Musculoskeletal System of Huge Tarsometatarsal Region in the Dong Tao Fowls from North Vietnam

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A macroscopic examination of the huge leg of the Dong Tao breed from North Vietnam was conducted. Bone and muscular tendon morphometric data demonstrated that the Dong Tao breed was equipped with the extraordinarily thick and large tarsometatarsal bone and distal parts of the related tibiotarsus regions. Morphological differences between dorsal and plantar sides were clearly observed. First, on the dorsal side, fleshy bundles were extended effectively using the enlarged dorsal surface of tarsometatarsal bone shown as Musculus extensor digitorum brevis, M.extensordigitiIbrevisandM.adductordigitiIV. The strong and fleshy extensor bellies of M.tibialis cranialis and M. extensor digitorum longus were enlarged in the crural region, functioning to dorsally pull the heavy tarsometatarsal region through the ankle joint. Second, on the plantar side, the flexor tendon groups around the ankle joint were wider and thicker than those of other ordinary breeds, possibly to stabilize the tarsometatarsal bone and to flex the phalange as observed in M. flexor perforatus digitii II, M. flexor perforans et perforatus digitii II, M. flexor perforatus digitii III, M. flexor perforans et perforatus digitii III, M. flexor perforatus digitii IV, and M. flexor perforans digitorum profundus. The mass of the huge tarsometatarsal region does not contribute to effective locomotion in the Dong Tao fowl in comparison with that associated with normal breeds. However, we suggest that these morphological changes in the musculoskeletal system may functionally compensate for the physical disadvantages of the large weight of the distal part of the hindlimb in the Dong Tao fowl.

Key words: Dong Tao, extensor muscle, flexor muscle, tarsometatarsal bone, Vietnam

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Introduction

The exact archaeological record shows that domestic fowl originated from the Mohenjo-Daro Region in India approximately 4000 years ago (Sewell and Guha, 1931; Zeuner, 1963). The strong relationships between red jungle fowl (Gallus gallus) and various breeds of domestic fowl has been demonstrated in Southeast Asia using molecular phylogenetic data (Akishinonomiya et al., 1996; Niu et al., 2002; Kanginakudru et al., 2008; Riztyan et al., 2014), whereas the Ceylon jungle fowl has also partially provided genes to the domestic fowl lineage (Nishibori et al., 2005; Eriksson et al., 2008; Tixier-Boichard et al., 2011). The Southeast and South Asian Districts have shown early domestication of fowl and later became areas involved in the creation of breeds. As various fowls have been bred not only for agricultural food production but also for ceremonial and entertainment purposes (Sauer, 1952; Issac, 1970; Crawford, 1990; Nishida et al., 2000; Smith and Daniel, 2000; Komiyama et al., 2003, 2004; Oka et al., 2007), the Asian countries have traditionally possessed many native breeds for non-economic uses. The Dong Tao fowl has been bred and maintained in the Dong Tao District in North Vietnam (Su, 2004). It is one of the large-sized domestic chickens with the huge leg, particularly the large tarsometatarsal bone. The specific morphological characteristics of the distal part of the hindlimb of this breed are noticeable with regard to func-
tional influences on locomotion. The functional modifications of the ankle joint-associated extensor and flexor muscles, tarsometatarsal bone and phalanges are thus expected to reveal morphological characteristics of this breed. In this study, the functional-morphological specializations of the musculo-skeletal system of the distal part of the hindlimb accompanied by the enlargement of the tarsometatarsal region will be elucidated. As the huge tarsometatarsal bone hinders the locomotion in the Dong Tao fowl, the aim of this research is to morphologically confirm the functional adptational factors that compensate for the disadvantages of the large tarsometatarsal region.

