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APPEARANCE AND INCIDENCE OF CORONARY DENS INVAGINATUS ON THE BASIS OF STUDIES ON RECENT AND PALEOANTHROPOLOGICAL SAMPLES

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Abstract

With the help of x-ray pictures authors searched for tooth enamel invaginations of the dilated from on 500 and 277 upper lateral incisors, resp., studying recent and paleoanthropological samples. The frequency of appearance of the invagination was determined: 2.4% in recent samples, and 7.2% in paleoanthropological ones. The found values do not differ greatly from those reported in the literature. Authors also studied the frequency of bilateral appearance, the multiple occurrence, variations between the two sexes, as well as the medical historical aspects of the phenomenon. A summary is given of the histology and etiology of the invagination, on the basis of literary data. Such a study has not been carried out so far in the Hungarian paleoanthropological series.
Key words: invagination, foramen coecum, recent and paleoanthropological samples.

Introduction

The infolding of the surface layer of an organ into the organ itself is a known clinical picture called invagination. Intestinal invagination is frequent, when the oral intestine part infolds into the aboral section of the intestine. In case of teeth, the phenomenon is called invagination when the surface layer turns towards the inside of the tooth. If the opening of the invagination is on the crown of the tooth, we speak of coronary invagination. When the starting point is the surface of the root, this is called the rooted form. Regarding it's expansion the coronary invagination can be divided into the surface and deep form. The difference is decided by whether the invagination overreaches the enamel-cement border or not. Certain authors, like HALLETT (1953) and SCHULZE (1970) hold the foramen coecum as an invagination, too, while others only hold this to be a coronary variant. The process may start from the foramen coecum or from a corner; according to observations this latter results an invagination of extreme size.

The disease has been known for over 100 years. HUNTER (1951) studied the question of priority; according to him it was first reported by SALTER in 1855, SOCRATES in 1856, and TOMES in 1859 in his work „A System of Dental Surgery". According to SCHULZE (1970) however, the case described by SALTER was with all probability a geminate tooth. We have found an illustration of a tooth in the first book written in Hungarian, dealing with dentistry (BARNA, 1871). According to our opinion this is an invaginated left upper molar tooth (Fig. 1).

The alteration was given many different namings. The naming „dens invaginatus" given by HALLETT in 1953 is also in accordance with the conception of the coronary and rooted alteration. The naming dens in dente (BUSCH, 1897) used earlier is inaccurate in its original meaning, but has become so inveterate that even the WHO (1978) mentions it besides the previous one. Nevertheless, it can only be used in such form

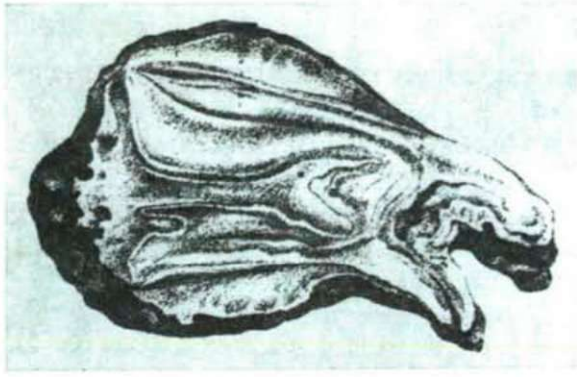

Fig. 1. Illustration of the left upper molar tooth from the book of BARNA published in 1871. The cross sectional picture (right side) shows invagination.

of the coronary type where the tissue elements of the invagination are enamel and dentin, furthermore, where the invaginated part is so large that the part of the tooth which has inverse structure fills out completely the pulp cavity of the original tooth structure, deforming the tooth.

Materials and Methods

1. The x-ray pictures of 500 upper small incisors were studied, obtained from the patient material of the Department of Orthodoncy, Clinic of Dental and Oral Surgery, Medical University of Szeged.

2. Further specimens for studying were obtained from skulls from three cemeteries of the Avarage, originating from the 7.—8. century (Szeged-Kundomb, Szeged-Makkoserdő, and Szeged-Fehértó). Totally 277 upper small incisors were studied from 5510 teeth of 225 skulls (120 males and 105 females).

