The radiographic recognition of disease requires a sound knowledge of radiographic appearance of normal structures. Intelligent radiologic diagnosis cannot be attempted without an appreciation of a wide range of variation on the appearance of normal anatomic structures. Similarly, it should be recognized that most normal patients demonstrate many of normal radiographic landmarks, but it is a rare patient who shows all of them. Accordingly, the absence of one or even several such landmarks in any individuals should not necessarily be considered abnormal.

**Variation in the radiographic density of the structures**

The density of the structure being radiographed exerts a profound influence of the resultant image formed on a diagnostic radiograph.

The greater density of an object, or an area within the object, the greater attenuation of X-Ray beam directed through the object or area.

In the oral cavity the relative densities of various natural structures, in order of decreasing density, are enamel dentin and cementum, bone, soft tissue, fat, and air.

Metallic objects, such as restorations, are far more dense and hence better absorbers, than enamel.

As X-ray beam is differentially attenuated by these absorbers, the resultant beam carries information that is recorded on the radiographic image to be light are said to be radiopaque; objects that are not good absorbers cast a dark area on the film that corresponds to the radiolucent object.
**Radiolucent:** Radiolucent refers to that portion of a processed radiograph that is dark or black. A structure that appears radiolucent on a radiograph lacks density and permits the passage of the X-ray beam with little or no resistance. For example, air space freely permits the passage of dental X-rays and appears mostly radiolucent on a dental radiograph.

**Radiopaque:** Radiopaque refers to that portion of a processed radiograph that appears light or white. Radiopaque structures are dense and absorb or resist the passage of the X-ray beam.

**Radiographical anatomy of teeth and their supporting structure**

Teeth are composed primarily of pulp, dentin with an enamel cap over the coronal portion and a thin layer of cementum over the root surface.

1. **Enamel:** is the most radiopaque structure (most dense naturally occurring substance in the body)
2. **Dentin:** is smooth and homogenous on radiographs because of its uniform morphology. It's less radiopaque than enamel, and has the same radiopacity as bone.
3. **Cementum:** is not usually apparent radiographically because the contrast between it and dentin is so low and the cementum layer is so thin.
4. **Pulp:** is composed of soft tissue and consequently appears radiolucent. The chambers and root canals containing the pulp extend from the interior of the crown to the apices of the roots.
5. **Lamina dura:** A radiograph of sound teeth in a normal dental arch demonstrates that the tooth sockets are bounded by a thin radiopaque layer of dense bone called lamina dura (hard layer), is derived from its radiographic appearance.
6. Alveolar crest: The gingival margin of the alveolar process that extends between the teeth is apparent on radiographs as a radiopaque line, the alveolar crest. The level of this bony crest is considered normal when it is not more than 1.5 mm from the cementoenamel junction of the adjacent teeth.

7. Periodontal ligament space: (PDL) is composed primarily of collagen, so it appears as a radiolucent space between the tooth root and the lamina dura. This space begins at the alveolar crest, extends around the portions of the tooth roots within the alveolus, and returns to the alveolar crest on the opposite side of the tooth. The PDL varies in width from patient to patient, from tooth to tooth in the individual, and even from location to location around one tooth.

8. Jaw bone: The cancellous bone (also called trabecular bone or spongiosa) lies between the cortical plates in both jaws. It is composed of thin radiopaque plates and rods (trabeculae) surrounding many small radiolucent pockets of marrow. The trabeculae in maxilla are fine and arranged in a lace like pattern, whereas in the mandible they are usually coarse and run in a horizontal pattern with larger bone trabecular spaces than in maxillary bone.

- Dental gem: early stages appear radiolucent then since calcification begins there will be V or U-shaped radiopaque foci within the radiolucency.

Landmarks in radiographs of maxilla

1. Median suture or intermaxillary suture: appear as a thin radiolucent line in the midline between maxillary central incisors.

2. Incisive or anterior palatine foramen or nasopalatine foramen: oval radiolucency, but sometimes appear round, heart shaped or diamond-shaped, located between or above maxillary central incisors. If the foramen is larger, distinction between it and small incisive canal cyst is often difficult.
3. Anterior nasal spine: V-shaped radiopacity seen in the inferior aspect of nasal fossa above or superimposed on it.

4. Nasal septum: separates the two nasal fossae in the midline, appear gray or white shadow above central incisors.

5. Nasal cavity: bilateral radiolucencies in radiographs of incisors area. The floor of the nasal cavity overlaps the radiolucency of maxillary sinus in the radiographs of cusped area.

