Postural balance control ability of visually impaired and unimpaired judoists

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Abstract

Background and Study Aim: This research proposal aims to evaluate the postural balance control ability of visually impaired and unimpaired judoists among different sensory conditions (eyes open or closed) using a simple field test.

Material/Methods: A total of 38 volunteers men aged 28.7±6.8 years assigned into three groups, 10 visually impaired judoists of world-level, 14 visually unimpaired judoists of national level and 14 non-athletes without health disorder were chosen as the control group. They performed in randomized trials the Unipedal Stance Test three times successively in both sensory conditions, eyes open or closed. The mean and the best Unipedal Stance Test score of the 3 trails were recorded for each patient.

Results: The Unipedal Stance Test results obtained with eyes open were better than those for eyes closed as expected. The best values for eyes open and closed were: 45 *vs.* 30.5 sec, 45 *vs.* 26.5 sec and 45 *vs.* 11.3 sec for visually unimpaired judoist, visually unimpaired judoists and non-athletes, respectively. Better Unipedal Stance Test score with closed eyes was recorded for both judoists groups compared to non-athletes.

Conclusions: Our finding could suggest that the regular practice of specific judo training improve significantly the proprioceptive system of visually impaired persons

Key words: Judo • visual impairment • proprioception • Unipedal Stance Test

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Background

Judo means 'gentle way' and it is the only martial art on the Paralympic Games program Judo's emphasis on touch, balance and kinaesthetics complements the highly developed skills of athletes. Judo is leisure sport and accessible for all people, anyone can practice it without or with motor impairment (amputee, hemiplegic, paraplegic, cerebral palsy, etc.), mental disorder (mental retardation, emotional or mental illness, organic brain syndrome, Tourette syndrome, etc.), hearing impairment (voiceless or deaf) and/or **visual impairment** (blindness or lower vision). The participation to official judo tournament depends of handicap degrees.

In case of visual impairments, judoists match both *Kata* (technical demonstration) and *Shiai* (fight). However, there has always been a need for uniformity according to the rules of the International Blind Sports Federation (IBSF) [1] at various events where the VIMJ contest

Judo – meaning "gentle way" is a modern Japanese martial art and combat sport that was created in Japan in 1882 by Dr Kano Jigoro [17].

Visual impairment – Visual impairment or low vision is a severe reduction in vision that cannot be corrected with standard glasses or contact lenses and reduces a person's ability to function at certain or all tasks [21].

against unimpaired judoists. Training for the VIMJ should include specific instruction on the rules applicable to their participation according to the International Judo Federation (IJF) [2]. As more visually impaired athletes take part at different competition levels, world championship, Paralympic Games etc. The judges and referees should also be familiar with the rules of judo competition involving VIMJ. The judo competition rules for VIMJ are exclusively defined by the IBSF.

Current rules call for the judge to clap once with arms outstretched in front. The opponents then go forward each other until contact is established. They connect in gripping (*Kumi-kata*) (grip each other's *gi*). The opponents should have their feet even or parallel with each other and then the judge announces the word "*hajime*".

The IBSF recognize officially three handicap categories of ophthalmological viewpoint, i.e. persons who present visual impairment: B1 = from perception of light in either eye to the perception of light, but without the ability to recognize the shape of a hand at any distance or in any direction; B2 = from the ability to recognize the shape of a hand to a visual acuity of 2/60 and/or a visual field of less than 5 degrees; B3 = from a visual acuity above 2/60 up to visual acuity of 6/60 and/or a visual field of more than 5 degrees and less than 20 degrees. All classifications will be applied for both eyes, with the aid of the best corrective lenses, e.g., all the subjects who wear contact lenses or eyeglasses should be wearing when submitted for an ophthalmologic test (if they intend to make use of them while competing). All visually impaired person classifications B1, B2 and B3 will contest together in an official tournament.

Judo is characterized by static and dynamic actions, involves all muscle chains in the body and makes them work in a synchronized manner [3,4]. From biomechanical point of view, judo match analysis showed different phases of muscular work [5]: a) stand-up phase work (*nage-waza*) characterized by isometric effort in the upper body (use of static strength) and dynamic work in the lower body, sometimes explosive (use of pseudo-dynamic strength); b) ground phase work (*ne-waza*), mostly characterized by isometric work (use of maximal pseudo-dynamic strength) to maintain a posture and/or to immobilize the opponent (*osaekomi-waza*).

