ADAMANTINOMA

Hunterian Lecture delivered at the Royal College of Surgeons of England

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by

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THE PATHOLOGY OF tumours of the jaws has been studied in this College since its inception.

In 1827, and again in 1842, the subject proposed for the Jacksonian Prize Essay was " Injuries and Morbid Affections of the Maxillary Bones and Antrum." No dissertations, however, were sent in. In 1867, the subject was " The Injuries and Diseases of the Jaws, including those of the Antrum, with the Treatment by Operation or otherwise." This time Christopher Heath was the successful essayist, and in June 1887, he delivered a series of lectures in this College, based on his and Sir William Fergusson's practice.

To-day, 64 years later, we are still debating and discussing the nature of tumours of the jaws. We cannot describe the macroscopical morbid anatomy of these tumours better than John Hunter could; we can, however, make a more detailed study of the morbid histology of these lesions, and this, coupled with the clinical aspects, may give us a lead as to the origin and pathogenesis of many of them.

In 1949 a study of the occurrence of tumours of the jaws in South Africa was made. Records of pathological examinations performed in the laboratories at Cape Town, Port Elizabeth, Johannesburg and Pretoria were studied, and the slides and/or blocks of all cases labelled " jaw tumour " were obtained and studied. The periods covered were as follows:—

Cape Town	1920-1948—29 years.
Port Elizabeth	1930-1948—19 years.
Johannesburg	1911-1948—38 years.
Pretoria	1945-1948— 4 years.

After rejecting cases unsuitable for study for a variety of reasons, 872 cases remained for analysis. Of these, a total of 88 cases of adamantinoma were retained, and form the basis of this lecture. The microscopic diagnosis was confirmed and an analysis was made of the age, sex and race incidence, as well as the site of occurrence, where such information was available (see Table I).

The largest number of cases is seen between the ages of 30 and 50; it is to be noted, however, that the tumours may be present for many years before they are seen by a doctor. This pertains especially to our

TABLE 1

Race		Sex		Site		Age	
Bantu	53	M	42	U.	14	0-29	14
European ..	26	F	36	L.	53	30-49	28
Coloured ..	5	Unspecified	10	Unspecified	21	50-89	14
Indian ..	1					Unspecified	32
Unspecified ..	3						
Total	88		88		88		88

Note the preponderance of the growth among the Bantu race. Note the relative frequency of the growth in the mandible.

Bantu, who will go for many years with a large and growing tumour before reporting. The average age incidence is therefore probably nearer 30 than 50.

In trying to determine a cause for the preference this tumour has for the native, one could find only one constant factor, and that is mouth sepsis. Our native cases had, without exception, gross caries and mouth sepsis. The urban natives who attend our hospital invariably have caries and pyorrhœa. (The raw native from the native reserves, however, has perfectly healthy teeth.)

Present findings are thus :— that adamantinoma occurs predominantly in the lower jaw (lower jaw : upper jaw=79 per cent. : 21 per cent.) ; that most cases are seen around the age of 40, that males are slightly more affected than females and that natives are more frequently affected than Europeans. These figures do not differ greatly from those found in the literature.

Byars and Sarnat (1945) give corresponding figures, but they do not give the racial incidence.

Grimes and Stephens (1948) state that 85 per cent. of cases occur in the lower jaw.

Robinson (1937) gave an analysis of 379 cases. He found that females were slightly more affected than males, that the average age was 37·6 years, and that relation of lower to upper jaw was 83·7 : 16·3 per cent. Strangely, he presents no racial analysis.

Geschickter and Copeland (1949) give figures which correspond with the present series, and they state that the relative incidence of adamantinoma is high in coloured races.

My own interest in this tumour started in 1945 and the number of cases which I have studied and treated personally, now number 17. Their full clinical details will be published elsewhere.

It is not my intention to discuss the clinical aspects of the tumour, as they are too well known to those who have had to deal with them, and they are described in great detail in the many publications thereon.

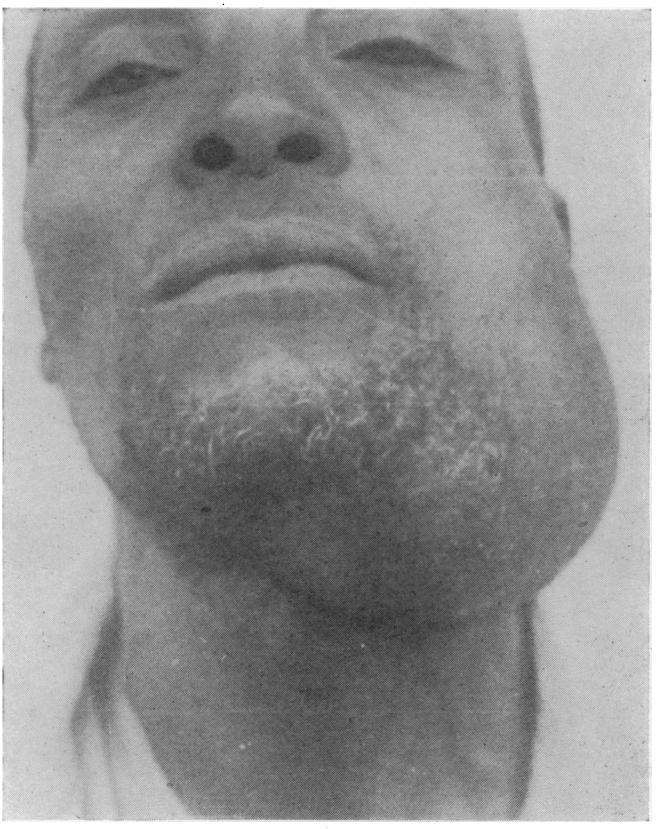

Fig. 1. Typical appearance of adamantinoma of the mandible.

In studying the literature on adamantinoma, however, it became clear that great confusion exists in the understanding of the pathogenesis and pathology of this lesion. Some of my cases presented excellent opportunities to study the pathological aspects of the tumour, and this, coupled with a critical analysis of the literature, led me to attempt to clarify what appeared to be confusing; it is hoped that the conclusions reached, if not finding general agreement, will stimulate others to study the problem of this interesting tumour.

" Adamantinoma " is a term which is in general use and indicates a slowly growing epithelial tumour possessing a low degree of malignancy; it often has histological features which correspond with those of the normal enamel organ, but is without enamel-forming properties.

