

PHYSIOLOGIC STUDIES ON "CHOKING" IN JUDO
—STUDIES ON "CHOKING" WITH REFERENCE
TO THE HYPOPHYSIO-ADRENOCORTICAL SYSTEM—

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The present paper is one of a series of studies conducted by the Society for Scientific Research of Judo, Kodokan, on the effect of the technique of "choking" on the human body. "Choking" occupies a special position among the various Judo techniques, and it consists in strangling the neck of the opponent, causing difficulty in breathing and subsequent unconsciousness. A physiologic study of the effect of "choking" on the human body is of special importance to the development of Judo as a sport, and also in the prevention of untoward accidents.

Aside from the report by Saito on his electroencephalographic studies, presentations dealing with the physiology of "choking" are almost nil.

The present paper deals with a physiologic study of "choking" and the subsequent state of unconsciousness from the point of view of the adaptation reaction of the hypophysio-adrenocortical system. The reaction of the hypophysio-adrenocortical system was investigated by observing changes in the amount of 17-keto-steroid excreted in the urine, and changes in the number of circulating eosinophiles. Furthermore, since difficulty in breathing is observed in the short interval between inception of "choking" and the subsequent state of unconsciousness, it is expected that hypoxia of the central nervous system results. With this in mind, oxygen saturation of the blood taken from the helix of the ear, and blood pressure were measured at different intervals in order to investigate changes in body reaction.

EXPERIMENTAL METHOD

Five students, all Dan graders in Judo, of the Tokyo University of Education were selected as experimental subjects. The "choking" technique was performed by Assist. Prof. Matsumoto of the same university, and a 7th Dan holder in Judo.

Ikai and Ogawa's method of experimental "choking" was adopted in this experiment, and only the Okuri-eri-jime was used for the sake of unity.

As a preliminary procedure, each experimental subject was made to lie on his side for 20–30 minutes prior to applying the technique, during which time various measurements were made in order to establish the normal values.

Measurements of the following items were made: blood pressure, oxygen saturation in the blood of the helix of the ear (ear-oximeter), plasma protein concentration (Hitachi refraction

Table 1

	Experimental subjects	Age (yrs.)	Height (cm.)	Body Wgt. (kg.)	Chest (cm.)	Grasping power, r. (kg.)	vital capacity (cc.)	Dan	Judo experience (yrs.)	Ochi* experience
A	T. Matsukawa	20.9	162.0	65.0	98.0	65	5200	3	5	+
B	Y. Iwami	20.10	167.0	71.0	96.0	75	4950	3	4.5	+
C	T. Mizukashi	19.11	176.0	68.6	96.0	—	5600	3	4	+
D	Y. Ito	21.11	173.0	78.0	96.0	70	4900	3	6	+
E	T. Kikuchi	23.3	172.0	74.0	99.0	80	5400	4	7	+

*Falling unconscious after being "choked".

proteinometer), blood water volume (Kuroda's method), hematocrit value, erythrocyte count, leucocyte count, eosinophile count (Hinkelmann-Thorn's method), and 17-keto-steroid content in the urine (Pincus' method). These measurements were made at different intervals from the inception of "choking" through the state of unconsciousness to the awakening period. The intervals for taking blood and urine are shown in Table 2. To establish the criterion for the amount of 17-keto-steroid excreted in the urine, measurements were made on the early morning urine and urine taken before the experiment.

Table 2. Periods for taking blood and urine, and items of measurement

		Resting state	A	B	C	D	15	30	60	120	180	240	mins.	
Blood	Plasma protein	○			○			○		○				
	Blood water	○			○			○		○				
	Hematocrit	○			○			○		○				
	blood cell	erythrocyte	○			○	○			○	○	○	○	
		leucocyte	○			○	○			○	○	○	○	
eosinophile		○			○	○			○	○	○	○		
Urine	17-Keto steroid	night urine								120		240	360 480	
		normal urine												

- A. Inception of "choking".
 B. Falling unconscious.
 C. Directly after B.
 D. Recovery of consciousness.