The principle philosophy of judo is «Maximum efficiency, minimum effort» (seiryoku zen'yo), which has showed a great interest using the strength of opponent in unbalance phase increase significantly the throwing efficiently. Judo technique is composed of three important phases from analytic viewpoint: (1) *kuzushi,* the first phase defined as preparatory phase to unbalance of opponent (2) *tsukuri,* the process of fitting into the throw to prepare to the throw *and*,(3) *kake* the air phase describing the execution of the throw itself [6].

Balance is the process of maintaining the position of the body's centre of gravity vertically over the base of support and relies on rapid, continuous feedback from visual, vestibular and somatosensory structures and then executing smooth and coordinated neuromuscular actions [7,8].

The visual feedback and posture kinetic function may become progressively more important as the sport achievement increases [9]. The same authors showed that the high-level judoist uses more visual information than lower-level judoists in order to maintain their posture. One judo study [10] stated that static balance is related to the level of judo experience. The time spent standing in combat and the total of break times is greater for VIMJ compared to VUMJ [11].The literature reviews show little studies of physiological [3,12,13] and biomechanical approaches related to judo [12,14] and even less for judo handicap. Although Judo is became a Paralympic sport since 24 years (Seoul, 1988) for men and 8 years for women (Athena, 2004), no previous studies has given knowledge about the balance variables of judoists with visual impairment.

This study aims to evaluate the postural balance of VIMJ, VUMJ and non-athletes (NA) in both sensory conditions, eyes open or closed.

Material and Methods

Patients

Thirty eight (n=38) male volunteers aged 28.7±6.8 years recruited randomly were evaluated in this study. They included 10 VIMJ (2B1, 5B2 and 3B3) of high-level including 3 World Championships winners' medals (Istanbul 2010) and qualified for the London 2012 Paralympic Games, 14 VUMJ of national-level and 14 NA. The both groups VIMJ and VUMJ carry out regularly 4-5 specific judo training sessions per week and took part to judo tournaments. All patients had no previous lower extremity injuries and signed an informed consent according to Helsinki's Declaration. This study was approved by the local Ethics Committee of the kinanthropology department of the University of Quebec in Montreal, Canada.

Measures and procedures

All subjects performed **Unipedal Stance Test** (UPST) and all measurements were conducted by one of us (R.A).

Proprioception – The proprioception can be defined as a specialized variation of the sensory modality of touch that encompasses the sensation of joint movement (kinesthesia) and joint position (joint position sense) [22].

Unipedal Stance Test – The Unipedal Stance Test is defined as a method of quantifying static balance ability [23].

Table1. Anthropometric characteristics and training experience of three groups VIMJ, VUMJ and NA (mean ±SD).

Groups	Age (years)	Weight (kg)	Height (cm)	Judo experience (years)
VIMJ	26.2±6.5	79.2±21.7	173.1±11.6	11.1±8.0
VUMJ	26.5±6.1	76.3±15.8	175.1±9.8	13.1±6.7
NA	32.2±6.2	80.1±21.0	178.0±8.7	No experience

VIMJ – visually impaired judoists; VUMJ –visually unimpaired judoists; NA – non-athletes.

Table 2. Results of UPST (sec) of three groups (VIMJ, VUMJ, and NA) for eyes open or eyes closed.

Condition	Eyes open (sec)	Eyes open (sec)	Eyes closed (sec)	Eyes closed (sec)
Results	Best (Median, Min–Max)	Average (Median, Min–Max)	Best (Median, Min–Max)	Average (Median, Min–Max)
VIMJ (n=10)	45.0, 19.0–45.0	42.5, 13.3–45.0	30.5, 8.0–45.0*	16.0, 6.2–40.7**
VUMJ (n=14)	45.0, 10.0–45.0	45.0, 8.0–45.0	26.5, 2.0–45.0	15.2, 1.3–45.0
NA (n=14)	45.0, 6.0–45.0	45.0, 4.7–45.0	11.3, 1.1–45.0*	7.9, 0.9–43.5**

VIMJ – visually impaired judoists; VUMJ –visually unimpaired judoists; NA – non-athletes; *p=0.014; **p=0.009.

