

Dimensional changes in lateral pterygoid muscles and disc position during mandibular movement using magnetic resonance imaging

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ABSTRACT | The lateral pterygoid muscle (LPM) has been the focus of numerous studies attempting to elucidate its possible role in temporomandibular disorders (TMDs). Disc displacement is widely accepted as a finding characteristic of this clinical condition. However, few studies have investigated the association between disc position and morphological alterations of the LPM. *Objectives:* to investigate the relationship between articular disc position and area measurements of the superior head (SH) and inferior head (IH) of the LPM using magnetic resonance (MR) imaging. *Methods:* The sample comprised 148 temporomandibular joints (TMJs) of 74 patients with complaints of pain and/or dysfunction in the TMJ area. Sagittal plane images were used for assessments of disc position and for tracings. Tracings of the areas of the heads were performed under 4 mandibular positions (at rest, and openings of 10 mm, 20 mm, and 30 mm) with the aid of image processing software. Data acquired was subjected to statistical analysis. *Results:* Statistical tests revealed changes in LPM head areas during mandibular opening movement, showing a reduction in total IH area and more heterogeneous changes in SH area. *Relevance:* The IH mean area was reduced in the positions assessed and showed no correlation with disc displacement. For the SH, reduced mean area was associated with anterior disc displacements without reduction, while increased mean areas were correlated with anterior disc displacement with reduction.

DESCRIPTORS | Magnetic Resonance Imaging; Temporomandibular Joint; Pterygoid Muscles.

RESUMO | **Avaliação por ressonância magnética da alteração dimensional do músculo pterigóideo e da posição do disco articular no movimento mandibular** • O músculo pterigóideo lateral (MPL) tem sido o foco de inúmeros estudos que tentam elucidar o seu possível papel na disfunção temporomandibular, condição na qual o deslocamento do disco é amplamente aceito como um possível aspecto clínico. No entanto, poucos estudos investigaram a associação entre a posição do disco e alterações morfológicas do MPL. *Objetivos:* investigar a relação entre a posição do disco articular e a área da porção superior e da porção inferior do músculo pterigóideo lateral usando ressonância magnética. *Métodos:* A amostra foi composta por 148 articulações temporomandibulares de 74 pacientes com queixa de dor e/ou disfunção articular. Imagens em plano sagital foram utilizadas para a avaliação da posição do disco e para traçados. Traçados das áreas do músculo foram realizados em 4 posições mandibulares (em repouso, e em aberturas de 10 mm, 20 mm e 30 mm) com a ajuda de software de processamento de imagem. Os dados adquiridos foram submetidos à análise estatística. *Resultados:* Os testes estatísticos revelaram mudanças nas áreas superior e inferior do músculo pterigóideo lateral durante o movimento de abertura mandibular, mostrando uma redução na área total e mudanças mais heterogêneas na área superior. *Relevância:* Observou-se que a área média da porção inferior muscular estava reduzida nas posições avaliadas e não mostrou correlação com deslocamento de disco. Para a porção superior, a redução da área média foi associada com o deslocamento anterior do disco sem redução, ao passo que o aumento da área média foi correlacionado com o deslocamento anterior do disco com redução.

DESCRITORES | Imagem por Ressonância Magnética; Articulação Temporomandibular; Músculos Pterigóides.

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INTRODUCTION

Studies on the anatomy and function of the masticatory muscles have had an important influence in dental clinical practice.¹ The lateral pterygoid muscle (LPM) is directly attached to the temporomandibular joint (TMJ), and is one of the key muscles in the physiology of mastication, participating in opening, closing, lateral and protrusive mandibular movements.²

The LPM consists of two parts, the superior head (SH) and inferior head (IH). Some fibers from the SH may insert into the anterior portion of the articular capsule and articular disc of the TMJ.³ Although temporomandibular disorders (TMDs) are multifactorial, it is widely accepted that disturbances in lateral pterygoid muscle activity play an important role in the etiology of these disorders.⁴ However, there is currently no rigorous scientific evidence correlating the two conditions.¹ Moreover, the role of LPM in normal functioning remains controversial.¹

Magnetic resonance (MR) imaging is considered the gold standard for evaluating alterations in the TMJ and masticatory muscles. The technique is able to provide morphological and positional information of the articular disc through high resolution images of soft tissue without exposing patients to radiation.²⁻⁵

Although the LPM has been extensively studied in recent years, its anatomy and physiological and clinical implications are not fully understood.⁴

The aim of this study was to determine the relationship between articular disc position and area measurements of the SH and IH of the LPM using MR imaging.