The ADI value of the small incisors was 0.43 (thus 43% was missing from the theoretically 450 pieces of upper small incisors). X-ray pictures were taken where foramen coecum was observed.

In both experimental groups the frequency of dilated invaginations was determined, which according to our opinion corresponds to the 3rd type according to the classification of HALLETT (1953) (Fig. 2), furthermore we looked for sexual dimorphism.

By evaluating the x-ray pictures, in the majority of the cases the abnormality could be determined, this is why we used this method. The result of the x-ray is uncertain in the cases of rather insignificant, or extremely large invaginations, resp. The invaginations may also be mimicked by projections, geminate forms and odontomas.

The received data were compared with the similar data found in the literature both in the case of the recent and paleoanthropological findings.

Results and discussion

Recent samples

From the 500 x-ray pictures of the upper second incisors, invagination of the dilated form was found in 12 cases, meaning a frequency of 2.4%.

From the 12 invaginated teeth three pairs were of bilateral appearance (6 invaginated small incisors), in 4 cases alterations were only observed on one side, in the right upper double teeth. In 2 cases only the x-ray picture of the small incisor on one side could be evaluated, thus in the case of the symmetry studies 10 instead of the 12 invaginations were examined. Accordingly, the unilateral-bilateral appearance had a frequency of 57—43% in our material.

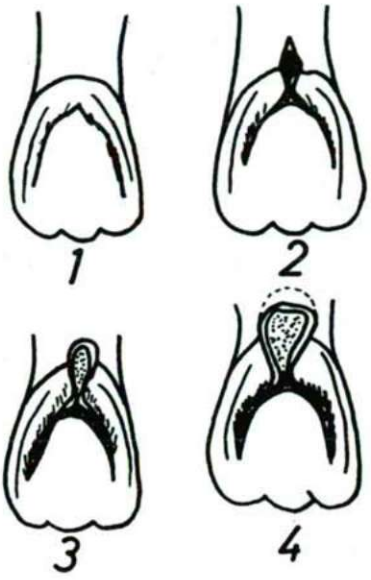

Fig. 2. The four types of invagination according to the expansion:
1. cleft palate enamel edge
2. deep foramen coecum; non-dilated invagination
3. dilated invagination
4. deep invagination; dens in dente (HALLETT, 1953)

Fig. 3. Geminated invagination in two supernumerary teeth (mesiodens).

In one case, as a secondary finding, we observed invagination in a supernumerary tooth, two-two enamel indentations in double mesiodenses (Fig. 3).

This alteration was found to be three-times more frequent in the case of females than in males.

Paleoanthropological samples

225 (120 male and 105 female) skulls were studied; from which a total of 20 invaginations of the small incisors (Fig. 4a, 4b) were found in 11 cases (4.89%). 5 were male, and 6 were female skulls.

In the 225 skulls 277 upper small incisors were present, 155 incisors belonged to male and 122 to female skulls. During the course of our studies we also searched for foramen coecum. Such abnormality was found in a total of 52 small incisors (18.7%), 25 on males, 27 on females teeth. From these 19 pairs (38 pieces) had symmetric appearance and one foramen coecum was unilateral. In 13 cases only the small incisor on one side was present.

On the x-ray pictures prepared of the foramen coecum 20 dilated invaginations were found on 10—10 male and female teeth, respectively. This means a frequency of 7.2%. Invagination was found on both-sided small incisors in 9 cases (18 pieces), while no unilateral appearance was observable. In two cases only one of the small incisors could be examined, therefore, these were not taken into consideration when studying the symmetrical appearance. On the basis of this the bilateral appearance could be regarded almost 100% in the paleoanthropological findings.

The literary data on the prevalence of invaginations also differ within a population. This is explained partly by the fact that the studies are not uniform, since certain authors (VÉGH, 1974; GOTOH et al. 1979) only studied the upper small incisors, while others also involved in their studies the whole row of teeth, including the probable supernumerary teeth, too. As we have already mentioned, several authors hold the foramen coecum, as well as the cleft palate enamel edge as a form of invagination, too, while AMOS (1955) only studied the appearance of the superficial-type invagination.

