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Course of the Maxillary Vein and its Positional Relationship With the Mandibular Ramus Require Attention During Mandibuloplasty

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Purpose: The maxillary vein is associated with major hemorrhage, an intraoperative risk factor during mandibuloplasty. Our objectives in this study were to identify the anatomical course of the maxillary vein relative to the mandible, and to ascertain the relationship of its course with that of the maxillary artery.

Methods: Thirteen sides of 13 cadavers in the possession of the Department of Anatomy of Tokyo Dental College were used. The maxillofacial region was first dissected, after which the upper part of the mandibular ramus was removed and the maxillary artery, maxillary vein, and pterygoid venous plexus were identified. The length of the maxillary vein and its height from the mandibular plane were then measured, and its anatomical course was recorded.

Results: The maxillary vein ran downward along the inner aspect of the temporal muscle, then from the base of the coronoid process it ran horizontally near the bone surface of the inner aspect of the mandibular ramus. After joining the inferior alveolar vein, it joined the superficial temporal vein to form the retromandibular vein. The mean length of the maxillary vein was 22.2 ± 3.2 mm. At the posterior margin of the mandibular ramus, its mean height above the mandibular plane was 34.2 ± 5.4 mm. From the posterior margin of the mandibular ramus to the lowest point of the mandibular notch, the maxillary vein was located within the areolar connective tissue directly above the periosteum adjoining the inner aspect of the mandibular ramus.

Conclusions: In the wide area from the center of the maxillary notch to the posterior margin of the mandibular ramus, the maxillary vein runs extremely close to the periosteum on the inner aspect of the mandibular ramus, suggesting that it may pose a risk of hemorrhage in various oral surgical procedures.

Key Words: Intraoral vertical ramus osteotomy (IVRO), maxillary vein, pterygoid plexus, ramus of mandible, sagittal split ramus osteotomy (SSRO)

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Advances in therapeutic techniques and surgical devices mean that orthognathic surgical procedures have become widely used as standard in oral surgery.[1–5] Two such procedures, sagittal split ramus osteotomy (SSRO) and intraoral vertical ramus osteotomy (IVRO), account for almost all mandibuloplasty operations.[6,7] Potential complications that require attention during these procedures include major hemorrhage, dysesthesia of the lower lip, and abnormal fracture.[1,8,9] Major hemorrhage in particular may occur at unexpected times and places, and may potentially be fatal. It is therefore important to carry out a preoperative assessment of the courses and positions of major vessels that could be damaged, decide on the approach to be used, and ensure that measures are in place to deal with intraoperative hemorrhage should this occur.[10,11]

The maxillary vein is located on the posteromedial side of the mandibular ramus, and carries the blood collected in the pterygoid venous plexus to the retromandibular vein.[12] Because the retromandibular vein, which originates from the confluence of the maxillary vein and the superficial temporal vein, empties into the internal jugular vein, the maxillary vein is regarded as an important vein draining blood from the maxillofacial region into the cervical region. In a study of important veins in the head and neck, Touré et al investigated the courses of the retromandibular vein and the facial nerve in cadavers, and described 6 different anatomical patterns.[13] Babademez et al noted that damage to the retromandibular vein and the facial nerve, which are located in the parotid space, are risk factors for facial nerve palsy in parotidectomy, and described them as anatomical structures to which attention should be paid.[14] However, almost no studies have focused on the course and distribution of the maxillary vein, which is the source of the blood flow into the retromandibular vein. In particular, basic data on the 3-dimensional positions of blood vessels in relation to bones may help oral surgeons to accurately predict the risk of hemorrhage during a range of different oral surgical procedures.

The maxillary vein runs along the inner aspect of the mandibular ramus, and accurate anatomical knowledge of its course is essential to conduct mandibuloplasty smoothly and safely. The objectives of

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this study were therefore to update our anatomical knowledge of the course of the maxillary vein by identifying its anatomical course relative to the mandible, and to ascertain the relationship of its anatomical course with that of the maxillary artery.

METHODS

Materials

Thirteen sides of 13 cadavers in the possession of the Department of Anatomy of Tokyo Dental College were used. After fixation in 10% formalin, the cadavers had been stored in 70% alcohol. This study was approved by the Ethics Review Board of Tokyo Dental College (ethics review number: 922).

The platysma muscle was detached from the mandible and turned back on itself, and structures including the superficial temporal vein and facial vein were identified, after which the parotid gland and the surrounding connective tissue were carefully removed. Next, the confluence of the internal jugular vein and the retromandibular vein was revealed by dividing the sternocleidomastoid muscle and the posterior belly of the digastric muscle while preserving the external jugular vein. The masseter muscle was then removed to expose the outer aspect of the mandibular ramus, the mandibular lingula on the inner aspect of the mandibular ramus was probed for and the outer aspect was marked, and photographs of the lateral view were taken. In cadavers with a highly developed mastoid process that impeded observations of the region of interest, the mastoid process was also removed. The mandibular ramus was then transected along a line passing through the mandibular lingula parallel to the occlusal plane, and its upper part was removed. The lateral pterygoid muscle was removed, and photographs of the lateral view were again taken after the maxillary artery, maxillary vein, and pterygoid venous plexus had been identified.

