

Lateral Pterygoid Muscle Location in Relation to Preauricular Skin Measured from CT Scans among a Sample of Yemeni Adults

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ABSTRACT

Aim: The aim of this study was to determine the lateral pterygoid muscle (LPM) in relation to preauricular skin measured from computed tomography (CT) scan measurements.

Materials and methods: CT scans of 160 patients aged between 18 and 75 years were retrospectively collected and analyzed, and the distances were measured to determine the location of the LPM center in relation to the preauricular skin. On axial CT crossing the maximum muscle width, two lines [the first line is below the center of the zygomatic arch (first position), while the second line was 5 mm posterior to the first one (second position)] were drawn from the preauricular skin to the medial border and then extended to the lateral border of the muscle. These measurements were used to calculate the distance to the center of the muscle mathematically. Data were statistically analyzed, and the differences between both genders and both sides were investigated. The level of significance was set at p -value <0.05 .

Results: Males displayed larger mean values in two positions (36.6 ± 2.25 and 35.97 ± 4.19 , respectively) than females (33.66 ± 4.46 and 32.80 ± 3.21 , respectively). The difference between both genders was found to be statistically significant. Measurements on the right side were also larger than those on the left side, but with no significant difference.

Conclusion: LPM center can be approached safely in males by inserting the needle about 36 mm at the first position and 33 mm at the second position. However, in females, these distances are located 3 mm shorter in both positions.

Clinical significance: The outcome of this study will provide the clinicians with measurements that can help in directing the needle or electromyography (EMG) electrode during the extraoral injection technique of the LPM.

Keywords: CT scan, Dystonia, Lateral pterygoid muscle, Preauricular skin.

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INTRODUCTION

The lateral pterygoid muscle (LPM) has been generally described as a muscle composed of two separate heads: the superior (upper) head and the inferior (lower) head.¹⁻³ The superior head of the muscle is reported to have various patterns of insertion; in some reports, the superior head inserts into the articular disc,^{2,4} whereas in other reports, it inserts into the articular disc and the pterygoid fovea of the mandible.^{5,6} However, some authors⁷⁻¹⁰ reported that according to precise morphological studies, the LPM is not clearly divided into distinct parts. The LPM plays an important role in jaw movement and is thought to play an important part in the control and/or stabilization of the joint during mastication and speech.¹¹⁻¹³ This muscle has been implicated in disease conditions, such as myositis and oromandibular dystonia.^{14,15}

Recently, improved tissue-imaging methods have provided the means to better determine the size and location of the muscles. It can differentiate tissues based on their attenuation characteristics, which depend on their density and the electron per unit mass.¹⁶ Nowadays, multi-slice spiral CT (MSCT) enables the acquisition of three-dimensional (3D) volume images of the human body while improving the speed scanning considerably as compared to previous systems.¹⁷ Submillimeter scanning is feasible with the modern MSCT systems having broad detector panels that may cover the whole region of interest per rotation.¹⁸

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Injection of botulinum toxin into LPM has been reported in the management of LPM dystonia,^{14,15,19,20} recurrent TMJ dislocation,²¹⁻²³ myofascial pain,²⁴ and anterior disc displacement.²⁵ Dry needling of LPM trigger points has been tried in myofascial pain management.^{26,27} The location of the injection site in the muscle body could change the spread of the botulinum toxin, this fact being responsible for side effects such as a diffusion to nearby muscles. Diffusion into the pharyngeal muscles is responsible for dysphagia, and injection in soft palate muscles can lead to dysphonia.²⁸⁻³⁰ The

penetration depth to LPM has been reported only in a few studies that included a limited number of subjects. Mahan et al.³¹ studied LPM activity, in nine subjects, using electromyography (EMG). During EMG electrode placement, the penetration distance from skin to LPM was about 35 to 50 mm. Five cases of TMJ dislocation were managed by Fu et al.,²³ where they inject botulinum toxin into LPM. The needle was advanced at a right angle to the skin, and the LPM was found at a depth of 3 to 4 cm. Alexoudi et al.¹⁹ treated a woman, presented with LPM dystonia, by EMG-assisted injection of botulinum toxin into LPM. A needle electrode was inserted 3 to 4 cm until it was contacted with the muscle.

To the best of our knowledge, there is no study so far that evaluated the location of LPM in relation to preauricular skin among adults. The aim of the present study, therefore, was to evaluate the location of LPM center from computed tomography (CT) scans in relation to preauricular skin. The outcome of this study will provide the clinicians with measurements that can help in directing the needle or EMG electrode during the extraoral injection technique of the LPM.

