

found irregular cavities due to an imperfect calcification of the enamel. On cross-section the enamel has the appearance of a mosaic pavement, each prism showing its hexagonal shape.

The cuticle of the enamel, or Nasmyth's membrane, is to be found in a freshly erupted tooth. It consists of

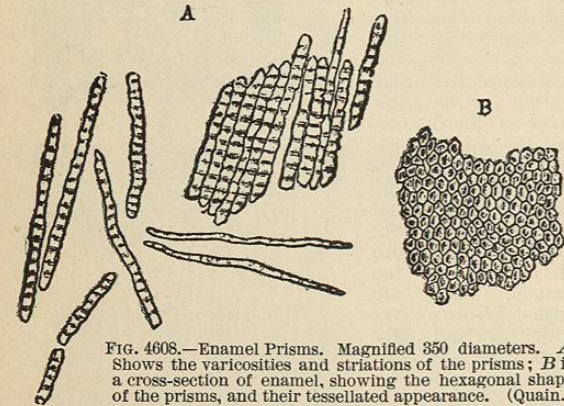


FIG. 4608.—Enamel Prisms. Magnified 350 diameters. A Shows the varicosities and striations of the prisms; B is a cross-section of enamel, showing the hexagonal shape of the prisms, and their tessellated appearance. (Quain.)

a delicate epithelial covering which encloses the enamel; it is, however, so delicate that in the slightest use it is worn away. It receives in hexagonal depressions on its under side the outer ends of the enamel prisms.

TIME OF ERUPTION OF THE TEETH.—The first dentition begins about the seventh month, and is completed about the twenty-fourth month. The second dentition begins about the sixth year, and is completed about the twenty-first. Considerable variation exists in the time at which individual teeth erupt, and no date can be absolutely fixed for the appearance of a given tooth. It is possible, however, to state the time when the eruption of a tooth is normally to be expected, and the following tables are appended:

Temporary Teeth.

The central incisor erupts at the	7th month.
The lateral incisor erupts at the	9th month.
The first molar erupts at the	12th month.
The canine erupts at the	18th month.
The second molar erupts at the	24th month.

Permanent Teeth.

The first molar erupts at the	6th year.
The central incisor erupts at the	7th year.
The lateral incisor erupts at the	8th year.
The first bicuspid erupts at the	9th year.
The second bicuspid erupts at the	10th year.
The canine erupts at the	11th year.
The second molar erupts at the	12th year.
The third molar erupts at the	17th to 21st year.

As a rule, in both the first and second dentitions the lower teeth erupt before corresponding teeth in the upper jaw.

PHYSIOLOGY OF THE TEETH.—Under this head we naturally consider the purposes for which teeth exist, and how they perform their several functions. The subject may be divided into three heads:

(1) The function of the teeth in facial expression. (2) The function of the teeth in mastication. (3) The function of the teeth in articulation.

The importance of the teeth in facial expression becomes apparent when we consider the effect of their absence, as shown in aged people. In such the lower part of the face has lost the round and graceful lines of early years; the chin is pointed, and approximates the end of the nose; the lips are retracted and flabby, and a characteristic hollow extends along the cheek. When present, each tooth aids in sustaining the proper proportions of the face. The upper front teeth, by being slightly in advance of the lower, produce that slight projection of the upper lip beyond the lower, found in normally shaped features. The bicuspids and molars, by their apposition, fix the relation of the lower to the upper

jaw, and by their bulk give fulness to the cheeks. The bony alveolus, also, in which the teeth are embedded, has an important relation to facial expression, for when a tooth has been lost its bony support, being no longer needed, is absorbed, and thus the features are still further deprived of support.

The function of the teeth in mastication is the most obvious and important. Standing as they do at the entrance to the digestive tract, it is their duty to seize upon food, sever its connection with its surroundings, and comminute it so that it can be acted upon readily by the various digestive fluids. The act of seizing and cutting is performed by the six anterior teeth, whose edges, by the protrusion of the lower jaw, are brought opposite to each other. When once a morsel of food has been detached by the anterior teeth, it is passed backward by the tongue and cheeks, to be operated upon by the bicuspids and molars. The bicuspids are fitted both to cut and to grind. They cut by the outer cusps of opposing teeth meeting and passing each other like the blades of a pair of scissors. They crush by a lateral motion, the crowns of the lower bicuspids moving across those of the upper. The function of the molar teeth is to crush and grind, for which purpose they are fitted by their broad crowns. They crush by means of an up-and-down movement, and grind by a lateral movement.

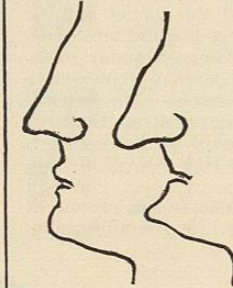


FIG. 4609.—The first profile represents the features undisturbed by loss of teeth. The second represents the edentulous condition, in which the lips fall in and the chin becomes pointed and inclined toward the nose.

