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Human-induced traumas in the skulls excavated from Gokurakuji site, Kamakura, Japan

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Abstract This study investigates the human-induced traumas in the skulls excavated from the Gokurakuji site macroscopically. Human-induced traumas were classified into four types, like gashes, incisions, scratches, and blunt force trauma. The results revealed that the number of skulls with gashes or incisions tended to be low (1 individual with a gash and 4 individuals with incisions out of 331 individuals) among those of previously reported populations in medieval and recent Japan. These results suggested that the skulls found on Gokurakuji site might be not have belonged to victims of the battle of Nitta Yoshisada in 1333. Additionally, the relatively high number of specimens with scratches (21 or 6.3%), also the second highest among the discussed sites, could have resulted from differences in diagnostic standards or differences in the purpose or method used for inducing scratches.

Key words: Human-induced, trauma, Kamakura, Medieval, Skull

Introduction

Human-induced traumas in human skeletal materials have been examined as objective evidence of interpersonal violence in the fields of physical and forensic anthropology (Suzuki, 1956; Boylston, 2000; Williamson *et al.*, 2003; Nagaoka and Abe, 2007; Dodo *et al.*, 2008; Sakaue, 2010).

Many studies of weapon-related traumas have focused on the human skeletal remains excavated from the medieval sites in Japan (Suzuki, 1956, 1975, 1989; Morimoto, 1987; Morimoto and Hirata, 1992; Hirata *et al.*, 2004; Nagaoka *et al.*, 2009; Nagaoka *et al.*, 2010). Most of these studies focused on the archeological sites in the Yuigahama area in Kamakura city, Japan. In this area, more than 5000 human skeletons have been found from four sites (the Yuigahama-minami site, the Seiyokan site, the Zaimokuza site, and the Yuigahama Chusei Shudan Bochi site). The Yuigahama area, a sandy beach, is thought to have been utilized as a large cemetery from the 12th to 13th centuries based on ^{14}C aging of human skeletal remains from the Yuigahama Chusei Shudan Bochi and Yuigahama-minami sites (Minami *et al.*, 2006).

According to Suzuki (1956)'s theory, the sharp-edged traumas of the skulls excavated from the Yuigahama area are classified into three types: "gashes (penetrating both the external and internal laminae of a skull)," "incisions (penetrating only the external and not the internal lamina of a skull)," and "scratches (short and shallow linear cut marks only on the external surface of a skull)" (Suzuki, 1956; Hirata *et al.*, 2004; Nagaoka *et al.*, 2010). In the Yuigahama area, the frequencies of these trauma types differed in each site, with a significantly higher number of scratches (153 individuals out of 283) in the skulls in Zaimokuza site. Of the remaining sites in this area, three skulls with scratches were found only in the Chusei Shudan Bochi site (Nagaoka *et al.*, 2010).

The Gokurakuji site is located at a hill on the west end of Yuigahama beach and is about 1 km

Fig. 1. Map of Gokurakuji site.

south-west of the Yuigahama-minami site (Figure 1). This site was found and excavated by Hisashi Suzuki and the members of the Department of Anthropology, the University of Tokyo in 1959 (Suzuki, 1998). Five graves containing a large amount of human cranial bones, and a relatively small number of mandibles, postcranial bones, and animal bones (horse, cow, dog, and deer) were found, and the total number of individuals was estimated to be approximately 1000. Although the archaeological report of the Gokurakuji site has not been published, a case report about a male skull penetrated by an iron arrowhead excavated from Gokurakuji site was reported in the paper (Suzuki, 1975), and a simplified outline of the Gokurakuji site was provided in his book "Hone ga kataru Nihonshi (Bones tell the history of Japan)". In this book, he noted some characteristics of the skulls found in the Gokurakuji site in an essay. Examples of statements include "There were some skulls with weapon-related traumas," and "I had thought that more scratches would be frequently recognized in the skulls of the Gokurakuji site. But the result, contrary to my expectation, indicated that there was no scratch on the skulls found on this site." (Suzuki, 1998: pp. 140–151). Thus, no detailed reports are available on the human-induced traumas in the human skeletal remains excavated from the Gokurakuji site.

Suzuki (1998) regarded the human skeletal remains of Gokurakuji site as victims of the battle in which Nitta Yoshisada attacked the capital, Kamakura city that ended with the fall of the Kamakura shogunate in 1333 because of the following reasons: 1) This site is located near the Gokurakuji Kiritoshi, a narrow slope used as one of the military gates for the capital Kamakura where a severe battle was fought between the regular army of the Kamakura shogunate and the troops of Nitta Yoshisada in 1333. 2) Mass cranial graves were the results of secondary burial, and these crania were gathered after the corpses had been decomposed and skeletonized judging from bite marks of dogs on human bones and piles of cranial fragments like dishes in situ. This implied that the corpses had been left on the ground without a first burial, supporting the the-

ory that many casualties had been left behind following a severe battle. 3) Horse bones were the most popular among the animal bones mixed in Gokurakuji site, which were used by the military in medieval Japan. 4) There were many skulls with human induced traumas, particularly No. 404 that was thought to have been shot on his head by an iron arrow (Suzuki, 1975).

This study aims to macroscopically investigate the human-induced traumas in the skulls found on the Gokurakuji site and examine the validity of the relationship between these traumas and the battle.

Materials and methods

All the skeletal materials excavated from the Gokurakuji site are stored in the Human Osteological Collection at the Department of Anthropology, National Museum of Nature and Science, Tokyo (i.e. NMNST). After the completion of the excavation in 1959, these materials were first moved and stored in the Department of Anthropology, the University of Tokyo, following which Dr. Suzuki borrowed these materials from the University of Tokyo and shifted them to NMNST in 1972 after he became the first head of the Division of Anthropology in NMNST. In 2003, these materials were officially transferred to the Department of Anthropology, NMNST.

Because all skulls from this site had been broken into fragments, the materials for investigation in this study were limited to specimens which any three bones composing the calvarium can be reconstructed almost completely. A total of 331 specimens were available for investigation.

The skull penetrated by the iron arrowhead (No. 404) was not found in both NMNST and the University Museum of the University of Tokyo under this investigation. Unfortunately, this specimen could not be included in this study.

The sex of adult individuals was determined by the cranial features (Sakaue and Adachi, 2009). Metrical estimations of sex were also performed (Nagaoka *et al.*, 2008), and all estimated sexes were no discrepancy between those results. The estimations of the age at death were carried out based on cranial suture closure (Sakaue, 2015), dental formation, and eruption (Ubelaker, 1989), and the samples were classified into four age categories as child (approximately 0–9 years old), young (approximately 10–19), adult (approximately 20–59), old (approximately over 60).

The cut marks on the posterior border of a mandibular ramus can be regarded as evidence of decapitation in Japan (Morimoto and Hirata, 1992). In order to confirm decapitation in the Gokurakuji samples, the right and left mandibular ramus were separately investigated because almost all mandibles were disarticulated from the crania and broken into the half (Suzuki, 1998). The minimum number of individuals was 158 on the basis of right mandible ramus.

In this study, a fracture in which the breakage was the same color as the surface of surrounding bone was considered to be perimortem (Sauer, 1998; Ortner, 2008). Primarily, human-induced traumas were discriminated on the basis of morphological similarity to "sharp force trauma" and "blunt force trauma" that have been reported and defined in previous works in the field of forensic anthropology (Berryman and Symes, 1998; Arbour, 2008; Boutros-Ghali, 2008; Berryman *et al.*, 2012). A cut mark made by a sharp-edge instrument was identified as a fracture with "linearity", "a well-defined clean edge (margin of bone defect)", and "a flat, smooth, polished cut surface" on macroscopic observation in this study (Boylston, 2000). In reference to Suzuki's definition, cut marks were sub-classified into "gashes," "incisions," and "scratches". The "scratches" could only be macroscopically seen as linear striation without a smooth cut surface and several striations were found together in one group and were often in parallel direction within a group in this study.