Materials and Methods

Two male individuals of the Dong Tao fowl were dissected around the tarsometatarsal region. The two individuals were 20 and 11 months old, and both weighed 3100 g. The typical body weight of adult male is approximately 4500 g in the Dong Tao fowl, although growth rate has remained unclear (Su, 2004); therefore, the two individuals used in this study were thought to have not reached the growth plateau. The tarsometatarsal bone-associated muscles, including the ankle joint and proximal part of the digits were macroscopically examined. The ankle joint and phalanges-associated extensor and flexor muscles were observed, and their runnings, origins and insertions were described to clarify the development of the bundles and tendons, and to reveal the functional significance of the extraordinarily large-sized tarsometatarsal region. We examined 4 external dimensions and 16 measurements of the breadth and thickness of muscle tendons at the midpoint of the tarsometatarsal region (Table 1). After dissection, skeleton specimens were prepared and the osteometric data of 8 measurements of the leg were collected (Table 1). The external dimensions and osteometric data of the tarsometatarsal region were obtained using vernier caliper, accurate to the nearest 0.05 mm. Osteometric measurements were based on Driesch (1976). This study was carried out according to the Guideline of the Animal Experiments of The University of Tokyo.

Table 1. Measurement data of body size and tarsometatarsal region size

| 1. External measurements |
|--------------------------|
| Body weight | 3100 |
| Length of the metatarsal region | 121.7 |
| Circumference length of the midpoint of the metatarsal region | 98.5 |
| Length of the third digit with claw | 83.3 |
| Length of the third digit without claw | 73.5 |

| 2. Osteometric measurements |
|-----------------------------|
| Greatest length of tibiotarsus | 146.8 |
| Depth of the distal end of the tibiotarsus | 19.6 |
| Breadth of the distal end of the tibiotarsus | 19.2 |
| Greatest length of the tarsometatarsus | 24.4 |
| Breadth of the proximal end of the tarsometatarsus | 107.2 |
| Smallest breadth of the corpus in tarsometatarsus | 17.2 |
| Breadth of the distal end of the tarsotatarsus | 22.7 |
| Circumference length at the midpoint of tarsometatarsal | 47.6 |

| 3. Measurements of tendons |
|-----------------------------|
| Breadth of M. extensor digitorum longus tendon | 3.00 |
| Thickness of M. extensor digitorum longus tendon | 1.70 |
| Breadth of M. flexor perforatus digiti II | 2.70 |
| Thickness of M. flexor perforatus digiti II | 1.13 |
| Breadth of M. flexor perforans et perforatus digiti II | 2.15 |
| Thickness of M. flexor perforans et perforatus digiti II | 1.10 |
| Breadth of M. flexor perforatus digiti III | 4.10 |
| Thickness of M. flexor perforatus digiti III | 1.63 |
| Breadth of M. flexor perforans et perforatus digiti III | 2.45 |
| Thickness of M. flexor perforans et perforatus digiti III | 1.63 |
| Breadth of M. flexor perforatus digiti IV | 3.25 |
| Thickness of M. flexor perforatus digiti IV | 1.38 |
| Breadth of M. flexor perforans digitorum profundus | 2.65 |
| Thickness of M. flexor perforans digitorum profundus | 1.60 |
| Breadth of M. flexor digiti I longus | 2.33 |
| Breadth of M. flexor digiti I longus | 1.43 |

Mean values of the two individuals used in this study are arranged. The unit of distance is millimeters. The body weight expresses it in grams.
Results

The external appearance of the Dong Tao fowls is shown (Fig. 1). The plantar, lateral and medio-dorsal sides of the leg are seen (Fig. 2). The large-sized distal part of the hind-limb comprises the thick tarsometatarsal region and digits I, II, III and IV regions in which the thick scaly skin was enlarged. Since the thick scaly skin and the connective tissues enveloped the tarsometatarsal and phalangeal regions, the basal part of the claw in the digits and the spar in the tarsometatarsal bone could not be observed. The larger scales were arranged on the dorsal side, whereas smaller scales were observed on the plantar side (Fig. 2B).

The muscular system of the dorsal side (Figs. 3–4): The tendon of Musculus extensor digitorum longus was noticeable in the superficial area of the dorsal side of the tarsometatarsal region (Fig. 3A). The muscle showing a developed belly in the crural region sent the branched tendon to the phalanges of the digits II, III and IV (Figs. 3A and 4A). These tendons gradually widened in the distal part and the branches were separated to reach the three digits (Fig. 3A). The fleshy belly of M. tibialis cranialis accompanied medially the proximal parts of M. extensor digitorum longus in the crural region (Fig. 4A). These were fixed by the strong and wide extensor retinaculum in the proximal part (Fig. 4A). It lay beyond the ankle joint, attached to the most proximal part of the dorsal surface of the tarsometatarsal bone (Fig. 4A).

