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“Ninja” Respiration Management:

Medical Explanations from the Viewpoint of Anesthesiologists

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Abstract

In medieval Japan, special operation agents known as “Ninjas” had a profound interest in the management of respiration for successful completion of their mission as well as for their own survival. Examples of their knowledge regarding respiration include being able to estimate the depth of sleep by recognizing the difference between rapid-eye-movement (REM) and non-REM sleep, suppressing their own breathing sounds, adapting special breathing techniques for long distance running, and fostering mental stability through the use of unique breathing patterns. The classic literature notes that ninjas used special breathing apparatuses that allowed them to remain underwater for long durations. For the purposes of the present review, the practicality of these ninja snorkels was investigated in a simple experiment. The findings suggest that the extensive knowledge ninjas held about human respiration was practical and scientifically explainable from the perspective of modern medical science.

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Introduction

Respiration is a key issue for human survival. Anesthesiologists and intensivists are modern professionals who provide respiration care during surgery, as well as interventional procedures and intensive care. Before such modern medical management techniques were introduced, some specialized groups also had a profound interest in respiration management. We already introduced the physiological and pharmaceutical knowledge in ninja society in this journal. In this review, we explore the respiration-related knowledge of “ninjas”.

“Ninjas”: secret agents in medieval Japan

“Ninjas” were covert agents or mercenaries in feudal Japan, somewhat equivalent to a “007” working on a “mission impossible”. The functions of the ninja included espionage, sabotage, infiltration, assassination and guerrilla warfare. They observed strict rules about honor and combat. This specially trained group of spies and mercenaries appeared in the warring state period of Japan.¹

Ninjas first arose during the power struggles of ninth and tenth century Japan, which saw an increasing demand for spies, informants, and assassins. They were mostly hired by local landlords known as “*daimyo*,” and were most active during the fifteenth century. They were employed until the mid-1600s, when they disappeared due to social trends that sought to destroy the established system.²

Superhuman or supernatural powers were often associated with ninjas. Some legendary abilities include flight, invisibility, shape-shifting, splitting into multiple bodies, and animal summoning. The tales of these magical powers may be rooted in the ninjas’ own efforts to

disseminate fanciful information.

Along with the mystical aspect of ninjas, there is a tendency to depict them as the medieval equivalent to modern special operation forces. This viewpoint also includes mythologizing the ninja, describing them as emotionless living weapons with nearly superhuman abilities derived from extensive training. They were believed to possess vast knowledge regarding toxicology, physiology, psychology, and advanced military technology. Extremely strict self-discipline was mandatory.^{3,4}

“*Ninjutsu*” refers to the various techniques utilized by ninjas. Extensive training in a variety of martial arts enabled ninjas to climb sheer walls and cliffs, control their breathing underwater and their heartbeat under enemy scrutiny, leap from great heights, free themselves from knots and chains, walk or run for long distances, remain motionless for long durations, blend in with shadows, trees, and statues, disguise themselves as people of every class, and move about freely, even in areas that were under heavy surveillance (Fig. 1).⁵



Fig. 1 A ninja devising a sneak attack in a traditional Japanese house

Ninja tactics textbooks

Ninja activities and knowledge were not clearly documented because they did not want their special techniques to be revealed to greater society, especially potential enemies. Most of their knowledge was transmitted by direct verbal communication and direct technical training. Ninjas were known to be particularly secretive about their existence and actions.⁵

However, three textbooks were prepared near the final stages of the ninja era. These were “*Ninpiden*” (1655), “*Bansenshukai*” (1675), and “*Shōninki*” (1681).^{2,6,7} Some of the content in these texts were based on Chinese military philosophy.^{2,4,6,7} Although the first copies of these works were not well known, they were eventually transcribed several times and gradually disseminated among specialized groups of people who had a degree of interest in military tactics and/or martial arts (Fig. 2). The information described here is primarily based on descriptions of these three textbooks and the related historical literature, which combines original notes on the textbooks accompanied by undocumented information from several martial arts masters who were trying to maintain a number of ninja techniques within their own

