Studies on Reflex Action in Judo

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Forword

The posture and movement of the human body are under the control of the will, but behind it lies an important factor, reflex regulation. The reflex which regulates posture is called postural reflex. Postural reflex has mostly been studied in decerebrate animals, and is said to take place in the central nervous system below the cerebrum. For some time it was thought than in man this postural reflex was manifested only under pathological condition of the cerebrum, but recently it has been made clear that under certain conditions it does occur even in healthy individuals. In every day life this postural reflex is obscured by voluntary regulation, and to observe it in an isolated form is rather difficult. However, when an external force is suddenly and unexpectedly applied to the body, or when one suddenly adopts a certain posture or carriage this postural reflex may be clearly elicited.

Fukuda(1) and Nishihata(8) have reported on their observations on postural reflex during the performance of sports, and Nishihata(8) has commented on the importance of postural reflex in judo.

The present study was made in order to investigate the rationality of the various techniques of judo from the point of view of postural reflex of both the offensive and the defensive during a throwing performance.

I. Forms of Postural Reflex

There are various froms of postural reflex, but here we would like to state briefly on the forms necessary for our present study.

a) Labyrinthine reflex. This reflex is initiated by the stimulation of labyrinthine proprioceptors, and is responsible for the change in tonus of the muscles of the extremities and eyes. In this form of reflex there are a static and a kinetic reflex.

Static reflex. When the head changes its position in relation to the direction of the gravitational force, the labyrinths also change their positions and are stimulated causing a change in the tonus of the muscles of the extremities. As the head approaches the inverted position the tonus of the extensor muscles of the extremities is increased(9). A schematic representation of the condition is shown in Fig. 1. Here, we shall not refer to the eye muscles.

Kinetic reflex. When the body rotates around its axis, the tonus of the muscles of the extremities also changes. This is also produced by stimulation in the labyrinths. When

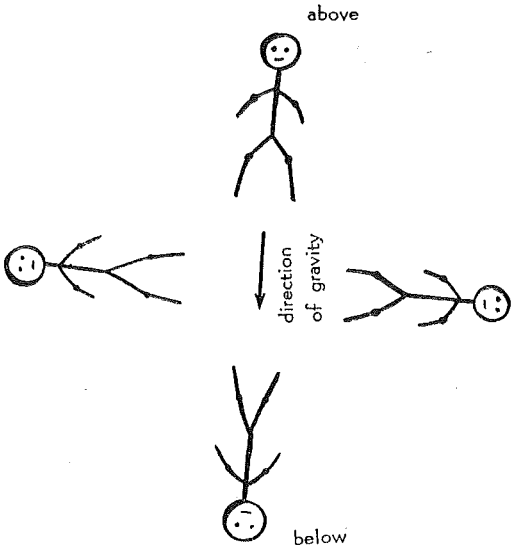

Fig. 1. Static labyrinthine reflex. As the head approaches the inverted position, the extension of the legs increases.

a person is sitting on a revolving chair, revolving slowly (less than one revolution every 6 secs.) the tonus ot the extensor muscles of the leg on the side of the direction of revolution is increased, whilst the tonus of the corresponding muscles of the opposite leg is decreased. Conversely, when the speed of revolution is fast (more than one revolution every 6 secs.) the tonus of the extensor muscles of the leg on the opposite side of the direction of revolution is decreased, whilst the tonus of the corresponding muscles of the opposite leg is increased(6).

When the body is moved vertically or horizontally, there is an

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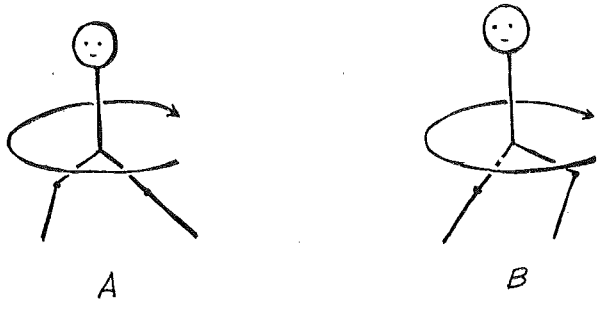

Fig. 2. Kinetic labyrinthine reflex. As the body on the whole revolves, the tonus of leg muscles increases or decreses asymetrically. A, when the speed of revolution is fast (more than one revolution every 6 secs). B, when the speed of revolution is slow (less than one revolution every 6 secs.)

