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BIOMECHANIC CLASSIFICATION OF NAGE-WAZA THROWING TECHNIQUES (II)

IOAN-NELU POP[1,*], LEON GOMBOS[1] & COSMIN PRODEA[1]

ABSTRACT. At the first glimpse all throwing techniques can seem different as regarding their form, but a scientific analysis reveals that every throwing technique is a combination of general and particular characteristics. General characteristics are those main actions, which can be found in a large number of techniques, while particular characteristics stop at data level. A bio-mechanic analysis of throwing techniques cannot ignore the problem of rational classification for successive stages: simplification first; generalization and elevating to a principle for all throwing categories. For the principle of simplification of the force class problem, which we are dealing with, the KANO differentiating model will be used, i.e. the subdivision of the throwing motion in three stages. TUKURI - all preparatory movements, meant to prepare the loss of balance of UKE and the positioning of the body of TORI for the throwing. KUZUSHI – the action of the balance loss forces and the direction and final orientation. KAKE – final execution of the movement in order to perform the throwing and UKE analysis, by simplifying the secondary forces, then moving towards generalizing the categories of forces the KAKE phase is subject to. This method used by Attilio Sacripanti in his paper "Biomecanica del JUDO" allowed that the throwing techniques be grouped from a bio-mechanical point of view in two groups based on two execution mechanisms of the technical procedures:

a) Techniques where TORI uses a FORCE COUPLE in order to throw UKE,
b) Techniques where TORI uses the force moment (lever) in order to throw UKE.

The classification of the NAGE-WAZA throwing techniques based on the force couple and lever principle is the classification based on scientific support, which analyses the directions of the forces, static analysis, and the pathway of UKE's body during the throwing phase (flying phase), dynamic analysis, as well as the symmetries of the bio-dynamic group of the athlete couple TORI and UKE.

Keywords: judo, biomechanics classification.

[1] *Babes-Bolyai University, Faculty of Physical Education and Sport, Cluj-Napoca, Romania*.
* *Correponding author: nelupopp@gmail.com*

REZUMAT. ***Clasificarea biomecanică a tehnicilor de proiectare din picioare nage-waza*.** La o primă abordare toate tehnicile de aruncare pot apărea diferite în forma lor, dar o analiză ştiinţifică ne permite a spune că fiecare tehnică de aruncare are în ea caracteristici generale şi caracteristici particulare. Caracteristicile generale sunt acele acţiuni principale care se regăsesc la un număr mare de tehnici, în timp ce caracteristicile particulare se opresc asupra datelor. O analiză biomecanică a proiectărilor nu poate face abstracţii, de înfruntarea problemei clasificării raţionale pentru stadii succesive: simplificare mai întâi ; generalizare şi ridicare la nivel principiu pentru toate categoriile de proiectări. Principiul de simplificare a problemei claselor de forţa în joc se utilizează metodica diferenţială a lui KANO, subdivizarea mişcării de aruncare în trei faze. TUKURI – toate mişcările pregătitoare menite să pregătească dezechilibrarea corpului lui UKE şi poziţionarea corpului lui TORI pentru aruncare. KUZUSHI - acţiunea forţelor de dezechilibrare şi direcţia şi sensul final. KAKE – execuţia finală a mişcărilor pentru efectuarea aruncării şi analiza apoi a lui UKE simplificând efectele forţelor secundare, trecând apoi la generalizarea categoriilor de forţe căruia este supus faza de KAKE. Această metodă aplicată de Attilio Sacripanti în lucrarea sa „Biomecanica del JUDO" a permis gruparea tehnicilor de proiectare din punct de vedere biomecanic în două grupe având la baza două mecanisme de execuţie a procedeelor tehnice:

a) Tehnici în care TORI foloseşte un CUPLU DE FORŢE pentru proiectarea lui UKER;
b) Tehnici în care TORI foloseşte momentul forţei (pârghie fizică) pentru proiectarea lui UKE.

Clasificarea procedeelor tehnice de aruncare NAGE – WAZA având ca principiu de execuţie cuplu de forţe şi pârghia fizică este clasificarea care are un suport ştiinţific care face analiza asupra direcţiilor forţelor, analiză statică, cât şi o analiză a traiectoriilor corpului lui UKE în faza de aruncare (de zbor), analiza dinamica, precum şi simetriile grupării biodinamice a cuplului de sportivi TORI şi UKE.

Cuvinte Cheie: Judo, Clasificarea Biomecanica.