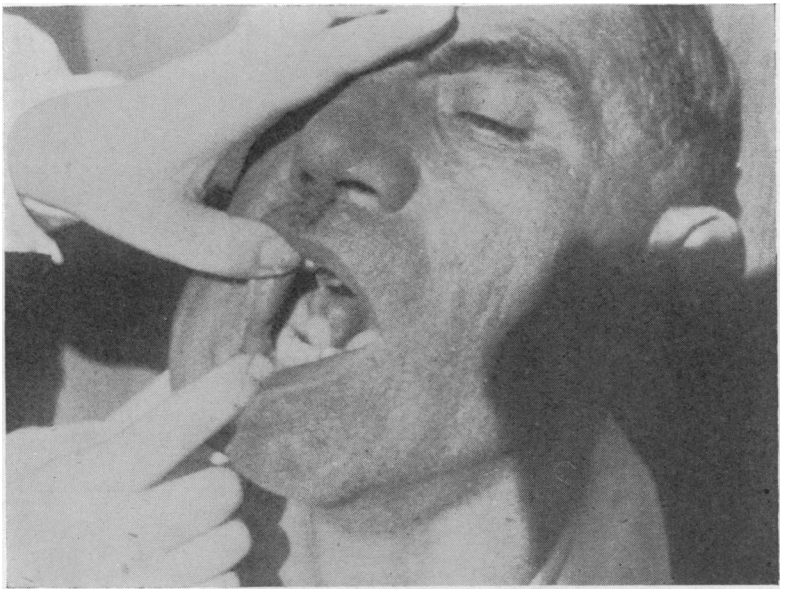

Fig. 2. Adamantinoma ulcerating into the mouth.

The term " enamel " originates from the Greek " ἀδάμας," meaning " the hardness of stone or diamond, or something which cannot be worn away." The tumour of this tissue becomes " adamantinoma," and the enamel-forming cell, the " adamantoblast."

MORBID ANATOMY

The tumour appears most frequently in the mandible, but may occur in the maxilla, and more rarely in the region of the pituitary, as well as in long bones such as the tibia and ulna.

In its more usual form in the mandible, it is seen as a hard mass, the mandible appearing " expanded " (Fig. 1); as it increases in size it may ulcerate into the mouth, or the tumour becomes secondarily infected from within the mouth (Fig. 2); a purulent discharge and secondary hæmorrhage may then occur. A radiograph of a typical resection specimen shows the coarse, trabeculated appearance so well known to radiologists (Fig. 3). It also shows how the tumour eventually progresses beyond the confines of the bone, and may invade soft tissues. Section of a typical specimen (Fig. 4), shows large and small cystic areas, filled with a brownish fluid or a gelatinous material. Other areas consist of a more solid tissue, soft or firm in consistency, and usually whitish in

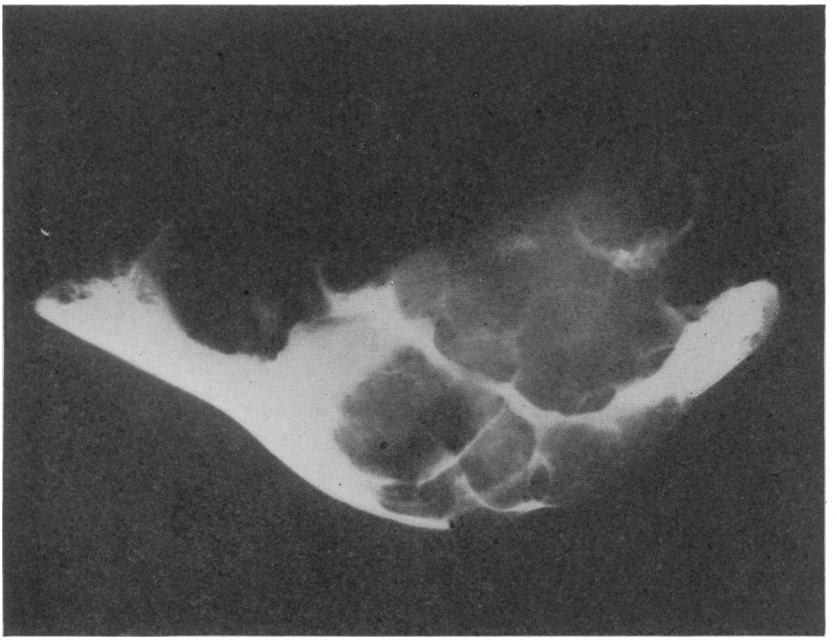

Fig. 3. A typical radiographic appearance of adamantinoma (operation specimen). Note the coarse trabeculations.

colour. The growth may present as a fleshy, cauliflower projection into the mouth (Fig. 5), or simply as a solid mass of tumour tissue, without cyst formation.

MORBID HISTOLOGY

The microscopic appearance generally regarded as " typical " is shown in Fig. 6.

Masses of epithelial cells are seen, the peripheral cells being columnar and arranged in a pallisade fashion, the central stellate cells in a reticular fashion, corresponding with the reticular cells of the normal enamel organ.

The stroma may consist of very loose areolar tissue, or is often more cellular. Blood vessels are frequent.

The central areas of the epithelial clumps frequently become cystic, all stages of this cyst formation being seen in Fig. 7. In other cases, the epithelial cell arrangement resembles that of basal-cell carcinoma (" rodent ulcer ") of the skin (Fig. 8); frequently epidermoid features are present, such as epithelial pearls (Fig. 9), or prickle cells. Mitoses may be seen in the more malignant types, and other changes such as infection or hæmorrhage may be present.

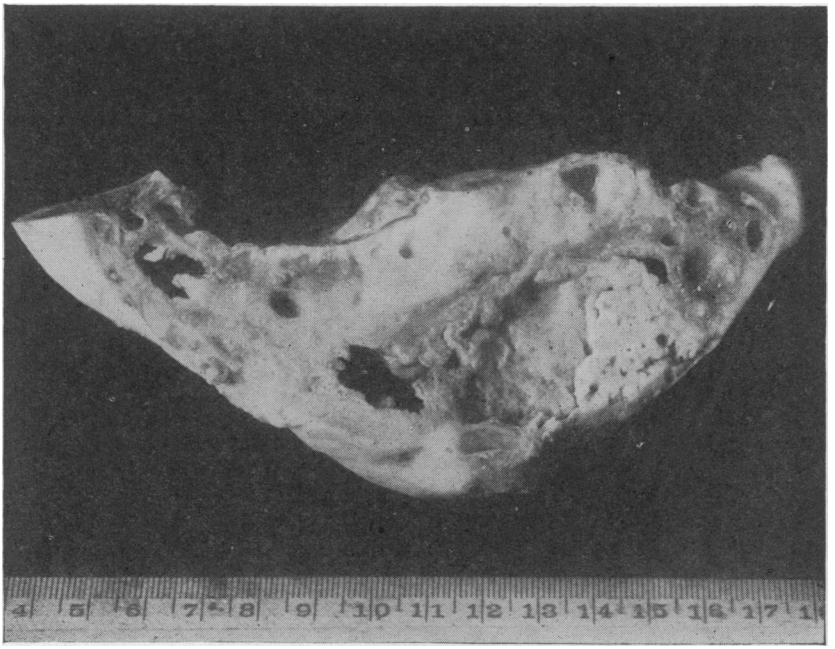

Fig. 4. Macroscopic appearance of bisected specimen of adamantinoma of the mandible. Note cystic as well as solid areas of tumour. (Scale in centimetres.)

