

Optimal needle placement for extensor hallucis longus muscle using ultrasound verification

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Introduction

The extensor hallucis longus muscle (EHL) arises from the middle part of the anterior surface of the fibula and the interosseous membrane and is attached to the dorsal aspect of the base of the distal phalanx of the great toe. The EHL muscle is important for the diagnosis of neurologic lesions and is also a target muscle for injection treatment. Various Methods for needle placement on EHL have been suggested, but none of these can provide the essential information about the appropriate depth or accurate location of the needle insertion for safety purposes. Therefore, we investigated the EHL with ultrasonography in order to identify the motor point of the muscle and to determine safe needle placement.

Methods

A total of 96 legs of 48 healthy volunteers were examined through ultrasonography. The structures that would be penetrated by four referred Methods were assessed (Figure 1), and we identified the midpoint of EHL (MD') using landmarks to find the optimal needle placement.

Results

The mean values of bimalleolar line-MD' and tibial crest-MD' were 10.5 ± 1.2 cm and 3.6 ± 0.4 cm, respectively. The depth of midpoint was 1.6 ± 0.2 cm. According to the four referred Methods, the probability of the needle penetrating EHL was 13% to 79% and that of the needle penetrating the neurovascular bundle was 50% to 89%. The anatomical structures that would be penetrated according to the four different referred Methods are demonstrated in Table 1 and the ultrasound cross-section views of each point are shown in Figure 2. Fifty-four legs of 27 participants who agreed to participate in additional analysis were evaluated by ultrasound to see if the needle was placed in the EHL. Using the mean values, the accuracy of the needle on EHL was 100%.

Conclusion

Various Methods for needle placement on EHL have been suggested, but none of these can provide the essential information about the appropriate depth or accurate location of the needle insertion for safety purposes. In our study, the optimal needle placement for EHL could be performed safely at the point about 10.5 cm proximal from the BML and

about 3.6 cm lateral from TC' with 1.6 cm depth. This needle placement showed 100% accuracy and is expected to be employed with ease in clinical practice.

Table 1. Anatomical structures that would be penetrated according to the four different referred methods in the ultrasound cross-section view (n = 96)

	EHL muscle (middle portion + other)	Middle portion of EHL	NVB	EHL tendon	TA tendon	TA muscle	EDL muscle
A*	68 (70.8) 1.45-2.69 cm [‡]	11 (11.5)	63 (65.6) 2.69 cm [§]	0 (0.0)	0 (0.0)	79 (82.3)	15 (15.6)
B†	28 (29.2) 0.94-1.46 cm [‡]	0 (0.0)	89 (92.7) 1.67 cm [§]	1 (1.0)	0 (0.0)	62 (64.6)	0 (0.0)
C‡	13 (13.5) 0.97-1.37 cm [‡]	0 (0.0)	50 (52.1) 1.42 cm [§]	1 (1.0)	64 (66.7)	92 (95.8)	0 (0.0)
D§	79 (82.3) 1.39-2.69 cm [‡]	22 (22.9)	63 (65.6) 2.66 cm [§]	0 (0.0)	0 (0.0)	66 (68.8)	35 (36.5)

Data expressed as number of penetrated (% of the number of penetrated over total n). EHL, extensor hallucis longus muscle; NVB, neurovascular bundle; TA, tibialis anterior; EDL, extensor digitorum longus.

*A: Lee and DeLisa, †B: Preston and Shapiro, ‡C: Perotto and Delagi, §D: Chu-Andrews and Johnson; ‡ In case of the needle penetrating EHL, the value means the range of the mean superficial and deep depth of EHL, § In case of the needle penetrating NVB, the value means the mean depth of NVB.