M. extensor digitorum brevis and M. extensor digit I brevis were discernible between the distal branches of M. extensor digitorum longus (Figs. 3A and 4A). These muscles occupied the space beneath M. extensor digitorum longus with M. adductor digit IV (Fig. 3B). These three muscles possessed the thickly developed bundles because of enlargement of the tarsometatarsal bone surface unlike in other fowl breeds (Fig. 4B). M. extensor digiti I brevis with a thin bundle arose from the medio-dorsal side of the distal part of the tarsometatarsal bone and ran medially to insert into the phalanges of digit I (Figs. 3B and 4B). M. extensor digitorum brevis showed a longer and thicker belly than that of M. extensor digit I brevis in the dorsal part, and sent tendons to the phalanges of digits II and III (Fig. 3B). The insertion to digit II was much thicker than that to digit III (Fig. 3B). As one of the deeper extensors, M. adductor digit IV bundle was enlarged in the entire region of the dorso-medial surface of the tarsometatarsal bone (Fig. 3B). The soft tendon firmly reached the medial side of the phalanges of digit IV. These three muscles appeared much larger depending on the extraordinarily large-sized tarsometatarsal bone in the Dong Tao fowl relative to other breeds.

Muscular system of the plantar side: Beneath the scaly skin, adipose and connective tissues, the most superficial layer of the muscular system comprised the aponeurosis plantaris which was connected to M. gastrocnemius (Fig. 5). The fleshy bellies and strong tendon of M. gastrocnemius developed into the enlarged tendinous sheet covering the entire area of the plantar side of the tarsometatarsal bone and digits through the cartilaginous plate of the intertarsal joint. This aponeurosis plantaris transmitted the strong tension from M. gastrocnemius through the calcaneal tendon and articular cartilaginous plate.

Under the aponeurosis plantaris, a series of tendons associated with flexion of the digits were confirmed (Figs. 6–8). The width and thickness of the hard cartilaginous tendons at the midpoint of the tarsometatarsal region are indicated (Table 1).

The three parallel tendon groups which run to the phalanges of digit II, III and IV were observed on the plantar...
Fig. 3. **Tarsometatarsal region of the left leg.** Proximal direction at the top. A) Dorsal aspect. The tendon of M. extensor digitorum longus can be seen (arrows). The branches of the tendon are separated to run to the digits II, III and IV. B) Medio-dorsal aspect. After removing M. extensor digitorum longus, M. extensor digitorum brevis (B) and M. extensor digiti I brevis (I) are discerned. The thick bundle of M. extensor digiti I brevis runs entirely in the medio-dorsal area of the tarsometatarsal bone, whereas M. extensor digitorum brevis sends the two elongated bundles (B) to the digits II and III. 4, the well-developed bundle of M. adductor digiti IV.

Fig. 4. **A) Medio-dorsal aspect around the left ankle joint.** Proximal direction at the left. The fleshy bellies of M. tibialis cranialis (T) and M. extensor digitorum longus (E) are discerned in the cruris area. The retinaculum of extensor muscle (large arrow) is noticeable in the proximal point of the ankle joint. The tendon of M. extensor digitorum longus is also connected by the retinaculum of tarsometatarsal area (small arrow). 1, M. extensor digiti I brevis. B) Medial aspect of the region of distal tarsometatarsal bone and proximal digits in left side. Proximal direction at the left. The thickly-developed bundles of M. extensor digiti I brevis (I) is inserted to the proximal part of the digit I. The medial bundle of M. extensor digitorum brevis (B) is seen to run to the digit II.
side of the tarsometatarsal region (Fig. 6). On digit II, M. flexor perforatus digiti II and M. flexor perforans et perforatus digiti II were distinguished (Fig. 7). The two muscles completely developed into thin cartilaginous tendinous structure at the distal part of the tarsometatarsal region. Wider M. flexor perforatus digiti II occupied the superficial space of narrower M. flexor perforans et perforatus digiti II in the distal part of the tarsometatarsal bone (Fig. 7). The belly of M. peroneus longus was observed in the proximal part from the ankle joint (Fig. 6).

