The Peroneus Tertius Muscle in the Crab-eating Monkey

(*Macaca fascicularis*)

By

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Summary: The peroneus tertius muscle was observed in five legs (2.9%) of three male specimens (3.4%) out of 174 legs of 87 (45 male and 42 female) crab-eating monkeys (*Macaca fascicularis*). They were all supplied by the deep peroneal nerve. Two types were observed in three legs of two specimens and grouped into Types III or IV and VIII or IX as classified by Kaneff (1980). These comprise a tendinous or a muscular expansion of the lateral compartment of the extensor digitorum longus muscle. While the muscle observed in both feet of another specimen seems to correspond to the “so-called peroneus tertius” reported by Sommer (1907) and Preuschoft (1961) in gorillas.

During the course of a myological survey of the crab-eating monkey (*Macaca fascicularis*), the peroneus tertius were observed in five cases (2.9%) out of 174 limbs. This is the first report on this muscle in the crab-eating monkey. In Old World monkey, it has been observed only two exceptional instances in the pig tailed baboon (*Papio ursinus*) by Wells (1935) and in the Toque monkey (*Macaca sinica*) by Kaneff (1964).

Since Vesalius (1555) described the peroneus tertius muscle as the ninth muscle belonging to the foot, and as an individual muscle, it has repeatedly been deprived of its separate identity and linked with the extensor digitorum longus (Krammer et al., 1979). Forster (1916) discussed the true manner of the peroneus tertius and described that it was not the third muscle of the peroneal group nor the muscle which inserted into the third toe. Krammer et al.

(1979) described a normal feature of the peroneus tertius in man as follows: although the muscle essentially is the most lateral fasciculus of the extensor digitorum longus, it is identified as a small muscle clearly separated from the latter. In a well developed case, the muscle arises fleshy from the distal third or fourth of the anterior surface of the fibula and the interosseous membrane. In textbooks of human anatomy, the peroneus tertius is generally described as being the partially separated portion of the extensor digitorum longus, arising in common with it from the lower part of the anterior surface of the fibula and from the adjoining fascia. Its tendon runs with those of the extensor digitorum longus but is inserted into the dorsum of the fifth metatarsal near its base, or into the deep fascia nearby. The muscle is supplied by a branch (L.5; S.1) from the deep peroneal nerve.

The muscle is absent in 0 to 23.6% (on the average, 4.8%) of legs in human cadavers of various racial populations: (Wood, 1867, 1868; Schwalbe and Pfitzner, 1889, 1891; Le Double, 1897; Koganei et al., 1903; Adachi, 1910, Nakano, 1923; Vallois, 1926; Matsushima, 1927; Leblanc et al., 1929; Loth, 1931; Shiina, 1931; Ryu, 1932; Posmykiewicz, 1934; Hoshiba, 1938; Ikari, 1950; Imamura, 1950; Tsukamoto, 1951; Hillebrand, 1952; Ishida, 1954; Shigematsu et al. 1956; Sho, 1957; Prystasz, 1972; Morimoto, 1973; Sokołowska-Pituchowa et al., 1974, 1975; Krammer et al., 1979 and Reimann, 1981. It has been stated that the genetic component of the interaction between genetic and non-genetic factors leading to the absence of the peroneus tertius might comprise single autosomal alleles with variable expression or reduced penetrance or both (Spuhler, 1950; Morimoto et al., 1959).

Occasionally the peroneus tertius has been observed in chimpanzees and gorillas, but it has not been found in the gibbon (Bischoff, 1870) or orang-utan (Chapman, 1881). In chimpanzees, Hecker (1922) observed it in one case, but Champneys (1872), Chapman (1880), Straus (1930), Miller (1952) and Kaneff (1964) stated that the muscle is absent. According to Loth (1931), the muscle is observed in 5% of chimpanzees. In gorillas, Rothschild (1888), Eisler (1895), Ranke (1897), Sommer (1907), Morton (1924) and Preuschoft (1961) observed it totally in 8 cases, but Duveoy (1855), Huxley (1864), Macalister (1874), Chapman (1879), Bischoff (1880), Deniker (1886), Hartmann (1886), Symington (1890), Hepburn (1892), Pira (1914), Sonntag (1924), Raven (1950), Preuschoft (1961) and Kaneff (1964) did not find it in 19 specimens. Straus (1930) estimated that the peroneus tertius occurs in about 33.3% (6/18) of gorillas. Including the data after

that, its frequency is calculated as 29.6% (8/27). It has not yet been recorded in prosimians and New World monkeys, while in Old World monkeys its presence has been observed in only two exceptional instances: in the pig tailed baboon (*Papio ursinus*) (Wells, 1935) and in the Toque monkey (*Macaca sinica*) (Kaneff, 1964). In "The Anatomy of the Rhesus Monkey", Howell and Straus (1933) stated that the peroneus tertius muscle is absent in Rhesus monkeys (*Macaca mulatta*). Okuda (1953) did not find the muscle in 40 legs of Rhesus monkey, while Kaneff (1964) also did not find it in many species of marsupials and mammals including some prosimians and New and Old World monkeys with the exception mentioned above.

