Topographic anatomy of the deep temporal nerve: with references to the superior head of lateral pterygoid

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Abstract

Topographic anatomy of the deep temporal nerve: with references to the superior head of lateral pterygoid

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The mandibular nerve branches descend through the foramen ovale into the infratemporal fossa and divide into small anterior and large posterior trunks. The anterior trunk is composed of the deep temporal, buccal and masseteric nerves as mainly motor fibers. Commonly, these nerve branches pass between the roof of the infratemporal fossa and the superior head of the lateral pterygoid muscle. However, during dissections, the varied courses of the mandibular nerve branches can be frequently observed.

The aims of this study were to clarify the positional relationships between the branches from the anterior mandibular nerve trunk and the superior head of the lateral pterygoid muscle. In order to find out the clinical consideration on varied courses of the mandibular nerve branches with references to the surrounding anatomical structures, I examined 28 hemi-sectioned Korean heads.

The results were as follows.

In 16 cases, the posterior deep temporal nerve had a common trunk with the masseteric nerve before giving a branch either

anteriorly (11 cases) and posteriorly (5 cases). In 12 cases, the posterior deep temporal nerve arose from the mandibular nerve trunk independently; the posterior deep temporal nerve was running anteriorly (6 cases) and posteriorly (7 cases) compared to location of the masseteric nerve.

Based on the branching patterns of the middle deep temporal nerve, four categories (Type A ~ D) were classified. Type A (one twig of the middle deep temporal nerve) was most in 39.3%. Type B (two twigs), Type C (three twigs) and Type D (four twigs) were observed in 35.7%, 17.9%, and 7.1% respectively. Interestingly, the middle deep temporal nerve arose from the masseteric nerve in 6 cases and from the posterior deep temporal nerve in 2 cases respectively.

The twigs of the middle deep temporal nerve, which is piercing the muscle fibers of the superior head of lateral pterygoid was found in 18 cases (64.3%). The middle deep temporal nerve pierced the overall part of the superior head of the lateral pterygoid were most (11 cases, 55%), but the piercing site was located on the medial 1/3 region of the superior head was not observed.

These results suggest that the piercing patterns of the middle deep temporal nerve may have a chance to be compressed during the actions of the superior head of lateral pterygoid, which might be leading to entrapment neuropathies.

I. Introduction

Anatomically, the mandibular nerve branches descend through the foramen ovale into the infratemporal fossa. In close association with the lateral pterygoid muscle, the mandibular nerve divides into a smaller anterior and a larger posterior trunk (Sicher, 1952; Clemente, 1985; Williams et al., 1995; Moore et al., 1999).

The anterior trunk contains the buccal nerve, which is composed of sensory fibers, and the deep temporal and masseteric nerves as the mainly motor fibers (Sicher, 1952; Williams et al., 1995; Moore et al., 1999). Within those fibers, the deep temporal and masseteric nerve branches pass between the roof of the infratemporal fossa and the superior head of the lateral pterygoid muscle (Clemente, 1985; Williams et al., 1995).

Previous reports explain that the small posterior deep temporal nerve sometimes arises in common with the masseteric nerve and anterior deep temporal nerve is frequently originated from the buccal nerve, also a middle deep temporal nerve branch often occurs (Sicher, 1952; Clemente, 1985; Williams et al., 1995; Moore et al., 1999).

It is known that the nerve to lateral pterygoid mainly arising from the buccal nerve (Sicher, 1952; Clemente, 1985; Williams et al., 1995; Moore et al., 1999). However, Foucart et al. (1998) reported that the main lateral pterygoid innervation came from the anterior mandibular nerve trunk. Also, Akita et al. (2000) observed that twigs of the anterior deep temporal, middle deep temporal and the mandibular nerve trunk were distributed to lateral pterygoid muscle.

However, the varied courses of the deep temporal nerve branches can be frequently observed during dissections. Loughner et al. (1990) reported that the anterior deep temporal nerve was entrapped with muscle fibers of the superior head of the lateral pterygoid in one of the 52 dissected specimens. Also Akita et al.

(2000) observed that the twigs to the midmedial muscle bundle of temporalis pierced the superior head of the lateral pterygoid. Concerning the varied courses of anterior mandibular nerve trunk, it can be assumed of a close relationship between entrapped nerve twigs and its clinical symptom.

The aims of this study were to clarify the positional relationships between the branches from the anterior mandibular nerve trunk and the superior head of the lateral pterygoid muscle and to find out the clinical relevance of the varied courses of the mandibular nerve branches with references to the surrounding anatomical structures.

