each sport modality to design training programs according with these [1]. Specifically in judo contest, there are lots of studies that measure some of these demands, as physiological [2-7] and related to strength production [4-6, 8-10] although other physical capacities take place in this sport modality [11, 12]. The balance ability applied to judo is one of demand from which is needed more quantity of information due to the fact that only a few studies of it has been published [13, 14].

Several studies show that some indicators that indicate the injury risk are related to balance ability [15-18]. Therefore, it becomes evident the importance of postural balance as a predictor of future injuries [19]. In the same line, other studies have assessment different training programs about postural balance, obtaining the levels of inherent risk injury and the recovery time necessary to a complete recovery of proprioceptive indicators [20-24]. Consequently, physical trainers (coaches) can considerate the risk injury with athletes should training in each time of the season to design training programs according with this fact [23]. On the contrary, some authors [22] indicate that there are not several studies about related indicators in use of centre of pressures (COP) associated with high performance and injury risk [25-29].

Judo athletes have an efficient balance control, being vulnerable to unexpected movements occasioned by the opponents [25]. The postural control of judo athletes is based not only in his own movements and actions, but also in a several kinds of external forces from opponent that constantly attempt to balance ability [30]. Same authors indicate that the specific judo grip is directly related with balance due to the fact that it provides somaesthetic information about movements and positions to take into consideration and a way control of the judoka's own balance. Due to balance demands involved in the combat and training, judo athletes should work on this ability through the training time [25]. High performance sport demands the highest level of postural control [31, 32], since balance capabilities are unquestionably one of the most important determinants of a judoka's performance [30]. This is the reason why balance training may be useful for both male and female judokas for increasing strength and balance [33]. Although balance abilities are taken into account in training programs nowadays, there are not studies about acute effect of a judo contest on balance abilities.

The problem statement of this study is the necessity of knows the evolution of balance ability in judo competition. As a novelty, COP and balance ability were measured during a real situation of a judo contest. The purpose was to know the variability in body balance during the successive bouts of a judo contest and possible loss percentages in this ability.

MATERIAL AND METHODS

Design

This was a repeated measures study consisting in a simulated judo contest with 5 five-minute matches, separated by 15 minutes of passive rest between them, according with the recommendations of some authors [5, 6, 34-36], after a weight-control by impedance (Figure 1). According with some authors [5, 6, 36], there were not a difference higher than 10% of muscle mass. The combat time no finished when an ippon (see glossary) was scored. This simulated judo contest was developed at the end of one mesocycle (see glossary) before an official judo contest classificatory for athletes, as a way to assessment too. The IJF (International Judo Federation) round-robin format for six contenders in the same weight category was applied, in where all athletes fight against all of them. All of COP indicators for non dominant, dominant and both legs, as ellipse of area (EA), Sway long (SL) and mean velocity (MV) were obtained immediately after each match, through the Sway test.

Subjects

Twenty-two male judo athletes (21.05 ±2.89 years; 78.31 ±7.95 kg; 173.7 ±3.4 cm; 22.01 ±1.64 kg/m2 BMI; 10.65 ±4.05% body fat; 69.86 ±5.45% muscle mass) voluntarily participated in current study. After receiving detailed information on the study, participants (or his parents) provided written informed consent in accordance with the ethical standards established the World Medical Association's Declaration of Helsinki (2008). The study was approved by the local ethics committee and was conducted according to the European Community's guidelines for good clinical practice (111/3976/88; July 1990) and the National legal framework for clinical research on humans (RD 561/1993 on

Body balance – physical ability with direct relation in judo with technical movements [14].

Judo contest – championship or tournament in judo that is composed by successive bouts [6].

Judo bout – judo match with 5 minutes of duration or some maximal punctuation occurs.

Sway test – balance test standing on a leg during 10 seconds and the other at 90° forward, while arms were on the side and head erect [19, 23, 29].

Centre of pressures – medium pressures zone during a balance test [22].

Ellipse of area – balance parameter related to area filled during develop of a Sway test [19, 23, 29].

Sway long – specific parameter from Sway test [19, 23, 29].

Mean velocity – mean velocity of pressure on a balance platform [19, 23, 29].

Dominant leg – leg more skilled.

Baseline test – test that is developed in a resting situation, without any previous physical load [6, 11, 12].

