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mRNA Expression of Myosin Heavy Chain Isoforms in the Sphenomandibularis Portion of the Temporalis Muscle

Expresión de ARNm de las Isoformas de la Cadena Pesada de la Miosina en la Porción Esfenomandibular del Músculo Temporal

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SUMMARY: The main objective of this study was to analyze by real-time quantitative polymerase chain reaction (RT-qPCR) the expression patterns of the myosin heavy chain (MHC) isoforms (MHC-I, MHC-IIa, MHC-IIx) in the sphenomandibularis portion of the temporalis muscle. We expected to find differences between the sphenomandibularis and the other portions of the temporalis that could be related to the functional characteristics of the sphenomandibularis identified by electromyography. We dissected the right temporalis muscle of ten adult human individuals (five men and five women). Samples of the anterior and posterior temporalis and of the sphenomandibularis portion were obtained from each dissected muscle. These samples were analyzed by RT-qPCR to determine the percentages of expression of the MHC-I, MHC-IIa and MHC-IIx isoforms. No significant differences were identified between the anterior and the posterior temporalis in the expression patterns of the MHC-I, MHC-IIa and MHC-IIx isoforms. However, there were significant differences between the sphenomandibularis and the anterior temporalis. Specifically, the sphenomandibularis portion had a higher percentage of expression of the MHC-I isoform (P=0.04) and a lower percentage of expression of the MHC-IIx isoform (P=0.003). The pattern of expression that we observed in the sphenomandibularis reflects a greater resistance to fatigue, a lower contraction speed, and a lower capacity of force generation in the sphenomandibularis compared to the anterior temporalis. These characteristics are consistent with electromyographic findings on the functional differences between these two portions.

KEY WORDS: Sphenomandibularis; Temporalis muscle; Myosin heavy chain.

INTRODUCTION

The temporalis muscle is a bipennate muscle that originates in the temporal fossa and in the temporal fascia and inserts onto the coronoid process of the mandible and the anterior margin of the ramus of the mandible (Williams & Warwick, 1980). Together with the masseter and medial pterygoid muscles, the temporalis acts to elevate the jaw and participates in complex functions like mastication and phonation (Basmajian & de Luca, 1985). Several anatomical studies have described the presence in some individuals of a superficial muscular layer at the main portion of the temporalis, with no functional relevance in humans. This muscular layer is a vestige of the superficial portion of the temporalis muscle that is observed in other primate species of the superfamily Hominoidea (Aiello & Dean, 1990; Gaudy *et al*., 2001; Oxnard & Franklin, 2008; Sedlmayr *et al*., 2009; Lee *et al*., 2012). The sphenomandibularis portion of the temporalis is located deep in the temporalis, originating in the infratemporal surface of the greater wing of the sphenoid bone and inserting into the temporal crest of the mandible (Dunn *et al*., 1996; Türp *et al*., 1997) (Fig. 1). Some authors consider the sphenomandibularis to be a separate muscle of mastication that is differentiated from the temporalis muscle (Dunn *et al*., 1996), while others argue that it is a deep bundle of the temporalis itself because there is no fascia between the two structures nor is there a specific vascularization or innervation of the sphenomandibularis (Türp *et al*., 1997; Ybarra & Bauer, 2001; Geers *et al*., 2005; Akita *et al*., 2019). The sphenomandibularis has also been identified in other primate species of the superfamily Hominoidea, such as chimpanzees (Pan troglodytes) (Ciurana *et al*., 2017).