6. Maxillary sinus: not seen until after 5 years of age, it is a dominant radiolucency in radiographs of bicuspid area and molars and extend to the tuberosity. The borders of the maxillary sinus appear on periapical radiographs as a thin, delicate, tenuous radiopaque line (actually a thin layer of cortical bone, and on periapical radiographs of the canine, the floors of the sinus and nasal cavity are often superimposed and may be seen crossing one another, forming an inverted Y shape in the area).

7. Lateral fossa. Bony depression in the labial cortical plate of maxillary lateral incisor area (Diminished radiopacity).

8. Zygomatic (malar) process of maxilla and zygomatic bone: zygomatic process seen as V-shaped radiopacity in the apical films of molar area. Zygomatic arch appears as a radiopaque bond extending posteriorly from the V-shaped radiopacity of the zygomaticomaxillary Junction.

9. Coronoid process of mandible: a triangular radiopaque structure in radiographs of posterior maxillary teeth and is easily identified.

10. Hamulus and lateral plate of pterygoid process: pterygoid process of sphenoid bone has two plates, lateral plate wide round radiopacity behind the maxillary sinus. The inferior end of the medial place ends in a thin curved process called pterygiod hamulus.
Landmarks in radiographs of the mandible

1. Mandibular Symphysis: Radiographs of the region of the mandibular symphysis in infants demonstrate a radiolucent line through the midline of the jaw between the forming deciduous central incisors. This suture usually fuses by the end of the first year of life, after which it is no longer radiographically apparent.

2. Mental fossae: is a depression on the labial aspect of the mandible extending laterally from the midline and above the mental (diminished radiopacity).

3. Mental ridge: bony prominence extending from midline of the mandible to the area of premolars (Radiopaque).

4. Lingual foramen: single radiolucent area in the midline of the mandible.

5. Genial tubercles: radiopaque zones located in the radiographs of lower incisors area. The genial tubercles (also called the mental spine) are located on the lingual surface of the mandible slightly above the inferior border and in the midline. They are bony protuberances, more or less spine shaped, that often are divided into a right and left prominence and a superior and inferior prominence. They serve to attach the genioglossus muscles (at the superior tubercles) and the geniohyoid muscles (at the inferior tubercles) to the mandible.

6. Mental foramen: oval, round, or irregular radiolucency in the radiographs of premolars, when superimposed on the apex of a tooth it may misdiagnosed as periapical pathology.

7. Mandibular canal (inferior dental canal) radiolucent structure extends from the mandibular foramen to the mental foramen.

8. Mandibular foramen: Foramen in the ramus, is funnel shaped area radiolucency that varies greatly in size and location.

9. External oblique line: radiopaque structures that corresponds to the anterior border of the ramus and descend to the area of the third molar.
10. Internal oblique line: radiopaque structure that descends downward and forward from coronary process below the external oblique line it possess downward and forward from the ramus and gradually fades in bicuspid area.

11. Submaxillary gland fossa: Zone of relative radiolucency below the molars, it may mistaken with radiolucent lesion.

12. Nutrient canals: carry a neurovascular bundle and appear as radiolucent lines of fairly uniform width. They are most often seen on mandibular periapical radiographs running vertically from the inferior dental canal directly running vertically from the inferior dental canal directly to the apex of a tooth or into the interdental space between the mandibular incisors.

Note: Nutrient canal can be seen else where in mandible and maxilla.

**Restorative Materials**

Restorative materials vary in their radiographic appearance, depending primarily on their thickness, density, and atomic number. Of these, the atomic number is most influential.

A variety of restorative materials may be recognized on intraoral radiographs.

- Radiopaque materials such as: silver amalgam, Gold, Stainless steel pins, gutta-percha, Silver points, stain-less steel crowns Zinc oxide – eugenol, Zinc phosphate cement, Metal bands, Metal wires and orthodontic appliances.

- Radiolucent materials such as: Acrylic, Silicates, Calcium hydroxide pastes &Porcelain.

Note: porcelain, now usually fused to a metallic coping, also Composite restorative materials so they may be radiopaque.
Radiographic appearance of dental anatomical variations

Dental anomalies include variation in normal number, size, eruption or morphology of the teeth. It's may be developmental or acquired.

1. Dens invaginatus

Is a malformation of teeth most likely resulting from an infolding of the dental papilla during tooth development or invagination of all layer of the enamel organ in dental papillae. Also called dens in dent.

Affected teeth show a deep infolding of enamel and dentine starting from the foramen coecum or even the tip of the cusps and which may extend deep into the root. Teeth most affected are maxillary lateral incisors and bilateral occurrence is not uncommon. The malformation shows a broad spectrum of morphologic variations and frequently results in early pulp necrosis. Root canal therapy may present severe problems because of the complex anatomy of the teeth.

