Lingual Perimandibular Vessels Associated with Life-Threatening Bleeding: An Anatomic Study

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Purpose: *To describe the anatomy of the lingual perimandibular vessels and emphasize the distance to the bone.* ***Materials and Methods:*** *The hemifacial lower third was dissected in 12 human cadavers. The blood vessels in the floor of the mouth were exposed using sagittal incisions at the canine, mental foramen, and second molar areas.* ***Results:*** *The diameter of the dissected vessels ranged from 0.5 to 3 mm (mean, 1.5 mm). Most vessels were found superior to the mylohyoid muscle in the canine area and beneath the muscle in the mental and second molar areas. The smallest median vertical distance from blood vessel to bone was in the canine area (14.5 mm), followed by the mental foramen area (15.5 mm) and the second premolar area (19 mm). The median horizontal distance of the vessels from the lingual plate was 2 mm at the canine and second molar areas and 4 mm at the mental area.* ***Discussion:*** *Lingual plate perforation, especially anterior to the canine area, can easily injure blood vessels in the floor of the mouth and cause life-threatening hemorrhage following implant placement. Bleeding can occur when the mandibular lingual plate is perforated. Care should be taken to recognize situations where this complication may occur.* ***Conclusions:*** *Based on the study of human cadavers, it appears that vessels in the floor of the mouth are sometimes in close proximity to the site of implant placement. Caution should be exercised when placing implants in this area.* (Basic Science) Int J Oral Maxillofac Implants 2007;22:127–131

Key words: *dental implants, lingual perimandibular vessels, sublingual artery, submental artery*

Dental implant placement is a relatively safe procedure. However, surgical complications can occur. Sublingual hematoma during surgical placement of mandibular dental implants is a rare but potentially life-threatening complication.[1–13] Bleeding can result from damage to the lingual perimandibular vessels primarily caused by perforation of the lingual cortex during drilling of the implant socket. The hemorrhage can spread in the loose tissues of the floor of the mouth, eg, the sublingual space and the space between the lingual muscles. Swelling can develop rapidly and cause airway obstruction, which may require intubation or an emergency tracheotomy. Similar complications have been observed during other surgical procedures in the floor of the mouth and alveolar crest, such as lingual local anesthesia, biopsy specimen removal, ranula removal, and root extraction.[14–16]

Blood vessels attached to the mandibular lingual plate are considered terminal small-diameter vessels. They mainly originate from the sublingual artery or the submental artery in the floor of the mouth. Several anatomic studies have been conducted regarding the blood supply of the floor of the mouth. However, these studies focused on the origin, diameter, and course of the vessels[17,18] rather than on the correlation between the mandibular bone and the distance between the vessels and the bone. The possibility of injuring the lingual perimandibular vessels depends on the type and diameter of the vessel and on its proximity to the mandibular bone.

The purpose of the present study was to characterize the anatomy of the lingual perimandibular vessels with special focus to the distance to the bone. The results are discussed in light of a comprehensive review of the literature.

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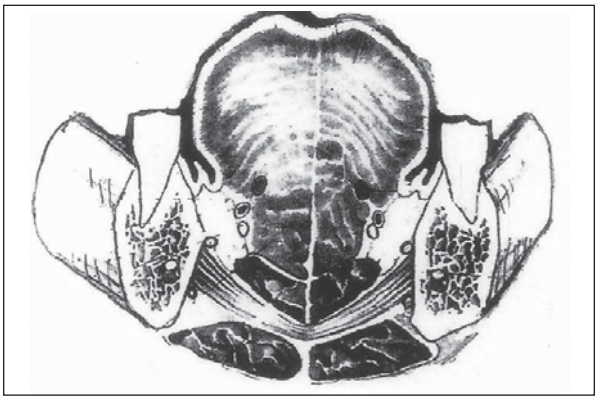

Fig 1 Incisions divided each area into an "open book," exposing the perimandibular blood vessels at the floor of the mouth.

Table 1 Anatomic Relationship Between Blood Vessels and Neighboring Structures

	Area of incision		
	Canine	Mental	Second molar
No. of mandibles in which vessels were identified	12	10	9
Type of vessel identified			
Veins only	7	8	4
Arteries and veins	5	2	5
Alveolar crest* (mm)			
Range	6–26	2–26	2–22
Mean	15.6	15.3	11.6
Median	14.5	15.5	19
Lingual plate† (mm)			
Range	1–7.5	1–9	1–7
Mean	2.8	3.95	2.8
Median	2	4	2
Mylohyoid‡			
Above	11	3	2
Below	1	7	7

*Vertical distance from the alveolar crest to the vessels entering lingually.
†Horizontal distance of the vessels from the lingual plate.
‡Location relative to the mylohyoid muscle.

MATERIALS AND METHODS

The study consisted of 12 human cadavers, with equal gender distribution. Age ranged from 58 to 86 years (mean, 72 years). The hemifacial lower third was fixed in 4% formalin supplied by the Department of Anatomy, Tel Aviv University. Specimens were dissected by 3 sharp sagittal incisions at the canine, mental foramen, and second molar areas. The surgical incision included a cross-section of the buccal perimandibular soft tissue, submandibular floor of the mouth, tongue, and mandibular bone. The incisions divided each area into an "open book" (Fig 1), exposing the perimandibular blood vessels at the floor of the mouth.

