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A Case of Hemivertebra Found in a Human Skeletal Remain of Jomon Period from Ebishima Shell Mound, Iwate Prefecture

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An upper thoracic hemivertebra causing serious scoliosis was found in an adult female skeleton unearthed at a shell mound of the Jomon period in Iwate Prefecture. It demonstrates that a person handicapped by severe congenital deformity could grow up to adulthood in a food-gatherers' society of the Jomon period.

The Skeletal Material

The skeleton in question, Ebishima 61, is one of the 26 human skeletal remains excavated from a fresh-water shell mound of the late and latest phases of the Jomon period (approx. 1st and 2nd millennia B.C.) at Ebishima (alias Kaitori), Hanaizumi-cho, Iwate Prefecture by Professor Hisashi SUZUKI and his associates of the University of Tokyo in 1957. It is now in the custody of the Department of Anthropology, the National Science Museum, Tokyo.

Nothing particular was found in the burial form of this skeleton. It lay on its back with the head pointing to the northwest. The elbows and knees were fully flexed and the thighs were slightly bent to the right. The direction and position of the body fully conform to the prevailing style of burial in this site (YAMAGUCHI, 1983).

Unfortunately, however, the condition of preservation of the Ebishima 61 skeleton is considerably worse than the average of the entire Ebishima series. The skull is broken into small pieces and cannot be restored to its original state. The cervical and upper thoracic vertebrae are relatively well preserved, but all other postcranial bones are in more or less fragmentary conditions.

The cranial vault sutures are open on the outside but partially closed in the interior. The spheno-occipital junction is completely ossified, but the metopic suture persists in its entire course. The incisors show wear of BROCA's grade 2 or 3 but wear of other teeth reaches only the grade 1 or 2. The epiphyses of the upper and lower limb bones are all completed. No sign of osteoarthritic change is observed except in some vertebrae. A fragment of the right ilium has a large pre-auricular fossa.

Chief measurements of the preserved portions of the skeleton are as follows:

Maximum cranial breadth (M.* 8)	(133)
Biasterionic breadth (M. 12)	(107)
Bigonial breadth (M. 66)	(106)

Mandibular length (M. 68)	80
Maximum diameter of humeral midshaft (M. 5)	R 21.1
Minimum diameter of humeral midshaft (M. 6)	R 13.8
Breadth of humeral head (M.9)	L 36.2
Length of humeral head (M. 10)	L 38.3
Sagittal diameter of femoral midshaft (M. 6)	R 26.5
Transverse diameter of femoral midshaft (M. 7)	R 23.6

(* See MARTIN, 1928, for definitions.)

From these measurements and above-mentioned morphological observations of the skeleton, the individual can be considered to be a young adult female. Moreover, it is a typical Jomon skeleton with edge-to-edge relationship of the incisors, pilastric structure of the femoral shaft, and squatting facets in the ankle joint.

Description of the Vertebrae

The primary abnormality is in the 2nd thoracic vertebra (T II). It utterly lacks the left half congenitally and the rest fuses on to the 3rd thoracic vertebra (T III). Various secondary deformities such as fusion and asymmetry can be observed in other vertebrae.

The Hemivertebra and the 3rd Thoracic Vertebra (Fig. 1)

The 2nd thoracic vertebra consists only of the right half. The body is wedge-shaped with the apex directed medially and attached to the body of T III at the anterior and the posterior surfaces. The superior facet for the head of rib is normal. The inferior facet cannot be observed because of partial surface erosion. The joint facet of the superior articular process is osteoarthritic, being enlarged by marginal osteophytes and eroded in its central part. The inferior articular process is totally fused with the superior articular process of T III. The lamina lies on top of the right lamina of T III and they are partially fused together. In the midplane the right lamina of the hemivertebra joins the left lamina of T III to form the base of a common spinous process. Unfortunately the spine proper is not preserved. Needless to say, the intervetebral foramen between the 2nd and 3rd thoracic vertebrae is present only on the right side.

The superior and inferior articular processes of T III are normal on the left side. On the right side, however, the superior process is ankylosed with the inferior process of the hemivertebra, and the joint facet of the inferior articular process is enlarged pathologically by moderate lipping. The left lamina of T III meets not only the right lamina of T III but also the lamina of the hemivertebra.

