

Care for Bone Fractures during the Jomon Period: Evidence from the Pathological Condition of Fractures

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Abstract The pathological state of bone fractures and conditions of care under which the fractures were maintained is discussed for 3 individuals from the Neolithic Jomon period in Japan. The human skeletal remains were excavated from the Sanganji Shell Mound in Fukushima Prefecture and were housed at the University Museum of the University of Tokyo. The 3 individuals had fractures of the distal radius (Colles fracture), a malunited talus fracture, and a clavicular fracture, respectively. All were presumed to have fallen down or taken a fall from a high place as a result of the lifestyle of the people of that time. Since people of the Jomon period formed a hunter-gatherer society, there was frequent strenuous activity taking place under dangerous conditions. All the cases in our study displayed fractures with malunions resulting from a lack of proper treatment. In general, a fracture is a pathology that results in considerable limitation of physical freedom. Therefore, it is believed that the family and community of the injured individuals must have provided assistance until the bone fracture healed. Although the results do not provide a causal explanation regarding caregiver behavior, we believe that in such situations the origin of care is found. By conducting further studies examining more cases from multilateral viewpoints, we believe that the origins of human care may be investigated.

Key words : bone fracture, care, malunion, Jomon period, palaeopathology

Introduction

The society of the Neolithic Jomon period in Japan was at an economic stage supported by hunters and gatherers. Daily life involved strenuous physical activity in dangerous situations. The frequency of bone fractures due to falls, especially from high

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places, is believed to have been high.

The objectives of this study were to investigate bone fractures in human skeletal remains from the Jomon period and the circumstances that resulted in those fractures, as well as to speculate on the types of treatment given, as seen from the healing condition of the fractures. Previous studies in the statement of only bone fracture have been reported all over the world¹⁾⁻⁵⁾, but to our knowledge, the study on various aspects of human care by palaeopathological investigation of bone fracture in the ancient human skeletal remains has not been done in the world.

A bone fracture is a pathology that considerably limits physical freedom. Therefore, people of the Jomon period who suffered bone fractures are believed to have received some type of care from their families and communities. For example, acts such as the following are conceivable: cheering up the individual who has a fractured bone, cooling the affected area, immobilizing the affected area, and providing food.

An additional objective of this study was to speculate on the origin of human care and situations surrounding that care. Up to now, there have been no reports on the origin of care using such an approach. It is believed that this study may add a new perspective to understanding human care.

Materials and Methods

The Jomon period begun around 12000 yrs. B. P. and ended around 2300 yrs. B. P. It was a non-agricultural Neolithic era in Japan. The Sanganj Shell Mound site and the skeletal series are belonged to the late Jomon period (4000-3000 yrs. B. P.).

We examined the presence of bone scars from fractures in the postcranial skeletons of human skeletal remains from the Sanganj Shell Mound in Fukushima Prefecture in Japan. The human skeletal remains were housed at the Department of Anthropology and Prehistory, the University Museum, at the University of Tokyo. See the footnote for further details of the materials. The method of examination was by visual inspection since radiographs were not available for the human skeletal remains.

Results

Case 1 : Malunited fracture of the distal radius

Case 1 showed a malunited fracture of the distal radius (Fig. 1). The fracture most

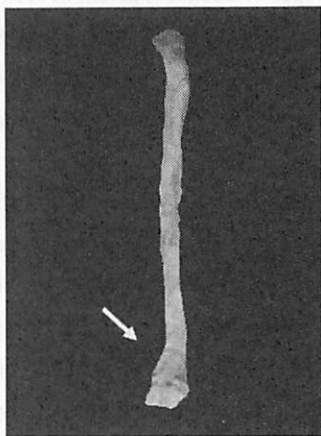


Fig.1: Fracture of distal radius (Colles fracture)