The type of vessel (either artery or vein), diameter, relation with the mylohyoid muscle, and distance from the lingual plate and from the alveolar crest were recorded. Since incisions were sagittal, the vessels could not be traced to their origin, ie, the sublingual artery/vein or the perforating vessels of the submental artery. Vessels found under the mylohyoid muscle were identified as submental.

Each mandible was classified according to ridge type following the classification of Lekholm and Zarb.[19]

RESULTS

Six of the 12 hemimandibles were edentulous. Three ridges were classified as type A, 2 as type B, and 2 as type C. Five ridges were considered a combination of types A, B, and C. Table 1 summarizes the anatomic relationships between the blood vessels and the adjacent structures. In the canine area, vessels were identified in all 12 mandibles dissected; in the mental area, vessels were identified in 10 of 12 mandibles, and in the second molar area, vessels were identified in 9 of 12 mandibles. The diameter of the dissected vessels ranged from 0.5 to 3 mm (mean, 1.5 mm; median, 1.2 mm).

Submental vessels were seen at all premolar and second molar areas where vessels were identified.

Type of vessels found in the dissected area varied along the dissected planes. In the canine area, veins were found in 7 cases and both arteries and veins in 5 case. In the mental area, 8 cases contained veins, and both an artery and a vein were observed in 2 cases. In the second molar area, veins were identified in 4 cases and both arteries and veins were identified in 5 cases. Most vessels were found above the mylohyoid muscle in the canine area and beneath the muscle in the posterior areas.

The distance measured between the vessels and mandibular bone showed wide variability in both dimensions. The mean vertical distance from the alveolar crest to the vessels was smaller in the second molar area (mean, 2.8 mm) than in the canine and mental areas. The mean horizontal distance of the vessels from the lingual plate was smaller in the canine and second molar areas and longer in the mental area.

DISCUSSION

An atrophic edentulous ridge may allow blood vessels to lie against the bone, giving rise to severe hemorrhage when the vessel is injured following bone perforation. In the floor of the mouth, there are 2 ves-

Table 2 Literature Review: Life-Threatening Hemorrhage Following Implantation

Author/year	Patient Age	Patient M/F	Location	No. of Implants	Size of implants	Treatment
Krenkel & Holzner 1986[12]	59	F	Anterior mandible	1	–	Hemostasis
Laboda 1990[8]	67	M	Mandibular symphysis	2	–	Intubation, artery ligation
Mason et al 1990[10]	54	F	Interforaminal area	5	18 mm long	Intubation, artery ligation
Givol et al 1990[5]	63	F	Left mandibular canine	1	3.75 mm wide, 18 mm long	Tracheotomy, artery ligation
ten Bruggenkate et al 1993[6]	58	F	Interforaminal area	3	–	Intubation, hemostasis
Darriba & Mendonca-Caridad 1997[7]	72	M	Mandibular symphysis	4	–	Tracheotomy, artery ligation
Mordenfeld et al 1997[4]	69	F	Interforaminal area	5	15 to 18 mm long	Intubation, hematoma evacuation, artery ligation
Panula & Oikarinen 1999[11]	42	M	Mandible canine	2	–	Artery ligation
Niamtu 2001[3]	64	F	Mandibular canine	2	–	Tracheostomy
Weibrich et al 2002[9]	60	M	Mandible First molar area	1	10 mm long	Facial artery ligation
Boyes-Varley & Lownie 2002[2]	50	M	Mandible Lateral incisor area	1	3.75 mm wide, 15 mm long	Tracheotomy, artery ligation
Ratschew et al 1994[13]	80	M	Canine area	1	–	Local pressure intubation
Isaacson 2004[1]	56	M	Interforaminal area	5	15 mm long	Local pressure

– = not reported.

sels: the submental artery (a branch of the facial artery) in the middle lingual mandible and the sublingual or submental arteries in the anterior mandible terminal branches.[20] The sublingual and submental arteries run anteroposteriorly above and below the mylohyoid muscle respectively; the submental artery penetrates the muscle into the floor of the mouth, anastomosing with the sublingual artery. The submental artery is important either as a supplementary or principal source of blood supply to the floor of the mouth.[17,18] The vessels were not traced to their origins in the present study; nevertheless, most vessels were located above the mylohyoid muscle in anterior areas and below the muscle in posterior areas, which may support the existence of additional vessels in the anterior mandible originating from below the mylohyoid muscle.