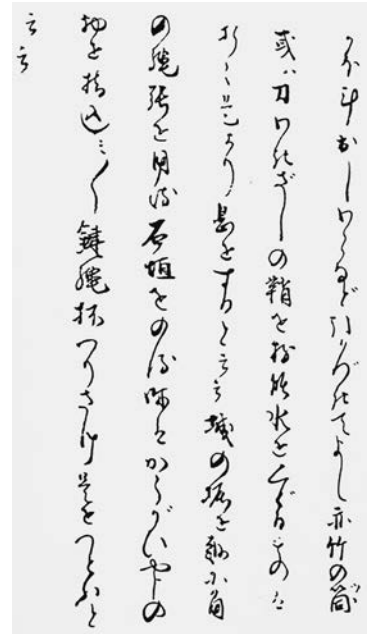


Fig. 2 Description of a ninja snorkel in “*Shōninki*” (1681)

sects. Some of these masters were Masaaki Hatsumi (*Bujinkan*), Stephen K. Hayes (*To-Shin Do*), and Jinichi Kawakami (*Banke Shinobinoden*).^{8,9}

Breath observation and silent breathing during a sneak attack

Observing the breath of sleeping or resting enemies was important to enable a successful sneak attack. For the reason, both “*Bansenshukai*” and “*Shōninki*” contain descriptions regarding how to estimate sleep depth. These textbooks note the following three points in estimating the depth of sleep: age and body shape (thin or fat), character and appearance, and mental status. Impatient and dry individuals tend to sleep lightly, whereas individuals with a peaceful mind tend to sleep deeply.^{6,7,10}

In addition, although no details were shown, the following five important points were noted regarding snoring sounds: learn to use a special tube for better listening over a wall, learn to distinguish real sleep from fake sleep, learn to distinguish fake snoring, learn to estimate sleep depth, and learn to distinguish between deep and shallow sleep without snoring.

“*Shōninki*” described two sleeping patterns characterized by regular and irregular breathing, depending on the depth of sleep. One noted historian hypothesized that the author of “*Shōninki*” clearly knew the difference between rapid-eye-movement (REM) and non-REM sleep.⁷

In addition to the estimation of sleep depth, it was mandatory for ninjas to learn how to suppress their own breathing sounds. In “*Ninpiden*”, it was noted that holding a sheet of paper between the teeth was an effective method to mask breathing sounds when near a sleeping enemy (Fig. 3).² “*Musokunin*” refers to a type of ninja training for suppressing breathing sounds immediately after strenuous physical activity. In this type of training, ninjas first engage in strenuous exercise. Next, they sit down and inhale slowly and deeply through the nostrils,



Fig. 3 Holding a sheet of paper between the teeth was considered effective to suppress the sound of breathing

and then hold it in for a short duration. Next, they exhale slowly and silently through the nostrils.

To evaluate the effectiveness of this method, two of the authors measured their breathing sounds immediately after running up five sets of stairs (approximately 25 m in distance) in 70s. Next, they held a sheet of paper between their teeth, and the sound of their breathing was measured for 1 min with 30 cm between their nose and a microphone using a db meter (20-130 Hz, Decibel 10th, ver.5.0.0., SkyPaw, Inc. on an iPad (Apple Inc., Cupertino, CA, USA). The maximum recorded value was 46 db. When the same measurement was performed on a different occasion without holding paper between the teeth, the maximum recorded value was 75 db (Table 1). This technique was therefore shown to block unintentional air flow through the mouth, which makes a relatively loud noise, and direct most of the air flow through the nostrils. However, breathing only thorough the nostrils immediately after strenuous physical exercise delays the normalization of carbon dioxide, which can be uncomfortable for untrained subjects.