II. Materials and Methods

Twenty-eight hemi-sectioned heads from 19 Korean cadavers (13 males, 6 females) with an average age of 61.8 years (range: 20~94) were used. Except 10 fresh specimens, the others were taken from embalmed cadavers and preserved in 10% formalin solution.

The calvarium and brain were removed from these specimens. The bony elements of the middle cranial fossa region (squamous part of temporal bone and the greater wing of the sphenoid) were entirely removed according to the superior approach reported by Pinto (1962) and Akita et al. (2000). Through the careful dissections, the nerve twigs from the anterior mandibular nerve trunk were clearly exposed with special attention paid to the positional relationships on the superior head of the lateral pterygoid (LPMs) (Fig. 1).

After exposing the nerve branches from the anterior mandibular nerve trunk, the origin of the posterior deep temporal nerve was observed (Fig. 2) and the branching patterns of the middle deep temporal nerve was classified according to its number of nerve twigs (Fig. 3).

In cases of the piercing appearance, the patterns of the middle deep temporal nerve was observed according to the piercing location. The amount of muscle covering over the branches of the deep temporal nerve was measured with digital vernier caliper (Mitsutoyo Co., Japan). All dissections were performed under the surgical microscope (Karl Zeiss Co., Germany).

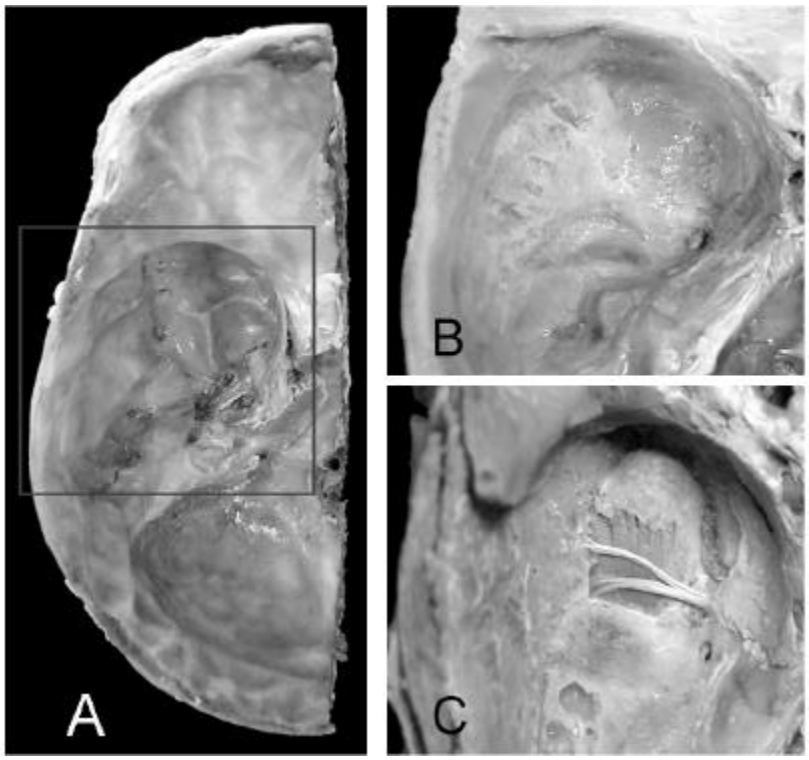

Fig. 1. The serial dissection of the middle cranial fossa. The dissection was performed in the outlined region of the middle cranial fossa (A). The squamous part of temporal bone and greater wing of sphenoid were removed (B). Deep temporal nerve and superior head of lateral pterygoid were exposed (C).