MATERIALS AND METHODS

This study evaluated MR images of 148 TMJs, drawn from the files of 74 patients (51 female and 23 male, 19 to 78 years old) submitted to scans after indication by their physician and/or dentist. The inclusion criterion was the presence of at least one

sign and/or symptom of TMD reported during clinical examination.

Scans were performed on a Sigma MR device (GE Medical Systems, Madison, WI, USA) at 1.5 tesla electromagnetic power using transverse relaxation time (T2) and proton density (PD)-weighted scan sequences with a 20 cm diameter dual surface coil (GE Medical Systems, Madison, WI, USA). Images were acquired on the sagittal plane using 3 mm-thick slices (7 slices per joint), a 0.3 mm reconstruction interval with 1500 ms relaxation time, and stored in Digital Imaging and Communication in Medicine (DICOM) format. The images obtained were assessed using a workstation running a high-resolution graphics processing program (Easy Vision, Philips Medical Systems, Best, The Netherlands).

The joints were assessed, bilaterally, in closed-mouth position and at openings of 10 mm, 20 mm and 30 mm. Mouth-opening positions were established with the aid of an intraoral plastic stabilizer (GE Medical Systems, Madison, WI, USA) bearing a scale in millimeters.

The sagittal PD slices chosen to trace SH and IH areas of the LPM and assess the disc positions were those offering the best visualization of the respective points of insertion and origin of the muscles and their relationship with the articular disc. These areas were measured independently by two examiners at different times, the first a physician and the second a dentist, both of whom were radiologists with at least ten years' experience. The areas of the LPM were traced as follows.

- SH: the boundaries between the fibers and the cortical bone of the infratemporal fossa and lateral perpendicular lamina of the sphenoid bone were outlined, descending tangentially to the fibrous borders of the upper part of the IH, following the fatty tissue or cord which separates the two heads up to the anterior segment of the articular disc;
- IH: the outermost boundaries of its fibers in re-

lation to the SH and to the fatty cord separating the two heads, projecting anteriorly up to the lateral and inferior bellies, were outlined, following the downward curve to the borders of its insertion into the pterygoid fovea of the condyle.

For enhanced visualization of the outline and borders of the effective head areas, color was introduced (Figure 1, A and B).

Disc status was classified as follows.

- Normal: the disc is located in the upper portion of the head of the mandible;
- Disc displacement with reduction (DDwR): the disc is displaced in the closed-mouth position and normal in the open-mouth position;
- Disc displacement without reduction (DDwoR): the disc is displaced in both open- and closed-mouth positions.

The study was approved by the Research Ethics committee, School of Dentistry, University of São Paulo, under protocol no. 80/04.

All data regarding the areas of SH and IH of the LPM and disc positions were treated with descriptive statistics and analysis of variance (ANOVA), adopting a 5% margin of error as the significance level.

Statistically significant results were submitted to the Tukey test. Statistical analyses were performed using the Statistical Package for Social Sciences (SPSS for Windows, version 11.0, Chicago, IL, USA).

RESULTS

Analysis of the data showed that, regarding gender distribution of the 148 TMJs of 74 patients, 51 (68.9%) were female and 23 (31.1%), male.

With regard to gender and age interaction, the data showed a predominance of both genders in the 30–39 year age group and of female gender in the 40–49 year age group.

Regarding disc status, 94 TMJs (63.5%) were normal, 34 (23%) presented DDwoR, 19 (12.8%) presented DDwR, and 1 (0.7%) presented posterior disc displacement.

