An Anatomical Study of Extensor Expansion of Thumb

Stelin Agnes Michael1  Gaddam Vijaya Lakshmi1

1Department of Anatomy, Pushpagiri Institute of Medical Sciences and Research Centre, Thiruvalla, Kerala, India

Address for correspondence  Gaddam Vijaya Lakshmi, MD, Department of Anatomy, Pushpagiri Institute of Medical Sciences and Research Centre, Thiruvalla, Kerala 689101, India (e-mail: seenuvijaylakshmi@gmail.com).

Abstract

Introduction  The presence of extensor expansion of the thumb has been reported in the literature and its mode of formation and contribution from the palmar muscles has been studied earlier. Yet, some authors deny its presence in the thumb.

Objective  This article evaluates the presence of the extensor expansion of thumb (EET) and its formation and contributions from palmar muscles.

Methods  Dissection was carried on the dorsum of the hand on 80 free upper limbs. The dorsum of thumb was carefully cleaned to look for the presence of extensor expansion. When present, its mode of formation and the contributing muscles were looked into. The mode of insertion of the extensor tendons onto the phalanges was also observed.

Results  In all specimens, EET had tendons of extensor pollicis longus (EPL) and extensor pollicis brevis (EPB) along its central axis. It received expansion from abductor pollicis brevis (APB; 100%) and flexor pollicis brevis (FPB; 41.2%) on the lateral side, and adductor pollicis (AP; 100%) and first palmar interosseous (PI; 50%) on the medial side. Attachment of EPL to distal phalanx (DP) was seen in 45%, and to both phalanges in 55%. EPB insertion onto proximal phalanx alone, DP alone, and both phalanges was in 46.2, 25, and 23.75%, respectively.

Conclusion  Extensor expansion was noted in all limbs studied. It is formed by the extensor tendons of the thumb with expansions from APB and AP on its margins. Contribution from the first PI and FPB was found to be variable. Differences in insertion of EPL and EPB to the phalanges were also noted.

Keywords
- extensor expansion
- thumb extensors
- intrinsic muscles
- phalanges

Introduction

Thumb is a unique organ in human body that performs intricate movements aided by several muscles. Unlike the other digits of hand, thumb exhibits complex movements,1 accounting for its extensive representation in the brain.2 Thumb enjoys great stability and strength due to the stabilizing action of the muscles and tendons crossing the first carpometacarpal joint.

Presence of an extensor expansion of thumb (EET) on its dorsum has been described in the textbooks since late 20th century. But it did not receive much attention compared with the extensor expansion of the other digits. The EET is a triangular expansion seen on the dorsum of the proximal phalanx (PP) of the thumb. It is formed by contributions from extensor pollicis longus (EPL), extensor pollicis brevis (EPB), and most of the intrinsic muscles of the thumb.

The EPL tendon is seen running along the central axis of the expansion, toward its insertion generally onto the base of the distal phalanx (DP), and often into base of PP also. The tendon of EPB enters the EET as it crosses the metacarpophalangeal (MCP) joint, and lies lateral to EPL. It is usually attached to the base of the PP. It may sometimes be attached to the bases of both phalanges or occasionally to the DP alone.2 The medial margin of EET is better defined and receives contribution from the adductor pollicis (AP) and first
palmar interosseous muscle (PI). Its lateral margin receives expansions from abductor pollicis brevis (APB) and often from flexor pollicis brevis (FPB).2,3

The structural arrangement of EET is different from the dorsal digital expansion (DDE) seen on other digits. The EET does not divide into three slips as noticed in the DDE of the fingers. Through its apex, it is inserted into the base of the DP. Though the attachments of EPL and EPB have been studied recently, there are no studies on the EET in the recent past. We were able to find only one study on the formation and description of EET in 2008. Hence, we wanted to study the formation of EET, along with the attachments of EPL and EPB.