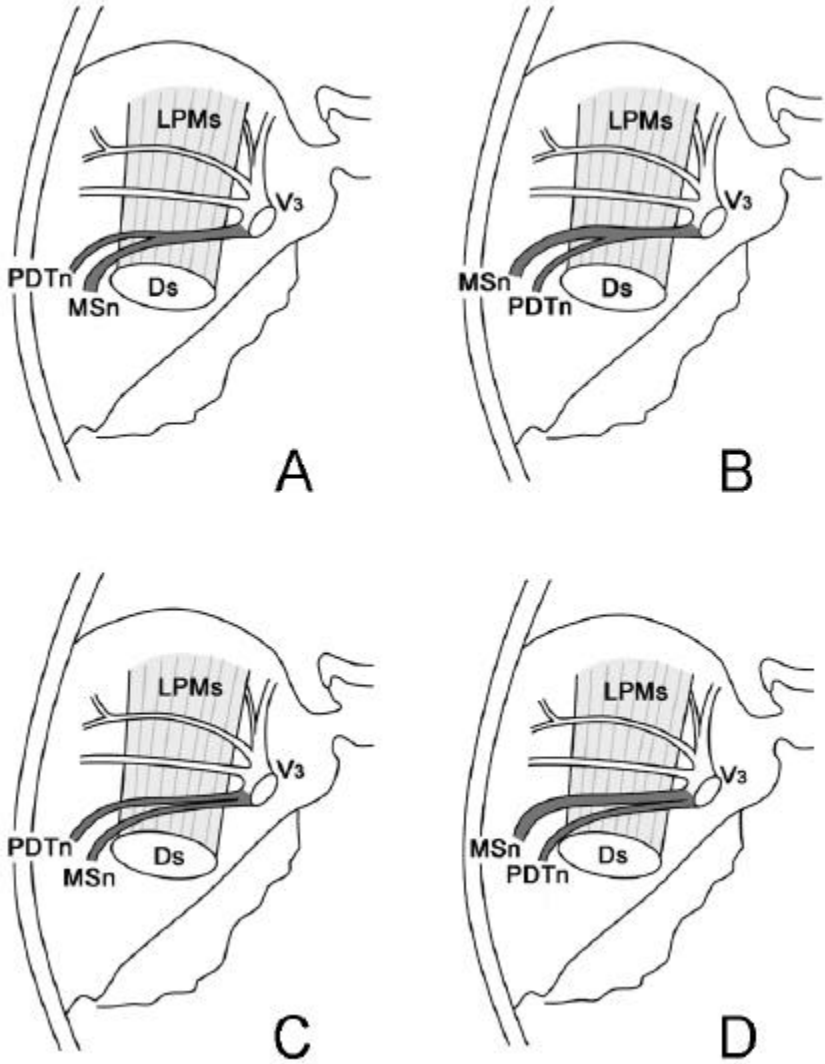

Fig. 2. Schematic illustrations concerning the origins of the posterior deep temporal nerve. The posterior deep temporal nerve (PDTn) forms a common trunk with the masseteric nerve (MSn) and then dividing into anteriorly (A) and posteriorly (B) compared to the location of masseteric nerve. The posterior deep temporal nerve from the anterior mandibular nerve trunk is running anteriorly (C) and posteriorly (D) compared to the location of masseteric nerve (LPMs: superior head of the lateral pterygoid, V_3: main trunk of the mandibular nerve, Ds: temporomandibular joint disk).

