Anatomical considerations in implant placement surgery

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What landmarks should we consider during implant placement?

- maxilla
  - Maxillary sinus
  - Incisive foramen
  - Nasal cavity
  - Infra orbital foramen
  - Maxillary artery/nerve
What landmarks should we consider during implant placement?

- Mandible
  - Inferior canal alveolar
  - Mental foramen
  - Mandibular artery/nerve
  - Mylohyoid ridge
Implants???

• An implant is a medical device manufactured to replace a missing biological structure, support a damaged biological structure, or enhance an existing biological structure.

• A dental implant (also known as an endosseous implant or fixture) is a surgical component that interfaces with the bone of the jaw or skull to support a dental prosthesis such as a crown, bridge, denture, facial prosthesis or to act as an orthodontic anchor.
Dental implants are most like natural teeth...

- **Natural tooth crown**
  with enamel outside and dentin inside

- **Implant abutment** is the connector between the crown and implant.

- **Periodontal ligament**
  holds the tooth root into the bone

- **Bone** actually grows onto the surface of the implant to hold it securely into place.

Dental lab makes a beautiful porcelain crown that matches with your natural teeth.
• All clinicians who perform periodontal or implant surgical procedures must have a thorough knowledge and appreciation for oral and head and neck anatomy.

• Several vital structures and anatomical features are in the surgical field and/or in close proximity to teeth and jaws. These structures are at risk of injury or damage during periodontal and implant surgical procedures.

• This chapter reviews important anatomic structures of the maxilla, mandible and surrounding tissues that are critical to recognize when planning and performing periodontal and implant surgical procedures.
Maxillary arch morphology

• The **osseous morphology** of dentoalveolar process is influenced by **masticatory forces**, transmitted to alveolus through teeth and PDL.

• The **maxillary post.teeth** are inclined **buccally 5 to 10 degrees**, opposing **mandibular** are inclined **lingually**.

• This transverse curvature of dental arches “the curve of **Wilson**”

• This inclination of opp.dentition is considered in planning treatment for implant cases → proper alignment and adequate bone support.
Maxillary sinus

- The maxillary sinus is **pyramidal** in shape.
- The sinus has a non-physiologic drainage port high on the medial wall (maxillary ostium) that opens into the nasal cavity between the **middle** and **lower nasal conchae**.
- The **maxillary sinus** maintains its overall size while the **posterior teeth remain** in function.
- The sinus expands with age, and especially when posterior teeth are lost.
- The average volume of a fully developed sinus is about **15 mL** but may range between **4.5** and **35.2 mL**.
Maxillary sinus

• One or more septa, termed “Underwood’s septa”, may divide the maxillary sinus into several recesses.

• Sinus septa is most common in the area between the second premolar and the first molar. Edentulous segments have a higher prevalence of sinus septa than dentate maxillary segments.

• The sinus epithelium (schneiderian membrane) is thin but tightly bound to underlying periosteum.

• The blood supply to the maxillary sinus is derived primarily from the maxillary artery and, to a lesser degree, from the anterior ethmoidal and superior labial arteries.
Treatment options in the posterior maxilla:

- short implants
- Tilted implants
- extra-long zygomatic implants
- sinus floor elevation with a transalveolar approach
- the one- or two-stage sinus floor elevation with a lateral approach
Sinus floor elevation with the transalveolar approach (osteotome technique)

- **Indications:**
  - flat sinus floor
  - residual bone height of at least 5 mm
  - adequate crestal bone width

- **Contraindications:**
  - patients with a history of inner ear complications and positional vertigo
  - oblique sinus floor (>45° inclination)
Fig. 51-33  (a) Implant site is prepared to a distance of approximately 2 mm below the sinus floor with a small diameter pilot drill. (b) After reaching the sinus floor, the osteotome is pushed approximately 1 mm further with light malleting in order to create a “greenstick” fracture on the compact bone of the sinus floor. (c) Grafting material is slowly pushed into the sinus cavity with a straight osteotome. This procedure is repeated several times. (d) Tip of the osteotome is only supposed to enter the sinus cavity after some grafting material has been pushed through the preparation site to elevate the sinus membrane. (e) Inserted implant and the grafting material maintain space below the sinus membrane.
Sinus floor elevation with the transalveolar approach (osteotome technique)

