

A Literature Survey of a Hundred Years of Anatomic and Functional Lateral Pterygoid Muscle Research

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Controversial topics that influence the etiology and the treatment of temporomandibular disorders include anatomy and function of the lateral pterygoid muscle, and the nature of the disc-muscle connection. To explore whether an agreement has been reached among researchers, a literature survey focusing on the structure, performance, and disc-muscle interface of the lateral pterygoid muscle was performed. Eighty-nine original research articles were identified in the Index Medicus information system from 1879 to 1994 by applying the keyword phrase "lateral pterygoid muscle." A majority of references (65%) identified two separate parts of the lateral pterygoid muscle as well as insertions into the disc, the capsule, and the condyle. Seventy-five percent of the articles agreed on three major functions. This literature survey revealed a consensus regarding anatomy, function, and disc connection among the majority of the researchers. However, diverging opinions were persistent and could be identified.

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Knowledge of anatomy is necessary for diagnosing as well as treating craniomandibular disorders, especially when temporomandibular joint components are directly involved, such as in internal derangement.^{1,2} In these conditions, the lateral pterygoid muscle plays an active part,^{3,4} and therefore, detailed information about the anatomy of this muscle will enlighten the background of these pathologic joint disorders.⁵ However, a preliminary survey of the literature revealed a lack of consensus regarding the regional lateral pterygoid muscle anatomy. According to Honée,⁶ the lateral pterygoid muscle consists of a superior and an inferior head, while other researchers such as Grant⁷ could not identify separate parts. Furthermore, the anatomic configuration of the disc-muscle insertion is debatable. Honée⁶ as well as Porter⁸ claimed that the superior lateral pterygoid muscle is attached to the disc, while Rees⁹ and Choukas and Sicher¹⁰ found a small fraction of the muscle fibers joining the disc. However, Pinkert^{11,12} reported fibrous septa separating the disc from the muscle. The function of the lateral pterygoid muscle is also controversial. White¹³ claimed that the disc moved actively due to a contraction of the lateral pterygoid muscle. Yet Findlay¹⁴ and Osborn¹⁵ found only secondary disc movements totally dependent on the condylar pathways. Thus, such conflicting views led to the present survey of the literature in an attempt to further explore whether diverging opinions exist in the scientific community about lateral pterygoid anatomy and function.

Materials and Methods

Original research articles that focused on lateral pterygoid muscle anatomy, the nature of the disc-

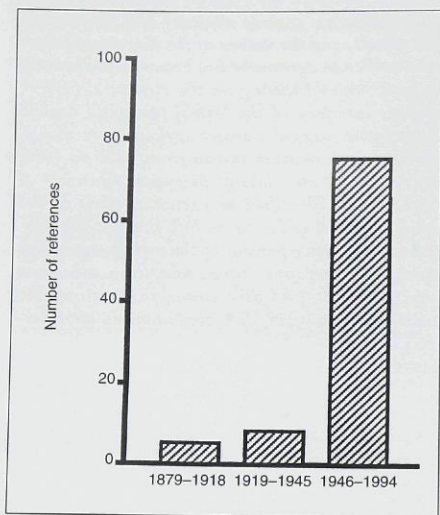


Fig 1 Distribution of articles concerning lateral pterygoid muscle anatomy and physiology published during 1879 to 1994.

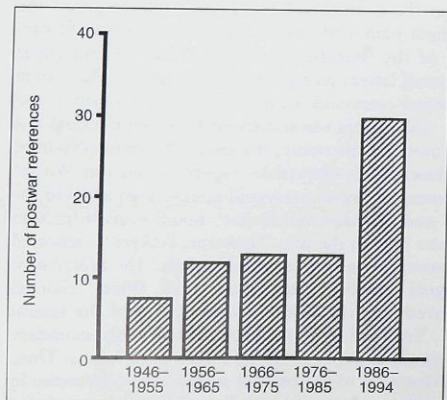


Fig 2 Distribution of lateral pterygoid muscle references after World War II.