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Fig. 3. Neck reflex. When the head revolves clockwise the right extremities extend.

increase in the tonus of the extensor muscles of the extremities during the downward movement, whilst an increase in the tonus of the extensor muscle of the left upper and lower extremities is produced during the leftward movement(10).

b) Neck reflex. This reflex is produced when the position of the neck in relation to the trunk is changed, and results in a change in the tonus of the muscles of the extremities. When the neck revolves clockwise, there results an increase in the tonus of the extensor muscles of the right upper and lower extremities, whilst that of the left upper and lower

extremities is decreased. When the neck is flexed ventrally the tonus of the flexor muscles of both upper extremities is increased, whilst when the neck is flexed dorsally the tonus of the extensor muscles of both upper extremities is increased. This reflex may be elicited in a healthy individual(2). The receptor of this reflex was thought to be situated in the neck muscles, however recent researches have clarified the fact that it is situated around the atlanto-occipital joint(5). Fig. 3 shows a schematic diagram of the neck reflex.

c) Hip reflex. This reflex is elicited when the trunk is twisted in relation to the hip, and results in a change in the tonus of the legs. When the trunk is twisted clockwise the right leg is flexed and outwardly rotated at the hip joint, the knee joint extended, and the ankle joint slightly flexed. The left hip joint is slightly rotated inward, and the knee joint flexed(7) (Fig. 4).

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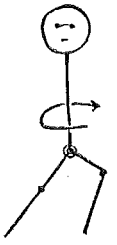


Fig. 4. Hip reflex. When the trunk revolves clokwise, the right knee joint is extended.

d) Supporting reflex. When the load on the lower extremities is increased, the tonus of the extensor muscles of the legs is increased and strengthens the support. This reflex is called the supporting reflex. This is produced by the stimulation of the receptors in the muscle as a result of it being stretched, initiating a reflex action which causes an increase in the tonus of the muscles concerned.

e) Crossed extension reflex. When the tonus of the muscles of one leg is increased, the tonus of the muscles of the other leg is reflexly increased. This reflex is relayed via the spinal cord(3).

II. Experimental Methods

By using a 16mm high speed camera action photographs were taken of the Seoi-nage, Ashi-harai, Uchi-mata, Ouchi-gari, and Tai-otoshi, at speeds of 16 and 64 frames per second. They were enlarged on printing paper and the successive photographs studied.

The performances were taken at the Kodokan with Messrs. Ishikawa, Hatori, Daigo, Ito and Mizutani as performers. Photography was done under special lighting, and taken from two angles most convenient for analysis.

III. Study in Reflex Action of Throwing Technique

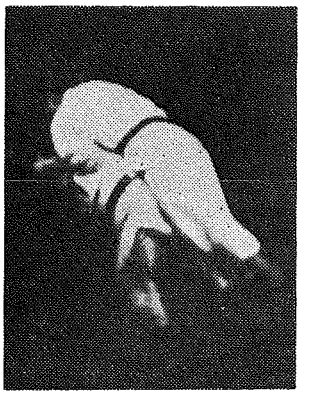
1) Seoi-nage, left (Photos. A, B)

Offensive : Hatori (seventh grade) Defensive : Daigo (seventh grade)

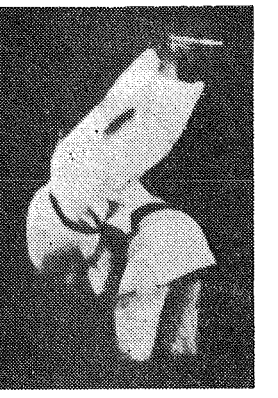
a) Photo A. In positions 4, 5, 6 the chin of the offensive is drawn. This results in a neck reflex which strengthens the pull of both arms. At 6 the centre of gravity of the offensive is placed under that of the defensive, and is seen to be unbalancing him. While the defensive's position moves from 7, 8, 9 to 10 his legs are clearly seen to become extended. At 10 the legs are not only extended, but apart. The extention of the legs of the defensive is pronounced when he is rotating around and falling from the offensive's shoulder. From the point of view of kinetics this action of extending the legs increases the moment

