

# Frequency and Characteristics of Extensor Hallucis Capsularis: A Cadaveric Study

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**Background:** Extensor hallucis capsularis is an accessory extensor tendon that is sporadically observed at the medial side of the extensor hallucis longus tendon. Knowledge regarding frequency of occurrence and size of the tendon may help surgeons decide whether to use this tendon or not when tendon graft is needed during foot surgery.

**Objective:** To evaluate the frequency, size, origin, and insertion of the extensor hallucis capsularis tendon in cadaveric study subjects.

**Material and Method:** Extensor hallucis capsularis tendon was examined via dissection of 55 cadaveric feet. Thirty-six male and 19 female cadavers were included, with an age range of 33 to 90 years (mean 67.3±14.0). One foot from each study subject was dissected and evaluated (29 left feet and 26 right feet). Demographic data (gender, age, and height) and outcome data (frequency, origin, insertion, length, and width of the tendon) were recorded. Tendon measurement reliability was evaluated by intraclass correlation coefficient.

**Results:** Extensor hallucis capsularis tendon was found in 90.9% of cadaveric subjects. Mean tendon length and width was 11.3±4.0 cm and 1.6±0.6 mm, respectively. Most tendons branched from the extensor hallucis longus tendon and attached to the first metatarsophalangeal joint capsule.

**Conclusion:** Extensor hallucis capsularis tendon was found in the vast majority of cadavers evaluated in this study. Most originated from the extensor hallucis longus tendon and inserted into the first metatarsophalangeal joint capsule. Application of this tendon as a tendon graft should be carefully considered due to variations of the length and the narrow width which may limited strength of this tendon graft.

**Keywords:** Extensor hallucis capsularis, Extensor hallucis longus, Accessory tendon, Cadaveric study, Tendon graft

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Extensor hallucis capsularis (EHC) is an accessory extensor tendon of the foot that is located medial to the extensor hallucis longus tendon<sup>(1)</sup>. This tendon was first described by Macalister in 1886 as an extensor ossis metatarsi hallucis and an extensor primi internodii hallucis<sup>(2,3)</sup>. EHC originates as a tendinous slip of the extensor hallucis longus tendon<sup>(4)</sup>, but it may be found as a branch splitting from the tibialis anterior tendon or the extensor hallucis brevis tendon<sup>(1,3)</sup>. The insertion of EHC is found blending at either the first metatarsophalangeal joint capsule or the base of the first proximal phalanx<sup>(1)</sup>. The function of EHC is to complement the extensor hallucis longus tendon<sup>(1)</sup> and to stabilize the first metatarsophalangeal joint capsule during dorsiflexion of the hallux<sup>(3)</sup>. However, absence of the EHC was found to have no adverse effect on foot function<sup>(1)</sup>. As such, the EHC has been proposed

as a possible source for autogenous tendon graft transfer in foot surgery<sup>(1,5)</sup>.

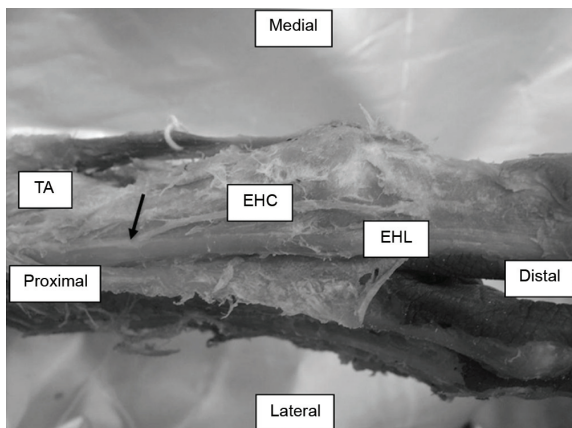
The frequency, origin, insertion, length, and width of the EHC tendon all varied in previous reports. The aim of this study was to evaluate the frequency, size, origin, and insertion of the extensor hallucis capsularis tendon in cadaveric study subjects.