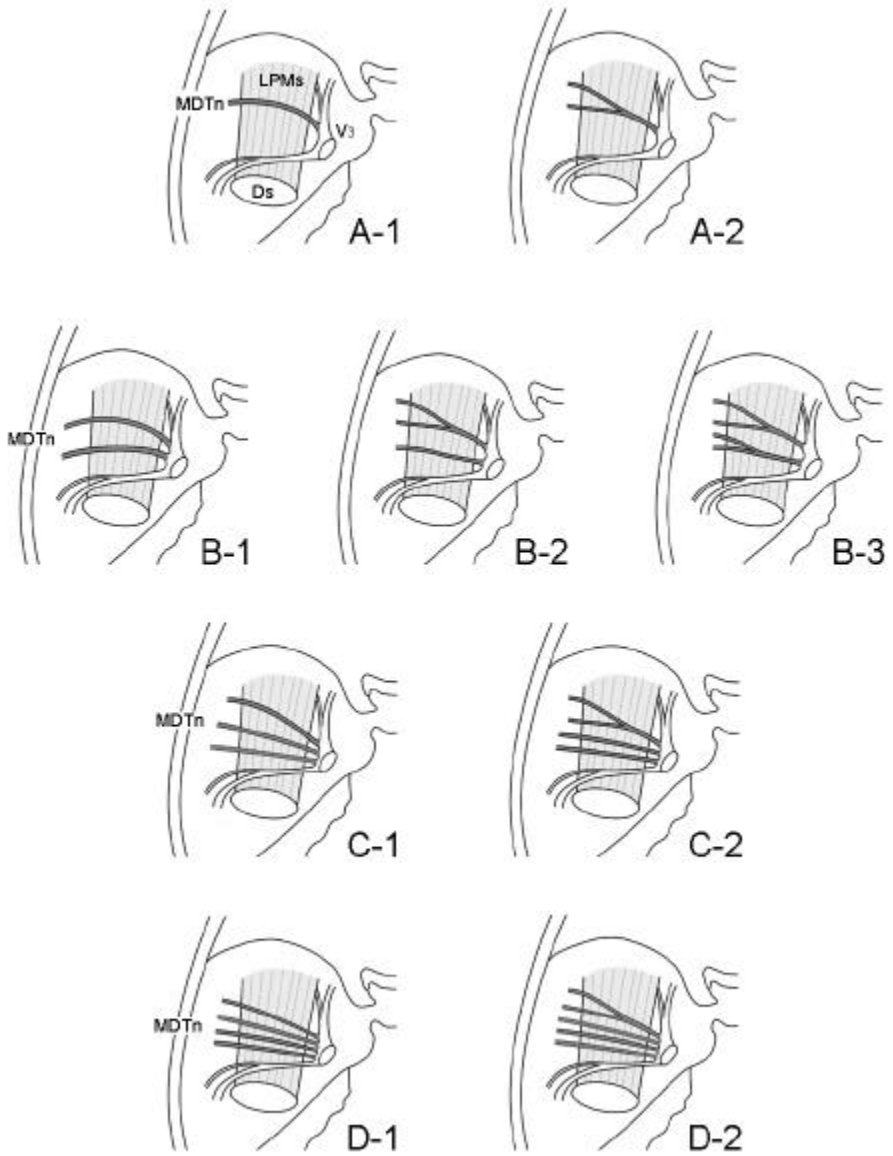

Fig. 3. Schematic illustrations on the classifications of the branching pattern of the middle deep temporal nerve (MDTn) according to its number of nerve twigs (A: Type A, B: Type B, C: Type C, D: Type D). (LPMs: superior head of the lateral pterygoid, V_3: main trunk of the mandibular nerve, Ds: temporomandibular joint disk)

III. Results

1. The origins of the posterior deep temporal nerve

The posterior deep temporal nerves in which formed in common trunk with the masseteric nerves were observed in 16 cases (57.1%). In 11 cases of the specimens, the posterior deep temporal nerve were divided from the masseteric nerve and then were running anteriorly to the masseteric nerve (Fig. 4A). In 5 cases, the posterior deep temporal nerve were running posteriorly to the masseteric nerve (Fig. 4B).

The posterior deep temporal nerve that arises independently from the anterior mandibular nerve trunk was observed in 12 cases (42.9%). In 6 cases, the posterior deep temporal nerve were running in front of the masseteric nerve (Fig. 4C). In 7 cases, the posterior deep temporal nerve were located behind to the masseteric nerve (Fig. 4D). In 1 case, the posterior deep temporal nerve was separated dividing into anterior and posterior directions as shown above, unexpectedly, those two branches joined together at the end.

