Title	Perspectives on the role of the lateral pterygoid muscle and the sphenomandibular ligament in temporomandibular joint function
Author(s)	Abe, S; Ouchi, Y; Ide, Y; Yonezu, H
Journal	Cranio : the journal of craniomandibular practice, 15(3): 203-207
URL	http://hdl.handle.net/10130/1099
Right	

Perspectives On the Role of the Lateral Pterygoid Muscle and the Sphenomandibular Ligament in Temporomandibular Joint Function

Shinichi Abe, D.D.S., Ph.D.; Yoshihito Ouchi, D.D.S., Ph.D.;
Yoshinobu Ide, D.D.S., Ph.D.; Hakubun Yonezu, D.D.S., Ph.D.

0886-9634/1503-203$03.00/0, THE JOURNAL OF CRANIOMANDIBULAR PRACTICE,

Manuscript received August 19, 1996; revised manuscript received December 11, 1996; accepted March 31, 1997

Address for reprint requests:
Dr. Shinichi Abe
Tokyo Dental College
Dept. of Anatomy
1-2-2 Masago, Mihama-ku
Chiba-shi, Chiba 261
Japan
Email:
tdc-anat@ppp.bekkoame.or.jp

ABSTRACT: The lateral pterygoid muscle plays an important role in the movement of the mandible and has been studied from several points of view, including structural and functional anatomy. What matters clinically is the relative position of the muscle fibers attached medially to the mandibular condyle. In the following study, we observed not only the attachment of the lateral pterygoid muscle fibers to the articular disk, but also the relative position of the mandibular condyle to a base line set up on the mandibular condyle . According to our observations, the lateral pterygoid muscle fibers attach to the articular disk at the inner point of the medial pole. Based on this finding, we can say that the muscle fibers can both draw the articular disk anteriorly and balance it by supporting it posteriorly. That is to say, the lateral pterygoid muscle has two actions: to elevate the articular disk anteriorly and to support the articular disk. Furthermore, the sphenomandibular ligament has continuity with the articular disk tissue medially. This relationship suggests that the ligament fibers attached to the articular disk draw the disk posteriorly in its course of mandibular closing, thus enabling the articular disk to move smoothly.

Dr. Shinichi Abe *received his D.D.S. degree from Tokyo Dental College in 1989 and his Ph.D. degree in 1993 from the same college. Dr. Abe is currently an instructor in the Department of Anatomy at Tokyo Dental College.*

Dr. Yoshihito Ouchi *received his D.D.S. degree from Tokyo Dental College in 1992 and his Ph.D. from the same college in 1996. Dr. Ouchi is currently in residency at the Tokyo Dental College in the Department of Anatomy.*

The lateral pterygoid muscle plays an important role in the movement of the mandible and has been studied from several points of view, including biology and functional anatomy.[1,2] For the attachment of the lateral pterygoid muscle fiber to the temporomandibular joint, especially at the insertion, numerous studies have been done[3,4] but without consistent results. A recent application of a different dissection approach has made it possible to fully observe the medial attachment of the lateral pterygoid muscle fibers to the articular disk.[5,6] Since the superior and inferior heads of the lateral pterygoid muscle approach the insertion combined and entangled, it is difficult to determine where these muscle fibers originate even using the superior approach. Even though we can observe on slices or by the superior approach, how the muscle fibers are attached to the articular disk, it is difficult to determine whether they are from the superior head or the inferior head. The possibility of error exists when determining the attachment through the superior observation approach method or on slices. Therefore, it is only possible to make a correct determination by tracing each individual thread of fiber under a microscope. Dr. Abe has pointed out limitations in the superior approach and reported the attachment of the lateral pterygoid muscle fibers to the articular disk.[7] In describing the

heads of origin of the fibers attached to the articular disk, what matters clinically is the relative position of the muscle fibers attached medially to the mandibular condyle. In this study, we observed not only the attachment of the lateral pterygoid muscle fibers to the articular disk, but also the relative position of the head of mandible to a base line set up on the head of mandible.

