Morphometric properties of the tensor fascia lata muscle in human fetuses

Authors: Orhan Beger, Turan Koç, Burhan Beger, Deniz Uzmansel, Zeliha Kurtoğlu

DOI: 10.5603/FM.a2018.0007

Article type: ORIGINAL ARTICLES

Submitted: 2017-12-27

Accepted: 2018-01-04

Published online: 2018-01-11

This article has been peer reviewed and published immediately upon acceptance. It is an open access article, which means that it can be downloaded, printed, and distributed freely, provided the work is properly cited. Articles in "Folia Morphologica" are listed in PubMed.
Morphometric properties of the tensor fascia lata muscle in human fetuses
Running title: Properties of the tensor fascia lata

Orhan Beger¹, Turan Koç¹, Burhan Beger², Deniz Uzman Sel¹, Zeliha Kuroğlu¹
¹Mersin University Faculty of Medicine, Department of Anatomy, Mersin, Turkey
²Van Yüzüncü Yıl University Faculty of Medicine, Department of Pediatric Surgery, Van, Turkey

Address for correspondence: Orhan Beger, Mersin University Faculty of Medicine, Department of Anatomy, Ciftlikkoy Campus, 33343, Mersin, Turkey, tel: +90 3243610683/1092, fax: +90 324 3412400, e-mail: obeger@gmail.com

Abstract
In neonatal and early childhood surgeries such as meningomyelocele repairs, closing deep wounds and oncological treatment, tensor fasciae lata (TFL) flaps are used. However, there are not enough data about structural properties of TFL in fetuses, which can be considered as the closest to neonates in terms of sampling. This study’s main objective is to gather data about morphological structures of TFL in human fetuses to be used in newborn surgery. Fifty formalin-fixed fetuses (24 Male – 26 Female) with gestational age ranging from 18 – 30 weeks (mean 22.94±3.23 weeks) were included in the study. TFL samples were obtained by bilateral dissection and then surface area, width and length parameters were recorded. Digital calipers were used for length and width measurements whereas surface area was calculated using digital image analysis software. No statistically significant differences were found in terms of numerical value of parameters between sides and sexes (p>0.05). Linear functions for TFL surface area, width, anterior and posterior margin lengths were calculated as y = -225.652 + 14.417 x Age (weeks), y = -5.571 + 0.595 x Age (weeks), y = -4.276 + 0.909 x Age (weeks) and y = -4.468 + 0.779 x Age (weeks), respectively. Linear functions for TFL surface area, width and lengths can be used in designing TFL flap dimensions in newborn surgery. In addition, using those described linear functions can also be beneficial in prediction of TFL flap dimensions both in autopsy studies.

Key words: tensor fascia lata; linear functions; surface area; fetus
INTRODUCTION

Tensor fascia lata (TFL), a muscle in gluteal region, originates from the outer lip of the iliac crest, the anterolateral iliac fossa just below the iliac crest, the deep surface of the fascia lata, the iliac tubercle, the lateral aspect of the anterior superior iliac spine and a notch below the anterior superior iliac spine. TFL attaches to two layers of the iliotibial tract of the fascia lata and ends usually around the greater trochanter. It assists the medial rotation and abduction of thigh in addition to lateral rotation of leg by iliotibial tract [11, 12, 15, 27].

Flaps of TFL, which is short and straight, are not only widely used in a large number of applications in adults [6, 15, 19-21, 26], but also in early childhood surgeries as well [1, 20, 22]. Some of the applications where musculocutaneous or free-form flaps of TFL are used can be summarized as burn treatments [1], chest and abdominal wall reconstruction [6, 21], correcting defects in head-neck region [3, 5, 9], treatment of oncology patients [7, 10, 24], meningomyelocele repair [22, 23], and correction of functional disorders of upper or lower extremities [16, 28].

In the literature, data about TFL structural properties in fetuses, which can be considered as the closest in resemblance to neonates, is quite limited. Our study’s main objective is to define morphometric properties of TFL in fetal period and its growth dynamics to be used in neonatal surgery.

MATERIALS AND METHODS

Fifty fetuses (24 Male – 26 Female) with gestational age range from 18 – 30 weeks (mean 22.94±3.23 weeks) present in Mersin University Faculty of Medicine Anatomy Department were included in the study and bilateral dissection was performed in each sample. Between 2000 and 2005, fetuses were donated to our department. There were limited documentary of the cause of death of fetuses. Therefore, fetuses with structural defects were excluded from this study. They were preserved in 10 % formalin solution for more than 12 years. The study was approved by the Ethics Board of Medicine Faculty (2017/313). After positioning the fetuses in lateral decubitis, skin and fascias
were lifted. TFL was exposed by microscope-aided (Carl Zeiss f-170) dissection. The following parameters were recorded (Fig. 1):

- TFL surface area,
- TFL lengths of the anterior and posterior margin (the distance between its origin and insertion)
- TFL width (at its widest level)
- TFL proximal attachment sites and attachment levels to iliotibial tract in distal plane.