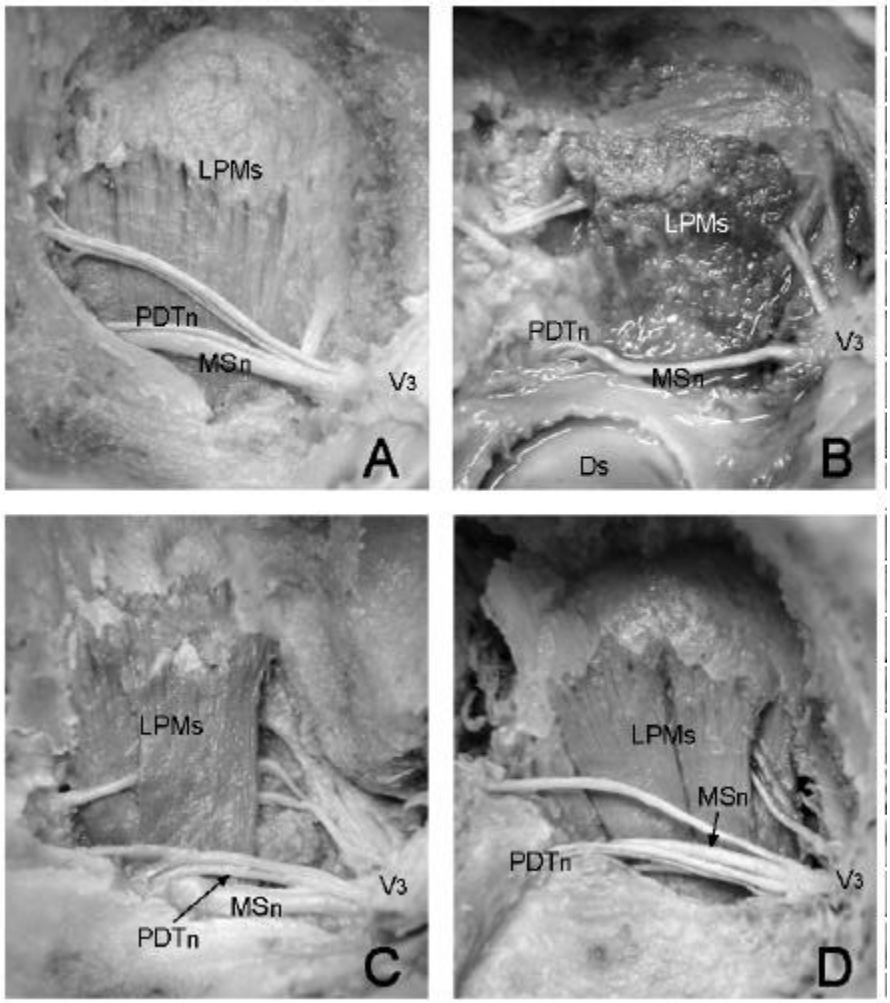

Fig. 4. Superior aspects of the lateral pterygoid through the middle cranial fossa shown the patterns of origins and courses of the posterior deep temporal nerve.

The posterior deep temporal nerve (PDTn) forms a common trunk with the masseteric nerve (MSn) and then dividing into anteriorly (A) and posteriorly (B) compared to the location of masseteric nerve. Whereas, the posterior deep temporal nerve from the anterior mandibular nerve trunk is running anteriorly (C) and posteriorly (D) compared to the location of masseteric nerve. (LPMs: superior head of the lateral pterygoid, V_3: main trunk of the mandibular nerve, Ds: temporomandibular joint disk).

2. The branching patterns of the middle deep temporal nerve

Based on the number of nerve twigs, the branching patterns of the middle deep temporal nerve on the superior head of the lateral pterygoid were classified into four categories (Fig. 5). Type A was shown the most at the middle deep temporal nerve, which formed in as one nerve twig or two branches from one nerve twig in 11 cases (39.3%) (Fig. 5, A). The others showed two twigs in 10 cases (Type B, 35.7%), three twigs in 5 cases (Type C, 17.9%), and four twigs in 2 cases (Type D, 7.1%).

Besides these four patterns, the middle deep temporal nerve was originated from either the masseteric nerve or posterior deep temporal nerve, which can be observed in 6 and 2 cases respectively (Fig. 6).

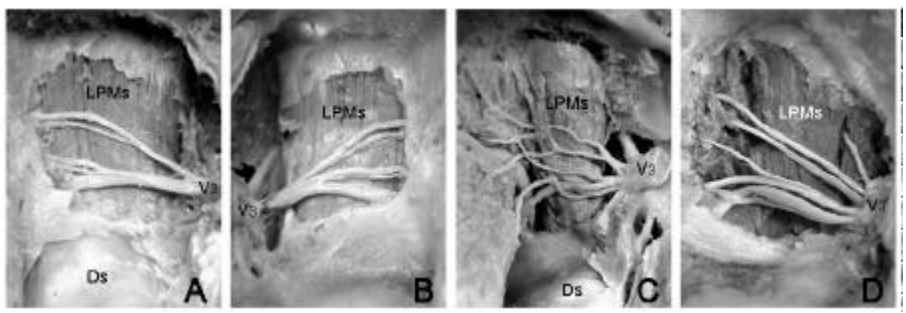

Fig. 5. Superior aspects of the lateral pterygoid through the middle cranial fossa shown the four branching patterns of the middle deep temporal nerve. These patterns were classified according to its number of nerve twigs. Type A (middle deep temporal nerve as one twig) was most in 39.3%. Type B (two twigs), Type C (three twigs) and Type D (four twigs) were observed in 35.7%, 17.9%, and 7.1%, respectively (A: Type A, B: Type B, C: Type C, D: Type D) (LPMs: superior head of the lateral pterygoid, V_3: main trunk of the mandibular nerve, Ds: temporomandibular joint disk).