Bio-mechanic classification of Nage-Waza – force couple techniques

The classification of these techniques is presented in table no. 1; the techniques are grouped according to TORI's body parts, which create the force couple.

a) – Couple formed by arm – arm +
b) – Couple formed by arm – calf
c) – Couple formed by torso – calf +

d) – Couple formed by torso – arm
e) – Couple formed by calf – calf

The NAGE-WAZA techniques analyzed within this paragraph are those where throwing (KAKE) occurs as a result of TORI applying a FORCE COUPLE upon UKE's body. After a physical analysis it can be claimed that the techniques of the FORCE COUPLE group will be the more efficient the more TORI's action resembles a physical force couple applied to UKE.

Table no. 1

Couple techniques

Couple techniques	**Applied by the arms**	Kuchiki daoshi Kibisu gaeshi Kakato gaeshi Te guruma	
	Applied by the torso to the claf	O soto gari O stoto giruma Uchi mata Okurikomi uchi mata Harai goshi Hane goshi Hane makikomi Yama arashi	O tsubushi O soto otoshi Kou chi makikomi
	Applied by the arms of claves	De ashi barai Okuri ashi barai Ko uchi barai O uchi barai T subame gaeshi Ko uchi gari Ko soto gari	O uchi gari Ko uchi gake Ko soto gake Harai tsuri komi ashi Yoko gake O soto gake O uchi gake
	Applied by the torso (back) and arms	Morote gari	
	Applied by the two claves	Kani basami	

The couple momentum M = F x d is what characterizes the force couple, where F are the two parallel, but opposite direction, d is the distance between the points, where the forces are applied. The momentum M can be amplified by amplifying the force F, which also implies amplified energy consumption or by amplifying the distance d between the points, where the force is applied, i.e. the grasping points. In throwing techniques by force couple amplifying the duration d as much as the grasping points allow and amplifying the force F is to be presented only in situations, when extra force is needed in order to throw UKE. The extent of the couple momentum of TORI needs to defeat the momentum created by UKE while trying to resist the throw.

$$M_{TORI} > M_{UKE}$$

In order for UKE to resist the force couple moment applied by Tori, they need to block the simultaneity of applying the two forces of the couple by diverging the single direction between the two forces. If the two forces are no longer equal, parallel and with opposite direction, they do not represent a force couple any longer, and thus the rotating momentum is not obtained any longer.

Fig. 1. The arms of claves

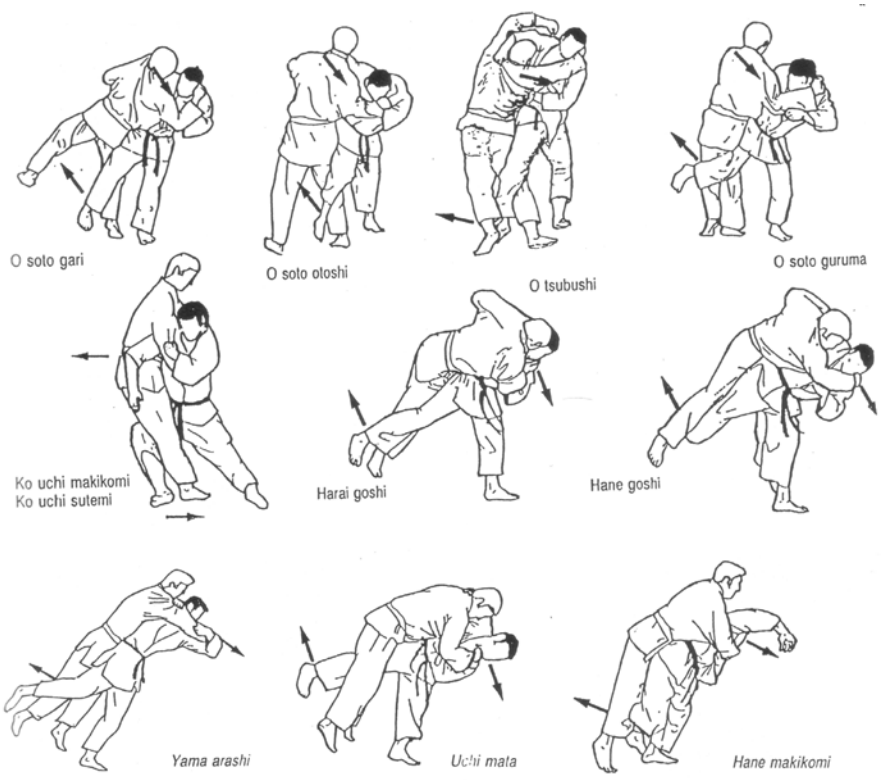

Fig. 2. The torso to the claf

Fig. 3. Claves- claves

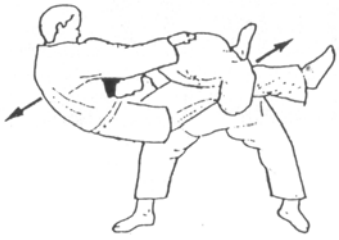

Fig. 4. Couple applied by torso-arms

Fig. 5. Couple applied by the two arms

In the case of performing throws by applying force couples the performance symmetry: O SOTO – GARI and UCHI – MATA, HARAI – GOSI and O SOTO GURUMP is retrieved.

