Dens in Dente.

By

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Dens in dente is the name generally used for an abnormally shaped tooth, the hard tissues of which during the development have grown in such a way that it may seem as if another tooth lies inside it. Although the cases mentioned and described in literature are not very many, the malformation is hardly rarer than that it clinically may be of importance to know the different forms. A close examination of this malformation also reveals a number of things of more theoretical interest. From the casuistry appearing in literature, and from the theories about the development of the malformation, it is evident that there are two distinct main forms of dens in dente: a radical ("root in the root") and a coronal form.

Dens in dente of the radical main form is thoroughly dealt with exclusively by DE JONGE COHEN in some articles from 1918 and later. According to him, the deformity develops by invagination of the linguo-mesial furrow on the root of the 1st premolar in the lower jaw. The thus separated "extra root" will then remain lying in the pulp cavity of the main root, and its hard tissues consist of dentin and cement in layers invertedly to the normal. DE JONGE COHEN has outlined how he figures the various steps in the process leading to "root in the root", fig. 1. Furthermore, he has a photography of cross sections of 5 different 1st premolars in the lower jaw, where the invagination process has stopped at different stages of development corresponding to each of his sketches. He does not go into the cause of the Hertwig's sheath in certain cases showing this peculiar course during the development of this particular tooth.

In this article, the coronal main form only will be further dealt with. It most frequently appears in the front region of the upper jaw. Fig. 2 shows a sketch of a longitudinal section of a typically formed dens in dente in an incisor of the upper jaw. The crown has a comparatively normal appearance. The root has a wider circumference than a normal tooth; it is also somewhat shorter and has a large foramen apicale, as if it is resorbed from apex, or has stopped too early in its development. In this longitudinal section, which goes through foramen coecum, the enamel can be traced down into the interior of the tooth, where it covers

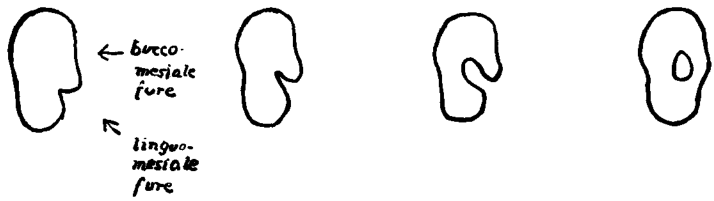


Fig. 1. Various steps in the development which lead to "root within root". Shown in horizontal sections (DE JONGE COHEN).

the walls in an almost bottle-formed, inflated *cavity*. The enamel becomes less noticeable towards the bottom of the cavity. Thus we can distinguish between the *outer enamel coating* which forces itself through foramen coecum and forms an *inner enamel coating*. The dentin mainly follows the outer contour of the tooth normally, but coronally it turns over and also follows the contour of the inner enamel. We see an *outer* and *inner dentin coating*, coronally coherent. The two dentin coatings are elsewhere separated by the pulp, which thereby takes a form that may be compared with a goblet with a stem, but without a foot. The contents of the goblet are the most characteristic part of the malformation, and are that part that reminds of an inner tooth. It consists of the central cavity, the inner enamel and the inner dentin, and will in the following be called the *inner formation*. The rest of the tooth, namely the pulp, the outer dentin, the outer enamel and the cementum, will be called the *outer part*. By summarizing the criterions now generally used to characterize dens in dente, we get the following points:

1. Within a more or less irregularly formed tooth there is a toothlike body, the hard substance of which consists of dentin and enamel.

2. The hard tissues of the inner formation are primarily formed,

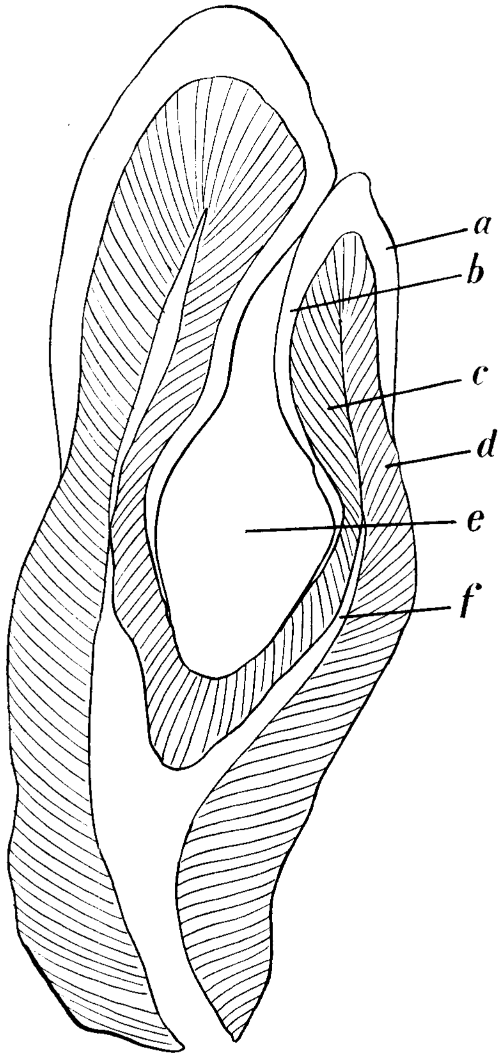


Fig. 2. Sketch of dens in dente in longitudinal section.
a. outer enamel, *b.* inner enamel, *c.* inner dentin, *d.* outer dentin. *e.* cavity, *f.* pulp.

at the same time as those of the outer part. It has always the dentin on the outside.

3. The inner formation is to some degree free in the pulp cavity, to some degree coherent with the outer part, and

4. it encloses a cavity, reminding of a pulp cavity.

In general, it is now taken as a fact that dens in dente is formed by a single tooth germ, because its enamel organ at an early stage has attained a certain peculiar abnormal form.

Previous investigations.

JOHN TOMES is presumably the first who has mentioned the malformation in literature. His description from 1859, of a case with the same form as in fig. 2, is precise and sharp. He did not give it any special name nor did he speculate about its origin.

The next authors we find dealing with the subject took it for granted that this was a matter of some kind of a fusion of two tooth germs, whereof one had grown around the other. It was on this basis that BUSCH in 1897 gave the deformity the earcatching name it has since kept, although it can no longer be called correct. The consequence is that if anyone today found a tooth engulfed by and coalesced with another, he ought not, without comments, to call this finding dens in dente.

Statistics.