MATERIALS AND METHODS

The study population comprised 160 subjects who had undergone CT scan imaging for craniofacial diagnosis in a private medical hospital in Dhamar city, Yemen, from October 2016 to October 2020. The study protocol was approved by the Ethical Research Committee at the Faculty of Dentistry, Thamar University (Ref#:2020005). Fractures of the mandible caused LPM to contract and displace the proximal bone fragment with a resultant change in LPM insertion position. Also, tumors and cysts affecting the infratemporal region might displace the LPM. So, patients with a history of fracture, tumors, or cysts, which might have affected the position and measurement of the LPM, were excluded from the study.

Imaging and Measurements

The CT scans were conducted using 32-slice spiral CT (Hitachi, Ltd., Supria, Japan) according to the following protocol: 120 kV, 64 to 200 mAs, 0.5-mm slice thickness, and 512 × 512 matrix. CT images were saved in digital imaging and communications in medicine (DICOM) format and were processed using the SimPlant software (SimPlant 3-D Pro; Materialize, Leuven, Belgium).

The axial image that crossed through the maximum width of the muscle was determined. We marked two perpendicular lines from the skin surface to the muscle as proposed by FU et al.²³ The first line was located below the central zygomatic arch (first position), reached the lateral border of the muscle (distance A), and then extended to its medial border (distance B). The second line marked 5 mm posterior to the first line (second position), also reached the lateral border of the muscle (distance C), and then extended to its medial border (distance D) (Fig. 1). The distance to the center of the muscle in both sites was determined by the following equations:

$$\text{Distance to the center of the muscle in the first position} = \frac{\text{distance B} - \text{distance A}}{2} + \text{distance A}$$

$$\text{Distance to the center of the muscle in the second position} = \frac{\text{distance D} - \text{distance C}}{2} + \text{distance C}$$

On coronal CT view, we determined the distance between the inferior border of the zygomatic arch and the point of entry

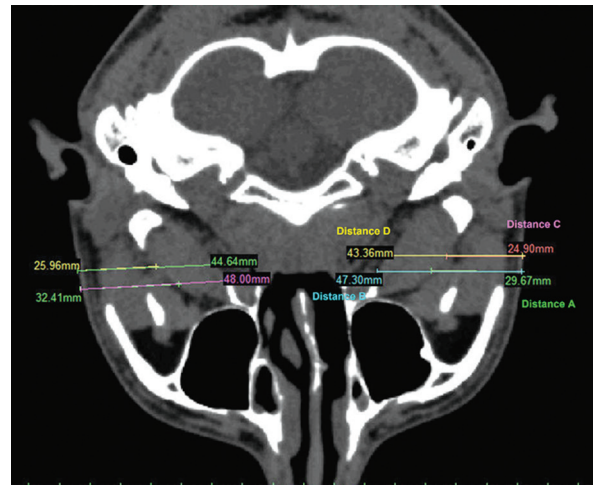


Fig. 1: Measurements at first and second positions from preauricular skin to medial and lateral borders of LPM

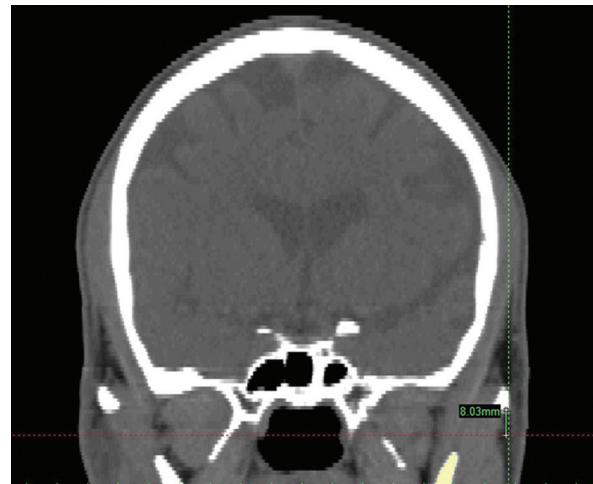


Fig. 2: Determination of the distance between the inferior border of the zygomatic arch and entry point on preauricular skin

on the preauricular skin (Fig. 2). The above measurements were done for the right and left sides. Measurements were done by two investigators independently who evaluated the CT images. The inter-rater reliability was tested by the intraclass correlation coefficient, and the level of agreement was perfect (ICC = 0.947; *p*-value <0.001).

Statistical Analysis

Data analysis was processed using SPSS v20.0 statistical software. Descriptive statistics, including mean, standard deviation, and minimum and maximum values, were calculated for the various measurements. Independent samples *t*-tests were used for the differences between male and female subjects and between right and left sides. The significance level was predetermined at 0.05 for all tests.