The vowels are musical notes formed by the vocal cords, and given quality or timbre by the size and shape of the air column in the resonant cavities above. The consonants are sounds produced by the same mechanism, but due to irregular vibrations, and hence are noises. The oral cavity, being able to change its size and shape in numberless ways, is the most important agent in sound modification.

To produce articulate sounds the column of air must be obstructed and forced into channels of definite size and shape. The column of air is obstructed in three ways: first, by applying the back of the tongue to the palate; second, by applying the tip of the tongue to the posterior surfaces of the anterior teeth; and third, by a closure of the lips. It is forced into definite channels by pressing the tongue against different parts of the roof of the mouth, and against the inner surface of the upper teeth.

PATHOLOGY OF THE TEETH.—*Pathology in the Number of Dentitions and their Time.*—While two is the normal number of dentitions, much can be heard and read of a third dentition,

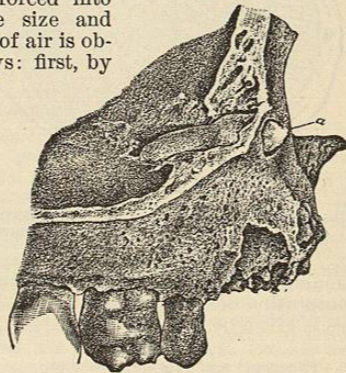


FIG. 4610.—Illustrates the Impaction of a Right Superior Lateral (c), which lies in the superior maxillary bone at right angles to its normal position. (Wedl.)

Pathology in the Number of Teeth in a given Dentition.—In connection with both the first and second dentitions

the authority for which, however, rests, as a rule, with unscientific observers, and is of very little value.

The entire absence of one or both of the normal dentitions is an established fact; such cases, however, are decidedly rare, especially those in which neither dentition has occurred. There is usually associated with this condition a failure in the growth of hair throughout the body. The condition of the alveolar ridge in such cases is similar to that which ensues on the extraction of the permanent teeth. Artificial

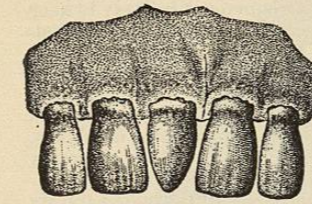


FIG. 4611.—A Conical Supernumerary Tooth Located between the Superior Central Incisors. (Carabelli.)

substitutes, however, are not always necessary, inasmuch as the gum, in such cases, is very tough, and capable of performing with remarkable facility the duties of mastication.

Pathology in the Time of Dentition.—The deciduous teeth are in rare instances erupted at birth. When deciduous teeth are delayed in their eruption it is commonly due to rickets. A delay in the eruption of the permanent teeth is also frequently noticed. An important cause for this delay is the prolonged retention of the deciduous teeth, an obstacle being thus present which prevents the permanent teeth from taking their place. Cases are on record of deciduous teeth persisting till middle or old age. It often happens, however, that a permanent tooth is kept from eruption because its place has been taken by another permanent tooth which had an earlier start, and which has occupied all the available room. This is especially liable to happen with the superior canines, on account of their coming to the surface after the lateral and the first bicuspid have taken their place in the arch. If, as often happens, the temporary canine has been prematurely extracted, allowing the adjoining teeth to close in the gap, or if the arch is unusually narrow, or the teeth unusually large—then the canine is likely to be crowded out beyond the arch or to be imprisoned in the alveolus. The canine may be permanently imprisoned, or until the extraction of a bicuspid or lateral incisor offers it a chance to erupt.

The wisdom teeth are always very liable to detention within the jaw, and their eruption may be either prevented or long delayed. This happens from causes similar to those just described with regard to the canine. The modern civilized jaw seems to be made too short to contain a full complement of developed teeth, and, as the wisdom teeth come last, they, though of stunted size, are frequently unable to enter the arch. Imprisoned or partly erupted wisdom teeth, especially of the lower jaw, may cause very serious symptoms, both local and reflex. The local symptoms consist of pain and swelling in the vicinity of the tooth; the reflex symptoms of neuralgias about the head, and a tonic contraction of the muscles which close the jaw. In some cases an abscess may be formed which, if lacking prompt exit, may open by fistula on the outside of the face, at the angle of the jaw, or in the neck, or even as low down as the subclavicular region. Imprisoned canine and incisor teeth are sometimes found far from their normal position. Cases are cited in which the crown of the superior canine has penetrated the nasal cavity and the antrum; they have also been located in the palatine portion of the superior maxillary bone. Lower canines have been found with their long axes parallel to the body of the jaw, at or near the tips of the roots of the inferior lateral and bicuspids. The superior lateral may be delayed in its eruption, or imprisoned for want of room in the arch, and may in consequence take abnormal positions similar to those taken by the superior canine.

