EPITHELIOMA ADAMANTINUM.

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An effort is made to include here the more important literature of the subject of this article appearing since 1884. Many cases are reported under titles that make them difficult to find. Others are not described with sufficient accuracy for their certain recognition. The description of the paradental epithelial débris (débris épithéliaux parodontaires) and the pointing out of its probable relation to these tumors by Malassez (1) in 1885 gave to their pathology a more logical and firmer basis than it had previously possessed. Little has been added to knowledge of the subject since that time. The most notable contribution is perhaps that of Chibret (2), who described the formation of enamel and of cemento-dental tissue in one of these tumors. In 1897 there was published by Goebel (3) a review of the literature on all tumors of the jaw bones referable to the dental system. The majority of the contributions appearing before 1885 are, to a considerable extent, only of historical value. The statistics here presented are based upon twenty-two cases. A brief synopsis of these cases is appended. I have had the opportunity of studying the following case.

Abstract from the Clinical History.—The patient, female, aged thirty years, was admitted to St. Joseph's Hospital. Two years and three months ago she first noticed a small, hard tumor near the first bicuspid tooth on the left side of the lower jaw bone. It grew slowly. In childhood there was nothing unusual about her teeth, which were perfectly regular and even up to the time of her present illness. Examination shows that the tumor extends from angle of jaw nearly to the median line.

The dentist of the patient furnished the following history. Two years and three months ago the patient consulted him for what she considered to be an abscess in connection with a tooth. The enlargement

was apparent both inside and outside the mouth and was quite painful. As nearly as he remembers the teeth were all intact, the crowns being normal and no fillings having been introduced. The inferior maxillary bone was enlarged in the neighborhood of the first and second molar teeth, both of which were loose. On extracting the second molar no fluid appeared. On extracting the first molar there was a considerable discharge of thin, brown fluid without odor (evidently the contents of a cyst). The roots of the extracted teeth were almost absent. The patient was referred for treatment to St. Joseph's Hospital, where an operation was performed by Dr. Nathan Jacobson. Six months after operation there is no evidence of recurrence.

Abstract from the Pathological Record.—The specimen consists of part of the left lower jaw bone, extending from the angle nearly to the median line. The enlargement begins about 3 cm. anterior to the angle of the jaw and involves the bone for a distance of 7 cm. The tumor measures 7 x 3 cm. It is covered with a thin shell of bone.

There are at my disposal for description a few small blocks of tissue from the tumor fixed in Zenker's fluid and decalcified in five per cent nitric acid. In this tissue the cystic quality of the tumor is evident. The largest cyst seen is 7 mm. in diameter and is empty. Sections are cut in paraffin 6 μ thick, and stained with eosin and methylene blue.

MICROSCOPICAL EXAMINATION.—Many of the sections show the mucous membrane of the mouth and a thin shell of bone and fibrous tissue surrounding the tumor. The layer of bone is interrupted in many places. The areas of bone are partially surrounded by osteoblasts and an occasional osteoclast is seen. The tumor itself consists of a connective-tissue stroma, in which there are alveoli formed by epithelial cells. The appearance under low power is well represented in Borst's (4) plates. The epithelial elements represent the enamel organ and are largely in the stage corresponding to the greatest development of the stratum mucosum (Fig. 1). One or two areas, somewhat removed from the periphery, represent the stage immediately preceding the development of the stratum intermedium and the stratum mucosum (Fig. 2, c). No definite karyokinetic figures are seen here, but some nuclei stain more deeply than others and have a

slightly ragged surface. This is represented at d, Fig. 2, where, apparently, the stratum intermedium is beginning to develop. Inter-cellular bridges, perhaps corresponding to those of the epithelium of the mucous membrane of the mouth, are seen. The appearance here suggests carcinoma. In many places the stratum mucosum is largely replaced by cysts containing a finely granular material staining with eosin. Anastomosis of the alveoli suggests that the epithelial constituents form a solid framework similar to that which has been shown to exist in carcinoma by means of reconstructed serial sections.