Physical capacities in judo – capacities according with physiological, neuromuscular and balance classifications that in judo contest occur [7, 8, 11, 14].

Recovery time – rest time between bout in a judo contest [6].

Ippon – one point. Achieved through the execution of a valid technique on the opponent [40].

Mesocycle – *noun* a training cycle that typically lasts for a few weeks [41].

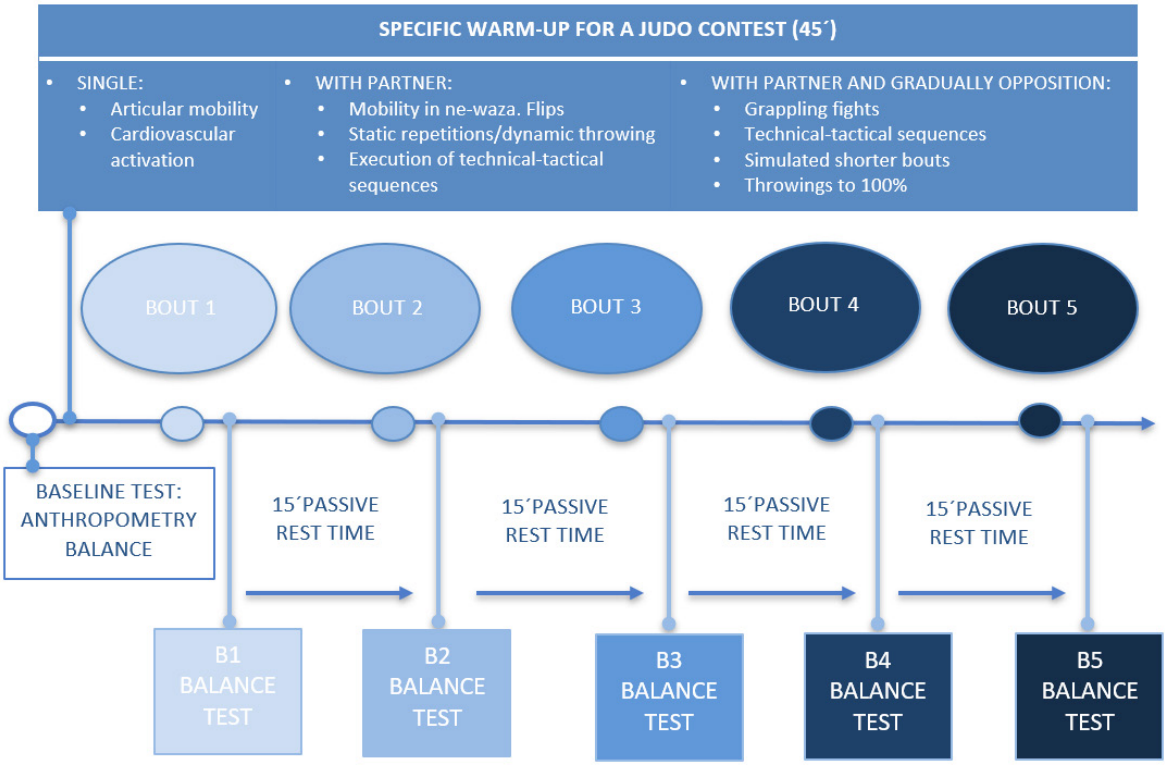

Figure 1. Study design. B_n Balance Test: test done immediately after end of $bout_n$.

clinical trials). All participants were medallists in the National Championship in several age categories and had at least 10 years of experience of judo and 4 years of experience in judo competitions. All of them trained at least 8 hours per week and had not been injured for more than one week in the 3 months before the study.

Procedures

Body mass (kg), body fat and muscle mass variables (kg, %) were obtained with a Tanita 330 S Portable (Tanita Corporation, Arlington Heights, IL, USA), according with recommendations of some authors [37]. The COP and balance abilities were measured during a monopodal stabilometric test with a barompometric device FreeMed® Base (Sensormédica, Roma, Italia). In this test, immediately after each bout, athletes must have to stand on a leg during 10 seconds, with other leg at 90º forward, changing the positions between them. Arms were on the side and head erect head facing forward. This protocol has been tested by several authors [19, 22, 23, 29]. The length and area of the surface occupied by the centre of pressures (CP), as well as the speed of movements in the CP were obtained.