Another symmetry which appears in some throwing techniques using force couple is performance symmetry in the three planes frontal, horizontal and sagittal.

Fundamentals for the PHYSICAL LEVER group

The Nage-Waza techniques analyzed in this paragraph are those where throwing occurs by applying the lever principle on UKE's body.

In the preceding paragraphs we presented the elements of a lever, the type of lever and the amplifying degree of the lever. This paragraph we will present a bone lever, which constitutes the basis of performing the techniques in this category.

We remind the components of a lever:

R – resistant force; F – active force; d – arm of the resistant force; d_2 – arm of the active force; s – supporting point. The two momentums of the two forces according to the supporting point:

$M_1 = M_2$; M_1 = momentum of the active force

M_2 = momentum of the resistant force

$M_1 = F \times d_2$; $M_2 = R \times d_1 \Rightarrow M_1 = M_2 \Rightarrow F \times d_2 = R \times d_1$

the balance relation of a lever.

In order for TORI to be able to defeat UKE's resistance they need to break the balance by amplifying the momentum M_1.

$M_1 > M_2 \Rightarrow F \times d_2 > R \times d_1$

In order for $M_1 > M_2$ either the force F needs to be amplified, which means energy consumption, or the force of the arm d_2 needs be amplified, without energy consumption, only by modifying the support point s.

Throwing techniques, which are based on the lever principle, are classified according to the length of the arm of the force d_2 and the supporting point s.

a) Minimum arm d_2 – supporting point under UKE's belt
b) Medium arm d_2 – supporting point under UKE's knees
c) Maximum arm d_2 – supporting point under UKE's ankle
d) Minimum arm d_2 – supporting point under UKE's belt
e) Variable arm d_2 – variable supporting point from UKE's belt to under UKE's knee.

Bio-mechanic classification of NAGE-WAZA - force momentum techniques

Table no. 2

Force momentum techniques

Force momentum techniques	Minimum arm (supporting point under the belt)	O guruma Kata guruma Tama guruma Maki komi	Sukui nage Ushiro Goshi Utsuri goshi Obi Otoshi	Tawara gaeshi Ura nage Ganseki otoshi Uchi makikomi	Soto makikomi
	Medium arm (supporting point under the knee)	Ashi guruma	Hiza guruma		
	Maximum arm (supporting point under the ankle)	Uki otoshi Yoko otoshi Sumi otoshi Ura otoshi Waki otoshi Tani otoshi	Tai otoshi Dai sharin Tomoe nage Sumi gaeshi Uki waza Yoko guruma	Yoko Wakare Seoi Otoshi Hiza seoi Obi seoi Suso seoi Ikkomi gaeshi	Sasae Tsurimoki Ashi
	Variable arm (variable supporting point from the belt to under the knee)	Tsuri komi goshi Sasae tsurikomi goshi Ko tsurikomi goshi O tsurikomi goshi	Sode tsurikomi goshi Uki goshi O goshi Koshi guruma	Kubi nage Seoi nage Eri seoi nage Morote seoi nage	