It was difficult to identify whether some fractures in the bone had been caused by blunt force instruments, particularly in archeological samples. Thus, blunt force traumas were defined as complex fractures with both radial fractures and concentric fractures as typical fractures by a

blunt instrument in this study (Kimmerle and Baraybar, 2008).

All statistical analyses were conducted using Microsoft Excel 2010 (Microsoft Co., ltd.), and Tukey's wholly significant difference (WSD) tests were performed for post hoc comparison between proportions according to Ryan's procedure (1960). Statistically significant levels in this study were at 5%.

Results and discussion

Table 1 indicates the number of the estimated sex and age groups of the Gokurakuji site. Although males (146 individuals, 44.1%) were more in number than the females (103 individuals, 31.1%), it could be said that no extreme sex-ratio bias was seen in this site. The numbers of the age groups except for "adult" was up to 20. Thus, the demographic composition of this site was not as extraordinary as young adult males might be predominant casualties during battle in medieval Japan.

As can be seen in Table 2 and Figures 2–38, 27 out of 331 individuals had any type of human-induced trauma, and only three individuals had two types of traumas (I-162, IV-412, and IV481).

Table 1. The composition of Sex and Age-at-death of human skeletal remains of Gokurakuji site

	Male	Female	Unknown	Sum
Child	0	0	6	6
Young	0	0	11	11
Adult	113	71	18	202
Old	1	2	0	3
Unknown	32	30	47	109
Sum	146	103	82	331

Table 2. List of human induced trauma in crania of Gokurakuji site

No.	Type of human induced trauma				Sex	Age group	Location	Figure No.
	Gashes	Incisions	Scratches	Blunt				
I-162		3	1		Male	Adult	2 frontal, 2 left parietal	2 (scratch and incision), 3 (incisions)
I-169			1		Female	Adult	Occipital	4
I-172			1		Female		Right parietal	5
IV-406				1			Frontal	6
IV-412			1	1	Male	Adult	2 frontal	7 (scratch), 8 (blunt)
IV-425			1		Male	Adult	Left parietal	9
IV-446			1			Child	Left temporal	10
IV-470				1	Male	Adult	Right parietal	11
IV-481		1	1		Male	Adult	2 frontal	12
IV-486			6		Female	Adult	2 frontal, 4 left parietal	13–15
IV-489				1		Child	Frontal	16
V-520			1		Male	Adult	Frontal	17
V-532	1				Male	Adult	Right parietal	18
V-562		1			Male	Adult	Frontal	19
V-575			1			Adult	Left parietal	20
V-580			1				Frontal	21
V-606			1		Male	Adult	Right parietal	22
V-610			2				Right parietal, left parietal	23 (right parietal), 24 (left parietal)
V-640			1		Male	Adult	Frontal	25
V-643			1		Female	Old	Frontal	26
V-660			1		Male	Adult	Frontal	27
V-664			1				Left parietal	28
V-697			1		Female	Adult	Left parietal	29
V-765			1		Female		Frontal	30
V-779		3			Male	Adult	Frontal, right parietal, left parietal	31 (frontal), 32 (right parietal), 33 (left parietal)
V-830			4		Male	Adult	Frontal, 3 right parietal	34 (frontal), 35 (anterior), 36 (top), 37 (posterior)
V-917			2		Male	Adult	2 left parietal	38

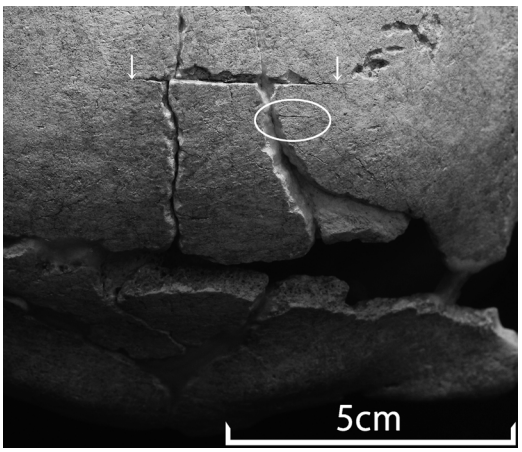

Fig. 2. Scratch and incision in Sample No. I-162.

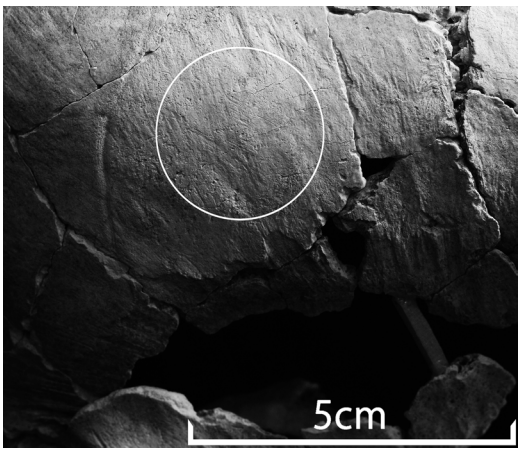

Fig. 5. Scratch in Sample No. I-172.

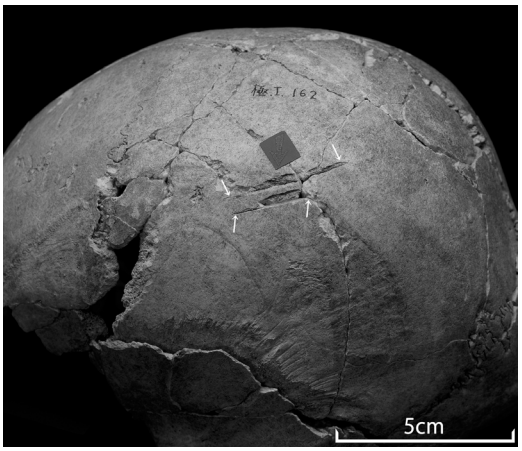

Fig. 3. Incisions in Sample No. I-162.

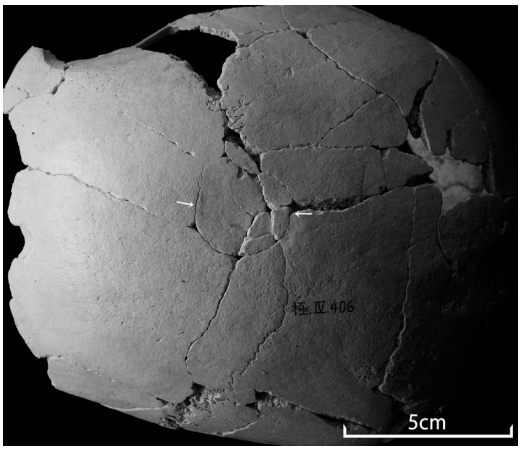

Fig. 6. Blunt force trauma in Sample No. IV-406. Arrows on the photo indicate the concentric fractures.

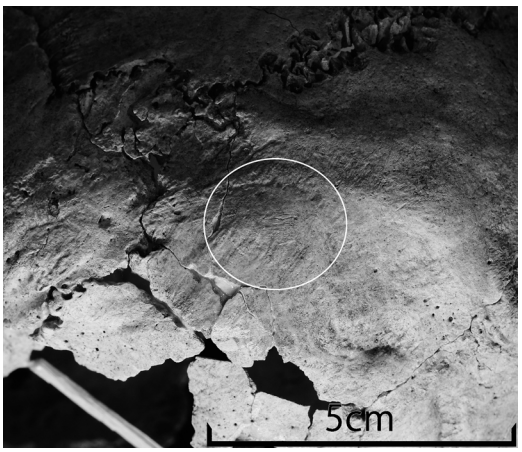

Fig. 4. Scratch in Sample No. I-169.