2. Dilaceration

is a deviation or bend in the linear relationship of tooth crown to its root; it is an angulation or sharp curve in the root or the crown of a developed tooth of 90º or more.

3. Macrodontia

A condition in which the teeth are abnormally large. Also called megadontism or megalodontia

4. Microdontia

is a condition in which teeth appear smaller than normal. In the generalized form, all teeth are involved. In the localized form, only a few teeth are involved. The most common teeth affected are the upper lateral incisors and third molars. The affected teeth may be of normal or abnormal morphology

There are 3 types of microdontia:

1. True generalized microdontia
2. Relative generalized microdontia
3. Microdontia involving a single tooth
5. **Twinning defect**

This is called a "gemination", which has a single tooth root with two anatomic crowns. Gemination is a rare anomaly that arises when the tooth bud of a single tooth attempts to divide. The result may be an invagination of the crown, with partial division, or in rare cases complete division throughout the crown and root, producing identical structures. Complete twinning results in a normal tooth plus a supernumerary tooth in the arch.

Clinically: Gemination more frequently affects the primary teeth, but it may occur in both dentitions, usually in the incisor region. It can be detected clinically after the anomalous tooth erupts. The occurrence in males and females is about equal. The enamel or dentin of geminated teeth may be hypoplastic or hypocalcified.

Radiographically: Radiographs reveal the altered shape of the hard tissue and pulp chamber of the geminated tooth. Radiopaque enamel outlines the clefts in the crowns and invaginations and thus accentuates them. The pulp chamber is usually single and enlarged and may be partially divided.

The opposite case does occur, where two teeth fuse into a single anatomic crown "fusion". Fusion of teeth results when two tooth germs develop so close together that as they grow, they contact and fuse before calcification. Or results when physical force or pressure generated during development causes contact of adjacent tooth buds.

Clinically: Fusion usually causes a reduced number of teeth in the arch. It occurs in deciduous and permanent dentitions, although it is more common between deciduous teeth. When a deciduous canine and lateral incisor fuse, the corresponding permanent lateral incisor may be absent. Fusion is more common in anterior teeth of both the permanent and deciduous dentition.

Radiographically: Fused teeth may show an unusual configuration of the pulp chamber, root canal, or crown.

Fusion arises through the union of two normally separated tooth germs, whereas gemination arises from an attempt at division of a single tooth germ. The phenomenon of fusion has often been confused with gemination, especially if it involves a supernumerary tooth.
6. Hyperdontia
is the condition of having supernumerary teeth, or teeth which appear in addition to the regular number of teeth. Supernumerary tooth classified by position in to mesiodens, a paramolar, or a distomolar.
The most common supernumerary tooth is a mesiodens, which is a mal-formed, peg-like tooth that occurs between the maxillary central incisors
Fourth and fifth molars that form behind the third molars are another kind of supernumerary teeth.
It could be associated with Cleidocranial Dysplasia, an inherited disorder involving the cranium, face, clavicles and supernumerary teeth

7. Hypodontia
is the condition at which the patient has missing teeth as a result of their failure to develop.
Include oligodontia and anadontia (according to the number of missing teeth)
It could happen in Ectodermal Dysplasia… lack of hair, sweat glands (hypohydrotic) and teeth (partial anodontia)

8. Odontodysplasia (ghost teeth)
A marked decrease in radiodensity, Very thin enamel and dentin, large pulp chamber, Cells don’t change fully.

9. Amelogenesis imperfecta
Genetic disturbances in enamel formation leading to altered morphology of enamel. There is normal dentin and pulp formation.

10. Dentinogenesis imperfect
Dentinogenesis imperfect is a developmental disturbance primarily of the dentin. Enamel may be thinner than normal in this condition. (radiographically: Pulp obliteration and short blunt roots)

11. Talon cusp:
Clinical features: accessory cusp like structure projecting from the cingulum area or cemento enamel junction of the maxillary or mandibular anterior teeth

12. Turner hypoplasia
Frequent pattern of enamel defects seen in permanent teeth secondary to periapical inflammatory disease of the overlying deciduous tooth
The altered tooth is called Turner's tooth.
13. **Enamel pearls**
are small spherical enamel masses located at the root of the molars and are found in 2% of the population. There can be a small pulp chamber extending from the parent tooth.

14. **Taurodontism**
Is a condition found in the molar teeth of humans whereby the body of the tooth and pulp chamber is enlarged vertically at the expense of the roots. As a result, the floor of the pulp and the furcation of the tooth is moved apically down the root.