NOMENCLATURE

In early literature the following terms for this tumour are used (report of B.D.A., 1914) :—

" Multilocular cystic epithelial tumour,
Multilocular cyst,
Fibrocystic tumour of the jaw,
Cystic epithelioma,
Cystic sarcoma,
Cystic adenoma,
Proliferating follicular cystoma,
Epithelial odontome,
Adamantinoma,
Adamantine epithelioma."

In later years (Zegarelli, 1944) other terms were coined :—

" Adamantoma,
Ameloblastoma,
Enameloblastoma,
Cystadenoma adamantinum,
Adamantinocarcinoma,
Adamantoblastoma."

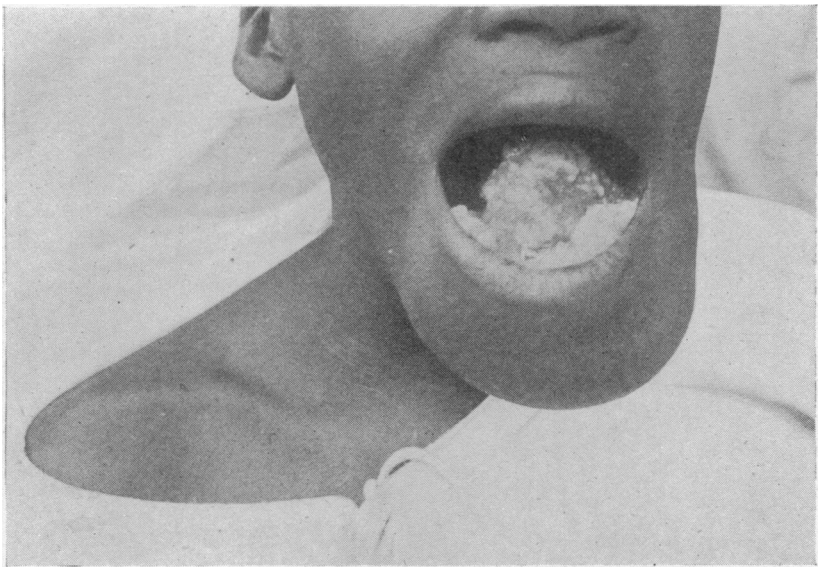

Fig. 5. A soft, fleshy type of adamantinoma, projecting and ulcerating into the mouth.

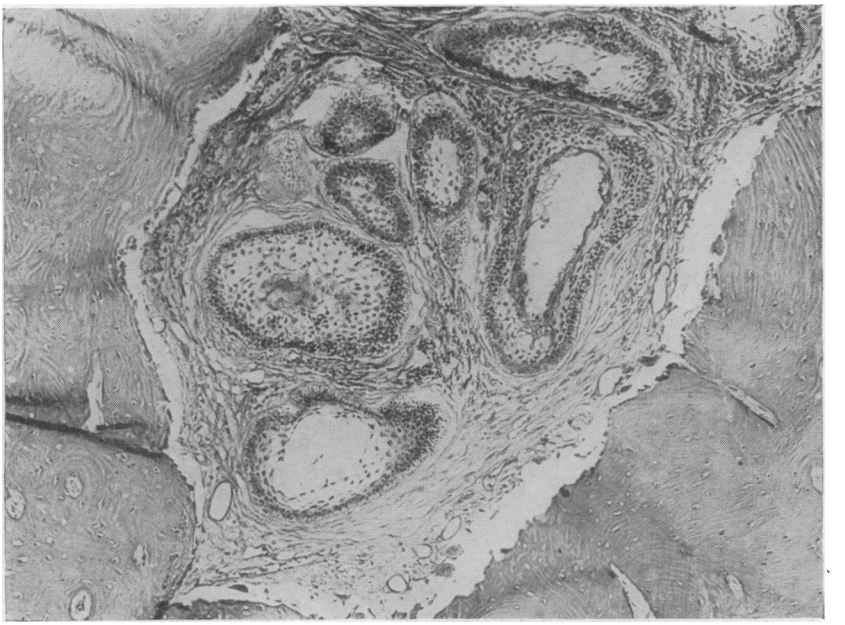

Fig. 6. Microscopic appearance of the more common type of adamantinoma. Note masses of epithelium, with peripheral pallisading, and central stellate reticulum, with beginning cyst formation.

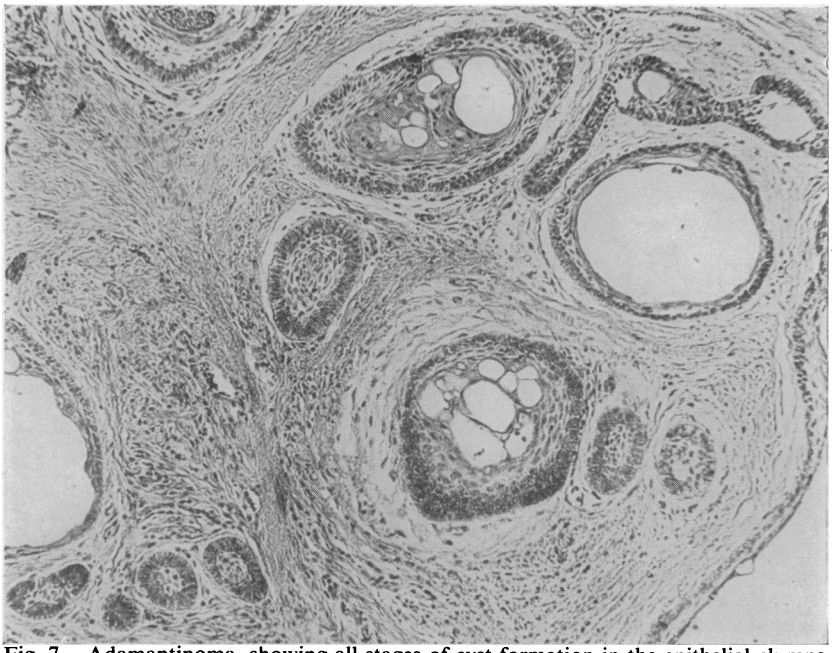

Fig. 7. Adamantinoma, showing all stages of cyst formation in the epithelial clumps.