likely occurred as the individual used his hand in a reflex action to protect his head and body when he fell. Classification of distal radius fractures differ slightly among different researchers and are as follows: (1) extension fracture (Colles fracture), (2) flexion fracture (Smith fracture), (3) fracture of the volar articular surface (volar Barton fracture) and fracture of the dorsal articular surface (dorsal Barton fracture), (4) radial styloid fracture (Chaffeur fracture), or (5) epiphyseal separation as seen in young children⁶⁾. As shown in the figure, a fracture in which the distal region is dislocated dorsally is classified as a Colles fracture. In Case 1, the affected area was believed to have appeared externally as a fork-shaped deformation. In the present day, there are 3 age groups in which the Colles fracture is commonly seen: children, young adults, and the elderly⁶⁾. Many cases occur during childhood with the mechanism of injury involving sports, such as a fall from an exercise bar⁷⁾. There is no difference in occurrence of Colles fractures in children based on sex. Many cases that appear during early adulthood occur due to accidental falls, such as a fall from a high place during work, and occur largely in males⁷⁾. Many of these cases are intraarticular comminuted fractures

due to the strong external forces involved⁷⁾. Some cases in the elderly are a result of falling, but many cases involve osteoporosis and are largely seen in females⁷⁾. In a Colles fracture, a median nerve injury can occur due to a penetrating bone spur that protrudes to the volar side. In addition, rupture of the extensor pollicis longus tendon can easily occur, either at the time of the fracture or as a late onset injury. It cannot be determined with certainty whether Case 1 had such an injury. However, we speculate that there was marked limitation of movement in dorsal, volar, radial, ulnar flexions, and pronation and supination due to pain. A present-day injury such as this would require approximately 5 weeks of cast immobilization⁸⁾. However, since orthopedic surgery was not available during the Jomon period, there is a pronounced extension of the wrist area to the dorsal side in Case 1, which had healed with malunion as shown in Fig. 1.

Technically, a Colles fracture is an extraarticular extension fracture, but intraarticular extension fractures are called Colles-type fractures and occur with high frequency, contributing to over 90% of all fractures of the distal radius, including Smith-type fractures. Colles fractures occur when there is a fall while the wrist is in dorsiflexion. A Colles fracture occurs when the wrist is at 60-90° dorsiflexion at the time of fall, and that a carpal fracture occurs when the wrist is greater than 90° dorsiflexion. Scaphoid fractures frequently occur with Colles fractures⁶⁾. We encountered a few other cases of Colles fractures in addition to Case 1, and believe that the frequency of Colles fractures was fairly high among the Jomon people.

Case 2 : Malunited talus fracture

Case 2 displayed a left talus fracture. A talus fracture generally occurs from an episode of high-energy trauma such as a fall or other impact injury⁹⁾. The mechanism requires a sudden dorsiflexion, and involves impact of the anterior border of the lower end of the tibia with the talus¹⁰⁾. For a type I fracture, the patient usually requires 4-6 weeks of cast immobilization and then is allowed to walk with a PTB (Patella Tendon Weight Bearing) cast or short leg cast for the next 4 weeks¹¹⁾. A malunited talus fracture consistently results in severe impairment. A malunion can occur in the head and/or body of the talus and can lead to a mismatched ankle joint, subtalar joint, and

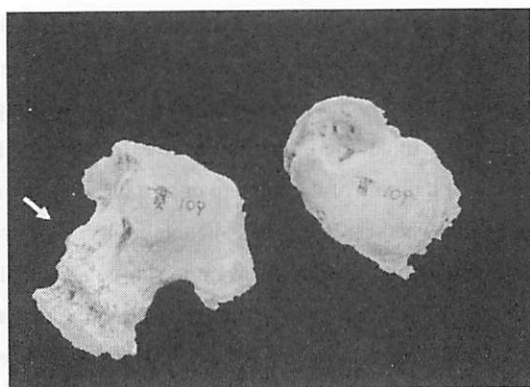


Fig.2: Fracture of malunited left talus fracture

talonavicular joint.