## Material and Method

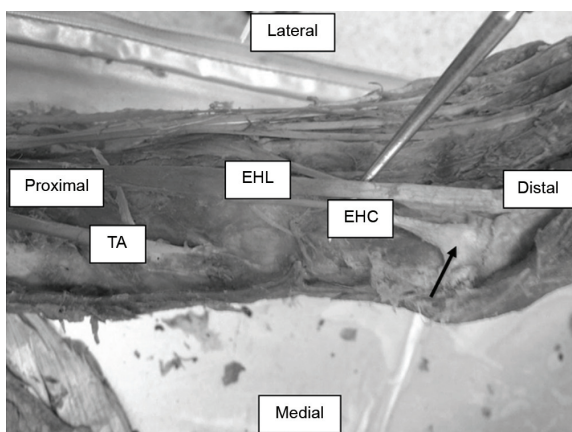
Fifty-five uninjured soft cadaveric legs and feet were dissected and evaluated. Thirty-six male and 19 female cadavers were included, with an age range of 33 to 90 years (mean 67.3±14.0). Twenty-nine of the evaluated feet were left feet and the remaining 26 were right feet. Height of the cadavers ranged from 135.0 to 180.0 cm (mean 160.5±10.2). A longitudinal skin incision was made that began at the anterior part of the distal one-fourth of the leg, continued along the extensor hallucis longus tendon, and ended at the nail fold of the big toe. The skin and subcutaneous layer were exposed. Tissue around the distal muscular part and musculotendinous junction of the extensor hallucis

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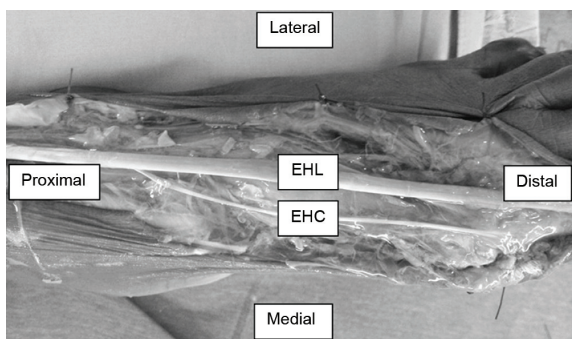
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**Fig. 1** A photograph showing the origin of EHC tendon from the extensor hallucis longus tendon (arrow) (TA = tibialis anterior; EHL = extensor hallucis longus).



**Fig. 2** A photograph showing the insertion of EHC tendon at the first metatarsophalangeal joint capsule (arrow) (TA = tibialis anterior; EHL = extensor hallucis longus).



**Fig. 3** A photograph showing the total length of EHC tendon (EHL = extensor hallucis longus).

longus and the tibialis anterior, and along these tendons was dissected. If presented, the accessory extensor tendon was identified and noted. The origin (i.e., the point of bifurcation on the main tendon) and the insertion (i.e., the point at which the tendon blended with or attached to the beneath structure) of the tendon were recorded (Fig. 1, 2). Total length from the origin to the insertion site and the maximal width of the tendon were measured (Fig. 3). Data collection and measurement was performed on all cadavers by one investigator (Jarusriwana A). Reliability of the measurements was performed and intraobserver and interobserver were evaluated using intraclass correlation coefficient analysis. Data were analyzed using SPSS Statistics version 18 (SPSS Inc., Chicago, IL, USA). The protocol for this study was approved by the Siriraj Institutional Review Board (SIRB), Faculty of Medicine Siriraj Hospital, Mahidol University.

## Results

The presence of EHC tendon was observed in 50 of 55 cadaveric feet (90.9%). EHC was found in all female cadavers (19 of 19) and in 86% of male cadavers (31 of 36). However, the difference in proportion between genders did not achieve statistical significance ( $p = 0.092$ ). In subjects with EHC tendon, the origin was from the extensor hallucis longus tendon in 96% of cadavers (48 of 50) and from the tibialis anterior tendon in 4% of cadavers (2 of 50). EHC tendon inserted into the first metatarsophalangeal joint capsule in 82% of cadavers (41 of 50), into the base of the first proximal phalanx in 16% (8 of 50), and into the head of the first metatarsal bone in 2% (1 of 50) (Table 1).