The phylogeny of the peroneus tertius has been discussed by Chapman (1879), Forster (1915), Straus (1930), Wells (1935), Kaneff (1964), Lewis (1966), Sokołowska-Pituchowa et al. (1974), Singer and Gajisin (1975), Krammer et al. (1979) and Reimann (1978, 1981, 1983). Even, the occurrence of the peroneus tertius has not been studied statistically based on the data observed on a large number of samples except man, many authors accept an idea that the muscle has appeared progressively during the evolutionary process from apes to man.

Materials

For this study, 174 legs of 45 male and 42 female crab-eating monkeys were examined. All the specimens were obtained from the Japanese National Institute of Health. They were preserved in a 10% formalin solution for three months at least. Their ages and body weights are unknown. On the basis of physical condition, tooth eruption and ossification of the skeleton, all the animals were considered to be sub-adult. Dissections and observations were carried out

by one of us (Y.T.) according to the routine methods described previously (Kimura et al., 1970, 1980, 1981 and 1983). Five cases of the peroneus tertius observed in three males were reexamined and considered by both of the authors.

Results

The peroneus tertius was found in the left leg of the no. 6043 male specimen, and in the left and right legs of the no. 5847 and no. 14577 male specimens.

Figure 1 presents the peroneus tertius on the left foot of no. 6043. It has a well developed muscle belly arising from the anterior intermuscular septum and the anterior surface of the fibula on the lateral side of the extensor digitorum longus. The uppermost and lowest margins of the origin are located at distances of 40 mm and 26 mm from the lower edge of the lateral malleolus, respectively. It forms a tendon 1 mm wide just above the lateral malleolus and runs downward with the extensor digitorum longus along the lateral aspect of its lateral (third) tendon to insert by two slips into the opposed surfaces of the base and shaft of the fourth and fifth metatarsal bones.

Figure 2 presents the peroneus tertius on the right foot of no. 14577. It is a small tendon which is 2 mm in width at the branching point and 21 mm in length from that point to the retinaculum. A similar pattern was observed on the left foot of the same animal.

Figures 3 and 4 present the peroneus tertius in the left and right feet of no. 5847. These are composed of three successive fibrous parts which are clearly continuous, as shown in the magnified Figure 4. The proximal part (black arrow) is only a weak tendinous expansion from the lateral margin of the tendon of the extensor digitorum longus just after passing deep to the inferior

extensor retinaculum. The tendon spreads its fibers over the dorsum of the foot to form a thick fascial band, the intermediate part (curved arrow), which runs transversely to the base of the fifth metatarsal bone. From there, a well developed tendon, the distal part (white arrow), which is about 2 mm in width, extends to the medial surface of the fifth toe to blend with the lateral (third) tendon of the extensor digitorum longus on the distal two phalanges. Consequently, the tendon of the peroneus tertius shows on the whole a S-shaped course on the lateral side of the dorsum pedis. This is most easily seen in Figure 4.

In the peroneus tertius with a well developed muscular belly observed from antero-medial aspect in the left leg of no. 6043 (Figure 5), the deep peroneal nerve (N: in Fig. 5) penetrates the medial, intermediate and lateral fasciculi of the extensor digitorum longus to reach the peroneus tertius muscle. It is supplied by the perforating branch of the peroneal artery. Figure 6 shows the extensor digitorum longus and the tendinous peroneus tertius cut off from the right leg of no. 14577. The deep peroneal nerve fibers enter the posterior surface of the belly of the extensor digitorum longus by two to four twigs in the upper third of the leg.

Discussion

Studying the peroneus tertius in 50 human fetuses, Ikari (1950) classified the muscle into five types based on its manner of insertion. On the basis of 101 human feet, Sokołowska-Pituchowa et al. (1974, 1975) classified the muscle into four types. Types I and II, observed in 10.8% and 38.7% of cases, respectively, are characterized by the presence of an insertion on the opposed surfaces of the fourth and fifth metatarsal bones, a narrow belly or an intermediate width of the belly of the muscle and a long and narrow tendon. Types III and IV,

observed in 34.4% and 16.1% of cases, respectively, are characterized by an insertion on the dorsum of the fifth metatarsal bone at its base, a wide belly and a wide, long or short tendon. They regarded that the first two types are primitive (anthropogenic) forms, and the remaining two types are progressive (eugenic) forms. Ikari (1950) and Sokołowska-Pituchowa et al. (1974, 1975) did not consider a muscle without a muscular belly as a *peroneus tertius*. According to their definitions, only the muscle observed in no. 6043 of this series may be classified as a *peroneus tertius*, namely, a Type I of Sokołowska-Pituchowa et al. (1974, 1975).