As the reduction of plasticity was reported as approximately 0.5–1% in the previous studies [8, 14], tissue shrinkage caused by formalin fixation was disregarded. All samples were photographed from the same distance in the same position with millimetric scales (LG) and surface area was calculated using digital image analysis software (Digimizer Software). The length and width parameters were measured using digital calipers with 0.01 mm precision. All the parametric measurements were performed by the same researcher (O.B.) under same conditions in three different dates and the mean value of measurements were calculated. One-way ANOVA test, post-hoc RIR Tukey tests and intra-class correlation coefficients (ICC) were used to assess intra-observer reproducibility. Gestational age was determined by measuring foot lengths according to Malas et al. [18]’s study. Normality controls were performed with the Shapiro-Wilk test. Gestational age (months) was used in comparison of sides and sexes. Paired sample t-test was used for comparing sides and independent sample-t test was used to compare sexes. Homogeneity of variances was tested using Levene test. One-way ANOVA and Bonferroni tests were used to compare the changes with gestational age (months) in surface area and morphometric data on length and width. Simple linear regression analysis was used to calculate the regression equations which showed the relationship of changes in morphometric data with respect to gestational age (weeks). Statistical significance level was set as p<0.05.

RESULTS

Table 1 summarizes the demographic values of fetuses included in the study. All sides had TFL (Fig. 1). No statistically significant difference was found in the assessment of intra-observer reproducibility of numerical values of TFL (p>0.05). In
addition, ICC score for TFL parameters was calculated as ICC = 0.996-0.999 (p<0.001) which shows an excellent intra-observer reproducibility. As TFL surface area, width and length did not show a statistically significant difference between the sides and sexes (p>0.05), numerical values were summarized in Table 2, according to gestational months. Figure 2 and 3 show the regression graphs and equations which show the parameter changes with gestational weeks. Linear functions for TFL surface area, width, anterior and posterior margin lengths were calculated as 

\[ y = -225.652 + 14.417 \times \text{Age (weeks)} \]

\[ y = -5.571 + 0.595 \times \text{Age (weeks)} \]

\[ y = -4.276 + 0.909 \times \text{Age (weeks)} \]

\[ y = -4.468 + 0.779 \times \text{Age (weeks)} \]

respectively. Anterior margin of TFL was found to be longer than posterior margin (p<0.001). TFL attached to the lateral aspect of the anterior superior iliac spine and a notch below it by tendinous fibers and the deep surface of fascia lata in proximal plane. In distal plane, TFL joined iliotibial tract under greater trochanter on the upper 1/3 area of thigh.

**DISCUSSION**

In this study, we obtained precious data regarding the morphometric properties of TFL in fetuses to be used in neonatal surgery, which is quite limited in the literature. We revealed the algebraic change of TFL in fetuses between 18th and 30th weeks of gestational age.

TFL flaps are used in closing deep wounds, meningomyelocele repairs and treatment of oncology patients during the early term of life [7, 20, 22-24]. Akyürek and Şafak [1] treated a 12-month old male with a burn on his right arm using TFL flap. Ohno et al. [20] used TFL flap in treatment of rhabdomyosarcoma in pelvic region in a 10-month-old male patient and reported no complications or function loss. Phillips and Lindseth [22] retrospectively reviewed 47 meningomyelocele patients with a mean age of 4.6 years and reported that 41 were treated using the external oblique, the adductors and TFL (triple transfer) method. However, the authors also reported that the remaining six patients were treated with a double transfer of the external obliques and the adductors due to insufficient TFL tissue [22]. Since it’s known that burns, congenital malignant tumors or meningomyelocele can be seen during neonatal period and TFL flaps can be used in the treatment of those conditions [10, 22, 23], the importance of defining algebraic anatomy and variations of TFL becomes clear for neonatal surgery. In our study, TFL was present in all sides without any exceptions. As the numerical data of
TFL showed no statistically significant difference between sides, TFL flaps on both sides can be used in treatment of conditions where TFL free tissue flaps are used. As expressed in Beger et al. [4]’s study on latissimus dorsi muscle, TFL regression equations can be used in designing TFL flap dimensions, especially in treatment of conditions such as meningomyelocele.

Although literature reported a number of differences in many muscle growth dynamics between fetuses [2, 4, 13, 14, 17, 25], no quantitative studies on TFL were found. In accordance with the previous study results on morphometric properties of different muscle groups [2, 4, 13, 14, 17], this study revealed a rational increase in numerical values of TFL surface area, width and lengths from 18th to 30th week and showed no statistically significant difference between sides and sexes.