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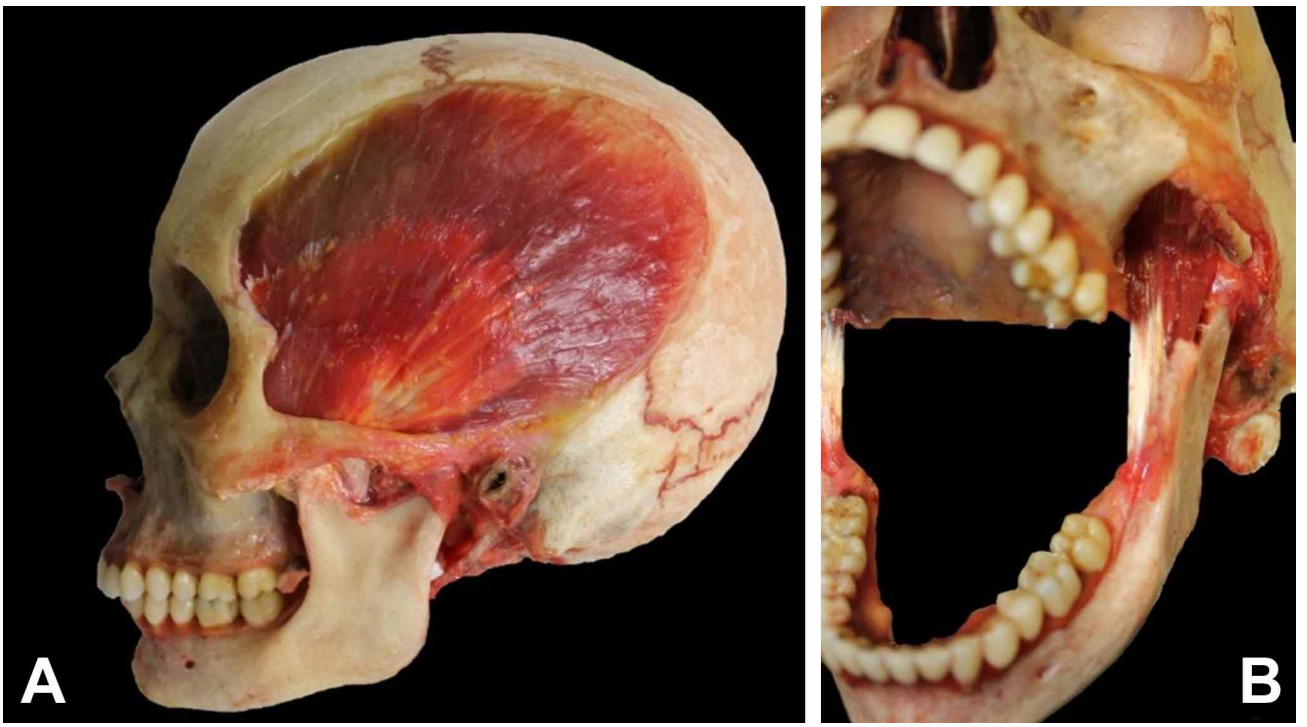

Fig. 1. Dissection of (a) the entire temporalis muscle and (b) the sphenomandibularis portion.

Several electromyographic studies analyzing the function of the different portions of the temporalis have indicated that the functional characteristics of the sphenomandibularis portion are different from those of the rest of the temporalis, which is divided functionally into an anterior and a posterior portion (Blanksma & van Eijden, 1995). The anterior temporalis acts mainly in the vertical elevation of the mandible and increases the recruitment of its fibers when greater force or a higher contraction speed is required (Blanksma *et al*., 1997). The posterior temporalis acts mainly in the retrusion and lateralization of the mandible and in the maintenance of mandibular postures (Ahlgren, 1986; Blanksma *et al*., 1997). In contrast, the sphenomandibularis portion acts mainly in the lateralization of the mandible, acting synergistically with the lateral pterygoid muscle, and also participates in the maintenance of mandibular postures and in the stabilization of the temporomandibular joint (Zenker, 1955; Wood, 1986; Fuentes *et al*., 2012).