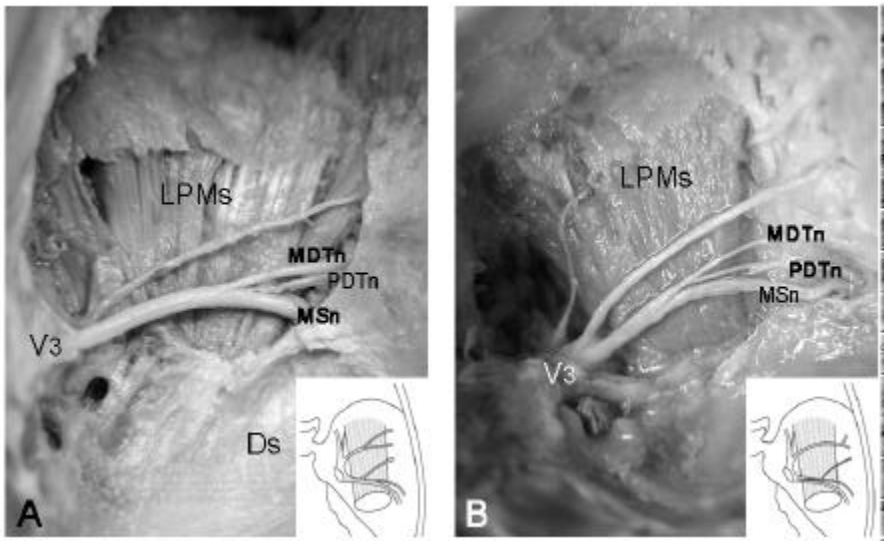

Fig. 6. Superior aspects of the lateral pterygoid through the middle cranial fossa. The middle deep temporal nerve was originated from the masseteric nerve (MSn) (A) and the posterior deep temporal nerve (B). (LPMs: superior head of the lateral pterygoid, V_3: main trunk of the mandibular nerve, Ds: temporomandibular joint disk)

3. The piercing aspects of the middle deep temporal nerve through the superior head of lateral pterygoid

Among the 28 specimens, 18 cases was shown the middle deep temporal nerve pierced through muscle fibers of the superior head of lateral pterygoid (64.3%) (Fig. 7).

According to the divisions of the superior head of the lateral pterygoid (medial 1/3, middle 1/3, lateral 1/3), the middle deep temporal nerve was classified into four different piercing locations (medial 1/3, middle 1/3, lateral 1/3, all areas of the superior head). In 11 cases, the middle deep temporal nerve pierced through all areas of the superior head (55.0%). The middle deep

temporal nerve pierced through the middle 1/3 and lateral 1/3 area of the superior head were observed in 3 (15.0%) and 6 cases (30.0%), respectively. But, there was no case that pierced through the medial 1/3 area of the superior head (Fig. 7). Mean value of the amount of muscle covering over the branches of the deep temporal nerve was 10.9±4.0㎜ (from 2.5㎜ to 16.9㎜).

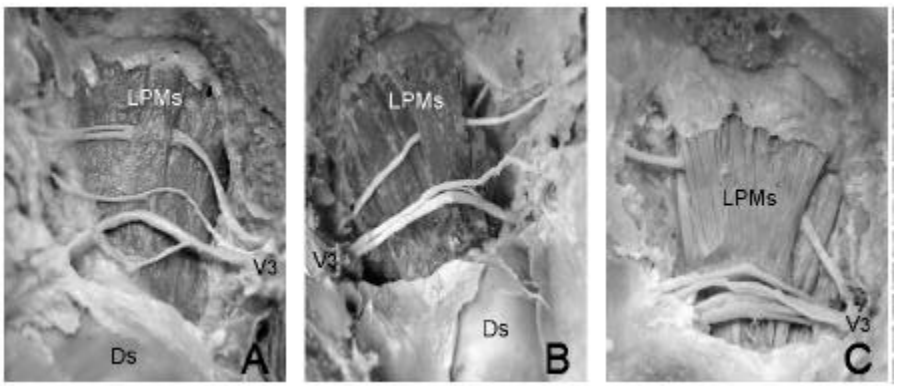

Fig. 7. Superior views of the superior head of lateral pterygoid shown the piercing aspects of the middle deep temporal nerve through the superior head. Middle deep temporal nerve pierced through the middle 1/3 of superior head (A), lateral 1/3 (B) and all areas (C) were shown. (LPMs: superior head of the lateral pterygoid, V_3: main trunk of the mandibular nerve, Ds: temporomandibular joint disk).