In the large alveoli is seen an external layer of cells, which in some places are cylindrical, in other places cubical (Fig. 1, a). The layer is occasionally invaginated and therefore appears in the section to be situated inside of the alveolus. The cylindrical cells perhaps correspond to the inner epithelial layer of the enamel organ, the cubical cells to the outer epithelial layer. Often, but not regularly, within the external layer are one or more layers of flattened cells, which tend little by little to assume the stellate form and correspond to the stratum intermedium (Fig. 1, b). Occupying most of the interior of the solid alveoli is the most characteristic feature of the tumor, the stratum mucosum, or enamel pulp, consisting of anastomosing stellate cells (Fig. 1, c). When seen under a lower power it might be mistaken for mucoid tissue and, especially when present in large areas, might lead to a diagnosis of myxoma. There are invaginations of the external layer of cells which with the adjacent stroma simulate the "Anlagen" of teeth in their early stages (Fig. 1, a). This gives to the alveoli the appearance of gland tubules in a stroma of mucoid tissue (Fig. 1), especially in places where the invaginated stroma has largely lost its fibrillar character and appears homogeneous (Fig. 1, d). Evidences of karyokinesis are seen in the external layer, and to a less extent in the stratum intermedium.

Various stages in the development of cysts are well seen. They are due evidently to a hyaline and granular degeneration of the stellate cells and to an accumulation of fluid between these cells. The formation of the stratum mucosum is apparently associated with

an accumulation of fluid between the cells, the formation of long processes of the cellular protoplasm, and the gradual disappearance of the intercellular bridges (Fig. 1). No evidence of enamel, dentine, or cement is seen. Chibret (2) has described the formation both of enamel and of cemento-dental tissue in a similar tumor. The stroma (Fig. 2, a) consists of dense connective tissue in which only a few blood vessels (Fig. 2, bb) are apparent.

The tumors under consideration probably originate from structures described by Malassez (1) as paradental epithelial débris (*débris épithéliaux paradentaires*). A rational theory of the histogenesis of this class of tumors dates apparently from the publication of his first article. He carefully describes and illustrates these cell masses as they occur in the adult and discusses their histogenesis. He attempts to explain how epithelial tumors may originate in the bodies of the jaw bones at a considerable distance from surface epithelium. In the intra-alveolar tissue surrounding the roots of normal teeth he has found masses of cells, and from a study of the developing jaw he concludes that these masses represent the remains of the dental ridge and some of the epithelial structures originating from it, especially the neck and the outer epithelial layer of the enamel organ. A consideration of the histogenesis of adamantine epithelium suggests the possibility that adamantine tumors may arise from the gingival epithelium and from any of the derivatives of the dental ridge. The cellular masses described by Malassez are distributed in the alveolo-dental ligament from the apices of the roots to the epithelium covering the gums. The "débris" may be present in the marrow spaces of the jaw bones entirely outside the alveolo-dental ligament. This fact furnishes an anatomical basis for the origin of tumors of the jaw bones more or less independent of teeth.

Efforts have been made to associate the etiology with irregularities in the development of the teeth, with inflammatory processes, trauma, etc.; but these conditions are probably secondary rather than primary.

The sex of the individuals affected is stated in eighteen recorded cases, eight occurring in men and ten in women. The age when

the tumor was first noticed could be estimated in sixteen cases. The youngest individual was eight years of age and the oldest, fifty-eight. The greatest number of patients, five, were in the fourth decade. In two other cases the specimens are described as consisting of the jaw bones of adults. It has been thought that these tumors are prone to occur in young individuals, especially during the period of dental development. The description and figure from a case described by Massin (8) as congenital do not give evidence that he observed a tumor of this class.

The location of the tumor is mentioned in twenty cases; seventeen times it was situated in the lower jaw, twice in the upper. Becker (5) has called attention to a possible influence of the difference in anatomical relations. In the maxilla perhaps such a tumor might grow into the sinus and not cause any apparent swelling or other prominent disturbances; possibly indefinite neuralgic and other symptoms might be caused in this way.

The situation appears to be as frequent on one side as on the other. In the lower jaw the main mass of the tumor is most frequently at the angle of the jaw. From here it may extend upward to the articular surface and into the coronoid process and ventrally as far as the median line. In one case the tumor is said to have implicated one entire inferior maxilla; twice the location was in the body ventral to the angle and four times its position was median. Of the two cases affecting the upper jaw, both were on the left side and in one of these the sinus had been invaded. In Case No. 13 (see Table) both sinuses were invaded and both sides of the lower jaw bone were implicated. A median position in the upper jaw is not mentioned.

These tumors develop in the interior of the jaw bone which remains as a thin parchment-like covering. At the time of operation they have varied in size from that of a plum to that of the head of a foetus, but are most frequently about the size of a hen's egg. In two cases it is stated that the tumor was easily separable from the surrounding bone, which suggests that it was encapsulated. In four cases no macroscopical cysts were present, the tumors being solid

throughout. Most of the tumors described have been cystic. The cysts may be as large as a hen's egg and usually contain a clear, yellowish, slightly viscid or serous fluid in which cholesterin crystals may be present. Such cysts may give to the tumor an irregular surface. The presence of a bony framework in the tumor is mentioned in twelve cases. Perhaps this framework corresponds to the alveolar process which forms about normally developing teeth. In Case No. 13 fully developed teeth were present.