When we consider the role of the lateral pterygoid muscle in the temporomandibular joint, it is necessary to describe the lateral pterygoid muscle fibers' attachment to the articular disk. But we wondered what made the articular disk go back to the initial position during jaw-closing. When the bone surrounding the temporomandibular joint is normal, the articular disk may return to its initial position by being drawn with the posterior connective tissue of the temporomandibular joint in coordination with translocation of the mandibular condyle. However in practice, the bone and peripheral soft tissue surrounding the temporomandibular joint is subject to changes due to aging, occlusal collapse, or temporomandibular joint disease. Is there a tissue that draws back the articular disk posteriorly without being affected by these changes?

Materials and Methods

All subjects for this study had 20-29 teeth. The subjects ranged in age from 38 to 59 years.

Attachments of the Lateral Pterygoid Muscle to the Articular Disk

Studies of the attachment of the lateral pterygoid muscle to the articular disk were made on 20 samples from ten cadavers at the Department of Anatomy of the Tokyo Dental College. All specimens were free of damage to the temporomandibular joint.

The condylar neck was cut at its junction with the ramus of the mandible in order to remove the mandibular component of the TMJ along with the disk and lateral pterygoid muscle (**Figure 1**). With the articular disk viewed from the superior head, we marked the spots we deemed the lateral pole and the medial pole of the mandibular condyle. We then drew a line (the base line) joining the lateral and medial poles. This line corresponds to the long axis of the head of the mandible(**Figure 2**). With the muscle fibers still attached to the articular disk, all muscle fibers attached to the fossa of the lateral pterygoid were cut, the mandible removed, and the articular disk observed from below.(**Figure 3**) We marked the most medial point of the muscle fibers attached to the articular disk, and drew a line joining that point and the lateral pole. The angle formed between this line and the

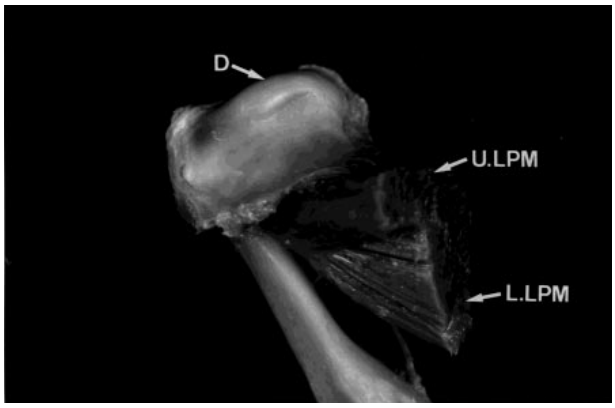

Figure 1
The lateral pterygoid muscle, joint projection and articular disk were extracted as a unit. **D**: articular disk; **U.LPM**: upper head of the lateral pterygoid muscle; **L.LPM**: Lower head of the lateral pterygoid muscle.

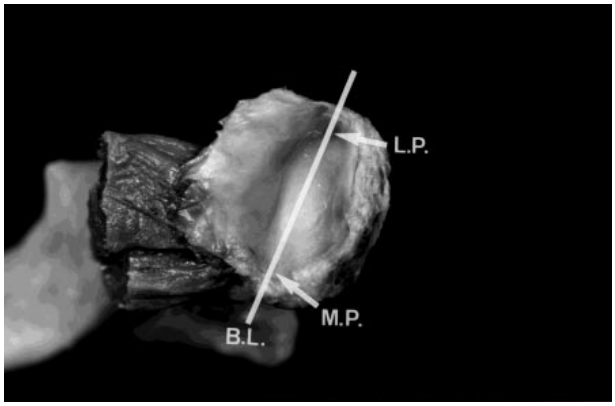

Figure 2
The articular disk viewed from superior. **M.P.**: medial pole; **L.P.**: lateral pole; **B.L.**: base line.