The assessor used a stopwatch to measure the amount of time the subject was capable of standing on one leg. Time was measured from the moment when the subject raised the foot off the floor. Time measurement was stopped when the subject: (1) used his arms (i.e. uncrossed arms), (2) used the raised foot (moved it toward or away from the standing leg or touched the floor), (3) moved the weight-bearing foot to maintain his balance (i.e., rotated foot on the ground), (4) a maximum of 45 seconds elapsed, or (5) opened eyes on eyes closed trials. The protocol was repeated 3 times and each one was recorded. The patient performed 3 eyes closed trials, alternating between the conditions e.g. 1 trial with eyes open alternated y 1 trial with eyes closed considered as 1 trial set. The trials order was randomized based on the national identity number. Three minutes of rest were respected between each trial set to avoid the fatigue effect. The best and average UPST score of the 3 trials were considered for analysis. We used the same procedure described previously [15].

Data analysis

Three trials of UPST were recorded for each subject and only the average and the best score were considered for analysis and interpretation. Visual testing of the distribution of the highest and mean values of UPST in the histogram and their standardized. Skewness and Kurtosis which should be range between –2 and +2 was not in agreement with parametric statistics assumptions. The Kruskal-Wallis test was used for group factor. The condition significance (repeated factor) was tested by sign test. The descriptive statistics of UPST best results and median were reported in this study. All data were analyzed by Statgraphics Centurion XVI.I software. The significance level was set at 0.05 ($p<0.05$).

Results

Table 1 shows the homogeneity of physical characteristics of three group according to means and standard deviations ($p>0.05$). Their average age was within the first standard group i.e. 18–39 years [15].

Table 2 shows the results of UPST (sec) for each group (VIMJ, VUMJ and NA) in both eyes open and closed conditions.

The Kruskal-Wallis test confirmed the null hypothesis that the average rank of the UPST results in eyes open condition should be the same in the three compared groups. The test statistics for the UPST best and mean results were 1.20 ($p=0.548$). However the comparison of average ranks of UPST for the best results with eyes closed condition revealed significant differences between the groups (test statistic =6.71, $p=0.035$). A significant difference between medians of VUMJ and NA (15.2 sec) and VIMJ (19.2 sec) was observed. The VIMJ and VUMJ groups were homogenous in this respect. Figure 1 presents the best results of UPST for three groups. This graph shows 3 box-and-whisker plots, one for each group. The middle part of the plot extends from the lower quartile (25%) to the upper quartile (75%), covering the center half of each sample. The center lines within each box show the location of the sample medians. The whiskers extend

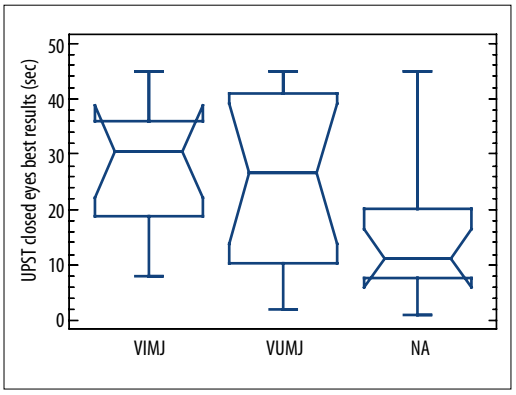

Figure 1. Medians comparisons of the best results of UPST with eyes closed condition. VIMJ –visually impaired judoist, VUMJ – visually unimpaired judoists, NA – non-athletes.

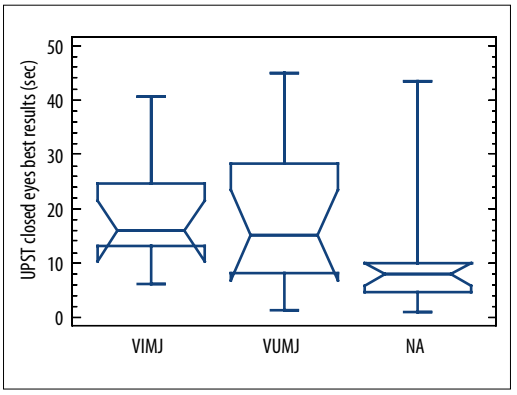

Figure 2. Medians comparisons of mean results of UPST within eyes closed condition. VIMJ –visually impaired judoist, VUMJ – visually unimpaired judoists, NA – non-athletes.

from the box to the minimum and maximum values in each sample.

The same observations were conducted during the analysis of mean results of UPST obtained for the eyes closed condition (Figure 2), where results for the time obtained by judoists were twice longer (better) than the times measured in NA group.

The range covered by each notch shows the uncertainty associated with the estimate of the median in the group. The notches are scaled in such a way that any two samples with notches that do not overlap can be declared to have significantly different medians at the significance level of 5%. In the above plot (Figure 2), the notches for the groups VIMJ and VUMJ overlap, but the median for NA group is significantly lower than that of the groups of judoists.