Of the microscopical appearance of these tumors the clearest description is that given by Kruse (6). He reports three cases representing different stages in the development of the enamel organ. In the individual cases, also, different stages are represented. In the first case the epithelial constituents consist of dendritically branching twigs composed of epithelial cells and forming solid masses, situated in a poorly vascularized stroma. The form and arrangement of the cells is similar to that of the dental ridge in an early stage of development. The tumor therefore corresponds in its structure to an early stage of the "Anlage" of the tooth. Kruse's second case has in part the same structure as the first, but there is more tendency toward the formation of a peripheral layer of cylindrical cells. In some places small cysts are present and there is one macroscopical cyst 2 cm. in diameter. Comparison with a somewhat later stage of the dental "Anlage," where outer and inner enamel epithelium, stratum intermedium and stratum mucosum are present, show, according to the description, that the epithelial twigs of the tumor are in all details like the dental "Anlage," and that the relation of the cells to each other is the same. The third tumor is conspicuously cystic. Some cysts are microscopical in size while the largest is the size of a hen's egg. But the solid parts are microscopically like the first two tumors, presenting solid twigs of polygonal epithelial cells, some with a peripheral layer of cylindrical cells, some with beginning cyst-formation. The tumor consists largely of well developed cysts. The size and the structure of the cysts vary, but in general a definite size corresponds to a definite arrangement of the cells. In the smaller

cysts the wall is lined with low cylindrical epithelium, while the lumen contains a granular hyaline material. The larger cysts are lined by a more or less cubical epithelium and three to four layers of squamous cells. There is then, according to Kruse, a continuous series representing different degrees of differentiation, each of which has certain individual characters and in addition presents transitional stages to the others.

Chibret's (2) work is especially valuable. He describes a case in which there is a pronounced tendency toward the formation of the various tissues of the teeth. The case presents all the stages in the formation of the tooth up to the development of enamel and of cemento-dental tissue. These substances are found at the borders of the most highly differentiated alveoli. The cemento-dental tissue resembles cement on the one hand, since it contains large osteoblasts, and dentine on the other hand, since branching canaliculi are present and vessels are wanting. In very few of the cases described in the literature does there appear to have been represented the epithelial sheath of Hertwig. Perhaps this explains the absence of roots and of characteristic cement and dentine.

A remarkable specimen is described by Hildebrand (7). He observed in the case of a boy nine years old an excessive development of masses of teeth in the interior of the upper and lower jaw bones on both sides. Not only conglomerations of teeth, but also more or less completely isolated teeth were present. The eruption of the teeth appeared to have been entirely irregular. Perhaps the entire epithelial "Anlage" of the teeth had assumed an abnormal function. In the soft tissues "Anlagen" of teeth in all stages of development were represented, together with dendritically branching masses of epithelium. These masses of epithelium are not described in detail, but if they are similar to those in the cases previously cited, the case perhaps belongs to the group under consideration.

The growth of such tumors apparently takes place by the formation of new epithelial twigs from those already present. The microscopical appearances are not always entirely typical. Some areas

may be extremely suggestive of carcinoma, the alveoli being irregular and containing epithelial cells that are only slightly differentiated. Structures closely resembling epithelial pearls are described. Bennecke (9) has described an invasion of the epithelial masses by vascular processes of the surrounding connective tissue. He believes that this process corresponds to a similar one that takes place in the normal enamel organ. The adamantine epitheliomata are relatively benign. I find no instance in which metastases have occurred. Enlargement of the lymph nodes may result from associated inflammatory processes. In one case a diagnosis of abscess was made and the tumor was not recognized until the abscess was opened.

The name "Adamantinoma" is suggested by Borst (4) for these tumors. The term *Epithelioma adamantinum* is perhaps more accurately descriptive. Where the cystic quality is pronounced the adjective "cysticum" may be added to the name as proposed by Goebel (3).