On digit III, M. flexor perforatus digiti III and M. flexor perforans et perforatus digiti III ran in the superficial space of the metatarsal region (Fig. 7). The tendon of M. flexor perforatus digiti III appeared much wider than that of M. flexor perforans et perforatus digiti III, corresponding to the relationships between M. flexor perforatus digiti II and M. flexor perforans et perforatus digiti II. However, M. peroneus longus was inserted to M. flexor perforatus digiti III by a short tendon unlike M. flexor perforatus digiti II without associating with other flexors (Fig. 7). M. flexor perforatus digiti III which was pulled strongly by M. peroneus longus ran medio-laterally to insert into the phalanges in the most superficial layer. With respect to digit IV, only M. flexor perforatus digiti IV could be found (Fig. 7). Although digit IV was equipped with only one tendon of the flexors, its hard and wide tendon was well-developed in the distal part of the tarsometatarsal region.

In the deeper flexors, M. flexor digiti I longus and M. flexor digiti I brevis ran parallel to the phalanges of digit I (Fig. 8). These two muscles appeared completely separated. M. flexor digiti I longus comprised the thin and hard cartilaginous tendon in the tarsometatarsal region as well as the series of M. flexor perforatus and M. flexor perforans et perforatus in digits II, III and IV (Figs. 7 and 8). The tendon was attached to M. flexor perforans digitorum profundus in the entire region of the tarsometatarsal bone (Fig. 8). Unlike M. flexor digiti I longus, M. flexor digiti I brevis comprised the fleshy bundle largely attached to the tarsometatarsal bone (Fig. 8). The tendon originated in the superficial surface of the bundle to reach the lateral side of the phalanges of digit I. M. flexor perforans digitorum profundus was the largest flexor in the deep region (Fig. 8). This tendinous muscle formed a long, thin and hard structure attached to M. flexor digiti I longus in the tarsometatarsal region, and was
separated into three branches to digits II, III and IV in the distal part the tendon. On digit IV, M. flexor digitorum brevis independently possessed the elongated origin on the plantar side of the tarsometatarsal bone (Fig. 8). This muscle possessed the fleshy bundles in the tarsometatarsal region and the soft tendon was inserted to the phalanges of digit IV. The external dimensions and osteometric data of the tarsometatarsal and tibiotarsus bones are shown (Table 1). The size of the muscle tendons is also shown (Table 1). The tarsometatarsal bone was medio-laterally widened with a slightly flat dorsal surface and a low ridge continuing to the articulation for proximal phalanx III in the distal part (Fig. 9A), whereas the deep and wide groove was observed in the plantar side (Fig. 9B). The breadth and thickness of the cartilaginous tendons were measured at the midpoint of each cartilaginous area (Table 1).

Discussion

The hens of the Dong Tao fowl begin laying at approximately 160 days, and lay approximately 70 eggs during a 10-month period, with each egg weight ranging between 48–55 g (Su, 2004). These economic characteristics are obviously poor for food production, and so the Vietnamese people sacrifice the Dong Tao fowl mainly for festivals to satisfy traditional spirits in the Dong Tao District (Su, 2004). In fact, this breed is maintained not only as a livestock product but also as a traditional cultural symbol of happiness in a restricted district of North Vietnam.

Although the fundamental arrangement of the muscles associated with the tarsometatarsal region is similar between the Dong Tao fowl and other breeds, functional-morphological characteristics are clearly different between the dorsal and plantar sides in the Dong Tao fowl. The large...
The huge tarsometatarsal region in the Dong Tao fowl:

We suggest that the large tarsometatarsal bone has resulted in the increase in size of muscles in the tarsometatarsal region of the Dong Tao fowls. In these fowls, the heavy and large tarsometatarsal bone and digits require a greater amount of torque to be produced by the muscles, for extending and flexing the tarsometatarsal bone and phalanges than that produced by those of other breeds with a similar body weight. We assume that the large tarsometatarsal bone of the Dong Tao fowl can provide a larger attachment surface for muscle bundles and a larger space through which the tendons can run.

