anatomy
An International Journal of Experimental and Clinical Anatomy
www.anatomy.org.tr

Original Article

www.anatomy.org.tr
Received: July 4, 2019; Accepted: July, 24, 2019
doi:10.2399/ana.19.064

Dimensional assessment of the tensor fasciae latae muscle in fetal cadavers with meningomyelocele for flap surgery

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Abstract

Objectives: The tensor fasciae latae (TFL) muscle may be preferred for the closure of superficial dorsal layers in patients with meningomyelocele (MMC). This study aimed to display the algebraic anatomy of TFL in fetal cadavers with MMC compared to that in normal fetuses.

Methods: Seven formalin-fixed fetuses with MMC (4 males and 3 females) aged from 18 to 27 weeks of gestation were dissected. A digital caliper (for the length and width of TFL) and digital image analysis software (for the surface area of TFL) were used to perform morphometric measurements. The numerical values of this study were compared with the calculated data obtained from the regression formula of a previously published article, considering fetal cadavers at the same gestational week.

Results: No statistically significant difference was observed between the quantitative values related to TFL sizes in terms of side and gender (p>0.05). Considering the calculated data obtained from the regression formulas, TFL dimensions in fetal cadavers with MMC did not statistically differ from normal fetuses without any malformations (p>0.05). TFL sizes including length, area, and width in some fetuses with MMC were smaller (3 fetal cadavers) or larger (1 fetal cadaver) than those of normal fetuses described previously.

Conclusion: TFL sizes including length, width and surface area in fetal cadavers with MMC were found similar to normal fetuses, statistically. Taking into account the individual differences related to TFL dimensions, whether MMC influences lower extremity muscle morphology should be examined in future studies. This anatomical knowledge related to TFL in fetuses with MMC should be taken into account when designing flap size.

Keywords: fetus; flap; meningomyelocele; regression; tensor fasciae latae

Anatomy 2019;13(2):102–106

Introduction

Meningomyelocele (MMC) causes important problems (e.g. sexual disability, urinary or fecal incontinence, hindbrain herniation, and hydrocephalus) associated with the central nervous system. It is generally repaired immediately after birth within 24 to 48 hours in order to eliminate the effects of environmental factors such as infection, desiccation and heat.[1–6] However, based on the "two-hit hypothesis (the first-hit: the interruption of the neurulation in early pregnancy, and the second-hit: the destructive effect caused by intrauterine environment in the remaining period)", some surgeons recommend intrauterine MMC repair before 26 weeks of gestation to remedy "second-hit"-induced damage.[1-3,7–13] In addition, MMC repairs *in utero* decrease ventriculoperitoneal shunt dependence, prevent the progression of spinal cord damage, and improve neurological functions.[1–3,8,11] In this context, prenatal MMC repair has appealed more and more surgeons.[1–3,7–13]

Following the repair of the neural parts of the spinal cord, superficial dorsal layer renovations are performed with myocutaneous and muscular flaps such as latissimus dorsi and gluteus maximus.[5,7–10,14] Morphometric features of these muscles used in MMC repair have recently become an area of interest for anatomists to determine if there is a dimensional change in fetuses with MMC.[15] On the other hand, the tensor fasciae latae (TFL) flaps can be preferred in the treatment of MMC.[16,17] In this regard, due to the fact that there is no previous study on the algebraic anatomy of TFL including its length, width and surface area in fetuses with this pathology, the main aim of this study was to determine of the morphometric features of TFL in fetuses with MMC compared to normal fetuses.

Materials and Methods

After approval of the Clinical Research Ethics Committee of Mersin University School of Medicine, seven formalin-fixed fetuses with MMC (4 males and 3 females) with 18 to 27 weeks of gestational age were dissected. Skin and fascia were removed to display TFL in the lateral decubitus position were dissected under a surgical microscope (Carl Zeiss f170, Carl Zeiss Meditec AG, Jena, Germany). Taking into account the former study by Beger et al.,[18] the following parameters of TFL were measured: surface area, anterior and posterior border lengths, and width.