Most of the cases described have in common that they are localized to the front tooth and cuspid region of the upper jaw, in permanent and supernumerary teeth. According to the literature available to me about dens in dente, either in the original or in a fairly satisfactory report, they are divided up as follows (p. 57).

These cases can be added to by the tooth in fig. 3, a ground section prepared and given to me by G. FREDERIKSEN, Dental Surgeon of Oslo. The section shows the malformation in a small supernumerary tooth of the premolar form, found palatinally + 3 and + 4.

In addition to this, I have found described four cases outside the front of the upper jaw:

BUSCH 1897 lateral incisor in the lower jaw.
HASSEL 1914 wisdom tooth in the upper jaw.
ADELER 1939 central incisor in the lower jaw.
EULER 1939 cuspid in the lower jaw.

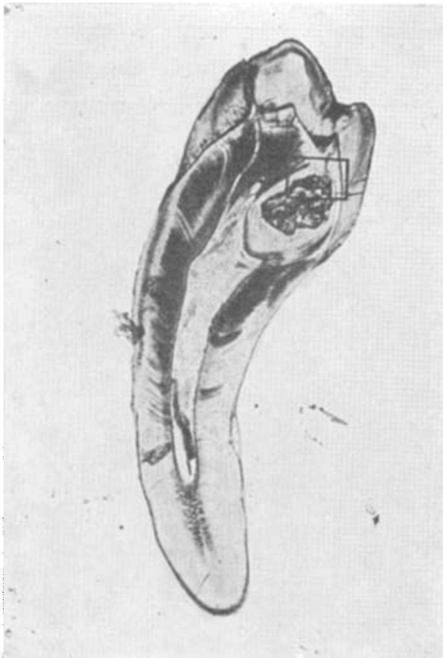
Conformities and deviations.

These findings show partly some more, rather ordinary conformities than mentioned in the introduction, partly some deviations which deserve to be observed.

The different writers' statement of the tooth.

		U. jaw. front t.	Centr.	Lat.	Cusp.	Supern. t.
TOMES	1859	1				
SALTER	1875			1		
BAUME	1877				1	
BUSCH	1897		1			3
MILLER	1901				1	
ZECKENDORF	1911			1		
MORAL	1918					1
MC DONALD	»		1			
KIRK	»				1	
LEJEUNE	1920		1			
WUSTROW	»				1	
BODENHEIMER	»	1				
GNAMM	1922	1				
NEUWIRTH	1927	4				
GOTTARDI	1928				1	
JESENSKY	»					several
LEBOURG	1933	1				
RØMER			1			
PORT-EULER						1
KRONFELD	1934			1		
REBEL	»			1		
HAMMER	1935			1	1	
HOEPFEL	1936			3		
FISCHER	»			2		
KITCHIN	»			1		
HYDE	1944			1		
		8	4	12	6	5 + several

When foramen coecum is the place where the inner enamel is coherent with the outer, it is invariably described that the lingual surface of the tooth is heavily thickened, or shows a pronounced tuberculum dentis. Photographs and drawings show that the tubercle often is strongly developed even on cuspids, and on incisors in the lower jaw, where it normally very rarely is found. Foramen coecum is generally macroscopically closed. But some cases show deviations with regard to the place where the outer enamel turns inside. Thus REBEL describes, on the incisal edge itself, a funnel-shaped pit leading to the cavity. HOEPFEL and KITCHIN show similar teeth. MILLER'S case is quite unique, as he describes a superdimensional 3+ with about 15 intrusions of varying depth in the crown, each one showing the same characteristics as a dens in dente. SALTER gives us a drawing of an upper jaw lateral with "tooth within tooth", where the abnormally thickened and folded labial surface of the crown seems to be the invagination point.



A

Fig. 3. Ground section of dens in dente in a small supernumerary tooth of premolar form. *A*. Survey. *B*. Enlargement of an area where the inner enamel is seen near the middle of the picture.

B

Some of the cases indicate that the inner formation has an apical foramen of its own, which can be seen or probed through the real foramen apicale. The root section is then, as a rule, shorter than usual. BUSCH, ZECKENDORF, LEJEUNE and HOEPFEL for instance show such teeth. But where the inner formation to all appearance is closed in its apical part, those authors who have studied this in section series, have always found microscopical communication channels to the pulp in this area (KRONFELD, FISCHER, a. o.).

Already BUSCH mentioned that the cavity in vivo must have contained remains of the enamel organ. LEJEUNE showed, on his decalcified and stained frontal sections, two necrotic strings lying in a narrow channel which led from outside through a pit (foramen coecum) and into the cavity, and which he presumed were remains of the enamel pulp. A necrotic string in the channel through "the bottle-neck", and a looser necrotic tissue inside of the cavity, explained in the same manner, is also pointed out later. Besides, here calculi have been found along with cementum- and bonelike masses, presumably owing to mesenchymal tissue forcing its way into the cavity from the pulp via the macroscopical or microscopical channels in the apical part of the inner formation. And finally, foreign bodies have here been pointed out, which must have forced their way in through the channel at the invagination point during chewing, after the eruption of the tooth.

An erupted dens in dente always seems to show symptoms of periapical inflammation. The entrance for the infection is presumed to be the invagination point which, even when it is macroscopically closed, has been the passage for microscopic bodies. The pulp is infected through the communication channels from the cavity.

Both the inner and the outer dentin coatings are likely to have heavy layers of secondary dentin on the side facing the pulp. These layers often obturate the goblet-formed pulp over a long distance, so that here new places are created with solid connection between the two coatings of dentin.

The size of the inner formation varies strongly. But one similarity is repeated in the descriptions, as the cavity is called inflated, pear-formed, ampulla-like, bottle-formed, ringformy extended etc. HAMMER'S two cases have extremely large cavities. In the sections the two dentin coatings only look like narrow ribbons in the periphery of the tooth. Neither did HAMMER recognize these two findings as dens in dente, but gave them an uncertain diagnosis.

However, HOPEFEL pointed out that they had all the criterions characterizing them as dens in dente, in our present conception of the matter, although none of the cases resembles "tooth in tooth".

The development.