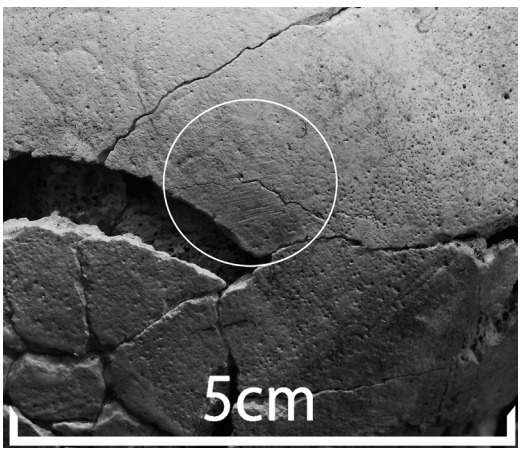

Fig. 7. Scratch in Sample No. IV-412.

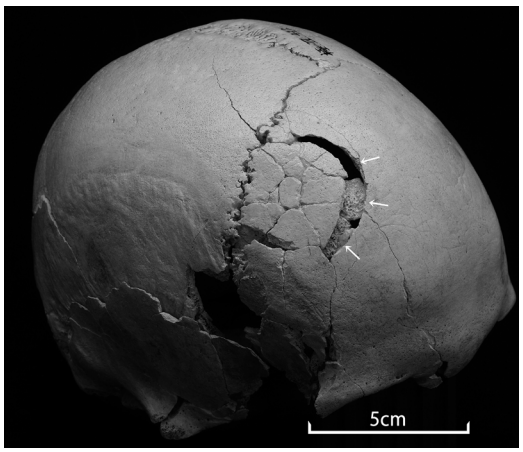

Fig. 8. Blunt force trauma in Sample No. IV-412. Arrows on the photo indicate concentric fractures.

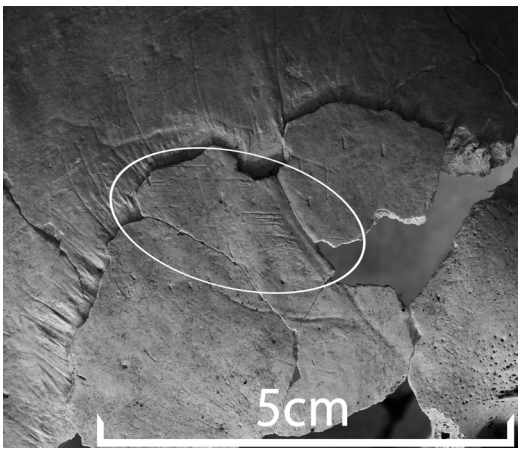

Fig. 10. Scratch in Sample No. IV-446.

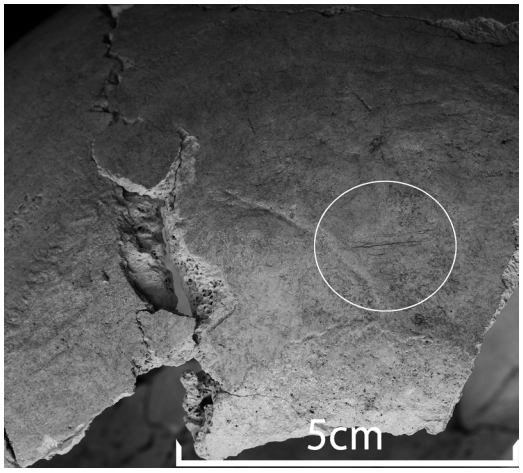

Fig. 9. Scratch in Sample No. IV-425.

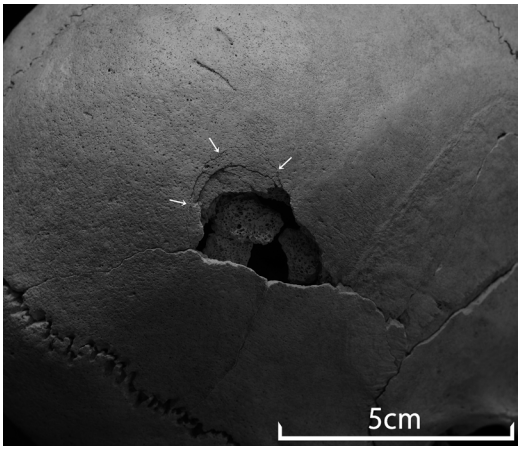

Fig. 11. Blunt force trauma in Sample No. IV-470. Arrows on the photo indicate concentric fractures.

Table 3 illustrates the frequencies of each type of trauma found in the Gokurakuji, Zaimokuza, Yuigahama Chusei Shudan Bochi, Yuigahama-minami, Seiyokan (Nagaoka *et al.*, 2010), Kojyo-nishi (Baba *et al.*, 1987), and the Edo sites (Sakaue, 2014). The frequencies of gashes and incisions in the Kojyo-nishi site were the highest among these sites, where the human skeletal remains were thought to have belonged to the victims of the fall of the Edosaki castle in 1590 (Baba *et al.*, 1987). The frequencies of the Edo sites can be taken as the control group, which illustrates the occurrence of trauma during peaceful times because the capital Edo was not devastated by war during the Edo period except for the battle of Ueno that was limited to the Ueno Mountain in 1868.

Frontal bones were the most frequently harmed bones in the skulls found on Gokurakuji site (19 locations), followed by the left parietal bones (14 locations), and the right parietal bone (9 locations) (Table 2). Similar to the Yuigahama Chusei Shudan Bochi and Yuigahama-minami sites, no evidence of human-induced trauma was

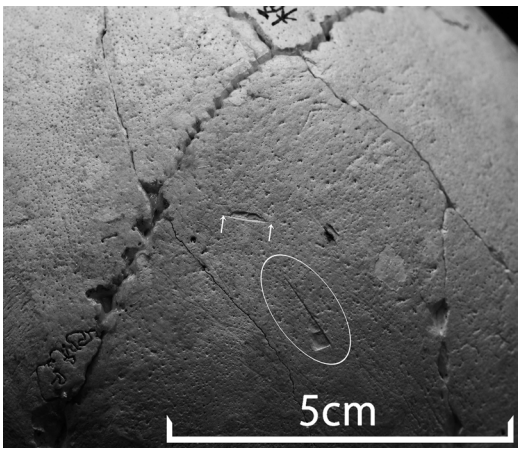

Fig. 12. Scratch and incision in Sample No. IV-481.

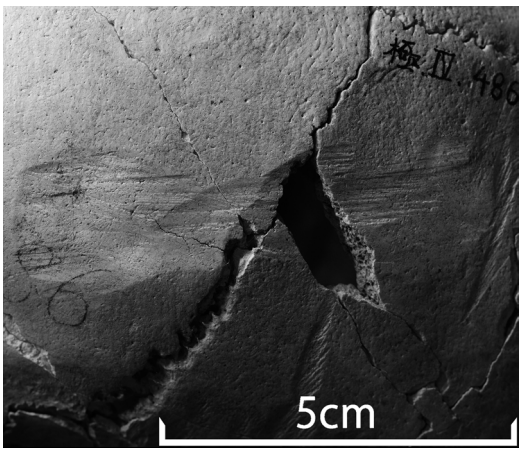

Fig. 14. Upper part of scratches in Sample No. IV-486.