Seoi-nage, left A—1

A—2



A—3



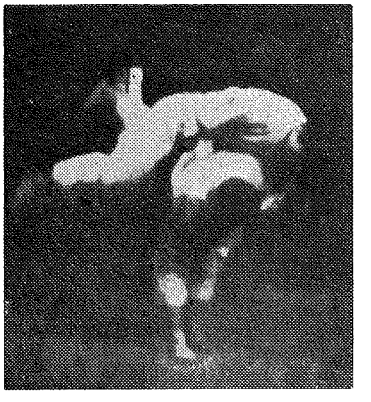
of inertia, and decreases the speed of rotation, thus deadening the force which is throwing him down. This extension of the legs is more of a reflex action than a voluntary one, i. e. as the head is rotated it approaches the inverted position causing a labyrinthine reflex, which extends the legs. As regards the abduction of the legs at 10, although there is no definite proof that it is the result of a reflex action, it is presumed to be caused by the kinetic labyrinthine reflex. On the other hand the abduction of the legs is a part of the basic posture in judo, and is a manifestation of the defensive attitude, hence it may be a combination of reflex action and habit formed by the long training in judo.

Seoi-nage, left B—1

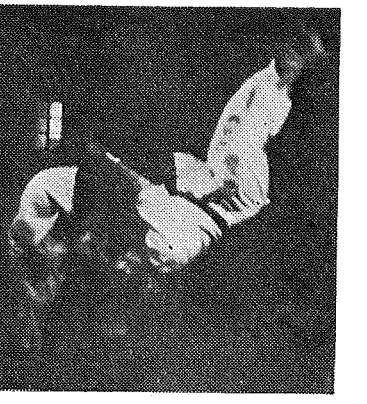
B—2

b) Photo. A'. As the offensive moves from positions 5, 6, to 8 the upper half of his body revolves forward 180° with the hip as the pivot. Furthermore, it inclines forward and downward 90°, also with the hip as the pivot. The centre of gravity of the offensive is at its lowest at 6, and slightly become raised at 8. This is done in order to add speed and force which causes the elevation of the centre of gravity of his opponent.

B—3



B—4



The body of the defensive at 9 is completely raised and is horizontal. The centre of gravity of

the offensive is elevated and his legs become extended. At 10 the offensive's centre of gravity is again lowered and his legs flexed. This attitude serves to increase the rotatory speed of his opponent as he strengthens the pull of his arms.

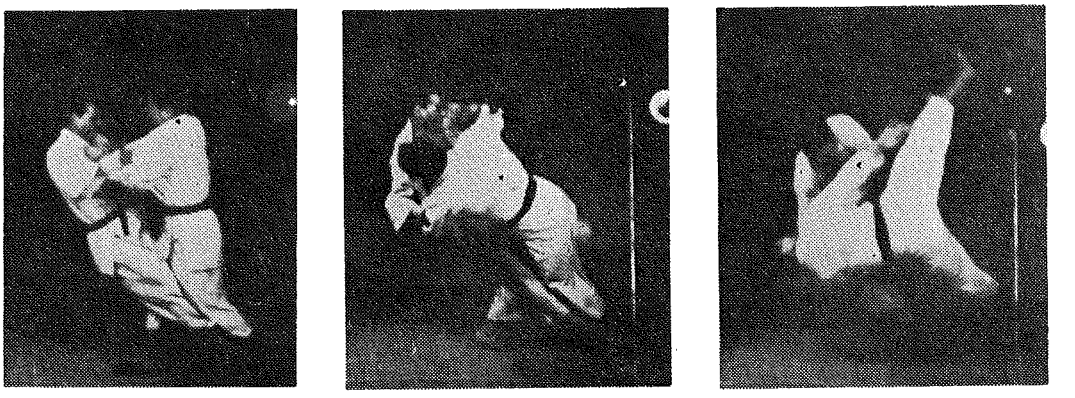
The body of the opponent from 9 to 10 rotates 90°, meanwhile his upper and lower extremities become extended and reach their maximum extension at 11. At 12 the offensive draws in the defensive, and imparts acceleration to the rotation. At this moment the defensive's legs are extended reflexly as stated above.

At 12 the defensive prepares himself to hit the mat with his right hand. Although this attitude is the habit formed by long training in judo, the posture taken when he falls is identical to the one formed as a result of the neck reflex.

2) Ashi-harai (photo. C)

Thrower: Daigo (seventh grade) Opponent: Ito (sixth grade)

Ashi-harai C—1 C—2 C—3



When the thrower does the right Ashi-harai at 4, 5 he lowers his centre of gravity, while at the same time draws in the defensive imparting a clockwise forward rotatory motion. At this moment the offensive's chin is drawn in, causing a neck reflex which strengthens the flexion of the arms.