Pathology in the Number of Teeth in a given Dentition.—In connection with both the first and second dentitions

we find at times both an excess and also a deficiency of teeth. Teeth in excess of the normal are called supernumerary teeth. Such may be coincident in time of eruption with the teeth in whose neighborhood they appear, or they may precede or follow. Supernumerary teeth are divided into two main classes—teeth whose form differs from that of normal teeth (conical teeth), and teeth whose form resembles that of normal teeth. Supernumerary teeth are not common in connection with the first dentition; when they occur they are found more frequently in the lower jaw, and belong in shape to the second class, inasmuch as they resemble the teeth with which they are associated. The duplicate tooth is usually a lower incisor, and it takes its place regularly in the arch, being erupted at about the same time as its companion incisor. Supernumerary teeth are more frequently found in connection with the second dentition, and are usually located in the upper jaw.

They as a rule make their appearance just after the adjoining tooth is erupted. Conical supernumerary teeth are the most common kind. They have the same structure as normal teeth, but in shape resemble a diminutive cuspid. Their crown, however, has not the angular outline belonging to that tooth, but is cone-shaped, as their name implies. The root is round and tapering. These teeth occur most frequently in connection with the superior incisors. One may be located between the two centrals in the arch, or between the central and the lateral. They may be placed without the arch, on either its labial or palatal side. Conical teeth are not commonly found adjoining the molars, bicuspids, or cuspids, though they may exceptionally be found in all these localities. If found outside the arch, conical teeth are of no value and should be extracted; if found in the arch, it often becomes a question whether their presence or absence produces the greater deformity. Supernumerary teeth which resemble normal teeth are generally found among the upper incisors and regularly placed in the arch; they do not necessarily produce deformity, and by the unprofessional eye would not be noticed. A supernumerary superior lateral is most commonly found; next in frequency comes the superior central, while duplicates of the superior molars, bicuspids, and canines are rare. Carl Wedl, in his "Pathology of the Teeth," gives a drawing of the superior and inferior maxillæ of a negro, in which appear four molars on each side of both the upper and under jaw, besides an extra bicuspid in the lower jaw, making five supernumerary teeth in all; the molars are all in the dental arch, but the bicuspid is situated at the inner side of its neighboring bicuspid. A third kind of supernumerary tooth, sometimes described, is called the cubic-crowned tooth; it resembles in shape the lower bicuspid, and occurs in the anterior part of the mouth behind the superior incisors.

Pathology in the Arrangement of the Teeth.—A pathological arrangement or irregularity may affect groups of teeth or individual teeth.

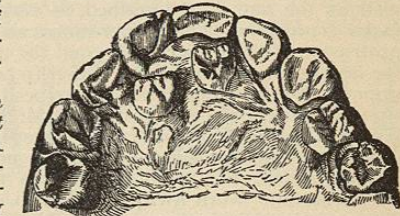


FIG. 4612.—Shows Two Cubic-crowned Supernumerary Teeth, Occurring Behind the Upper Central Incisors. (Salter.)

Among the irregularities which affect groups of teeth are cases in which the anterior teeth of the upper jaw project so far in advance of the corresponding teeth of the under jaw that a considerable space exists between the anterior surface of the lower teeth and the posterior surface of the upper teeth. This arrangement is in many cases hereditary, but may be induced by thumb-sucking in infancy. Infants addicted to this habit place the thumb between the front teeth and pry the upper teeth forward, using the under as a fulcrum. The force exerted is very slight, but, being continued for perhaps

several hours during the day, is sufficient to move the imperfectly calcified bony alveolus.
An irregularity the reverse of the above, and of frequent occurrence, is produced when the anterior teeth of

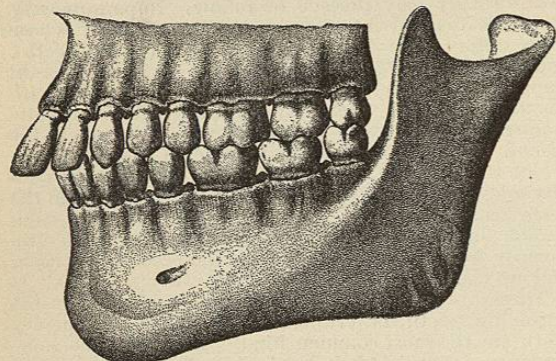


FIG. 4613.—A Case of Projecting Upper Front Teeth. (Carabelli.)

the under jaw are placed in advance of those of the upper jaw, leaving an interval between their posterior surfaces and the anterior surfaces of the superior teeth. To this condition the name underhung jaw has been given.

