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Review Article

Interforaminal hemorrhage during anterior mandibular implant placement: An overview

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ABSTRACT

Implant surgery in mandibular anterior region may turn from an easy minor surgery into a complicated one for the surgeon, due to inadequate knowledge of the anatomy of the surgical area and/or ignorance toward the required surgical protocol. Hence, the purpose of this article is to present an overview on the: (a) Incidence of massive bleeding and its consequences after implant placement in mandibular anterior region. (b) Its etiology, the precautionary measures to be taken to avoid such an incidence in clinical practice and management of such a hemorrhage if at all happens. An inclusion criterion for selection of article was defined, and an electronic Medline search through different database using different keywords and manual search in journals and books was executed. Relevant articles were selected based upon inclusion criteria to form the valid protocols for implant surgery in the anterior mandible. Further, from the selected articles, 21 articles describing case reports were summarized separately in a table to alert the dental surgeons about the morbidity they could come across while operating in this region. If all the required adequate measures for diagnosis and treatment planning are taken and appropriate surgical protocol is followed, mandibular anterior region is no doubt a preferable area for implant placement.

Key Words: Clinical protocol, dental implantation, diagnostic imaging, hemorrhage, mandible, safety

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INTRODUCTION

Placing dental implant in the mandibular anterior region is believed to be a regular and a relatively simple and safe procedure; however the current concepts indicate that this region is susceptible to potential morbidity and should be operated with caution.

In the mandibular anterior lingual region, blood vessel are considered to be of 1-2 mm diameter and it has been estimated in the study conducted by Flanagan that 400 ml of blood could be drained from a blood vessel of 1-2 mm intravascular diameter in 30 min.[1] This data gives the idea of an alarming situation if hemorrhage occurs in the mandibular anterior lingual region. In addition, since the mandible and the superficial layer of deep cervical fascia provide restriction to the hematoma anteriorly, the sublingual and the submandibular hematoma extend superiorly and posteriorly displacing the tongue and the floor of mouth to obstruct the airway [Figure 1].[2-4] Cases with delayed postoperative hemorrhage have also been reported, which could be linked to the compensatory vasodilatation of the offended vessel due to gradual absorption of epinephrine, loss of clot and presumptive bleeding.[5-7] The exploration of hematoma in this region is very technique sensitive because of engorgement of the tissues and the nature of injured arteries to retract into deeper

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Figure 1: Frontal and lateral views of the patient after emergency tracheostomy. Note the severe hematoma of the tongue and floor of the mouth. The tongue is blue from extravasation of blood, and the submental area is grossly expanded from hematoma. It is this type of swelling that forces the tongue against the hard and soft palate and obstructs the airway. (Adopted from Naimtu J 3rd. Near-fatal airway obstruction after routine implant placement. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2001;92:597-600) [Publication permission License number 3535430380325].

tissues. This further adds to the woe and increases the complications. It has also been reported that placing implants in mandibular anterior region has claimed three lives of otherwise healthy individuals, which included a 16-year-old teenager.[8] In the last 10 years, no article has been found briefing about the precautionary measures, etiology and management of the aforementioned situation.

Hence, the purpose of this article is to: Overview the published literature relevant to defined inclusion criteria and thereby:

1. To tabulate the cases reported between 1986 and 2013 in order to give a quick overview to the dental surgeons about the potential morbidity they could come across while placing implants in this zone and to have a comprehensive view on reasons of occurrence of such incidents.
2. To present a protocol to avoid inter-foraminal hemorrhagic incidents and for their immediate management, if at all such a situation arises during or after implant placement.

MATERIALS AND METHODS

To select the articles to be included in this overview, following inclusion criteria were defined.

Inclusion criteria

- Articles describing case reports of hemorrhagic incidence during anterior mandibular implant placement.
- Articles describing anatomy of anterior mandibular region.
- Studies evaluating various dental imaging modalities.
- Studies describing various approaches to managing hemorrhagic incidents involving the floor of the mouth.