Breathing during strenuous activity

Ninjas sometimes had to run long distances to escape from their enemies and to relay important information to their employers without delay. Therefore, they trained special breathing techniques for long-distance running. One master of “*iga ninja*” trends reported that ninjas adopted a special breathing technique known as “*igaryu senri-zenso-no-hou*”, which translates as “*iga*’ 4000-km good running method”, in which ninjas repeated the following breathing sequence: “inhale-exhale-exhale-inhale-exhale-inhale-inhale-exhale”.⁴

Ninjas were also known to employ several survival techniques from a sect combining Buddhism and the domestic Japanese religion, “Shintoism”, known as “*shugendo*”. Repeatedly reciting a short phrase during strenuous long-distance walking or running was considered to be one such special breathing technique.

Breathing during meditation

Among the ninja society, breathing methods were known to significantly affect mental stability and self-confidence. This knowledge was very important for safely and successfully completing high-risk missions. “*Shōninki*” noted that mental stability and the capability to take inspirational action without time-consuming planning were mandatory skills for ninjas.^{7,10} Specialized ninja breathing methods, including “*kyujigoshinhou*”,



Fig. 4 “*Kyujigoshinhou*” is a special breathing method using hypnotic suggestion that involves making nine sequential finger shapes

Table 1 Breathing sounds immediately after physical exercise

		Breathing normally (db: minimum-maximum)	Breathing while holding paper between the teeth (db: minimum-maximum)
Subject A (female) (26 yrs, 160 cm, 53 kg)	Pre-exercise	39 – 43	39 – 42
	Post-exercise	42 – 57	39 – 42
Subject B (male) (55 yrs, 169 cm, 58 kg)	Pre-exercise	39 – 44	39 – 42
	Post-exercise	43 – 75	40 – 46

Breathing sounds immediately after running up five sets of stairs (approximately 25 m in distance) in 70 s was measured in a soundproof chamber in two participants for 1 min, keeping a distance of 30 cm between the nose and microphone. When the participants held a sheet of paper between their teeth, the sound of their breathing was effectively suppressed, as described in the ninja textbook, “*Ninpiden*”.

which refers to quiet breathing with hypnotic suggestion involving making nine sequential finger shapes, have also been described (Fig. 4).¹¹ This breathing method would be expected to make a significant contribution to the successful completion of a mission, as calm breathing is well known in athletics and the military as an essential variable for achieving victory.

Underwater breathing with special devices: bamboo snorkels and related devices

In addition to training in a variety of martial arts, ninjas also trained in a range of survival techniques.⁵ Among these were several tactics regarding crossing moats surrounding castles by going over or under the surface of the water.

In several textbooks and the related literature, ninjas were shown to use specialized breathing apparatuses such as bamboo snorkels to stay underwater in the moat of an enemy's castle for long durations. The purpose of using these devices was primarily concealment. In "*Shōninki*", ninjas were described as carrying a bamboo tube or short sword sheath (a specially designed scabbard with a hole at the bottom) for temporary breathing in order to travel successfully underwater.⁷ Similar underwater skills were also mentioned in "*Ninpiden*".²

One historian describing a classic document entitled, "*Settou-ichiryuu-densho*", noted that a breathing bag devised for underwater breathing enabled an adequate amount of air to be reserved for inhalation. Also described was a bamboo tube several centimeters in diameter and approximately 1 m in length (the length could be changed depending on seasonal changes in water clarity), with the inside nodes removed, a phantom great cormorant (*Phalacrocorax carbo*) with an air intake attached at the head for imitation, and an angled mouthpiece attached at the bottom, that was usable for underwater walking.⁶ Concealing the body with leaves or imitating a duck may have been effective in secrete operations. In other literature, ninjas were described as carrying a short sword. The sheath of the sword had a small hole at the bottom and could be used as a snorkel for underwater breathing.¹⁰

Another ninja historian reported that ninjas used long bamboo tubes approximately 120 cm long for underwater breathing that they tested themselves.⁹ These tubes were made of *Sasamorphia borealis* (a species of bamboo grass unique to Japan), had mouthpieces, and were used for "*suiton-no-jutsu*", a special underwater

hiding or escape technique.⁸

Such ninja tactics have also been shown in the English literature regarding Japanese military history.¹ Turnbull showed a picture of a young ninja who was learning how to breathe underwater using a bamboo tube, noting that this technique could save his life if he had to hide for hours underwater to evade pursuing enemies.