Case 2 had marked bone formation in the lower left talus and was a very rare case. Several hundred bodies from individuals were examined which had been excavated from the Sanganji archeological site. A considerable number of human skeletal remains from other archeological sites were also examined. However, deformations such as those in the cases of this study were not found. We have not seen reports of this type of injury in the literature, but speculate that the individual had great impairment in walking. In addition, the morphology of the right talus was fairly deformed compared to that of a normal talus. This deformation was presumed to be an effect of the walking impairment due to the left talus fracture and to have resulted from considerable limitation of right lower limb movement. In any case, future detailed study using radiographs is necessary to examine the mechanism of fracture and healing.

Case 3 : Right clavicular fracture

Case 3 had a clavicular fracture. The clavicle is attached at the sternal end by the sternoclavicular and costoclavicular ligaments, and the acromial end in the chest region is attached to the scapula by acromioclavicular and coracoclavicular ligaments. The clavicle acts as the only skeletal support that maintains shoulder width.

In the present day, clavicular fractures constitute approximately 10% of all fractures¹²⁾. Such fractures largely occur due to external forces, such as landing on the

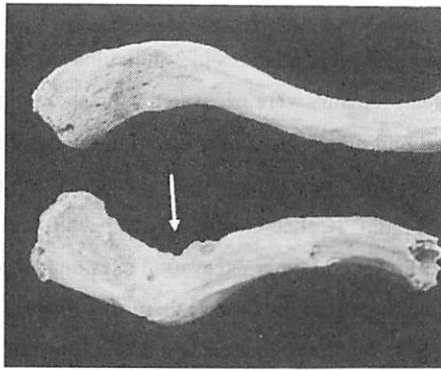


Fig.3: Right clavicular fracture

shoulder when falling from a high place or trying to brace a fall with the hand. In many cases, the shoulder is hit from the anterior or lateral direction, and the middle one-third of the clavicle is fractured. This type of injury occurs because the clavicle is S-shaped, and the middle portion of the clavicle experiences a shearing force from the lateral force of a fall¹²⁾. Neer has classified clavicular fractures into 3 groups according to the fracture site¹³⁾: Type I has no injury to the coracoclavicular ligament and no dislocation, Type II has an anterior dislocation of the medial bone fragment due to rupture of the coracoclavicular ligament, Type III has a bone fracture line extending to the acromioclavicular joint surface. In Case 3, the bone fracture occurred in the lateral one-third of the clavicle and displayed a malunion, but no pseudoarthrosis was observed (Fig. 3). Since a Type II fracture is unstable, pseudoarthrosis frequently occurs. However, Case 3 was likely not Type II. It is unknown whether or not the coracoid ligament had ruptured. For a clavicular fracture, the duration of external fixation may vary with age, degree of dislocation, and the presence of a third bone segment. An approximate guideline for duration of fixation is 1-2 weeks for young children, 2-3 weeks for grade-school-age children, 3-4 weeks for junior and high school-age children, and 4-5 weeks for adults.

Discussion

In this study, we examined bone fractures in 3 individuals from the late Jomon period, whose human skeletal remains were excavated from the Sanganji Shell Mound in Fukushima Prefecture. In all three cases, falls related to the hunting and gathering lifestyle of the people of that time were believed to have caused the injuries.

Fractures of the distal radius (Colles fractures) have been found in Jomon period human skeletal remains from several other excavation sites and were likely common occurrences during the Jomon period. In Case 1, there was likely a marked limitation of movement due to pain from the injury that made it difficult for the individual to participate in regular activity. In addition, the irregular dorsal extension of the wrist due to the malunion would also have made it difficult to take part in regular activities even after the injury healed.

In Case 2, the trochlear surface of the left talus appeared to be preserved to some degree, but the inferior region of the talus had a pronounced bone formation and ruptures of the posterior talofibular ligament and calcaneofibular ligament had possibly occurred. In addition, the right talus showed considerable deformity, likely due to walking impairment from the left talus injury. In the future, examination of fractures of the lower limbs will necessitate full attention to the state of the bones on the contralateral side of the fracture. This individual also likely had great difficulty in performing the regular daily activities of a hunting and gathering society.

