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Multiple muscular variations including the tenuissimus and tensor fascia suralis
muscles in the posterior thigh of a human case

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A short running title: Multiple variations in posterior thigh

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Abstract

The posterior thigh muscles in right side of an 81-year-old male cadaver had multiple variations named as muscles I to IV. The muscle I originated from the posteromedial surface of the greater trochanter and divided into two muscle bellies. These muscle bellies fused with the long head of the biceps femoris and were innervated by two branches from muscular branches of the semitendinosus and long head of the biceps.

The muscle II separated from the medial surface of the long head of biceps in the proximal third and fused with the semitendinosus in the distal fourth. The muscle III was a biventer muscle. Its superior belly separated from medial surface of the long head of the biceps in the distal third. The inferior belly of this muscle fused with the posterior surface of the crural fascia and was innervated by the tibial nerve. The muscle IV separated from the adductor magnus muscle, passed between the long and short heads of the biceps, fused with the inferior belly of the muscle III and was innervated by the muscular branch of the common fibular nerve to the short head of biceps. Peeling the epineurium of the muscular branches to the inferior belly of the muscle III showed that this nerve fascicle divided from the common trunk with branches to the gastrocnemius and soleus muscles. The inferior belly of the muscle III and muscle IV were thought to be equivalent to the tensor fascia lata and tenuissimus muscles, respectively.

Key words: Dissection, Evolution, Innervation, Primitive, Variation

Introduction

Muscular variation in the posterior thigh of the human, especially, tensor fascia suralis muscles are extremely rare (Barry and Bothroyd, 1924; Miyauchi et al., 1985; Tubbs et al., 2006). In the tensor fascia suralis muscle of the human cadavers (Barry and Bothroyd, 1924, Miyauchi et al., 1985, Tubbs et al., 2006), descriptions of the insertion of this muscle (i.e., posterior surface of the crucial fascia) are similar among these reports, although the origin of this muscle and its innervation are varied. The anatomical reports explaining the tenuissimus muscle of human cadaver case are extremely rare (Green, 1931; Ouchi, 1951; Akita et al., 1992). Here we present a human case which had tenuissimus and tensor fascia suralis muscles ipsilaterally. In addition to this variation, this case had two supernumerary muscles in the same side of the posterior thigh. To discuss the derives of these supernumerary muscles, analysis of the innervation pattern is useful to identify their developmental origins, as previously reported (Arakawa et al., 2005, 2006, 2008; Tsutsumi et al., 2015). In the present study, the innervation patterns of these four supernumerary muscles were examined and nerve fascicle analysis was performed partially.

Case report

This case was an 81-year-old male. Multiple muscular variations were found in right side of the posterior thigh. These supernumerary muscular variations in this case were designated as muscle I, II, III and IV in order from proximal (Fig. 1). Except for these four muscles, there was no variation in other muscles of both sides in the thigh and leg.

The muscle I: This muscle originated from the posteromedial surface of the greater trochanter, it descended beneath the sciatic nerve and divided into two muscle bellies medially and laterally. The medial muscle belly appeared from the medial side of the sciatic nerve and fused with the anterior surface of the long head of the biceps femoris in near its origin. The lateral muscle belly appeared from the lateral side of the sciatic nerve and merged with the long head laterally in proximal fourth. This muscle was innervated by two muscular branches; one branch separated from the common trunk with the muscular branch to the semitendinosus muscle and the other separated from the common trunk with the muscular branch to the long head of the biceps femoris (Fig. 1, black stars).

The muscle II: This muscle was separated from the medial surface of the long head of the biceps femoris in the proximal third, coursed medially and fused with the lateral surface of the semitendinosus muscle in the distal fourth. Innervated nerve branches to this muscle could not be found.

The muscle III: This muscle was a biventer muscle. The superior belly of this muscle separated from the medial surface of the long head of biceps femoris in the distal third. This muscle was externally-rotated about ninety-degree. The inferior belly of this muscle continued the aponeurosis in distal end and fused with the posterior surface of the crural fascia with which covered the lateral head of the gastrocnemius. The nerve branch to innervate the superior belly of this muscle could not be found. The inferior belly was innervated by the tibial nerve.

The muscular branch to the inferior belly of this muscle was further examined to the nerve fascicle analysis by peeling off the epineurium with using a stereoscopic microscope. This analysis showed that the muscular branch to the inferior belly of this muscle separated from the common nerve fascicle with the muscular branches to the lateral and medial heads of the gastrocnemius and soleus muscles (Fig. 2).

The muscle IV: This variant muscle was separated from the posterior surface of the adductor magnus muscle. This was flat and thin muscle and it passed between the long head and short head of the biceps. Finally, this muscle fused with the inferior belly of the muscle III. The muscle IV was innervated by the muscular branch to the short head of biceps (Fig. 1, asterisk). This muscular branch separated from the common fibular nerve which divided from the sciatic nerve.

Discussion

The muscle I of this case is extremely rare and there is no previous report to show the similar finding as far as we investigated. In the nonprimate mammals, semitendinosus and long head of biceps femoris muscles originate not only from the ischial tuberosity but also from the posterior surface of the sacrum and coccygeus (Chauveau, 1885). The origin of the muscle I in the present case is similar to the semitendinosus in the nonprimate mammals. It is still unclear what nerve branch innervates this muscle in nonprimate mammals. Therefore, it must be awaited to elucidate the innervation pattern for the muscular part of the additional origin of the semitendinosus and the long head of biceps in order to discuss the derivation of this muscle and the homology among primates.