Statistical analysis

The software SPSS version 19.0 for Windows (SPSS, Inc., Chicago, IL, USA) was used to analyse the data (means and standard deviation: SD or ±), with a significance level of $p \leq 0.05$. A normally distribution of data was confirm by Levene's test and the Shapiro-Wilk test, while pre- and post-test data were compared by one-way repeated measures analysis of variance (ANOVA). Post hoc assessment of pairwise differences was obtained by Bonferroni's test. Finally, a Pearson correlation analysis and increases comparing with the difference between post-bout 5 and basal test were obtained (D).

RESULTS

According to SL (Sway long), there were significant differences between SLND ($p<0.001$) and SLB ($p = 0.009$), MV experimented the highest significant differences between 5 bouts: MVND $p = 0.010$; MVD $p = 0.003$; MV2 $p = 0.005$ (Table 1).

We found a significant decrease (51.24%) of EAD respect to baseline test, being the indicator than higher loss percentage obtained (Figure 2).

Table 1. Results (mean and SD) of static balance indicators before (PB0) and after each bout (PB1 to -5) and their significance level.

Variable	Results (a to f refers to Post hoc)							
	PB0 (a)	PB						
		1 (b)	2 (c)	3 (d)	4 (e)	5 (f)	P	ES (h)
EAND (cm)	534.10 ±523.94	640.33 ±425.83	409.29 ±281.65	421.75 ±311.65	400.03 ±286.65	521.75 ±779.03	0.253	0.548
EAD (cm)	653.03 ±429.00 f	613.17 ±524.98	593.78 ±877.27	523.55 ±428.91	429.21 ±239.75	318.41 ±308.71 a	**0.050**	0.736
EA2 (cm)	593.57 ±424.30	626.75 ±453.05	419.25 ±229.68	507.76 ±574.60	522.65 ±489.81	326.00 ±186.27	0.111	0.662
SLND (mm)	313.66 ±42.25 c, d, e, f	281.23 ±81.89 e, f	228.46 ±67.13 a	204.83 ±69.60 a	192.84 ±49.29 a, b	172.77 ±53.40 a, b	**<0.001**	0.957
SLD (mm)	443.94 ±69.07	430.76 ±41.14	423.9 ±53.03	408.56 ±43.54	407.42 ±75.72	399.39 ±61.84	0.288	0.526
SL2 (mm)	378.80 ±35.38 c, d, f	356.00 ±51.53 f	326.19 ±45.73 a	306.70 ±40.56 a	335.13 ±93.77)	286.08 ±46.98 a, b	**0.009**	0.849
MVND (m/s)	39.71 ±5.59	23.22 ±6.65 e, f	20.36 ±5.69 f	19.58 ±6.93	18.66 ±4.62 b	15.05 ±3.73 b, c	**0.010**	0.844
MVD (m/s)	24.24 ±5.15 f	25.08 ±5.71 f	20.35 ±4.03	19.52 ±4.80	21.37 ±9.75	17.65 ±4.38 a, b	**0.003**	0.886
MV2 (m/s)	31.97 ±8.40	24.15 ±5.24 c, f	20.36 ±3.66 b, f	19.55 ±5.21	20.01 ±6.36	16.35 ±2.89 b, c	**0.005**	0.874
YmeanND (mm)	−17.28 ±7.70	−25.12 ±11.42	−18.88 ±6.96	−19.14 ±7.77	−15.68 ±9.18	−35.02 ±65.91	0.186	0.618
YmeanD (mm)	−13.21 ±10.50	−18.52 ±8.19	−18.34 ±12.51	−16.90 ±12.84	−14.24 ±13.43	−8.77 ±16.23	0.256	0.539
Ymean2 (mm)	−15.25 ±7.76	−21.82 ±8.50	−18.61 ±8.37	−18.02 ±9.78	−14.96 ±10.70	−21.90 ±36.08	0.318	0.432
XeamnND (mm)	3.00 ±5.92 f	3.27 ±3.83	2.24 ±4.14	1.25 ±5.41	1.17 ±5.60	−0.48 ±4.30 a	**0.009**	0.891
XmeanD (mm)	−1.08 ±5.85	−1.96 ±5.00	−2.16 ±4.34	−3.79 ±4.23	−0.23 ±4.16	−0.57 ±5.80	0.150	0.612
Xmean2 (mm)	0.96 ±2.69	0.65 ±2.42	0.04 ±2.33	−1.27 ±2.71	0.47 3.71	−0.52 2.55	0.213	0.553