RESULTS AND DISCUSSION

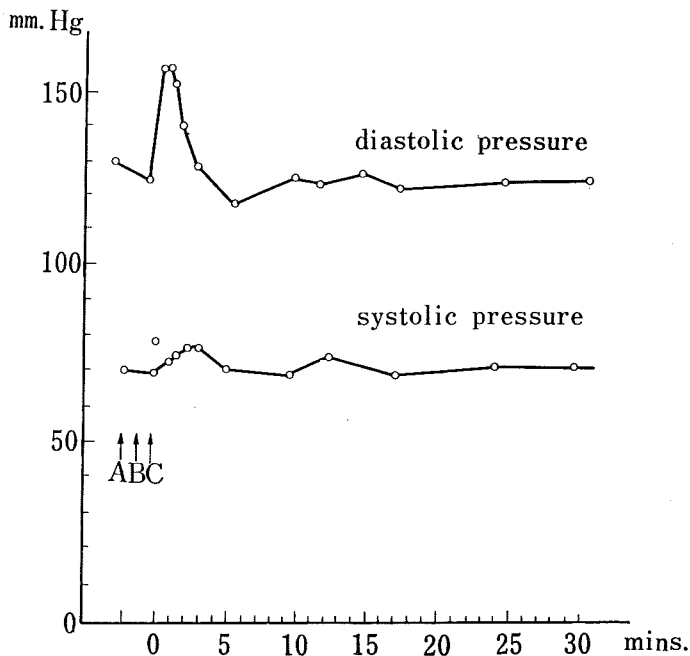
With the inception of "choking" the experimental subjects, in general, showed an agonized and a dogged expression on their faces, and lost consciousness in 8-14 seconds. The performer let go his hold as soon as the experimental subject lost consciousness, so that the subject regained consciousness naturally and without any difficulty in 10-20 seconds. This was followed by a rapid return to normal resting condition. Most subjects experienced pleasant dreams during the unconscious period. The pupils were dilated, and in most subjects general clonic or tonic

cramps was observed during this period.

1) Blood Pressure

Systolic and diastolic pressures of the brachial artery were measured by the auscultatory method. The duration of unconsciousness was only a few seconds, and since the experimental subjects were convulsed, accurate and complete measurements were not possible in some cases. Fig. 1 shows a representative example in which complete measurements were possible. In general, systolic pressure rose by 30–40 mm. Hg immediately after recovering consciousness, and rapidly returned to normal values in 3–4 minutes. Diastolic pressure showed a similar tendency, however, the degree of rise was comparatively mild. From the changes in blood pressure before and after the unconscious period, it is inferred that blood pressure is lowered while the subject is unconscious.

Fig. 1 Effect of "choking" on blood pressure



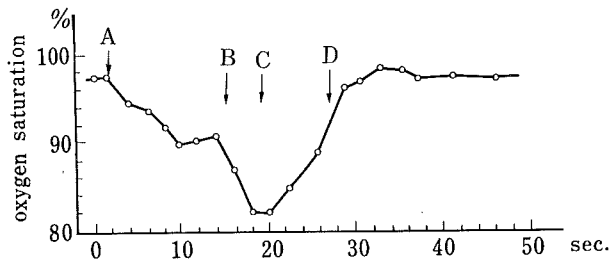
A : resting period B : "choking" C : recovery period

2) Oxygen Saturation in Blood

In order to determine whether or not lack of oxygen in the central nervous system is responsible for the unconsciousness resulting from "choking", oxygen saturation in the blood of the helix of the ear was measured by an ear-oximeter, result of which is shown in Fig. 2.

With the inception of "choking", oxygen saturation began to decrease and was lowered to 86% (normal: 95%) when the subject lost consciousness, and reached a minimum of 82% in 2–4 seconds. Since the performer let go his hold immediately after the subject fell unconscious, the oxygen saturation rapidly increased, and the subject regained consciousness when the oxygen saturation reached 90–92%. From the foregoing results it is inferred that hypoxia of the cerebrum is an important causative factor in the unconsciousness resulting from "choking".

Fig. 2 Changes in oxygen saturation in blood



A : "choking" B : "Ochi" (falling unconscious) C : release hold D : recovery

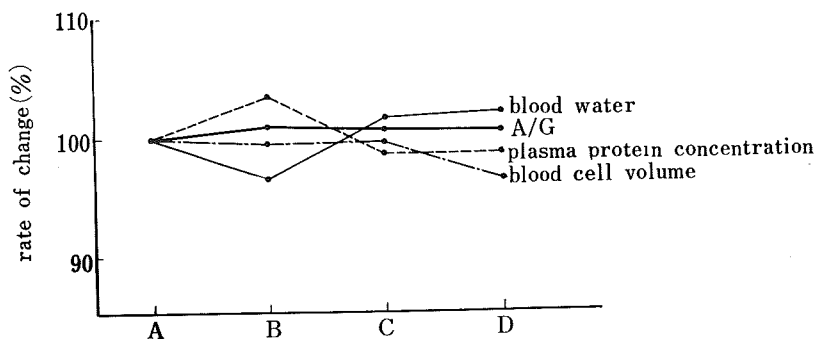
3) Blood Water Volume, Volume of Blood Corpuscles, Blood Plasma Protein, and Variations in A/G Ratio.

"Choking" produces unconsciousness very rapidly, and is accompanied by general convulsion. Although the duration is very short, the condition resembles that following electric shock therapy. Measurements were made four times at fixed intervals, before and after the state of unconsciousness.