The condition factor effect was significant (signed test statistic for best and mean results =5.13 and 5.17, $p<0.001$).Naturally, the results obtained with eyes open condition were better than those with the eyes closed condition. The median values recorded were 45 *vs.* 19.6 sec and 45 *vs.* 7.9 sec for eyes open and closed conditions, respectively.

Discussion

The most common physical strains of visually impaired patients are those of balance, posture, coordination, tense neck and shoulder muscles, loss of spinal rotation and reciprocal arm swing [16]. The UPST standards proposed for young untrained men aged 18–39 were 44.4 sec for eyes open and 16.9 sec for eyes closed [15]. The present study showed that groups of judoists reached the maximum level of mean results obtained in UPST tests performed with eyes open (mean =45-secs) and better than the closed eyes standard (15.2 sec).

The results of UPST with eyes open were similar for three groups.The results obtained for the NA were much worse in the eyes closed condition (7.9 sec). It was found that both VIMJ and VUMJ displayed superior static unipedal balance compared to the NA. In this condition, VIMJ did not show the disadvantage as compared to VUMJ or NA. It is likely that UPST test with eyes open was too easy when performed by the most of the subjects who reached their maximum level (ceiling effect).

The UPST seemed more indicative when it realized with eyes closed condition. Although the three groups showed a decreasing in UPST performance (in second) compared to the eyes open condition. Nevertheless, when considering the best values, the VIMJ showed an identical performance to both VIMJ and VUMJ for eyes open condition. Despite bipedal stances recommended in judo textbooks [17] judoists usually make stepping motions and turn their body around of vertical axis. They usually keep their body balance on one lower extremity when doing a step or sweeping an opponent leg(s). Also, they often perform static unilateral actions engaging antigravity muscles that need enhanced balance ability [18]. It can be assumed that these study results reveal a chronic neuromuscular adaptation derived from specific judo training, and more significantly for the VIMJ meaning a compensatory reaction. It' the role of prioprioceptive function ensures the improving control of vertical body posture rather than engaging sight Naturally, when the judoist want to do an attack, the systematic reaction of opponent is to resist or try to avoid the attacker. In these cases, despite strong contracting muscles (static work), they are unable to alternate with any motion. However, the expert judoists might sense resistance and program another attack direction by default because of efficiently proprioceptive information from the kinesthetic system signals about the movements and disposition of the body. Technical and tactical training aimed to develop mechanisms and timing in order to counter-attacks

and/or technical combinations should allow to improving the prioprioceptive signals responsible while keeping of vertical posture. One of this study interests is to underline the efficiently of judo exercise without visual information in control and keeping of postural balance. Our observations are similar with those reported by some authors [19] previously who stated that judoists had superior static balance compared to untrained subject for eyes closed condition. However, it is important to underline the uncertain information hypothesis that the judoists successful in competitions at different levels should display better static balance [9] was not confirmed really as showed in current specialized literature reviewed [7]. Another research [10] observed that senior judoists expressed better balance ability compared to both juniors and cadets. The balance training may lead to task specific neural adaptation at the spinal and supra-spinal levels, such as muscle stretch reflex during postural task, which leads to less destabilizing movements and improved balance ability [7]. The effect of gymnastics on postural control was also demonstrated. Indeed, the gymnasts experts seem to use more efficiently the visual information and other sensory systems than untrained subject [20].

Although the results presented here originate from a cross-sectional study, it seems important to prescribe for visually impaired persons a specific judo exercises in order to develop efficiently their proprioceptive function. This approach might successfully supplement a valuable set of exercises used for development of balance and coordination abilities [7].

Conclusions

Our results could suggest that it's useless to test the static balance of judoist with open eyes condition. Better UPST performance was revealed with eyes closed for both VIMJ and VUMJ, who performed significantly longer times of keeping body position with closed eyes condition compared to NA. The subjects who have experience in judo training and fights improved significantly their postural balance than NA

Application

A specific judo task should be integrated in postural rehabilitation processes for person with or without visual disability in order to prevent a risk of fall.

Perspective

In future research, we will investigate the postural kinetic function of both VIMJ and VUMJ in altered sensory conditions on the platform mechanic device.

Highlights

This study is the first one to give information about the proprioception and kinaesthetic adaptations resulted from chronic judo training for visually impaired judoist.

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