As previously briefly mentioned, BUSCH thought, and others before him, that dens in dente originated from one tooth germ growing around another, but none of them tried to explain why

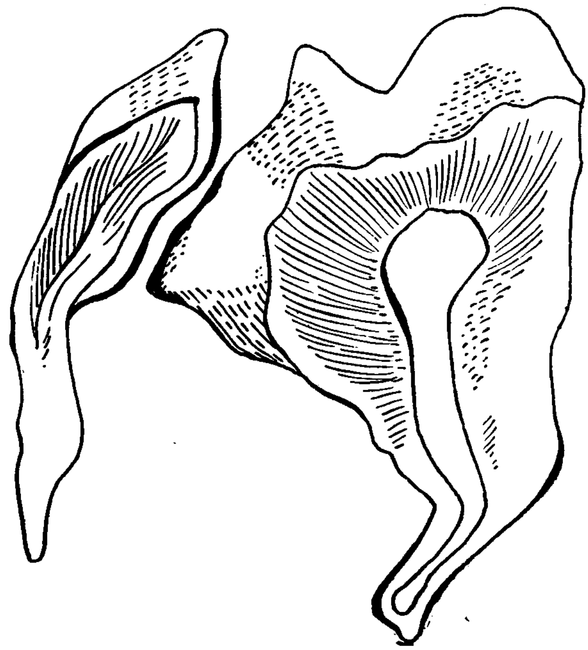


Fig. 4. Hassel's sketch of a ground section. Enamel lined channel through a + 8.

"the inner tooth" seemed to have turned inside out. Reference was chiefly made to the findings by probing through the foramen apicale, and by horizontal ground sections. This interpretation was uncontradicted until MORAL in 1918 submitted a new theory. However, in 1914, he had a predecessor in HASSEL, who at that time could hardly be aware of the fact that in his article he dealt with a quite unique case of dens in dente.

HASSEL's +8 has a channel on the inside coated with enamel, going out from a fissure in the occlusal surface and running in an almost vertical direction through the crown. The outlet of the

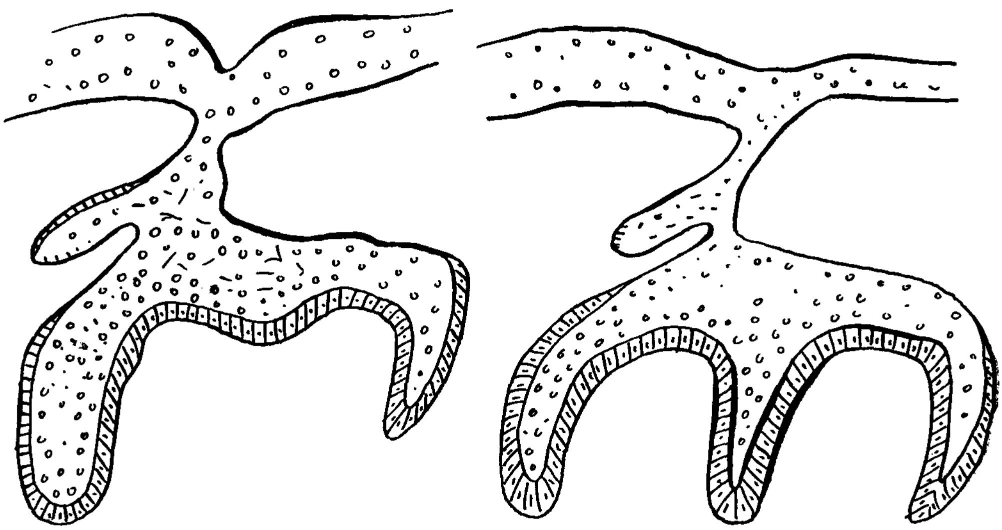


Fig. 5. Hassel's sketch of the bell stage.
A. Normal tooth germ. *B*. Preliminary stage to dens in dente.

channel, with an enamel crista around it, appears between the roots. A section through this tooth, along the longitudinal axis of the channel, apparently shows two teeth beside each other, whereof the little one on the left side has an obturated pulp cavity, fig. 4. In reality these two teeth are parts of the same tooth. Sections taken before and after this one would make the coherence clear. The pulp string in the left part coheres with the main pulp in that of the right, circularly around the abnormal channel formation (the goblet form). It is probably best understood if one compares fig. 4 with fig. 2, and in the latter imagines a big apical opening on the inner formation, the similarity then becoming striking. HASSEL's explanation of the origin of this malformation appears from his sketches in fig. 5. The inner enamel epithelium has during the development at one place grown abnormally deep in the papilla. At the bell stage we have an enamel organ tag, a "bell-tongue".

MORAL extended the same explanation during the discussion of a dens in dente, in a supernumerary front-tooth of the upper jaw. His sketches of the development at the bell stage are essentially identical to HASSEL's. He emphasizes that the histological structure of the inner formation shows us that it is a primarily originated malformation, and no secondary formation as are the denticles. The inner enamel can only be conceived as the consequence of an infold of the enamel organ, which must have occurred at such an early stage that the calcification has yet not commenced, that is, before a calcified dentin layer could impede the vagination at this spot. Right opposite the ameloblasts of the "bell-tongue" the odontoblasts develop in the regular way, and as the development progresses, the usual picture of dens in dente is produced. Hereby MORAL left the supposition of a fusion between two tooth germs, and his theory has later remained as the better one.

Nevertheless, sometimes we find later writers contending to a different point of view with regard to the formal genesis.

With his sections as a basis, sections to some degree reminding one of HASSEL'S, LEJEUNE in 1920 submitted the idea of a coalescence, or a double germ, because he was not aware of the fact that the two apparently independent pulp strings circularly cohere around the inner formation, on account of the goblet-form of the pulp.

WUSTROW in his case, also in 1920, made a ground section along the longitudinal axis. The section goes through foramen apicale, but it has not hit the invagination point of the inner enamel, for which reason the inner formation looks as if it is closed in its coronal part. He gives the same sketches of the development at the bell stage as HASSEL and MORAL, but, furthermore, presumes that the enamel organ tag has separated itself from the rest of the enamel organ, because he does not see the invagination point on his section. This conclusion has been strongly contradicted by later writers, as it is assumed that such a separation must hinder the supply of nutrition, and thereby the further development of the inner formation.

Finally, it may be mentioned that APFFELSTAEDT, as late as 1928, asserted the old conception, even by suggesting a new and equally misleading name. But he did not try to give a better explanation than that of BUSCH.

Varying degrees of development.