On the basis of 214 human legs, Kaneff (1980) classified the *peroneus tertius* into nine types according to the grade of differentiation from the extensor digitorum longus and suggested that the most primitive form of the *peroneus tertius* was only a tendinous slip of the terminal tendon of extensor digitorum longus at the lateral side. Type I, in which the muscle is absent, was observed in 10.3% of cases. When the fourth tendon of the extensor digitorum longus extends to the fifth toe and gains a new attachment on the dorsum of the fifth metatarsal bone, it was classified into types II to IV according to sites of insertion; the base, shaft or head of the bone. These types were totally recorded in 14% of cases. When a developed muscular mass, even if not split off into a distinct muscle occurred with the tendon, it was grouped into Types V to VII. A well developed *peroneus tertius* was grouped into Types VIII and IX. Types V–IX were found in 75.7% of cases. According to this classification, no. 14577 and no. 6043 specimens in the present study can be grouped into Types III or IV and VIII or IX, respectively. The *peroneus tertius* muscles observed in no. 6043 and 14577 crab-eating monkey specimens of the present study could be classified into those observed

in man.

However, no. 5847 specimen is not grouped into any of the types mentioned above. Sommer (1907) reported a similar case of a muscle with a tendinous expansion in gorillas, which he regarded as the *peroneus tertius*. However, Straus (1930) claimed that the case reported by Sommer (1907) was a doubtful one. Accordingly, Preuschoft (1961) observed the similar tendon in a gorilla and described the case as the "so-called *M. peroneus tertius*" in his paper.

From a phylogenic study, Krammer et al. (1979) have suggested that the *peroneus tertius* developed from the lateral compartment of the extensor digitorum longus in a comparatively recent evolutionary course of man. Reimann (1981) has also proposed the following hypothesis: in primitive tetrapods three extensor muscles (long, fibular and short extensor muscle groups) exist for the toes, whereas in mammals two of these muscles are in a rivaling but not vicarious relationship: While the long extensor muscle (the extensor digitorum longus) remains in all trinomial toes, the fibular extensor muscles (the *peronei digitorum*) are laterally displaced by the short extensor muscles (the extensor digitorum brevis). Although in man the fibular extensor muscles are largely suppressed, the short extensor muscles do not often reach the fifth toe because this involuting toe is only of limited motor importance with regard to the entire function of the human foot. The ontogenetic involution of the fibular extensor muscles (the *peroneus digiti quarti* and *quinti*) usually remains at an intermediate stage, i.e. a tendon of the *peroneus brevis* branches off towards the dorsum pedis. In the anthropoids this involution is associated with the evolution and acquisition of the *peroneus tertius*. From this hypothesis, it seems that the *peroneus tertius* observed in no. 5847 of

the present series may have been developed from the extensor digitorum longus under these conditions.

In addition, from the present observation, it could be suggested that a regional situation of muscles, nerves and other components in the foot has been already ready for appearance of the peroneus tertius in the phylogenetic stage of crab-eating monkeys.

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Explanation of Figures

Plate I

- Fig. 1 Anterolateral aspect of the left limb of no. 6043 specimen. The extensor digitorum longus (EDL) divides into three tendons (I, II and III). The peroneus tertius has a muscle belly (black arrow) and tendon of insertion (white arrow).
- Fig. 2. The dorsum of the right foot of no. 14577 specimen. A small tendon (white arrow) leaves the lateral (third) tendon of the extensor digitorum longus and inserts into the dorsum of fifth metatarsal bone on its base and shaft.

Plate II

Fig. 3. The peroneus tertius (black and white arrows) in the left limb of no. 5847 specimen. Its tendon takes an S-shaped course to reach the insertion.

Fig. 4. The peroneus tertius in the right limb of no. 5847 specimen. The magnified figure presents more clearly the similar course of the tendon as shown in Fig. 3.

Plate III

- Fig. 5. The anteromedial aspect of the peroneus tertius in no. 6043 specimen. The deep peroneal nerve (N) penetrates each of the fasciculi (I, II and III) of the extensor digitorum longus (EDL) to reach the peroneus tertius muscle (black arrow). A perforating branch of the peroneal artery (A) supplies the muscle.
- Fig. 6. The deep peroneal nerve fibers (N) enter the posterior surface of the belly of the extensor digitorum longus (EDL) by two to four twigs in the upper third of the leg in no. 14577. The tendinous peroneus tertius (white arrow) branches from the third tendon of the extensor digitorum longus (EDL).