EAD ellipse of area dominant leg; **EAND** ellipse of area no dominant leg; **EA2** ellipse of area both legs; **ES** effect size; **Post hoc** the same letter in different column show significant differences between them, all of them below p<0.05; **SD** standard deviation; **SLD** Sway long dominant leg; **SLND** Sway long no dominant leg; **SL2** Sway long both legs; **MVND** mean velocity no dominant leg; **MVD** mean velocity dominant leg; **MV2** mean velocity both legs; **XmeanD** mean in medial-lateral direction for dominant leg; **XmeanND** mean in medial-lateral direction for no dominant leg; **Xmean2** mean in medial-lateral direction for both legs; **YmeanD** mean in anterior posterior direction for dominant leg; **YmeanND** mean in anteroposterior direction for no dominant leg; **Ymean2** mean in anteroposterior direction for both legs

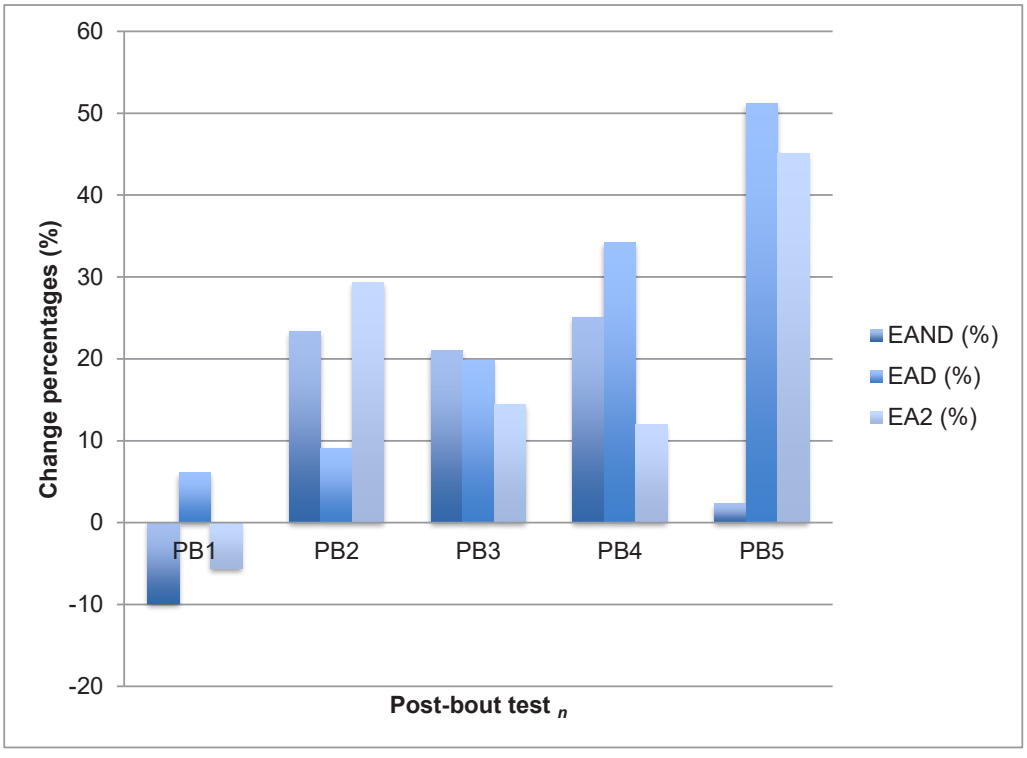

Figure 2. Change percentages (%) in ellipse of area (EA) in a static balance test (Sway test) during a baseline test and after each bout of a judo contest: PB post-bout; EAND ellipse of area no dominant leg; EAD ellipse of area dominant leg; EA2 ellipse of area both legs (mean).

