"IDO MOVEMENT FOR CULTURE. Journal of Martial Arts Anthropology",
Vol. 19, no. 1S (2019), pp. 3–5
DOI: 10.14589/ido.19.1S.2

SAFETY

Fuminori Nakiri
Tokyo University of Agriculture and Technology (Japan)
Research Organization for Nano & Life Innovation, Waseda University, Tokyo (Japan)
e-mail: nakiri@cc.tuat.ac.jp

Research on safety measures for Kendo equipment for prevention of injury. In *Budo* (Kendo)

Submission: 21.10.2018; acceptance: 10.01.2019

Key words: *kendo*, safety standard for kendo equipment, *Shinai*, *Kendo-gu, Men, Men-gane*, *Men-buton,* cushioning performance, striking force, impact force, *Carbon-shinai,* dummy, human head impact tolerance curve

Introduction

Kendo developed as an athletic contest between protagonists who compete to score *Yuko-datotsu* (Ippon, or valid strikes) on specified target areas (*Men, Kote, Do,* and *Tsuki*) using a bamboo sword (*Shinai*). Therefore, from an athletic perspective in which competitors don protective gear and strike each other, there is an inherent possibility that injury may occur should the equipment be insufficient. To enjoy participation in Kendo throughout one's lifetime, the prevention of injury and accidents is essential, and, to this end, safety measures for Kendo equipment are extremely important.

To date, examples of serious accidents attributed to faulty Kendo equipment (*Shinai* and *Kendo-gu*) include eye injuries (1982) and even death (1977 and 1987) through breakage (of fibers) in *Shinai* made from natural bamboo. To prevent the reoccurrence of such serious accidents, rigid safety measures have been implemented to improve the equipment utilized in Kendo. In Japan, the Medical and Science Committee of the All Japan Kendo Federation instigated a project for empirical research into improving safety which continues to this day.

With regard to *Shinai*, a product made of carbon graphite (*Carbon-Shinai*) was developed as a new option to replace bamboo and has been officially authorized for use from 1987. However, popular dissemination of the *Carbon-Shinai* remained low in the early ages because many Kendo *aficionados* preferred the cultural value of traditional bamboo *Shinai*, and the retail price of *Carbon-Shinai* was significantly higher. As these innovations were being made, another serious incident leading to blindness occurred in 1989 when a bamboo splinter entered a practitioner's eye after passing through the bars of the *Men-gane* (protective metal grill on the front of the mask). This incident encouraged more empirical research to find ways of improving the structure of the *Shinai* and materials used in the *Men-gane*.

It has become increasingly necessary to monitor the standardization of Kendo equipment due to the rapid increase in overseas production, the decrease in experienced domestic craftsmen, the depletion of traditional materials, the internationalization of Kendo, and to social demands for safety improvements. Following the enforcement of the Product Liability Act (PL Act) in 1995, the Medical and Science Committee of All Japan Kendo Federation commenced studies toward the standardization of Kendo equipment. At the same time, under the leadership of the Consumer Product Safety Association, the Joint Committee of the Japan Martial Arts Equipment and Japan Budo Supplies Manufacturer's Association was launched, and certification for safety standards was examined. Based on this, the "Standards for *Shinai* and Kendo Equipment" were formulated in 1998. Subsequently, Kendo equipment was required to be manufactured according to these established standards. Safety was further augmented in Kendo competitions through the revision of match rules.

Aim and Method

This paper reviews basic and empirical research into establishing safety standards for Kendo equipment published in papers and reports in "The Research Journal of Budo" (journal of the Japanese Academy of Budo), and the AJKF's Medical and Science Committee.

Results and Discussion

1.Fundamental Research for the Creation of Safety Standards for Kendo Equipment [Nakiri *et al.* 1992; 1994; 1995; 2002; 2003]

1.1. Measurements of striking force in Kendo and its effects on the human head [*Ibidem*].

Research into striking power in Kendo was conducted by Sugie [1965], Kubo *et al.* [1969], Ajiro *et al.* [1982] and Tatsumi *et al.* [1982]. However, the measuring methodology (strain gauge, piezoelectric element, coloring type pressure paper, etc.) was fragmentary and there were problems in data accuracy. The authors [Oya *et al.* 1996; 1998; Yokoyama *et al.* 1989; 1991; Yamagaki *et al.* 1993] produced a striking force measuring device equipped with a piezoelectric transducer for three-component force measurement (9067 manufactured by Kistler Co., Ltd.). By using the device to gauge different age groups (male and females from elementary school through to university students and adults), basic data on *Men* and *Kote* striking force components were acquired and analyzed. In addition, the differences in striking force components of variant striking styles (from the *Jodan* overhead stance, and *Nito* two-sword style) were also clarified.