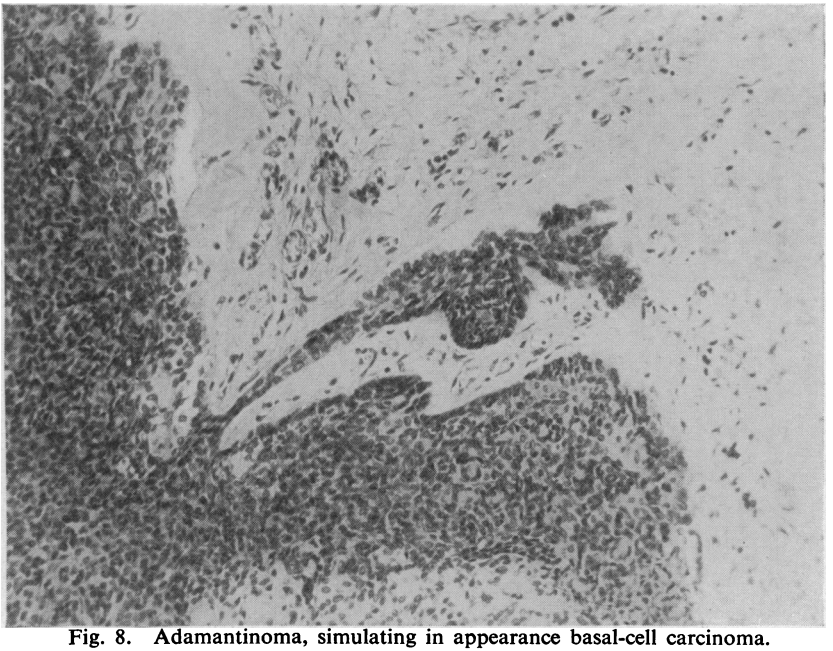

Fig. 8. Adamantinoma, simulating in appearance basal-cell carcinoma.

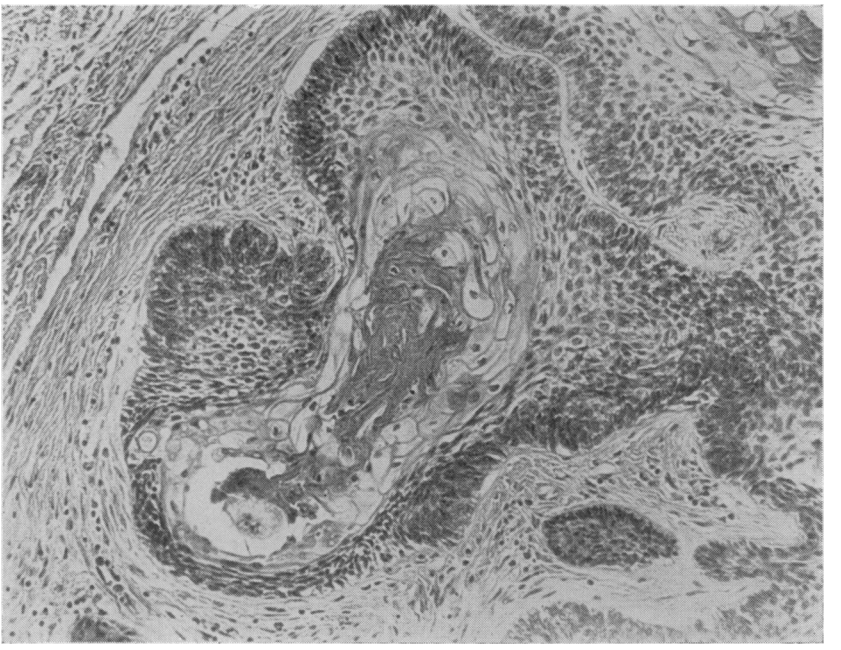

Fig. 9. Squamous epithelial " pearl " formation in adamantinoma.

We have, therefore, at least 16 names for one tumour. Some of these terms are purely descriptive and have been abandoned, *e.g.*, " multilocular cystic epithelial tumour, multilocular cyst, fibrocystic tumour of the jaw, proliferating follicular cystoma." The terms " cystic epithelioma, cystic sarcoma, and cystic adenoma " are pathologically incorrect. " Epithelial odontome " is incorrect as the tumour is not an odontome.

" Adamantinoma " is the term in general use. Etymologically, however, the term indicates a tumour consisting of enamel, rather than one which grows from enamel-forming cells ; a better term has to be used.

" Enameloblastoma " indicates a tumour consisting of enameloblasts, *i.e.*, fully matured enamel-forming cells. These are seldom found, however, and the term is not accurate.

" Ameloblastoma " is a term which has become popular. It indicates a tumour originating from, or consisting of, enamel-forming cells. It would appear to mean that the embryonal enamel-forming cell is the basic cell in all tumours ; this is not the case.

" Adamantoblastoma," suggested by Zegarelli (1944) is probably the most acceptable term, as it indicates the possible cells of origin, with

histological and morphological descriptive meanings included. The term includes all types of epithelial forms which may develop from the multipotential embryonic enamel-forming cells.

As will be seen from the investigations of the author, it is found that the " adamantinoma " bears many similarities to basal-celled carcinoma, and it may even be more correct to name these tumours " basal-celled carcinoma of the jaw." In close harmony with this theory we find that Willis (1948) suggests that these tumours be called " carcinomas of the toothgerm residues." The tendency to continue the use of wrong terms in medical literature is reflected in the phrase by McFarland and Patterson (1931): " The term ' adamantinoma ' may be etymologically incorrect but it is in common usage, and implies a tumour derived from enamel-forming tissue. . . ." This tendency must be resisted, as well as the tendency to regard it as " too late " to change such a terminology. It would appear that the term " basal-celled carcinoma of the jaw " might very well replace " adamantinoma."

PATHOGENESIS

Numerous articles have been published about adamantinoma, and it seems unnecessary to review them all. Dew and Miller (1931) give an excellent historical survey from the description by Cusack in 1826 of a cystic tumour of the jaw to the beginning of the modern era by Bland-Sutton (1906). Lewis (1910) and again Zegarelli (1944) discuss in detail the theories of origin of this tumour.

1. *Residual epithelial rests.*—The " debris epitheliaux paradentaires " was described in an excellent publication by Malassez in 1885. He described small groups of enamel epithelium in embryonal as well as adult jaws, irregularly disposed between toothroots and gingival surface epithelium; it is suggested that adamantinoma originates from these cells.

2. *Proliferating disturbance of the enamel organ.*—This theory is vague as the enamel organ has various strata and it is uncertain from which layer the tumour originates.

3. *Mucous membrane epithelium of the jaw.*—Proponents of this theory suggest that the tumour originates in the basal layer of the epithelium of the gum, after which it invades and destroys the bone.

4. *Epithelium of odontogenic cysts.*—There is no doubt that typical adamantinoma tissue may be found in the wall of a cyst of the jaw; it is unlikely, however, that all tumours originate in this manner.

Thoma, during a lecture at this college in 1949, showed examples of all these four possibilities.