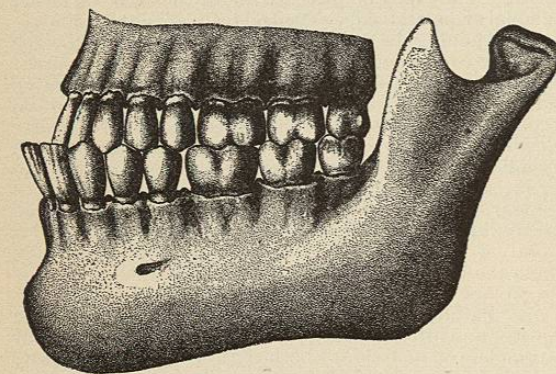


FIG. 4614.—An Underhung Jaw, the Lower Front Teeth in Advance of the Corresponding Upper Ones. (Carabelli.)

It is usually hereditary, and results either from an overdeveloped under jaw or from an underdeveloped upper jaw, the under jaw being normal. This irregularity, as well as the one first described, is very unfavorable to facial expression. The former causes an excessive protrusion of the upper lip beyond the under, and the latter a protrusion of the under lip beyond the upper. A third irregularity is produced when the superior anterior teeth, instead of slightly overlapping the inferior anterior teeth, meet them edge to edge. This arrangement causes no marked facial blemish, but is detrimental to the teeth, which become worn away by edge to edge contact, and thereby shortened.

The six anterior teeth of both jaws are sometimes tilted forward to a marked degree. This irregularity is commonly caused by the loss of molar and bicuspid teeth, which allows the whole force of occlusion to come upon the anterior teeth. This irregularity causes the upper and under lips to protrude.

On the other hand, the six anterior teeth of both jaws may be inverted, and a corresponding falling in of the lips occurs.

A V-shaped jaw is often seen; this irregularity is confined to the upper jaw, whose alveolar arch, instead of being in the form of a parabola, becomes so contracted in front that it resembles in shape the letter

V. In such a jaw the room for the tongue is much diminished, and a thick and somewhat indistinct articulation may result.

There are cases in which the back teeth are of undue length and prop the mouth open so wide that the anterior teeth do not meet. Such an arrangement is likely to keep the lips from closing, except as the result of conscious effort.

The dental arch may be asymmetrical. Such a condition may be congenital, or produced by tongue-sucking in infancy. In this habit the tongue is crowded against the alveolus bordering the upper molars and bicuspids, a constant repetition of force in this direction unevenly spreading and thus distorting the dental arch.

The "flat mouth," so called, is produced when the six anterior teeth of both jaws are arranged in nearly a straight line instead of in a curve. When so placed they join the bicuspids at a right angle, or nearly so, and give a characteristic flatness to the expression about the mouth.

These various irregularities are, as a rule, confined to the permanent set. An underhung jaw has, however, been noticed in the temporary set, followed by the same in the permanent.

Irregularities of individual teeth are to be explained by several causes, of which the most important is the occurrence of a small-sized jaw associated with large-sized teeth, a small-sized jaw being inherited from one parent and large teeth from the other.

The premature extraction of the temporary teeth is responsible for many cases of irregularity. The place of each temporary tooth is taken normally by a tooth of the permanent set, and, unless the temporary tooth remains *in situ* till the permanent is ready to be erupted, there is danger that the place which the permanent tooth should occupy will be encroached upon by an adjoining tooth.

The too long retention of the temporary teeth may produce irregularity. In this case the temporary teeth become an obstacle to the descending permanent teeth, and may deflect them from their course, forcing them to appear inside or outside the dental arch; or, as not infrequently happens, keeping them imprisoned within the maxillary bones.

Irregularities of individual teeth of the temporary set are rare. There may be a slight twisting or lapping of the incisors, but no great deformity has been observed. Most important irregularities occur in the permanent set; the superior central incisors may stand inside the dental arch, so that the inferior centrals close in front of them. Their crowns may be rotated either toward the median line or away from it, or may overlap each other. In the lower jaw the central incisors, owing to the frequent crowding of the lower anterior teeth, are often twisted or overlapped. The superior laterals are more frequently

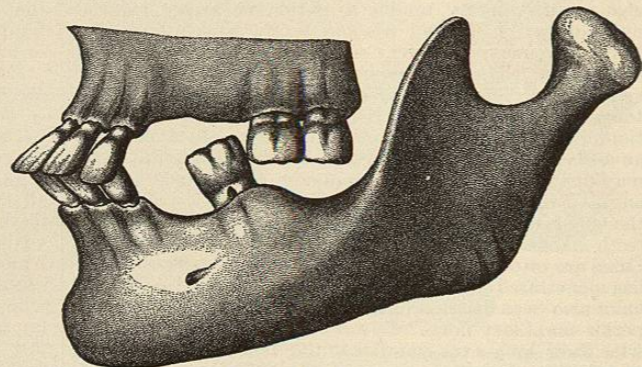


FIG. 4615.—Protrusion of the Anterior Teeth, caused by Loss of Bicuspids and Molars. (Carabelli.)