• to prepare the implant site to a distance approximately 2 mm below the sinus floor
• the osteotome is pushed about 1 mm further with light malleting in order to create a “greenstick” fracture on the compact bone of the sinus floor
• Valsalva maneuver (nose blowing)
Sinus floor elevation with the lateral approach

• **Indications:**
  - The residual alveolar bone height is < 5 mm

• **Contraindications:**
  - *intraoral* contraindications (odontogenic, periapical, radicular cysts)
  - *medical* conditions (uncontrolled diabetes, chemotherapy or radiotherapy, drug or alcohol abuse)
  - *local* contraindications (acute sinusitis, allergic rhinitis, local aggressive benign tumors, malignant tumors)
Conclusion and clinical suggestions:

- Residual bone height of $\geq 8$ mm and a flat sinus floor: standard implant placement.

- Residual bone height of $\geq 8$ mm and an oblique sinus floor: standard implant placement (short implant / Sinus floor elevation with the transalveolar approach)

- Residual bone height of 5–7 mm and a relatively flat sinus floor: Sinus floor elevation with the transalveolar approach with grafting material that is resistant to resorption.
Conclusion and clinical suggestions:

• Residual bone height of 5–7 mm and an oblique sinus floor: Sinus floor elevation with the lateral approach, and simultaneous implant placement (one-stage)

• Residual bone height of 3–4 mm and a flat or oblique sinus floor: Sinus floor elevation with the lateral approach, and simultaneous implant placement

• Residual bone height of 1–2 mm and a flat or oblique sinus floor: Sinus floor elevation with the lateral approach and delayed implant placement 4–8 months later (two-stage)
Innervation of maxilla:

- **Posterior superior alveolar nerve (PSA):**
  
  - The nerve arises within the pterygopalatine fossa, courses downward and forward passing through pterygomaxillary fissure and enters posterior maxilla.
  
  - This nerve supplies **sinus, molars, buccal gingival** and **adjoining portion of cheek**.
  
  - This nerve may get **injured** during **sinus augmentation**.
Innervation of maxilla:

- **Infra orbital nerve:**
  - Continuation of the maxillary division of the trigeminal nerve.
  - It leaves pterygopalatine fossa by passing through inferior orbital fissure to enter floor of orbit.
  - It runs through infra orbital groove and then in infra orbital canal, and exits the orbit through infra orbital foramen to give cutaneous branches to lower eye lid, ala of nose and skin.
  - In cases of maxillary sinus disorders the site of infra orbital foramen becomes tender leading to inflammation of infra orbital nerve, improper placement of implant may even lead to paresthesia.
Innervation of maxilla:

- **Palatine nerve:**
  - The greater and lesser palatine nerves supply the hard and the soft palate.
  - Runs forward in a groove on inferior surface of hard palate to supply palatal mucosa as incisor teeth.
  - The nerve communication with nasopalatine nerve.

- **Nasopalatin neve:**
  - The nerve supplies the nasal mucosa, descends to the floor of the nose near the septum, passes through the nasopalatine canal, and then exits onto the hard palate through the incisive foramen.
  - The incisive nerve should be anesthetized before elevation of the mucosa of the floor of the nose for subnasal grafts or implants that engage the nasal floor in the incisor region.
Blood supply (maxilla):

- **posterior superior alveolar artery:**
  - PSA is branch of the third part of the maxillary artery.
  - the molar and premolar teeth and the lining of the maxillary sinus.
  - Injury to this artery within the bone during lateral-approach sinus elevation procedures may cause hemorrhage, which requires coagulation or the use of bone wax to control the bone bleeding.
Blood supply (maxilla):