In more precise terms, this study attempted to measure changes in acceleration in attacks to the head of dummies (hybrid type III crash dummies) and actual human subjects, and the impact force on *Men* and *Tsuki* transmitted through the protective Kendo equipment to the human body from a biomechanical viewpoint, as well as investigate the safety values of *Men* in protecting the head based on the JARI human head impact tolerance curve [Nakiri *et al.* 2005],

A single impact to the head is not serious enough to cause damage such as a cranial fracture or cerebral concussion. However, because continuous or long-term impacts have the potential to cause chronic subdural hematoma, further investigations are necessary.

1.2. Examination of the cushioning performance of *Men* and *Kote* padding (*Futon*) using a hammering force generator [Nakiri *et al.* 1989; 1992; Nakiri 1992; 1997]

To measure the cushioning performance of Kendo equipment (*Men* and *Kote* padding), we made a continuous striking force generator and examined the difference between striking force components. The results showed that traditional cotton with rough stitching used as the core material in *Men* and *Kote* padding had a higher cushioning ability. In addition, we were able to clarify that the synthetic material Sorbosein was also effective as a highly-practical cushioning material.

1.3. Improvement of strength and structure in the *Men-gane* [Nakiri 1994; 1996; 1997]

Aluminum alloy and titanium are used for the *Men-gane* which is attached to the front of *Men* to protect the face, especially the eyes. We conducted a strength experiment with a tensile tester, and consequently set the safety standard of *Yoko-gane* (horizontal bars) at 0.5 mm in diameter, with the *Mono-mi* (viewing gap) distance 15 mm, and 75 mm of height from

Dai-wa to *Tate-gane*. Thanks to these safety standards there have been no accidents involving splinters of bamboo penetrating into the *Men-gane.*

2. Fundamental Research for Preparing Safety Standards of Shinai

2.1. Characteristics of the *Shinai* tip [Nakiri 1994; 1996; 1997]

Measurement surveys were conducted to ascertain the characteristics of the *Shinai*, especially the diameter of the tip used by junior high school, high school and university student Kendo practitioners participating in the national championships [*Ibidem*]. Although regulations stipulate that *Shinai* tips are to be 26 mm or more, there have been some cases in which tip diameter was adjusted by having a larger S*aki-gawa* (leather tip covering) even though the bamboo that it covered was thinner. This resulted in a higher risk of cases in which pieces of bamboo would break loose from the *Saki-gawa*. Therefore, safety standards for the shape of the *Saki-gawa*, the strength of the rubber tip stopper, as well as the diameter of the bamboo tip needed to be established.

2.2. Development of *Carbon-Shinai* to replace bamboo *Shinai* [Nakiri *et al.* 1987]

Carbon-Shinai made of carbon graphite as a substitute material for bamboo were developed. A comparison of the mechanical properties of bamboo *Shinai* and *Carbon-Shinai* of the same weight were made. When the hitting force of *Shinai* and *Carbon-Shinai* under the same conditions was measured, it was found that the parameter of the *Carbon-Shinai* was smaller in the maximum striking force and slightly larger in the impulse value than that of bamboo *Shinai*. This suggested that the *Carbon-Shinai* was highly elastic and the amount of bending deformation was large, so contact time to the striking area became longer. However, there are differences in the striking force component, especially the impulse value, caused by individual differences in the striking force of kendo practitioners, that is, differences due to individual skill level. This factor was not taken into account with the slight variance in the force product value caused by the machine-generated strikes. Compared with the *Shinai,* the *Carbon-Shinai* was judged to be safe from various perspectives because of the minimal risk of splinters or breakage. As a result, the *Carbon-Shinai* was certified as usable equipment in Kendo.

2.3. Standards of components (*Saki-gawa*, *Naka-yui*) required for *Shinai* assembly [Kusama *et al.* 2012; Nakiri 1994; 1996; 1997]

The *Shinai* consists of four slats of bamboo, connected by a *Naka-yui* (middle ties), *Saki -gawa*, *Tsuka-gawa* and *Tsuru*. Although the shape of the *Shinai* changes during the strike, the amount of deformation differs depending on the bamboo pieces, resulting in bamboo slats potentially breaking loose from the *Saki-gawa* and penetrating the *Men-gane*, thereby posing a risk to the eyes. Therefore, the authors proposed that the length of the *Saki-gaw*a be 50 mm in order to prevent the bamboo from being released from the *Saki-gawa* even when greatly deformed in the strike. Furthermore, we clarified that it is possible to minimize the amount of deformation of the *Shinai* by connecting the position of the *Naka-yui (*middle tie*s)* to 1/4 from the tip of the total length of the *Shinai*. The results of these demonstration experiments have been reflected in the established standards, and in the instruction of safety and maintenance of *Shinai*.