muscle interface, and function of the lateral pterygoid muscle were identified by applying the Index Medicus system (National Library of Medicine, Bethesda, MD) from 1879, the start year, to 1965. The Medline database was used thereafter (1966 to August 1994). This literature survey was performed at the Biomedical Library, University of Göteborg, Göteborg, Sweden. The lateral pterygoid muscle was not a possible separate keyword that could be used to search the 1879 to 1965 Index Medicus files. To locate articles that contain information about this muscle, the following procedure was performed: articles with the keywords "masticatory muscles," "facial muscles," "temporomandibular joint," and "temporomaxillary joint" were identified. These references were manually surveyed and combined with the subheadings "anatomy and histology," "physiology," and "pathophysiology." In 1966, the text word "pterygoid muscles" was introduced in the Medline database; in 1980, the term was converted to a MESH term. This enabled a computational combination of the keyword "pterygoid muscle" with the headings "anatomy," "physiology," and "pathology" in the Medline database. Literature about the medial pterygoid muscle was excluded.

Results

Publication Frequency

The distribution of the 89 identified original research articles is shown in Fig 1; five papers¹⁶⁻²⁰ published between 1879 and 1918, the end of the first world war, were identified. Eight publications²¹⁻²⁸ published during the time span 1919 to 1945 were identified. Seventy-six articles^{6-15,29-93} (84 %) were published from the end of the second world war to 1994.

During the first decade after World War II (1946 to 1955), seven scientific articles^{9,29-34} were identified. The following 10 years contributed 12 articles.^{7,10,14,35-43} However, the number of articles increased during the years 1966 to 1975, from which 13 articles^{6,8,11,44-53} were located. This number of articles focusing on lateral pterygoid muscle research was constant from the late 1970s to the middle '80s. Thirteen articles^{12,13,15,34-63} were identified during this time span. A peak in publication frequency was noted between 1986 to 1994. During these 8 years, 31 original articles⁶⁴⁻⁹³ (40% of the postwar papers) were published in the scientific literature (Fig 2).

Regional Anatomy

A majority of the references (65%) state that the lateral pterygoid muscle consists of two separate parts: a superior head and an inferior head. This opinion about anatomy is presented by Honée,⁶ Takano,⁶⁷ and Quemar et al.⁸⁰ However, 20% of the identified articles claim that the lateral pterygoid muscle is a single unit with a unipennate appearance impossible to separate.⁷ However, 15% of the articles state that the lateral pterygoid muscle is organized in three parts: a superior head consisting of two slips and an inferior part, which is inserted into the mandibular pterygoid fovea together with a medial head, inserted into the extreme medial portion of the articular capsule. This complicated anatomy has been reported by Troiano,⁴⁵ Sugisaki et al,⁶⁸ and Ögutten-Toller and Juniper⁹¹ (Fig 3).

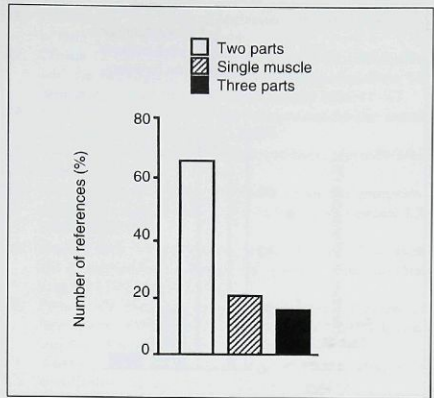


Fig 3 Opinions concerning the regional anatomy of the lateral pterygoid muscle.

Disc-Muscle Interface

A majority of the articles (60%) present the information that the lateral pterygoid muscle has three attachments and is inserted into the disc as well as into the temporomandibular joint capsule and into the condyle. This opinion was represented by Rees⁹ and McNamara.⁵⁰ However, 30% of the articles concluded what Wilkinson and Maryniuk⁶¹ and Wilkinson⁷³ claimed, that a majority of the lateral pterygoid muscle fibers are inserted into the condyle, whereas only a few muscle fibers are attached to the temporomandibular joint disc. A third opinion represented by Arstad³² and Pinkert^{11,12} suggests that the lateral pterygoid muscle is separate from the disc and totally lacks discal attachment. The lateral pterygoid muscle is inserted exclusively into the condyle. This point of view is presented in 10% of the literature articles. Wongwatana et al⁹³ reported that about half of the investigated TMJs showed histologic disc-muscle attachment, but the other half did not reveal any disc-muscle connection (Fig 4).