As a consequence of the new way of looking at the development, a connection between dens in dente and other form variations from normal was soon pointed out. In 1922 GNAMM set up a scheme for different degrees in the development of the coronal form of dens in dente, fig. 6, similar to what DE JONGE COHEN previously had set up for the radical form. The three first pictures in the scheme mostly illustrate a steadily stronger forcing down of the foramen coecum. Each individual link of the series separately tells us less than it does in such a connection. The row begins with a front tooth having a marked lingual cusp and a deep foramen coecum. Thereafter comes a tooth with a cup-formed or funnel-formed deepening in the lingual surface ("Tütenzahn"), a quite common form for supernumerary teeth. The third link is

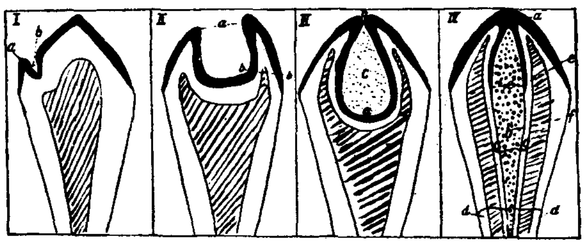


Fig. 6. Gnamm's scheme of various degrees of development of dens in dente

a dens in dente with a pear-formed cavity and a closed invagination point, while the fourth is a sketch of dens in dente where the cavity is apically open.

It may be said that HOEPFEL went further with this row, as in connection with the reflections about Hammer's cases previously mentioned, he called attention to a root-odontome, in 1935 pictured and described by HESSE. He says that even if these malformations are not so distinctly differentiated as regular dens in dente, such important parts of resemblance appear that it must be assumed that they from a formal genetic point of view can be included in the group of dens in dente.

Regarded from this angle, the picture of HESSE's root-odontome, fig. 7, can thus be described:

The invagination point is very large. It looks as if the whole enamel organ is pushed or sucked along in the growth of the "bell-tongue". Especially on the right side of the section we can easily see the two dentin coatings with the pulp in between, and their coronal coherence. On the inside of the inner dentin coating bits of enamel appear. But the whole cavity, being very large, is filled with confused tumor tissue of mesenchymal origin, presum-

Fig. 7. Root Odontome (HESSE).

ably related to the more scarce calculi and bone masses, as a rule appearing in the cavity on regular dens in dente, where the apical entrance has been small.

In 1939 EULER has supported HOEPFEL and showed a case of his own, similar to HESSE'S. Similar reproductions of root-odontomes are easily found elsewhere in the literature.

The Etiology.

The works of earlier writers give nothing else but hints about the cause of the origin of dens in dente.

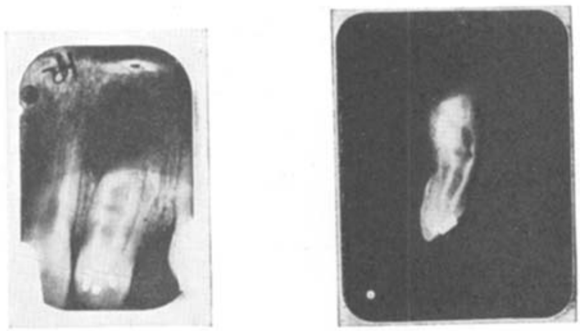
DE JONGE COHEN points out the great development of the lingual cusp (deuteromer), and assumes that it must be given a special significance. He does not go into in what direction this may be done. He presumably means that the formation can be explained phylogenetically by means of the dimer theory.

Having the idea of a coalescence of two teeth, LEJEUNE puts forth the question whether we have here an issue of atavism, that can possibly support the concrescence theory.

Hoepfel mentions the possibility of trauma, or disturbances in connection with the development of os intermaxillare.

Fischer points out that an infected milk tooth may be the decisive factor.

Euler regards the cause, in all likelihood, to be disturbances of growth during the development of the jaws that influence the tooth germ. He draws parallels with tooth formations in ovarial cysts, which may show enamel invaginations.



A B

Fig. 8. *A*. X-ray of +2. *B*. Mesio-distal x-ray of the same tooth.

My own finding.

Miss E. A., 18 years old, consultation concerning pains in 2+. The lingual surface is thicker and bulkier than on +2, and has three small amalgam fillings in its central part. The tooth is otherwise free from caries. 3+ is said to be removed earlier on account of the crowded arch, there is a space between 2+ and 4+. The tooth is sensitive to percussion and reacts to faradic current.

The X-ray shows an irregularly thick root, and a granulome or a cyst on the tip of the root, fig. 8A. But here also other things are observed, and they warn us against undertaking any root-treatment without closer investigations. The form of the pulp seems to deviate strongly from the normal. Pictures taken in other projections indicate that this must be due to an extraordinary formation of the interior of the tooth, and not, for instance, to a supernumerary tooth outside. A central, lengthened, somewhat irregularly inflated lumen within the tooth is limited by a hard substance of the same density as the enamel. The dentin is distally divided vertically into two by a thin pulp-chord, apically going out through at least two foramina.

Diagnosis: Dens in dente.

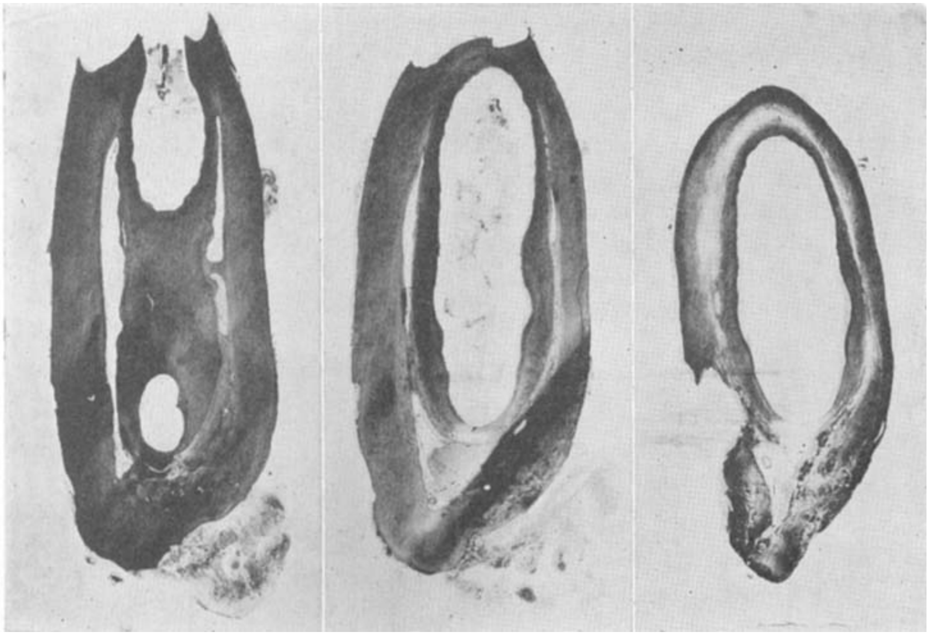


Fig. 9. Dens in dente cut frontally.
A. Section No. 95. *B*. Section No. 140. *C*. Section No. 200.