Conclusion

The safety of *Shinai* and Kendo equipment specifications were able to be refined based on the results of fundamental and empirical research projects conducted into establishing safety measurements. However, neglecting maintenance and management of equipment leads to unexpected accidents, therefore we believe that it is important to promote guidance into safety management. And, although 20 years have passed since the safety standards were established in 1998, it remains a voluntary regulation among manufacturers, and the absence of an accreditation body designed to conduct public safety examination tests is a serious problem. In the future, we think that it is necessary to review further safety standards and develop urgent international standards for Kendo equipment to accompanying the growing internationalization of Kendo.

References

1. Ajiro T., Yamanami Y., Tamura S., Hashimoto A., Inoue M. (1982), *Exercise physiological study of kendo [part 1] – Shomen striking motion and impact force*, "Research Journal of Budo", vol. 3, no. 1, p. 31 [in Japanese].
2. Kubo T., Asami T., Nakano Y., Sato N. (1969), *Analytical study on kendo movement using piezoelectric elements (1st Report)*, "Research Journal of Budo", vol. 22, no. 1, p. 38 [in Japanese].
3. Kusama M., Nakiri F., Kihara T., Yokoyama N. (2012), *A Consideration on the Striking Force of Shinai (Bamboo Sword) – Focusing on Position and Loose of Naka-yui,* "Research Journal of Budo", vol. 45, p. 46 [in Japanese].
4. Nakiri F. (1989-1992, 1996-2000, 2002, 2003), *Safety measures of the Kendo equipment,* All Japan Kendo Federation Medical and Scientific Committee Annual Report [in Japanese].
5. Nakiri F. (1997), *Basic research on safety of protective articles – Survey report of the second subcommittee –,* Survey report on the establishment of safety standards for the 1997 Basic research on safety of protective articles – Survey report of the second subcommittee –, Survey report on the establishment of safety standards for the 1997 Consumer Product Safety Association, pp. 66-83 [in Japanese].
6. Nakiri F., Takaki R., Ando K., Yamagami S., Tanaka Y., Yoshimura T. (1987), *On the Mechanical Properties of Shinai (Bamboo Sword) and Carbon-Sinai in Shou-men striking,* "Research Journal of Budo", vol. 20, no. 2, pp. 135-136 [in Japanese].
7. Nakiri F., Tanaka Y., Ando K. (1989), *On the cushioning effect of the Kendo gear using various core materials,* "Research Journal of Budo", vol. 22, no. 2, pp. 155-156.
8. Nakiri F., Yamagami S., Takaki R., Okada Y. (1992), *Mechanical study on safety of the Kendo equipment,* Japan Biomechanics Society 11th Annual Convention "Science of Motion and Sports", pp. 467-471 [in Japanese].
9. Nakiri F., Yokoyama N., Arita Y., Kubo T., Yamagami S. (2005), *Influence of Datotsu in Kendo on the Human Head: Impact Estimation Using Simulation with Crash Dummy*, "Research Journal of Budo", vol. 37, no. 3, pp. 1-11.
10. Oya M., Nakiri F. (1998), *Difference about the Impact Force of the man and woman in the Kote striking movement and a technical characteristic*, "International Budo University Journal", vol. 14, pp. 1-11 [in Japanese].
11. Oya M., Nakiri F., Yokoyama N., Yamagami S. (1996): *The Difference of High-Low Striking Point and Impact Force in the Motion of Face Mask Attack (Shou-men-Uchi) in Kendo,* "Research Journal of Budo", vol. 29, no. 2, pp. 27-35 [in Japanese].
12. Sugie R. (1965), *Measurement on striking force by the shinai,* Research report of the Department of Education, Gifu University, No. 1, pp. 34-38 [in Japanese].
13. Tatsumi N. (1982), *Measurement of striking pressure of kendo by color measurement type pressure measurement paper*, "Research Journal of Budo", vol. 15, no. 2, pp. 82-83 [in Japanese].
14. Yamagaki S., Nakiri F., Okada Y., Ae M. (1993): *Impact Forces of the Tobikomi-men and Hiki-men Striking in Kendo,* International Society of Biomechanics XIVth Congress (France).
15. Yokoyama N., Nakiri F. (1989), *A Study on Impact Force Component Generated by Striking movement in Kendo,* "Research Journal of Budo", vol. 22, no. 2, pp. 159-160 [in Japanese].
16. Yokoyama N., Nakiri F. (1991), *Safety measures of the Kendo equipment – Impact Force on the Shomen-uchi Movement in Kendo,* "Research Journal of Budo", vol. 24, no. 1, pp. 35-44 [in Japanese].