Postural patterns and adaptations in judo athletes

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Wagner Castropil[ADE], Carla Arnoni[BCD]

Instituto Vita, Sao Paulo, Brazil

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Abstract

Background & Study Aim: Regular practice results in physiological and postural adaptations that may correlate with a higher incidence of injuries in some sports. The postural adaptations in judo are not well understood. The aim of this study was the common posture patterns and misalignments of high-level judo athletes.

Material & Methods: The postures of 50 judo athletes (23 men and 27 women) were evaluated using a posture grid and plumb line. Full analysis was performed on 37 subjects (19 women and 18 men). This posture analysis method was chosen because it is accessible and can be easily applied by health professionals supporting athletes in the field.

Results: Only one athlete did not have any misalignment. The most common postural patterns observed were flat foot (80%), shoulder lateral asymmetry (70%), winged scapula (54%), and forward head posture (58%), all of which are likely to be related to the repetitive movements and sustained positions that are specific to judo.

Conclusion: This study provides the first complete description of postural patterns in judo athletes. Understanding the unique postural patterns and adaptations in judo will help improve training protocols to enhance performance while preventing injuries.

Keywords: injuries • injury prevention • martial arts

Author's address: Wagner Castropil, Instituto Vita, Rua Mato Grosso, 306 - 1o andar, Sao Paulo, 01239-020, Brasil; e-mail: castropil@institutovita.com.br

Introduction

Judo – Japanese meaning "gentle way" is a modern martial art created in Japan in 1882 by Jigoro Kano.

Uke – the receiver of the technique applied by the opponent.

Tori – an individual who applied a technique in judô training.

Postural pattern – shape or form of a stance.

The regular and intense practice of certain sports is known to result in physiological and postural adaptations in an athlete's body. In long-term studies, some of these adaptations have been reported to correlate with a higher incidence of injuries [1-3]. For instance, the scapula of the dominant shoulder in baseball players is more internally rotated and anteriorly inclined compared to that of the non-dominant shoulder [4] Such scapular positioning can, in turn, lead to subacromial impingement syndrome, which is worsened by concomitant thoracic hyperkyphosis and cervical hyperlordosis [5].

Judo is an ancient Japanese martial art that became an Olympic sport during the 1964 Tokyo Olympic Games. As with many contact sports, judo has a high incidence of injuries [6-8]. There are no reports in the literature that describe postural patterns and adaptations that are specific to judo or that address their possible relationships with the most common judo injuries. Based on findings reported for other activities [3,6,7], it is important to understand the postural patterns and adaptations that are unique to judo to design training protocols that emphasize the prevention of chronic and insidious injuries that may prevent athletes from competing.

Because frequent evaluations are necessary to assess the effectiveness of training or therapeutic intervention protocols, it is essential that the method used for posture evaluation be simple and accessible. We opted to use the posture grid, which meets these requirements and has been validated in the literature [9,10]. This method also allows for the collection of qualitative rather than quantitative posture data, which

are appropriate for this descriptive groundwork that aims to lay the foundation for future injury-prevention studies.

The aim of this study was the common posture patterns and misalignments of high level judo athletes and their implications for injury prevention.

Material and methods

Fifty high-level judo athletes from the Brazilian national team were evaluated for this study. We included 23 males and 27 females between 16 and 33 years of age from different categories and with a minimum of five years of experience. Sixty-six percent of these athletes were international-level competitors. Although we assessed the posture of 50 athletes, anthropomorphic data and practice history were only collected from 37 athletes (19 females and 18 males) (Tab. 1). None of the selected athletes had trained for another sport.

Approval from the Ethic Committee was obtained before the commencement of this paper and all subjects gave written informed consent.

The athletes were asked to complete a questionnaire to obtain pertinent anthropomorphic data and information regarding their judo practice histories.

