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Abstract: Judoka's balance consists in passing from an individual balance to an interdependent balance. The aim of this work is to study the mechanisms of imbalance and the mechanisms of postural regulation in judoka in order to deduce some considerations for teaching. The first part describes in the notion of imbalance in judoka. This is fundamental for technical learning. The objective analysis of postural control requires kinetic and kinematic measures. The second part relates how different scientific works were conducted in an attempt to understand the postural control in judoka. The role of the grip (kumi-kata) is presented in the postural regulation in judoka, the postural adaptations induced by judo training and the intrinsic postural factors of judoka that influence the direction of his falls. The various quoted pieces of information are illustrated with practical examples.

The role of the grip (kumi-kata) is fundamental for the judoka because

- it provides somaesthetic information about his own movements and positions as well as those of his opponent,
- it also enables controlling, attacking and defending forces to be applied against the opponent as well as control of the judoka's own balance.

On the basis of this, the authors make various proposals for training in order to improve the efficiency of the postural activities of judoka.

The mechanisms for balance are dependent on control of the posture in such a way that the vertical axis of gravity remains within the support surface (the support polygon). The movement of a single body part alters the position of the body's centre of gravity and the slightest body part movement is therefore a source of imbalance. In judo, the two opponents are balanced together by means of their grip (kumi-kata). A judoka's postural control is based on numerous complex factors because, apart from his own movements and actions, there is a wide range of external forces exerted by his opponent that constantly attempt to upset his balance. According to Cadières and Trilles [1998], the judoka not only alters his posture with reference to the vertical axis but also in respect of the forces applied against him by the opponent. One study has shown that the posture of the judoka influences the likelihood of his falling in a particular direction [Paillard *et al.* 2005]. Furthermore, the role of the grip (kumi-kata) is fundamental for the judoka because it provides somaesthetic information about his own movements and positions as well as those of his opponent (e.g. his opponent's movements and positions) and it

also enables controlling, attacking and defending forces to be applied against the opponent as well as control of the judoka's own balance [Paillard *et al.* 2005]. Furthermore, the motor activity of the judoka is very specific and results in particular postural adaptations to the movements that are practised by preference [Paillard *et al.* 2007].

The purpose of this study is to examine in detail the three issues referred to above:

1. The influence of posture on the direction of fall,
2. The role of kumi-kata,
3. Postural adaptations resulting from practice, and then, on the basis of the outcome of the examination of these three issues, to make various proposals for training.

1. The influence of posture on the direction of a judoka's fall

In an experiment carried out with judoka experts, Paillard *et al.* [2005] considered whether it was possible that the postural positions of a subject,

evaluated on a force platform in relation to the anteroposterior axis, in a bipedal condition and without an opponent, could influence the direction of falls (forwards or backwards) in combat situations. In other words, a hypothesis might be made that judokas with a forward centre of pressure (CP) might be predisposed to fall forwards more often. However, the analysis of the results produced the opposite conclusion. The average position of the CP of pressure of subjects who are “forward fallers” is, in fact, situated more in a backward position. The forward faller, in a situation of precarious balance which could be broken by imbalance to the rear, will be likely to react by a reflex movement which involves pushing the arm against the opponent, which can be exploited in turn by a forward-throwing attack.

1.1. Practical aspects

Action-reaction attacks (causing the opponent to make forward-backward or backward-forward movements) using attack sequences or feigning attacks would have the advantage of upsetting the opponent's balance and causing him to fall. That is to say that a backward-forward movement would be particularly effective against an opponent with a CP positioned towards the rear.

1.2. Proposals for judo training

It is advisable therefore to make the judoka aware of his own predispositions in respect of his vulnerability either to forward-backward movements or to backward-forward movements. Different training exercises, working especially on action-reaction attacks, can be used to work on balance disturbance. For example, uchi komi or nage komi can be used to produce a feigned attack on the rear in order to then attack the front.

However, using the same training exercises or in pre-arranged combat (Yaku soku geiko, kakari geiko), random forms of attack should still be used. Thus, uke must never know in advance if an attack is going to be made in the form of a direct attack or an action-reaction attack. This point is paramount to ensure that the opponent's actions are not over-anticipated and, especially, to ensure that he is aware of the postural adjustments that have been made. Here, it is necessary to be very attentive to the slightest body part movements that need to be made when in a difficult postural position in order to maintain postural control. The judoka must therefore learn to auto-regulate himself and be conscious of the reactions in his chest, arms and legs, according to the particular attack made against

him. He must also learn to take advantage of precise feedback from his partner or trainer.