While it appears unnecessary to discuss various writers and their theories in detail, Zegarelli's (1944) work should be considered. He investigated 79 cases of adamantinoma in mice of the Maud Slye Colony at the University of Chicago. Each animal had a tumour of the mandible

and Zegarelli showed fairly convincingly that the adamantinoma takes origin from the group of cells constituting the outside layer of the enamel organ. He also considers odontogenic cysts to be stages in the development of adamantinoma. He further illustrates cases of adamantinoma originating in an enamel organ, while adjacent paradental epithelium remains dormant.

An objection against the theory that this tumour grows from the enamel organ or from the paradental epithelial débris, is its occurrence in other parts of the body such as the tibia, ulna and hypophysis.

Even if the tumour does originate from the outer (germinative) layer of the enamel-organ, we feel that these cells correspond to the basal—or germinative layer—cells of the epithelium from which the enamel organ originated. In this sense we might postulate that this is a " basal-celled " tumour. The polygonal and stellate cells are further stages of differentiation.

There is no doubt that frequently an adamantinoma shows direct continuity with the basal-layer of the mucous membrane of the mouth (Fig. 10). This may, of course, only be a secondary connection, as mature gum epithelium probably cannot differentiate into enameloblasts.

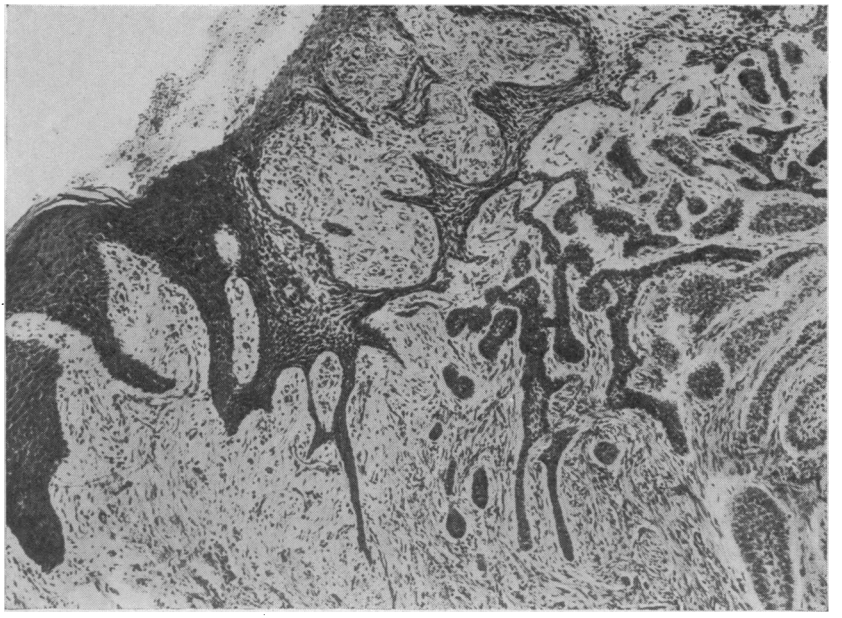

Fig. 10. Adamantinoma, continuous with basal layer of overlying oral epithelium.

If the possibility of its origin from basal-layer cells is accepted, then the pathogenesis of adamantinoma of the tibia and ulna becomes clearer. It is then suggested that these tumours are examples of primary basal-celled carcinoma, originating from epithelial cells, either driven into the periosteum by trauma, or from embryonic cell-rests.

The adamantinoma of the pituitary could be explained on the basis of origin of " Rathke's pouch " from the same epithelium which gives origin to the enamel organs, and which therefore possesses the same potentialities. Ewing (1928) states that a basal-celled carcinoma originates only from basal-cells, and also frequently from displaced and embryonal groups of epithelial cells; the final differentiation into squamous epithelium, however, does not occur.

The potentiality of the cells, originally from the squamous epithelial lining of the oral cavity, is frequently seen in the formation of groups of squamous epithelium and epithelial " pearls " in an adamantinoma (Fig. 9).

Some types of adamantinoma of the upper jaw are not distinguishable from the so-called " basal-celled carcinoma of the antrum" (Fig. 8).

To develop the theory of the nature of the tumour, it is necessary to examine the extra-oral adamantinoma, as well as the question of malignancy and metastases.

Adamantinoma of the Pituitary

Chont (1943) describes how Mihalcovics proved the ectodermal origin of the anterior pituitary in 1875, and how Erdheim in 1906 found isolated groups of epithelial cells along the anterior surface of the infundibulum and on the superior aspect of the anterior lobe of the pituitary. It is from such cells, possessing the same potentialities as those of the oral mucosa, that adamantinoma may originate. Cases have been described by Wohl (1916), Duffy (1920), Critchley and Ironside (1926), Peet (1927), McFarland and Patterson (1931), Drummond (1938), Shelden and Love (1939), McCallum (1941), Love and Marshall (1950), and others. These tumours are benign or " locally malignant," and as such they correspond in their course to basal-celled carcinomata elsewhere.

Adamantinoma of the Ovary

A case was described by Zajewloschin (1931). A reasonable explanation appears to be that it represents a single type of basal-celled growth in an ovarian teratoma.

Adamantinoma of the Femur

Bell (1942) reported a case from Nigeria in a native boy of 16. The swelling was thought to be an abscess, but at operation a tumour was

found; histological examination showed it to be an adamantinoma, but the author gave no explanation of its occurrence in this queer position.

This single case is not convincing. There is a possibility that it may have been a metastic malignant growth. Furthermore, the figure shown in the article does not appear to resemble adamantinoma.

Adamantinoma of the Ulna

Anderson and Saunders (1942) report the first case in a European male, aged 45. A traumatic theory is presented, where, as the result of trauma, epithelium is driven into the periosteum; as the result of interference with healing, however, an epithelial tumour develops.

Adamantinoma of the Tibia

The first case was described by Fischer (1913). The patient was a European male, aged 37, who had five months previously received a hard blow on the tibia. Fischer discusses the theories of origin of the tumour at this site. He does not agree with the theory of a cell-rest of true enamel epithelium, nor with the theory of intra-uterine displacement of the developing enamel organ from mouth to tibia :—

> " Man müsste denn annehmen, dass der Embryo zu der Zeit, als die Schmelzkeim-anlagen entstanden, intra-uterin in sein linkes Bein gebissen hat und dadurch einen Schmelzepithelkern in die Tibia hinein befördert hat. Aber diese Annahme dürfte zu absurd sein, um näher diskutiert zu werden."

Following on Fischer's case, further cases were described by Richter (1930), Baker and Hawksley (1930), Ryrie (1932), Petrov and Glasunow (1933), Holden and Gray (1934), Bishop (1937), Oberling *et al* (1938), Wolfort and Sloane (1938), Rehbock and Barker (1938), Dunne (1938), Thomas (1938), Rankin (1939), Hebbel (1940), Dockerty and Meyerding (1942), Halpert and Dohn (1947), Meffley and Northup (1947), and Cagnoli (see Halpert and Dohn (1947)).