The EHC length varied from 4.2 to 27.8 cm, with an average of 11.3 cm and a standard deviation (SD) of 4.0 cm. The maximal tendon width was 1.0 mm in 25 cadavers (50%), 2.0 mm in 22 cadavers (44%), and 3.0 mm in 3 cadavers (6%). The average width was 1.6 mm with a standard deviation (SD) of 0.6 mm. In subgroup analysis, cadavers with 1.0 mm tendon width had an average tendon length of 9.7 cm (range 4.2 to 23.5, SD 3.6), cadavers with 2.0 mm tendon width had an average tendon length of 12.1 cm (range 8.9 to 27.8, SD 3.8), and cadavers with 3.0 mm tendon width had an average tendon length of 14.0 cm (range 13.8 to 19.3, SD 3.1). A statistically significant correlation was found between length and width of the EHC ( $p = 0.002$ ). However, no significant correlation was observed between cadaver height and length or width of the EHC ( $p = 0.098$  and  $p = 0.107$ ,

**Table 1.** Frequency, origin, and insertion of EHC tendon

Parameters	Number (%)
Number of cadavers	55
Frequency of EHC tendon	50 (90.9)
Origin	
Extensor hallucis longus tendon	48 (96.0)
Tibialis anterior tendon	2 (4.0)
Insertion	
First metatarsophalangeal joint capsule	41 (82.0)
Base of the first proximal phalanx	8 (16.0)
Head of the first metatarsal bone	1 (2.0)

EHC = extensor hallucis capsularis

respectively). Intraclass correlation coefficient for intraobserver and interobserver reliability of tendon length measurement was 0.783 and 0.878, and tendon width measurement was 0.977 and 0.988, respectively.

## Discussion

An accessory extensor tendon of the foot has been described in many reports. A document published by Macalister in 1866 described a distinct muscle belly branching from the anterior edge of tibialis anterior as an extensor ossis metatarsi hallucis<sup>(2)</sup>. He also found and described a slip lying nearby the extensor hallucis longus, which he referred to as an extensor primi internodii hallucis<sup>(2)</sup>. In 1867, Wood found more than one half of a long tendon attached to the inner part of the base of the first phalanx of the great toe that was distinct from the extensor hallucis longus<sup>(6)</sup>. Many reports have mentioned an accessory tendon of the foot only at the medial side of the extensor hallucis longus<sup>(1,3-5,7,8)</sup>. However, the accessory extensor tendon of the foot can be found either medial or lateral to the extensor hallucis longus<sup>(9)</sup>. Al-Saggaf proposed three different patterns relative to insertion of the extensor hallucis longus tendon, as follows: single tendon, two tendons (main and medial accessory tendon), and three tendons (main, medial, and lateral accessory tendon)<sup>(9)</sup>. Tezer and Cicekcibasi reported an accessory extensor tendon of the foot between extensor hallucis longus and extensor digitorum longus muscle that they called the accessory extensor digiti secundus muscle, with a described primary function of extending the second toe<sup>(10)</sup>.

Extensor hallucis capsularis is the name of the accessory extensor tendon of the foot which is located medial to the extensor hallucis longus tendon<sup>(1,3,4,8)</sup>. Alternative names for this tendon are secondary extensor hallucis longus<sup>(11)</sup>, accessory extensor tendon

of the first metatarsophalangeal joint<sup>(1)</sup>, extensor ossis metatarsi hallucis, and extensor primi internodii hallucis<sup>(1,2)</sup>. Boyd et al reported a frequency of EHC of 88%<sup>(1)</sup>. In that study, EHC originated from the extensor hallucis longus tendon or muscle in 93% of cases and inserted into the first metatarsophalangeal joint capsule in 99% of cases. Bibbo et al found EHC in 81.25% of cases, with the tendon originating from the extensor hallucis longus tendon in 92.3% and from the tibialis anterior tendon in 7.7% of cadavers<sup>(3)</sup>. Insertion at the dorsal or dorsomedial aspect of first metatarsophalangeal joint capsule was found in 100% of cases. Denk et al described double tendons attachment of the extensor hallucis longus in 72.34% of cases in his study<sup>(5)</sup>. However, Al-Saggaf found the accessory extensor tendon in 35% of cadavers<sup>(9)</sup> and Arora et al reported double tendons of the extensor hallucis longus in only 10% of cases<sup>(7)</sup>. Aktekin et al conducted a study of the accessory tendon of extensor hallucis longus in aborted fetuses and found the accessory tendon in 51% of cases, with bilateral tendons in 65% and unilateral tendon in 35% of fetuses<sup>(8)</sup>. According to fetal age, age groups 16 to 21 weeks, 22 to 27 weeks, and 28 to 34 weeks had the accessory tendon in 52%, 43%, and 67% of cases, respectively.