**Materials and Methods**

The study was performed on 80 free upper limbs of unknown sex obtained from the anatomy department of Pushpagiri Medical College, Thiruvalla, Kerala, India. Upper limbs with soft tissue abnormalities and those with any deformities were excluded. The extensor retinaculum of hand was divided longitudinally over the first and third compartments to expose the underlying tendons. The dorsum of thumb was dissected to examine the extensor tendons to the thumb and the EET. The position of EPL and EPB in the expansion was noted. The margins of EET were cleaned and defined. Expansions joining the sides of tendons of EPL and EPB from intrinsic muscles of thumb such as APB, FPB, AP, and PI were noted down and photographed. Following that, EET was cut along the lateral margin of EPL and EPB, to study their attachments onto the phalanges. Variations in phalangeal attachments were looked into and photographed. The contribution of different muscles and tendons to the formation of EET, and the variations in the phalangeal attachments of EPL and EPB were expressed as percentages and frequencies.

**Results**

In all specimens, EET was observed as a well-defined triangular expansion on the dorsum of the proximal phalanx of the thumb. The EPL tendon was seen along the central axis of the expansion in its entire length. The EPB tendon also joined the expansion on the lateral side of the EPL tendon (Fig. 1).

The lateral margin of EET received expansion from APB in 100% and from FPB in 41.25% of the specimens studied (Fig. 2). Whereas the medial margin of EET received expansions from deep fibers of AP in all the limbs studied (Fig. 3), and from the first PI when present (Fig. 4). The first PI was absent in 50% of the specimens.

EPL was inserted onto both phalanges in 55% of the hands (Fig. 5), and into DP alone in only 45%. EPB was inserted into PP in only 46.2%. It was inserted into both phalanges in 23.75% (Fig. 6), and onto DP alone in 25% of the limbs. EPB was absent in 5% of the limbs.

**Discussion**

EET is similar to the DDE of the other digits in many aspects. It is seen as a triangular hood over the dorsum of the proximal phalanx of the thumb, with its base covering the MCP joint and apex at the base of the DP. The long extensor tendons of the thumb can be seen in the center of the expansion. And some intrinsic muscles of the thumb join the margins of the expansion. The presence of an expansion allows for extension at the interphalangeal (IP) joint even when MCP is flexed. EET moves distally on flexion of the MCP joint and proximally during its extension.
At the same time, the tendons and muscles contributing to the formation of EET are different from those involved in the formation of DDE of the other digits. Moreover, EET bears striking structural difference in that it does not divide into three slips as seen in other digits. Its apex is directly attached to the base of DP. EET also lacks attachment to the volar plate and fibrous flexor sheath of the thumb. Though the EET has been described as the DDE of thumb in earlier literature, in view of the above differences, we have preferred to use the term EET throughout the article.

The muscle and tendons contributing to the formation of EET as observed in our study were compared with the findings in the literature (►Table 1). We noticed that the expansion was formed by both the extensor tendons of the thumb (EPL and EPB). Similar observation was reported by Joshi et al.3
EPL was seen in the central portion of the EET in all the specimens studied similar to the descriptions given in the literature.\(^{4,5}\) As EPB crosses the MCP joint, it joins the expansion just lateral to the EPL. This mode of attachment of EPB to the EET was also described by Joshi et al.\(^1\) Contribution of EPB to the EET has been described positively by several authors, though the mode of contribution was variable.\(^{6,5}\) Connections between the tendons of EPL and EPB have also been described as they lie side by side on the dorsum of the MCP joint.\(^6\) Yet, others have reported that EPB commonly reaches the DP through a fasciculus that joins the EPL, in addition to its normal insertion into the PP.\(^2\)

Several authors believe that EPL and EPB replace the capsule of the MCP joint on its dorsal aspect.\(^{6,5}\) But we could not observe any such finding, though the possibility of the tendons fusing with the joint capsule cannot be totally ruled out.