In addition to electromyography, the functional characteristics of a given muscle can be analyzed through the expression of myosin heavy chain (MHC) isoforms (Bottinelli & Reggiani, 2000). MHC is a protein containing the enzyme ATPase, which determines the capacity for force generation, the contraction speed, and the resistance to fatigue of muscle fibers (Bottinelli *et al*., 1996; Harridge *et al*., 1996; Pette & Staron, 2000). The main MHC isoforms that are expressed in mammalian skeletal muscle are MHC-I, MHC-IIa, and MHC-IIx (Pette & Staron, 2000; Sciote & Morris, 2000; Hoh, 2002). The MHC-I isoform has low ATPase activity and is the most resistant to fatigue (Schiaffino & Reggiani, 2011). This isoform is expressed in "slow-oxidative" or type I fibers, which are the predominant type of fibers in tonic and postural muscles (Korfage *et al*., 2005). The MHC-IIx isoform has high ATPase activity, which provides a greater capacity for force generation and a higher contraction speed, but it is the least resistant to fatigue (Schiaffino & Reggiani, 2011). This isoform is expressed in "fast-twitch glycolitic" or type IIx fibers, which are highly present in phasic muscles (Korfage *et al*., 2005). Finally, the MHC-IIa isoform presents an ATPase activity and a resistance to fatigue that are located between the MHC-I and MHC-IIx isoforms; it is expressed in "fast-twitch oxidative-glycolytic" or type IIa muscle fibers (Korfage *et al*., 2005; Schiaffino & Reggiani, 2011). In addition to the MHC-I, MHC-IIa, and MHC-IIx isoforms, human masticatory muscles can also express the MHC-M isoform (Ciurana *et al*., 2021), a specialized isoform that is associated with a moderate contraction speed (between that of the MHC-I and MHC-IIa isoforms) and with a high capacity of force generation (superior to that of the MHC-IIx isoform). (Rowlerson *et al*., 1983; Hoh, 2002; Toniolo *et al*., 2008). However, this isoform is expressed in humans at the mRNA level, but not at the protein level, due to a deactivation of the MYH16 gene, which encodes the MHC-

M isoform, as a consequence of a frameshift deletion in codon 660 that produces a stop codon in the coding sequence (Stedman *et al*., 2004). Therefore, this gene can be transcribed into mRNA, but this mRNA cannot be translated into protein. This phenomenon is related evolutionarily to the reduction in size suffered by the masticatory muscles of the genus Homo in comparison with non-human primates (Perry *et al*., 2004; Stedman *et al*., 2004).

The composition and distribution of the different types of muscle fibers in the temporalis have been studied using ATPase staining and immunohistochemistry (IHC). (Ringqvist, 1974; Vignon *et al*., 1980; Korfage & Van Eijden, 1999; Korfage *et al*., 2000). Studies performed with ATPase staining show 31-37 % of type I fibers and 62-65 % of type II fibers (Ringqvist, 1974; Vignon *et al*., 1980). In contrast, IHC studies show 45 % of type I fibers, 24.5 % of type II fibers (13.5 % of type IIa and 11 % of IIx), and 30.6 % of hybrid fibers (Korfage & Van Eijden, 1999). Hybrid fibers express more than one type of MHC isoform, while pure fibers express only one type (Pette & Staron, 2000). The most abundant hybrid fiber in the temporalis expresses the MHC-I+MHC-IIa isoforms (Korfage & Van Eijden, 1999). Although there are no differences in the proportion of type IIa, IIx or hybrid fibers between the anterior and posterior temporalis, there are differences in the proportion of type I fibers (Korfage & Van Eijden, 1999). The anterior temporalis has 46 % of type I fibers, while the posterior has 24 % (Korfage & Van Eijden, 1999). To the best of our knowledge, no studies have analyzed by ATPase staining or IHC the composition and distribution of the different types of muscle fibers in the sphenomandibularis portion of the temporalis.

In the present study, we analyzed the expression patterns of MHC isoforms in the sphenomandibularis portion of the temporalis muscle in humans. Specifically, we analyzed by RT-qPCR not only the isoforms that are expressed both at the mRNA level and at the protein level (MHC-I, MHC-IIa and MHC-IIx) (Baldwin & Haddad, 2001) but also the MHC-M isoform, which is expressed only at the mRNA level in humans but is important in the evolution of the human masticatory muscles (Stedman *et al*., 2004). RT-qPCR allows the direct quantification of the percentages of mRNA expression of each isoform, so the results are not affected by the presence of hybrid fibers. Our main objective was to identify differences in the expression patterns of the MHC isoforms between the sphenomandibularis and the other portions of the temporalis that could be related to the different functional characteristics of the sphenomandibularis observed in electromyographic studies (Zenker, 1955; Wood, 1986; Fuentes *et al*., 2012). Because the sphenomandibularis portion participates in the maintenance of mandibular postures and in the stabilization of the temporomandibular joint to a greater extent than the rest of the temporalis muscle, we hypothesized that it would express a higher percentage of the MHC-I isoform, which would reflect a greater resistance to fatigue. We believe our results will help to better understand the anatomical and functional characteristics of the sphenomandibularis portion of the temporalis muscle, a relatively understudied portion.

