

## Injuries by Martial Art "Taekwondo"

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— 국문초록 —

### 무술 "태권도"에 의한 손상

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자기 방어와 정신수양을 목적으로 하는 무술중에서도 가장 오래된 태권도는 중국의 쿵후나 일본의 가라테와는 전혀 다른 것으로 우리나라에 기원을 두고 세계대회가 열릴 정도로 전 세계에 널리 퍼져 있는 운동이다.

태권도는 여러가지 형태의 공격과 방어동작이 순간적으로 변화, 연결되면서 무서운 파괴력을 창출하는 무술로 정신집중을 상당히 요하는 스포츠의 한 분야이다. 또한 태권도의 한 영역으로 격파술이 있는데 이는 파괴력의 증진을 도모하기 위한 술기로서 우리는 격파술 시범을 통하여 놀라운 파괴력과 태권도의 우수성을 보게 된다.

저자들은 태권도에 의한 손상을 이해하기 위해 1981년부터 1983년까지 만 3년간 태권도를 하다 손상을 받아 수도통합병원에서 치료를 받았던 117례에 대한 임상 분석을 하여 다음과 같은 결론을 얻었다.

- 1) 운동 기간, 단수와는 별 관계없이 손상을 받았다.
- 2) 수상후 3주가 지나 치료를 받은 예가 12예 (10%)로 그 중 4예에 대하여 수술적 치료를 시행하였다.
- 3) 연부조직 손상은 신체의 어느 부분이나 생길 수 있으나 골 손상은 주로 상지에서 발생하였으며 (88%), 그 중에서도 제 5중수골이 가장 흔하였다 (38%).
- 4) 격파 도중 발생한 4예의 주상골 골절과 수년동안 태권도를 한 선수중 3예에서 특별한 원인 없이 생긴 요척측 변형에 대하여는 앞으로 자세한 연구가 필요하다고 생각되었다.
- 5) 태권도 손상은 수상시의 동작에 따라 공격시 손상, 수비시 손상, 태권도중 넘어짐으로써 생기는 손상 그리고 격파시 손상으로 구분할 수 있었다.
- 6) 골 손상의 경우 불안정성을 나타내는 예는 없었으며, 전박부나 하퇴부에서는 하나의 골반 손상을 받았다.

**Key Words:** Taekwondo, Injuries.

### INTRODUCTION

Taekwondo, known as the oldest self-defense art in the world, was begun in 37 B. C. in the Koguryo Dynasty founded in the

northern part of the Korean peninsula. It was different from Chinese Kungfu and Japanese Karate<sup>10</sup>.

In recent years, Taekwondo has become the most popular martial art in Korea and the Korean Taekwondo Association have a membership of about three millions. Further, it has already spread to more than one hundred nations as a modern world sport

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12). Moreover, there is a subject of discussion that it must be adopted in the Olympic Games.

Taekwondo practitioner are used to break the several bricks or piles of roof tile with only their bare hands or feet. As yet, only a few westerners have seen the powerful forces of the human body with their own naked eyes. And the competition practice was a part of promotion test. This was carried out freely in attack and/or defense fashion(Fig.1, 2).

We have experienced the various kinds of injuries during the Taekwondo performance for several years. And we studied 117 cases clinically who visited the Capital Armed Forces General Hospital from 1981 to 1983. Aim of present study was the general consideration in this athletic injuries and was to protect the players from injuries through the clinical analysis. And we also studied the fracture mechanism of certain bones.

## MATERIALS & RESULTS

Age ranged from 21 to 40 years with an average of 24.8 years. Duration of the athletic participation was from 7 days to 18 years. Thirty-two cases had less than one year of experience. Forty-two cases practiced from one to three and 43 cases more than three years(Table 1). And their grades of skill, indicating the objective rating, were over grade 1 except 24 cases(Table 2).