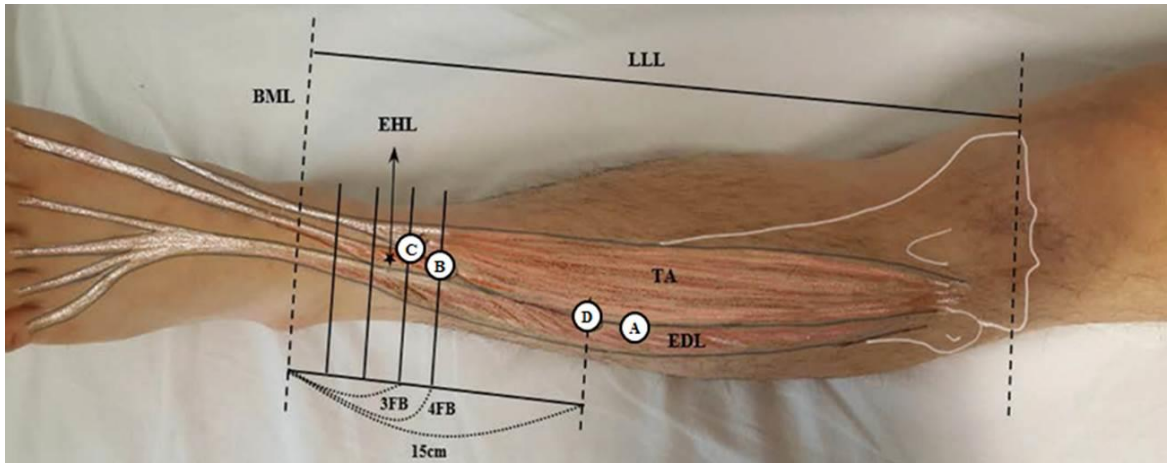


FIGURE 1. The various Methods for extensor hallucis longus muscle needle placement (A, Lee and DeLisa, inserting the needle at the junction between the middle and lower third of the tibia and at the space between the tendons of tibialis anterior and extensor digitorum longus; B, Preston and Shapiro, inserting the needle at four fingerbreadths above the ankle lateral to the tibialis anterior muscle; C, Perotto and Delagi, inserting the needle at three fingerbreadths above the bimalleolar line (BML) of the ankle just lateral to the crest; D, Chu-Andrews and Johnson, inserting the needle 15 cm proximal to the BML between the tendons of tibialis anterior and extensor digitorum longus). BML, bimalleolar line; LLL, lower leg length; EHL, extensor hallucis longus muscle; TA, tibialis anterior; EDL, extensor digitorum longus; FB, fingerbreadths.

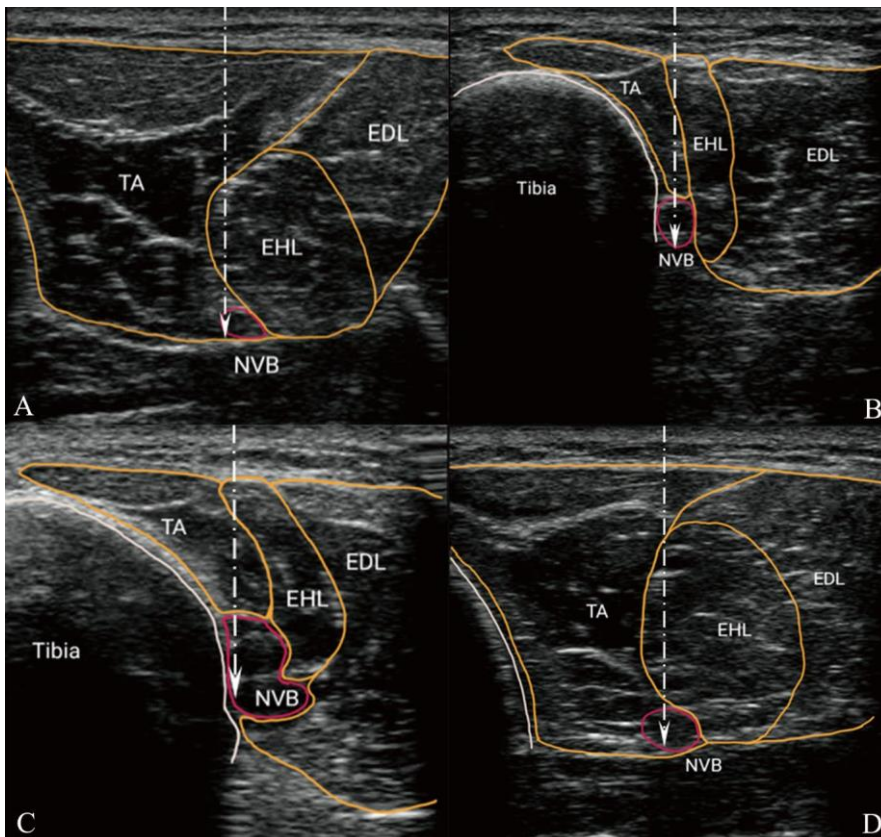


FIGURE 2. Cross-section views of referred Methods and anatomical structures that would be penetrated (A, Lee and DeLisa; B, Preston and Shapiro; C, Perotto and Delagi; D, Chu-Andrews and Johnson). White arrow demonstrates the needle pathway. TA, tibialis anterior; EDL, extensor digitorum longus; EHL, extensor hallucis longus muscle; NVB, neurovascular bundle.