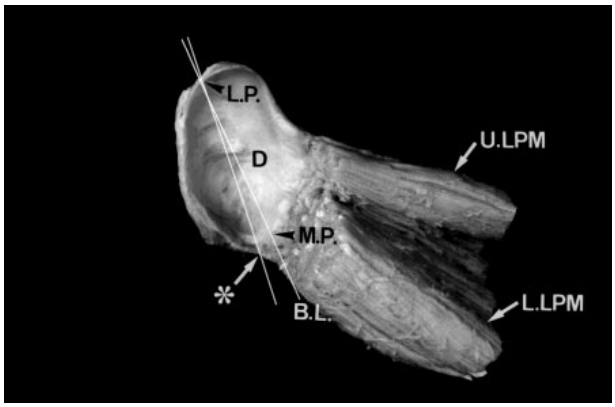

Figure 3
The articular disk observed from below. **D**: articular disk; **B.L.**: base line; **L.P.**: lateral pole; **M.P.**: medial pole; **U.LPM**: upper head of the lateral pterygoid muscle; **L.LPM**: lower head of the lateral pterygoid muscle; ❇: the most medial point of the muscle fiber attached to the articular disk.

base line was measured. The unit of angle is shown as a plus when the attachment end extends medially beyond the base line, and a minus when it does not extend beyond the base line. In the same manner, we marked the most medial point of the attachment area with the upper head muscle fibers and joined the most medial point and the lateral pole to create a line. We then measured the angle between this line and the baseline.

Existence of the Ligament which Draws the Articular Disk Posteriorly During Jaw-closing

Studies of the existence of the ligament that draws the articular disk posteriorly during jaw-closing were made on four samples from two cadavers in the collection of the Department of Anatomy of the Tokyo Dental College and were made on eight samples from four cadavers in the collection of the Institute for Anatomy of the Free University Berlin. All specimens were muscles with upper and lower heads, and they were all free of damage to the temporomandibular joint.

In our lateral approach, after resectioning the zygomatic arch and masseter muscle, we severed the coronoid process of the mandible at its basal part and removed the temporalis muscle (**Figure 4**). In the medial approach, we cut the cadaver head in the sagittal section, removed the soft tissue surrounding the ramus of mandible, and finally removed the medial pterygoid muscle (**Figure 5**). Thus it was possible to observe the attachment of the sphenomandibular ligament medially.

Results

Attachments of the Lateral Pterygoid Muscle to the Articular Disk

The attachment of fibers from both heads of the lateral pterygoid muscle to the articular disk was observed in all specimens. The circumference of the articular disks averaged 58.1 mm, the width of attachment zone of the superior head muscle fibers averaged 11.9 mm, and the width of the attachment zone of the inferior head muscle fibers was 4.3 mm (**Table 1**). The angle formed between the tip of the attachment area of the upper head muscle fibers and the baseline averaged -4.5°, and that between the tip of the attachment area of the lower head muscle fibers averaged 6.1° (**Table 2**).

Existence of the Ligament which Draws the Articular Disk Posteriorly During Jaw-closing

As a result of our detailed observation of the sphenomandibular ligament at its attachment area with peripheral bones of the temporomandibular joint, we found the ligament was firmly attached to the spine of sphenoid,

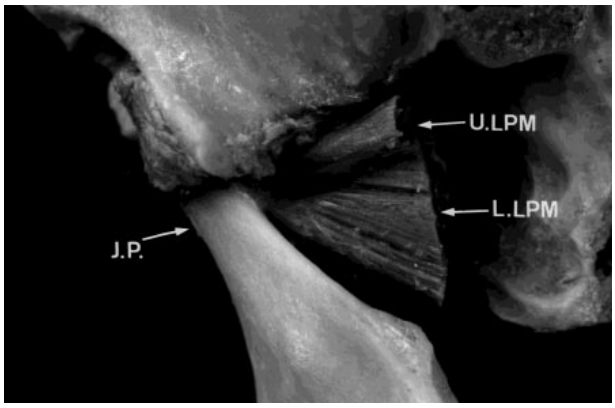

Figure 4
Lateral approach. **J.P.**: joint projection; **U.LPM**: upper head of the lateral pterygoid muscle; **L.LPM**: lower head of the lateral pterygoid muscle.

and under a stereoscope the sphenomandibular ligament's fibers extended toward the tympanosquamosal fissure. With all 12 sides of the specimens, we confirmed that these fibers were connected with the articular disk (**Figure 6**).