Table 3. Changes in blood water volume, blood cell volume, and A/G ratio

	at rest	directly after	30 mins. after	120 mins. after
Blood water	81.068 %	78.492 %	81.264 %	81.746 %
	100	96.8	100.2	100.8
Hematocrit	44 %	44.1 %	43.4 %	42.6 %
	100	100.2	98.6	96.9
A/G	1.42	1.44	1.42	1.41
	100	101.1	99.9	99.5
Plasma protein concentration	6.9 g/dl	7.1 g/hl	6.8 g/dl	6.8 g/dl
	100	102.9	98.6	98.6

Fig. 3 Changes in blood water volume, blood volume, and A/G ratio.



A : at rest B : directly after C : 30mins after D : 120mins after

Table 3 shows the average values of the various measurements. It will be seen that no significant changes were seen in the hematocrit values and the A/G ratio, however, blood water volume decreased considerably, and plasma protein concentration increased somewhat directly after falling unconscious. The progress of the changes is diagrammatically illustrated in Fig. 3. It will be seen that blood water volume and plasma protein concentration are in a mirror image relation with each other, directly after falling unconscious. This result is in agreement with that obtained by Oya (2) on patients subjected to electric shock therapy. It is inferred that during the unconscious state resulting from "choking", the permeability of the blood vessels is increased, causing blood concentration just as in the case of the unconscious state following electric shock.

4) Blood Corpuscles

As an index for determining changes in the hypophysio-adrenocortical system, blood counts centering on the eosinophiles were made at fixed intervals before and after the unconscious state. Results of the measurements are summarized in Table 4. "Choking" produced a temporary increase of the eosinophile count in all the experimental subjects, excepting D. Thereafter, the eosinophile count in all subjects showed a tendency to decrease, and after 4 hours, a minimum of $-50\% \sim -90\%$ was observed (Fig. 4). Since, during the 240 minutes following recovery of consciousness in which blood was taken at fixed intervals for the study, the subjects remained in a recumbent position, a comparison with the blood count of subjects in a recumbent position under normal conditions was made. From this comparison it may be inferred that this marked decrease in the eosinophile count was due to the influence of the stress produced by "choking" and the subsequent unconsciousness.

Fig. 4 Changes in circulating eosinophiles.

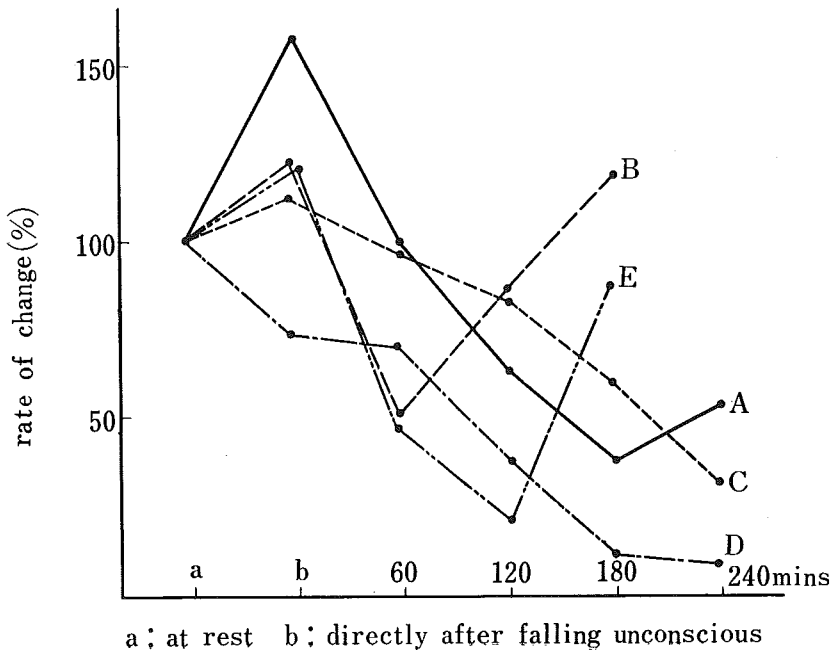


Table 4. Effect of "choking" and subsequent state of unconsciousness on blood cell count

Erythrocytes

(10,000 units)

	at rest	directly after	60 mins. after	120 mins. after	180 mins. after	240 mins. after
A	330	340	352	361	383	356
B	429	459	392	462	445	—
C	322	379	290	448	435	420
D	385	405	395	353	312	306
E	420	430	392	462	445	—
Average	369.6	402.6	364.2	397.2	404.0	360.7
%	100	108.9	98.5	100.7	104.3	97.6