Other Thoracic Vertebrae (Figs. 2, 3, 4, 5)

The 1st thoracic vertebra is incomplete. The left arch and spinous process are missing and the anterior portion of the body is eroded. So far as the preserved parts are concerned, no indication of asymmetry can be observed. The joint facet of the

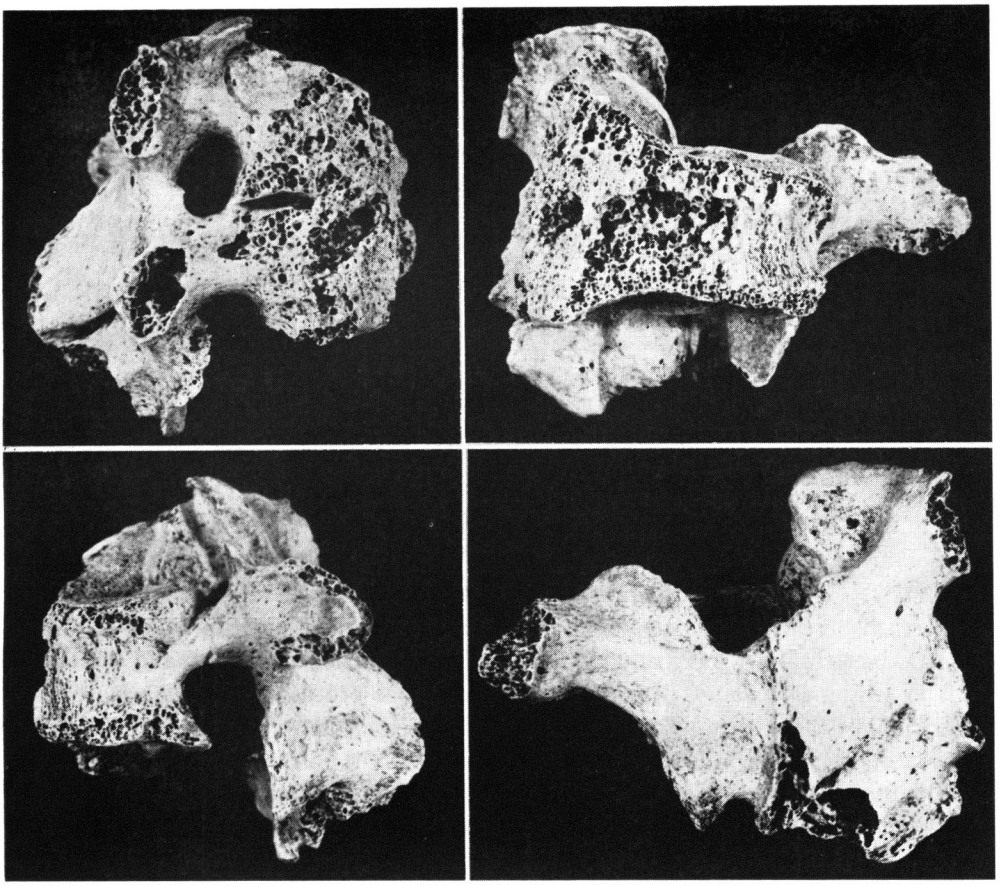

Fig. 1. Right hemivertebra (T II) fused with the 3rd thoracic vertebra. Top: right and anterior views. Bottom: left and posterior views.

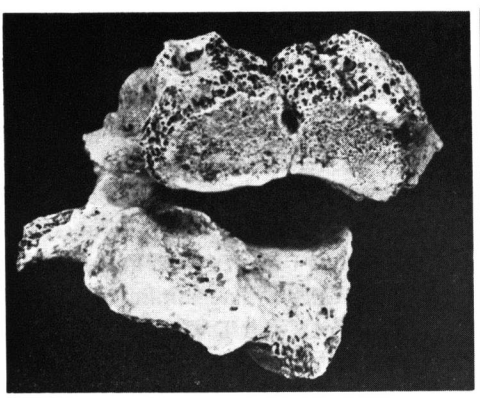

Fig. 2. Inferior view of the 1st thoracic vertebra.

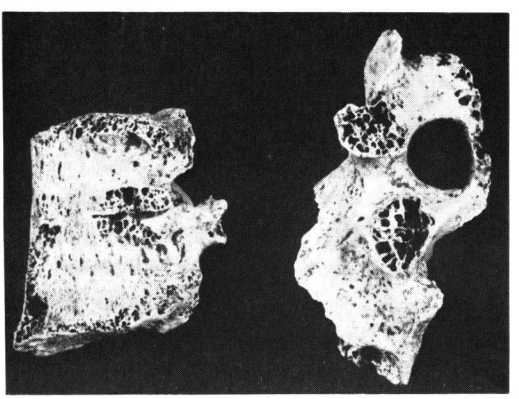

Fig. 3. Fragments of the fused 4th and 5th thoracic vertebrae.