IV. Discussion

Details of deep temporal nerve has been treated with little interest, because these nerve branches are presumed not to have important clinical applications. A detailed description of the positional relationships between the lateral pterygoid and deep temporal nerve is not available in the literature or in anatomy textbooks. Generally, like in Gray's Anatomy (Williams et al., 1995), it is known that the deep temporal nerve passes above the lateral pterygoid to enter the deep surface of temporalis.

The nerves to temporalis are described and classified in a various ways (Sicher, 1952; Clemente, 1985; Williams et al., 1995; Ziccardi et al., 1998; Akita et al., 2000). In present study, nerve to temporalis is classified according to Terada and Sato (1982) and Akita et al. (2000), which is based on its positional relationship to the lateral pterygoid. The classification as follows; (1) the anterior deep temporal nerve arises from the buccal nerve and is distributed into the anterior portion of temporalis. (2) The middle deep temporal nerve forms a common trunk with the masseteric nerve and separates early from the main nerve to distribute into the middle portion of the muscle. (3) The posterior deep temporal nerve arises from the masseteric nerve independently of the middle deep temporal nerve and is distributed into the posterior portion of the muscle.

In this classification, nerve to temporalis was classified by origin aspect and distribution area. But it was not considered that the differences between the origin and the distribution due to the

varied courses of nerves often occurred. Also, the meaning of this classification for three branching patterns can be left some doubts. It means that there have difficulties in classifying these nerve branches precisely. The classification of anterior, middle and the posterior deep temporal nerve in this study also can be debated. But, it is an obvious fact that these nerves are the branches of deep temporal nerve. A further study should be performed to clarify the meaningful classification on the deep temporal nerves based on its nature.

According to the previous studies, the nerves to lateral pterygoid mainly arise from the buccal nerve (Clemente, 1985; Williams et al., 1995; Aziz et al., 1998). Foucart (1998) reported that the main lateral pterygoid innervation came from the anterior trunk of the manibular nerve by one to three terminal nerves, and accessory innervation came from the buccal, auriculotemporal and masseteric nerves. Akita et al.(2000) observed that twigs of the anterior deep temporal, middle deep temporal and the mandibular nerve trunk were distributed to the lateral pterygoid.

The EMG phase of the superior head of lateral pterygoid shows a strong activity during clenching and an absence of marked activity during protrusion and opening (Juniper, 1983; Mahan et al., 1983; Widmalm et al., 1987). Interestingly, the temporalis and the superior head of lateral pterygoid have a similar aspect in their functions. This means that the temporalis and superior head of lateral pterygoid could be originated from the common anlage.

The relationship between the nerves to temporalis and the superior head of lateral pterygoid was examined and it could be

assumed further that the varied course of the middle deep temporal nerve may influence on the clinical symptoms of the temporalis and the superior head of lateral pterygoid.

It is generally accepted that the smaller posterior deep temporal nerve arises in common with the masseteric nerves (Clemente, 1985; Williams et al., 1995; Akita et al., 2000). But in present study, the posterior deep temporal nerves that arises in common trunk with the masseteric nerve or originates from the anterior mandibular nerve trunk were observed in 16 and 12 cases, respectively. This results have some differences from previous descriptions on the origin of the posterior deep temporal nerve.

Akita et al. (2000) described that the superior head of lateral pterygoid was innervated by the middle deep temporal nerve. In this study, it also was confirmed that the middle deep temporal nerve innervated the superior head of lateral pterygoid during dissections.

In present study, the middle deep temporal nerve was classified into four patterns as Type A (one twig), Type B (two twigs), Type C (Three twigs), and Type D (four twigs) according to the number of nerve twigs and the branching patterns. Besides these four patterns, the middle deep temporal nerve was originated from either the masseteric nerve or posterior deep temporal nerve. This result is different from the descriptions of anatomy textbook (Sicher, 1952; Clemente, 1985; Williams et al., 1995; Moore et al., 1999) and some reports that it had been described the middle deep temporal nerve divided from masseteric nerve (Terada et al., 1982; Akita et al., 2000).