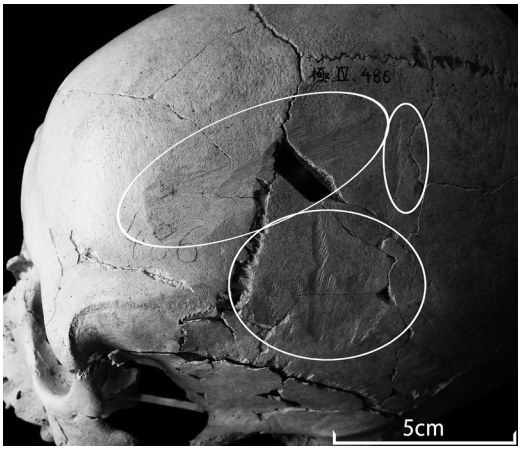

Fig. 13. Overview of scratches in Sample No. IV-486.

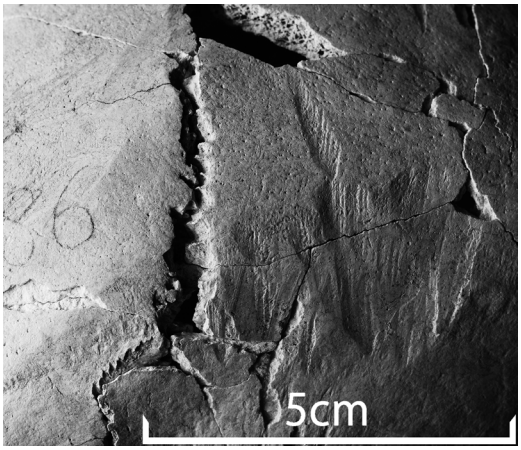

Fig. 15. Lower part of scratches in Sample No. IV-486.

found on the facial bones found on this site.

The gash trauma can be recognized on only one skull (0.3% as in Table 2, Figure 18 and 39). Although this cut mark has linearity and is made on a smooth cut surface, it is without a clean edge and presents a jagged and partly crushed margin (three hollow arrows in Figure 18) in comparison with the clean edge of the gash (parietal bone of the Edo period, in Figure 39). It is possible that the duller edge of a Japanese sword or halberd might have caused this gash. Even if the No. 404 skull with an iron arrowhead that Suzuki (1975) reported is taken into account, the number and frequency of the gashes is the smallest among those reported in the other sites (Table 3). Tukey's WSD tests in gash trauma indicated that the frequency of this site was significantly lower than the Seiyokan and Kojyo-nishi sites (Table 4).

The number of specimens with incisions was four (1.2%) on the Gokurakuji site, and the number of incisions was eight, which were almost the same as those found on the Yuigahama Chusei Shudan Bochi, Yuigahama-minami, Seiyokan, and Edo sites (Table 3). The characteristics of the incisions in this site were shallow and small, and

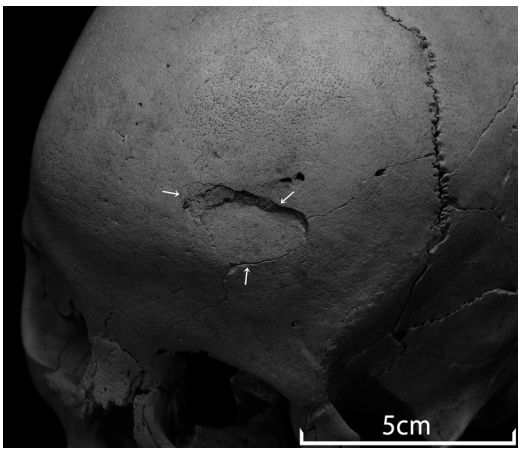

Fig. 16. Blunt force trauma in Sample No. IV-489. Arrows on the photo indicate concentric fractures.

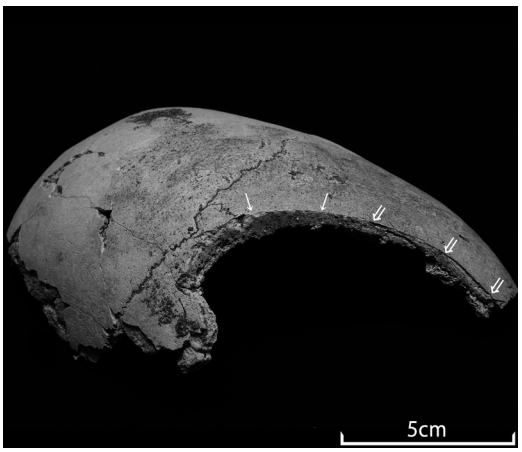

Fig. 18. Gash in Sample No. V-532.

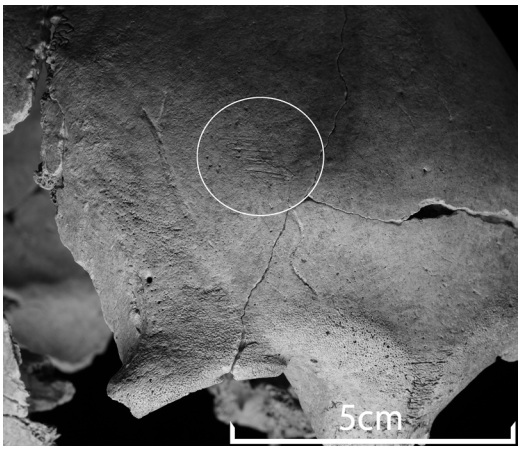

Fig. 17. Scratch and incision in Sample No. V-520.

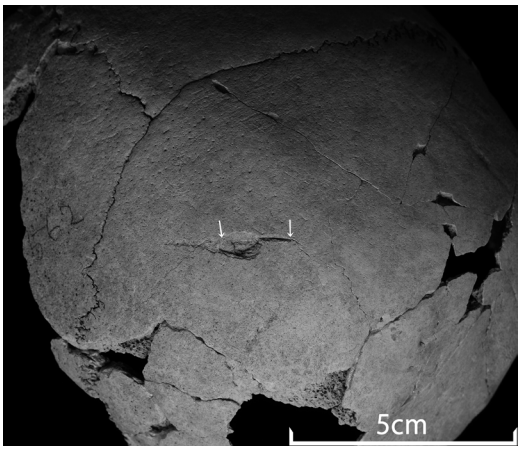

Fig. 19. Incision in Sample No. V-562.

were found on the front bones (4 incisions out of 8). The cut marks in I-162 (in this sample, one scratch just before one incision, in Figure 2) resembled those on the Zaimokuza skulls in that several cut marks were located at the frontal bone near the bregma, that they were close, horizontal marks in parallel, and that many parallel cut marks were located around the top of head of the same individual (Suzuki, 1956). Suzuki (1956) thought that these cut marks might have been caused because of taking one's scalp after battle given the difficulty of making parallel and horizontal incisions at the top of the forehead during conflict. Although it is interesting that this style of incision could be recognized in the Gokurakuji site as well, only one specimen is not explainable. The frequency of this site was significantly lower than the Zaimokuza and Kojyonishi sites (Table 4).

In contrast, the number of specimens with scratches found on the Gokurakuji site was 21 (6.3%), making it the second highest, with significant differences from other sites (Table 4). The scratches in this site appeared to have some vari-

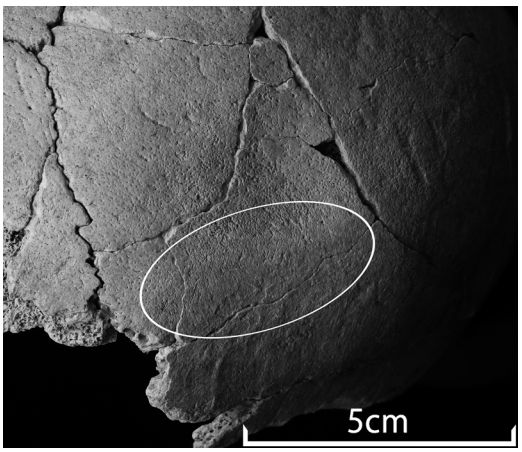

Fig. 20. Scratch in Sample No. V-575.