An electronic search was executed using the key words: Arteries, bleeding, cone beam computed tomography (CBCT), dental implants, dental radiography, hemostasis, naso-tracheal intubation, preoperative care and tracheostomy. This search was supplemented by a manual search accessing the secondary references cited in all selected publications as well as by referring to the textbooks pertaining to the topic. All selected articles were evaluated in detail to classify the information given into four sections as follows:

1. Possible reason for hemorrhagic incidence in inter-foraminal region.
2. Why the hemorrhagic incidence in mandibular anterior region is considered so hazardous.
3. The preventive measures to be considered before proceeding towards implant placement in this region.
4. Different options to manage such incidents if it happens.

All the collected information was then formulated to present a protocol, which may act as a guide for any operator who is planning to place dental implants in inter-foraminal region. The articles describing case reports were tabulated to present a bird's eye-view on this situation and warn the implantologists about the graveness of the hemorrhagic consequences of implant placement in this region.

RESULTS

From the articles that appeared through these different keywords, 52 articles were selected according to the defined inclusion criteria to form an overview on the safety protocols for surgical implant placement in inter-foraminal region and of these selected articles, 21 articles[2-7,9-23] describing case reports of hemorrhagic accident in mandibular interforaminal region during implant placement were tabulated in Table 1 to present a brief overview of morbidity a dental surgeon could come across if such incident occurs.

Table 1: Case reports with IF hemorrhagic incident after IMP placement in this region

References	Details of IMP placement	Haemorrhage		Airway management	Hematoma management
		Onset	Reason		
Krenkel *et al.* 1985[5]	1 IMP in PEM (number 22)	After 4 h	PRF (O)	Intubation	IMP removal evacuation
Mason *et al.*[6]	5 IMP in CEM for FP (number 27: 18 mm)	After 4-5 h	PRF (S)	NST intubation	Compression evacuation (INT) Ligation (INT)
Laboda[9]	2 IMP in CEM for OD (number 22)	Suturing	—	Intubation	Compression evacuation (EXT) Ligation (EXT)
ten Bruggenkate *et al.*[7]	3 IMP in CEM for OD (number 22 or number 27)	After 6 h	—	NST intubation	Haemostatic agents evacuation (INT)
	4 IMP in CEM for OD (number 28)	IOP	PRF (O)	Observation	Compression evacuation (INT)
Ratschew *et al.*[10]	4 IMP in CEM (number 27: 15 mm)	IOP	PRF (O)	Intubation	Conservative (compression)
Mordenfeld *et al.*[11]	5 IMP in CEM for FP (number 27: 15 mm)	Implantation	PRF (S)	NST intubation	Evacuation (EXT) Ligation (EXT)
Darriba and Mendonca-Caridad[12]	4 IMP in CEM	Implantation	DSM	USC intubation tracheostomy	Evacuation (INT) Ligation (INT)
Panula and Oikarinen[13]	4 IMP in PEM	After 30 min	TLP	Intubation	Compression surgical exploration (INT)
Givol *et al.*[14]	Immediate IMP in PEM (number 22: 18 mm)	Suturing	PRF (R)	USC intubation tracheostomy	Mucosal incision ligation (INT)
Niamtu[15]	2 IMP in CEM (number 22)	IOP	PRF (O)	USC intubation laryngeal mask tracheostomy	Conservative (haemostatic agent) (compression)
Boyes-Varley and Lownite[16]	Single IMP (number 23: 15 mm)	After 30 min	PRF (RS)	Tracheostomy	Surgical exploration (INT)
Isaacson[17]	Number 27: 15 mm	During implantation	PRF (R)	Expectant	IMP removal evacuation ligation (IO)
Kalpidis and Konstantinidis[18]	Number 28: 15 mm	During implantation	PRF (O)	Expectant	Compression
Budihardja *et al.*[19]	4 IMP IF	After second stage surgery	PRF (R)	Intubation	Evacuation ligation
Woo *et al.*[20]	4 IMP (number 25)	During implantation	PRF (O)	Tracheostomy	Evacuation ligation
Pigadas *et al.*[2]	Anterior mandible	During implantation	PRF (O)	Tracheostomy	Administration of IV steroids
Dubois *et al.*[3]	Number 27	During implantation	PRF (O)	Tracheostomy	Compression
	Number 27 L, 12 mm	After 6-7 h	PRF (R)	Tracheostomy	Compression evacuation ligation
Frenken *et al.*[21]	Two IMP	During implantation	PRF (O)	Intensive observation	Administration of medication
Felisati *et al.*[4]	IMP in anterior mandible	After implantation	PRF (O)	Tracheostomy	Ligation of mylohyoid artery
Lee *et al.*[22]	Number 22, 15 mm	During implantation	PRF (O)	Not required	Floseal application
Sakka and Krenkel[23]	4 IMP IF (diameter: 4.1 mm, length: 16 mm)	After implantation	PRF (S)	Observation	Electro cauterization of bleeding vessel