RESULTS

The study population comprised 160 subjects [90 (56.25%) males, 70 (43.75%) females]. The mean age was 45.3 ± 12.3 years for males, ranging from 18 to 75 years; and 46.4 ± 10.4 years for females,

Table 1: Mean distances and differences between right and left sides at the first and second positions (mm)

	Mean \pm SD	Min–Max	Mean difference	95% CI of difference		p
				Lower	Upper	
Measurements in the first position						
Right (N = 160)	35.32 \pm 3.70	27.12–41.7	0.73	-0.13	1.59	0.094
Left (N = 160)	34.58 \pm 4.10	26.31–40.9				
Measurements in the second position						
Right (N = 160)	32.09 \pm 2.80	24.81–37.17	0.30	-0.34	0.93	0.358
Left (N = 160)	31.80 \pm 2.98	24.75–37.14				

Table 2: Mean distances and differences between males and females at the first and second positions (mm)

	Mean \pm SD	Min–Max	Mean difference	95% CI of difference		p
				Lower	Upper	
Measurements in the first position						
Male (N = 90)	36.29 \pm 2.61	31.11–41.6	3.05	2.13	3.98	<0.001
Female (N = 70)	33.23 \pm 3.29	27.73–38.85				
Measurements in the second position						
Male (N = 90)	33.09 \pm 1.85	29.64–42.81	2.62	1.81	3.44	<0.001
Female (N = 70)	30.47 \pm 3.02	36.91–35.26				

ranging from 19 to 70 years. The vertical distance on coronal CT from below the inferior border of the mid zygomatic arch to the skin point of measurement ranged from 7.5 to 10 mm in males and from 7 to 10 mm in females.

The mean distance at the first position to the muscle center was 35.31 \pm 3.69 mm on the right side and 34.58 \pm 4.10 mm on the left side. At the second position, the mean distance was 32.09 \pm 2.80 mm on the right side and 31.79 \pm 2.98 mm on the left side. There were no statistically significant differences between right and left sides at the first and second positions (*p*-value = 0.094 and *p*-value = 0.358, respectively). More details are presented in Table 1.

As shown in Table 2, the mean distances in males at the first and second positions were 36.28 \pm 2.6 and 33.09 \pm 1.84 mm, respectively. While in females, these distances were 33.23 \pm 3.29 and 30.46 \pm 3.02 mm, respectively. There were highly statistically significant differences between males and females regarding the first (mean diff. = 3.05 mm; *p*-value <0.001) and second (mean diff. = 2.62 mm; *p*-value <0.001) positions.

DISCUSSION

CT is a valuable tool in the diagnosis of different conditions and is useful for defining the anatomical structures and recording their measurements. Many authors³²⁻³⁹ used CT for studying different anatomical structures in the maxillofacial region. LPM is an essential component in masticatory function and TMD genesis, and sometimes there is a need for targeting and injecting the muscle.⁴⁰ In the current study, the measuring point on the skin below the zygomatic arch, which coincides with the maximum width of the muscle, was 7 to 9 mm for females and 7.5 to 10 mm for males. Similarly, Fu et al.²³ proposed an insertion point of 10 mm below the zygomatic arch. In contrast, Orfanos et al.⁴¹ suggested needle insertion at 5 to 6 mm inferior to the lower border of the

zygomatic arch. However, the maximum muscle width was not mentioned as a target point in their study. Most of the previous studies,^{20,24,41-43} which reported on injection of LPM extraorally, lack the information about how deep the needle can be inserted and where the maximum width of the muscle could be found.

In our study, we measured the distances to the lateral and medial borders of the muscle and mathematically calculated the distance to the muscle center because the muscle borders can be easily identified and marked on CT. The distance from preauricular skin to the center of LPM (the first position) was slightly higher on the right side than on the left side. When the distance was measured at the second position, it was found to be lower on both sides. However, the differences between right and left sides at each position were statistically not significant.

The distances to the muscle center in the first and second positions were longer in males than in females. Comparison with the scarce available literature will be limited. Fu et al.²³ and Alexoudi et al.¹⁹ have reported similar findings. They found that the distance from skin to LPM was about 30 to 40 mm. Similarly, in a study on a human cadaver, the distance was measured and found to be 35 mm for the superior head of the LPM muscle.⁴⁴

In contrast to our findings, Mahan et al.³¹ recommended a more insertion depth ranged from 35 to 50 mm. This difference could be the result of using different insertion points on the skin and different angulation.

Although the study could clearly investigate the normal range for the LPM injection in the adult population, a number of limitations should be acknowledged. The sample size was taken from one area, so the results might be limited to the study population. This study did not evaluate the clinical effectiveness of the proposed injection approach. Future randomized controlled trials should include these guidelines for the management of disorders that need LPM injection or needling to further evaluate its clinical effectiveness.

CONCLUSION

This radiographic study suggests that injection of the LPM can be properly performed at 7 to 10 mm below the mid zygomatic arch, and the needle could be inserted, in males, approximately 36 and 33 mm in the recommended first and second positions, respectively, while in females, shorter insertion distances by about 3 mm should be used in both positions.

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