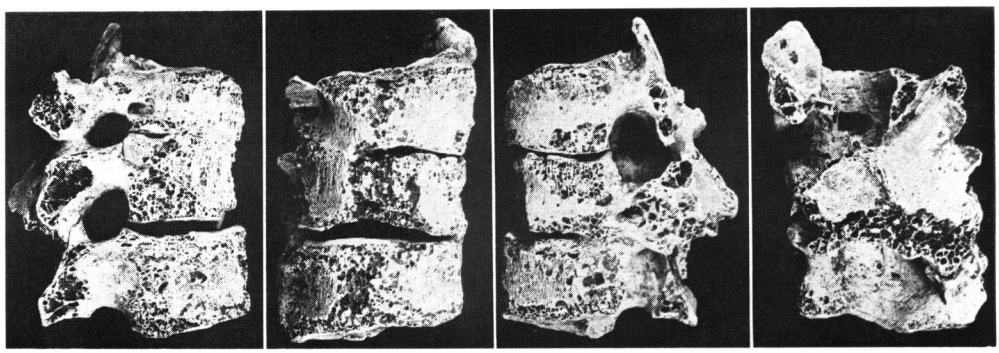

Fig. 4. Block of the 6th, 7th, and 8th thoracic vertebrae. From left: right, anterior, left, and posterior views.

right superior articular process is almost normal but that of the right inferior one is deformed by osteoarthritic lipping and erosion (Fig. 2).

The 4th and 5th thoracic vertebrae form another block vertebrae. They are fragmented and only the left half of the bodies and the right portion of the arches remain separately. The bodies are united, without any outgrowth of osteophyte, leaving a short slit on the lateral side. The joint facet of the right superior articular process of T IV is slightly osteoarthritic. The right inferior articular process and the lamina of T IV are utterly united with the superior articular process and the lamina of T V. There is no structural trace of right zygapophyseal joint between T IV and T V. The joint facet of the right inferior articular process of T V is enlarged by marginal lipping. All the transverse and spinous processes are broken and missing (Fig. 3).

The 6th, 7th, and 8th thoracic vertebrae are again fused together to form the third block. T VI and T VII are united at the right half of the bodies and the right articular processes and laminae. The left lamina of T VI and the left T VI/T VII zygapophyseal joint are broken and cannot be observed. There is a small depression, probably due to defective ossification, in the middle of the superior surface of the T VI body. The joint facet of the left superior articular process of T VI is slightly enlarged by lipping. The right superior articular process is broken. The spinous process of T VI is also broken, but the asymmetric structure of its base suggests that the spine inclined to the right. The bodies of T VII and T VIII are fused partially at the posterior portion, leaving wide gap in front. The left inferior articular process and lamina of T VII completely fuse on to the left superior articular process and lamina of T VIII, and enclose a very small intervertebral foramen, with a diameter of about 2 mm, from behind. The right zygapophyseal joint between T VII and T VIII is ankylosed but it shows articular structure in appearance. The lamina of T VIII is largely broken. The column of the bodies of T VI, T VII, and T VIII is not vertical but is tilted to the left (Fig. 4).

The 9th thoracic vertebra lacks the greater part of the vertebral arch. The body is dysplastic with median depressions in the posterior part of the upper and the lower

surfaces. These depressions give a butterfly shape to the back view of the body. Moreover, the butterfly is asymmetric, with the right wing being in a lower position than the left (Fig. 5). When T IX is articulated with T VI-VIII block, a slight curvature, convex to the right, becomes visible.

Two broken pieces of the body are the only remains of the 10th thoracic vertebra.

The body of the 11th thoracic vertebra is also broken. Its arch lacks the left pedicle. The articular processes are preserved with the only exception of the left superior one. All the facets in the remaining articular processes are exempt from pathological changes. The transverse and spinous processes are broken. No sign of anomaly can be recognized in the fragments of T X and T XI.

The body of the 12th thoracic vertebra is slightly tilted to the left. Otherwise the body is normal, showing no indications of osteophytes. There is a fovea for the head of rib on each side. The joint facets on the right and left superior articular processes are symmetric and normal, but those on the inferior processes are asymmetric in size and direction, with the right facet being enlarged, partially eroded, and turned more laterally. Judging from preserved basal part of the spinous process, the spine seems to have been directed almost normally.