Fetal cadavers with MMC in the current study were previously used to display the morphometric features of the latissimus dorsi, thoracodorsal artery and nerve compared to normal fetuses.[15] The shrinkage percentage in the tissues on account of fixative solution was determined as less than 1% by Cutts;[19] therefore, the effect of 10% formalin on numerical data was underestimated. Using a digital caliper (0.01 mm precision, Mahr, 16 ER, Göttingen, Germany), the measurements including TFL length and width were performed. A digital camera (Nikon d3300, Nikon, Tokyo, Japan) was used to photograph TFL with a millimeter scale in the same position under the same environmental conditions (**Figure 1**). Utilizing a digital image analysis software (ImageJ, NIH, Bethesda, MD, USA, https://imagej.nih.gov/ij/, 1997–2018), the surface area of TFL was calculated by photograph analysis.[15,18,20] The averages of three repeated measurements were given in the tables. ANOVA with repeated measurements and post hoc RIR Tukey tests were used to assess intra-observer reproducibility of dataset. Length of the right foot of fetuses was measured to determine the gestational weeks of specimens. Student's t-test was used to compare the sides (paired samples t-test) and gender (independent samples t-test). The calculated data obtained from the regression formulas of Beger et al.'s[18] study considering fetuses at the same gestational week were compared to the measurements of this study including the length, width and surface area of TFL. Statistical significance level was set as $p<0.05$.

Results

The demographic data of age, foot length, and gender, numerical values of this study, and the calculated data

Table 1

Demographic (age, number, foot length and gender) and morphometric (length, width and surface area of TFL) data related to fetuses.

Fetuses	Fetus 1	Fetus 2	Fetus 3	Fetus 4	Fetus 5	Fetus 6	Fetus 7
Age	18	19	20	22	23	26	27
Foot length	25.43	28.66	29.57	34.61	39.02	46.47	48.11
Gender	Male	Female	Female	Male	Male	Male	Female
Surface area (mm^2) (R/L)	**20.10**[a]/44.30	53.15/57.50	72.88/**87.01**[b]	80.49/115.77	114.01/90.31	**95.48**[a]/**84.99**[a]	154.34/157.90
Calculated values (mm^2)*	33.85	48.27	62.69	91.52	105.94	149.19	163.61
Average values (mm^2)†	58.45±19.35	58.45±19.35	58.45±19.35	94.14±22.46	94.14±22.46	150.92±33.19	150.92±33.19
Length of anterior margin (mm) (R/L)	11.06/14.08	11.40/13.89	15.03/16.21	14.16/15.78	17.32/17.07	16.58/16.45	18.56/19.51
Calculated values (mm)*	12.09	13.01	13.90	15.72	16.63	19.36	20.27
Average values (mm)†	13.09±2.67	13.09±2.67	13.09±2.67	16.24±2.15	16.24±2.15	19.45±2.94	19.45±2.94
Length of posterior margin (mm) (R/L)	10.04/9.78	10.37/11.32	11.72/**16.14**[b]	**10.33**[a]/12.05	13.40/12.88	**9.82**[a]/**10.73**[a]	13.72/13.75
Calculated values (mm)*	9.55	10.33	11.11	12.67	13.45	15.79	16.57
Average values (mm)†	10.70±2.81	10.70±2.81	10.70±2.81	12.89±2.38	12.89±2.38	16.37±2.67	16.37±2.67
Width (mm) (R/L)	**2.79**[a]/**4.48**[a]	5.30/6.17	6.21/7.15	6.39/7.38	8.01/7.70	**7.52**[a]/**7.48**[a]	10.84/9.79
Calculated values (mm)*	5.14	5.73	6.33	7.52	8.11	9.90	10.49
Average values (mm)†	5.95±1.28	5.95±1.28	5.95±1.28	7.85±1.68	7.85±1.68	9.91±0.96	9.91±0.96

L: left; **R:** right. *The calculated data obtained from the regression formulas of Beger et al.'s[18] study considering fetuses at the same gestational week. †Average values of Beger et al.'s[18] study considering fetuses at the same gestational month. [a]Values smaller thanthe range of Beger et al.'s[18] fetuses for the same month. [b]Values greater than the range of Beger et al.'s[18] fetuses for the same month.

obtained from the regression formulas of Beger et al.'s[18] study are shown in **Tables 1** and **2**.