When the defensive falls as he rotates anticlockwise and forward, his legs are stretched and abducted. At 7, 8, 9, 10 his left leg becomes the support, and the load on it increases causing a supporting reflex, which strengthens the extension of the left legs. Meanwhile, due to the cross extension reflex the right leg is extened, and serves to strengthen the supporting reflex of the left leg. The resulting abducted position of the legs is as stated above, a part of the defensive attitude, however the labyrinthine reflex initated by the rotatory motion may partly be its cause.

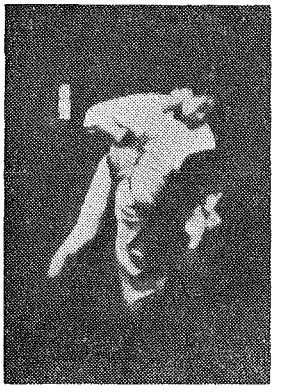
The photograph clearly demonstrates that at 9 the defensive's face is oriented toward the right, and his right extremities are in extension. This posture coincides with that initiated by the neck reflex, however it weakens the tonus of the muscles of the left supporting leg and hinders his rallying action. From the point of view of the offensive this attitude of the defensive naturally becomes advantageous.

3) Uchi-mata (photo. D, E)

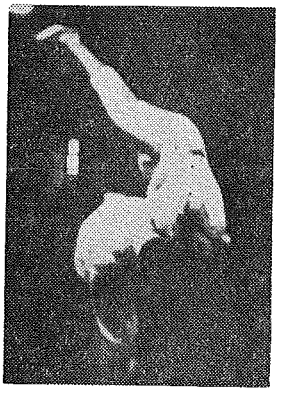
Offensive: Daigo (seventh grade) Defensive: Ito (sixth grade)

a) The body of the offensive rotates 90°. At 5, 6 he raises his opponent, and at 7

Uchi-mata D—1



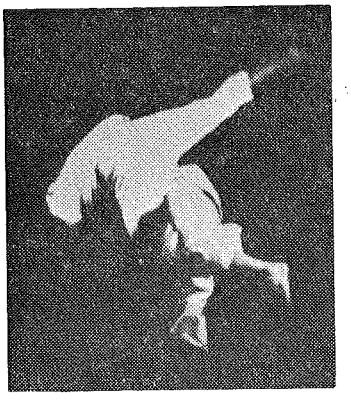
D—2



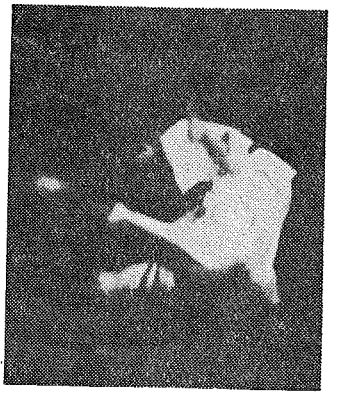
completely lifts him and rotates him clockwisely and forward. At 7 the legs of the defensive are exended, but at 9 as he falls become flexed. At 10 as the rotation increases, the legs again become extended. In this throwing technique the defensive is not only thrown sideways, but is rotated and drawn forward.

b) Photo. C. This photograph was taken with the defensive's back to the camera, i. e. from the opposite direction to the one taken to photograph Photo. C. This facilitates the analysis of the defensive's movements. At 12, 13, 14 the defensive's movements. At 12, 13, 14

Uchi-mata E—1



E—2

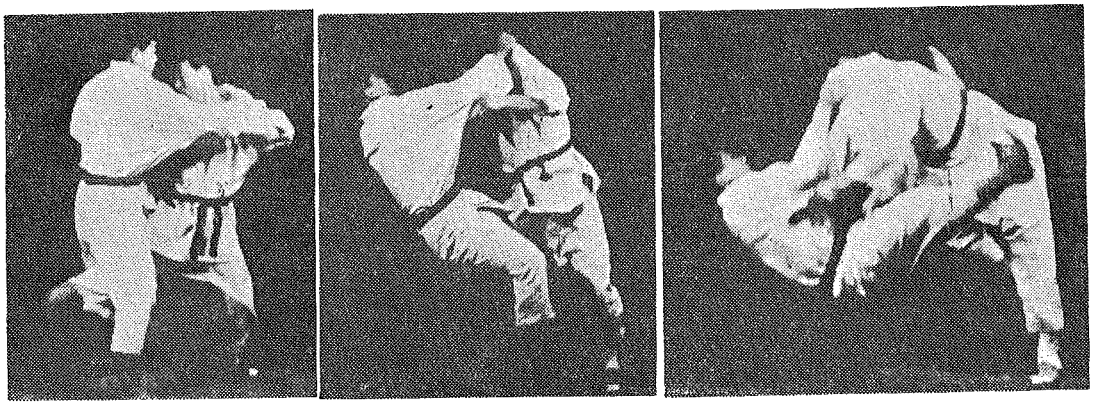


the defensive's trunk in relation to the hip is twisted, and the body as a whole is being rotated anticlockwise and forward. Simultaneously, his legs, especially the right leg, is in extreme extension.