It is seen that this is a rare condition as only 21 cases had been reported up to 1947.

THEORIES REGARDING PATHOGENESIS OF ADAMANTINOMA OF THE TIBIA

(1) **Fœtal cell-rests.** The whole skin surface of the embryo may originally have been multi-potential, including the ability to form tooth-germs; but this state exists only during the short period of toothgerm formation in the jaws. Thus the tumour in the tibia must have originated from that time. Ewing (1940) postulates a downgrowth of epithelium into the bone, exactly analogous to the downgrowth of epithelium into the jawbones.

(2) **Trauma.** It appears possible that trauma of the skin overlying a subcutaneous bone (tibia, ulna), may drive portions of the deep layers of the skin into a periosteal tear, where the epithelium may then undergo certain changes.

Baker and Hawksley (1930) think that the enamel organ is subperiosteal from birth, and that it is stimulated into growth by trauma.

(3) **"Thwarted repair" theory of Ryrie.** As far as is known, the only specimen of adamantinoma of the tibia in South Africa is in the Department of Pathology, University of Cape Town. This case was reported by Prof. B. J. Ryrie (1932). He sums up; "These tumours are basal-cell carcinomas, of traumatic origin, having their basis not in congenital cell rests, but in the passage of a constantly frustrated reparative hyperplasia into neoplasia, in a special environment of tissue reaction."

The histological picture in his case was a mixed one of adamantinoma, basal-cell carcinoma, and rodent ulcer.

Dockerty and Meyerding (1942) observed the following changes in the skin overlying the tumour: the apices of the papillary layer were irregular and hyperchromatic. Here and there masses of basal-cells projected into the subcutaneous tissue. It appeared to be a basal-cell carcinoma *in situ*. They suggest that there may be a relation between these changes and the tumour in the bone.

An interesting attempt was made by Sutro and Pomerantz (1939) to determine whether an enamel organ could exist or develop in the tibia. They implanted primitive enamel organs of kittens into their tibiae and found that they survive and grow, but they could make no further suggestion regarding the growth of adamantinoma in the tibia.

Hebbel (1940) considers these to be basal-cell tumours and he suggests that they may represent one type of primary epithelial tumour. It is well known that primary squamous-cell carcinoma may occur in the jaws (Thoma, 1944), and there may be a relation between this process and the origin of adamantinoma.

Petrov and Glasunow (1933) mention eight cases of primary bone tumour in the tibia and ulna, all of basal-cell type except three (two in the tibia, one in the ulna), which were labelled "primary epithelioma."

One wonders, however, if these tumours were not all of the nature of adamantinoma and if epithelial cell nests and pearls gave the impression of squamous epithelioma. The writers consider these tumours to originate in cell-rests, and trauma to be coincidental.

The question arises now, whether cell-rests do occur in bone? They certainly exist in the jaws, as first described by Malassez (1884). A hair-containing cyst was described in the mandible of a calf by Simkevič, and he has also found hair in human bones; he has gone to the extreme of naming this condition "osteotrichosis."

Adib-Chasin describes a case where the ulna of a 24-year-old man was explored for osteomyelitis (with unbroken skin), and where an intra-osseous cyst was found, lined by glandular epithelium.

Although the evidence is not strong, we can postulate that down-growth of epithelium into underlying bone is possible in the embryo,

and that such epithelium may be stimulated into tumour formation by influences such as trauma.

It appears therefore that the pathogenesis of these tumours is uncertain. The relationship to trauma is notable in over 70 per cent. of cases, but it is equally certain that a very large number of persons receive blows on the tibiae without developing tumours ! It is possible that trauma irritates cell-rests which are present since birth.

If we accept the origin of primary intra-alveolar squamous carcinoma in the jaws from proved cell-rests, then we might postulate that primary basal-celled carcinoma (or adamantinoma) could originate from epithelial cells situated in the particular bones. This would explain the presence of adamantinoma in the femur (Bell, 1942).

Willis (1948), brilliant and dogmatic pathologist, states that adamantinoma of the tibia is a bone-infiltrating epidermoid carcinoma, parts of which sometimes resemble adamantinoma. He gives no opinion as to the cells of origin of these tumours.

MALIGNANCY

There exists great confusion in the literature regarding the " malignant " and " benign " adamantinomata. Attempts to distinguish between these two types is not only impossible, but it serves no purpose. The tumours are all malignant in so far as they are locally infiltrating and are inclined to recur. They may also metastasize. It is simply a question of *how* malignant they are.

Ewing (1928) mentions a case of " epidermoid carcinoma," originating from the enamel organ, which recurred four times. With each successive examination there was an increased degree of anaplasia ; the final tumour was a " diffuse round-cell carcinoma." Other cases have been described where each successive recurrence appeared to be more malignant than the previous one.

Robinson (1937) reports 4·5 per cent. out of 379 cases of adamantinoma, which were histologically " malignant," or which showed evidences of metastases. In 119 cases recurrences took place after excision. The majority of authors mention the prevalence of recurrence after excision.

Ewing (1940) stated the following criteria for malignancy :—

(1) Metastases to neighbouring lymph glands.
(2) Infiltration into surrounding tissues.
(3) Locally destructive properties.
(4) Local interference with function.

The adamantinoma possesses all these properties to a greater or lesser degree.

One personal case (described in another publication), was a white male, aged 70, from whom three specimens were obtained. The first was from a biopsy done in Johannesburg in 1918. The second was from a recurrence, again in Johannesburg, in 1940, and the third was examined

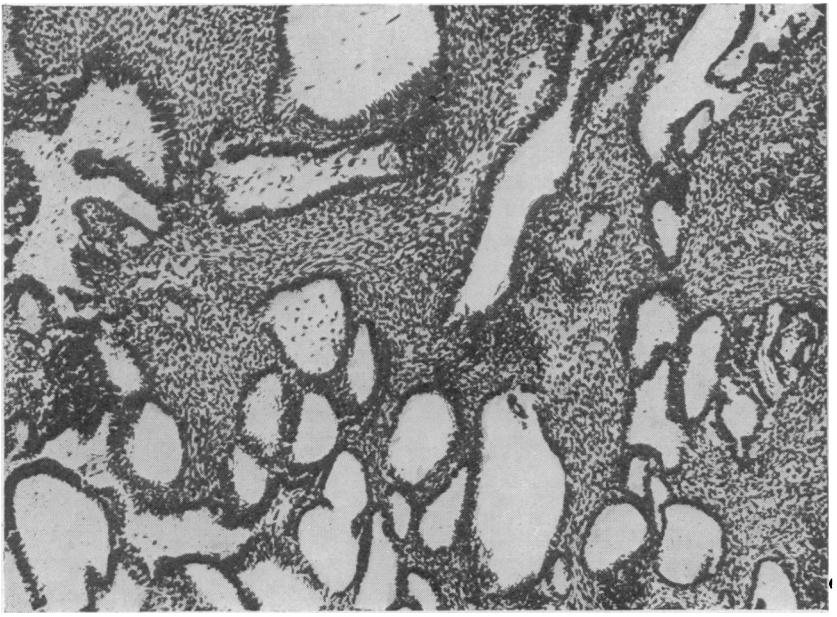

Fig. 11. Adamantinoma of mandible, 1918 (see text).