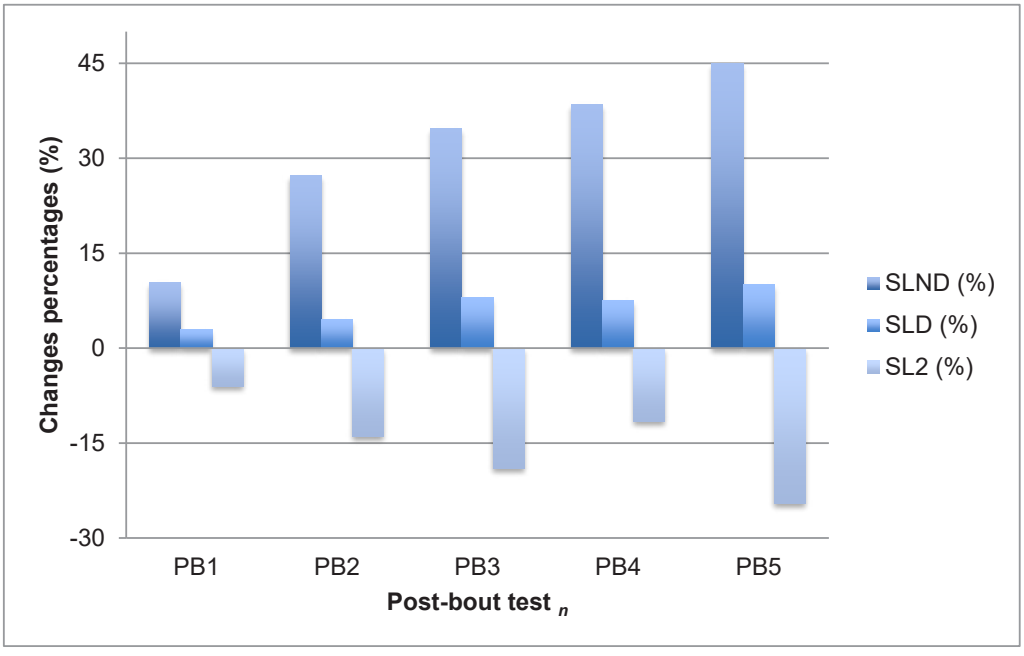

Figure 3. Potentiation percentages (%) in Sway long (SL) in a static balance test (Sway test) during a baseline test and after each bout of a judo contest: PB post-bout; SLND Sway long no dominant leg; SLD Sway long dominant leg; SL2 Sway long both legs (mean).