MATERIAL AND METHOD

Muscle samples. We dissected the right temporalis muscle and its sphenomandibularis portion in ten individuals (five men and five women), aged between 31 and 94 years (mean, 72.3 ± 19.0). All the individuals came from the Body Donation Service of the Faculty of Medicine of the University of Barcelona (UB). Specimens were cryopreserved 12-24 h postmortem at -18ºC and thawed 24 hours before dissection. All specimens were dissected by the same researcher (NC), who identified and isolated the right temporalis muscles and separated the sphenomandibularis portion. The main portion of the temporalis and the sphenomandibularis were weighed immediately after detachment with a precision scale (model Sartorius PT610 with a resolution of 0.1 g) to calculate their muscle mass (MM) in grams. Samples of 0.5 cm3 were obtained from the anterior, posterior and sphenomandibularis portions of each temporalis muscle and frozen at –21ºC in saline solution for subsequent molecular analysis.

Expression of MHC isoforms. We extracted the RNA from the muscle samples using the commercial RNeasy mini kit (Qiagen, Valencia, CA) according to the manufacturer's protocol. We used a NanoDrop 1000 Spectrophotometer to determine the concentration, purity and amount of RNA and TaqMan Reverse Transcription Reagent Kit (Applied Biosystems, Foster City, CA) to synthesize cDNA. We performed reverse transcription using 330 ng of total RNA in 10 µl of RT Buffer, 22 ml of 25 mM magnesium chloride, 20 µl dNTPs, 5 µl Random Hexamers, 2 µl RNAse Inhibitor, 2.5 µl MultiScribe Reverse Transcription and RNA sample plus RNAse-free water, for a final volume of 100 µl, in the following thermal cycler conditions: 10 min 25ºC, 48 min 30 ºC and 5 min 95 ºC.

Applied Biosystems supplied primers and probes. Primers are labeled at the 5' end with the reporter dye molecule FAM. MYH-I (Hs00165276_m1), MYH-IIa (Hs00430042_m1), MYH-IIx (Hs00428600_m1) and MYH-M (Hs01385213_m1) genes were analyzed.

We performed RT-qPCR in a total volume of 20 µl in the ABI Prism 7700 Sequence Detection System (Applied Biosystems) using the following master mix conditions: 10 µl of the TaqMan Universal PCR Master Mix, 1 µl of the primers and probes, 2 µl of the cDNA and 7 µl of the RNAse-free water. We ran all samples for each gene in duplicate using this thermal cycler conditions: 2 min 50 ºC, 10 min 95 ºC and 40x (15 s 95 ºC and 1 min 60 ºC). We used genomic DNA as negative control in each run. We captured fluorescent emission data and quantified mRNA concentrations by using the critical threshold value and 2-ΔΔCt. In order to avoid any possible effects of post-mortem mRNA degradation, the mRNA values for each of the MHC isoforms were normalized using the reference gene ACTB, which is preserved intact for up to eight days after death in skeletal muscle (Bahar *et al*., 2007).

Finally, we calculated the percentage of expression of each MHC isoform mRNA transcript relative to the total expression of all MHC isoforms (%MHC-I, %MHC-IIa, and %MHC-IIx).

Statistical analyses. Sample normality was tested using the Shapiro-Wilk test. The parametric T-test and the nonparametric Mann-Whitney U test were used to compare the expression patterns of the MHC isoforms in the different portions of the temporalis muscle. We used SPSS Statistics 25 for all statistical analyses and set statistical significance at P≤0.05.

Ethical note. The study was approved by the Institutional Review Board (or Ethics Committee) of the University of Barcelona (protocol code 00003099, 18 September 2017).