The athletes' postures were evaluated using a symmetrographic posture grid (Sanny, Brazil) and a plumb line. This grid consists of a 2.0 X 1.0 m acrylic board divided into 10.0 X 10.0 cm squares [9,10]. The athletes were evaluated in their swimwear while standing on a 20-cm high step positioned in front of the grid. They were then photographed using a digital camera (Canon G12, USA) mounted on a 70-cm high tripod and positioned 2.5 m from the posture grid. Images of the anterior and lateral views of subjects in the orthostatic position were used to assess the alignment of certain body parts in relation to the gridlines. Angles were calculated using the Dartfish software (Dartfish,

Table 1. Anthropomorphic characteristics and practice histories of the judo athletes.

A - Anthropomorphic characteristics of the judo athletes.					
	Maximum age (years)	Minimum age (years)	Average age (years)	Average weight (kg)	Average height (m)
Women (n = 19)	29	16	23.31	69.15	1.64
Men (n = 18)	33	20	26.50	89.56	1.77
Total (n = 37)	33	16	24.86	7.06	1.70

B - Practice history of the judo athletes.						
	Age at the beginning of practice (years)			Age at the beginning of competition (years)		
	Minimum	Maximum	Average	Minimum	Maximum	Average
Women (n = 19)	4	16	9.63	5	15	11
Men (n = 18)	4	14	6.27	5	16	9.64
Total (n = 37)	4	16	8.00	5	16	10.29

A

Foot Posture	n	%
Flat foot (Flat)	40	80
High arch (HArch)	2	4
Normal (NL)	8	16

B

Figure 1. Postural pattern of the foot (total and gender differences).

USA). Relevant anatomical landmarks were marked with surgical tape to facilitate the image identification; these landmarks included the spinous process of C7, bilateral coracoid processes, bilateral anterosuperior portion of the iliac crests, bilateral center of the patellae, and bilateral malleoli [11-13]. Each athlete's posture was assessed for each body part and classified as follows.

Cervical: Normal or Forward Head Posture. The cervical angle was obtained from the lateral view photographs by drawing a horizontal line through C7 and a line from the superior aspect of its spinous process to the tragus of the ear. The normal angle is between 122.6° and 133° [11,14]. Forward head posture was assigned to the athletes with cervical angles that were less than 33.0°.

Shoulder: Normal, Lateral Asymmetry (one side higher than the other), and Forward Shoulder Posture. To assess lateral symmetry based on the anterior view photograph, we calculated the distance between each coracoid process and the nearest horizontal line of the grid. Lateral asymmetry was assigned to those athletes with different distances on the right and left sides. To determine forward shoulder posture, we used the lateral view photograph and drew a line connecting the lateral aspect of each shoulder to C7. The angle between this line and the horizontal line running through the scapula was obtained. Angles were considered normal when between 33.8° and 59.6° [14]. Forward shoulder posture was assigned when angles were less than 33.8°.

Scapula: Normal or Winged. The scapula was considered to be winged when any of its borders (superior, medial, or inferior) was prominent or lifted away from the ribcage [15].

Knee: Normal, Valgus, or Varus. Knee alignment was determined based on the Q angle. Normal ranges are between 6.4 and 16.2° for men (valgus Q angles > 16.2°; varus Q angles < 6.4°) and between 7.8 and 18.8° for women (valgus Q angle > 18.8°; varus < 7.8°) [16].

Ankle and Foot: Normal, Flat, or High Arch. The plantar arch was evaluated subjectively by an orthopedic surgeon who specialized in foot and ankle surgery.

The knees, feet and scapulae were considered to be asymmetrical when at least one side was misaligned.