IMP: Implant; IF: Inter-foraminal; CEM: completely edentulous mandible; PEM: partially edentulous mandible; FP: Fixed prosthesis; OD: Overdenture; site of bleeding has been presented within parentheses followed by implant length, if provided; IOP: Implant osteotomy preparation; DSM: Detrimental surgical manipulation; TLP: tear of lingual periosteum; PRF: Perforation of lingual plate which was felt through osteotomy (O), Detected surgically (S), or revealed radiographically (R); NST: Nasotracheal; USC: unsuccessful; INT: Intraoral approach; EXT: Extra oral approach

DISCUSSION

There are many possible causes for hemorrhagic accidents after/during implant placement which are well documented in various articles published in this regard. Apart from gross negligence on the part of the dental surgeon which includes inadequate investigations, wrong diagnosis, tissue mishandling, etc., there are some situations where likeliness of hemorrhage increases even after taking adequate precautionary measures. These situations may be summarized as follows.

Regional anatomy

The most likely reason for hemorrhages to occur was bleeding from sublingual artery or its branches secondary to the lingual cortex perforation, during osteotomy preparation for implant placement.[19] Furthermore, in the review of literature it was found that in the canine region the sublingual artery follows a horizontal course to the direction of drill, but 90° to the spin of drill; therefore, at this site the sublingual artery is at greater risk for laceration or transection.[24] Several authors have concluded that the lingual aspect

of central and para-symphysial mandibular region are very richly supplied by arterial plexus, which increases the probability of severe bleeding in this region.[1,25] Another cause of hemorrhage could be due to resorption patterns, which are centrifugal in maxilla and centripetal in mandible. If this fact is ignored, prosthetically driven implants may get angulated in severely atrophic jaws resulting in lingual perforation and severe hemorrhage.[26] The lingual periosteum is richly supplied by blood vessels [Figure 2]. Any flap tearing at the time of flap elevation may turn out to be the reason for hemorrhage.[19] Sometimes extensive detrimental surgical manipulations into the deep muscular layers of the floor of the mouth or direct multiple arterial damage could lead to such life threatening hemorrhage.[26]

Anatomic variation of principal arteries in this region

The textbooks of anatomy mention the sublingual branch of the lingual artery as the principal blood vessel to supply the floor of mouth; however, variations have been reported in many recent cadaver studies describing submental branch of facial artery as the main supply for this region.[25,27] Extensive arterial anastomoses have been reported in the mandibular anterior lingual region [Figures 2 and 3]. The mylohyoid muscle has been considered as an extensive anastomosing field between the sublingual and submental arteries. However, their anatomical variations were highly debated in the literature. Bavitz *et al*., in his cadaver study, found that in 53% of cases sublingual artery was either small, unimportant or absent.[27] In another relevant article published by Hofschneider *et al*., it was found that incidence of missing sublingual artery (29%) and the frequency of large submental arterial branch in sublingual region (41%) were significantly lower.[25] Despite the difference in opinion regarding its occurrence, these arteries may lie superficially in atrophic cases and can be considered as potent reason of hemorrhage, if traumatized, during implant placement.