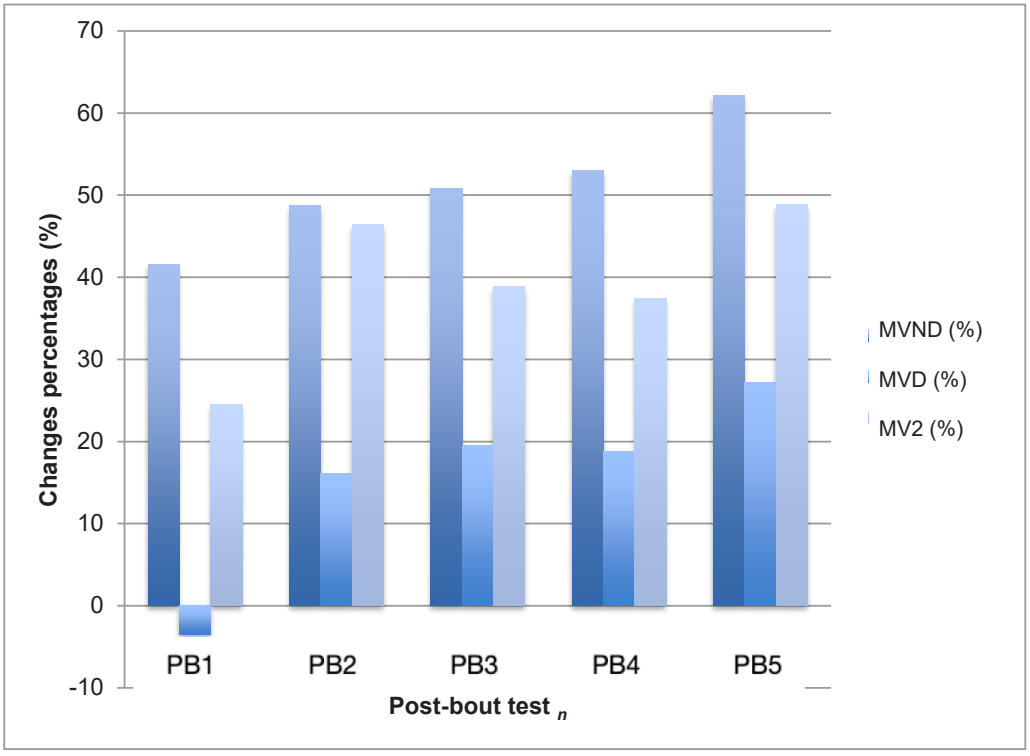

Figure 4. Potentiation percentages (%) in mean velocity (MV) in a static balance test (Sway test) during a baseline test and after each bout of a judo contest: PB post-bout; MVND mean velocity in no dominant leg; MVD mean velocity in dominant leg; MV2 mean velocity in both legs (mean).

Expressing in percentages, it was found a decrease of 44.92% in SLND (Figure 3) between post-bout 5 and baseline test, while a 24.48% of decrease was found in SLB with the same comparison.

We found a 62.10% of decrease was found in MVND, a 27.18% in MVD and a 48.86% in MV2, taking into account post-bout 5 and baseline test (Figure 4).

In Figure 5, it is showed significant differences ($p = 0.009$) in XmeanND but no in XmeanD ($p = 0.150$) and Xmean2 ($p = 0.213$). Also, we not found significant differences in YmeanND ($p = 0.186$), YmeanD ($p = 0.256$) and Ymean2 ($p = 0.318$).

DISCUSSION

One of the strength of our experiment was the obtaining of loss percentages of body balance ability in judo athletes during 5 successive bouts. We have shown an important decrease of indicators, although his evolution has not a regular evolution comparing non-dominant, dominant and both legs. This way, it could be considered as insufficient 15 minutes of official rest-time between bouts to recovery baseline indicators.

No studies have been found with results about balance ability during a judo contest, as in current study. A previous study [22] performed on two groups of athletes, after finishing a group 40x100m (GE1) and the other 10x400 (GE2), an 8.24% increase was obtained in EA (average of both leg) and $p = 0.812$ for GE1, whereas the GE2 obtained a loss of 40.83% ($p = 0.006$). In current study, a 2.31, 51.24 and 45.08% loss in the EAND (ellipse of area no dominant leg), EAD (ellipse of area dominant leg) and EA2 variables was obtained, respectively, comparing the baseline test with the post-bout 5. Comparing our baseline data with some previous studies in taekwondo [38] and karate [39] athletes, it is observed that judo athletes occupy a larger area of EA, due to the type of supports (more stable lasting in time than in taekwondo and karate). On the other hand, in current study, the EA values do not evolve in a constant