No statistically significant difference was found between the measurements repeated for three times (p>0.05), indicating that the reliability of intra-observer repeatability was successful. No statistically significant difference was observed between the quantitative values in terms of side and gender (p>0.05). Considering the calculated data obtained from the regression formulas of Beger et al.'s[18] study, TFL dimensions in fetal cadavers with MMC did not statistically different from normal fetuses (**Table 2**) (p>0.05). TFL surface area in a 26-week-old fetus was bilaterally smaller than that of value range reported by Beger et al.[18] The area on the right side of an 18-week-old fetus was smaller than the value range, while the area on the left side of a 20-week-old fetus was larger than the value range (**Table 1**).

The posterior border length of TFL in a 26-week-old fetus was bilaterally smaller than that of value range reported by Beger et al.[18] The length on the right side of a 22-week-old fetus was smaller than the value range, while the length on the left side of a 20-week-old fetus was greater than the value range (**Table 1**). TFL widths in 18-week-old and 26-week-old fetuses were bilaterally smaller than that of value range reported by Beger et al.[18] (**Table 1**).

Table 2

Comparison of the average values of the cases with the calculated data obtained from Beger et al.'s[18] study.

Parameters	Current study	Calculated values*	p	Change %
Surface area (mm^2)	87.73±38.89	93.58±49.64	0.556	-%6.25
Length of anterior margin (mm)	15.48±2.39	15.85±3.12	0.540	-%2.33
Length of posterior margin (mm)	11.86±11.89	12.78±2.68	0.399	-%7.20
Width (mm)	6.94±2.02	7.60±2.04	0.123	-%8.68

*The calculated data obtained from the regression formulas of Beger et al.'s[18] study considering fetuses at the same gestational week.

Discussion

The most and heaviest form of the spina bifida is MMC, which might cause ventriculoperitoneal shunt dependence, hindbrain herniation, high mortality rate, hydrocephalus, neurological disability, sexual dysfunction, and Arnold-Chiari II malformation.[1–4] MMC repairs *in utero* may prevent these negative conditions, although it carries risks such as fetal death or premature birth.[1,2] Therefore, some surgeons recommend MMC repairs *in utero* due to the neurodevelopmental outcome of children following fetal MMC closure.[1–3,11] After the repair of the neural part, superficial dorsal layer closure can be performed with different muscular flaps such as the latissimus dorsi and gluteus maximus.[7–10,14,15] Posma[17] recommended the use of TFL flaps in the repairs of MMC. Phillips and Lindseth[16] studied 47 patients with MMC and stated that the external oblique, the adductors and