irregular than are the centrals. The most common irregularity consists in the crown of the lateral overlapping that of the central. The laterals may be placed

within the dental arch and held in that position by the interlocking of the lower teeth. Sometimes it happens that they are prevented from eruption by the canines, which have, by premature eruption, occupied their

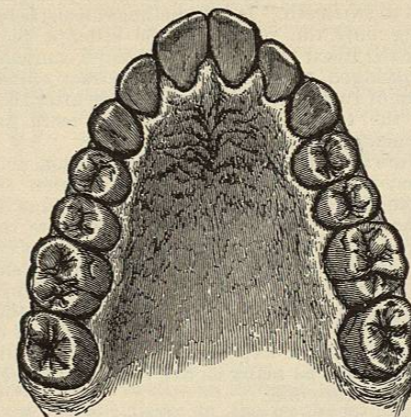


FIG. 4616.—A V-shaped Upper Jaw, from Kingsley's "Oral Deformities." (By permission.)

space. The inferior laterals are liable to irregularities similar to those described in connection with the inferior centrals; such irregularities produce, as a rule, no marked deformity, and are not usually of sufficient importance to be regulated. The superior canines are more often irregular than any other tooth in the mouth. The reason for this is not difficult to find, and has already been partly explained. Erupting, as they do, subsequent to the lateral and first bicuspid, it often happens that the space necessary for their regular appearance in the dental arch has been encroached upon by the adjoining teeth. In consequence the canines must take a position either on the outside of the arch or within. Sometimes the canine takes a position alongside the central incisor; when this is the case, the displaced lateral is usually within the arch. A rotated canine is not uncommon, the rotation being toward the median line or away from it. The lower canines are seldom irregular. The upper first bicuspid also usually finds its normal place, on account of the period of its eruption and the fact that its crown is smaller than that of the first temporary molar which it supplants.

The second upper bicuspid is much more frequently out of place than is the first. Though its crown takes up much less room than that of the second deciduous molar, which it replaces, still the teeth adjoining it (namely, the first bicuspid and first molar), being in position some time before the second bicuspid is ready to erupt, may encroach upon the space which should have been reserved for that tooth. Such a condition usually results from the too early extraction of the second deciduous molar. As a result of such extraction the neighboring teeth move together, and sufficient room is not left for the free eruption of the second bicuspid, and that tooth in consequence, finding its way in the direction of least resistance, is compelled to appear within or without the dental arch, as the case may be. The lower bicuspids are subject to irregularities similar to those of the upper bicuspids, although they occur less frequently. The first and second molars are rarely irregular in either jaw; each in turn being developed behind teeth already in place, there is nothing to crowd them from their normal position. The third molar, on the con-

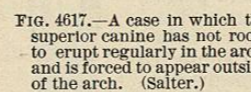


FIG. 4617.—A case in which the superior canine has not room to erupt regularly in the arch, and is forced to appear outside of the arch. (Salter.)

traction the neighboring teeth move together, and sufficient room is not left for the free eruption of the second bicuspid, and that tooth in consequence, finding its way in the direction of least resistance, is compelled to appear within or without the dental arch, as the case may be. The lower bicuspids are subject to irregularities similar to those of the upper bicuspids, although they occur less frequently. The first and second molars are rarely irregular in either jaw; each in turn being developed behind teeth already in place, there is nothing to crowd them from their normal position. The third molar, on the con-

trary, has scanty room for eruption, and in consequence presents frequent irregularity. The lower third molar is often found with its crown presenting toward the posterior surface of the crown of the second molar. Sometimes it is tipped forward so far that the force of occlusion and mastication is borne upon its distal surface. This is the most usual form of irregularity, but the tooth may assume almost any position, even with the crown pointing backward toward the ramus of the jaw. The most frequent irregularity of the upper wisdom tooth is the turning of its crown outward or backward.

Pathology in Size and Shape of the Teeth.—As a rule, the size of the teeth is in harmony with the proportions of the body. Giants have teeth which would be abnormally large if found in a person of ordinary size. The teeth of males are larger than those of females. When teeth are of unusual size, but proportioned to the size of the individual, they are normal for that individual. There occur cases, however, in which certain teeth are entirely out of proportion to the alveolar arch. Such

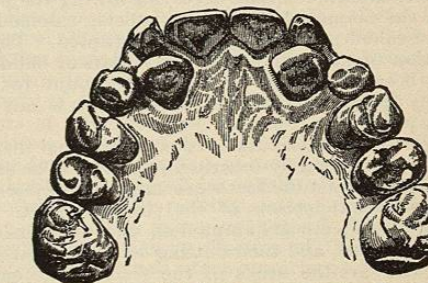


FIG. 4618.—A case in which the superior canines have not room to erupt regularly in the arch, and are forced to appear within the arch. (Salter.)

teeth may be too large or too small. Upper central incisors, in rare instances, become a monstrosity in the excessive size of their crowns; the roots in such cases are not developed in similar proportion.