- The **mucoperiosteum of anterior maxilla** is supplied by branches of the infraorbital and superior labial artery (branch of the facial artery).
- The **buccal mucoperiosteum** of the maxilla is supplied by vessels of the PSA, ASA, and buccal arteries.
- The **mucoperiosteum of the hard palate** is supplied by branches from the greater (anterior) palatine and the nasopalatine arteries.
- The **lesser (posterior) palatine artery** supplies the soft palate.
- The **blood supply** is maintained by means of the anastomoses present in the soft palate.

Thus one should be careful during reflection, implant placement, grafting procedures and ridge augmentation.
• The **greater palatine foramen** opens **3 to 4 mm** anterior to the posterior border of the hard palate.

• The terminal branches of the nasopalatine nerve and vessels pass through the **incisive canal**, which opens in the **midline anterior area** of the palate.
Incisive Foramen Implant

- The **overdenture** is the intended final prosthesis.
- **This structure contains** terminal branches of the nasopalatine nerve, the greater palatine artery, and a short mucosal canal (**Stensen's organ**).
- The incisive canal ranges in **length** from 4 to **26 mm** (directly related to the height of bone in the premaxilla).
- the placement of a **9 to 14mm implant**.
- A large-diameter threaded implant (**>5 mm**) is generally used.
Incisive Foramen Implant

- **Complications:**

  - **surgical complications:** mobility implant/bleeding
  - **short-term complication:** neurological impairment of the soft tissues in the anterior palate
  - **long-term complication:** the regeneration of the soft tissue in the incisive canal
Subnasal elevation

• When the residual crest in the anterior maxilla is adequate in width but only 7 to 11 mm in height.

• Subnasal elevation may be used in the C-h premaxilla, because the nasal floor can be elevated from a to 4 mm in the central or lateral incisor region and up to 4 mm in the canine area.

Complications:

• tearing the nasal mucosa and the implant extending into the nares proper
Mandibular arch morphology:

- The mandible is a strong, arched bone, fused at the midline (mental symphysis) and is the only movable bone of the face and performs work of mastication.
- In the inner surface of mandible the area adjacent to the roots of third molar, the mylohyoid line or ridge is there, which courses inferiorly and anteriorly.
- It continues to inferior border of mandible in between the genial tubercles and diagastric fossa.
- The ridge is formed due to origin to mylohyoid muscle offering important horizontal reinforcement to mandible.
- The concavity inferior to mylohyoid ridge is submandibular fossa related to anterior surface of deep portion of submandibular gland.
Mandibular arch morphology:

- The slight depression located superior to anterior extent of mylohyoid ridge is **sublingual fossa**, which houses sublingual gland.
- The **palpation** of this region is necessary before implant placement to determine shape of ridge and extent of submandibular fossa.

**Implants placed in the posterior mandible** are at risk of entering this region, which is highly **vascularized**, with resultant risks of **haemorrhage**.
Mandibular canal

- The **mandibular foramen** through which the **inferior alveolar neurovascular bundle** enters the mandible is located on inner aspect of ramus.
- The mandibular canal passes from the mandibular foramen inferiorly and anteriorly, then courses horizontally, laterally, usually just below the root apices of the 3rd molar teeth. As the canal approaches the mental foramen, it curves superiorly.
- IAC: surrounding by **cortical bone**
Mandibular canal

- The location of the mandibular canal **radiographically** had been classified as (vertical dimension):
  a) **High** (within 2 mm of the apices of the *first* and *second* molars)
  b) **Intermediate** (%68)
  c) **Low**

- In a **dentate individual**, the distance between the root apices of first and second molars and the upper border of the mandibular canal ranges from 3.5 to 4.5 mm.
- The mean distance from inf. Border to lowest point a long course of mandibular canal is $5.9 \pm 2.2 \text{mm}$ with range of $2-11 \text{mm}$. 
Mandibular canal