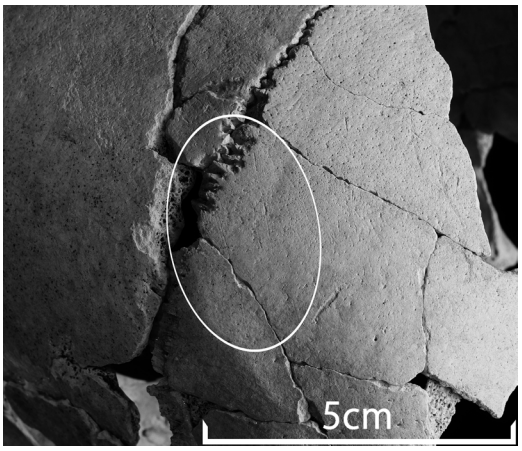

Fig. 21. Scratch in Sample No. V-580.

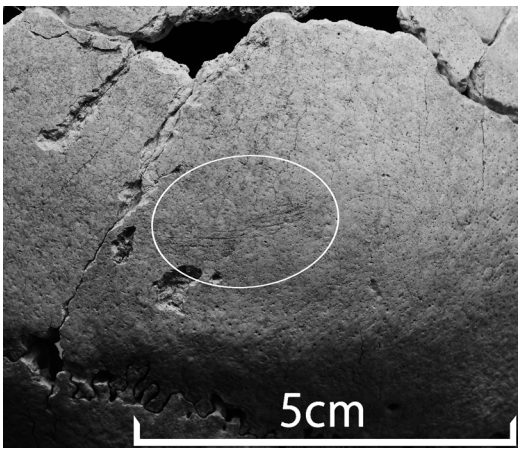

Fig. 22. Scratch in Sample No. V-606.

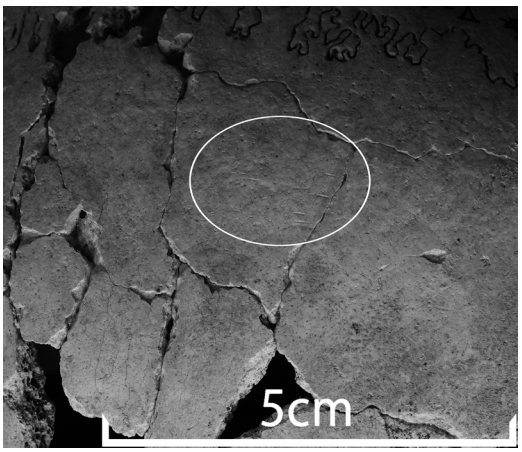

Fig. 23. Scratch in right parietal bone of Sample No. V-610.

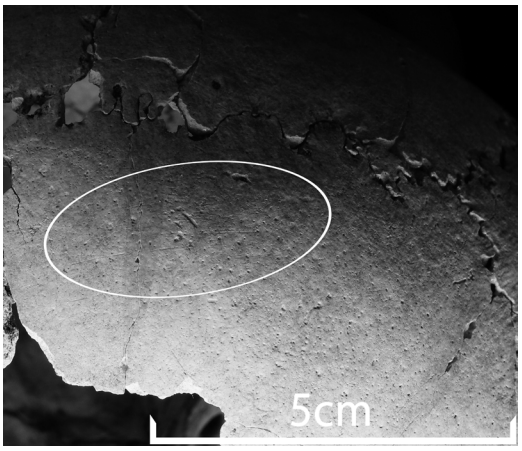

Fig. 24. Scratch in left parietal bone of Sample No. V-610.

ety in their shapes such as short and sharp scratch(es), as illustrated in I-162 (Figure 2), IV-425 (Figure 9), IV-446 (Figure 10), IV-481 (Figure 12), V-610 (Figure 23), and V-643 (Figure 26), weak and slight scratches like I-169 (Figure 4), I-172 (Figure 5), IV-412 (Figure 7), V-520 (Figure 17), V-575 (Figure 20), V-580 (Figure 21), V-606 (Figure 22), V-610 (Figure 24), V-640 (Figure 25), V-660 (Figure 27), V-697 (Figure 29), V-765 (Figure 30), V-830 (Figure 34), V-830 (Figure 36), V-830 (Figure 37); flat surface with striations, as illustrated in IV-486 (Figure 13–15), V-917 (Figure 38); and relatively

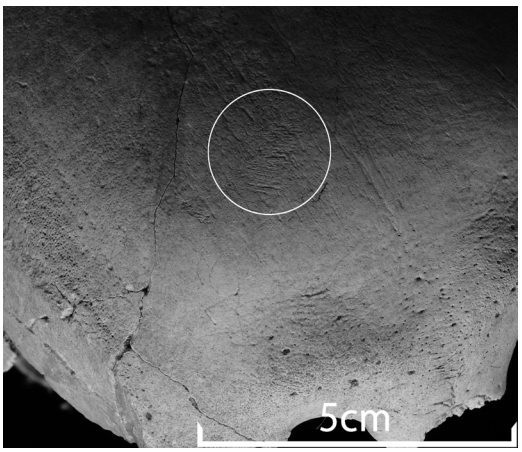

Fig. 25. Scratch in Sample No. V-640.

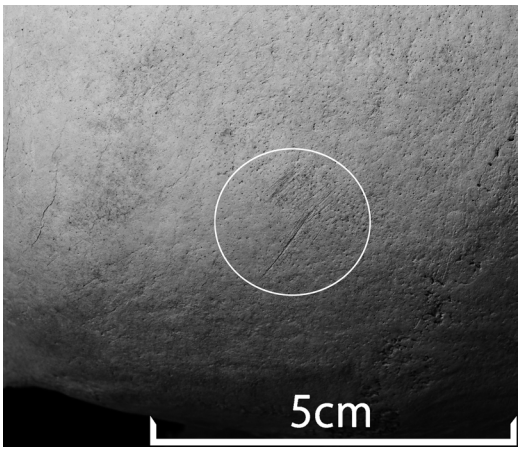

Fig. 26. Scratch in Sample No. V-643.

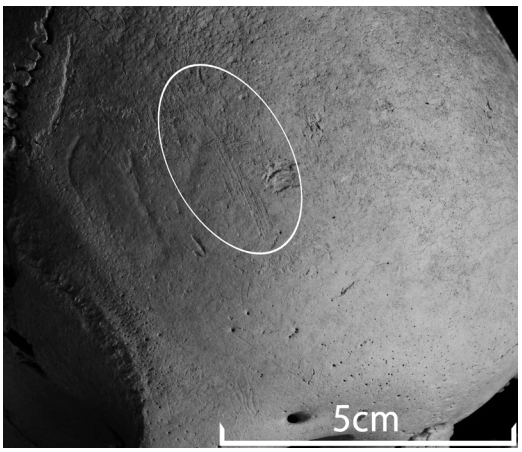

Fig. 27. Scratch in Sample No. V-660.

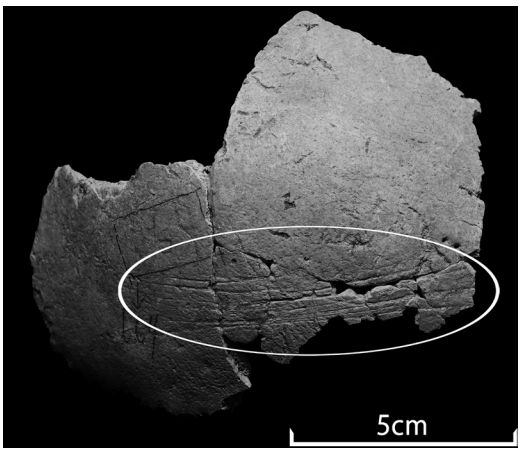

Fig. 28. Scratch in Sample No. V-664.