The EHC size also varied in previous reports. Boyd et al found an average EHC length of 10.8 cm and an average width less than 2 mm in a majority of cadaveric study subjects<sup>(1)</sup>. Bibbo et al reported a mean EHC distance of 16.9 cm, with an average length of free tendon of 5.5 cm<sup>(3)</sup>. Denk et al reported a mean length of medial accessory tendon of 12.4 cm<sup>(5)</sup>. EHC has been proposed as a possible source for autogenous tendon graft transfer in foot surgery, especially operative repairs of hallux pathology. By way of example, ruptured extensor hallucis longus tendon may be a good graft recipient candidate due to the close proximity of the EHC to the extensor hallucis longus tendon<sup>(1,5)</sup>. EHC was also shown to have no role in the development of deformity at the first metatarsophalangeal joint, such as a hallux valgus<sup>(3,5)</sup>.

Findings from the present study confirm a high frequency of EHC (90.9%) in cadaveric subjects, with an average length of 11.3±4.0 cm and significant correlation between tendon length and width. A mentionable limitation of this study is the condition of the cadavers, which are principally prepared for use by medical students. All cadavers had been preserved and kept in room air for at least one year prior to the start of this study. Tendon shrinkage may, therefore, have resulted.

## Conclusion

EHC was found in the vast majority of cadavers evaluated in this study. Most originated from the extensor hallucis longus tendon and inserted into the first metatarsophalangeal joint capsule. Application of EHC as a tendon graft should be carefully considered due to variations of the length and the narrow width which may limited strength of this tendon graft.

## What is already known this topic?

An accessory extensor tendon of the foot has been found for more than a hundred years, but the studies about its characteristics and clinical application were just proposed over the last twenty years. Recent study showed a high frequency and the potential application of this tendon as a tendon graft. However, the frequency and the size of EHC tendon varied in the previous literatures.

## What this study adds?

This study confirmed a high frequency of EHC tendon and the correlation between tendon length and width in cadavers. The origin and insertion of EHC was reported that the tendon mostly branched from the extensor hallucis longus tendon and attached to the first metatarsophalangeal joint capsule.

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## Potential conflicts of interest

None.

## References

1. Boyd N, Brock H, Meier A, Miller R, Mlady G, Firoozbakhsh K. Extensor hallucis capsularis: frequency and identification on MRI. *Foot Ankle Int* 2006; 27: 181-4.
2. Macalister A. Notes on muscular anomalies in human anatomy. *Proc R Irish Acad* 1866; 9: 444-69.
3. Bibbo C, Arangio G, Patel DV. The accessory extensor tendon of the first metatarsophalangeal joint. *Foot Ankle Int* 2004; 25: 387-90.
4. Uzel M, Cetinus E, Gumusalan Y, Coban YK. An anomalous muscle on the dorsomedial aspect of the foot (m. cuneo-naviculo-fascialis): case report. *Foot Ankle Int* 2004; 25: 647-9.
5. Denk CC, Öznur A, Sürücü HS. Double tendons at the distal attachment of the extensor hallucis longus muscle. *Surg Radiol Anat* 2002; 24: 50-2.
6. Wood J. Variations in human myology observed during the winter session of 1866-67 at King's College, London. *Proc R Soc Lond B* 1867; 15: 518-46.
7. Arora AK, Verma P, Abrol S. Study of extensor hallucis longus muscle in adult human cadavers of Punjab. *J Life Sci* 2011; 3: 101-5.
8. Aktekin M, Uzmansel D, Kurtoglu Z, Sanli EC, Kara AB. Examination of the accessory tendons of extensor hallucis longus muscle in fetuses. *Clin Anat* 2008; 21: 713-7.
9. Al saggaf S. Variations in the insertion of the extensor hallucis longus muscle. *Folia Morphol (Warsz)* 2003; 62: 147-55.
10. Tezer M, Cicekcibasi AE. A variation of the extensor hallucis longus muscle (accessory extensor digiti secundus muscle). *Anat Sci Int* 2012; 87: 111-4.
11. Lundeen RO, Latva D, Yant J. The secondary tendinous slip of the extensor hallucis longus (extensor ossis metatarsi hallucis). *J Foot Surg* 1983; 22: 142-4.