The anamnesis tells us nothing about the cause, as for instance heredity, trauma and such like.

After having again ascertained that the tooth reacted to a warm instrument and faradic current, it was removed along with the granulome attached. Fig. 8B shows an X-ray in mesio-distal direction of the extracted tooth.

The tooth was fixed in Müller-formol, decalcified in nitric acid and mounted in celloidin. It was cut frontally in series and stained with haematoxylin-eosin and Mallory. Pictures giving a survey, fig. 9.

The outer enamel with the shallow amalgam-fillings has disappeared during the decalcification. The cementum is normal with some layers of secondary cement on the tip of the root. Here also some resorbed areas are found, of which one particularly large, lying disto-palatinally, can be traced right through the outer dentin coating and into the pulp, fig. 9C. An unusually big and irregularly formed apical foramen, labially and a little coronally

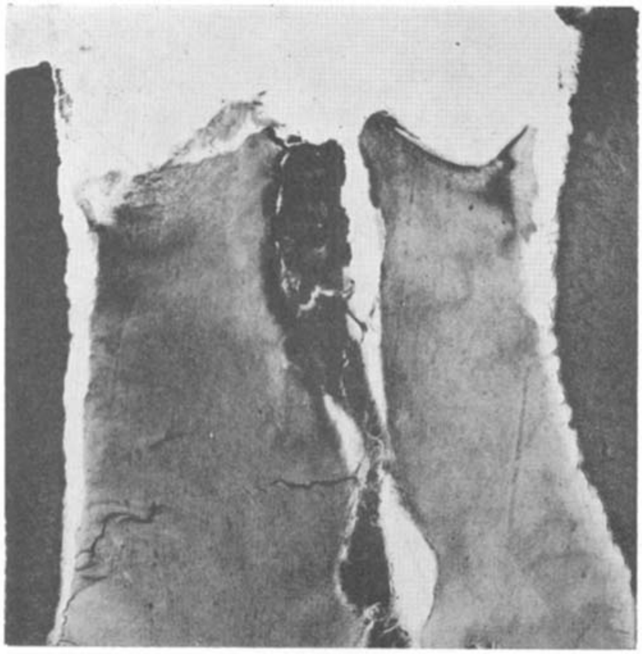


Fig. 10. Detail from fig. 9 A, foramen coecum with the necrotic string and the enamel layer on each side.

to the tip of the root, is mostly filled with granulation tissues. Besides, a more regularly formed foramen and some small foramina are found at the end of the root.

The outer dentin coating is about twice as thick distally and labially as mesially and palatinally. It shows a quite normal picture, with a regular course of the dentinal tubules in the coronal two thirds of the tooth, with some layers of secondary dentin towards the pulp. The apical one third, however, is more anomal, with irregular dentin of all degrees, and shows many resorption channels towards the end of the root.

The outer dentin coating goes coronally without any limitation into the inner, which also shows a quite normal dentin in its upper part. Towards the apical part of the inner formation, its dentin coating also becomes all the more irregular, especially at the side facing the pulp, where, in addition, it is furnished with tremendous secondary deposits. The most apical part of the inner formation has a peculiar form. The dentin layers are here lying like the leaves of an onion, and form a big oval body around a channel, leading from the large cavity direct to the large foramen.

The pulp tissue has a number of denticles. It takes up a very moderate space between the dentin layers, often entirely obturating the pulp's lumen over a long distance, and it shows heavy necrotic degeneration. Traces of the normal odontoblasts appear at certain spots coronally. Otherwise only reticularly atrofied tissue apically mixed with or substituted by granulation tissue is found.

In the cavity much of the enamel structure can still be seen. Centrally in foramen coecum the frequently described chord of necrotic tissue appears coming from the outside, and running through the foramen. See fig. 9A and 10. It goes through the channel of the "bottle-neck", and into the cavity, where it expands and forms a looser net of necrotic tissue. The diameter of the chord is about 0.1 mm at the narrowest part, and its density indicates that it has been compressed by the inner enamel during development. Centrally in the necrotic chord, visible only in a few sections following in sequence, a channel goes in the longitudinal direction of the chord, filled with non-descript substances, of a little lighter shade than the rest of the chord. These substances seem to be compressed in the longitudinal direction, as they partly consist of lengthwise running filaments squeezed into a spiral form. This channel inside of the chord must be the entrance for foreign bodies (plant fibres, cellulose particles and the like), a number of which appear within the necrotic tissue in the cavity. But the rest of the chord adheres to the enamel along its borders, and in many places sends lamellae-like offshoots into the enamel. It is difficult to imagine any other explanation than that indicating that the parts of the chord adhering to the enamel are remains of enamel organ. (The fissures in the chord, seen in fig. 10, are undoubtedly developed during the preparation of the object.) In the cavity the necrotic tissue is in the same way coherent with the inner enamel, with long lamellae-like offshoots. Connective tissue can here be observed in abundance. We find a good many calcified masses, but no distinct formations of bone or cementum. The necrotic enamel-pulp shows numerous traces of cholesterin crystals.

The enamel structure shows a fairly normal picture in foramen coecum and also some distance further down. Diazonies and parazonies are clearly seen, and the main direction of the prisms is radiant to the necrotic chord. Most coronally the prisms turn

Fig. 11. Detail from section No. 60. Cross section of the channel from the cavity to the large foramen. In the middle of the channel enamel pulp is seen, limited by ameloblast layer and young enamel. In the right upper fourth part of the picture, a part of the pulp cavity, filled with granulation tissue. Between the pulp and the channel deposit of dentinoid substance in layers.

away from this course, upwards to the outer enamel. Further down the prisms are seen in cross section, where the cutting has hit the chord tangentially in its labial or palatinal wall. Along the walls of the cavity the enamel loses its normal structure more and more, until, in the oval body in the apical part, it seems to have stopped in its very first stages of development. Some areas where the ameloblasts still can be distinguished are here seen. Furthermore, the structure of a tissue, recembling the enamel-pulp is clearly visible, although here too the initiated necrotic destruction appears from cholesterin crystals, fig. 11.