Concerning the various types of teeth the abnormality is the most frequent in the upper second incisors, this is why many authors — including us — only study these teeth. According to HALLETT (1953) invagination is 8 times more frequent in the upper double teeth than in the upper single teeth.

Invagination frequently occurs in the supernumerary teeth. Compared to these, the incidence is rare in other types of teeth. SCHAEFER (1953) elaborated the data of over 100 authors, according to which this abnormality may occur in every type of teeth. Recently BANNER (1978) reported on invagination on four lower premolars, and CONKLIN (1978) on two lower incisor teeth. From the Hungarian authors BRUSZT (1950), MIKLÓS (1976) and VERECKEI (1977) described cases of deep invagination in upper lateral incisors, VÉGH (1974) reported on poor and deep invaginations, ADLER (1939) gave a report on such an abnormality in a lower incisor, while KÉRI and BAKODY (1973) as well as VÉGH (1978) in the case of the lower canine tooth. In our opinion the afore—mentioned illustration of BARNA (1871) also shows this abnormality on an upper molar.

The data concerning the prevalence of coronary invagination are summarized in Tables 1 and 2. It can be seen from these two Tables that the frequency regarding the upper small incisors is a value around 4%, TWIESSELMANN and BRABANT (1967) did not find any invaginations, and according to the studies of HALLETT (1953) the prevalence of invagination in concern of the upper small incisors is a value of 48.98%; this

latter, however, includes all four types (Fig. 2), from which the 3rd type of invagination is a value of 4.44%.

The prevalence values found by us (2.4% in negative direction in the recent samples, while 7.2% in positive direction in the paleoanthropologic samples) slightly differ from those of the literary data, nevertheless, the 4.89% skull number average of the paleoanthropological samples fits into the average value determined in the case of the recent group, and on the other hand, it also does not differ essentially from the 4.2% value of BRABANT and SAHLY (1962) found in their material from Neolithic.

In the case of the paleoanthropological findings the 18.7% frequency of the foramen coecum (also including the invaginated teeth) is approximately identical with the appearance of the 2nd and 3rd type of invagination according to HALLETT (1953). (In his report the lst and 2nd type of invagination of the upper small incisors appear in 43.17% referring to individuals, and the 3rd type appears in 4.61%. The tooth average is 25.77% in the case of the lst type, 16.55% in the case of the 2nd type, which corresponds the best to the foramen coecum; and the 2nd and 3rd types together are 20.99%.

On the basis of the afore-mentioned, therefore, we think that the difference from the literary data is not considerable, but can rather be characterized as extreme data. Nevertheless, the fact that the studies carried out with same procedure resulted a prevalence value of 2.4% in case of the living group, while a value of 7.2% was obtained in the group that lived 1200 years ago, encourage us to continue our researches in this direction.

Table 1. Frequency of coronary invagination and its distribution according to sexes (Data related to living population)

Authors	No. of studied persons or teeth	Occurrence %	Males %	Females %
SHAFER, 1953	2452 persons	1.26	58.0	42.0
AMOS, 1955	1000 persons	5.1	49.0	51.0
AMOS, 1955	203 persons	6.89	—	—
GOTOH et al. 1979	766 persons	2.6	—	—
HALLETT, 1953	1172 upper small incisors	4.44 3rd type invagination	—	—
STEPHENS, 1953	300 upper small incisors	5.0	—	—
VÉGH, 1974	500 upper small incisors	3.6	—	—
Present study	500 upper small incisors	2.4	25.0	74.0

Table 2. Frequency of coronary invagination and its distribution according to sexes. (Data related to paleoanthropological series)

Authors	No. of studied skulls or teeth	Occurrence %	Males %	Females %
BRABANT and SAHLY, 1962	3008 teeth late neolitic	4.2	—	—
TWIESSELMANN and BRABANT, 1967	605 skulls IV.—X. century	0	—	—
Present study	225 skulls	4.89	45.2	54.8
Present study	277 upper incisors, resp. VII.—VIII. century	7.2	47.6	52.4

Sexual differences in the recent sample were not demonstrable on the basis of summarizing the data found in the literature. Significant differences between sexes were also unobservable in the case of the series from the 7.—8. century, both in regard of the appearance of invagination and foramen coecum.