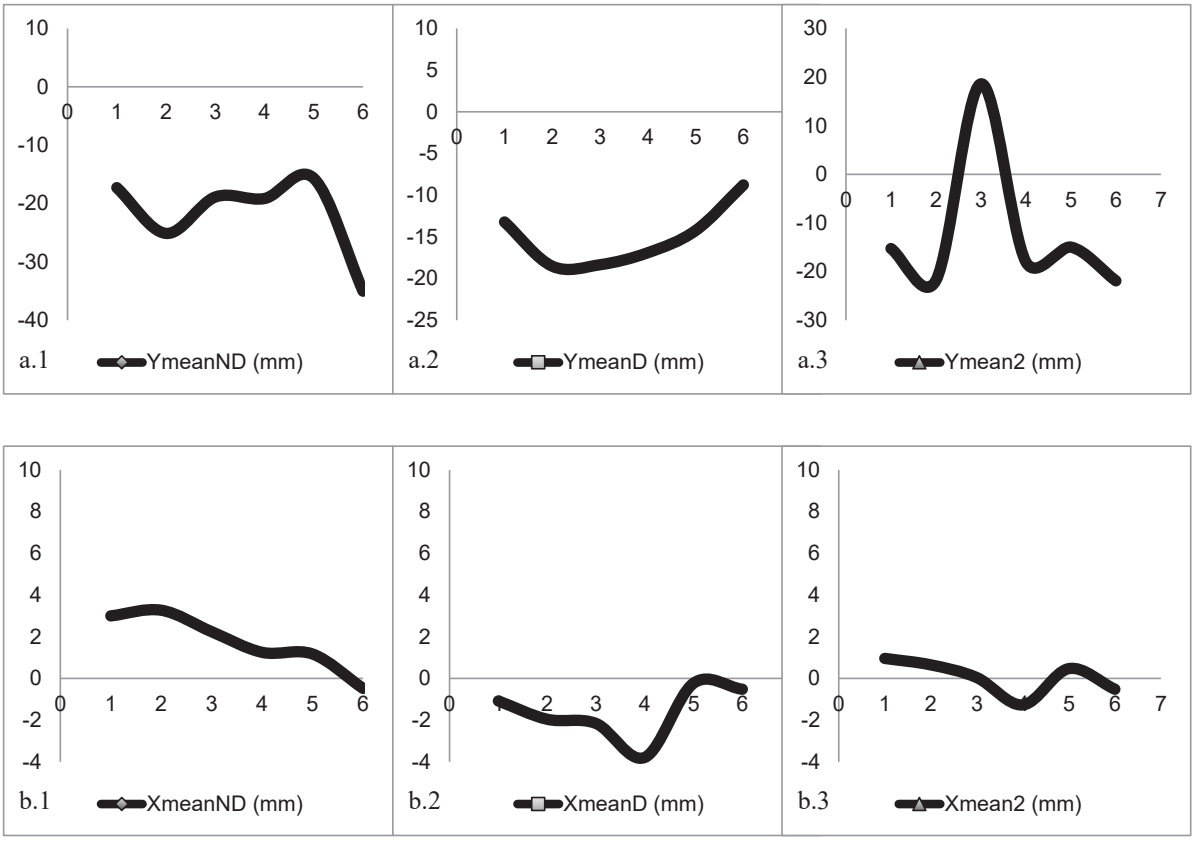

Figure 5. Graphics of center of pressures (COP) in the anteroposterior direction (Y mean: a) and in medial-lateral direction (X mean: b) in a static balance test (Sway test) during a baseline test and after each bout of a judo contest. a.1 no dominant leg; a.2 dominant leg; a.3 mean of bout legs; b.1 no dominant leg; b.2 dominant leg; b.3 mean of bout legs; 1 baseline test; 2 test after bout 1; 3 test after bout 2; 4 test after bout 3; 5 test after bout 4; 6: test after bout 5.

or gradual way among its different variables, as it happened in the study previously mentioned about karate athletes [39], which could be due to the great variability to which it is subject judo bout.

About SL, other study on athletes [22] obtained a loss percentage of 11.59% in EG2 between baseline test and post series (p = 0.020), while EG2 showed a 18.13% of loss (p = 0.001). In current study, it was obtained a decrease of 44.92, 10.03 and 24.48 in SLND, SLD and SLB, respectively, being higher indicators than athletes study. Specifically in judo movements executed on support leg (no-dominant) there is an important decrease in balance ability result of our study.

According MV, the same study [22] obtained a decrease of 12.86% (p = 0.364) in EG1, while EG2 obtained a 19.21% (p = 0.004). Regarding MVND, MVD and MV2 were obtained 62.10, 27.18 y 48.86% of loss, respectively. These data could be construed so as judo contest decrease balance ability indicators across the contest, doing bigger the balance area and smaller MV due to fatigue accumulated by bouts.

Yet, because judo is a sport with higher situations variability, these loss percentages are not proportional and no have a similar evolution with other physical capacities. According with some authors [28, 30], balance ability depends on postural adaptations of each judo athlete.

CONCLUSIONS

The balance ability is modified during a judo contest. There is an important loss that affects to assessment of dominant, no dominant and mean values to both legs. Due to the fact that there are a high variability of situations that occurs in judo and individuals adaptations postural to aim a high performance, there is not a proportional loss in balance that in others capacities.

PRACTICAL APLICATIONS

It is known the importance of static balance and the relation with judo, not only on physical performance but also the injury prevention. There are lots studies about postural balance related with jump capacity, with higher incidence on judo contest and as a predictor of muscle power. This way, the importance of maintains an appropriate level in balance ability.

According with these facts, it seem to be crucial the implementation of proprioceptive, postural and static balance in training programs, with special interest on information showed in current study about evolution of balance ability during a judo contest.

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