This tooth has been erupted and has functioned for approximately 10 years before being removed. It has been treated by the school dentist, who has filled enamel fissures on the lingual surface, probably without noticing anything but the tooth being here a little irregularly shaped. The infection has, of course, taken place immediately upon the eruption, but it must have had slow progress through the cavity and the big foramen to apex, and as an ascending pulpitis back again toward the pulp branches. The structure of the tooth shows that its active tissues have had a two-sided struggle, first against the abnormal growth of its interior, and next against the infection. The apparently normal reaction to faradic current indicates that certain pulp branches have still contained living nerve tissue, which the form of the pulp and the many foramina make explicable.

Discussion.

Because we find some normal folds reminding of dens in dente in a number of mammal's teeth, both molars and front teeth, I will to begin with try to draw a comparison. For this purpose I choose the front tooth of a horse, in its outer form reminding one strongly of that of man.

We see in fig. 12 a sketched longitudinal section of a horse-incisor, as it looks before the crown has been worn down, and we use the same terms for describing it as for dens in dente.

Centrally in the broad incisal edge the enamel forces its way deep into the tooth, and with an even layer lines an apically closed, cylinder-formed cavity, which for the greater part is filled with cementum. The outer and inner dentin coatings are in all essentials as in dens in dente, also the goblet-form of the pulp.

As will be observed, there is also a decided difference, first of all in the form of the cavity, which is not inflated, and where no constricting "bottle-neck" has hampered a normal development of the inner enamel. Furthermore, the cementum here located within the cavity, is normally shaped. It originates from the tissue of the dental sac, previously called the osteo-cement pulp, gradually having deposited its product in the direction from the incisal edge towards the bottom of the cavity. Finally, no signs of pathological reactions from the form-moulding elements are usually found. These distinctions are so important that no conclusions of significance should be drawn, for instance of a phylogenetical connection between the pathological dens in dente and the normal form of these mammalian teeth.

But it must be noticed that the normal enamel in the cavity of a horse-tooth cannot be conceived unless both the outer and the inner enamel epithelium have joined the invagination at the earlier stage of development. And the mesenchymal tissue in the cavity, represented by the cementum, can only have come in through the coronal opening. It may also be mentioned that if the development

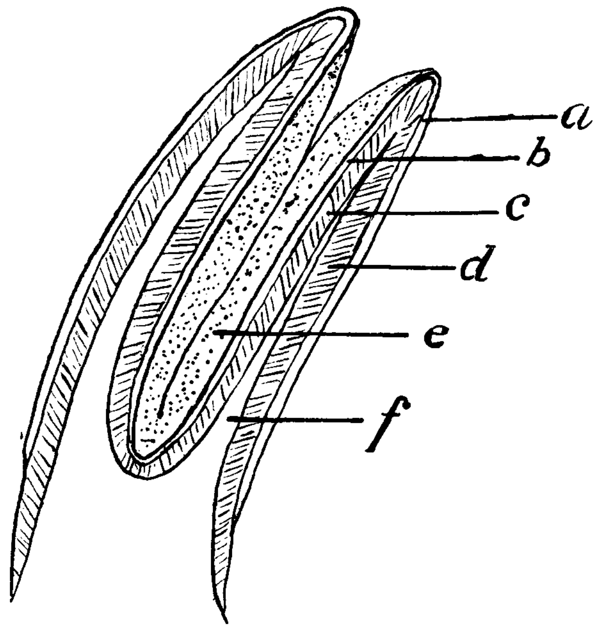


Fig. 12. Sketch of horse-incisor in longitudinal section.
a. outer enamel, *b.* inner enamel. *c.* inner dentin, *d.* outer dentin,
e. cementum in the cavity, *f.* pulp.

of the horse-tooth is interrupted, for instance by an extraction, before the completion of the forming of the long crown, it resembles a dens in dente where the inner formation is apically open.

We now turn to an estimation of the previous findings and my own in conjunction.

The statistics recorded are not many, but will, nevertheless, give support to some conclusions:

Dens in dente is never described in deciduous teeth. *The first dentition shows also in this respect a greater immutability than the permanent teeth do.*

Among 22 cases (including the last one described, 23) where one specially mentioned tooth in the upper jaw is malformed, one half is localized to the lateral incisor, while the other half is almost equally divided between the central incisor and the cuspid. *The lateral seems to be located in the focus of the disturbance bringing forth the variation.* This is a feature that dens in dente has in common with other anomalies in the same field; reduction, doubling, agensis etc.

Findings of dens in dente in supernumerary teeth are described 5 times + the case of Frederiksen + Jesensky's report of "several", this being a high percentage of the entire number of cases in comparison with the occurrence of supernumerary teeth on the whole. If we accept GNAMM's scheme, including "Tütenzähne", this becomes still more pronounced. *Dens in dente appears comparatively far more frequent in supernumerary teeth in the front of the upper jaw, than in the normally present teeth.*

If the case I have described is compared with the previous findings, it shows all the typical characteristics of dens in dente. At the same time, it offers quite definite facts in support of the earlier supposition, that the necrotic tissue in the cavity is remains of the enamel organ, as it shows traces of the structure of the enamel organ. The transitory forms from this and to the wholly necrotic part of the enamel organ, inclusive of parts of the necrotic chord in "the bottle-neck", hereby become definite to classify.

The channel in the necrotic chord is another new observation. Through this channel foreign bodies are pressed down into the cavity. If this finding is seen in connection with the picture simultaneously described of the course of the enamel prisms in the "bottle-neck", we have a basis for a revisal of the HASSEL-MORAL sketching of the initial stage, reproduced in fig. 5. Provided this drawing had been right, we would have expected that all the prisms had swung up in an incisal direction and out through foramen coecum to take the regular main direction, vertically to the outer enamel epithelium. Instead of that, most of the prisms in this section run parallel to the outer enamel epithelium sketched in fig. 5. KVAM has, although on a different basis, recently dealt with the question whether the course of the enamel prisms can deviate at a right angle from the regular main direction, and he answered in the negative: "It is not very probable, and we have never found that the columnar epithelium cells at any time during the formation of enamel have lain parallel to the enamel surface."