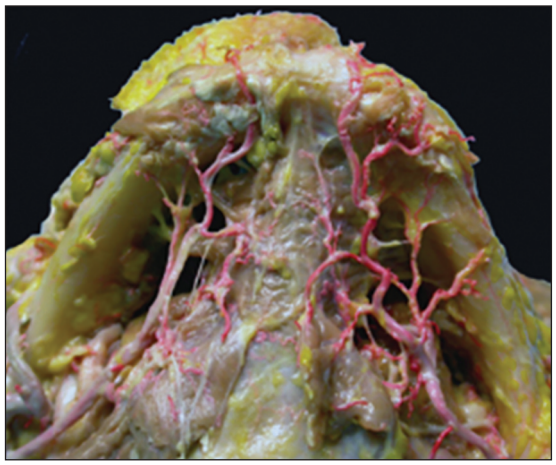

Figure 2: A branch of the submental artery perforating the mylohyoid muscle is often present in the floor of the mouth. For this reason, this artery must be considered as either an important supplementary or a principal source of blood supply to the floor of the mouth. (Adopted from Rosano G, Taschieri S, Gaudy JF, Testori T, Del Fabbro M. Anatomic assessment of the anterior mandible and relative hemorrhage risk in implant dentistry: A cadaveric study. Clin Oral Implants Res 2009;20:791-5) [Publication permission license number 3537451021820].

Accessory lingual mandibular foramen of anterior segment

Presence of numerous accessory foramina in both buccal and lingual surfaces of the mandible has been widely documented.[5,22] They vary in the content, distribution, size, position, and incidence. Of these accessory lingual mandibular foramina, the median lingual foramen [Figure 4] is most consistent and had been reported in 85–99% of cases.[5,22] Its mean diameter has been reported to be 0.54 mm and location may vary from 10 to 13.7 mm from inferior alveolar border [Figures 4 and 5].[22,28] The lateral lingual foramen has been stated to be situated 6 mm from the inferior mandibular border, but when compared to the median lingual foramen, location of the lateral lingual foramen [Figure 5] is even more variable.[22,26]

Figure 3: Perforating anastomosing branches of left and right sublingual arteries. (Adopted from Rosano G, Taschieri S, Gaudy JF, Testori T, Del Fabbro M. Anatomic assessment of the anterior mandible and relative hemorrhage risk in implant dentistry: A cadaveric study. Clin Oral Implants Res 2009;20:791-5) [Publication permission license number 3537451021820].

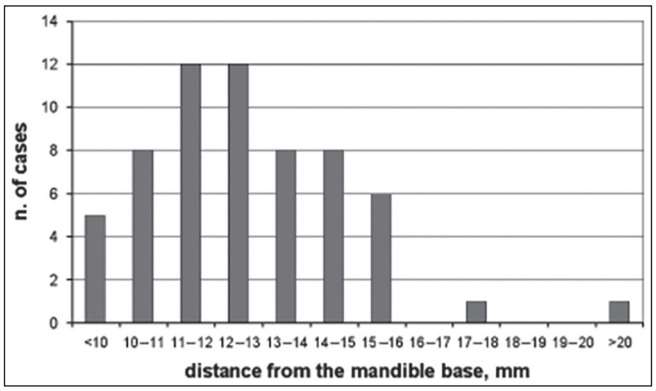

Figure 4: Distribution of the superior genial foramina according to the vertical distance respect to the mandible base. (Adopted from Rosano G, Taschieri S, Gaudy JF, Testori T, Del Fabbro M. Anatomic assessment of the anterior mandible and relative hemorrhage risk in implant dentistry: A cadaveric study. Clin Oral Implants Res 2009;20:791-5) [Publication permission license number 3537451021820].