In some of the cases already cited there has been a history of trauma, such as a blow upon the jaw. Not infrequently it is said that an inflammatory process in connection with a tooth has been present at the onset. With the growth of the tumor there is pain and swelling, although pain is sometimes stated to be absent. Enlargement of the lymph nodes is mentioned only in infected cases and in four cases was said to have been absent. The absence of ulceration of the mucous membrane is emphasized in seven cases. Its presence is mentioned in only two cases and was apparently due to operative procedures or to inflammatory processes in connection with teeth. In the most careful descriptions it is insisted that the tumors have no connection with the epithelium of the mucous membrane. In the region of the tumor the teeth become more or less irregular and to a considerable extent are lost. In Case No. 13 the development of the teeth is said to have been irregular. Fluctuation could be demonstrated in one case. Its demonstration depends upon the presence of a fairly large cyst near the surface of the tumor. In Case No. 13 the teeth in the tumor could be palpated. The presence of parchment-like crepitation is mentioned in five cases, but could per-

Reference.	Sex and Age.	Duration.	Chief Symptoms.	Situation.	Character of Tumor.	Operation.	Result.
1. Albarran. Soc. de biol., 1887, 618, 667.	Male, 63 years.	(Recur- rence) 8 years.	Tumor in mouth.	Left maxilla, in region of second molar; growing into sinus.	In large part solid with two cysts; bony frame- work, fibrous and "mu- coid" stroma.	Three incisions in 10 years; extir- pation; resection.	Recurrence; sec- ond recurrence after 18 years; subsequent history unknown.
2. Becker (I). Arch. f. klin. Chir., 1894, xlvii, 52.	Female, 41 years.	3 years.	"Dental peri- ostitis" at onset; infected.	Left; mandibula from incisors to angle.	Irregular surface.	Incision evacu- ating pus; part of alveolar process removed.	Recurrence after three years.
3. Ibid. (II).	Female, 26 years.	(Recur- rence) 1½ years.	Many teeth de- stroyed; fluctu- ation; crepita- tion.	Left angle of mandibula.	Recurrence 4 cm. in diameter; contains cysts with clear serous fluid; fibrous stroma contain- ing bone.	Resection of left half of man- dibula.	Recovery; No re- currence at end of one year.
4. Ibid. (III).	.....	.....	.....	.....	One large cyst with thick, solid wall; con- tains yellowish fluid.	Two incisions in mouth; external incision with re- moval of cyst wall.	No recurrence after 2½ years.
5. Ibid. (IV).	Male, 39 years.	6 months.	Teeth destroyed; fistula in mouth.	Molar region and ramus man- dibula on left side	Microscopically re- sembles No. 3.	.....	.....
6. Bennecke (I).	Adult.	.....	Teeth about tumor few and irregular.	Median part of mandibula, ex- tending farthest to left.	Recurrence contains one large cyst contain- ing serous fluid; epithe- lial pearl-like structures.	Incision partly removing wall of cyst.	Recurrence after six months.
7. Ibid. (II).	Adult.	.....	Teeth made ir- regular and loose.	Median part of mandibula.	Nodular, 6 cm. in diam- eter; thin covering of bone; bony framework; numerous large cysts.	Resection.	No recurrence six months after resec- tion.
8. Borst. Die Lehre von den Geschwül- sten, ii, 605.	.....	.....	.....	.....	Thin shell of bone; one small cyst. Cellular stroma but little stratum mucosum, 5 cm. in diam- eter.	Resection.	Not stated.
					Cystic; epithelial pearl- like structures without cornification.	.....	.....

Reference.	Sex and Age.	Duration.	Chief Symptoms.	Situation.	Character of Tumor.	Operation.	Result.
9. Chibret. Arch. de méd. expér., 1884, vi, 278.	Male, 53 years.	.....	Teeth made irregular; pain; crepitation; ulceration of mucous membrane.	Right; mandibula	Large as head of a foetus; cystic; cemento-dental tissue; enamel.	Resection of right half of mandibula.	Recovery; no recurrence after two years.
10. Derujinsky. Wiener klin. Wochenschr., 1890, III, 775, 795.	Female, 25 years.	4 years.	Crepitation; ulceration of mucous membrane; probably secondary to operation; infection; enlarged cervical lymph nodes.	Left angle and ramus mandibula	Cystic and solid.	Two years ago removal of tumor ("Sarcoma"). Resection of left half of mandibula.	Recurrence. Not stated.
11. Haasler. Arch. f. klin. Chir., 1886, III, 749.	Female, 64 years.	6 years.	Onset with dental abscess; teeth over tumor lost; crepitation.	Median part of mandibula, extending farthest to right.	Cysts filled with pale yellow fluid, slightly viscid containing cholesterol crystals; bony framework; fibrous stroma.	Resection.	Two years without recurrence.
12. Hammer. Virchow's Archiv, exIII, 508.	Male.	6 years.	.....	Left maxilla.	One large cyst with many smaller; dense, fibrous stroma with bony framework.	Resection of part of left maxilla.	Ten years without recurrence.
13. Hildebrand. Zeitschr. f. Chir., 1880, xxxi, 283; 1883, xxxv.	Male, 9 years.	1 year.	Teeth irregular and more numerous than normal; enlargement of maxillae and both sides of mandibula; teeth palpable through thinned bone.	Mandibula on right side from angle to median line; left side; both sinuses involved.	Sinuses on each side filled with masses of developing teeth; about 200 teeth in all. Masses of epithelial cells branching dendritically.	Incision after six months. External incision into both sinuses; apparently incomplete removal.	Recurrence on both sides of mandibula and in right maxilla one and a half years later.
14. Kruse (I). Virchow's Archiv, 1891, cxxiv, 137.	Male, 21 years.	10 years.	Dental abscess at onset; varying rate of growth; infected cyst; teeth absent in part over tumor.	Mandibula on right side from angle to median process to canine tooth.	Nodular; easily separable from bone; microscopic cysts; stroma with bony framework; thin bony shell.	Repeated. Resection of right half of mandibula.	Recovery.