Measurement of the Length of the Maxillary Vein and its Anatomical Course

The length of the maxillary vein was measured after its origin where the pterygoid venous plexus is collected and its endpoint at its confluence with the superficial temporal vein had been identified (Fig. 1). Photographs before and after the resection of the mandibular ramus were then superimposed to identify the positional relationship of the maxillary vein and the mandible. A parallel line was drawn in the mandibular plane. The height of the confluence of the maxillary vein and the superficial temporal vein was then measured using this as the reference line. The positional relationship between the maxillary vein and the maxillary artery running alongside it was also explored.

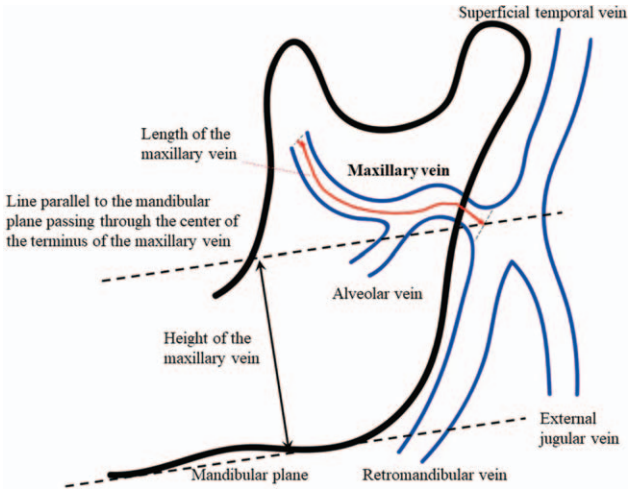

FIGURE 1. Measurements of maxillary vein relative to the mandible.

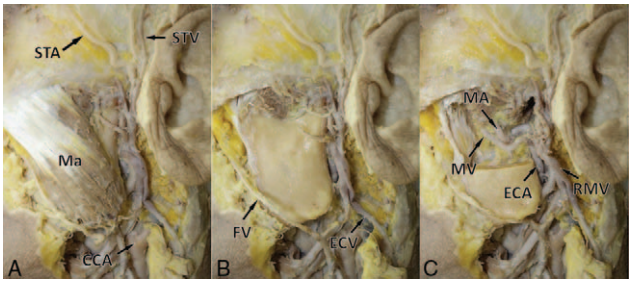

FIGURE 2. Left lateral views of a cadaver mandible and the courses of the surrounding. veins. (A) Mandible with the masseter muscle attached and its positional relationship with the neighboring tissue. (B) Mandible after masseter resection and observation of the neighboring veins. (C) Maxillary vein at the mandibular ramus revealed by transection of the ramus at the height of the mandibular lingula.

RESULTS

The maxillary vein ran downward along the inner aspect of the temporal muscle, then from the base of the coronoid process it ran horizontally close to the bone surface of the inner aspect of the mandibular ramus. After joining the inferior alveolar vein, it joined the superficial temporal vein to form the retromandibular vein (Fig. 2). The maximum length of the maxillary vein was 27.9 mm, its minimum length was 15.3 mm, and its mean length was 22.2 ± 3.2 mm (Supplemental Digital Content, Table 1, http://links.lww.com/SCS/B94). At the posterior margin of the mandibular ramus, its maximum height above the mandibular plane was 43.5 mm, its minimum height was 29.9 mm, and its mean height was 34.2 ± 5.4 mm. In all the cadavers in this study, the maxillary vein was located within the areolar connective tissue directly above the periosteum adjoining the inner aspect of the mandibular ramus, and from the posterior margin of the mandibular ramus to directly under the lowest point of the mandibular notch it ran horizontally in extremely close contact with the periosteum (Fig. 3). At this point in its course, the maxillary vein was sufficiently close to the mandible that it could be seen through the periosteum when the mandibular ramus had been removed. After this, in the area anterior to the lowest point of the mandibular notch the maxillary vein ran perpendicularly through the areolar connective tissue immediately medial to the temporal muscle fascia, and was connected to the pterygoid venous plexus located in the pterygomandibular and infratemporal spaces. In all the cadavers used in this study, the maxillary vein ran along the outer side of the lateral pterygoid muscle and was shallower than (on the outside of) the maxillary artery.