The alteration may appear at the same time on several teeth within a mouth. SWANSON and MCCARTHY (1947) were the first to report on the bilateral form. According to VÉGH (1974) this is not rare; from 18 cases 10 were bilateral (5 pairs) and 8 were unilateral. According to AMOS (1955) the frequency of the bilateral, non-dilated invagination is 40%. According to our studies carried out on the living population the bilateral occurrence is 43%. In the paleoanthropological samples the bilateral appearance of the foramen coecum is 19-folds that of the unilateral occurrence, and the invagination was found to be of symmetrical appearance in 100%. This result is near that of HALLETT (1953), who during the study of 586 canine teeth found invagination of symmetrical appearance in 278 cases (types 1—4) and observed unilateral occurence only in 13 cases (95.22% and 4.48%, respectively).

The multiple occurrence of dens invaginatus has also been described in the case of a single tooth. CONKLIN (1975) reported on a case of bilateral double invagination, MANSON-HING (1960) described a case of double invagination appearing on all the four premolars, MADER (1977) published the case of triple appearance, TOWNEND (1975) reported on multiple invagination in the upper small incisor, in the area of which the tooth became fungous in structure. In their paper, GUSTAFSON and SUND-

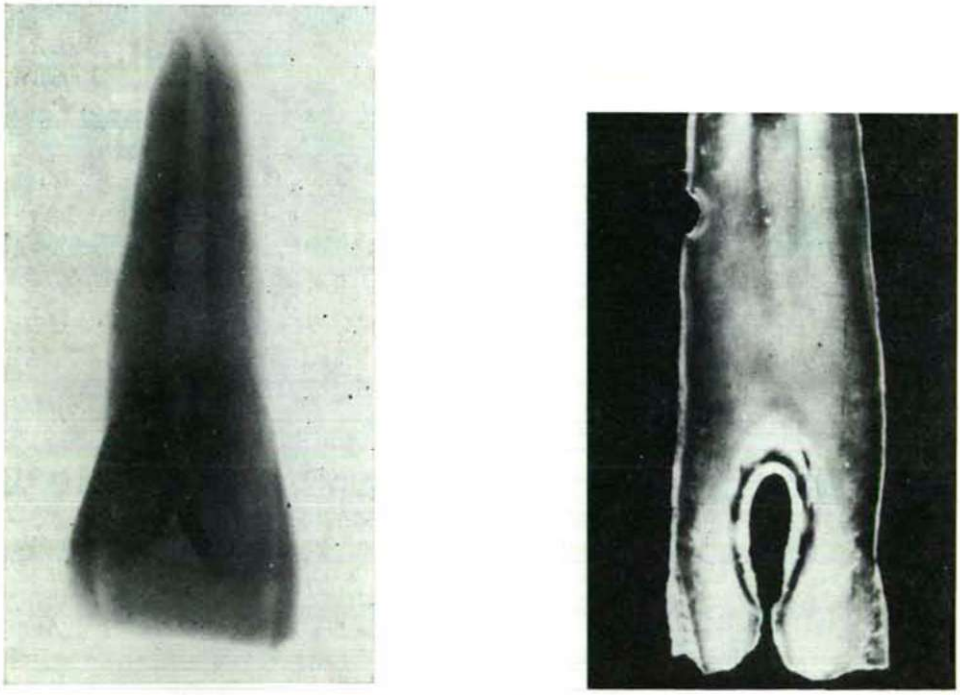

Fig. 4 a) X-ray picture of the right upper double tooth from the Avar-age (inventory no. 1562, tomb no. 323, Fehértó-A.). Invagination of dilated form can be seen in it.
b) The polished picture of the previous tooth, with the magnification of the invagination. The enamel covering the surface of the invagination has an amorphous structure, it became poorly calcified.

BERG (1950) mention MILLER (1901), who described a tooth which became invaginated in 15 different places (although this is not a typical dens in dente in our opinion). Multiple invaginations are not rare in the supernumerary teeth, which fact is also supported by the case observed by us (Fig. 3).