Proximal and distal attachment points of TFL show variety [11, 12, 15, 27]. In our study, we showed that TFL originates from the deep surface of the fascia lata and lateral aspect of the anterior superior iliac spine and a notch below it in proximal plane by tendinous fibers. In distal plane, TFL joined iliotibial tract under greater trochanter on the upper 1/3 area of thigh. Our data related to attachment points of TFL showed greatly coherent with previous studies [11, 12, 15, 27].

CONCLUSIONS

The algebraic values of TFL surface area, width and lengths showed a rational increase from 18th to 30th week and no statistically significant difference between sides and sexes. Linear function of surface area, which was calculated as “y = -225.652 + 14.417 x Age (weeks)”, can be used in designing TFL flap dimensions in neonatal surgeries. Using linear functions to approximate TFL flap dimensions can be beneficial in autopsy studies.

REFERENCES


Table 1: Data related to age, number and sex of fetuses.

<table>
<thead>
<tr>
<th>Gestational Age</th>
<th>Foot Length (mm)</th>
<th>Number of Side</th>
<th>Number of Sexes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Months Weeks</td>
<td></td>
<td>Number of Side</td>
<td>Male</td>
</tr>
<tr>
<td>18 V</td>
<td>25.55±0.28</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>19 V</td>
<td>27.98±0.27</td>
<td>8</td>
<td>2</td>
</tr>
<tr>
<td>20 V</td>
<td>30.72±0.26</td>
<td>14</td>
<td>1</td>
</tr>
<tr>
<td>21 V</td>
<td>32.80±0.20</td>
<td>10</td>
<td>2</td>
</tr>
<tr>
<td>22 V</td>
<td>34.50±0.30</td>
<td>12</td>
<td>5</td>
</tr>
<tr>
<td>23 V</td>
<td>38.65±0.33</td>
<td>12</td>
<td>2</td>
</tr>
<tr>
<td>24 VI</td>
<td>40.71±0.36</td>
<td>8</td>
<td>3</td>
</tr>
<tr>
<td>25 VI</td>
<td>41.89±0.49</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>26 VI</td>
<td>45.56±0.36</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>27 VI</td>
<td>48.42±0.44</td>
<td>8</td>
<td>2</td>
</tr>
<tr>
<td>28 VII</td>
<td>52.01±0.28</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>29 VII</td>
<td>53.30±0.11</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>30 VII</td>
<td>54.57±0.59</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>100</td>
<td>24</td>
</tr>
</tbody>
</table>
Table 2: Morphometric data related to TFL considering the gestational months.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>V Month (N=28)</th>
<th>VI Month (N=42)</th>
<th>VII Month (N=24)</th>
<th>VIII Month (N=6)</th>
<th>Total (N=100)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface Area (mm²)</td>
<td>58.45±19.35</td>
<td>94.14±22.46</td>
<td>150.92±33.19</td>
<td>215.75±17.71</td>
<td>105.07±50.01</td>
<td>&lt;0.00</td>
</tr>
<tr>
<td>Length of Anterior Margin (mm)</td>
<td>13.09±2.67</td>
<td>16.24±2.15</td>
<td>19.45±2.94</td>
<td>19.58±1.37</td>
<td>16.57±3.69</td>
<td>&lt;0.00</td>
</tr>
<tr>
<td>Length of Posterior Margin (mm)</td>
<td>10.70±2.81</td>
<td>12.89±2.38</td>
<td>16.37±2.67</td>
<td>17.58±1.58</td>
<td>13.39±3.41</td>
<td>&lt;0.00</td>
</tr>
<tr>
<td>Width (the widest level) (mm)</td>
<td>5.95±1.28</td>
<td>7.85±1.68</td>
<td>9.91±0.96</td>
<td>12.06±0.71</td>
<td>8.06±2.22</td>
<td>1</td>
</tr>
</tbody>
</table>

FIGURE LEGENDS

Figure 1. TFL and measured parameters A TFL with millimetric scale, B TFL Surface area, C TFL parameters a) anterior margin, b) posterior margin, c) Width (at widest level). ASIS: Anterior superior iliac spine, GM: Gluteus medius muscle.

Figure 2. Linear regression lines. A TFL surface area, B The width of TFL

Figure 3. Linear regression lines. A Length of anterior margin, B Length of posterior margin.
\[ y = -225.662 + 14.417 \times \text{Age} \ (p < 0.001) \]

\[ y = -5.571 + 0.596 \times \text{Age} \ (p < 0.001) \]
y = -4.276 + 0.909 \times \text{Age} \ (p < 0.001)

y = -4.468 + 0.779 \times \text{Age} \ (p < 0.001)