The arteries associated with the accessory lingual foramina are of sufficient size to be demarcated as a cause in severe hemorrhagic episodes during implant placement in mandibular inter-foraminal region.[26]

Sublingual fossa

It is present in the lingual aspect of the anterior mandible, spanning between lateral incisor and first premolar.[5] Its concavity varies from barely discernable to severely pronounced. This region is highly vulnerable for perforation during implant placement procedure [Figure 6].[25]

Mandibular incisive canal

Trauma to mandibular incisive canal (MIC) can lead to severe bleeding. A study has shown that MIC should also be considered as limiting factor for deciding the length of the implant apart from the mental anterior loop when placing implants in the anterior region. This fact is often ignored as a panoramic radiograph can detect only 2.7% of MIC where as its occurrence has been shown in 95% of cases. Hence, the authors suggest for the use of more advanced forms of diagnostic aids such as CBCT to detect MIC.[29]

Preventive measures to be considered before or during inter-foraminal implant placement

While placing implants in the inter-foraminal region, implant length and angulations must be well planned before the gentle surgical manipulation of lingual soft tissue.[26,30] Here are few measures which may help the dental surgeons in preventing an inadvertent hemorrhage.

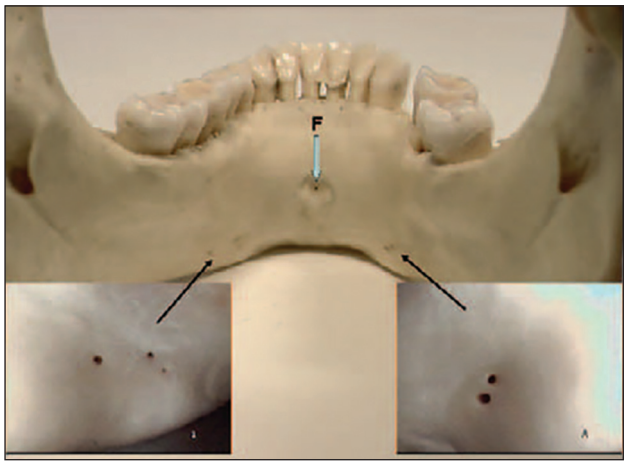

Figure 5: In a dry mandibular specimen, there is a superior genial spinal foramen (see arrow F) and several lateral lingual foramina located on both left and right sides in the mandibular anterior region. (Adopted from Liang X, Lambrichts I, Corpas L, Politis C, Vrielinck L, Ma GW, Jacobs R. Neurovascular Disturbance Associated with Implant Placement in the Anterior Mandible and its Surgical Implications: Literature Review including Report of a Case. The Chinese Journal of Dental Research 2008;11:56-64) [Publication permission obtained].

Proper diagnostic imaging

Due to the presence of anatomical variations in mandibular anterior lingual region, it is very much indicated to incorporate various imaging modalities in diagnostic procedures before proceeding with implant surgeries in this region so as to presume any possible danger while performing implant placement. Imaging procedures commonly employed in planning implant include:

1. Periapical radiograph.
2. Occlusal radiograph.
3. Orthopantamograph.
4. Computed tomography scan.
5. Cone beam computed tomography scan.

Periapical radiograph

Paralleling technique can be used to minimize image distortion although it is less practical in the anterior region where mandible is curved. Errors may get induced by bending the radiographic film to minimize patient discomfort.[31] Hence, extra cautions should be applied while interpreting these images for evaluation of mandibular canal position, facial and lingual concavities present in mandibular anterior region and ridge width.

Occlusal radiograph

It may assist in providing information about the deep lingual fossa, but most of the time the base

Figure 6: Anatomic view of the sublingual fossa of the mandible (arrow). (Adopted from Hofschneider U, Tepper G, Gahleitner A, Ulm C. Assessment of the blood supply to the mental region for reduction of bleeding complications during implant surgery in the interforaminal region. Int J Oral Maxillofac Implants 1999;14:379-83) [Publication permission obtained].

or the crest of the mandible overlap and render the radiograph diagnostically useless in this regard.[32]