Regarded from this point of view, and with an extra support in the conditions of the horse-tooth, it must be assumed, that the form of the enamel organ at the initial stage has had more likeness to what I have suggested in fig. 13. Neither is it then impossible that foramen coecum at an early stage may have been the entrance for mesenchymal tissue in the cavity.

In addition to the 4 points of criterions, mentioned in the introduction of this article, we can after perusal of the earlier findings, further add point No. 5: the inflated form of the cavity, and No. 6: the pronounced tuberculum dentis. These characteris-

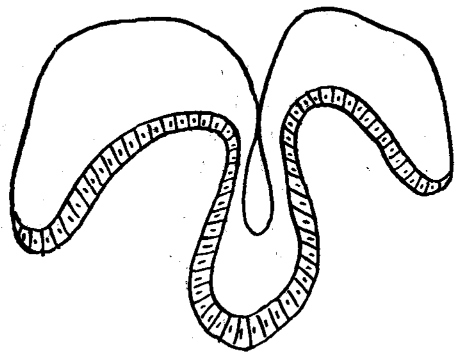


Fig. 13.

tics are not quite constant, but they certainly have a particular significance, and demand special attention.

Point 5. The inflated form of the cavity is especially pronounced in the cases where the inner formation is macroscopically quite, or almost quite apically closed. It is reasonable to assume that an active power has here been prevalent for a certain length of time during the development, and that this power is an increased tissue-pressure within the enamel organ tag. Moreover, it must be presumed that this pressure arises on account of stasis, as the circular enamel formation at the invagination point, where we found the necrotic chord, gradually compresses the soft tissues centrally. This tissue-pressure in the cavity has further marked the whole form of the root, as the Hertwig's sheath takes a wider shape than normal. At the same time we see the fact, mentioned by Moral, that the inner dentin coating is thinner where the cavity has extensions, and thicker where it is narrow. Thereby the limit of the inner dentin coating outwards becomes smoother than inwards, and the circumscription of the pulp more even. A fight has been going on between the abnormal growth impulse and the normal forming elements of the tooth. During this combat the last mentioned have revealed a high elasticity to check the abnormal element. The pressure in the cavity must necessarily decrease again when all provisions through the invagination point are stopped on account of the compression, or if it gains an outlet in apical direction. If this does not occur too late, the tooth may, nevertheless, attain an approximately normal form, seen from the outside. Thus we see, that if dens in dente originates on account of an influence on the enamel organ from the outside, and not only is due to a tendency to over-growth within the tooth germ, the malformation gives us a proof that in a normal tooth germ there may exist latent possibilities of growth. Then one may regard HAMMER's cases as occurrences where these possibilities are stretched to the utmost to show an approximately normal tooth, while HESSE's odontome gives a case where the normal forming elements are defeated. It is quite another matter that also a regular dens in dente as a rule will be condemned to destruction later, on account of the disturbances which the inner formation causes in the normal life and function of the tooth.

The inflated form of the cavity is less pronounced where the inner formation has a big apical opening. But at the same time here also we see that the root section of the outer part is very short, and besides has a big foramen. It almost looks as if the whole tooth in these cases has stopped earlier in its development, for which reason neither the inner formation nor the outer part has had time to be quite calcified, analogous to the horse-tooth that was not completed. This may have obvious causes, for instance lacking growth potential or infection after the eruption. MC DONALD gives particularly clear illustrations of a case like this. As a consequence the picture of such a tooth ought rather to come as No. 3 than as No. 4 in GNAMM's scheme.

Point 6: Practically always a thickening seems to appear around the invagination point, and it comes into view as a strong tuberculum dentis especially clear when the outer and the inner enamel are coherent through a macroscopically quite closed foramen coecum, as we have seen it frequently described in typical dens in dente. This characteristic must also be due to an over-production within the tooth germ, and that is particularly interesting, *i. a.* because it again points towards a connection with other tooth anomalies than GNAMM's scheme shows us:

Coincident with the depth-growth of the enamel organ tag, we have another phenomenon, which, isolatedly regarded, has taken a broad place in the odontological literature about the significance of the different form variations. We know that this variation most frequently appears alone, without a simultaneous inner formation, even if a marked foramen coecum appears. It is more common, contemporaneously with the tuberculum dentis to find on the root mesial and distal longitudinal furrows, which in an unbroken series of transitions distinctly points towards a splitting of the tooth in a labial and lingual part. There is no difficulty, by means of photographs from literature to put down such a series, going through all stages from a small tuberculum, through increasing degrees of independence and size of this, to a palatinally located side-tooth, the connection of which with the mother-tooth is very little. The next step is then a supernumerary tooth, the conical-shaped tooth, liberated from the mother-tooth. This "schizogenous variation", *i. a.* Bolk has clearly explained. Again we see that if it can be proven that dens in dente is caused by an incitament hitting an originally normal tooth germ from the outside, the enamel organ of this tooth germ may react by developing latent possibilities of growth also at another place, and this time with signs in a direction generally pointing towards the division of the tooth germ. It may then easily be assumed that it is only a different combination of the same etiological factors that determines whether the result turns out to be one thing or the other.

As a basis for another extension of Gnamm's scheme, I shall also point out Miller's case showing abt. 15 dens in dentelike invaginations in the crown. Provided an incitament, striking the enamel organ of this tooth, for instance by hitting it earlier and/or stronger, had been able to divide the germ into 15 small parts, each of these parts would presumably have had possibilities to build a tooth-like body. Then the result could only have been a composite odontome.

Finally, I shall again call attention to Salter's atypical case previously mentioned, where the invagination point was quite another, namely the labial surface. Also here we could see abnormal growth, thickenings around the invagination point, which probably only can be explained as the reaction of the normal forming elements against an influence on the enamel organ from the outside. A more common case, which can be compared with this, is seen in *fig.* 14, showing +4 with a vertical furrow in about the middle of the labial surface, surrounded by thickenings. (Here it also ought to be observed that the milk-cuspid persists, and +3 is impacted.) It is an obvious conclusion, that the result in both of these cases would have shown greater changes, for instance partial or whole splitting of the tooth germ, if a presumptive influential power had been still stronger and/or hit the tooth germ at an earlier stage in its development. And from this we can extend the comparison to other variations and malformations with furrowing

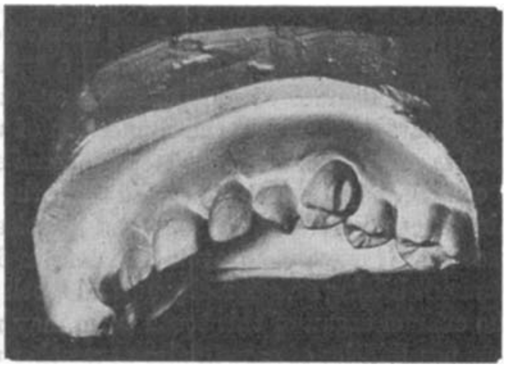


Fig. 14. Vertical furrow on the labial surface of +4, with thickenings around.

and over-growth of the crown, as for instance seen at various degrees of so-called coalescences between a supernumerary and a normal tooth.