Analysis of the relationship between mean head areas (SH and IH) and articular disc position revealed that the highest means for the SH were observed in DDwR joints. A progressive increase was observed in these mean areas from at rest to maximum opening (30 mm) positions. The lowest mean areas of the SH were observed in DDwoR joints (Figure 2, A and B, and Table 1). For IH, the highest mean areas were observed in DDwR joints at

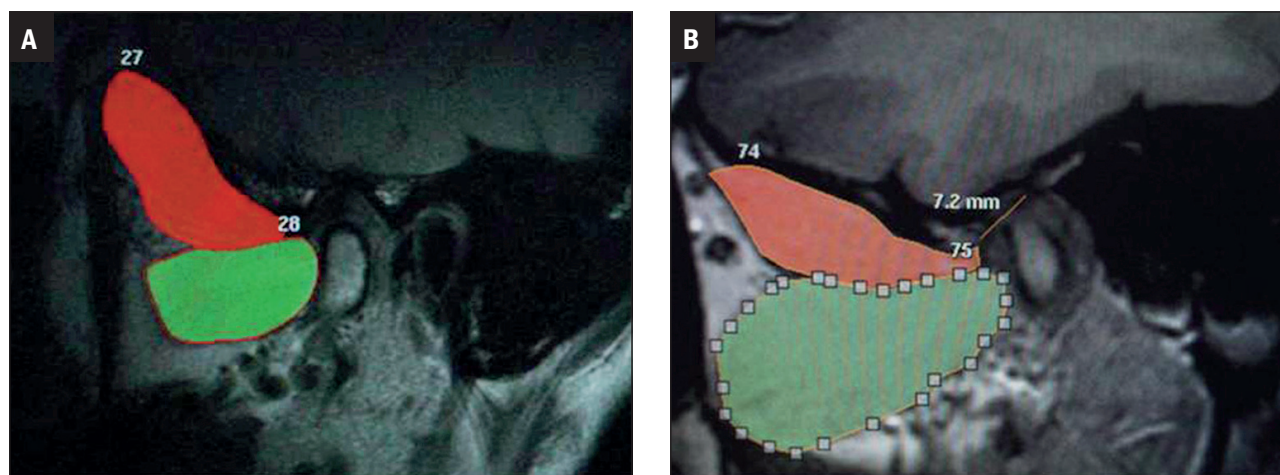


Figure 1 | Coloring of SH (orange) and IH (green) areas: delimitation and presentation of morphological characteristics of the pterygoid muscle and its relationship with articular disc and pterygoid fovea.

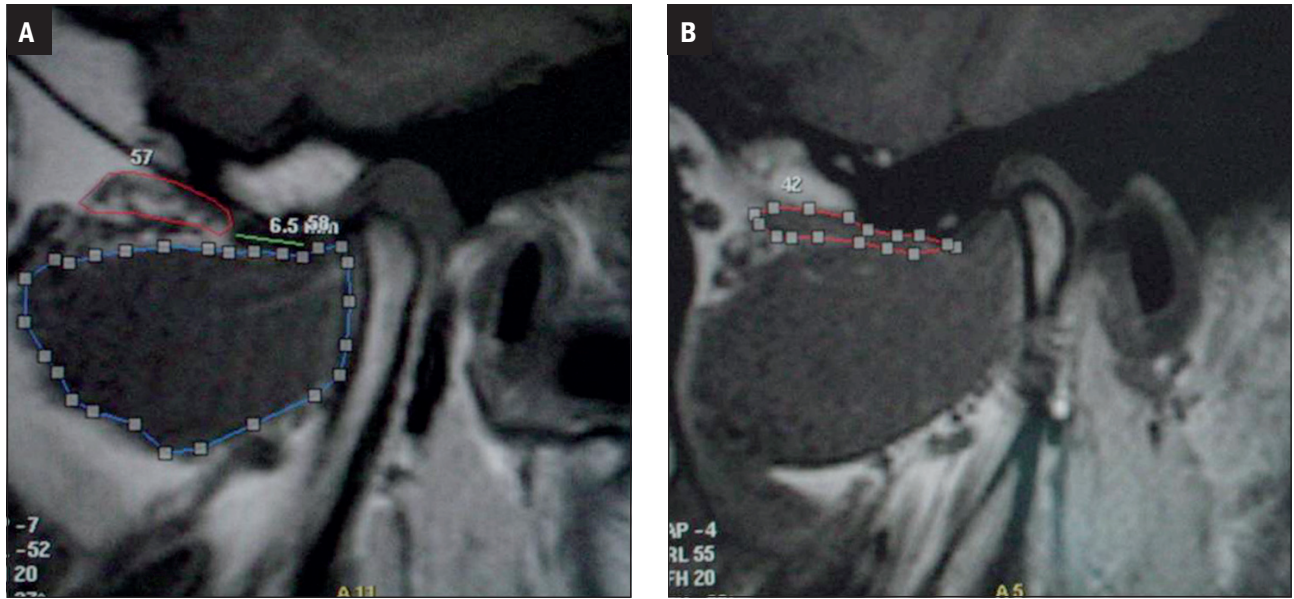


Figure 2 | LPM evidencing reduced SH area and changes in disc position.