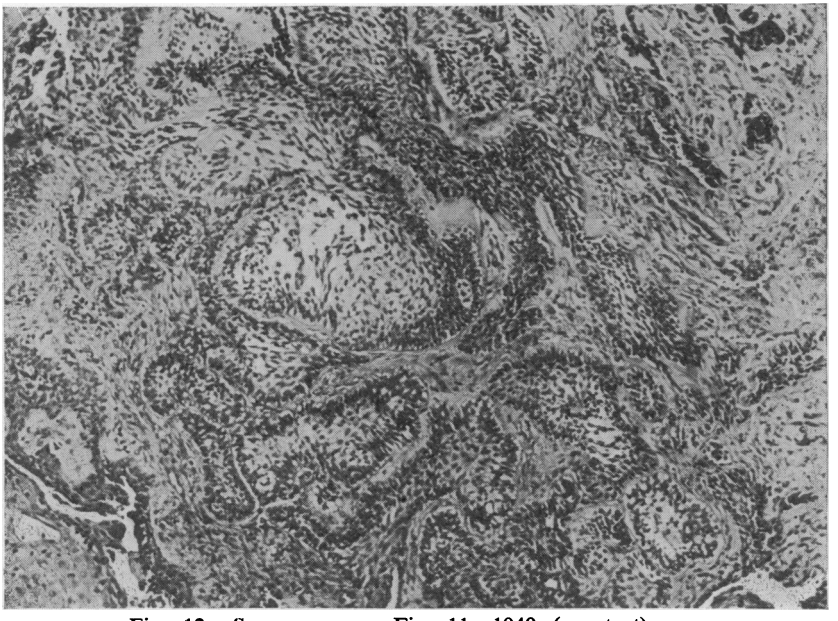

Fig. 12. Same case as Fig. 11, 1940 (see text).

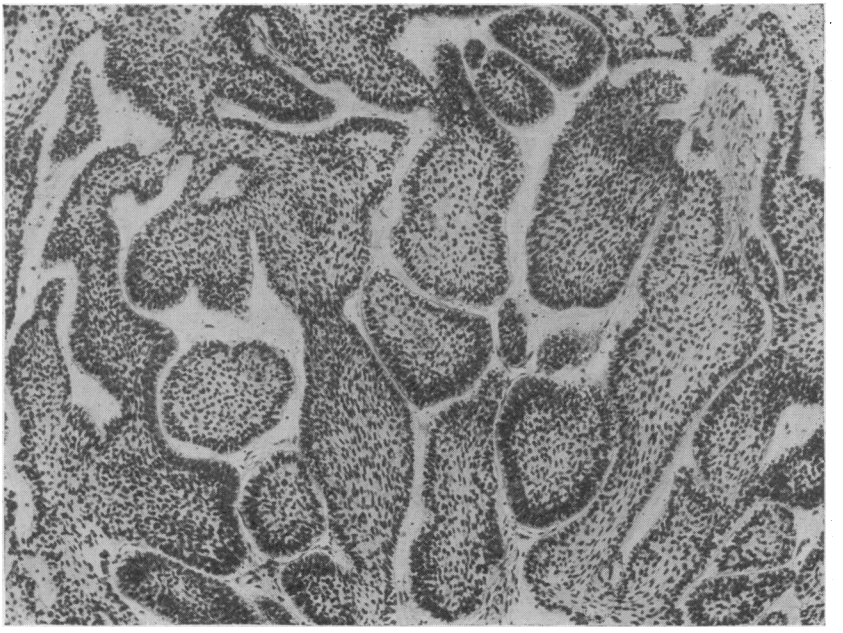

Fig. 13. Same case as Figs. 11 and 12, 1947 (see text).

in Pretoria in 1947, after radical removal of the tumour (Figs. 11, 12 and 13). Study of these slides showed no increased cell activity. Here was a good opportunity to examine specimens of the same tumour over a period of 30 years, and although it recurred, there were no definite signs, clinically or microscopically, of malignancy in the sense of mitoses or pleomorphism. The case indicates how the tumour may remain locally destructive for a very long period of time, without metastasizing.

METASTASES

The first case of adamantinoma of the jaw with lymph gland metastases was described by Eve (1883). Since then cases with gland or lung metastases have been described by Heath (1887), Horsley (1924), Simmons (1928), Spring (1932), Vorzimer and Perla (1932), New (1938), Havens (1939), Ewing (1940), Chont (1943), Schweitzer and Barnfield (1943), Grimes and Stephens (1948), Waterworth and Pullar (1948).

Schweitzer and Barnfield (1943) mention 32 cases from the literature, labelled " malignant," ten of them with metastases. It is not clear what their evidences of malignancy are, especially of those which did not have metastases ; the statement is too vague to be of much help.

Grimes and Stephens (1948) mention an interesting case of a white woman aged 56 years, who had ten years previously had an adamantinoma of the maxilla removed, and who then underwent lobectomy for a single metastasis in the lung.

Waterworth and Pullar (1948) mention the case of a white man aged 57, who, 2½ years after the development of an adamantinoma of the mandible, showed " cannonball " metastases in the lungs (proved histologically). They mention the fact that in other cases of adamantinoma metastases usually occurred ten or more years after the start of the jaw tumour.

Vorzimer and Perla (1932) allege, that in their case the pulmonary metastases occurred by way of aspiration. In the case of Waterworth and Pullar (1948), however, the case was clearly one of hæmatogenous spread.

There appears to be sufficient evidence now that adamantinoma may metastasize to lymph glands, and by way of the blood-stream. The statement in books and journals that adamantinoma is only " locally malignant," is incorrect. Admittedly metastases occur seldom and late, yet it may be suggested now that an adamantinoma could be defined as " a malignant epithelial tumour, of basal-cell type, which may metastasize."

Basal-cell carcinoma of the jaw

Worth (1939) described a basal-cell carcinoma of the mandible. Histologically this lesion was not to be distinguished from basal-cell carcinoma of the skin.