RESULTS

The mean MM was 24.3 ± 9.4 grams for the main portion of the temporalis and 2.5 ± 0.7 grams for the sphenomandibularis portion. The mean MM of the entire temporalis muscle, including the sphenomandibularis, was 26.8 ±10.0 grams; the sphenomandibularis accounted for 9.6 % ± 2.3 % of the total MM. No significant differences were identified between men and women in the mean MM of the main portion of the temporalis muscle (26.4 ± 12.5 grams vs 22.2 ± 5.8 grams; P=0.516), in the mean MM of the sphenomandibularis portion (2.3 ± 0.9 grams vs 2.6 ± 0.6 grams; P=0.517), in the mean MM of the entire temporalis muscle (28.7 ± 13.3 grams vs 24.9 ± 6.2 grams; P=0.572), or in the percentage of the mean MM of the entire temporalis muscle attributable to the sphenomandibularis portion (8.4 % ± 1.5 % vs 10.8 % ± 2.4 %; P=0.095).

Not all individuals in our sample expressed the MHC-M isoform at the mRNA level. Six individuals (three men and three women) expressed it in the anterior temporalis, while four individuals (three men and one woman) expressed it in the posterior temporalis and in the sphenomandibularis. In these individuals, the %MHC-M relative to all four MCH isoforms analyzed (MHC-I, MHC-IIa, MHC-IIx, MHC-M) was 22.2 % ± 6.1 % in the anterior temporalis, 26.6 % ± 9.4 % in the posterior temporalis, and 14.0 % ± 8.3 % in the sphenomandibularis.

Tables I and II summarize the results of the analysis of the three MHC isoforms that are expressed at both the mRNA and the protein level (MHC-I, MHC-IIa, MHC-IIx). The three portions of the temporalis had an expression pattern characteristic of phasic muscles, with <50 % of MHC-I isoform expression, >50 % of MHC-II isoform expression, and ≥20 % of MHC-IIx isoform expression. In all three portions, the most highly expressed isoform was MHC-IIa, followed by MHC-I and MHC-IIx (Table I). No significant differences in the percentages of expression of the three isoforms were observed between the anterior and posterior temporalis or between the posterior temporalis and the sphenomandibularis (Table II). However, significant differences were observed between the anterior temporalis and the sphenomandibularis; the anterior temporalis had a higher %MHC-IIx (29.1 % ± 6.2 % vs. 19.4 % ± 6.4 %; P=0.003) and a lower %MHC-I (29.7 ± 10.8 % vs. 39.6 ± 9.3 %; P=0.042).

Table I. Means and standard deviations (SD) of the percentages of mRNA expression of the three MHC isoforms in the three portions of the temporalis muscle.

		%MHC-I	%MHC-IIa	%MHC-IIx
Anterior temporalis	*Mean*	29.7	41.2	29.1
	SD	10.8	7.6	6.2
Posterior temporalis	*Mean*	31.2	43.3	25.4
	SD	10.4	12.1	8.6
Sphenomandibularis	*Mean*	39.6	41.0	19.4
	SD	9.3	7.9	6.4

MHC = myosin heavy chain.

Table II. P-values for the comparison of the percentages of the mRNA expression of the MHC isoforms in the three portions of the temporalis muscle.

	%MHC-I	%MHC-IIa	%MHC-IIx
AT vs PT	P=0.765	P=0.644	P=0.300
AT vs SM	*P=0.042**	P=0.959	*P=0.003**
PT vs SM	P=0.082	P=0.621	P=0.100

MHC = myosin heavy chain; AT = anterior temporalis; PT = posterior temporalis; SM = sphenomandibularis.* Statistically significant (P≤0.05).

DISCUSSION

The sphenomandibularis portion of the temporalis muscle is considered an independent masticatory muscle by some authors (Dunn *et al*., 1996), while others argue that it is a deep bundle of the temporalis. (Türp *et al*., 1997; Ybarra & Bauer, 2001; Geers *et al*., 2005; Akita *et al*., 2019). In all the dissections performed in the present study, we were able to identify and isolate the sphenomandibularis portion from the rest of the temporalis muscle (Fig. 1) and found that it originated at the infratemporal aspect of the sphenoid and inserted at the temporal crest of the mandible. The absence of fascia between the two portions of the temporalis muscle and their common innervation by the deep temporal nerve lead us to believe that the sphenomandibularis portion does not constitute an independent masticatory muscle but is rather a deep bundle in the temporalis muscle. (Türp *et al*., 1997; Ybarra & Bauer, 2001; Geers *et al*., 2005; Akita *et al*., 2019).