2. Interdependent balance in judo – the key role of kumi-kata

In judo, the two opponents are balanced together by means of their grip (kumi-kata). This grip can be such that on occasions the projected centre of gravity of one or even both combatants is situated outside their own support polygon. The kumi-kata of the judoka provides somaesthetic information about his own movements and positions as well as those of his opponent (e.g. his opponent's movements and positions) but it also enables controlling, attacking and defending forces to be applied against the opponent as well as control of the judoka's own postural balance.

The judoka's postural regulation results (apart from visual and vestibular information), from proprioceptive and cutaneous information, which originates from four additional sources - two hand supports and two supports from the soles of the feet. The sensory receptors of the first three cervical vertebrae transmit proprioceptive information that is useful for the judoka's process of postural regulation.

2.1. Practical aspects

It is difficult for the judoka, especially the beginner, to discern the relevant information that will enable him to maintain his postural stability. In a combat situation it is advisable to avoid a kumi-kata from above (a hold behind the head which blocks the head and pushes it downwards). Apart from limiting the judoka technically and tactically, this disturbs the process of obtaining proprioceptive information and impedes the visual field. It is also important to teach the beginner how to carry out the “traditional” grip (one hand on the elbow and the other at the back and bottom of the neck), which enables him to use all the receptors that can detect any possible error. This grip with its potential follow-up actions (using traction, pushing and compressions forces) is also a source of imbalance because it frequently changes in direction and intensity simultaneously as a result of offensive or defensive tactics.

In relation to this last point, it is proposed that a beginner judoka must establish new balance references and new sensorimotor skills in order to learn to balance while carrying out pushing or traction forces with the use of his upper limbs, through the use of compensatory movements of the chest or anticipatory or compensatory movements

of the lower limbs. The positioning of the hands on the judoka opponent, as well as the positioning of the forearms or trunk on the opponent's trunk also provides potential additional supports for balancing or re-balancing.

2.2. Proposals for judo training

Many traditional training exercises can be used for teaching the judoka techniques of balance and re-balance (*yaku soku geiko*, *kakari geiko* etc.) since there is a dynamic aspect and it is very important to master this dynamic power in relation to movements with an effective opponent. On the other hand, static positions or movements that are carried out too slowly are to be avoided.

By way of illustration, we propose two exercises that can be used to teach balance for a judoka when facing a uke attack.

These exercises can be carried out in two ways:

- firstly, uke responds to tori's moves without trying to anticipate them
- secondly, the judoka tries to anticipate tori's moves doing a *tai-sabaki*.

First exercise:

- The objective: to adapt to the opponent's moves in order to maintain balance
- The aim for tori: take his *kumi-kata* and then destabilise uke, making his opponent lose his balance only by changes of position and arm actions (having an intention to attack but not actually carrying out any throwing techniques)
- The aim for uke: to maintain or re-establish his balance as quickly as possible
- Instructions: The emphasis must be on mobility (the legs should be slightly bent and the pelvis should be centred). The chest should be straight and the head should be aligned with the vertebral column. The feet should be able to preserve contact with the ground and hold enough space to enable balance (avoid jumping actions or excessive movements with the feet), and arms should be flexible, not tense, in order to feel and respond to the opponent's actions.

Possible developments with a variable grip to make uke aware of ways to maintain balance:

- Uke does not grasp tori but keeps both hands on his own belt.
- Uke grips first with one hand then the other, with one hand always remaining on the belt.
- Uke grips with both hands but keeps his eyes closed.
- Uke allows himself to be grasped behind his head.

Comments: Exercises that include a specific position to reach or result in the withdrawal of the opponent, such as might be used in sumo, have been avoided here because it seems to us that these kinds of actions do not correspond sufficiently to the specific balance requirements of judo.

Second exercise:

- The objective: to adapt to the opponent's attacks in order to maintain balance.
- Uke unbalances tori by pushing or by traction and tori makes a slight resistance to this force. The arms should not be tense.
- The aim for tori is to choose a moment for attack to throw uke with the use of a push or traction
- The aim for uke is to slip out of the position or re-establish balance as quickly as possible. Uke can slip out of the position or even successfully counter the opponent's attack by using his opponent's body for support. In this case, the support comes from the hands, elbows, abdomen and even the thighs.
- Possible variations:
 - Uke has to hold a particular position (e.g. he has one leg clearly positioned forward).
 - A throwing technique is announced in advance or not.
 - An attack is made either after a signal or randomly.
 - Uke tries to make a counter attack after taking evasive action, and he must have re-established his balance to do this.
 - An action-reaction sequence is also possible for tori

These two exercises are intended to give uke an opportunity to feel and experience the disturbances while in a position of interdependent balance and then to consciously reflect on ways of maintaining or re-establishing balance.