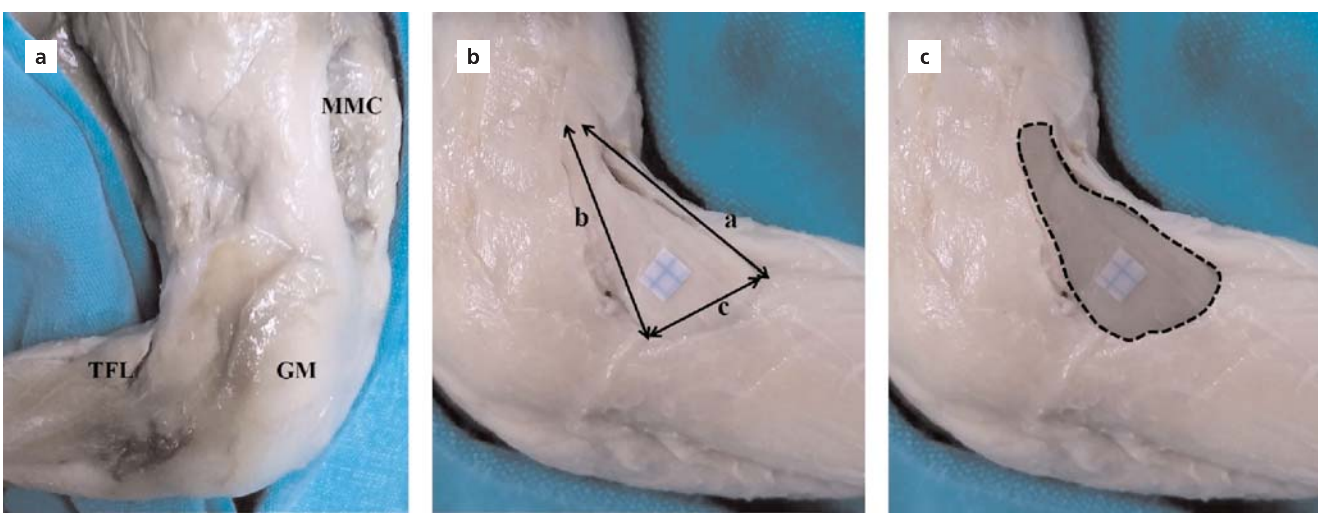

Figure 1. (**a**) The tensor fasciae latae (TFL) and gluteus maximus (GM) muscles, and meningomyelocele (MMC); (**b**) Anterior (a) and posterior (b) margin lengths and (c) width of the tensor fascia lata; (**c**) Surface area of the tensor fascia lata. [Color figure can be viewed in the online issue, which is available at www.anatomy.org.tr]

TFL (triple transfer) were used to close the superficial dorsal layer of 41 patients. They used the external oblique and the adductors (double transfer) in six patients, due to insufficient dimension of TFL.[16] Beger et al.[18] studied the algebraic anatomy of TFL in 50 normal fetal cadavers aged from 18 to 30 (mean 22.94±3.23) weeks of gestation and reported that its morphometric features were important for neurosurgeons and pediatric surgeons during the neonatal MMC treatment. However, no study conducted on the quantitative properties of TFL in fetuses with MMC was found in the literature.

The regression equations related to the dimensions (e.g. length, width and surface area) of different muscles such as the latissimus dorsi were calculated to estimate their size in normal fetuses.[18,20] In our previous studies conducted on seven fetal cadavers with MMC, the morphometric features of the latissimus dorsi, thoracodorsal artery and nerve were compared with the estimations of the regression equations.[15,20] We found that the surface area, length and width of the latissimus dorsi in fetuses with MMC were 3–10% smaller than normal fetal cadavers and concluded that this reduction should be taken into account when designing flap sizes.[15,20] From this anatomical perspective, we suggested that the anatomical variations in dimensions of the muscles used as flap in MMC repairs should be displayed.[15] In the current study, the algebraic anatomy of TFL in fetal cadavers with MMC were evaluated to estimate its size using the calculated values obtained from the regression formulas of Beger et al.'s[18] study considering fetuses at the same gestational week. Therefore, the dimensions of TFL including its length, width and surface area in fetal cadavers with MMC were found similar to normal fetuses statistically. Considering the study of Phillips and Lindseth,[16] small TFL observed in some patients with MMC may be due to individual differences. According to the previously reported data range, the reason why individual differences do not achieve statistical significance may be the small number of cases or the variable level of disruptions that may affect muscle morphology in the nerve tissues due to MMC. These should be further investigated in larger series.

Conclusion

The findings of this study showed that the dimension of TFL in fetuses with MMC were similar to normal fetuses, statistically. Considering the individual differences related to TFL dimensions, whether MMC influences lower extremity muscle morphology should be examined in future studies.

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Conflict of interest statement: No conflicts declared.