Reference.	Sex and Age.	Duration.	Chief Symptoms.	Situation.	Character of Tumor.	Operation.	Result.
15. Ibid. (II).	Female, 12 years.	1 year.	Onset with toothache and swelling of bone; teeth in part absent.	Mandibula on right side from 3 mm. below articulation to canine.	Nodular; greatest diameter 8.2 cm.; cysts 2 cm. in diameter; stroma cellular with bony framework; bony shell.	Resection of right half of mandibula.	Recovery.
16. Ibid. (III).	Female, 30 years.	18 years.	Abscess at onset; irregular rate of growth; infection; fistula. Teeth absent; crepitation.	Mandibula on right side from articular surface nearly to median line.	Greatest diameter 13 cm.; nodular, cysts containing tenacious fluid; bony shell.	Resection of right half of mandibula.	Recovery.
7. Malassez (I).	Male, 11 years.	2 years.	Not stated.	Median part of mandibula.	Bony shell and framework; no cysts.	Resection.	Not stated.
18. Ibid. (II).	Male, 60 years.	23 years.	Irregular rate of growth; mucous membrane not connected with tumor.	Entire right body of mandibula.	Thin shell of bone; greatest diameter 8 cm.; many large cysts; bony framework; epithelial pearl-like structures; irregular masses of undifferentiated cells.	Not stated.	Not stated.
19. Monguidi. Correspondenzblatt f. Zahnärzte, 1886, xxiv, 17.	Female, 10 years.	1 year.	Swelling of cheek.	Right side of mandibula.	Thin shell of bone which is easily separated.	Excised several times.	Recurrence.
20. Nasse. Centralbl. f. Chir., 1890, xvii, Beilage zu No. 25, p. 33.	Female, 41 years.	10 years.	.....	Left side of mandibula.	Numerous small cysts; bony framework.	Resection of right half of mandibula.	Not stated.
21. Pryn. Virchow's Archiv, 1897, cxlviii, 93.	Female, 31 years.	6 months.	Pain; swelling.	Right side of mandibula from angle to 3 cm. from spina mentalis and to coronoid process.	Cysts only microscopical; bony framework; cellular, nonvascular stroma.	Resection of left half of mandibula.	Not stated.
22. Steensland.	Female, 30 years.	2 years.	Swelling and pain; roots of teeth absorbed.	Left side of mandibula.	Diameter 7 cm.; thin shell of bone; cystic; stroma fibrous; dense, bony framework.	Resection.	No recurrence after 6 months.

haps have been demonstrated in more as the tumors were all surrounded by a thin shell of bone. In five cases the tumor was infected. There was present either an abscess or a fistula leading into the mouth. One may readily understand how a cyst might become infected as a result of incisions or inflammatory processes in connection with teeth. In three cases variation in the rate of growth of the tumor is mentioned.

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DESCRIPTION OF PLATE.

Fig. 1.—Showing part of an alveolus.

- a. External layer of cubical and cylindrical cells, which is in places invaginated and therefore appears to be within the alveolus.
- b. Layer of cells corresponding to stratum intermedium.
- c. Tissue formed by anastomosing stellate cells, corresponding to stratum mucosum.
- d. Invaginated stroma.
- e. Blood vessels in invaginated stroma.

Fig. 2.—*a.* Stroma.

b. Blood vessels in stroma.

c. Cells representing that stage which precedes the formation of the stratum intermedium and stratum mucosum.

d. Cells representing the early development of the stratum intermedium. Nuclei are deeply stained and have a ragged surface suggesting karyokinesis.

Fig.1

Fig 2