

– Abstract –

Electrophysiologic Observations of Segmental Innervation (myotome) in Lower Extremity Muscles of Humans

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Objective : To determine the ratio of segmental innervation in the lower extremity muscles of humans utilizing electrophysiologic methodology.

Methods : Nineteen healthy men were studied. We stimulated the L4, L5, and S1 roots using a 7cm Teflon-coated monopolar needle and recorded the compound muscle action potentials (CMAPs) of the tibialis anticus, tensor fascia lata, extensor digitorum brevis, abductor hallucis, peroneus longus, gastrocnemius medial head, and gastrocnemius lateral head. Maximum CMAP amplitudes recorded from each muscle were used as a parameter of innervation. The formula used to calculate segmental innervation is CMAP amplitude of each root stimulation divided by the sum of CMAP amplitudes of L4, L5, and S1 root stimulation.

Results : Segmental innervation of lower limb muscles from L4, L5 and S1 spinal roots were as follows: L4 44.8%, L5 36.2%, S1 19.0% for tibialis anticus; L4 26.6%, L5 49.7%, S1 23.7% for tensor fascia lata; L4 16.2%, L5 53.7%, S1 30.1% for peroneus longus; L4 21.9% L5 47.5%, S1 30.6% for extensor digitorum brevis; L4 17.3%, L5 44.9%, S1 37.8% for abductor hallucis; L4 10.0%, L5 31.9%, S1 58.1% for gastrocnemius medial head; L4 13.0%, L5 34.5%, S1 52.5% for gastrocnemius lateral head. Of the muscles studied, the tibialis anticus and tensor fascia lata were L4 and L5 dominant muscles ($p < 0.05$). L5 dominant muscles were extensor digitorum brevis and peroneus longus ($p < 0.05$). Abductor hallucis was innervated by L5 and S1 dominantly ($p < 0.05$). Gastrocnemius medial and lateral heads were dominantly innervated by S1 ($p < 0.05$).

Conclusion : We conclude that the segmental innervation of lower extremity muscles of a normal person is variable. However, there are gross trends of dominantly innervated segments of each muscle: L4 to tibialis anticus and tensor fascia lata; L5 to extensor digitorum brevis, peroneus longus, tibialis anticus, and tensor fascia lata; S1 to gastrocnemius medial and lateral head.

Key Words : Myotome, Segmental innervation, Innervation ratio, Spinal root

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mius meidal head), (gastrocnemius lateral head) 7

0.2msec

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4, 5

1

SPSS 9.0 for Windows

ANOVA

. 1892 Sherrington¹

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^{2,5}

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3.96 ± 1.64mV, 5.29 ± 2.08mV, 2.45 ± 1.76mV, 15.90 ± 4.93mV, 14.15 ± 3.02mV, 6.39 ± 3.03mV, 5.55 ± 4.47mV, 13.10 ± 3.25mV, 6.98 ± 1.19mV, 3.46 ± 1.36mV, 7.18 ± 4.55mV, 4.03 ± 2.08mV, 4.44 ± 3.20mV, 10.13 ± 5.82mV, 8.65 ± 5.62mV, 3.71 ± 1.46mV, 10.60 ± 6.85mV, 18.94 ± 5.68mV, 5.67 ± 3.69mV, 12.19 ± 6.52mV, 18.45 ± 5.96mV (Table 1, Fig. 1).

4

5

1

(p<0.05).

19

10

9

4

가

5

(p>0.05), 1

(Counterpoint MKII, Dantec)

4-5

5

1

(p<0.05).

5

1

7cm

4, 5

1

(p<0.05).

5

0.5~1cm

4

가

1

(p>0.05).

3cm

1

5

1

(p<0.05).

4, 5

5

4

1

4, 5

1

⁶

26.6 ± 14.6%, 49.7 ± 19.1%, 23.7 ± 17.12%

(tibialis anticus),

(tensor fascia lata),

44.8 ± 14.0%, 36.2 ± 16.3%, 19.0 ± 7.1%

(extensor digitorum brevis),

(peroneus longus),

16.2 ± 12.8%, 53.7 ± 10.7%,

(abductor hallucis),

(gastrocne-

30.1 ± 10.6%,

21.9 ± 15.5%, 47.5 ±

Table 1. Amplitude of compound muscle action potential recorded from each muscle by L4, L5, and S1 root stimulation.