Our analysis of MM indicates that the human temporalis muscle is much smaller than that of other primates of the superfamily Hominoidea. If we compare the average MM in our study (26.8 ± 10.0 grams) with that of chimpanzees (120.5 ± 45.9 grams) (Ciurana *et al*., 2017), the hominoid primates most closely related phylogenetically to humans, we can see that the MM of the temporalis in humans is greatly reduced, with a ratio of 4.5:1 between the two species. However, this reduction in MM does not affect the proportion of the sphenomandibularis MM relative to the total MM of the temporalis, which was 9.6 % ± 2.3 % in humans in our sample and 9.9 % ± 3.5 % in chimpanzees (Ciurana *et al*., 2017). This small size of the human masticatory muscles in general (Aiello & Dean, 1990; Oxnard & Franklin, 2008) has been linked to the coding deactivation of the MYH16 gene of the MHC-M isoform, which allows this isoform to be expressed at the mRNA level but not at the protein level (Perry *et al*., 2004; Stedman *et al*., 2004). In our study, we observed that this deactivation of the MYH16 gene not only causes the disappearance of the MHC-M isoform at the protein level but also produces a marked reduction in its expression at the mRNA level. In contrast to chimpanzees (Ciurana *et al*., 2017), not all the human specimens in our study expressed the MHC-M isoform at the mRNA level. Only 60 % of individuals expressed it in the anterior temporalis and only 40 % expressed it in the posterior temporalis and the sphenomandibularis. Moreover, in those individuals who did express the MHC-M isoform, the %MHC-M was clearly reduced compared to that of chimpanzees (Ciurana *et al*., 2017): 22.2 % ± 6.1 % vs 43.0 % ± 4.9 % in the anterior temporalis; 26.6 % ± 9.4 % vs 43.3 % ± 10.9 % in the posterior temporalis; and 14.0 % ± 8.3 % and 33.6 ± 3.2 % in the sphenomandibularis, respectively. This smaller MM and the decreased capacity for force generation in the masticatory muscles of humans, as a consequence of the loss of MHC-M expression at the protein level (Rowlerson *et al*., 1983; Hoh, 2002; Toniolo *et al*., 2008), has been linked to their evolutionary adaptation to a relatively soft diet compared to that of chimpanzees (Oxnard & Franklin, 2008).

Three MHC isoforms with functional importance in humans are expressed at both the mRNA and protein level: MHC-I, MHC-IIa and MHC-IIx. Their expression in the three portions of the temporalis muscle in the present study is consistent with the characteristics of phasic muscles (Schiaffino & Reggiani, 2011), which have a high contraction speed and a great capacity of force generation. This result would be expected as the function of the temporalis is related to the elevation of the mandible during mastication (Basmajian & de Luca, 1985). The percentages of expression that we have observed by RT-qPCR are similar to those obtained by ATPase staining (Ringqvist, 1974; Vignon *et al*., 1980), where type I fibers represented 31-37 % and type II fibers 62-65 % of the total, while in our study, the %MHC-I was 29.7-39.6 % and the %MHC-II was 60.4-70.3 % of the total. However, our results are different from those obtained by IHC. (Ringqvist, 1974; Vignon *et al*., 1980; Korfage & Van Eijden, 1999; Korfage *et al*., 2000), which identified a higher percentage of type I fibers (45 %) and a clearly lower percentage of type II fibers (24.5 %) (Korfage & Van Eijden, 1999). These differences may be due to the fact that IHC identified a high percentage of hybrid fibers (30.6 %), which express more than one MHC isoform. This effect of hybrid fibers on the quantification of the expression of MHC isoforms can be avoided with the use of RT-qPCR, which allows the direct quantification of the percentages of mRNA expression of each isoform.