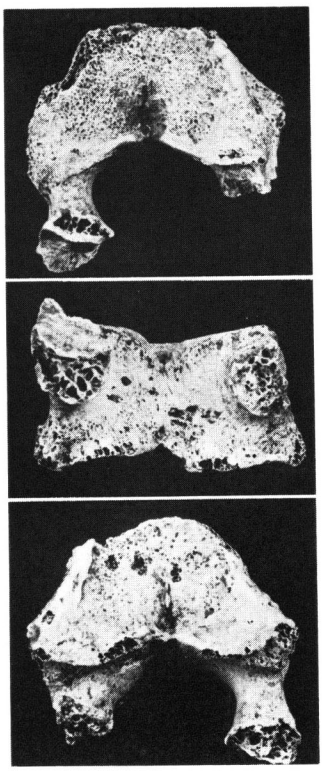

Fig. 5. The 9th thoracic vertebra. From top: superior, posterior, and inferior views.

Intervertebral Foramina and Costal Foveae

There are eleven intervertebral foramina, as is usual, on the right side within the thoracic region. On the left side, however, there are only ten intervertebral foramina because the 2nd thoracic vertebra is absent on this side. Moreover, the size of the foramina is not uniform. The foramina I/III and III/IV are very large, whereas the foramen IV/V is unusually small. Then the foramina VI/VII and VIII/IX are again very large, probably in compensation for the extremely small foramen at VII/VIII level. Under such anomalous conditions of the intervertebral nerve passages in the thoracic region, there can be little doubt that the number and anatomical constitution of the thoracic nerves were considerably disturbed on the left side.

Although the costal foveae on the body cannot be observed in some thoracic vertebrae due to surface erosion or destruction, nothing abnormal can be found in the observable cases. It is thus highly probable that there were twelve ribs on the right side and eleven on the left side.

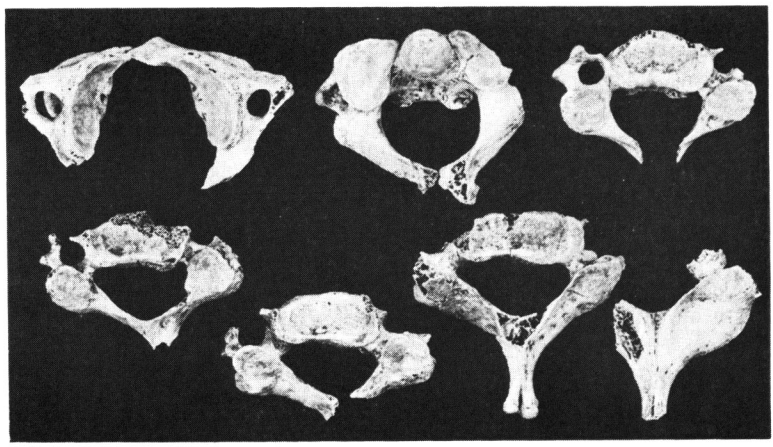

Fig. 6. Cervical vertebrae. Top, from left: the 1st, 2nd, and 3rd cervical vertebrae. Bottom, from left: the 4th, 5th, 6th, and 7th cervical vertebrae.

Unfortunately, however, the ribs themselves are largely missing.

Osteoarthritis of the Zygapophyseal Joints

The state of the joints between superior and inferior articular processes of the cervical and thoracic vertebrae is as follows:

	Right	Left		Right	Left
Occip./CI	normal	normal	TIII/TIV	arthritic	normal
CI/CII	normal	normal	TIV/TV	united	?
CII/CIII	normal	normal	TV/TVI	arthritic	normal (?)
CIII/CIV	normal	normal	TVI/TVII	united	?
CIV/CV	normal	normal	TVII/TVIII	fused	united
CV/CVI	slightly curved	normal	TVIII/TIX	?	?
CVI/CVII	normal	normal	TIX/TX	?	?
CVII/TI	normal	normal	TX/TXI	normal	?
TI/TII	arthritic	normal	TXI/TXII	normal	normal
TII/TIII	fused	normal	TXII/LI	arthritic	arthritic

The zygapophyseal joints in the cervical region are almost free from pathological changes. In the thoracic region, however, arthritic joint alternates with fused or united joint from T I down to T VII on the right side. As the left articular processes are missing in many thoracic vertebrae, it is hard to find any such significant pattern on the left side.

Other Vertebrae

Seven cervical vertebrae are present, but only five from C II to C VI are preserved in moderately good condition (Fig. 6). The atlas is broken into two lateral pieces and C VII lacks the body.