3. Postural adaptations produced by the practice of judo

Numerous authors [Crémieux, Mesure 1992; Mesure *et al.* 1996; Perrot *et al.* 1998] have shown how the regular practice of sport improves the ability to use proprioceptive and somesthetic information and to improve postural control, because sensorimotor strategies that are more developed and situationally appropriate can be used.

The practice of judo above all develops myotatic proprioception and vestibular and cutaneous plantar (soles of the feet) sensibility. In fact, according to Perrin *et al.* [2002], judokas have a more developed

sensibility than dancers. Sports practitioners at the highest competitive level also have the highest level of postural control [Era *et al.* 1996; Paillard, Noe 2006]. Furthermore, a relationship has been established between the specific nature of a judoka's motor activity and his postural activities [Paillard *et al.* 2002, 2007]. The repetition of specific movements induces postural adaptations that are related to the movements and new specific motor skills are developed. Thus judokas who prefer to perform throwing techniques in a bipedal condition have more stability than judokas who specialise in techniques in a mono pedal condition, when their postural control is evaluated in a bipedal condition. Conversely, specialists in techniques in a mono pedal condition are more efficient than specialists in techniques in a bipedal condition, when their posture is evaluated in a mono pedal condition.

3.1. Practical aspects

These results are not at all surprising considering the specific nature of judokas' competitive training which demands constant repetitions of favourite techniques during training exercises with a partner or in combat situations and postural control becomes more developed in relation to this specialised motricity.

3.2. Proposals for judo training

It is advisable to avoid the risk of excessive muscular and postural asymmetry. In fact, a left handed judoka practising techniques on the right foot support only, both in training and in combat, may develop postural asymmetry that results in pathology in the long term. He should therefore do exercises for muscular reinforcement of the non-supporting leg, and also do more specific judo exercises to develop techniques on the right side with a uni pedal support stance and techniques for double support for both sides.

Training must always involve specialised motricity in relation to his tokui waza (favourite techniques), or rather his specialisations, because successful judokas all have two or three favourite throwing techniques and a compensatory motricity, enabling the judoka to explore other throwing techniques.

Conclusion

Balance capabilities are unquestionably one of the most important determinants of a judoka's performance. It is hoped that this brief review of

the literature will have developed awareness of the postural adaptations induced by the practice of judo; most importantly, though, this has provided a sound theoretical basis for the construction of an appropriate training programme that focuses on balance, either for the beginning of the learning process, and especially to help those who have problems with balance to develop, or for the experienced practitioner to learn how to compensate for the effects of highly specialised motricity. New working perspectives would consist in integrating the researches concerning the adaptive movements of the judoka and analysis of patterns of response to the opponent's attacks [Sogabe *et al.* 2008].

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Nauczenie równowagi dla praktyków judo

Słowa kluczowe: równowaga, kontrola posturalna, nauczanie, judo

Streszczenie

Celem pracy jest zbadanie mechanizmów zakłócania równowagi i mechanizmów regulacji postawy dżudoków w celu znalezienia wytycznych do nauczania. Pierwsza część opisuje pojęcie równowagi u dżudoków, która ma fundamentalne znaczenie dla nauczania techniki tej walki. Cel analizy kontroli postawy wymaga kinetycznych i kinematycznych środków.

Druga część pracy dotyczy różnych badań naukowych próbujących zrozumieć kontrolę posturalną dżudoki. Rola chwytu (kumi-kata) jest zaprezentowana w regulacji postawy dżudoki, adaptacji posturalnej wywołanej przez trening dżudo i wewnętrznych posturalnych cechach dżudoki, które wpływają na kierunek jego upadku. Rola chwytu (kumi-kata) ma podstawowe znaczenie dla dżudoki ponieważ dostarcza somestetyczne informacje o własnych wykonywanych ruchach, pozycjach, a także tych, które wykonuje przeciwnik. Umożliwia zastosowanie siły odpowiedzialnej za kontrolę, atak i obronę, a także utrzymanie równowagi przez dżudokę. Równowaga ta polega na przejściu od równowagi indywidualnej do współzależnej. Praca zawiera liczne informacje zilustrowane praktycznymi przykładami. Na podstawie powyższych informacji autorzy przedstawiają różne propozycje treningu w celu poprawy efektywności ćwiczeń posturalnych dżudoki.