Time lapse after injury to treatment was variable. Seventy-one cases visited our hos-

**Table 1.** Duration of Taekwondo participation

Duration(Yrs)	No. of cases (%)
Less than 1 year	32 (27)
1 - 2 years	19 (16)
2 - 3 years	23 (20)
3 - 4 years	13 (11)
4 - 5 years	11 (10)
More than 5 years	19 (16)
Total	111 (100)

1A

1B

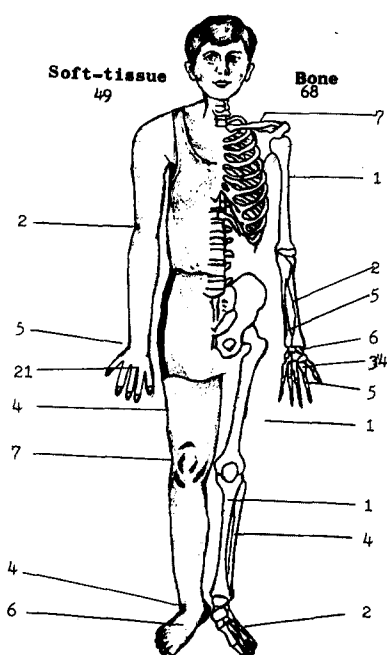
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**Fig.1-2.** 1A. Form just before breaking a brick. Mental concentration and control of respiration were required. 1B. Just after breaking a brick. The powerful force was shown in a moment with the counteraction of body and outcry(Yah).2. Various movements of the upper and lower extremities were carried out instantaneously in the freestyle competition of Taekwondo.

**Table 2. Distribution of grade\***

Grade	No. of cases (%)
Under Grade 1	24 (21)
Grade 1	53 (45)
Grade 2	24 (21)
Grade 3	10 ( 3)
Grade 4	5 ( 4)
Grade 5	1 ( 1)
Total	117 (100)

\* High grade indicates higher level of the Taekwondo skill.

**Fig.3. Sites of injuries of bones & soft-tissue.**

pital within three days after injury. Thirty-four cases from 4 to 21 days and twelve cases visited three weeks or more after injury (Table 3). Among eighty-eight cases injured in the upper extremities, sixty had the bony injuries. Among twenty-nine cases having injuries in the lower extremities, eight had the bony injuries.

Twenty-one had soft-tissue injuries in hands, 5 in wrist area and 2 elbow area. Seven had soft-tissue injuries in the knee region, 6 in dorsum of foot, 4 ankle and 4 thigh area (Fig.3). Three athletes had the cavus

**Table 3. Time lapse after injury to treatment**

Time lapse	No. of cases (%)
Less than 3 days	71 (61)
4 - 7 days	21 (18)
8 - 14 days	10 ( 9)
15 - 21 days	3 ( 2)
More than 3 weeks	12 (10)
Total	117 (100)

**Table 4. Site of bony fractures**

Site	No. of cases (%)
Upper extremity	
Metacarpal	34 (50)
Clavicle	7 (10)
Scaphoid	6 ( 8.9)
Prox. Phalanx	5 ( 7.3)
Ulna	5 ( 7.3)
Radius	2 ( 3)
Humerus	1 ( 1.5)
Subtotal	60 (88)
Lower extremity	
Fibula	4 (6)
Metatarsal	2 (3)
Tibia	1 (1.5)
Femur shaft	1 (1.5)
Subtotal	8 (12)

feet without neurologic impairment. They stated that the deformities came into being after playing the Taekwondo.

The most common bony injuries were the metacarpal fractures, which numbered thirty-four among the total sixty-eight bony injuries. Also the fifth metacarpal was the most commonly affected bone which numbered twenty-six.

Also multiple metacarpal fractures were present in seven cases (Table 4).

Scaphoid were affected in 6 cases. Two of them injured from the out-stretched fall during competition, and in remaining 4 cases during breaking the piles of roof tile. In eighty-nine cases right side was affected.

Injuries of Taekwondo were occurred during defense, attack, fall from competition activities and breaking-hard-object maneuver. Most of our series were injured during

last maneuver but clavicle, ulna, radius, femur shaft, fibula were injured during defense and metacarpal, proximal phalanx, tibia during attack. Two cases of scaphoid fracture and distal humerus fracture were injured during fall from competition activities.

Majority of cases were treated conservatively by cast immobilization and skeletal traction. A cases of tibial shaft fracture was treated by the skeletal traction. Twelve cases were treated surgically; 4 in metacarpal, 4 in ulna, 2 in radius, 1 in humerus and 1 in femur shaft. There was no complication in the management of these cases.

## DISCUSSION

In Taekwondo the edges of hands and feet, the elbow, knees and fists were used for attack, and the flat surfaces of legs and arms for defense.