The superior canines sometimes possess abnormally long roots, whose length may not be suspected till an attempt is made to extract them. Their extraction, on this account, is very difficult, or perhaps impossible. The molar teeth are sometimes abnormally developed, the crowns and roots alike being of unusual size. An abnormal diminution in the size of the teeth is not commonly found, except in the case of the upper wisdom teeth, which are often quite small, no larger than a conical supernumerary tooth. Teeth which are pathological in shape are frequently observed. Their unusual shape may be due to a constitutional disturbance, occurring during their formative period, or it may be due to a freak of nature—a cause unknown. Of the irregular

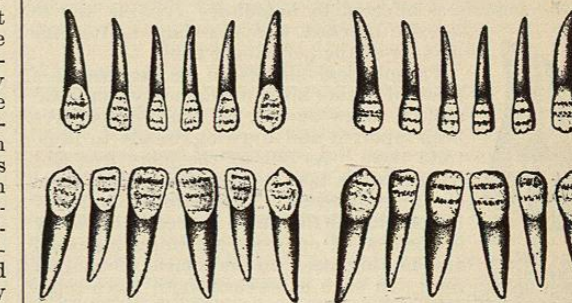


FIG. 4619.—A Pitting of the Enamel of the Six Anterior Teeth, due to Infantile Diseases Arresting the Process of Calcification of the Enamel. (Carabelli.)

shapes produced by a constitutional disturbance is to be noticed a pitting of the enamel of the six anterior teeth, and sometimes of the molars in either jaw. The pits may penetrate the entire surface of the enamel, or only a

part of it. They may be irregularly disposed, or, as usually occurs, may be arranged in horizontal rows, of which there may be two or three in a single crown. Sometimes the pits are stained a yellowish or yellowish-

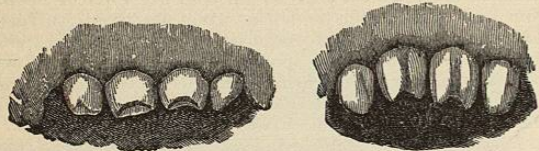


FIG. 4620.

FIG. 4621.

FIGS. 4620 AND 4621 Illustrate the Effects of Hereditary Syphilis on the Superior Incisors of a Boy and a Girl, aged Twelve and Fourteen Years, Respectively. These cases came under the observation of Henry W. Williams, M.D., and are copied by permission, from his "Diagnosis and Treatment of the Diseases of the Eye."

brown color. This irregular development is caused by some severe infantile disease occurring during the period in which the enamel of these teeth is being calcified, the process of calcification being thus interrupted. The administration of mercury in the early years of childhood has also been considered by some to account for this irregularly formed enamel, but such a view is not now generally accepted.

Another malformation due to a constitutional disturbance is that produced by inherited syphilis. The effects of this disease upon the teeth are most notably seen in the upper central incisors of the permanent set. The crowns of these teeth are stunted in size, are somewhat irregularly placed, and their cutting edges are narrower in width than are the necks of the teeth. The enamel on their cutting edges is imperfectly developed and soon crumbles away, leaving crescentic notches. The upper laterals and canines, as well as the lower centrals, laterals, and canines, may be affected in a similar but less marked way. The first molars are usually imperfectly developed, and from a loss of enamel the corners of the teeth are rounded off, giving to the crowns a domelike appearance. As the characteristics of teeth affected by inherited syphilis were first described by Jonathan Hutchinson, it is common to call such teeth Hutchinsonian teeth. They are also called notched teeth, from the notch which may be found in the cutting edge of the six anterior teeth. This notch, however, is obliterated by wear, and thus in time becomes lost as a diagnostic sign. The term peg teeth in this connection is commonly used, and refers to the peglike appearance of the crowns of the anterior teeth. The peg shape does not become obliterated by wear, and always remains a diagnostic sign. While inherited syphilis does not always leave its mark upon the teeth, yet when the appearances described are present they are considered to be positive evidence of this disease. The temporary teeth are said by good authority to be sometimes affected by hereditary syphilis, and to become notched and peg-shaped after the manner of the permanent teeth.



FIG. 4622.—A Case of Fusion of the Superior Central and Lateral Incisors.

Pathological shapes to be ascribed to a freak of nature are not commonly met with; still, a large number of such cases have been reported and drawings made to illustrate them. As one of the more frequent irregularities may be mentioned the fusion of adjacent teeth. There are two kinds of fusion: in one the union is accomplished by the cement of one root becoming increased and uniting itself to the cement of another root. In such cases each tooth has a separate pulp cavity and independent nourishment, the union being merely upon the outside and not affecting the individuality of either tooth. The other kind of fusion consists in the union of the dentine as well as the cement, and a fusion of the pulp cavities into a single irregularly shaped space. Such teeth have a common and interdependent life.