Discussion

Studies of the insertions of the lateral pterygoid muscle from lateral or superior perspectives or reconstruction from sections alone are not optimal because of the limited perspective. What then is most important? The answer is simple: to determine whether the muscle fibers are from the superior head or inferior head by tracing the fibers under a stereoscopic microscope. This practice of identifying the muscle fibers with one's own eyes, however simple it may seem, is really difficult because of the muscle fibers' positional relation and thus requires a high level of technical dexterity. After experimenting

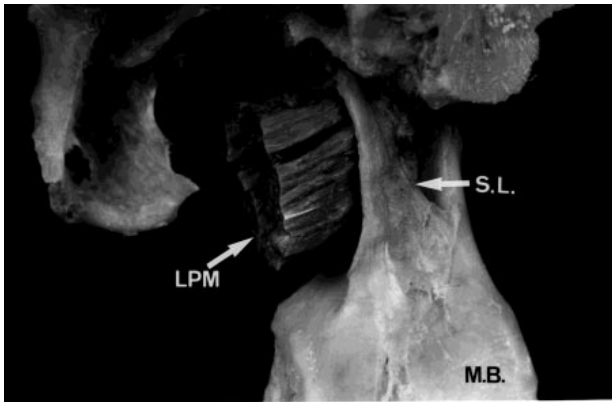

Figure 5
Medial approach. **LPM**: lateral pterygoid muscle; **S.L.**: sphenomandibular ligament; **M.B.**: mandibular bone.

Table 1
Attachments to the Articular Disk

	Mean (n = 20)	S.D.
The circumference length of the articular disk (mm)	59.4	3.1
The width of attachment zone of the upper head muscle fibers (mm)	12.2	2.2
The width of attachment zone of the lower head muscle fibers (mm)	4.1	0.9

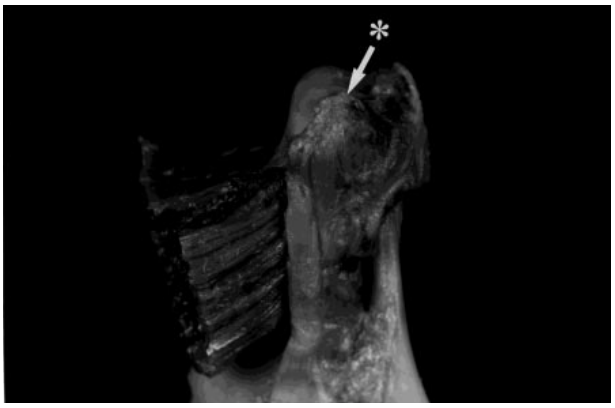

Figure 6
Fibers were connected with the articular disk (❇).

with various methods, Dr. Abe, one of the authors of this study, has established an observation method suitable for observing the peripheral tissues of articular disks.[7] Contrary to previous studies[4] which had demonstrated that there was very little attachment, if any, to the articular disk, the method applied in this study proved the inferior head muscle fibers were firmly attached to the articular disk medially. In terms of the relative position with the mandibular condyle, the lower head muscle fibers extended medially beyond the baseline between the lateral and medial poles. Based on this information, we can say that the muscle fibers can both draw the articular disk anteriorly and balance it by supporting it posteriorly.

Since most of the muscle fibers are attached to the anterior portion of the articular disk, they can cause the anterior transposition of the articular disk as previously reported.[6,8] In consideration of the medio-posterior attachment of the muscle fibers, however, they can pull the articular disk posteriorly. Therefore, we are convinced that these fibers attach to the articular disk beyond the base line and play an important role in balancing, maintaining, and stabilizing the complicated movements of the articular disk.