Perforation of the bone cortex can cause injury to the blood vessels, giving rise to severe hemorrhage and, in rare cases, life-threatening complications. A search of the literature between the years 1960 to 2004 disclosed 14 reported cases of life-threatening bleeding associated with dental implantation (Table 2). Most occurred anterior to the canine. In the edentulous patient, bone loss in the anterior mandible is horizontal, resulting in lingual angulation of the anterior mandible. A relatively long implant drilled in a vertical position can easily cause perforation. In the present study, the vessels were closer to the lingual plate and to the alveolar crest in the canine area than in the posterior regions (Table 1). Hemorrhage in the symphyseal region has been recorded as a result of injury to an intrabony artery.[7,8] It has been suggested that the main blood supply to the intercanine area is a single common arterial branch of the 2 opposite sublingual arteries that penetrate the mandible at the symphyseal area (Fig 2).[21] Using an ultrasound/doppler, Lustig and coworkers[22] found the diameter of that artery to be 0.18 to 1.8 mm, with a blood flow of 0.7 to 3.7 mL/minute, which explains the profuse hemorrhage that occurred upon injury.

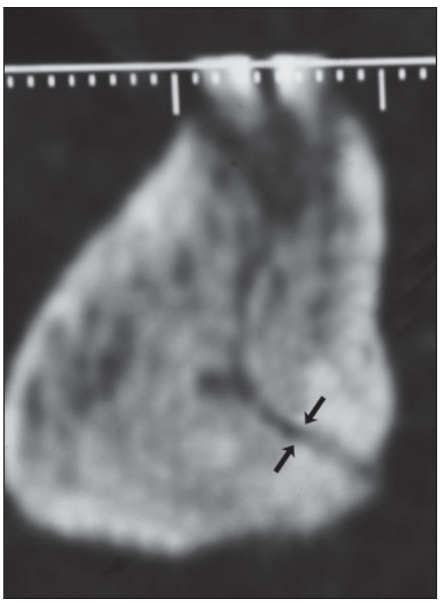

Fig 2 A CT scan demonstrating the main blood supply to the intercanine area through a single common arterial branch of the 2 opposite sublingual arteries that penetrate the mandible in the symphyseal area.

Potential injury to the blood vessels in the floor of the mouth depends on bone morphology at the surgical site, the diameter of the vessel, and the distance from the bone surface. Bone morphology should be carefully studied, especially in the atrophied mandible. The lingual angulation and the presence of sublingual fossa determine the inclination of the implant. Diagnostic knowledge of the surrounding soft tissue is mandatory. Blood vessels lie near the bone surface; the horizontal distance of the vessels from the lingual plate was found to be as short as 1 mm (range, 1 to 9 mm; Table 1). The shortest median distance of the vessels from the bone was recorded in the canine area. Therefore, laceration of blood vessels can be anticipated when the bone cortex is even slightly perforated. Nevertheless, in most cases the vessels are deeply situated. The vertical distance from the alveolar crest to the vessels entering lingually, ranged from 2 to 26 mm (median, 14.5 to 19 mm). This means that a long implant is needed to injure the blood vessels. In type A and B ridges, Lekholm and Zarb[19] recommend placement of implants no longer than 13 mm. In atrophied mandibles (types C and D), the vertical and horizontal dimensions are shorter, and implant length should be considered carefully.

Vessels can be as wide as 2 to 3 mm in diameter. Drilling can cause slight perforation of the mandibular lingual plate. For example, the drill could easily slip caudally 1 to 3 mm, causing a major hematoma and damage to the blood vessels.

Pre- and intraoperative assessment of bone morphology is essential to avoid perforation. Adequate diagnostic imaging, mainly computerized tomography (CT), is suitable for analysis of bone morphology. Dental CT can also demonstrate the site of entrance of the vessels into the lingual mental region.

When injury occurs to the blood vessels, basic bleeding measurements should be taken and immediate bimanual compression should be applied (posteriorly over the course of the arteries) to the suspected perforation site. Pressure over the anterior notch may control bleeding for vessels suspected of originating from the facial artery. For hematomas arising after implant placement, hemostasis should achieved by local pressure, and the patient should be transferred immediately to the emergency room for observation and airway management if necessary.

Injury to the vessels in the floor of the mouth is probably more prevalent than reported. Care should be taken when operating in the anterior mandible. Adequate diagnostic radiographs and appropriate operative procedures should be used, and awareness of the possible life-threatening emergencies that can arise is also essential.

CONCLUSIONS

Based on the study of human cadavers, it appears that vessels in the floor of the mouth may be in close proximity to the site of implant placement in some cases. Caution should be exercised when placing implants in this area.

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JOMI 2006 Outside Consultants

In the past year, a number of nonaffiliated consultants were invited by the editorial staff to serve as referees in paper reviews requiring their particular expertise. *The International Journal of Oral & Maxillofacial Implants* hereby gratefully acknowledges the contributions of these individuals, who gave so generously of their time and talents:

Tara Aghaloo, Stephen F. Balshi, Bruce Bavitz, Thomas Bernhardt, Robert Brey, Giuseppe Cardaropoli, David Chvartszald, Nicholas Dello Russo, Ingvar Ericsson, Stuart Froum, Paul Fugazzotto, Ray Gustafson, Keith Kirkwood, Georg Mailath-Pokorny, Eduardo Moraes, Sinan Muftu, Erik L. Ritman, Tom Vergo, Werner Winter