Clavicular fractures occur with fairly high frequency even among modern men, and the reduction is considered to be relatively easy. The cases examined in this study displayed malunions, but if no rupture of the ligaments occurred, we believe that the individuals were able to recover sufficiently to achieve nearly a full range of motion. However, Case 3 is believed to have had considerable limitation of arm movement, necessitating a large degree of assistance from other individuals in the group.

Among the human skeletal remains studied, we did not encounter any cases with femoral or tibial fractures. Such fractures tend to be open fractures, but even in cases of closed femoral fractures there would have been a high probability that more serious conditions could have resulted from this type of trauma, such as hemorrhagic shock. In addition, movement would have been markedly limited for a long period of time and

individuals with such conditions would very likely have died before their injuries healed.

Globally, research in the field of health behavioral science seems to have stressed the importance only of measuring health and healthcare behaviors of modern men, or of describing them. However, it is clear that understanding the healthcare behavior of ancient men can greatly contribute to the field of health behavioral science, because past, present, and future are continuous. In creating a vision of present or future health behavioral science, can one create a truly great vision without knowing the past cases? In today's academic disciplines in which knowledge is borderless, it may actually be unknown to anyone in what way research considered to be in a "different field" is contributing to the aforementioned academic discipline. It is erroneous to think that only research on modern events is important and research on the past has almost no significance. Matters need a historical viewpoint. Just because one handles ancient human skeletal remains does not mean that information obtained from such bones is also ancient. Such information can be new and valuable. There is a phrase in Japanese, "developing new ideas by studying the past." As in this phrase, it is necessary to think how such a discipline can be utilized in future healthcare science.

A physical anthropology approach can provide scientific grounds for evidence of early healthcare behavior or acts of care-giving in a society. Future studies will examine an increased number of cases and include the use of radiography in order to further clarify health conditions and the origin of care during the Jomon period.

Acknowledgement

We would like to thank Professor Gen Suwa of the Department of Anthropology and Prehistory, the University Museum, at the University of Tokyo for allowing us to study the materials under his care.

Footnote

In this study, the bone fractures of 3 individuals were not discovered unexpectedly, but rather, the report was the result of painstaking efforts by biological anthropologists with long years of training. They had made determinations of these bone fragments

from numerous fragments (a few hundred bodies) discovered from an archeological site. These bone fragments were underground over a few thousand years and were discovered in poor conditions and crushed. The biological anthropologists specified the site on the body from which the bone fragment came, identified whether it was on the left or right side, determined marks from bone fracture healing even if the bones were in very bad conditions, and reported the findings.

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縄文時代における骨折のケアについて

—骨折の病理学的状況からの証拠—

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要 旨

東京大学総合研究博物館所蔵の縄文時代人について、その骨折の病態を調べた。今回はそのなかでも福島県三貫地貝塚出土の古人骨について、骨折の鑑別診断が比較的容易であった3例について論じた。3例は、橈骨遠位端骨折 (Colles骨折)、距骨変形治癒骨折、鎖骨骨折であるが、いずれも転倒や高所からの転落など、当時の人々の生業に起因したものと推定された。即ち獣を求め狩猟をすることや、果実などの採集のために、彼らは現代人のわれわれより、身体を酷使し危険な状態に身を挺したと考えられた。今回の症例は、全て現代的な治療を受けることが出来なかった時代の骨折であり、骨折は変形治癒している。骨折は、その治癒過程において、身体自由度がかなり制限される疾患であることから、骨折の治療中は、食物の採集や摂取、排泄、身体の移動等の日常生活動作に関して、家族や集落の仲間などからのさまざまな援助があったと思われる。自然人類学的手法を用いて、ケアの起源を歴史的に明らかにすることが可能であると考えられる。今後は、より多くの症例を集め、多角的な見地から検討することによって、ケアの起源をさらに深く探ることが必要であると考えられた。

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