Fusion of this kind may be confined to the roots or include the crown as well, in which case a union occurs between the enamel of the two teeth. Fused teeth may be found in the temporary or in the permanent set, and any teeth may be so affected. Generally the fusion is confined to two teeth. It is sometimes unsuspected when involving only the roots, and the attempt to extract either of the fused teeth may result in its companion also being dislodged, or in a failure to extract either. The first form of fusion probably takes place after the formation of the teeth, the latter while the teeth are in a developmental stage.

There are irregular shapes not due to fusion, and which come under the head of miscellaneous forms. The incisors sometimes have their crown developed at right or obtuse angles with their roots, or have more than one root. The canines may have a twisted root, or one with a sharp bend occurring at the middle or upper end of its length. The bicuspid may have two or even three roots. In consequence of the tendency of the roots of the bicuspid to bifurcate, this occasional development of two distinct roots is to be expected. The upper and lower molars may have as many as five roots, or all their roots may be fused into one.

Pathology of the Component Tissues of the Teeth.—Of these tissues the pulp is most subject to pathological changes. Normally this delicate and sensitive organ is well guarded by rigid walls, which not only protect it against external force, but also against the extreme thermal changes to which the oral cavity is exposed. So long, then, as the pulp remains thus protected, it is not subject to pathological changes; morbid processes do not originate in its tissue. It is true that there are writers who describe affections of the pulp independent of outside influences, but the genuineness of such cases has not been well established. In general the pulp is subject to pathological changes similar to those found in the soft tissue in other parts of the body; such peculiarities as are found are due to the existence of the pulp within a bony incasement. It must be borne in mind that the pulp is very vascular and very sentient; that the vessels and nerves are supported by a parenchyma of connective tissue, and that the whole organ is contained in an unyielding cavity whose only entrance and exit is a small foramen, whose



FIG. 4623.—A Right Superior Canine with an Abrupt Curve at the End of the Root.

calibre may not be larger than a bristle. Through this foramen the blood enters, and is in due time returned—a delicate piece of machinery capable of easily performing its duties when in natural adjustment, but impaired or destroyed when affected by force from without. Any agency which interferes with the protection which nature has thrown around the pulp is calculated to set up morbid changes in its structure and interfere with its function. The most potent and frequent agency to be named is caries. When once this disease has located itself upon a tooth it usually progresses, unless checked by appropriate mechanical means, till a considerable portion of the enamel and dentine is destroyed and the pulp laid bare. Long, however, before the pulp is reached it has been subjected to conditions unfavorable to its healthy activity, and the chances are that when exposed by caries it is already in a pathological condition.

An agency in producing disturbances of the pulp less important than caries is the natural wearing away of the substance of the teeth in the process of mastication. Such wear is usually without serious effect upon the pulp up to the period of middle life. Subsequent to that time, however, it may so deprive the pulp of its natural covering as to induce pathological changes.

A third outside agency, and one less frequently met



FIG. 4624.—A Superior Bicuspid with Three Roots.

with than the other two, is mechanical violence, in the form of a blow or fall, of such a nature as to sever the union between the pulp and its blood and nerve supply.



FIG. 4625.—A Molar Tooth with Five Roots.

Under such circumstances the pulp, as a rule, dies. There are, however, cases reported in which a sound tooth having been pushed out of its socket has been replaced, and the pulp has apparently remained in a healthy condition. Such cases lend support to a supposition that a reunion is possible between the pulp and its blood and nerve supply; but this point has not yet been satisfactorily settled.

One of the simplest and commonest pathological affections of the pulp is congestion. A pulp examined in this condition shows increased redness, due to an increased flow of blood to the part and dilatation of the vessels. This condition is brought about through the vaso-motor system, which responds to an irritation of the dentinal fibrils, which are in connection with the nerves of the pulp, and so with the general nervous system. Inasmuch as the normal pulp fills its cavity, an increased supply of blood must compress the tissue in the neighborhood of the vessels. The nerves share this compression, and hence the severe pain which is the usual accompaniment of a congested pulp. Caries of the tooth is the most common cause of congestion of the pulp. Through it a cavity in the direction of the pulp is produced which allows hot and cold drinks, food, and cold air to approach so near the pulp that they irritate it. Salt and sweet substances, also, if allowed to enter the cavity produced by the caries, will act upon the dentinal fibrils and irritate the pulp. A congested pulp is hypersensitive, giving pain upon the slightest occasion. A draught of cold water, the effect of which upon a normal pulp might be but a momentary twinge, would cause a congested pulp to ache violently. This ache is one of the more common kinds of toothache; it is violent, intermittent, throbbing. It is very likely to be worse at night when the body is in a recumbent position. Congestion of the pulp does not necessarily result in a permanent pathological condition, provided the environment of the pulp can be so improved as to become normal, or nearly so. The normal environment may be restored by filling the cavity produced by caries, the pulp being thus removed from the near approach of heat or cold and irritating substances. The filling material should be a poor conductor of heat and cold, resembling in this respect, as far as possible, enamel and dentine. Gutta-percha or oxyphosphate cement have proved the best substances with which to protect a congested pulp. It frequently happens that the pulp becomes congested in a tooth which contains a large metallic filling. The metal filling, being a good conductor of heat and cold, conveys injurious shocks deep into the dentine and unfavorably affects the pulp. Such a condition may be remedied by substituting a non-metallic filling for a metallic one.