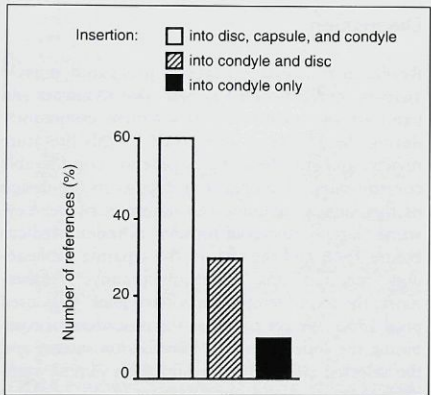


Fig 4 Viewpoints disclosing the disc-lateral pterygoid muscle interface.

Functional Contradictions

Almost 75% of the 87 original research articles identified in this survey (Fig 5) report that the lateral pterygoid muscle has three major functions: to produce lateral mandibular movements by unilateral jaw muscle action, to move the disc and condyle in a forward direction (bilateral muscle function), and to stabilize the disc-condyle complex.^{18,51,70} Arstad³² and Osborn¹⁵ are included in the 20% of references that present the viewpoints of

two functional activities of the lateral pterygoid muscle: to stabilize the temporomandibular joint disc during rotation and translation and to produce lateral jaw movements. However, the disc movements are strictly secondary and are totally dependent on the condyle. In contrast to these multifunctional tasks, four research articles (5%) claim that the lateral pterygoid muscle acts like a jaw opener without producing any lateral muscle forces.^{17,18,21,24}

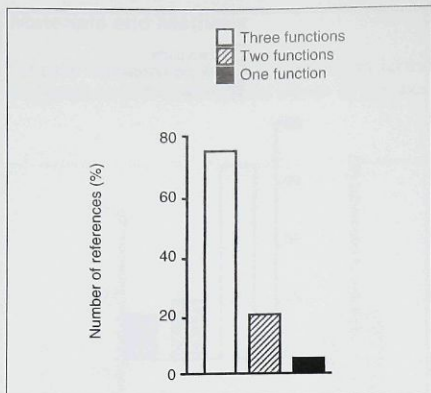


Fig 5 Opinions regarding the function of the lateral pterygoid muscle.

Discussion

Research focusing on lateral pterygoid muscle anatomy and function has been able to attract and maintain the interest of the scientific community during the 115 years monitored by this literature review, and still these topics generate considerable controversies.⁹³ Complicating factors in the design of this survey included the omission of the keyword "lateral pterygoid muscle" in Index Medicus before 1966 and the lack of the separate subheadings "function" and "electromyography." Furthermore, the term "temporomaxillary joint" was used until 1956. We are sure that the procedure of combining the Index Medicus information system and the selected subheadings enabled an almost complete separation and identification of the available references within the interests of this review.

The publication frequency of research papers dealing with lateral pterygoid muscles increased by almost 10 times after World War II, and as a consequence, about 80% of the articles were published after 1966. A peak in the publication process was noted during the late 1980s, especially the first three years of this decade. Analyzing the research covered by this survey did not reveal any clear-cut answers about the lateral pterygoid muscle. However, our research did reveal that from 1879 to the beginning of the current century, articles tended to focus on anatomic questions, especially the possible separation of the muscle in different parts, whereas from the 1950s to 1994, the

questions were directed toward functional aspects, as well as the nature of the disc-muscle interface.