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## ความถี่ในการพบและลักษณะของเส้นเอ็น *extensor hallucis capsularis*: การศึกษาในร่างอาจารย์ใหญ่

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**ภูมิหลัง:** เส้นเอ็น *extensor hallucis capsularis* เป็นเส้นเอ็นขนาดเล็กของเท้าที่สามารถพบได้บริเวณด้านหลังเท้าทางด้านใน ต่อเส้นเอ็น *extensor hallucis longus* ซึ่งความรู้และข้อมูลรายละเอียดของเส้นเอ็นนี้สามารถนำมาประยุกต์ใช้เพื่อเป็นเส้นเอ็นทดแทนสำหรับการผ่าตัดบริเวณเท้าได้ หากมีความถี่ในการพบสูงและมีขนาดของเส้นเอ็นที่เหมาะสม

**วัตถุประสงค์:** เพื่อประเมินความถี่ในการพบ รวมทั้งขนาด จุดเกาะต้น และจุดเกาะปลายของเส้นเอ็นนี้ในร่างอาจารย์ใหญ่

**วัสดุและวิธีการ:** ทำการศึกษาเส้นเอ็น *extensor hallucis capsularis* จากเท้าของร่างอาจารย์ใหญ่อายุจำนวน 55 ข้าง โดยเป็นอาจารย์ใหญ่เพศชาย 36 ข้าง และอาจารย์ใหญ่เพศหญิง 19 ข้าง อายุของอาจารย์ใหญ่อยู่ระหว่าง 33 ถึง 90 ปี (อายุเฉลี่ย  $67.3 \pm 14.0$  ปี) เท้าที่ทำการศึกษาเป็นเท้าซ้าย 29 ข้าง และเท้าขวา 26 ข้าง ข้อมูลที่ทำการศึกษาประกอบด้วยลักษณะทั่วไปของอาจารย์ใหญ่ (เพศ อายุ และส่วนสูง) และลักษณะของเส้นเอ็นที่ศึกษา (ความถี่ของเส้นเอ็นที่พบ จุดเกาะต้น จุดเกาะปลาย ความยาว และความกว้างของเส้นเอ็น) ซึ่งการวัดความยาวและความกว้างของเส้นเอ็นนั้นจะกระทำโดยผู้วิจัยและผู้ร่วมวิจัยเพื่อวิเคราะห์ความน่าเชื่อถือของกรวัด

**ผลการศึกษา:** พบว่าเส้นเอ็น *extensor hallucis capsularis* สามารถพบได้ถึง 90.9% โดยมีความยาวและความกว้างเฉลี่ยของเส้นเอ็นเท่ากับ  $11.3 \pm 4.0$  ซม. และ  $1.6 \pm 0.6$  มม. ตามลำดับ เส้นเอ็นนี้มีจุดเกาะต้นโดยส่วนใหญ่แยกออกมาจากเส้นเอ็น *extensor hallucis longus* และมีจุดเกาะปลายเชื่อมกับเยื่อหุ้มข้อ *first metatarsophalangeal*

**สรุป:** เส้นเอ็น *extensor hallucis capsularis* พบได้ในส่วนใหญ่ของร่างอาจารย์ใหญ่ โดยมีจุดเกาะต้นจากเส้นเอ็น *extensor hallucis longus* และจุดเกาะปลายบริเวณเยื่อหุ้มข้อ *first metatarsophalangeal* การประยุกต์ใช้เพื่อเป็นเส้นเอ็นทดแทนในการผ่าตัดนั้นควรพิจารณาด้วยความระมัดระวัง เนื่องจากความยาวของเส้นเอ็นนี้มีความหลากหลาย รวมทั้งความกว้างที่ค่อนข้างน้อยซึ่งอาจส่งผลกระทบต่อความแข็งแรงของเส้นเอ็นทดแทนได้

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