Muscle	L4 (mV)	L5 (mV)	S1 (mV)
Tibialis anticus	15.90±4.93*	14.15±3.02*	6.39±3.03
Tensor fascia lata	3.96±1.64*	5.29±2.08*	2.45±1.76
Extensor digitorum brevis	3.46±1.36	7.18±4.55*	4.03±2.08
Peroneus longus	5.55±4.47	13.10±3.25*	6.98±1.19
Abductor hallucis	4.44±3.20	10.13±5.82*	8.65±5.62*
Gastrocnemius, medial head	3.71±1.46	10.60±6.85	18.94±5.68*
Gastrocnemius, lateral head	5.67±3.69	12.19±6.52	18.45±5.96*

* means statistically significant (p<0.05) by ANOVA.

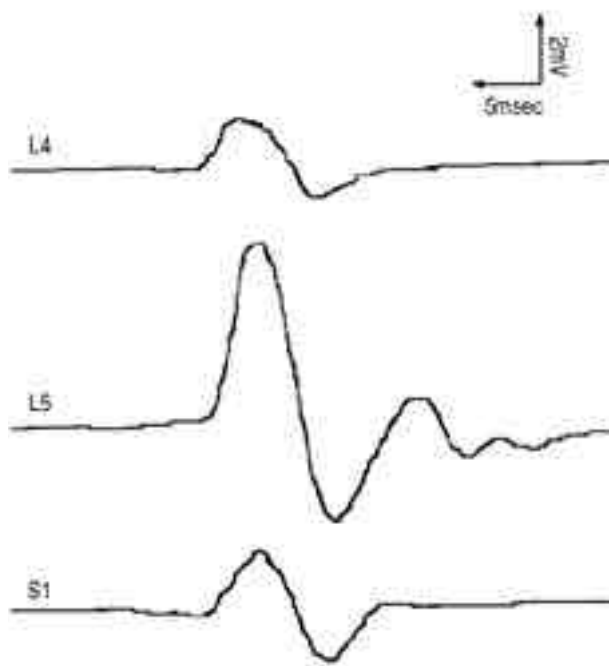


Fig. 1. An example of typical recordings obtained by stimulation of L4, L5, and S1 root: Extensor digitorum brevis

15.6%, 30.6 ± 17.0% . 17.3 ±
 10.5%, 44.9 ± 15.6%, 37.8 ± 14.7% ,
 10.0 ± 7.1%, 31.9 ± 20.5%, 58.1 ± 16.4%,
 13.0 ± 9.3%, 34.5 ± 19.4%, 52.5 ±
 13.1% (Fig. 2).

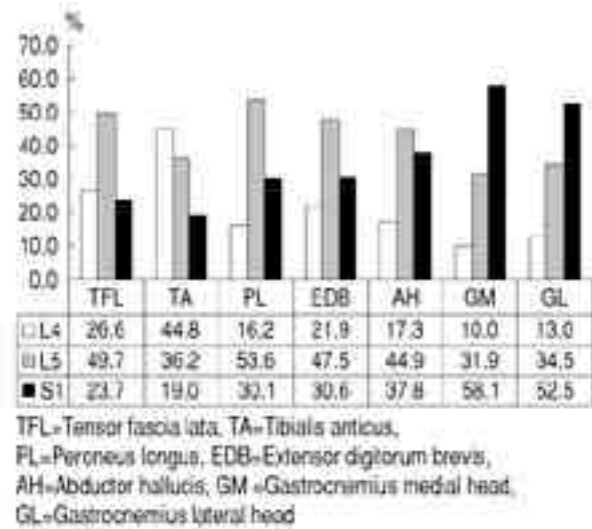


Fig. 2. Segmental innervation ratio of each muscle by L4, L5, and S1 root

2

10.0%, 31.9%, 58.1%,
13.0%, 34.5%, 52.5%

1982 Young

8 50

5

1

2

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. 1991 Phillips Park⁹ 123

. 1971 LaJoie¹⁰

54%

3

, 46%

1

4

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, Young⁸

8

,

1

84%

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가
가

Phillips Park⁹
27.9%

가

Yong⁸

16%

. Wilbourn Aminoff¹¹

가

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가

13.2%

4, 5

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1

가

10%

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4

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4, 5

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1

. 4, 5

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1

26.6%, 49.7%, 23.7%

44.8%, 36.2%, 19.0%

5

49.7%,

16.2%, 53.7%, 30.1%

4

44.8%,

5

,

21.9%, 47.5%, 30.6%

53.6%,

5

47.5%,

17.3%, 44.9%, 37.8%

5

44.9%,

1 58.1%,
 1 52.5% 가
 4 5 ,
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