Hand was the essential part both in defense and attack including breaking-hard-object technique. Either by flexed or extended fingers, variety of performance are carried out by hand. Most commonly used parts of the hand were the upper part of knuckles of the proximal phalanx of index and middle fingers and the ulnar edge of hand. Also foot does a important role in the powerful attack. The striking points were nearly all parts of foot; forepart of sole, hindpart of sole, heel, outer edge of hindpart of sole and the dorsum of foot.

The effective force can be attained in Taekwondo with the mental concentration, stability of body, agility, control of respiration and actual confrontation. A way to calculate force is:  $\text{Force} = \text{Mass} \times \text{Acceleration}$ . The weight of player is the mass and the speed of moving hands or feet is the acceleration. One cannot expect the powerful effect unless he moves his pelvis toward the direction of attack. And the strongest force can be attained when the whole body weight is concentrated on one point such as a

**Fig. 4.** The Taekwondo practitioners have to wear the protective garments (Ho-Goo) in all formal competition or in demonstration.

fist or edge of foot. On the other hand, the method to increase the speed is to expand the distance of target and agility of body.<sup>10)</sup>

In contrast to other sports, it was considered the incidence of injuries was not related to the duration of athletic participation. Perhaps there was some reasons to be considered. At first, this martial art is so powerful that practitioners must wear some padding for protection of the vital parts of body (Fig. 4). Also it was mandatory in our series that practitioners should demonstrate their power to break the objects such as the bricks, tiles and wooden boards. Therefore, there were always chances to be injured during breaking-hard-object maneuver and free-style competition activities.

In making early diagnosis and adequate treatment there were some delay. What was worse, twelve among the 117 cases consulted their problems with doctors more over three weeks after injury. The reason was

the ignorance of patients and their coaches. It was important that those people dealing with the injured athletes should well recognize the common type of injuries and the harmful effect of delayed diagnosis and treatment. An injury that was improperly treated or neglected might affect their remaining athletic lives, because many practitioners were the young ones<sup>9</sup>.

Through this study it is found that the soft-tissue injuries can occur in any part of body. But the fracture would occur mostly in the upper extremity (88%).

The metacarpal fracture was the most common one (50%) as in the boxers, and the fifth metacarpal fracture occurred in 26 cases out of 34 metacarpal fractures (Fig.5). This was explained by the anatomical consideration and the incorrect impact portion. At first, in the anatomical aspect the metacarpals were slightly curved in the long axis and concave on the palmar surface. And their weadest point was just behind the head<sup>9</sup>.

It is well known facts that the proximal ends of index and middle finger metacarpals are connected with the distal carpal row in nearly immobile articulation, while those of ring and littl efinger have approximately

15 and 25 degrees, respectively, of anteroposterior motion. In other words, the rigidity of the second, third metacarp<sup>2</sup> was due to the tight fit of the V-shaped trapezoid into the base of the sceond metacarpal and firmly attached capitate base<sup>9</sup>. These structures comprised the force-bearing axis of the wrist and effectively transmitted the compressive loads to the musculotendinous units crossing the carpus<sup>10</sup>.

When the external force was applied at the part of body, energy absorption was a function of body. The energy was distributed through the soft tissues, bones and articulations. It is an important fact that the coordinated absorption of energy should be taken by the proximal musculo-tendinous

6 A

6 B

**Fig.6 A-B.** **A.** Preoperative radiograph showing the Bennett's fracture induced by axial blow against the first metacarpal. Fracture occurred during breaking-hard-object maneuver by the secondary blow effect of broken tiles. **B.** Post-operative radiograph showing well reduced fracture with two K-wires.

**Fig.5.** The most common bony injuries were the fifth metacarpal neck fractures.

units<sup>9</sup>. Now, the final injury was determined by the type of three dimensional loading, the magnitude and duration of forces, the position of hand and biomechanical properties of surrounding ligaments and bones<sup>9</sup>.

Striking a blow with a fist, the line of force along the second, third metacarpal was transmitted directly to the radius via the trapezoid and scaphoid, and via the capitate and lunate. But, in the incorrect application of blow, external force was transmitted via the apex of hamate to a linear facet on lunate and radius. Also triquetrum and pisiform were not transmitters except during ulnar deviation. And the coordinated absorption of energy was insufficient<sup>4</sup>. It is suggested that fracture mechanism of the fourth and fifth metacarpal was a blow with a fist in the wrist extension and radial deviation.