In fact, on the dorsal side, M. tibialis cranialis as extensor of the ankle joint appears stronger, and M. extensor digitorum brevis and M. extensor digiti I brevis as extensors of the metatarsophalangeal joint are equipped with fleshy bundles. We suggest that the extensors with enlarged bundles, such as M. extensor digitorum brevis, M. extensor digiti I brevis and M. adductor digiti IV in the tarsometatarsal region, as well as M. tibialis cranialis and M. extensor digitorum longus in the tibiotarsus region may function as the mechanism providing lift to the distal part of the heavy leg in the Dong Tao breed. The groove in the plantar side of the tarsometatarsal bone is widened in the Dong Tao fowls compared with that in other fowl breeds. We suggest that the fleshy bundles of the extensors may act as an elevator of the heavy tarsometatarsal and phalangeal regions during locomotion, whereas the strong tendon groups of the flexors function as a mechanical fixer of the distal parts of the extraordinarily large hindlimb in the Dong Tao fowls.

The aponeurosis plantaris is also noteworthy, as it has become much thicker and stronger owing to the enlarged tarsometatarsal region in this breed. On digit I, it is certain that M. flexor digiti I longus and M. flexor digiti I brevis act as a flexion motor of digit I; however the ability of these muscles may be restricted. We suggest that the aponeurosis plantaris may act as a main stabilizer of not only the tarsometatarsal bone, but also of digit I. The aponeurosis plantaris functions to adequately maintain the angle of articulations from the tarsometatarsal to the phalangeal regions. As M. peroneus longus with a fleshy bundle transmits the contractile force, particularly to digit III, we suggest that digit III may have a larger force compared with the force of digit II and digit IV.

In this study we examined only two individuals of Dong Tao fowls, 3100 g in body weight, for dissection studies. Since the growth curve of the Dong Tao fowl has never been clarified, in the future, the development of the muscles and tendons of the tarsometatarsal region should be elucidated using individuals of various ages. Further research is expected to compare quantitative measurement data of the tarsometatarsal bone and flexor tendons between the Dong Tao breed. The huge tarsometatarsal region certainly disturbs efficient locomotion in comparison with normal breeds; however, we assume that the clear contrast of morphological differences between the dorsal and plantar sides of the musculoskeletal system may functionally compensate for the physical disadvantages of the huge leg in the Dong Tao fowl.

Fig. 9. Left tarsometatarsal bone. Proximal direction at the right. A) Dorsal aspect. The dorsal flat surface is seen. The low ridge (arrows) continues to the articulation for the proximal phalanx III in the distal part. B) Plantar aspect. The deep and wide groove (arrows) is obviously observed in the medio-laterally widened bone.
1981; Glocker et al., 2009). In addition to the facial features of the infant, we suggest that the strange walking patterns displayed by the Dong Tao fowls due to their huge tarsometatarsal region may be the reason for motivating caregivers of the Dong Tao fowls to maintain their breed despite extraordinarily large-sized legs being an economically undesirable attribute.

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References

Akishinonomiya F, Miyake T, Takada M, Shingu R, Endo T, Gojobori T, Kondo N and Ohno S. Monophyletic origin and unique dispersal patterns of domestic fowl. Proceedings of National Academy of Science of the United States of America, 93: 6792–6795. 1996.

Alley TR. Head shape and the perception of cuteness. Developmental Psychology, 17: 650–654. 1981.

Crawford RD. Poultry Breeding and Genetics. Elsevier. Amsterdam. 1990.

Driesch A. A Guide to the Measurement of Animal Bones from Archaeological Sites. Harvard University Press, Cambridge. 1976.

Eriksson J, Larson G, Gunnarsson U, Bed’hom B, Tixier-Boichard M, Strömstedt L, Wright D, Jungerius A, Vereijken A, Randi E, Jensen P and Andersson L. Identification of the Yellow Skin gene reveals a hybrid origin of the domestic chicken. PLoS Genetics, 4: e1000010. 2008.