The fibers from the intrinsic muscles of the hand that join the EET run transversely at the level of the MCP joint. They are attached not only to the sides of EPL and EPB, but also course dorsal to them at the level of the joint. Further distally, they run more obliquely toward the distal part of the thumb.\(^5\)

We noticed the lateral margin of EET received expansion from APB in all the specimens studied, whereas Joshi et al observed contribution from the muscle in only 68.2%.\(^3\) Though several textbooks comment on the contributions of different intrinsic muscles of the thumb to the EET, there are no frequencies mentioned to compare our values with. Expansion from FPB to the lateral margin of EET has been mentioned in only certain textbooks.\(^5,7\) We observed expansion from FPB joining the lateral margin in 41.25% of the specimens in contrast to 3.6% observed by Joshi et al (\(\text{Table 1}\)).

Several authors and anatomical textbooks describe that the deep fibers of AP pass into the medial side of EET.\(^2,5-7\) We observed deep fibers of AP joining the medial margin of EET in all the hands studied. This finding was similar to that observed by Joshi et al. Contribution from the first PI was mentioned in most of the textbooks.\(^2,4-6\) We observed the first PI in only 50% of the specimens. When present, it always joined the medial margin of EET. Joshi et al mentions the contribution of the first PI to the medial margin to be 62.7% (\(\text{Table 1}\)).

We found the medial margin to be more prominent compared with the lateral one, as was observed by Joshi et al. This is explained by the medial margin receiving contribution from AP which is the most powerful intrinsic muscle of the hand due to its crucial role in keeping the thumb in close approximation to other digits.\(^2\)

Attachment of EPL and EPB on the phalanges shows considerable variations. EPL was attached to the DP alone in only 45% of the limbs studied, in contrast to higher values observed by most of other authors.\(^3,6,10\) At the same time, EPL attachment into DP was reported to be only 5.3% by Abdel-Hamid et al.\(^5\) The attachment of EPL to both phalanges was seen in 55%, though higher values have been noted by Abdel-Hamid et al.\(^5\) Attachment of EPL to PP alone was reported by Esther Yamuna et al.\(^10\) In such cases, EPB invariably reaches the DP. But this finding was not observed in our study and was not reported by other authors (\(\text{Table 2}\)).

### Table 1  Comparison of present study results with previous studies

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</thead>
<tbody>
<tr>
<td>All specimens</td>
<td>All specimens</td>
<td>All specimens</td>
<td>All specimens</td>
<td>All specimens</td>
<td>All specimens</td>
<td>All specimens</td>
<td>All specimens</td>
</tr>
<tr>
<td>Formation from EPB</td>
<td>+</td>
<td>+</td>
<td>All specimens</td>
<td>May contribute</td>
<td>May contribute</td>
<td>May contribute</td>
<td>All specimens when present</td>
</tr>
<tr>
<td>Contribution from APB</td>
<td>+</td>
<td>+</td>
<td>68.21%</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>100%</td>
</tr>
<tr>
<td>Contribution from FPB</td>
<td>+</td>
<td>+</td>
<td>3.6%</td>
<td>Nil</td>
<td>Nil</td>
<td>Nil</td>
<td>41.2%</td>
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<tr>
<td>Contribution from AP</td>
<td>+</td>
<td>+</td>
<td>98.1%</td>
<td>+</td>
<td>+</td>
<td>Nil</td>
<td>100%</td>
</tr>
<tr>
<td>Contribution from first PI</td>
<td>Nil</td>
<td>+</td>
<td>62.7%</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>50%</td>
</tr>
</tbody>
</table>

Abbreviations: AP, adductor pollicis; APB, abductor pollicis brevis; EPB, extensor pollicis brevis; EPL, extensor pollicis longus; FPB, flexor pollicis brevis; PI, palmar interosseous.