Leucocytes

	at rest	directly after	60 mins. after	120 mins. after	180 mins. after	240 mins. after
A	5200	5400	5200	8200	7800	5200
B	4100	4200	2800	3550	4200	—
C	4200	5000	4900	3800	6500	7100
D	3600	5700	4700	5800	5800	5800
E	4050	4150	3800	2900	4200	—
Average	4230	4890	4280	5250	5700	6033.3
%	100	115.6	101.2	124.1	111.1	142.6

Eosinophiles

	at rest		directly after	60 mins. after	120 mins. after	180 mins. after	240 mins. after
A	%	100	157	90	64.2	38	54
	actual count	312	490	281	200	120	168
B	%	100	121	50	85.5	119	—
	actual count	312	381	156	268	375	—
C	%	100	113	96.4	83.5	60	32.6
	actual count	478	534	456	400	287	156
D	%	100	73.6	71	39	14	9.1
	actual count	262	173	187	102	37	24
E	%	100	121	48	22	87.5	—
	actual count	310	375	150	68	70.5	—
Average	%	100	117.1	71.1	58.8	63.7	31.9
	actual count	330.8	392.4	246	207.6	177.9	116

In the two cases in which the eosinophile count showed no marked decrease, the erythrocyte and leucocyte counts also showed no significant increases, however, in the other three cases marked increases in both the erythrocyte and leucocyte counts were observed following "choking". This is in conformity with the results obtained by similar experiments on individuals subjected to physical and mental stress. The erythrocyte count without exception increased directly after inception of "choking", however, thereafter, going through several fluctuations remained increased for 4 hours with the exception of one.

5) 17-Keto-Steroid in Urine

Table 5 shows the amount of 17-keto-steroid excreted in the urine of the experimental subjects on the day of the experiment.

The 17-keto-steroid level in the urine was low in the night urine and high in the morning urine. This is in conformity with previous reports (4, 5).

The amount of 17-keto-steroid excreted in the urine during the 2 hours directly following recovery of consciousness was very much increased, however, thereafter, a gradual return to normal level was seen, and by evening pre-choking level was reached. The timing of the increase in 17-keto-steroid matched with that of the decrease in the eosinophile count. From this it is assumed that "choking" acts as a typical stressor, mentally and physically, and that the influence of the stress completely disappears after 6-8 hours.

The foregoing data indicate that hypoxia of the cerebrum plays an important role in causing the unconsciousness following "choking", and from the presence of clonic convulsion during this state, similarity with the state of unconsciousness following electric shock therapy may be recognized. Changes in blood water volume, and plasma protein concentration were very similar to those after electric shock therapy. Also, from variations in the eosinophile count and the content of 17-keto-steroid in the urine, it is inferred that the state of unconsciousness following

Table 5. Keto-steroid excreted in urine (mg/24h)

experimental subject urine collecting time	A	B	C	D	E	Average
1. Night urine bedtime→awakening 7a.m.	1.3	9.6	18.1	3.2	11.6	8.8
2. Morning urine 7 a. m.→9 a. m.	2.8	10.0	14.6	2.2	12.1	8.3
3. Morning urine 9 a. m.→11 a. m.	9.4	7.2	8.6	7.4	17.9	10.1
4. Directly after "choking" 11 a. l.→1 p.m.	10.9	7.6	8.1	7.7	12.0	9.3
5. Recovery period 1 p.m.→3 p.m.	35.9	2.6	13.5	1.9	19.9	14.7
6. " " 3 p.m.→5 p.m.	9.6	11.4	8.4	6.2	17.2	10.6
7. " " 5 p.m.→7 p.m.	9.0	8.4	6.3	8.6	8.4	8.2
8. " " 7 p.m.→9 p.m.	11.3	5.0	10.3	3.6	9.2	7.9

“choking” produces, to a certain extent, a condition of stress. However, variations in blood pressure and in other physiologic functions studied concomitantly by other investigators indicate that changes are only temporary and mild.

SUMMARY

Studies were made on the condition of stress resulting from “choking” in Judo, by investigating changes in the circulatory and the hypophysio-adrenocortical systems.

1) Variations in blood pressure indicate that the unconscious state following “choking” is very similar to conditions accompanying central shock.

2) Variations in oxygen saturation in the blood of the helix of the ear suggest that hypoxia in the central nervous system is an important causative factor in the unconsciousness resulting from “choking”.

3) The mirror image relationship between the progress in changes of blood water volume and plasma protein concentration indicates that directly after falling unconscious, increased permeability of blood vessels results.

4) The circulating eosinophile count increases slightly, directly after falling unconscious, however, thereafter, a decrease typical during moments of stress is observed, and after 4 hours a minimum decrease of -50% -30% is seen.

5) Changes in the amount of 17-keto-steroid excreted in the urine follows a somewhat similar pattern to that of changes in eosinophile count, evidencing that “choking” acts as a stressor. However, its influence lasts only 6-8 hours.

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