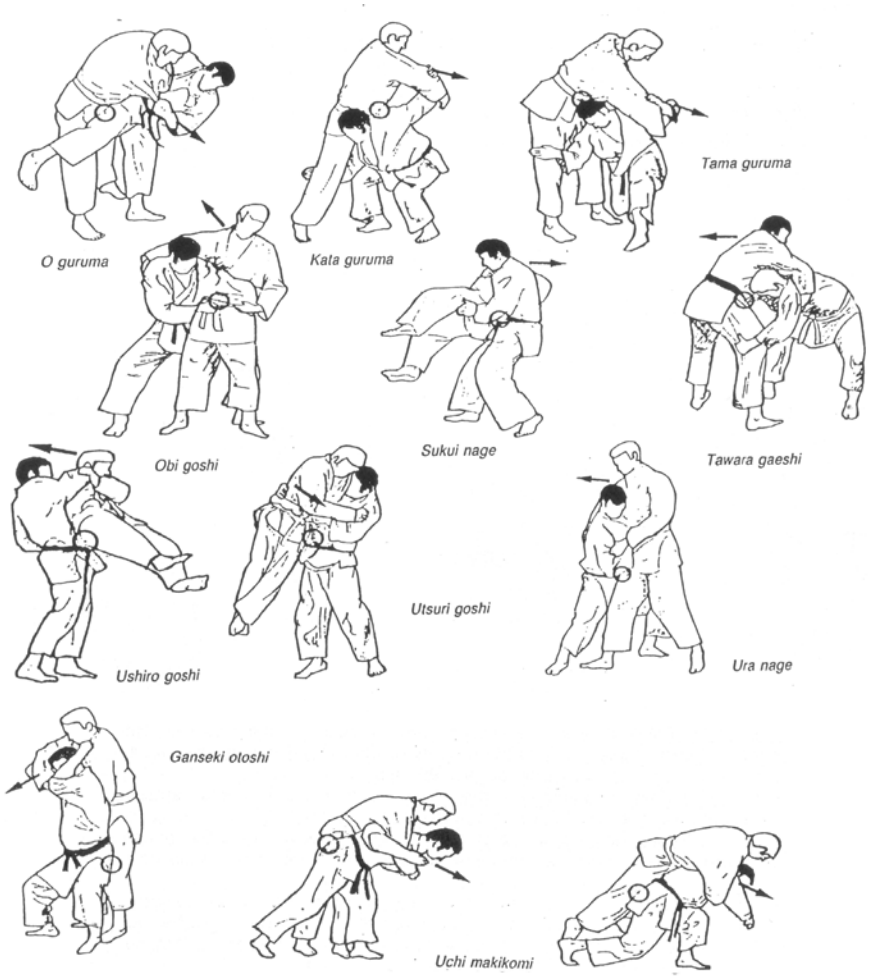

Fig. 6. Minimum arm (supporting point under the belt)

Fig. 7. Medium arm (supporting point under the knee)

Fig. 8. Maximum arm (supporting point under the ankle)

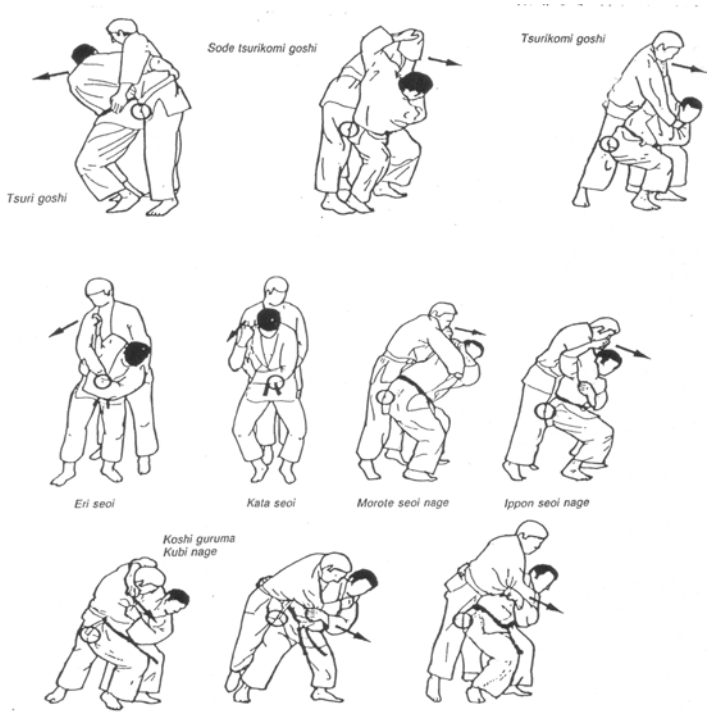

Fig. 9. Variable arm (variable supporting point from the belt to under the knee)

Conclusions regarding the classification of NAGE-WAZA throwing techniques using FORCE COUPLE and PHYSICAL LEVER

After a comparative analysis between the classification of the techniques according to Kardokan and the classification of the techniques from a bio-mechanical point of view based on the FORCE COUPLE and the PHYSICAL LEVER, a number of conclusions can be drawn:

1. The classification of the techniques according to Kardokan arises from the necessity to satisfy a double didactic request.

a) To group techniques according to logical criteria in order to facilitate an easier understanding and a rational, systematic study.

b) To group the techniques in an appropriate sequence in order to allow a gradual learning by the beginners, with the result that they master JUDO as whole.

2. The classification of the techniques from a bio-mechanical point of view, based on the two principles FORCE COUPLE and PHYSICAL LEVER are based on a scientific approach, using concepts from physics applied to JUDO, as the bio-mechanics of the human body.

3. Although the two approaches differ with respect to their quality, they add to one another as follows:

a) Within the classification of the techniques in KYU (groups), which aim at learning the techniques from a point of view of the accessibility of the athlete to learning the technique, the bio-mechanic classification presents the basic mechanisms, which enable that technique to be performed.

b) The bio-mechanic classification needs didactic means and methods in order to assimilate the technique from a bio-mechanical point of view as a completion.

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