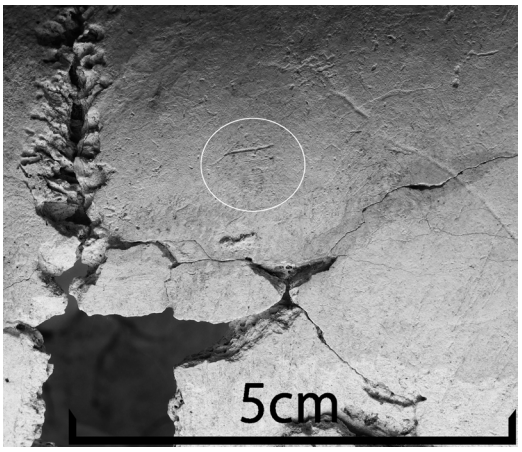

Fig. 29. Scratch in Sample No. V-697.

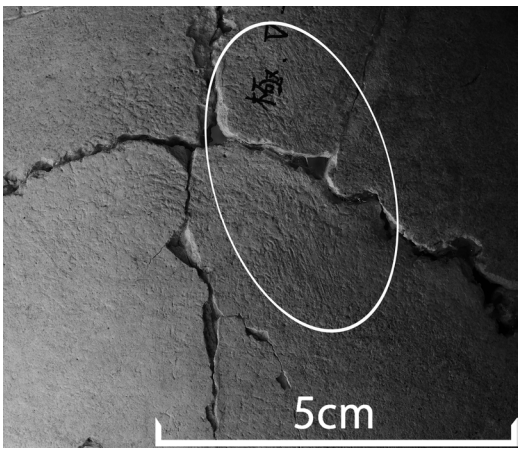

Fig. 30. Scratch in Sample No. V-765.

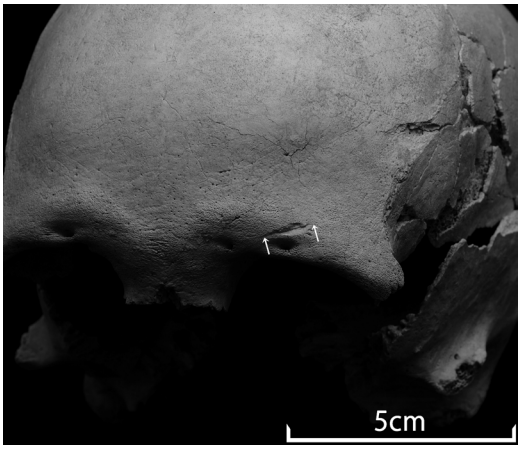

Fig. 31. Incision in frontal bone of Sample No. V-779.

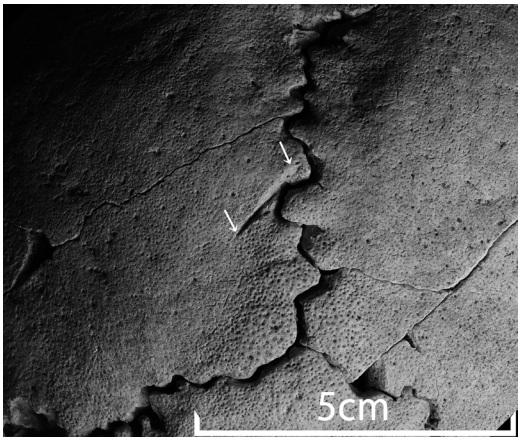

Fig. 33. Incision in left parietal bone of Sample No. V-779.

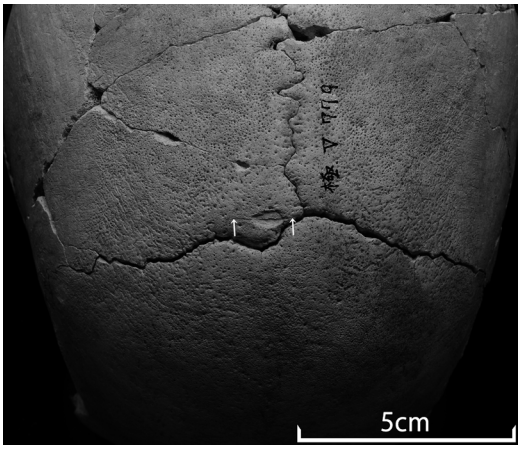

Fig. 32. Incision in right parietal bone of Sample No. V-779.

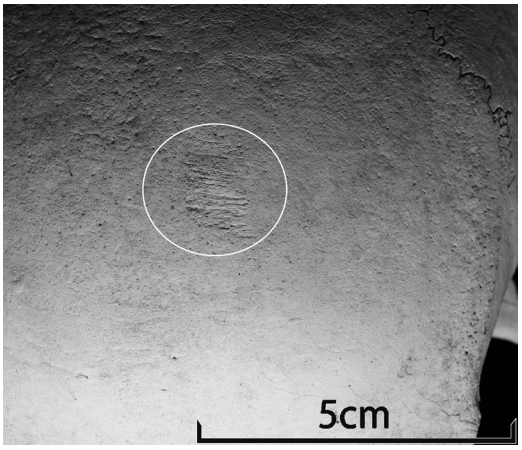

Fig. 34. Scratch in frontal bone of Sample No. V-830.

dull and clear scratch(es), as illustrated in V-664 (Figure 28), V-830 (Figure 35), V-917 (Figure 38). These scratches do not appear to have been caused by the same instrument and reason. For example, it was reasonable to assume that the scratches with the flat surface of IV-486 (Figure 13–15) could have resulted from scalping as Suzuki (1956) insisted. However, the above-mentioned short keen scratches and weak slight scratches were shallow and equal in depth and focused on small areas, which could not be easily regarded as cut marks of scalping. It is possible that the high frequencies of scratches in Zaimokuza and Gokurakuji sites might have been caused by preparation damages of cleaning, restoration, and curation because these skeletal remains were possibly handled in the same laboratory. However, this is not plausible because the scratches did not show fresh breaks even after being rinsed with acetone during this investigation, implying that the breakage had occurred before the burial. Nagaoka *et al.* (2010) had observed that one of the reasons why the reported frequencies of scratches varied among

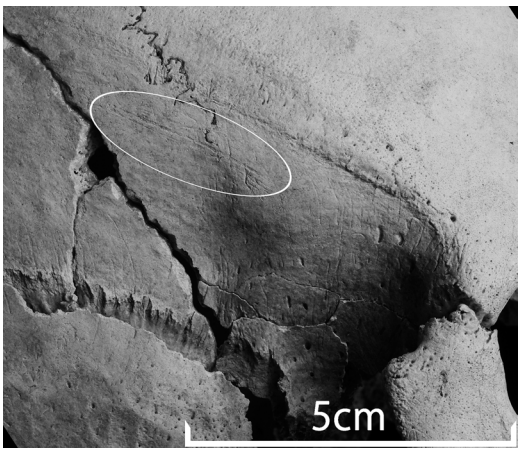

Fig. 35. Scratch in the anterior part of right parietal bone of Sample No. V-830.