Table 2
The Angle

	Mean (n = 20)	S.D.
The angle formed between the tip of the attachment area of the upper head muscle fibers and the base line (˚)	-4.7	1.3
The angle formed between the tip of the attachment area of the lower head muscle fibers and the base line (˚)	6.2	2.1

It has long been supposed that the major role of the sphenomandibular ligament is to suppress the movement of the mandible during jaw-opening.[8,9] After observing 12 specimens, we found that the sphenomandibular ligament has two major roles. We found two major bundles of fibers in the ligament. One bundle flows from the spine of the sphenoid and is attached to the tympanosquamosal fissure, and the other attaches to the articular disk.

The sphenomandibular ligament has two attachments to its fibers. The fibers attached to the spine of the sphenoid bone were observed to be strained during the mandible's opening motion. Therefore, we can say that the sphenomandibular ligament functions to limit the movements of the mandible, as previously demonstrated.[9] Close observation of the sphenomandibular ligament during jaw-closing showed that the fibers attached to the spine of the sphenoid bone are relaxed, and the fibers attached to the articular disk are strained. These findings suggest the ligament fibers attached to the articular disk draw the disk posteriorly in its course of mandibular closing, thus enabling the articular disk to move smoothly.

As described earlier,[9] there are few accurate reports on posterior supports for the articular disk. Although there have been many studies on the structure of tissues using slice images as "the posterior connective tissue of the articular disk," they are not convincing as to tissue supporting the articular disk posteriorly. In this study, we obtained new knowledge not only by observing the temporomandibular joint, but by observing the whole ramus of the mandible medially and tracing the sphenomandibular ligament's fibers as they travel to the temporomandibular joint. These important sphenomandibular ligament fibers are hidden in "the posterior connective tissue of the articular disk."

Acknowledgements

The authors wish to thank Professors Bogusch Gottfried, Graf Renate, and Merker Hans Joachim, the Free University Berlin and the Institute for Anatomy, for supporting this study.

References

1. Toller M, Juniper RP: The embryologic development of the human lateral pterygoid muscle and its relationships with the temporomandibular joint disk and Meckel's cartilage. *J Oral Maxillofac Surg* 1993; 51:772-778
2. Schmolke C: The relationship between the temporomandibular joint capsule, articular disk and jaw muscles. *J Anat* 1994; 184:335-345
3. Sicher H: Structual and functional basis for disorders of the temporomandibular articulation. *J Oral Surg* 1955; 13:275-279
4. Pinkert R: Die Beziehungen zwischen dem M. pterygoideus lateralis und dem discus articularis und deren Bedeutung fur die Bewegungen im Kiefergelenk. Zahn-. Mund-u. *Kieferheilkd*, 1984; 72:553-558
5. Troiano MF: New concept of the insertion of the lateral pterygoid muscle. *J Oral Surg* 1967; 25:337-340
6. Porter MF: The attachment of the lateral pterygoid muscle to the meniscus. *J Prosthet Dent* 1970; 24:555-562
7. Abe S, Takasaki I, Ichikawa K, Ide Y: Investigations of the run and the attachment of the lateral pterygoid muscle in Japanese. *Bulletin, Tokyo Dent Coll* 1993; 34: 135-139
8. Wilkinson TM: The relationship between the disk and the lateral pterygoid muscle in the human temporomandibular joint. *J Prosthet Dent* 1988; 60:715-724
9. Burch, J: Activity of the accessory ligaments of the temporomandibular joint. *J Prosthet Dent* 1970; 24:621-628

Dr. Yoshinobu Ide *received his D.D.S. degree from Tokyo Dental College in 1976 and his Ph.D. degree from the same college in 1980. Dr. Ide is currently a Professor in the Department of Anatomy at Tokyo Dental College.*

Dr. Hakubun Yonezu *received his D.D.S. degree from Tokyo Dental College in 1984 and his Ph.D. degree from the same college in 1988. Dr. Yonezu is currently an Instructor at the Tokyo Dental College in the Department of Oral and Maxillofacial Surgery.*