Results

Only one of the 50 athletes who were evaluated for posture did not present with any form of misalignment. The most frequent postural changes affected the feet and ankles, shoulders, and cervical region. The most common change was flat foot, which affected 80% of the athletes (Fig. 1), followed by shoulder lateral asymmetry (70%) and winged scapula (56%) (Fig. 2A). Forward shoulder posture was more frequent in the female athletes (Fig. 2B). Forward head posture was noted in more than half of all athletes (Fig. 3A) and seemed to affect women

A

Shoulder Posture	n	%
Shoulder asymmetry (ShA)	35	70
Forward shoulder (FSh)	10	20
Normal shoulder (N-Sh)	13	26
Winged scapula (WG)	28	56
Normal scapula (N-Sc)	22	44

B

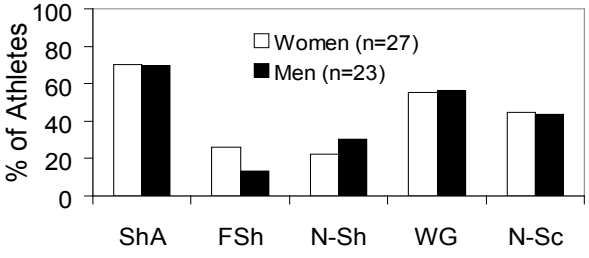

Figure 2. Postural pattern of the shoulder and scapula (total and gender differences).

A

Cervical Posture	n	%
Forward head posture (FH)	29	58
Normal (NL)	11	22

B

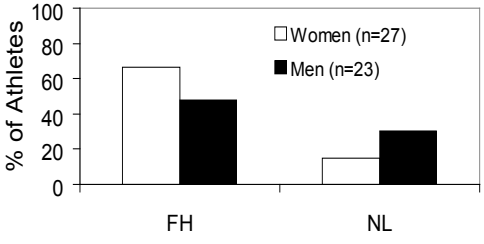

Figure 3. Cervical postural patterns (total and gender differences).

more than men (Fig. 3B). The majority of all athletes had varus knees (Fig. 4A); however, most female athletes had valgus knees (Fig. 4B).

Discussion

Physiological and cardiovascular adaptations to exercise are well understood, and their implications are usually considered when implementing physical training programs for athletes. However, biomechanical and postural adaptations are still poorly understood for most sports. Normal posture ranges are rarely reported in the literature, and little is known about the postural patterns that are unique to each activity. In this study, we evaluated a population of high-level judo athletes with at least five years of experience and who competed in international events. The most prevalent postural changes found in judo athletes, regardless of gender, were flat foot (80%), lateral shoulder asymmetry (70%), forward head posture (58%), and winged scapula (54%).

Note that the main objective of the sport is to throw or takedown the opponent by moving his or her center of gravity away from the base, causing a loss of balance [17]. To efficiently subdue the opponent, the athlete must maintain his or her balance throughout the competition. The movement efficiency increases with the number of contact points between the bare foot and the tatami and with the firmness of the base (obtained by standing with a wide stance).

Sogabe analized the changes in plantar pressure of the eight directions of Kuzushi for top-ranked judo players and reported that *uke* attempt to maintain stability by counteracting external force by pronating the foot and concentrating weight on the ball of his foot [19]. These unique characteristics of the judo stance may help to explain the flat foot posture that was observed in most of the athletes.

The normal plantar arch is supported by ligamentous structures that, if positioned repetitively under forced pronation, may stretch excessively and result in arch collapse and flat foot [20]. Collapse of the plantar arch has been associated with tibial posterior muscle weakness and altered foot function, including prolonged calcaneal eversion, increased tibial internal rotation, increased forefoot abduction, reduced efficiency of gait, and reduced shock absorption. As a result, greater stress might be applied to those structures involved in controlling these movements during the stance phase of the gait. Additionally, abnormal foot motion may increase stress on more proximal structures, such as the knee joint, predisposing both the foot and knee to lesions [20,21].