Diverging results were noted in the literature regarding regional lateral pterygoid muscle anatomy and especially about separation in different parts. These conflicting opinions could be attributed to methodologic and biologic factors.⁶⁵ Closer analyses of the dissection procedures may lead to a better understanding of these disagreements. The localization of the lateral pterygoid muscle situated deep in the infratemporal fossa below the zygomatic arch makes it rather difficult to access and requires a complicated surgical technique.³⁶ A majority of researchers used a lateral or medial dissection approach.^{27,40} Troiano⁴⁵ and later Porter⁸ suggested a superiorly directed dissection with the removal of the floor of the cranial fossa. One important biologic factor that might influence the anatomic interpretations of dissection studies is interindividual and intraindividual anatomic variations of the lateral pterygoid muscle.²⁹ Furthermore, a lack of consensus regarding the configuration of the disc-muscle interface was evident, as judged by this survey. These varying conclusions can be related to different technical approaches or variability in biologic structures. The location, type, and extent of the muscle fiber insertion into the disc can be examined in histologic sections^{42,93} by either dissection microscope or magnifying glass.⁶⁵ Both methods have obvious drawbacks.³² The disc-muscle interface could be under the influence of remodeling, sex differences, or age changes.¹⁴ Also, a different anatomic organization between the lateral and medial parts of the disc, as observed by Carpentier et al⁷¹ and Wilkinson,^{73,76} can explain some diverging results.

Lateral pterygoid muscle function has been deduced from anatomic reconstructions of the muscle, based on knowledge of the origin and insertion of the muscle.^{7,34} The visualization of functional patterns by this indirect statical approach has its limitations.⁴¹ The introduction of electromyography (EMG) has uncovered a direct approach to functional studies, especially for the monitoring of lateral pterygoid muscle activity during different jaw movements.^{35,64} However, a negative factor of EMG is the difficulty of achieving correct electrode placement and the interference of electrodes with jaw movements.^{57,58} The inferior head of the lateral pterygoid muscle can be isolated with good precision, but pain and hematoma have been reported during EMG investigations of the superior head.^{39,50} The functional independence of the superior and inferior lateral pterygoid muscle heads may introduce bias in the

functional evaluations.^{34,64} This monitoring of more than 100 years of lateral pterygoid muscle literature showed that the scientific community has a continual growing interest in solving anatomic and functional questions related to the lateral pterygoid muscle.

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Resumen

Estudio literario de cien años de investigación dedicada a la anatomía y función del músculo pterigoideo lateral

Algunos tópicos polémicos que influyen en la etiología y el tratamiento de los desórdenes temporomandibulares son la anatomía, función del músculo pterigoideo lateral, y la naturaleza de la conexión entre el músculo y el disco. Se realizó un estudio literario enfocado hacia la estructura, desempeño, y a la interfase músculo-disco del músculo pterigoideo lateral, para examinar si se ha alcanzado un acuerdo entre los investigadores. Se identificaron 89 artículos de investigación originales en el sistema de información del Index Medicus entre 1897 y 1994, utilizando la palabra clave "músculo pterigoideo lateral." Gran parte de las referencias (65%) identificaron dos partes separadas del músculo pterigoideo lateral además de inserciones dentro del disco, la cápsula, y el cóndilo. El 75% de los artículos estuvieron de acuerdo en tres funciones principales. Esta investigación literaria reveló un consenso en relación a la anatomía, función, y conexión del disco entre la mayoría de los investigadores. Sin embargo, los desacuerdos fueron persistentes y se pudieron identificar.

Zusammenfassung

Eine Literaturübersicht über hundert Jahre anatomische und funktionelle Erforschung des M. pterigoideus lateralis.

Umstrittene Themen, welche die Ätiologie und die Behandlung von Myoarthropathien beeinflussen, sind Anatomie und Funktion des M. pterigoideus lateralis und die Natur der Diskus-Muskel-Verbindung. Um zu erkunden, ob sich eine Einigung unter den Forschern entwickelt hat, wurde eine Literaturübersicht, welche sich auf die Struktur, Leistung, und die Diskus-Muskel-Verbindung des M. pterigoideus lateralis konzentriert, erstellt. 89 Originalarbeiten wurden im Index Medicus von 1897-1994 unter dem Stichwort "M. pterigoideus lateralis" gefunden. Die Mehrzahl der Referenzen (65%) identifizierten sowohl zwei getrennte Anteile des M. pterigoideus lateralis als auch Insertionen im Diskus, in die Kapsel, und den Kondylus. 75% der Artikel einigten sich auf drei hauptsächliche Funktionen. Diese Literaturübersicht zeigt einen Konsens bezüglich Anatomie, Funktion, und Diskusverbindung zwischen den meisten der Forscher. Es konnten jedoch auch immer davon abweichende Meinungen gefunden werden.