In contrast, Kuroi¹² did not seem to think that "ninja snorkels" actually existed because in order not to be seen by their enemies, ninjas had to dive deep in the water, and would therefore need long snorkels with a large air capacity. Apparently, long snorkels were impractical when ninjas had to move swiftly and secretly. Kuroi also mentioned that when ninjas dived deep underwater with bamboo tubes longer than modern snorkels, respiration was particularly difficult because of the substantial ambient water pressure.^{3,4} The authors of the present manuscript consider Kuroi's speculations to be reasonable and scientifically correct. To verify his considerations, we conducted the following experiment (see below, ninja snorkel experiment). It could be that the ninja snorkel was practical only in limited circumstances, such as in opaque water in moats and under limited surveillance by enemy soldiers.

Ninja snorkel experiment

To examine whether ninja snorkels were practical for surreptitious underwater movement, we prepared three different sizes of bamboo tubes and an imitation short sword sheath (Table 2, Fig. 5) and investigated their applicability in a modern swimming pool. The results of the experiment are as follows:



Fig. 5 Three bamboo snorkels and an imitation sword scabbard

Table 2 Underwater snorkel test
Prepared "ninja snorkels"

	Bamboo short One bamboo node	Bamboo intermediate Two bamboo nodes	Bamboo long Three bamboo nodes	Sword scabbard
Length (cm)	35	70	104	42
Diameter (cm) (inner/outer)	2.5/3.0	2.2/3.0	2.0/3.0	3 × 1.8 oval shape #
Volume (mL)	150	285	390	155

Oval shapes with longer and shorter inner diameters.

- 1) An adequately heavy lead weight (or other material) is necessary to stabilize the body underwater. This is well known among scuba divers.
- 2) Clearing the snorkel, which involves blowing deposited water out of the tube, is indispensable before the first inhalation. This action is only possible when the inside surface is smooth and all the water can be blown out on the first attempt. If the bamboo nodes inside the snorkel are not perfectly removed, a satisfactory “snorkel clearing” is difficult. In addition, the total inner volume of the bamboo tube should be adequately smaller than the maximum single expiratory volume of the person underwater. In our case, a single node of bamboo, which has an inner volume of approximately 150 ml, was the maximum possible size for snorkel clearing. Water gushing out from the bamboo is extremely obvious and would be easily recognized by the ninja’s enemies (Fig. 6).
- 3) Water pressure is extremely important for continuous underwater breathing. It is only possible to stay for a long duration at a shallow depth, probably when the depth of the thorax is less than 50 cm below the surface (Fig. 7). The oral cavity is also compressed by the water pressure. The accidental intake of water within the oral cavity must be avoided because it



Fig. 6 Water being cleared from a bamboo snorkel



Fig. 7 Remaining underwater with the assistance of a bamboo tube

would enter the airway and choke the individual. Since the surface area around the adult thorax is approximately $2,000 \text{ cm}^2$,¹³ the total weight load on the thorax at 30 cm depth is 60 kg, while that at 60 cm is 120 kg, and that at 100 cm is 200 kg. Breathing under a weight load of 200 kg is incredibly difficult.

From those experiments, we considered that the “ninja snorkel” was rather impractical. Such snorkels only seem to be usable under limited conditions, such as staying just beneath the water surface in murky water or under large floating leaves. As mentioned in “*Bansenshukai*” and “*Settou-ichiryuu-densho*”, attaching a phantom great cormorant to the head of the tube may be an effective method to deceive the enemy.⁶

Conclusion

Ninjas had ample knowledge regarding human respiration, and most of this knowledge was found to be practical and scientifically explainable from the perspective of modern medical science. With their advanced knowledge, trained anesthesiologists and intensivists may be able to work as ninjas and successfully complete a “mission impossible”.

Conflict of Interest Statement

There is no conflict of interest to have to disclose for all authors.

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