- The variation in the course of IAC are frequent.
- **OPG classification** of the course of the nerve (Liu et al 2009)
TYPE 1 (Linear) → Smallest curvature → Greater risk

TYPE 2 (Spoon shaped) → Largest curvature → Highest bone height → Most secure

TYPE 3 (Elliptic Arc) → Most common (48.5%) → Relatively secure

TYPE 4 (Turning Curve) → Largest variation → Greater risk
Mandibular canal

- Classified the location of the mandibular canal in the **buccolingual location** into three types:
  1. Canal follow the **lingual cortical plate** at the mandibular ramus and body (%70).
  2. Canal follows the **middle of ramus behind the 2\textsuperscript{nd} molar** and the **lingual plate passing through the 2\textsuperscript{nd} and 1\textsuperscript{st} molars** (%15)
  3. Canal follows the **middle or the lingual 1/3\textsuperscript{rd}** of the mandible from the ramus to the body (%15).
Zone of safety

- An area within the bone that can safely support implants without fear of impingement on the mandibular neurovascular bundle.
- Given by MISCH (1980)
- Determined on OPG or clinically during surgery.
Mandibular canal

• The safety zone between the tip of the implant and the border of the canal should be at least 1-2 mm.

• Patients with compromised vertical bone dimension can sometimes be treated by placing multiple shorter implants of optimal width followed by splinting the prosthetic crowns together during the restorative phase of therapy.
Mandibular canal

- Anatomical challenges, such as resorbed mandibular ridges and highly placed mandibular canal must be taken care of prior to implant placement:
  1. **Ridge augmentation** (Bone grafts)
  2. **Transpositioning** of the inferior alveolar artery and nerve

However, **tactile feedback cannot be relied upon**. No substitutes for **radiometrics**, safety devices.
Mental foramen and nerve

- **Location**: differs in horizontal and vertical plane
- The **anteroposterior position** of the mental foramen is variable and may correlate as far forward as the **apex of the first premolar** to as far distal as below the **mesial root of the first molar**.
- The mental foramen **vertical position** is usually found more **coronal** and **facial** than the **mandibular canal**.
- The **most common** mental foramina sites are between the **first** and **second premolar roots**
Mental foramen and nerve

<table>
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<th>1&lt;sup&gt;st&lt;/sup&gt; premolar</th>
<th>2&lt;sup&gt;nd&lt;/sup&gt; premolar</th>
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<td>Apical to apex</td>
<td>38.6%</td>
<td>24.5%</td>
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<tr>
<td>At apex</td>
<td>15.4%</td>
<td>13.9%</td>
</tr>
<tr>
<td>Coronal to apex</td>
<td>46.0%</td>
<td>61.6%</td>
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Anterior loop

• An **anterior loop** to the mandibular canal occurs when the canal proceeds inferior to the foramen, passes under the foramen for **1 to 3 mm**, and then curves **superior** and **distal** to exit the foramen.

• **Naber's 2N probe** may be used to determine the presence of an anterior loop to the mandibular canal. The probe is gently inserted along bone on the distal one-half of the foramen. If no nerve canal entry is palpated, the nerve must enter the foramen from the anterior aspect and an anterior loop is present.

The estimated **length** of the anterior loop ranges from **0.5 to 5.0 mm** (prevalence (**88%**)). Carranza 2019
Mental foramen and nerve

- The **position of the mental foramen** may be approximated by drawing an imaginary **vertical line** from the **pupil** or using one **finger width lateral to the nose** through the **infraorbital** and **mental foramina**.
Mental foramen and nerve

- the mental nerve divides into **three branches**: 
  - **One branch** of the nerve turns forward and downward to supply the **skin of the chin**.
  - The other **two branches** course anteriorly and upward to supply the **skin and mucous membrane of the lower lip** and the **mucosa of the labial alveolar surface**.