Glocker ML, Langleben DD, Ruparel K, Loughead JW, Gur RC and Sacher N. Baby schema in infant faces induces cuteness perception and motivation for caretaking in adults. Ethology, 115: 257–263. 2009.

Hildebrand M. Mechanics of support and movement. In: Analysis of Vertebrate Structure. 3rd ed. (Hildebrand M ed.). pp. 443–464. Wiley, New York. 1988.

Issac E. Geography of Domestication. Prentice-Hall, Englewood Cliffs. 1970.

Kanginakudru S, Metta M, Jakati RD and Nagaraju J. Genetic evidence from Indian red jungle fowl corroborates multiple domestication of modern day chicken. BMC Evolutionary Biology, 8: 174. 2008.

Kardong KV. Skeletal system: The appendicular skeleton. In: Vertebrates: Comparative Anatomy, Function, Evolution. 4th ed. (Kardong KV ed.). pp. 313–352. McGraw-Hill, New York. 2005.

Komiyama T, Ikeo K and Gojobori T. Where is the origin of the Japanese gamecock? Gene, 317: 195–202. 2003.

Komiyama T, Ikeo K and Gojobori T. The evolutionary origin of long-crowning chicken; its evolutionary relationship with fighting cocks disclosed by the mtDNA sequence analysis. Gene, 333: 91–94. 2004.

Lorenz K. Die angeborenen Formen möglicher Erfahrung. Zeitschrift für Tierpsychologie, 5: 235–409. 1943.

Nishida T, Rerkamnuaychoke W, Tung DG, Saignaleus S, Okamoto S, Kawamoto Y, Kimura J, Kawabe K, Tsunekawa N, Otaka H and Hayashi Y. Morphological identification and ecology of the red jungle fowl in Thailand, Laos and Vietnam. Animal Science Journal, 71: 470–480. 2000.

Nishibori MT, Shimogiri T, Hayashi T and Yasue H. Molecular evidence of hybridization of species in the genus Gallus except for Gallus varius. Animal Genetics, 36: 367–375. 2005.

Niu D, Fu Y, Luo J, Ruan H, Yu X-P, Chen G and Zhang Y-P. The origin and genetic diversity of Chinese native chicken breeds. Biochemical Genetics, 40: 163–174. 2002.

Oka T, Ino Y, Nomura K, Kawashima S, Kuwayama T, Hanada H, Amano T, Takada M, Takahata N, Hayashi Y and Akishinonomiya F. Analysis of mtDNA sequences shows Japanese native chickens have multiple origins. Animal Genetics, 38: 287–293. 2007.

Riztyan, Kawabe K, Shimogiri T, Kawamoto Y, Rerkamnuaychoke W, Nishida T and Okamoto S. Genetic diversity and ancestral relationships of red junglefowls and domestic chickens in Southeast Asia. Journal of Poultry Science, 51: 369–374. 2014.

Sauer CO. Agricultural Origins and Dispersals. American Geographical Society, New York. 1952.

Schmidt-Nielsen K. Movement, muscle, biomechanics. In: Animal Physiology. 5th ed. (Schmidt-Nielsen K ed.). pp. 395–463. Cambridge University Press, Cambridge. 1997.

Sewell RBS and Guha BS. Zoological remains. In: Mohenjo-Daro and the Indus Civilization. (Marshall J ed.). Vol.2. pp. 649–673. Arthur Probsbain, London. 1931.

Smith P and Daniel C. The Chicken Book. University of Georgia Press, Athens. 2000.

Sternglanz SH, Gray JL and Murakami M. Adult preferences for infantile facial features: An ethological approach. Animal Behaviour, 25: 108–115. 1977.

Su VV. Atlas: The Domestic Animals in Vietnam. National Institute of Animal Science, Ministry of Agriculture. Agriculture Publishing House, Hanoi. (in Vietnamese). 2004.

Tixier-Boichard M, Bed’hom B. and Rognon X. Chicken domestication: From archeology to genomics. Comptes Rendus Biologies, 334: 197–204. 2011.

Zeuner EF. A History of Domesticated Animals. Harper & Row, New York. 1963.