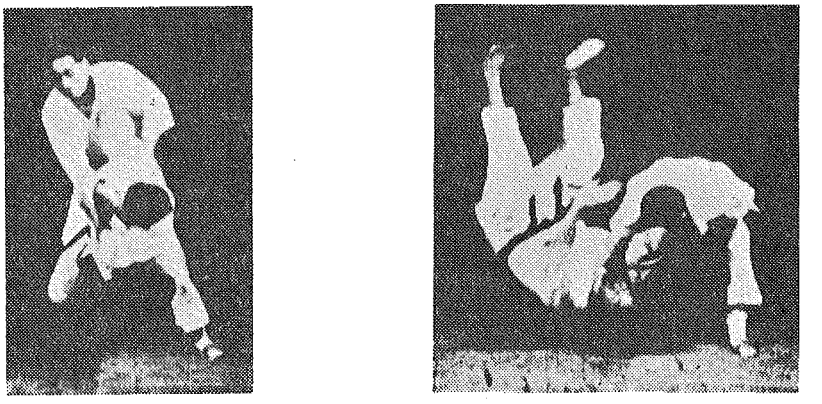
When the trunk is twisted clockwise the right knee joint becomes extended as a result of the hip reflex. This clockwise revolution from the point of view of the kinetic labyrinthine reflex is quite fast (less than one revolution per sec.), and results in the extention of the left leg. At this moment there is a horizontal motion in the movement of the defensive, and as he is moving toward the left, the kinetic labyrinthine reflex causes an extension of the left leg. When the photograph is carefully analyzed it will be seen that the posture coincides with that produced by the hip reflex. This posture is still recognizable even at 16 when the rotation has already stopped.

4) Ouchi-gari (Photo. F)

Ouchi-gari F—1 F—2 F—3



Tai-otoshi G—1 G—2



Offensive: Mizutani (sixth grade) Defensive: Ito (sixth grade)

As seen in Photo. D, at 5, 6, 7, the head of the offensive, as he puts on the trick, is extremely twisted clockwise. This initiates the neck reflex, and helps strengthen the extension of the arms used in throwing down his opponent.

At 10 the opponent's body is completely unbalanced, but at 11 his legs are extended. This extension of the legs is not exactly advantageous in checking the fall, however it helps to complete the fall.

5) Tai-otoshi (photo. G)

Offensive: Mizutani (sixth grade) Defensive: Ito (sixth grade)

According to Photo. E the offensive's face is rotated 180° anticlockwise (5-12). This puts into action the the neck reflex which helps strengthen the flexion of the right arm, and the extension of the left arm, moreover it increases the supporting strength of the left leg.

The defensive at 18, 19, 20 prepares for the defensive posture, and his left hand is put into action and hits the mat (21, 22) preliminay to landing. At 25 he lands on the mat with both legs apart. This posture is the result of training rather than that of reflex action.

Summary

By analysing successive photographs taken during the performances of several judo tech-

niques a study was made in the changes in posture from the point of view of reflex action.

It was observed that the offensive by utilizing the neck reflex strengthens the pull of his arms and the supporting power of his legs; also the offensive in order to perform the technique smoothly and advantageously, leads his opponent into a posture that the latter's neck reflex will not come into force.

The offensive takes advantage of the rotatory motion when throwing his opponent. The kinetics concerning this action will be considered separately. The defensive while being rotated and thrown extends and abducts his legs. This posture is the result of the static and kinetic labyrinthine reflexes. The lack of symmetry in extension of the legs may be seen when the subject is being rotated, and in the present study, it is thought to be due to the twist of the trunk in relation to the hip.

Although it is difficult during the performance of sports, to differentiate whether certain movements of the body are initiated reflexly or voluntarily, it is very advantageous to know and utilize the various postural reflexes during the performance of judo. This study was undertaken in order to elicit the various postural reflexes, and whether they were advantageously utilized.

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