Table 1 | Means and standard deviations for area (mm²) of the SH of the LPM.

| Group | Position | | | |
|----------------|--------------|--------------|--------------|--------------|
| | At rest | 10 mm | 20 mm | 30 mm |
| Normal | 154.7 (61.0) | 163.8 (63.1) | 159.3 (61.5) | 160.5 (64.1) |
| Anterior DDwR | 165.8 (66.7) | 168.0 (59.5) | 172.4 (62.4) | 188.5 (78.5) |
| Anterior DDwoR | 133.2 (38.1) | 130.3 (39.4) | 134.1 (46.5) | 135.4 (51.8) |

Table 2 | Means and standard deviations for area (mm²) of the IH of the LPM.

| Group | Position | | | |
|----------------|---------------|---------------|---------------|---------------|
| | At rest | 10 mm | 20 mm | 30 mm |
| Normal | 312.4 (109.5) | 308.5 (102.8) | 299.2 (96.2) | 297.3 (100.5) |
| Anterior DDwR | 364.7 (115.2) | 385.1 (111.7) | 334.4 (110.8) | 328.5 (108.2) |
| Anterior DDwoR | 335.5 (116.0) | 320.6 (123.9) | 313.6 (116.2) | 311.0 (112.7) |

rest and intermediate opening of 10 mm, while decreasing values were seen at openings of 20 mm and 30 mm. Decreasing mean areas were found among TMJs with normal disc and DDwoR positions, with the latter showing the highest mean values (Table 2).

DISCUSSION

There has been much speculation over the role of the LPM in TMD.⁴ It is believed that this disorder

may stem from LPM dysfunction or from poor co-ordination between the two heads.^{1,6} However, there is currently no compelling scientific evidence that LPMs of TMD patients are functionally disturbed.¹

The SH of the LPM has been the focus of numerous studies in a bid to explain the problems associated with the TMJ and anterior displacement of the disc.^{3,6} Although electromyographic studies have

demonstrated a relationship between the insertion pattern of the LPM directly into the articular disc and DDwR, the role of LPM in TMJ dynamics remains unclear.^{3,4,7} One reason for this incomplete understanding is that many studies on this muscle have been based on the dissection of human cadavers.^{8,9}

The pattern of insertion of fibers of the SH of the LPM into the condyle-disc complex is highly variable in the literature. While some studies have found a greater volume of SH fibers attached to medial aspects of the articular capsule and anterior aspects of the disc,^{10,11} others have observed SH fibers inserted directly into the pterygoid fovea or fused with IH fibers, and absence of muscle insertions directly into the discs.^{8,12} In the present study, most LPMs had fibers inserted into the articular disc and anterior portion of the articular capsule, with some fibers inserted into the pterygoid fovea of the neck of the mandible. Both heads were clearly observed in all MR image sequences analyzed, showing that this diagnostic method is effective for assessing LPM, corroborating previous reports.^{2,5}

There are few investigations involving dimensional studies of the masticatory muscles or assessing the relationship between dysfunction or

instability of LPM heads and disc displacement, hampering comparison and discussion of results.

This study evaluated the mean areas of LPM heads measured during mandibular movements and examined their relationship with disc position. A reduction in IH area was noted during mouth opening, predominantly from the 20 mm to the 30 mm openings, irrespective of disc position, corroborating findings of other authors.^{5,13} With regard to the SH, a variation in means was observed for the three types of disc position assessed (normal, DDwoR and DDwR), with the largest means being observed in DDwR joints. This increased area associated with DDwR may be indicative of muscle hyperactivity or some compensation overload. However, further morphological and quantitative studies are needed to clarify the relationship between these area changes and disc displacement, and to confirm whether this plays a role in TMD.

Based on our results, it can be concluded that the IH of the LPM exhibited reduced mean areas during the movement of mouth opening and showed no correlation with disc displacement status. Regarding the SH, reduced mean areas were associated with anterior disc displacement without reduction, while increased mean areas correlated with anterior disc displacement with reduction.

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