Such an interpretation of the various findings of dens in dente gives possibilities towards a more coherent consideration of a great number of the deviations from the normal, so comparatively often found in the front teeth of the upper jaw. This gives us *i. a.* the advantage that it is easier to discuss the etiology more as a whole, than of each finding separately. But it will then not be within the frame of this article to go into details. In the following I shall only indicate a few trends of thought.

In reflections on the etiology of a great many different variations from normal in the tooth-set, we previously often saw endogenous causes emphasized, such as heredity, mutation, atavism, defective tooth germ etc. Germ-bound causes, attached to the epithelium cells of the enamel organ, cannot be disregarded either as far as dens in dente or many of the other variations are concerned, but it is not easy to understand why such causes should be more frequently prevalent in the front of the upper jaw than elsewhere. The same thing may be said about defects of nutrition, *e. g.* avitaminòses, which have been proved to influence the cells of the tooth germ in other ways.

In later years mechanical factors have more and more been drawn into the discussion. A plain exogenous cause, such as infection in a deciduous tooth, may generally be left out of account, because it can hardly occur early enough to leave traces in the succeeding tooth germ, while its enamel-organ is still in the stage of proliferation. It is an obvious condition that the disturbance must take place so early, or even earlier, to produce the deviation we here speak about. Trauma may be excluded for equally obvious reasons.

But other possibilities must here be taken into consideration, especially disturbances of growth during the development of the jaw, perpetrating a mechanical pressure on the dental lamina, and/or certain germs. HOEPFEL, FISCHER and EULER mentioned this without going into further details. This is certainly an essential point, as such disturbances of growth often must be assumed to be prevalent in the front of the upper jaw, during the course of the special processes of development, which here take place in the embryonic life. A hindered or delayed evening out of the sulcus naso-palatinus must have consequences for the dental lamina around the point of intersection, as a rule located where we later get the lateral incisor. Such consequences are exceptionally distinct in the manifest cleft of the alveolar ridge, or where the cleft is "intrauterinally healed". But this fact alone does not seem to be a sufficient basis for a more comprehensive explanation of the variations. In this connection I will *i. a.* especially point out some processes of development seen at the coalescence of the processus palatini with the primary palate, and later in the same area. These are minutely described by RYDZEK and PETER. It is a question of processes of development taking place in the embryonic stage, and also later in the fetal stage, and which well may be assumed to act on the dental lamina and/or the tooth germs, by small or larger deviations from the normal course. As a rule they can only be observed over a short period of time, whereafter their traces, in the form of epithelium-invaginations, -strings and -islands within the mesenchymal tissue, more or less disappear again. A few of these epithelium-formations show heavy growth again in the region of the front teeth of the upper jaw some months before birth, that is exactly in a period critical to the germs of the permanent teeth. After that they gradually degenerate anew.

Recent American research (Warkany) indicates that various malformations of the body may be due to defects of nutrition. If then a relatively small defect of development, as a consequence of for example an avitaminosis, causes disturbances of the development of the surroundings of the tooth germ, it may be possible that it acts upon the form of the soft tooth germ, even if the cells of this organ itself are not, to any noticeable degree, influenced by the defect of nutrition.

If one now assumes that an impulse from the surroundings influence the dental lamina and/or -germ, a series of factors have to be taken into account:

The strength and direction of the impulse
» durability » » »
» point of attack » » » on the tooth-forming organ
» growth potential of the tooth germ
» tooth germ's way of reacting
» » » ability to react at that point of time in the development when it is hit.

The different imaginable combinations of these factors undoubtedly give sufficient possibilities to comprehend in connection with the various deviations from the tooth formation in the front of the upper jaw, mentioned in this article — and presumably some more — as first and foremost mechanically conditioned. The deeper cause of the growth-disturbances may very well be endogenous. At the same time this way of thinking makes the reaction of the tooth germ comprehensible for us in each case, as a result of inherited and phylogenetically immanent possibilities.

The rare appearance of dens in dente in the front of the lower jaw is in agreement with the fact that we here relatively seldom find other abnormalities which may be explained as a result of similar disturbances of development.

Summary.

Dens in dente is divided in two main parts, the radical and the coronal form, whereof only the latter is dealt with here. Through

a summing-up of most cases known from the literature, it appears that among the permanent teeth the lateral incisor in the upper jaw seems to be most frequently affected, thereafter the cuspid and the central incisor in the upper jaw, furthermore to a slight extent the front-teeth in the lower jaw. Supernumerary teeth in the front of the upper jaw appear to be comparatively often affected, while deciduous teeth with dens in dente are not found described. Findings from a number of the known cases are recorded, and a new case is investigated. Dens in dente is compared with certain animals' teeth, that normally show similar enamel-invaginations, and for a comparison in detail is chosen an incisor from a horse. Together with my own findings this supports a theory that both the outer and the inner enamel-epithelium are drawn into the invagination process. It is presumed that dens in dente, of which the inner formation shows a wide apical foramen, is not yet wholly calcified. The cause of the inflated form of the inner cavity is discussed. Furthermore the significance of the expanded form of the root and the frequently occurring tuberculum dentis are dealt with. These characteristics can be explained as indications for the innate abilities of the tooth-germ to react upon certain stimuli. A basis to regard dens in dente in connection with a series of other deviations from the normal in the front teeth in the upper jaw, *e.g.* supernumerary teeth, odontomes and some misbuildings, is pointed out. A series of different etiological factors are indicated, which must be of importance to the result of disturbances of the growth during the development of the dental lamina and the tooth-germs, and which make the different variations mentioned — and perhaps some more — intelligible in a wider connection.

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