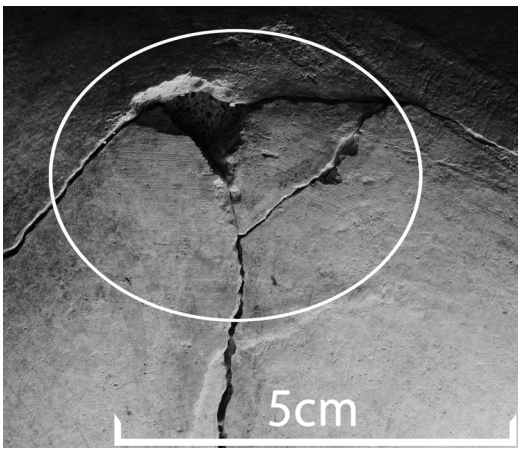

Fig. 37. Scratch in the posterior part of right parietal bone of Sample No. V-830.

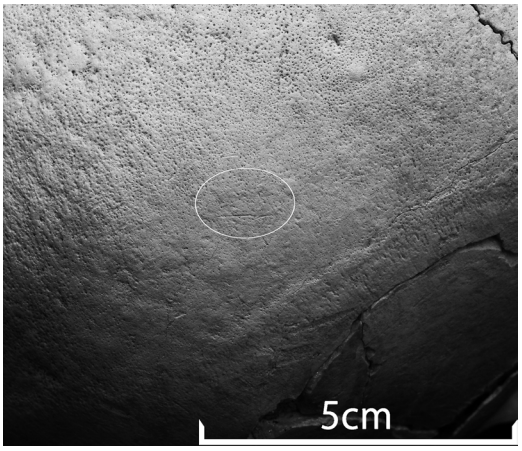

Fig. 36. Scratch in the top of right parietal bone of Sample No. V-830.

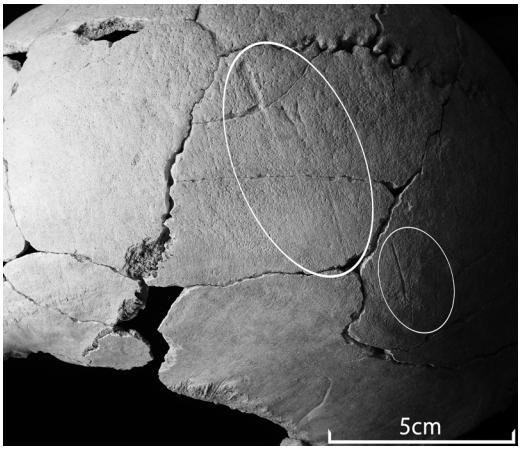

Fig. 38. Scratches in Sample No. V-917.

sites in the Yuigahama area could be the differences in diagnostic standards. Although this is possible, the results of this study suggest that the varieties of scratches might have been caused by specific reasons at each site and each case. For example, it was possible that some weak scratches might be caused as preparation damage of washing and cleaning connective tissues before burial in order to write some Buddhist scriptures with India ink on a skull as seen in skull fragments of the Zaimokuza site (Figure 40). These scratches must be examined using a scanning electron microscope (SEM), as Nagaoka *et al.* (2009, 2010) did, in the future.

No cut marks were found in the 158 mandibles excavated from the Gokurakuji site, which implying that no evidence for decapitation was found for this site. Certainly, the absence of cut marks does not imply that decapitation never occurred on this site because a decapitated skull does not always have cut marks at the posterior borders of the mandibular ramus. However, considering that 3 individuals had cut marks at the mandibular ramus out of the 110 individuals who had been thought to be victims of the battle between the families of Taketoki Kikuchi and the Chinzei Tandai (local commissioner in Kyushu

Table 3. Fequencies of each type of human-induced traumas in 7 archaeological sites

	Total number of individuals	Numbers of individuals with gashes	(%)	Numbers of gashes	(%)
Gokurakuji	331	1	(0.3%)	1	(0.3%)
Zaimokuza	283	5	(1.8%)	9	(3.2%)
Yuigahama Chusei Shudan Bochi	592	6	(1.0%)	9	(1.5%)
Yuigahama-minami	667	3	(0.4%)	8	(1.2%)
Seiyokan	91	6	(6.6%)	16	(17.6%)
Kojyo-nishi	24	11	(45.8%)	12	(50.0%)
Edo sites	1203	12	(1.0%)	35	(2.9%)

	Numbers of individuals with incisions	(%)	Numbers of incisions	(%)	Numbers of individuals with scratches	(%)	Numbers of individuals with blunt trauma	(%)
Gokurakuji	4	(1.2%)	8	(2.4%)	21	(6.3%)	4	(1.2%)
Zaimokuza	28	(9.9%)	94	(33.2%)	153	(54.1%)	10*	(3.5%)
Yuigahama Chusei Shudan Bochi	2	(0.3%)	2	(0.3%)	3	(0.5%)		( )
Yuigahama-minami	2	(0.3%)	5	(0.7%)	0	(0.0%)		( )
Seiyokan	1	(1.1%)	1	(1.1%)	0	(0.0%)	0	(0.0%)
Kojyo-nishi	10	(41.7%)	17	(70.8%)	0	(0.0%)	0	(0.0%)
Edo sites	9	(0.7%)	13	(1.1%)	0	(0.0%)	3	(0.2%)

*: Suzuki (1956) had reported nine specimens with “stab marks” and one with “blunt force trauma” in the Zaimokuza samples. Judging from the figures in Suzuki’s report, these stab marks can be considered blunt force trauma. Thus, the total number of instances of blunt force trauma in the Zaimakuza site was 10 in this study.
Please clarify why this site is being discussed instead of Gokurakuji.

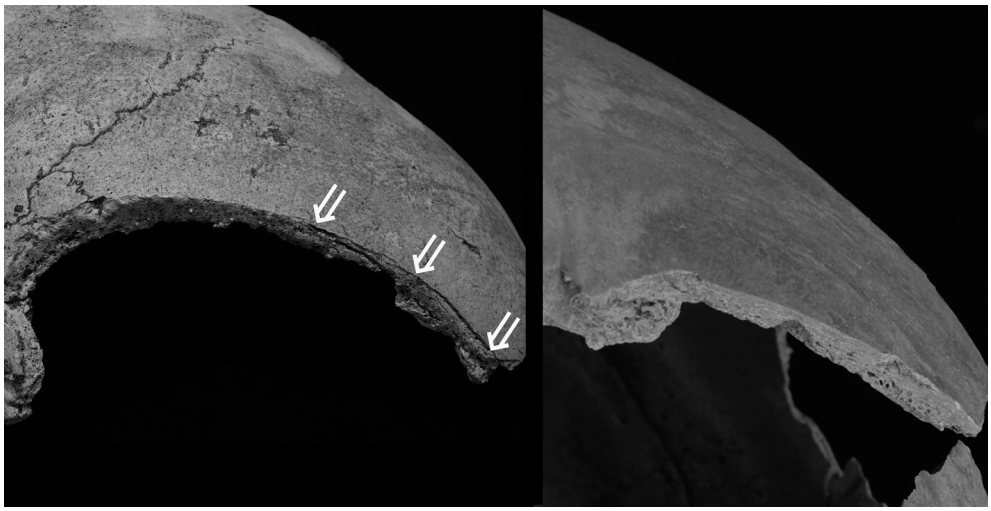

Fig. 39. Comparison between gash in Sample No. V-532 and gash in an Edo sample.
Left photo represents gash mark in the right and left parietal bones of Sample No. V-532, and the right one is gash mark in the right parietal bone of Sample No. 377/16/565 of Ikenohata shicikencho site of the Edo era.