The column of the cervical vertebrae from C II to C VI shows a slight scoliosis, convex to the left. Although the spinous process is broken off in most of cervical vertebrae, its position in the vertebral arch can be observed in C IV and C VI. In both cases it lies not in the midplane but a little to the right. No indications of osteoarthritic changes of the zygapophyseal joint facet nor of osteophytotic changes of the body are found in the cervical vertebrae.

The lumbar vertebrae are in poor condition. Little is preserved of the arches and processes. Nothing particularly abnormal is recognized in the remaining body fragments.

Little if anything remains of the sacrum. A fragment of the 1st coccygeal vertebra is preserved, but it shows nothing worthy of special mention.

Reconstruction of the Cervical and Thoracic Vertebral Column (Fig. 7)

Exact reconstruction of complicated scoliotic curves of this vertebral column is impossible because of incomplete state of preservation, particularly of the bodies of C VII, T IV, T V, T X, and T XI and of the zygapophyseal joints at many levels. Fig. 7 shows a tentative reconstruction of the vertebral column from C II down to T IX. The severe scoliosis at the level of T II, due to the right hemivertebra, is canceled out, to some extent, by an inverse curvature in the cervical region and a sigmoid curvature in the mid-thoracic region.

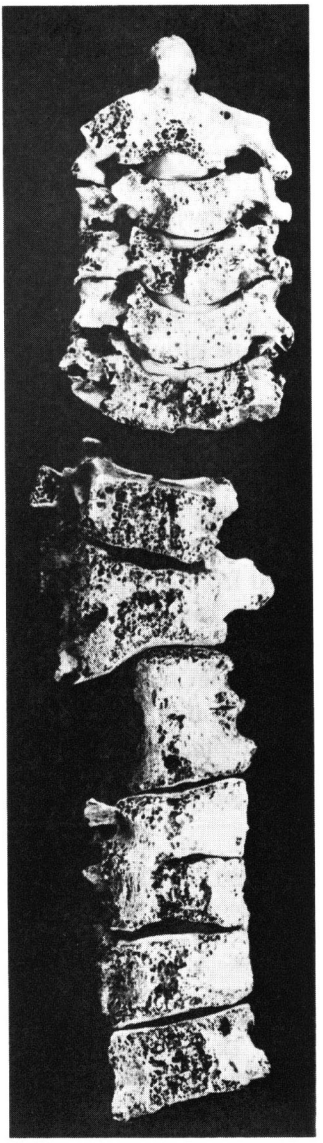

Fig. 7. Reconstructed anterior view of the partial vertebral column, from the 2nd cervical vertebra down to the 9th thoracic vertebra.

Discussion

This is probably the first case of hemivertebra ever found in excavated human skeletal remains from this country (cf. KIYONO, 1949; OGATA, 1981; SUZUKI, 1978; TASHIRO, 1982). However, a marked spinal deformity, due to congenital hemivertebrae, was found by BROTHWELL in a Bronze Age adult male skeleton excavated in 1940 from a barrow on Crichel Down, Dorset, southern England (BROTHWELL, 1961, 1967).

The English case is different from the present one in that there are two hemiver-

tebrae at the fourth and fifth thoracic levels, each fusing on to one of the whole vertebrae. As these hemivertebrae are placed at opposite sides of the column, the deformity at one level is canceled-out, to some extent, by the deformity at the other. Nevertheless, moderate osteoarthritic change is recognized on eleven other vertebrae. A similar case of paired hemivertebrae at either side was also found in the prehistoric skeletal series from Indian Knoll, Kentucky (SNOW, 1948).

In the present case, a single hemivertebra at the upper thoracic region causes severe scoliotic deformity of the cervico-thoracic region, and, probably, considerable asymmetry and irregularity of the thoracic nerves. One might speculate that the level of handicap was even worse than in the cases of the Crichel Down and Indian Knoll skeletons. It is remarkable that such a handicapped individual could survive until adulthood in the pre-agricultural society of the Jomon period.

Summary

A case of severe deformity of the vertebral column due to congenital lack of the left half of the second thoracic vertebra found in an adult female skeleton of the Jomon period from Ebishima shell mound, Iwate Prefecture, has been described. The hemivertebra causes not only scoliotic deformity at the upper thoracic region but also compensatory curvatures in the cervical and mid-thoracic regions. In addition to the complex scoliotic deformity, it is accompanied with block vertebrae, osteoarthritic involvement of zygapophyseal joints, size disorder of intervertebral foramina, and other anomalies at various levels of the vertebral column.

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