The first metacarpal injury had a different mode. It was said that this fracture was usually sustained in the fist fights, and that the mechanism of the injury was the axial blow against the partially flexed metacarpal<sup>9</sup>. There were two cases of Bennett's fracture (Fig. 6). They said that they were injured during breaking a pile of 10 roof tiles.

There were six cases of scaphoid fractures in our series. Among them four cases were injured during breaking-hard-object maneuver and remainders during fall competition activities. The mechanism of the scaphoid fracture is also controversial. Squire and Frykman side that forced radial deviation and dorsiflexion would fracture the scaphoid over the tip of radial styloid<sup>3,9</sup>. On the contrary to these, Fisk and Mayfield suggested the dorsiflexion and ulnar deviation<sup>1,7</sup>. At the time of injury, it is said that pronation and supination of the forearm cause the shearing forces at the scaphoid waist<sup>11</sup>.

We could not find out the exact mechanism of the scaphoid fracture because our cases were limited in numbers and the pa-

**Fig. 7-8.** Radio-Photograph (left) shows the waist fracture of the scaphoid. This fracture was well treated with the cast immobilization for 12 weeks. Fracture of fibular shaft (right) was sustained probably by cross-kicking maneuver with opponent.

tient could not provide good information about the mode of injury. Now and then we have observed that Taekwondo practitioners incorrectly used the palmar side of wrist instead of ulnar edge of hand in breaking-hard-object such as bricks or tiles. It is understandable if we know the following facts. All of our cases were military men. And, while it is not compulsory to break the hard objects in skill qualifying test, they have

to demonstrate the breaking-hard-object skill by any means using knuckles of metacarpophalangeal joints, ulnar edge of hand and foot, etc. In this practice, they often hit erroneously the object with the unwanted part of the hand, and thereby fracture may ensue.

Considering the basic movements of Taekwondo (hitting, stabbing, striking, kicking and defense attitude), it is thought that dividing the injuries into the several groups is reasonable. First is the injury afflicted during defense, and second is the one during attack. Clavicle, ulna, radius, femur shaft, fibula were injured during defense and the metacarpal, proximal phalanx, tibia during attack. There was another group of injury associated with fall during competition activities such as two cases of scaphoid fracture and distal humerus fracture. Now, there was an additional group in which injury was taken place during breaking-hard-object maneuver. Although most of our series were classified to the last group, there would be some difference of incidence and characters of injury between the military and civilian series.

All of fractures were stable with minimal displacement in our series. There was no open injury. We noticed that only one bone in the forearm or lower legs was affected. This explains that the fracture is caused by the direct blow as in the night-stick fracture of ulna.

Treatment was basically conservative and operation was performed only in twelve cases of 68 bone injuries (17.7%). Four of them were surgically treated for the malposition of fracture fragment due to delayed diagnosis.

In Taekwondo practice, we would say that any part of body would be injured by the variable powerful motion at attack and /or defense attitude. And it is suggested that this martial art has a high risk of injury, and special measure must be taken to lessen the incidence of injury by promoting

the skill by practice, good coaching and providing a protective garment.

## CONCLUSION

117 cases of Taekwondo injuries were clinically analysed. Although all of our patients were military personnel, it was very helpful to know the general pattern of Taekwondo injuries through this study and the following conclusions were made.

- 1) Incidence rate of injuries was not related with the duration of athletic participation.
- 2) Operation was done in 12 cases of 68 bone injuries. Four cases among them were diagnosed lately after injury. It is stressed that trainers and related persons should recognize the importance of early medical treatment.
- 3) It was found that soft-tissue injuries such as bruise, strain and mild ligamentous tear could occur in any part of body, but bone injuries were mostly in the upper extremity (88%). The most common bone injury was the metacarpal fracture, especially the fifth (38%).
- 4) Four cases of scaphoid fracture were sustained during breaking-hard-object maneuver. We found accidentally the cavus deformities in the three patients without neurologic impairment. In this regard, it is suggested that further specific investigation is required to clarify the mechanism of scaphoid fracture during breaking-hard-object maneuver and formation of cavus deformities.
- 5) Injuries of Taekwondo could be divided into four groups according to the way of practice. i. e. injuries during attack, defense, breaking-hard-object maneuver and out-stretched hand fall from competition activities.
- 6) All fractures were stable and minimally displaced. And only one bone in the forearm or lower legs was affected as in the nightstick fracture. It suggests the cause

of fracture mechanism is the direct blow by the hand or foot.

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