Scapular and shoulder asymmetries, such as having winged scapula and one shoulder that is higher than the other, were also frequent findings in our study population. These findings may be explained by the fact that the shoulder region is subject to frequent and direct trauma in judo. To protect themselves, athletes will often contract the pectoral muscles, closing the chest and bringing the shoulders up towards the ears. Judo athletes also use their shoulders to perform complex movements and transfer energy from the trunk to the upper limbs, while grappling, choking, and taking down the opponent. It is important to minimize shoulder asymmetry because it may alter the biomechanical characteristics of the scapular region and compromise the transfer of energy from the trunk to the upper limbs. The inefficiency of this local kinetic chain leads to shoulder strain and increased risk for subacromial impingement syndrome [22,23]. Forward head posture, which was present in more than half of the judo athletes we studied, may also impact the incidence of shoulder lesions. This type of cervical misalignment leads to anterior inclination of the scapula and decreases its ability to rotate upward, which is a common problem in patients with shoulder impingement [5,24]. Although there are no reports in the literature correlating judo practice with the development of forward head posture, frequent practice may favor this type of head positioning in defensive stances.

We observed a marked gender difference in knee joint positioning among the judo athletes, with the majority of women having valgus knees (associated with larger Q

A

Knee Posture	n	%
Valgus (Val)	17	34
Varus (Var)	27	54
Normal (NL)	6	12

B

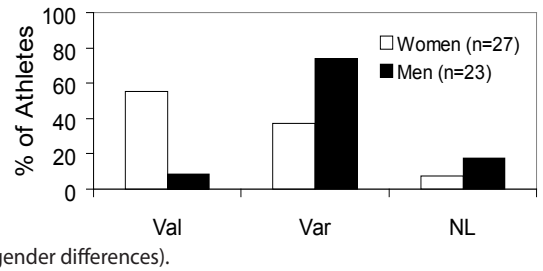

Figure 4. Postural pattern of the knee (total and gender differences).

angles) and most men having varus knees. However, this gender difference has been well described in the literature, regardless of sport practiced [25]. While it is agreed that female athletes have more frequent knee lesions than male athletes [26], there is disagreement as to the direct role of the Q_angle in the mechanism of knee lesions. Larger Q-angles, which are associated with valgus knees, are speculated to increase the lateral pull of the quadriceps muscles on the patella, thereby leading to pressure on the lateral facet of the patella and pain at the anterior knee [16]. However, other authors have not found a correlation between static knee misalignment (as evidenced by the Q angle) and knee lesion incidence; they believe that dynamic valgus alignment is more relevant [27]. Gender difference in the dynamic alignment of the lower limbs and knees during some activities, such as jumps and squats, is well studied and is particularly important in high-impact sports, such as volleyball, basketball, and floor exercises in gymnastics. Dynamic valgus, which occurs much more frequently in women, is exacerbated during landing, predisposing the athlete to lesions. However, a direct role for the Q angle in the development of dynamic valgus has not been demonstrated [25], as women also present wider adduction angles for hips, wider abduction angles for knees, and weaker neuromuscular control, all of which characterize a dynamic valgus alignment [28,29]. The knee joint is the most frequent site of injury in judo, most likely because of weight-bearing, closed-chain torsion [30,31]. However, the role of the Q_angle in closed-chain torsions remains unknown and deserves further study.

Our results suggest that preventive training protocols for judo should focus on strengthening the serratus and trapezius and stretching the pectoralis, which are responsible for stabilizing the scapula and supporting cervical alignment and correct head positioning. We also recommend strengthening the posterior tibial muscle, which plays an essential role in supporting a healthy plantar arch [24,32].

In summary, this report is the first to detail postural patterns and adaptations that are unique to judo, as determined by a simple and accessible evaluation method based on a posture grid. This subjective posture evaluation study lays the groundwork for posture analysis in judo, but further objective posture analysis of the cervical, shoulder, and plantar regions in judo athletes is warranted. Understanding how these posture patterns influence lesion incidence is essential for designing and evaluating the impact of lesion prevention protocols in this martial art.

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Competing Interests

Authors declare that we do not have any financial or personal relationships with other people or organisations that could inappropriately influence our paper.

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