Panoramic radiograph

It is very useful in analyzing the jaw anatomy and related anatomical structure grossly. It has limitations such as lack of image sharpness, distortion of image size up to or more than 30%, if patient position is compromised. This imaging modality is very unpromising in estimating the amount of alveolar bone particularly in horizontal planes and predicting the presence of any concavities in the mandibular anterior alveolar process.[32] These limitations should not be allowed to be the reason of poor diagnosis. Though mental foramen is found to be identifiable in a good percentage of panoramic radiographs, the visibility of the anterior loop of the mental nerve and incisive canal is controversial. In a study conducted by Jalili *et al*., mental foramen, anterior loop of the mental nerve and incisive canal was seen in 94%, 66% and 70.6% of evaluated panoramic radiograph.[33] In another study conducted by Jacobs *et al*., mental foramen, incisive canal and anterior loop of mental nerve was identified in 71%, 15% and 11% images respectively, but mandibular canal was observed in 99% of cases.[34] The author in the article gives reason for this variation between the observation of incisive and mandibular canal on panoramic radiograph as incisive canal is less corticalized and is of smaller diameter than mandibular canal; moreover, X-ray beam in panoramic radiograph is angulated about 7-8° from below which could result in misinterpretation due to distortion of mandibular anatomical image. Many authors have concluded that in order to detect MIC, cross-sectional imaging technique has definite advantage over panoramic or other imaging technique which are two-dimensional, especially in cases where <15 mm of bone is remaining in height for implant placement.[35,36]

Traditional computed tomography scan

It offers all ranges of images like cross-sectional, panoramic or three-dimensional view. Due to high discriminate gray scale discrimination, both the soft and the hard tissue can be identified. Yoshida *et al*. in their study concluded that radiographic visualization of lingual arteries is very tough, but vascular canals can be identified in CT very adequately.[37] In the study of Jacobs *et al*., they confirmed lingual foramen and incisive canal visibility on CT of 82% and 93% of population.[35] Due to the multiplanar reformation characteristic of CT, midline structures of the mandible are visible very clearly. Furthermore, the lingual canals and its size depicted by the CT correlate very well with the data of anatomical studies. Few limitations of CT include difficulty in visualizing small canals. This is an important concern in the analysis of mandibular anterior region for implant placement.[38] In spite of its minor limitation in interpreting interforaminal region of mandible, CT has been concluded to be very accurate to visualize position or anatomy of any structure, topography of bone and diagnosing dental implant associated bony pathology.[38]

Cone beam computed tomography scan

Cone beam computed tomography provides three-dimensional reconstruction and unique cross-sectional view. It assists in the diagnosis, treatment planning including vertical implant placement and transfer of the treatment plan to surgical sites.[39] Its advantages over other imaging modalities are:

- Mandibular foramen was visible in 100%, anterior loop in 84%, incisive canal in 83% and lingual foramen in 49% of cases as concluded by Parnia *et al*.[40]
- Incisive canals are visible in 83.5% and the lingual foramen can be identified in 81% of scans, as concluded by Makris *et al*.[41]
- In regard to linear accuracy of measurements obtained from images of CBCT and CT, CBCT image has been found to be more accurate.[42]

The voxel size of CT scan is 0.5 mm at minimum where as in CBCT it is 0.1 mm. Hence, CBCT images are sharper and diagnostically clearer.[43]

- Panoramic images reformatted from CBCT scan show better diagnostic results than ordinary digital panoramic images.[44]

In spite of all its advantages, few limitations of CBCT include marginal inaccuracy of measurements and the fact that measurements obtained by CBCT are proved to be less accurate compared with the ridge mapping technique.[45] Among the various imaging modalities available to be used in implant treatment planning, CBCT scan has been proved to be gold standard till the date, as it also enables us to do the digital preoperative mockup before proceeding with implant placement.