The similar case of the muscle II has been reported by Sinav et al. (1995). In this report, the proximal part of the long head of the biceps femoris separated to fuse with the distal part of the semitendinosus muscle which was innervated by the tibial nerve from the posterior surface. Since the innervation of the muscle II could not be found in the present study, it remains obscure whether the muscle II is homologous to the accessory muscle in the previous case (Sinav et al., 1995) or not.

Insertion of the muscle III in the present study is quite similar to the tensor fascia

suralis muscle in the previous reports (Barry and Bothroyd, 1924, Miyauchi et al., 1985, Tubbs et al., 2006). But among the previous reports, the origin of this muscle has been variedly described. According to Barry and Bothroyd (1924), this muscle separated from the long head of the biceps femoris. The whole shape of the muscle III in the present case is quite similar to this case (Barry and Bothroyd, 1924). In another case (Tubbs et al., 2006), however, this muscle separated from the semitendinosus muscle. In addition, Miyauchi et al. (1985) reported a case that tensor fascia suralis muscle has two heads which were separated from the long head of the biceps femoris and semitendinosus muscles. To discuss the homology of the muscles, to identify the innervation of the given muscle is quite important. The present nerve fascicle analysis of the muscular branch to the muscle III clarified that this muscular branch separated from the common nerve fascicle with the muscular branches to the lateral and medial heads of the gastrocnemius and the soleus (Fig. 2). In the case reported by Barry and Bothroyd (1924), this muscle was innervated by the independent muscular branch from the tibial nerve. In the case reported by Tubbs et al. (2006), this muscle was innervated by the muscular branch which separated from the common trunk with the muscular branch to the semitendinosus muscle (tibial nerve). Taken together with the present and previous cases, we discussed that the muscle III might equivalent to the tensor fascia

suralis muscle, due to its similar innervation patterns (tibial nerve), although the origins were different between the muscle III in the present and the similar muscles in the previous reports (Miyauchi et al., 1985, Tubbs et al., 2006). Rarely, muscle slip in which located superficial layer of the crural fascia observed in cadaveric dissection course (Okamoto et al., 2004; Kim et al., 2014). In addition, this muscle innervated by the tibial nerve (Okamoto et al., 2004; Kim et al., 2014) as in the inferior belly of the muscle III in this case. Though the homology of these previous cases and this case is unclear, future work would have resolve this homology and morphogenesis.

The muscle IV is similar to the tenuissimus or femorococcygeus muscle previously reported by Green (1931), although the detailed origin and insertion were different. The similarities of this muscle to the case in the previous report are spatial relationship and their innervation. They course between the long and short heads of the biceps femoris, and innervated by the common fibular nerve. Green (1931) suggested that the tenuissimus and the femorococcygeus, which are innervated by branches from the dorsal sciatic nerve. In addition, Green (1931) suggested that the nerve to the tenuissimus usually arises more distally from the common peroneal nerve, although the nerve to the femorococcygeus is commonly associated with the nerve to the gluteus maximus. Based on these findings and the innervation pattern, this aberrant muscle

might be homologous to the tenuissimus muscle. The tenuissimus muscle in human is extremely rare (Green, 1931; Ouchi, 1951; Akita et al., 1992), although the nonprimate mammal species have the tenuissimus muscle constantly (Parsons, 1898). In the new world monkey, the tenuissimus muscle constantly exists (Prejzner-Morawska, 1977). In the previous report (Prejzner-Morawska, 1977), tenuissimus muscle originates from the ischial tuberosity and fused with the crucial fascia in the *Cebus capucinus*.

The reason why these muscle variations occurred ipsilaterally is unclear. These muscle variations are thought to be evolutionary remnant muscles as discussed above. These anomalous muscles may disappear due to decrease in their functional merits. Future evolutionary and developmental studies will resolve abolishment of this muscle in human.

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Conflict of interest

None.

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Figure legends

Figure 1 The posterior view of the right thigh region. a: photograph, b: line drawing. Upper and right sides of this Figure are proximal and lateral, respectively. The muscle I is innervated by two branches (black stars), the proximal and the distal. The proximal branch separates from the common trunk with the muscular branch to the semitendinosus muscle (ST), while the distal branch separates from the common trunk with the muscular branch to the long head of the biceps femoris (BFl). The muscle II is separated from the medial surface of the long head of the biceps femoris and fuses with the lateral surface of the semitendinosus muscle. The muscular branch to the inferior belly of the muscle III ramifies with the tibial nerve (arrowheads). Muscular branch to the muscle IV (asterisk) separates from the muscular branch to the short head of the biceps femoris (BFs). Other abbreviations of this Figure: **GC**, gastrocnemius; **AM**, adductor magnus; **SM**, semimembranosus; **SN**, sciatic nerve; **So**, soleus.

Figure 2 The posterior view of the nerve-muscle sample after peeling the epineurium (nerve fascicle analysis) of the muscular branch to the inferior belly of the muscle III (arrowheads). a: photograph, b: line drawing. Upper and right sides of this Figure are proximal and lateral, respectively. Nerve fascicle of the muscular branch to

the inferior belly of the muscle III (arrowheads, green colored nerve in b) separates from the common trunk with the muscular branches to the lateral and medial heads of the gastrocnemius muscle (GC) and the soleus muscle (nerve to the soleus muscles; NSo). Other abbreviations of this Figure: **BFl**, lateral head of the biceps femoris; **BFs**, short head of the biceps femoris; **ST**, semitendinosus; **SM**, semimembranosus; **TN**, tibial nerve; **CFN**, common fibular nerve.