Table 4. Results of Tukey's wholly significant difference test of the frequencies of number of individuals with each trauma

Gashes	Gokurakuji	Zaimokuza	Y.C.S.B.	Y.M.	Seiyokan	Kojyo-nishi
Gokurakuji						
Zaimokuza	N.S.					
Y.C.S.B.	N.S.	N.S.				
Y.M.	N.S.	N.S.	N.S.			
Seiyokan	*	N.S.	*	*		
Kojyo-nishi	*	*	*	*	*	
Edo sites	N.S.	N.S.	N.S.	N.S.	*	*

Incisions	Gokurakuji	Zaimokuza	Y.C.S.B.	Y.M.	Seiyokan	Kojyo-nishi
Gokurakuji						
Zaimokuza	*					
Y.C.S.B.	N.S.	*				
Y.M.	N.S.	*	N.S.			
Seiyokan	N.S.	*	N.S.	N.S.		
Kojyo-nishi	*	*	*	*	*	
Edo sites	N.S.	*	N.S.	N.S.	N.S.	*

Scratches	Gokurakuji	Zaimokuza	Y.C.S.B.	Y.M.	Seiyokan	Kojyo-nishi
Gokurakuji						
Zaimokuza	*					
Y.C.S.B.	*	*				
Y.M.	*	*	N.S.			
Seiyokan	*	*	N.S.	N.S.		
Kojyo-nishi	*	*	N.S.	N.S.	N.S.	
Edo sites	*	*	N.S.	N.S.	N.S.	N.S.

Blunt force trauma	Gokurakuji	Zaimokuza	Y.C.S.B.	Y.M.	Seiyokan	Kojyo-nishi
Gokurakuji						
Zaimokuza	N.S.					
Y.C.S.B.						
Y.M.						
Seiyokan	N.S.	N.S.				
Kojyo-nishi	N.S.	*			N.S.	
Edo sites	N.S.	*			N.S.	N.S.

of the Kamakura shogunate) in 1333 (Nagai, 1986: Tomioka *et al.*, submitted). The casualties on the Gokurakuji site seem too few for a severe battle in medieval Japan.

Blunt force traumas were recognized in four specimens (1.2%) on the Gokurakuji site, and no significant differences were found between those on the Zaimokuza, Seiyokan, Kojyo-nishi, and Edo sites (Table 2 and 3). The frequencies of blunt force trauma tended to be lower than sharp force trauma in all sites, which might have caused from the difficulty in identification.

However, this study proves that sharp force traumas (gashes and incisions) and blunt force trauma were rarely recognized in the skulls of the Gokurakuji site, and there was no significant difference in the frequencies of the traumas compared with those on the Edo sites that could be regarded as illustrative of injuries under peace times. Decapitation could not be confirmed in this site as well. Knüsel (2014) summarized that the frequencies of cranio-facial injuries com-

Fig. 40. Frontal bone excavated from the Zaimokuza site with some Buddhist scriptures with India ink.
A circle in the figure indicates some weak scratches covered with India ink.

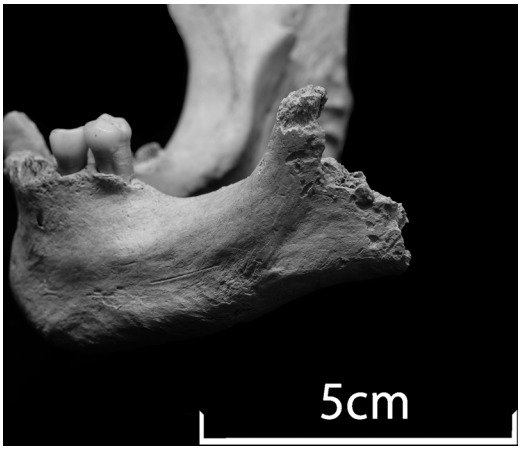

Fig. 42. Lateral view of the mandible with bite marks of the carnivore.

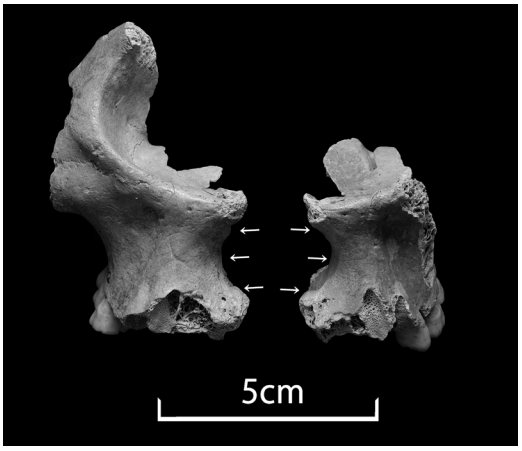

Fig. 41. Anterior view of the nasal aperture of Sample No. IV-412.
Arrows on the photo indicate the absorption of the margin of nasal aperture.

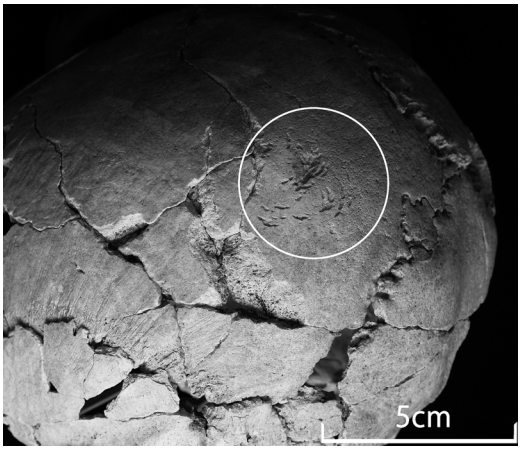

Fig. 43. Lateral view of the left parietal bone with rodent bit marks.

pared to the total numbers of identified perimortem injuries in the human skeletal remains excavated from five sites in Europe varied from 18% to 89% during the 11th to 16th centuries. Although this data cannot be directly compared with the data from the Japanese sites because of the differences in cultural backgrounds and army equipment, the European case does suggest that cranio-facial injuries were not so rare during close combat on the battle field.

Additionally, the location of this site was also near the Gokurakuji temple where Ninsho, a Japanese Shingon Risshu priest (1217–1303), built a facility for providing relief to leprosy patients. Takao Suzuki (1998), who was one of the pioneers of paleopathology in Japan, pointed out the possibility that the skulls of leprosy patients might be included in the Gokurakuji site because some of them exhibited inflammatory changes and absorption of lateral margins of the nasal aperture during his preliminary research on Gokurakuji skulls. In this research, it was seen that some individuals, regardless of the presence of human-induced traumas, had experienced

inflammatory changes and absorptions around the nasal aperture. Interestingly, three out of four individuals with blunt force traumas had inflammatory changes and absorption around nasal aperture (Figure 41, IV-412). Further paleopathological research is required for the Gokurakuji sample.

Some bite marks of some kind of carnivore (Figure 42) and many rodent bite marks (Figure 43) were found on the human skeletal remains found on the Gokuraku site. Particularly, the number with rodent bit marks reached up to 114 (34.4%). These facts supported that the crania of this site were gathered after decomposition and skeletonized of the corpse occurred upon or beneath the ground. Cases of leaving the body without burial appear to have been caused by war, natural disaster, and criminal case in modern Japan. However, Kenji Matsuo (2011), a historian of Buddhism in Japan, thought that the dead bodies of the majority of common people were not buried but abandoned at a specific place from the Kofun era until reclusive monks (*tonseiso*) began to conduct the funeral in order to answer the hope of common people in the Kamakura era. If this is true, it would be a plausible explanation for the many dead bodies that were left on the ground and bit by rodents and carnivore.

This study questions Suzuki's theory that the skulls found on the Gokurakuji site belonged to victims of the invasion of Nitta Yoshisada in 1333. As Suzuki (1998) suggested, the human skeletal remains excavated from Gokurakuji site were possibly persons concerned in the Gokurakuji temple.

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