### Table 2  Comparison of attachments of EPL with previous studies (values expressed as percentage)

<table>
<thead>
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<tbody>
<tr>
<td>PP</td>
<td>Nil</td>
<td>Nil</td>
<td>Nil</td>
<td>14.3</td>
<td>Nil</td>
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<tr>
<td>DP</td>
<td>98.2</td>
<td>5.3</td>
<td>98</td>
<td>85.7</td>
<td>45</td>
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<tr>
<td>Both PP and DP</td>
<td>1.8</td>
<td>94.7</td>
<td>2</td>
<td>Nil</td>
<td>55</td>
</tr>
</tbody>
</table>

Abbreviations: DP, distal phalanx; EPL, extensor pollicis longus; PP, proximal phalanx.
Table 3 Comparison of attachments of EPB with previous studies (values expressed as percentage)

<table>
<thead>
<tr>
<th>Study</th>
<th>PP</th>
<th>DP</th>
<th>Both PP and DP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Joshi et al(^a) (2008)</td>
<td>58.15</td>
<td>27.5</td>
<td>14.6</td>
</tr>
<tr>
<td>Roy et al(^b) (2012)</td>
<td>79</td>
<td>14</td>
<td>5</td>
</tr>
<tr>
<td>Sabnis(^c) (2013)</td>
<td>72</td>
<td>6.8</td>
<td>21.2</td>
</tr>
<tr>
<td>Ravi et al(^d) (2019)</td>
<td>58.7</td>
<td>36.25</td>
<td>0</td>
</tr>
<tr>
<td>Present study</td>
<td>46.2</td>
<td>25</td>
<td>23.75</td>
</tr>
</tbody>
</table>

Abbreviations: DP, distal phalanx; EPB, extensor pollicis brevis; PP, proximal phalanx.

EPB tendon was inserted into the base of PP in only 46.2% of the hands studied. This was closer to that reported by most of the authors,\(^{3,10–12}\) but far less than that observed by Sabnis\(^c\) and Roy et al.\(^{13}\) EPB was attached to the DP alone in 25% of the hands in our study similar to the findings of Joshi et al\(^a\) and Ravi et al.\(^{12}\) but higher than those obtained by Sabnis\(^c\) and Roy.\(^{13}\) Attachment of EPB to both the phalanges was observed in 23.75%, similar to Joshi et al\(^a\) and Sabnis\(^c\) (►Table 3).

Some studies have described the attachment of EPB into the EET in 40 to 44% of their cases.\(^{10,11,13}\) A literature review describes occasional variant insertion of EPB into first metacarpal, a feature of anthropoid apes.\(^{5,12}\) But in our study, EPB was attached to the EET in all cases, and none of them were attached to the first metacarpal. Agensis of EPB of up to 5% has also been reported earlier,\(^{7,11–13}\) and we noticed its absence in 5% of the hands dissected.

Extension of the thumb occurs in a balanced manner as a complex interplay between the long extensors of the thumb. Since EPL enters the thumb from the medial side in an oblique manner, extension is always accompanied by lateral rotation, and in later stages, with adduction.\(^7\) The EPB enters the thumb along the lateral margin, resulting in extension accompanied by abduction.\(^5\)

Rupture of EPL alone, as can be caused in Colles’ fracture, leads to significant loss of extension at the MCP joint. In such cases, extension at the IP joints is preserved due to the action of intrinsic muscles attached to the EET. Rupture of EPB and EET, along with displacement of EPL, causes flexion deformity at the MCP joint and hyperextension at the IP joint.\(^{14}\)

Limitations

Histological and morphometric studies would have thrown more light on the structure and dimensions of the EET.

Conclusion

EET is formed by the tendons of EPL and EPB along its axis, which are joined by the expansion from APB and AP on the lateral and medial sides, respectively. Contribution from the first PI and the FPB are variable. The first PI was observed in only 50% of the hands. But when present, it always contributed to its medial margin. Expansion from FPB joining the lateral margin is less than 50%. EET attaches by its apex onto the base of DP. Attachments of EPL and EPB onto phalanges are variable. EPL getting inserted into both phalanges was more common, than to DP alone. Insertion of EPB to PP alone was less than 50%, and their attachments to DP alone or to both phalanges are not uncommon.

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None.

Conflict of Interest

No conflict of interest relevant to this article was reported.

References

5. Spinner M. Kaplan’s Functional and Surgical Anatomy of Hand in Thumb, 3rd ed. PA, USA: J.B. Lippincott Company