The alteration may also be accompanied by other abnormalities. The presence of invagination is rendered probable by the unnormal shape of the crown of the tooth, golf-club or barrel shape, the enlargement of the lingual corner (talontip) on the front teeth (OEHLERS, 1957, SCHULZE, 1970, GOTOH et al. 1979). It is doubtless that the two characteristics — the invagination and the divergency in shape — may accompany each other, nevetheless, the joint occurrence is not exclusive.

MADER (1979) observed gemination and double invagination on one and the same tooth. SCHULZE (1972) also observed it together with the formation of a geminated tooth (regarding the invagination developed in such a way as another form), and the invagination of a lower canine tooth reported by VÉGH (1978) is also a similar case. The case of SHIFMAN and TAMIR (1979) is the concretion of an invaginated upper small incisor and a supernumerary tooth. WESTBORG and JULIN (1974) found macrodontia, multituberculism and central cusps apart from pulp invaginations. CASAMASSIMO et al. (1978) described such a case where besides dens invaginatus, microdontia and taurodontia were also observed.

Histologically the enamel of the invagination always developed and became calcified poorly (Figs. 4a and 4b). HAMMER (1935), KÉRI and BAKODY (1973) and other authors only found irregular masses. According to FISCHER (1936) the dentin tubules are also irregular. Several authors, like BUSCH (1896), FISCHER (1936), GUSTAFSON and SUNDBERG (1950), BRUSZT (1950) found connection between the pulp of the „dens in dente" type of invagination and the pulp ventricle. Many authors hold this as an explanation for the fact that these teeth lose their vitality soon. However, TAYLOR and MCDANIEL (1977) reported on two cases in which the pulp of the invagination was independent of the dental pulp, communicating parallel with it. In one of the cases the tooth appeared to be live on the effect of electric stimulus, but on the x-ray picture a granuloma was observable on the side of the bone of the invaginated pulp. The tooth was necrotic in the other case. Studying the small invagination starting from the foramen coecum, KRAMER (1953) did not find any correlations between the previously described two pulps.

The etiology of the abnormality is a question still much debated nowadays. In the case of the coronary from there are two conceptions; in the wording of SCHULZE (1970) the theory of one tooth and the theory of two teeth, respectively. The accepted form of the two teeth theory was elaborated by BRUSZT (1950). In his opinion two tooth embryos (one is usually a supernumerary tooth) become geminated due to pressure, but the enamel remains in a small part between them and this gives the invagination. The notion is found to be supported by the afore-mentioned connection between the invaginated space and the pulp ventricle.

Several conceptions arose regarding the invagination originating from one tooth. These were summarized by HALLETT (1953), while from the Hungarian authors it was MIKLÓS (1976) who dealt with these theories. Accordingly, the cause may be proliferation growth pressure, growth lag, infection, atavism, trauma, and even genetic factors may play role. The namings odontoma (HUNTER, 1951; OEHLERS, 1957), hamartoma, hamartoblastoma (TRATMAN, 1951) which assume tumorous origin are incorrect. Even if we follow the conception of HUNTER (1951), RUSHTON (1958) and others who speak of tumorous proliferation, this can only be accepted as by OEHLERS (1957), according to which author there may also be invaginations of proliferative origin. This tumorous proliferation, however, is only an assumption, needing further studying.

We should accept the classification of PONGRÁCZ (1965) who sharply separates the dens invaginatus from the odontomas.

On the basis of the literary data and our own studies, our opinion is that considering the tissue structure of the tooth invaginations and the alterations of the tooth and dental pulp, there are two kinds of abnormalities. One form — which we also studied in this work — in the alteration remaining from the foramen coecum, the true invagination of the tooth, the etiologic factors of which were listed when discussing the one tooth type. The other form — which may be in connection with the geminative abnormality — is the anomaly, more or less distorting the tooth and causing the necrosis of the dental pulp in a large percentage. The true etiology of this type has been described by BRUSZT (1950), SCHULZE (1972) and VÉGH (1978).

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