Loughner et al. (1990) reported that the anterior deep temporal

nerve was entrapped in fibers of the superior head of the lateral pterygoid in one of the 52 dissected specimens and impingement of this nerve could cause pain at the site of its distal distribution. Akita et al. (2000) observed that the twigs to the mid-medial muscle bundle of temporalis pierced the superior head of the lateral pterygoid. In present study, the piercing aspects of the superior head of lateral pterygoid muscle and deep temporal nerve was investigated. 18 cases out of 28 (64.3%) were shown that the middle temporal nerve passed through the superior head of lateral pterygoid muscle. Based on the classification of Terada and Sato (1982) and Akita et al. (2000), the author defined the nerves piercing through the muscle fibers as the middle deep temporal nerve. However, these patterns were shown different results from the report of Loughner (1990) in which described as the anterior deep temporal nerve was entrapped and impinged with the superior head of lateral pterygoid.

Entrapment neuropathies are specific forms of compressive neuropathies that occur where the nerves are normally confined to narrow anatomic passageways and therefore are susceptible to constricting pressures (Girard, 1979; Castaldo et al., 1984; Dyck et al., 1984; Sunderland, 1991; Halder et al., 1993; Omer et al., 1998). During muscle actions, there can be frictions between muscle and nerve fibers. And various causes could result in inflammatory edema due to the fasciitis around the nerves. So, in case of the nerve interlocked between muscle fibers, entrapment neuropathy can be caused.

According to present results, it can be explained that the middle deep temporal nerve piercing the muscle fibers might

cause the similar aspects of entrapment neuropathies. But there are some questions about clinical symptoms that could be caused by these varied courses of the middle deep temporal nerve.

These anatomic descriptions of branching and varied courses of the deep temporal nerve will be helpful in diagnosis and treatment planning of the neuropathies on the temporal region. However, further anatomical and clinical studies should be followed, considering that the middle deep temporal nerve is mainly motor and there are close relations with the lateral pterygoid.

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Abstract in Korean

가쪽날개근 윗갈래와의 관계에 따른 깊은관자신경의 국소해부

연세대학교 대학원 치의학과

고 선 주

아래턱신경가지는 타원구멍을 통과하여 관자아래우묵으로 들어오며, 작은 앞가지와 큰 뒤가지로 나뉘게 된다. 앞가지에는 깊은관자신경, 볼신경, 깨물근신경이 포함되며, 이들은 주로 운동신경으로 구성되어 있다. 일반적으로 이러한 신경가지들은 관자아래우묵의 윗벽과 가쪽날개근 윗갈래 사이를 지나게 된다. 그러나 해부하는 도중, 아래턱신경가지들의 주행변이들이 종종 관찰된다.

이 연구의 목적은 한국 성인의 얼굴 반쪽 28예에서 아래턱신경 앞가지와 가쪽날개근 윗갈래사이의 위치 관계를 확인하는 것이며, 주위의 해부학적 구조물들과 관련되어 아래턱신경가지들의 주행 변이가 갖는 임상적 연관성을 밝히는 것이다.

결과는 다음과 같다. 16예에서 뒤깊은관자신경은 깨물근신경과 공동 줄기를 이루었고, 깨물근신경의 앞쪽 (11예)과 뒤쪽 (5예)에서 나뉘는 양상을 보였다. 12예에서 뒤깊은관자신경은 아래턱신경 앞가지에서 독립적으로 일어났으며, 이중 깨물근신경의 앞쪽에서 일어나는 경우가 6예, 뒤쪽에서 일어나는 경우는 7예가 관찰되었다.

중간깊은관자신경이 나뉘는 양상에 근거하여, 4개의 유형(Type A- D)으로 분류하였다. 이 중 Type A(한 가닥의 중간깊은관자신경)가 가장 많았으며 (39.3%) type B (두가닥), type C (세가닥), type D (네가닥)는 각각 35.7%, 17.9%, 7.1% 관찰되었다. 그밖에 중

간깊은관자신경이 깨물근신경에서 갈라져 나오는 경우가 6예, 뒤깊은관자신경에서 갈라져 나오는 경우가 2예에서 관찰되었다.

중간깊은관자신경의 가지가 가쪽날개근 윗갈래의 근육섬유를 통과해서 지나는 경우가 18예 (64.3%)에서 관찰되었다. 이 중에서 중간깊은관자신경이 가쪽날개근 윗갈래의 전반에 걸쳐 통과해 가는 경우(11예, 55%)가 가장 많았으며, 안쪽 1/3만을 지나는 경우는 관찰되지 않았다.

이 연구의 결과는 가쪽날개근이 작용할 때에 근육사이를 통과하는 깊은관자신경이 눌림으로 인해 신경죄임병증 (entrapment neuropathies)이 나타날 가능성이 있음을 보여준다.