While a congested pulp may recover its normal condition, it frequently passes into a state of inflammation which may be either acute or chronic. In acute inflammation there succeeds to the active hyperæmia of congestion a stasis of blood in the inflamed portion; the vessels become dilated more than before, and often assume a tortuous course. The leucocytes can be seen leaving the capillaries and invading the surrounding tissue. If the inflammation is purulent, pus cells and broken-down tissues become abundant. The affection may be local, confined to a small point which has been exposed by caries, or it may be general, involving the entire pulp. The organ is swollen, as in congestion, and pain results from pressure upon the nerve fibres. If the inflammation is very violent, it is likely to destroy the life of the pulp in

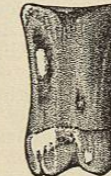


FIG. 4626.—A Molar Tooth whose Roots are Fused into One.

a short time, through pressure upon the blood-vessels at the foramen. The symptoms attending an inflammation of the pulp are similar to those of a congested pulp, but more severe. The pain is violent, throbbing, paroxysmal, and is commonly known as a "jumping toothache." The tooth is extremely sensitive to heat and cold, to sweet and salt substances, and to pressure within the cavity of decay.

Such an acute inflammation may subside or pass into a chronic inflammation, the symptoms of which resemble those of the acute, but are of a less severe grade. The cause of inflammation of the pulp is caries, which, as a rule, has penetrated to the pulp cavity and laid bare a minute portion of that organ, exposing it to the irritation of foreign bodies, thermal changes, and the secretions of the oral cavity. When suppurative inflammation occurs, the probable agency of bacteria is of interest, as it is well known that many varieties of these organisms exist in the mouth. Their approach to the pulp is made easy through the carious cavity, which lays bare the pulp, and the conditions seem favorable for their peculiar activity. Dr. H. C. Ernst says, in his "Consideration of the Bacteria of Surgical Diseases" (page 4): "The point being determined that there is at least a very strong probability that no suppuration occurs without the presence of bacteria, the study of the organism concerned in these processes becomes at once of great interest." Dr. Black, in the "American System of Dentistry," vol. i., p. 854, says: "I have found suppuration, or more properly ulceration, following a very superficial inflammation, in which the tissue was apparently melting down into a sanious pus thickly inhabited by micro-organisms." The course pursued by an inflammatory affection of the pulp depends largely on the extent to which its surface has been exposed through caries. That there is always such an exposure in case of inflammation of the pulp cannot be affirmed, but that it does exist in the large majority of cases is attested by experience. If this exposure is small and allows no relief to the swollen condition of the organ, and no sufficient outlet to products of inflammation, then an acute inflammation is likely rapidly to destroy the pulp, and transmit an inflammatory process along the root canals to the peridental membrane. If, however, the pulp has been freely exposed before an inflammation has been started up, then the inflamed pulp has a way of relief to its enlarged substance, and an exit for the products of inflammation. Such cases are more likely to assume a chronic form, inasmuch as the life of the pulp is not immediately threatened. It is a matter of some chance, in the case of a pulp exposed by caries, just how soon an inflammatory affection will be started up, though no pulp when once exposed can long escape. If the cavity which exposes the pulp is hidden away in the back of the mouth, or protected by adjoining teeth, so that the pulp of the tooth is, in a measure, protected from alternations of temperature and severe contact with food, then the inflammatory affection may be delayed, and, when it does come, decay may have so opened the pulp cavity as greatly to modify the severity of the inflammation. On the other hand, when caries attacks the crown of the first molar and lays bare the pulp, it is immediately subject to severe irritation in the process of mastication, and trouble begins at once. Inflammatory affections of the pulp do not tend to recovery, but generally end in death of the pulp. This result may be, however, somewhat delayed by appropriate treatment. The exposed pulp may be capped over with non-irritating, non-conducting material and thus shielded. It is sometimes possible to prolong the life of the pulp several years, provided the treatment is not long delayed after the beginning of the inflammatory affection. After having been thus treated the pulp may give no further sensation of pain; it does not, however, often regain its normal condition when it has once passed through the inflammatory process.

To alleviate the pain of a congested or inflamed pulp it is important, first, to determine which tooth is giving trouble. The testimony of patients cannot be relied upon to settle this point. They can usually indicate cor-