Implant length determination

To avoid any unwanted complication, the safety margin of 2 mm from the roof of the canal should not be violated.[46] Though, in all the published articles, the exact site liable for massive bleeding and the associated length of implant or implant osteotomy preparation depth has not been mentioned, most of the hemorrhagic cases have been reported in the canine region with the length of implant or implant osteotomy preparation depth of ≥15 mm.[5-7,9-11,23,25] Many authors in their studies have come to the conclusion that bicortical stabilization in this region is not very necessary for implant success as the bone quality is dense and cortical in nature. This fact stresses that the benefit versus risk ratio should be considered before selecting more than 13 mm implant.[14] Also, due to the presence of accessory lingual foramina within 10-13.5 mm from inferior border of mandible[22,26,28] [Figures 4 and 5], it is always safer to subtract this distance from the total height of mandible before deciding for length of implant in this region.

Laboratory investigations

In order to reduce the chance of hemorrhagic accident, preoperative blood tests must be considered before proceeding for implant placement. These include:[47]

- Bleeding time (1-5 min by Duke method and 5-11 min for Ivy method): As they help in evaluating the effectiveness of platelets in achieving hemostasis.
- Clotting time (2-8 min by capillary tube method and 5-12 min by Lee-White method): It is prolonged in disease where clotting factors are deficient. A patient must be subjected to detailed investigation to find missing coagulation factor, if clotting time is prolonged.
- Hemoglobin estimation (16.3 g/dl by Sahli method, 16 g/dl by Dare method, 15.6 g/dl by Harden method, 14.5 g/dl by Wintrobe method, 13.8 g/dl by Haldane method): It is mainly used to detect anemia. It is preferred over total red blood cells count as it is simple to perform and is less time consuming.
- Hematocrit value (Adult male-40-50%, Adult female-37-47%): It is more reliable than manually performed red cell count.
- Prothrombin time: It detects any defect in the process of formation of thrombin from Prothrombin.
- Activated partial thromboplastin time: Any defect in the intrinsic system of blood coagulation can be recognized by this test.

Tactile sensation

Digital palpation of the lingual surface of the mandible can also help in predicting the possibility of bony perforation during osteotomy preparation.[15] While doing an implant osteotomy preparation, if the operator encounters a resistance before reaching a planned depth, he must get alerted for drilling into the cortical bone of inferior border of mandible.[18]

Management of hemorrhagic accidents

If hemorrhagic accident occurs, it must be managed very promptly and actively by adopting the following steps:

Airway patency

The various options available for airway control include:

1. Close observation — For earliest diagnosis of airway obstruction by its signs and symptoms.
2. Blind or fiber assisted nasotracheal intubation — This is a straight forward procedure, as it is through the nose. Many authors have reported successful management of their cases through this approach, but to perform it in a limited period, considerable skill is required, as a rapid emergence from inhalation agent may result in laryngospasm.[5-7,9-11,13,19] Also, advancement of nasotracheal tube may lead to further bleeding due to traumatization of the nasal passage.
3. Cricothyroidotomy — The only absolute contraindication to surgical cricothyroidotomy is the age of the patient. The most conservative approach is to use 12 years as the cutoff age. In patients below this cutoff age, needle cricothyroidotomy is indicated.[48]

4. Tracheostomy — It is most effective modality in preventing death due to asphyxia. Felisati *et al*.[4] and many other authors have reported cases were emergency tracheostomy procedure proved to be life saving for their patients.[2-4,12,14-16,20] It is mainly indicated when cricothyroidotomy is not possible due to the presence of neck swelling.

After securing the airway, the bleeding may decrease by itself due to pressure on the traumatized vessel by the expanding hematoma. Sometimes pulling out of tongue at the time of hemorrhage may compress lingual artery against hyoid bone, thus reducing bleeding from the traumatized vessel.[14] If this does not happen, following efforts must be undertaken to control the hemorrhage.