DISCUSSION

Perhaps because intraoperative damage to a vein causes less hemorrhage than does damage to the maxillary artery, there have been few studies focusing on the courses of veins in the maxillofacial region in particular. In fact, damage to the maxillary artery in the region of the mandibular notch during IVRO is the accident that poses the greatest risk of major hemorrhage during mandibuloplasty.[15] In all the cadavers in this study, the maxillary vein ran along the outside of the lateral pterygoid muscle. The maxillary vein always ran alongside the maxillary artery, and was on the outside of this artery in all cases. An anatomical study by Lang et al stated that there are ethnic variations in the course of the maxillary artery,

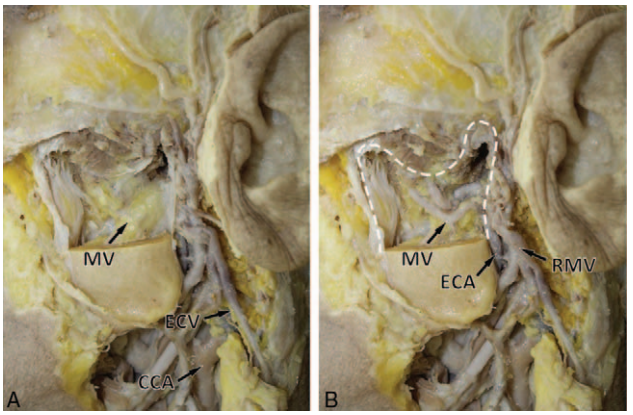

FIGURE 3. Three-dimensional positional relationships of the maxillary vein. (A) Lateral view after resection of the mandibular ramus, with the periosteum on its medial aspect left intact. The maxillary vein can be seen through the periosteum (→) from beneath. (B) Course of the maxillary vein with the mandibular ramus superimposed. The maxillary vein can be seen to run along the inner aspect of the mandibular ramus as far as the front of the mandibular notch. Medially to the coronoid process, it leaves the periosteum and runs perpendicularly to the inside of the temporal muscle fascia.

which runs inside the lateral pterygoid muscle in approximately 45% of Western Caucasians but outside this muscle in approximately 93% of Japanese.[16–18] This means that both the maxillary artery and vein run through the pterygomandibular space in a very high proportion of Japanese, and should therefore be noted.

Next, in our investigation of the anatomical course of the maxillary vein relative to the mandible, we found that its height was almost the same as that of the mandibular lingula in all the cadavers and that it touched the periosteum of the inner aspect of the mandibular ramus. The maxillary vein is thus at risk of damage during the use of a ramus retractor or periosteal elevators and raspatories to dissect the medial periosteum during SSRO, or when carrying out medial osteotomy after the insertion of a progeny retractor. In the area anterior to the lowest point of the mandibular notch, the maxillary vein also ran perpendicularly through the areolar connective tissue immediately medial to the temporal muscle fascia in all the cadavers in this study. This finding suggested that when dissecting the temporal muscle during dissection of medial periosteum for SSRO or IVRO, surgeons should be aware that the maxillary vein is in extremely close contact with the temporal muscle directly underneath, although the presence of the periosteum means that it often cannot be seen.

Non-orthognathic surgical procedures in which the maxillary vein should be carefully noted include coronoid process resection.[19,20] In this procedure, after a mucosal incision has been made at the anterior margin of the mandibular ramus, dissection is performed from the coronoid process to the mandibular notch. After a wire has been passed through an opening made in the anterior margin of the mandibular ramus, a reciprocating saw is used to perform osteotomy from this area to the mandibular notch. In coronoid process resection, the maxillary artery and vein are thus at risk of damage during both periosteal dissection and osteotomy. During mobilization of the temporomandibular joint carried out extra-orally, either adhesions are removed from the outside of the mandibular ramus, or in low operations the mandibular ramus is resected.[21,22] Even when this procedure is carried out using the Al-Kayat technique, which provides a clear field of view, the resection site corresponds exactly with the height and location of the maxillary vein, and caution is therefore required.[23]

In this study of Japanese cadavers, we identified the courses of veins on the inner aspect of the mandibular ramus and around its posterior aspect, areas that are difficult to observe during regular maxillofacial surgery. Our results showed that there is little individual variation in the position and course of the maxillary vein, which is at risk of damage during many surgeries carried out in the maxillofacial area. In the wide area from the center of the mandibular notch to the posterior margin of the mandibular ramus; however, the maxillary vein is in very close contact with the periosteum on the inner aspect of the mandibular ramus. It may thus pose a risk of hemorrhage during surgery involving operations affecting the anterior margin and medial aspect of the mandibular ramus, including orthognathic procedures in which a clear field of view is difficult to secure.

Summarizing, in the wide area from the center of the maxillary notch to the posterior margin of the mandibular ramus, the maxillary vein runs extremely close to the periosteum on the inner aspect of the mandibular ramus, suggesting that it may pose a risk of hemorrhage in a range of different oral surgical procedures.

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