When comparing the expression of MHC isoforms between the portions of the temporalis muscle, we observed significant differences between the anterior temporalis and the sphenomandibularis. These differences in expression patterns are consistent with the functional differences of the two portions as identified by electromyography. The significantly higher %MHC-IIx in the anterior temporalis (Tables I and II) indicates that it is characterized by a high contraction speed and a high capacity of force generation (Schiaffino & Reggiani, 2011), which is compatible with the main function of this portion of the temporalis as an elevator of the mandible during mastication (Blanksma *et al*., 1997). In contrast, the sphenomandibularis had a significantly higher %MHC-I (Tables I and II), indicating that it is characterized by a greater resistance to fatigue (Schiaffino & Reggiani, 2011), which is in line with its main function of maintenance of mandibular postures and

stabilization of the temporomandibular joint (Zenker, 1955; Wood, 1986; Fuentes *et al*., 2012). In contrast, no significant differences in the expression patterns of MHC isoforms were observed between the anterior and the posterior temporalis. The posterior temporalis, which also participates in the maintenance of mandibular postures (Ahlgren, 1986; Blanksma *et al*., 1997), had a higher %MHC-I and a lower %MHC-IIx compared to the anterior temporalis, but these differences were not significant (Tables I and II). This finding may be a result of the involvement of the posterior temporalis in other rapid movements of the jaw, such as retrusion and lateralization (Ahlgren, 1986; Blanksma *et al*., 1997).

In conclusion, we have found that the sphenomandibularis portion of the temporalis muscle presents a pattern of expression of MHC isoforms that is significantly different from that observed in the anterior temporalis, with a greater expression of the MHC-I isoform. This expression pattern can be related to the functional differences between the two portions of the muscle that have been observed in electromyographic studies. Our study has some limitations, including the relatively small sample size. In addition, our specimens came from older individuals, which may have conditioned the percentages of expression of some isoforms, as has been seen in other muscles, such as the vastus lateralis (Short *et al*., 2005). Nevertheless, to the best of our knowledge, this is the first study to compare the expression of MHC isoforms in the different portions of the temporalis muscle, and our RT-qPCR results provide new information that will lead to a better understanding of the sphenomandibularis and its functions.

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CIURANA, N.; ARTELLS, R.; CASADO, A.; POTAU, J. M. Expresión de ARNm de las isoformas de la cadena pesada de la miosina en la porción esfenomandibular del músculo temporal. *Int. J. Morphol., 40(3)*:728-734, 2022.

RESUMEN: El principal objetivo de este estudio fue analizar mediante real-time quantitative polymerase chain reaction (RT-qPCR) los patrones de expresión de las isoformas de la cadena pesada de la miosina (MHC-I, MHC-IIa y MHC-IIx) en la porción esfenomandibular del músculo temporal. Se esperó encontrar diferencias entre el esfenomandibular y las otras porciones del músculo temporal que se pudieran relacionar con las características funcionales del esfenomandibular, identificadas mediante electromiografía. Para obtener estos resultados, se diseccionó el músculo temporal derecho en diez humanos adultos (cinco hombres y cinco mujeres) y se obtuvieron muestras de la porción anterior y posterior del músculo temporal y de su porción esfenomandibular. Estas muestras fueron analizadas mediante RT-qPCR para determinar los porcentajes de expresión de las isoformas MHC-I, MHC-IIa y MHC-IIx. No se identificaron diferencias significativas de los patrones de expresión entre la porción anterior y la porción posterior del músculo temporal, pero sí que se observaron diferencias significativas entre la porción anterior del músculo temporal y su porción esfenomandibular. Concretamente, la porción esfenomandibular presentó un mayor porcentaje de expresión de la isoforma MHC-I (P=0.04) y un menor porcentaje de expresión de la isoforma MHC-IIx (P=0.003). El patrón de expresión que hemos observado en la porción esfenomandibular del músculo temporal refleja una mayor resistencia a la fatiga, una velocidad de contracción más lenta y una menor capacidad de generar fuerza si se compara esta porción con la porción anterior del músclo temporal. Estas características son consistentes con las diferencias funcionales que presentan estas dos porciones, que han sido descritas mediante electromiografía.

PALABRAS CLAVE: Esfenomandibular; Músculo temporal; Miosina.

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