Bleeding control

The basic measures to control bleeding include bimanual compression which requires placing the thumb inside the mouth over a stack of gauze and the index finger outside the mouth.[6,9,10,13] Compressing a broader area is advised to cover the posteriorly retracted vessel.[26] However, Kalpidis and Setayesh reported limited success for this method in achieving hemostasis.[26] When this measure fails, the various options available with a surgeon to terminate the intra-operative bleeding is divided into following groups:

Mechanical method

These include sutures, staples, ligating clips, fabric pads, gauzes, sponges, etc. ten Bruggenkate *et al*. has documented its successful application in achieving hemostasis after hemorrhagic accident during implant placement.[7] However, Pigadas *et al*. emphasized the need for drainage of hematoma and achieving hemostasis through intraoral or extra oral approach.[2] Surgical ligation of the bleeding vessel is the treatment of choice to treat hemorrhage cases. If surgical intervention is needed to achieve hemostasis, extra oral approach is preferred over intraoral for the ligation procedure. Reduced visualization, retraction of traumatized artery, distorted local anatomy of the affected site and difficulty in surgical ligation of arteries intra orally makes the intraoral approach very challenging.[1,14,15,17,26] The facial/submental artery is easily accessed and hence it must be ligated first.[25] If the bleeding does not decrease, the lingual artery must be ligated subsequently. According to the classic anatomy, lingual artery should be ligated in Pirogoff's triangle.[49]

Thermal method

These methods encompass laser coagulation, electrocautery, use of hemostatic scalpel, etc. This method scores over mechanical method as it can be used effectively to control bleeding from arteries of even smaller diameter (1-2 mm).[50] Hence, it might be comparatively more effective in achieving hemostasis in interforaminal region. Sakka and Krenkel reported successful intraoperative bleeding management through this approach.[23]

Limitations of above mentioned two methods are that, the mechanical method can be used only if the bleeders are identified, where as in the thermal methods specific official settings are required normally. Also, in cases where the source of bleeding is from the inflamed or friable vessels, the bony structures, and the multiple or diffuse bleeding capillaries or from the parenchymal tissues, the mechanical and the thermal methods may not be of much help. In such situations, chemical agents might prove to be more effective.

Chemical method

Systemic interventions

This includes hypotensive anesthesia, epinephrine, vitamin K, protamine, desmopressin, aminocaproic acid, tranexamic acid. This is kept as the last resort as it is associated with infectious as well as noninfectious risks.

Local interventions

Topical hemostat can act passively or actively in the hemorrhage control. Passive topical hemostats include collagen, cellulose, and gelatins, whereas active topical hemostats include thrombin and the products in which thrombin has been combined with passive agent (e.g. Floseal). Lee *et al*. have reported the successful application of Floseal in terminating acute bleeding from anterior MIC during implant surgery.[22] Apart from these agents the topical sealants such as fibrin sealants or the synthetic glues are also frequently used. Topical sealants and glues are preferred for rapid arterial bleeding, but for other cases like bleeding from capillaries topical hemostats are the agents of choice. These agents can be applied directly at the bleeding site; they prevent adverse effects of systemic coagulants like unwanted blood clot. Moreover, the flexibility associated with the application of topical hemostat also makes it a preferable option.

Advance measures

Finally, if all the methods to control bleeding fail, external carotid artery ligation may be necessary.[26] Alternatively, the diagnostic tool available with the operator is an endovascular angiography. This will help in the exact location and isolation of bleeding sources.[51] Super selective catheterization of bleeding feeders has also become possible now due to a recent advancement in endovascular technology.[52] Theoretically, this can embolize and occlude the involved artificial branch and can prove as the alternative therapeutic measure in the disaster management of severe iatrogenic bleeding after surgical procedures.[15] However, practically no document has employed this diagnostic/therapeutic approach in the management of such conditions till now.

CONCLUSION

Because of its easy accessibility and favorable location, the anterior mandibular region is often preferred for implant placement. However, advices generally given to inexperienced implantologists at various implant training centers to start implant placement with mandibular anterior region must be reconsidered in view of various reported cases of hazardous hemorrhagic accidents. In fact, all the appropriate preventive measures must be followed by inexperienced surgeons while placing implant in this region, to avoid such life threatening complications. Also training on "management of adequate airway occlusion" must be made mandatory with all the implant courses.

If all the required adequate measures for diagnosis and treatment planning are taken and appropriate surgical protocol is followed, mandibular anterior region is no doubt a preferable area for implant placement.

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