- **Surgical trauma** (pressure, manipulation, postsurgical swelling) to the mental nerve can produce **paresthesia of the lip**, which recovers slowly.

- **Partial or complete cutting** of the nerve can result in **permanent paresthesia, dysesthesia**, or both
Mental foramen and nerve

- The **position of the distal implant** between the foramen is affected by the **presence of an anterior loop**. The goal is to have the implant 2 mm in front of the mandibular nerve. When an anterior loop is present, the distal implant is placed farther mesial.
Mandibular incisive canal

• The **length** of the incisive canal **21.45 mm** (from the mesial aspect of the mental foramen and to terminate just **4 mm** from the midline)

• Reaches midline – only **%18**

• Terminates **apical** to **lateral** or **central incisor**

• Width **1.8mm**

• OPG: **%15 / CT: %93**

• Only **large sized canals** may **pose a problem**.
Lingual nerve

- The **lingual nerve** is a branch of the mandibular nerve that is given off in the infratemporal fossa.

- **Lingual nerve** passes superficially under the mucosa on the periosteum of lingual alveolar plate.

- It passes downward and forward between the ramus of the mandible and the medial pterygoid muscle. The nerve **enters the oral cavity** above the posterior edge of the mylohyoid muscle close to its origin at the third molar region (3 mm apical to the crest and 2 mm from the lingual cortical plate in the flap).

- It can be **damaged** during anesthetic injections and during oral surgery procedures (third molar extractions/ incision in retromolar pad region/ partial-thickness flap/ releasing incisions).
Life-Threatening Hemorrhage

- The cause of life-threatening hemorrhage is from significant internal bleeding in the floor of the mouth, usually caused by a perforation of the lingual cortical plate and a related swelling of the floor of the mouth and tongue, which causes respiratory obstruction.

- There are primarily two major arteries that supply the floor of the mouth and are related to life-threatening hemorrhage: the lingual artery and the facial artery.
Lingual artery

• The **lingual artery** is the major vessel to the **tongue**.

• when the bleeding is **suspected from this source**, pulling out the **tongue** compresses the lingual artery against the hyoid bone and decreases the flow of blood to this vessel.

• **sublingual artery (2mm)**: It supplies blood to the **lingual gingiva** and the lingual aspect of the **anterior cortical plate of the mandible**
• This **artery loops** under the bottom of the mandible (**second molar**), then laterally near the anterior border of the masseter muscle (**antegonial notch**) to supply portions of the **face**.

• **submental artery**: (2 mm) branches from the facial artery just before it crosses over the inferior border and courses along the **interior and inferior aspect of the mandible**.

• If this artery is suspected in the hemorrhage event, **pressure against the interior and lingual aspect of the mandibular notch**.
The **signs or symptoms of life-threatening hemorrhage** of the floor of the mouth include:

a) **swelling and elevation** of the floor of the mouth

b) an **increase in tongue size**, which may even protrude from the mouth

c) **difficulty in swallowing or speech**

d) **pulsating or profuse bleeding** from the osteotomy site or floor of the mouth.
The suggested methods to treat life-threatening hemorrhage, may include:

a) Bimanual compression

b) Pull out the tongue (lingual artery)/ Place deep pressure along the inner and inferior aspect of the body of the mandible at the antegonial notch region (facial artery).

c) Elevate the head (30%)

d) Place an oropharyngeal airway behind the tongue

e) Place hemostatic agents in the osteotomy on or in the lingual periosteal tissues.

f) Push with firm pressure against the transverse process of the fourth cervical vertebra in the neck, on the side of the bleeding.

g) Transport the patient to the hospital
Clinical conclusion:

- Implant placement is not a complicated procedure, if one has an adequate knowledge of the anatomical structures.
- The above slides tells about the anatomical considerations to be taken care off...NOT ANATOMICAL COMPLICATION
- Care should be taken at time of flap reflections.
- No uncontrolled forces should be applied.
- Clean and patient surgery is the key to success.
THE END
THE END
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THE END