Thoma (1944) describes basal-cell carcinoma of the alveolar mucosa as a clear-cut clinical entity. It is a solid tumour of low malignancy, greatly resistant against radiation. Thoma thinks that this tumour has a very close relationship to adamantino-blastoma ; it is known in the German literature as " Krompecher's carcinoma." Krompecher (1900) himself compares this tumour with adamantino-blastoma, and states :

" In both tumours the peripheral cells may be arranged in the fashion of cylinders, radially situated against each other. Both tumours tend to form the reticular structures and cysts as the result of progressive changes in the epithelium. Epithelial pearls may be seen."

Spring (1932) states that basal-cell carcinoma tends to give rise to hæmatogenous metastases, while epidermoid carcinoma favours lymph-spread. Both are rare in adamantinoma.

If we now compare basal-cell carcinoma of the skin (" rodent ulcer ") with adamantinoma, we find that it is also slow-growing, it is locally destructive, and it infiltrates surrounding structures at a late stage ; histologically it cannot be distinguished from basal-cell carcinoma of the oral mucosa, nor can it be easily distinguished from the solid, cellular type of adamantinoma which is mostly found in the upper jaw. Small

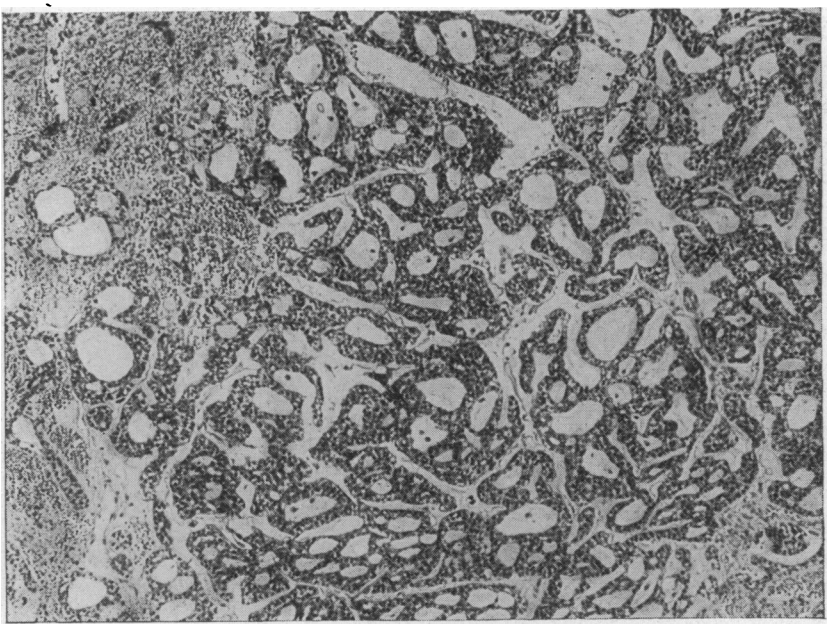

Fig. 14. Case diagnosed as " cystic basal-cell carcinoma of the antrum."

cysts may be seen in a basal-cell carcinoma of the skin, although stellate cells are absent. The similarity between basal-cell carcinoma and adamantinoma will be greater if a basal-cell carcinoma metastasizes. This it does, but seldom.

De Navasques (1941) mentions odd cases of basal-cell carcinoma metastasizing to lymph glands. He describes a personal case of a white woman of 49, with a basal-cell carcinoma on the forehead. Post-mortem examination revealed hæmatogenous secondary growths in the lungs and bones.

Fig. 14 shows a case diagnosed a " cystic basal-cell carcinoma of the antrum." Fig. 15 shows a case diagnosed as adamantinoma. In either case the diagnosis could have been reversed. It is often difficult to label a particular case one or the other. One case shows the difficulty. A specimen from a tumour of the gum of a coloured woman of 31 was reported upon as follows: " Basal-cell carcinoma. Is there possibly an under-lying tumour, such as adamantinoma? " The previous file showed that this was a large tumour occupying the whole of the upper jaw on one side. Here again the picture could fit in with basal-cell carcinoma or adamantinoma.

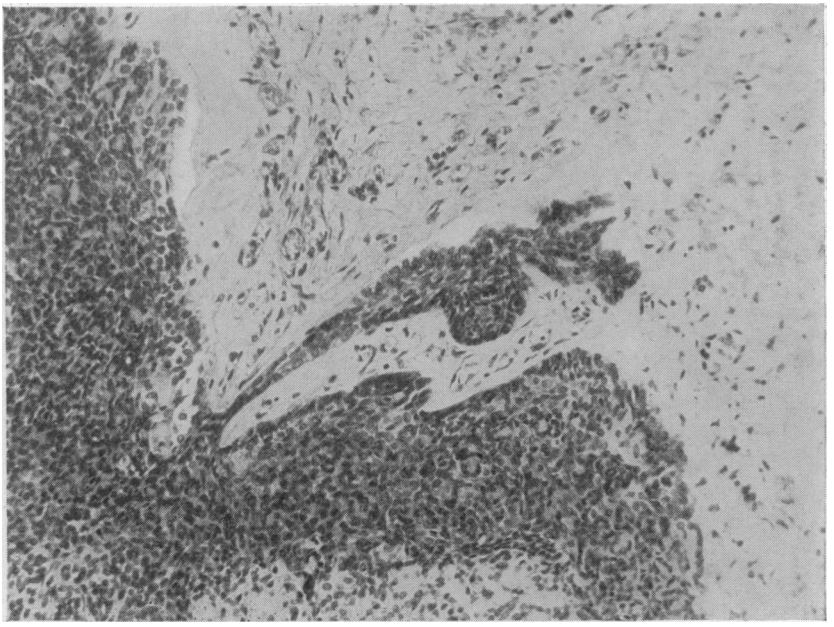

Fig. 15. Case diagnosed as adamantinoma.

The diagnosis of " basal-cell carcinoma " in either case should satisfy the clinician, as it indicates that radical local removal would be adequate treatment.

Fig. 16 shows a carcinoma of basal-cell type which infiltrates the bone of the jaw in such a manner that it is again difficult to distinguish from adamantinoma.

Fig. 17 shows basal-cell carcinoma of the jaw, in direct continuity with the basal layer of the oral epithelium. It is difficult to distinguish from adamantinoma (see also Fig. 10). Two important and interesting personal cases have been observed. (Described in detail in another publication.)

Fig. 18 is from a tumour of the mandible in a Bantu male of 30. He had obvious metastases to lymph glands in the neck and billiard ball metastases to the lungs confirmed by autopsy. The other case was a Bantu aged 46. He had a tumour of the maxilla with widespread skeletal metastases, and microscopy showed a basal-cell type of adamantinoma.

In these two cases we are concerned with basal-cell carcinomata originating in the jaws and giving rise to haematogenous metastases. The pathologist labelled them " adamantinoma of basal-cell type." Could they be labelled true adamantinoma ?

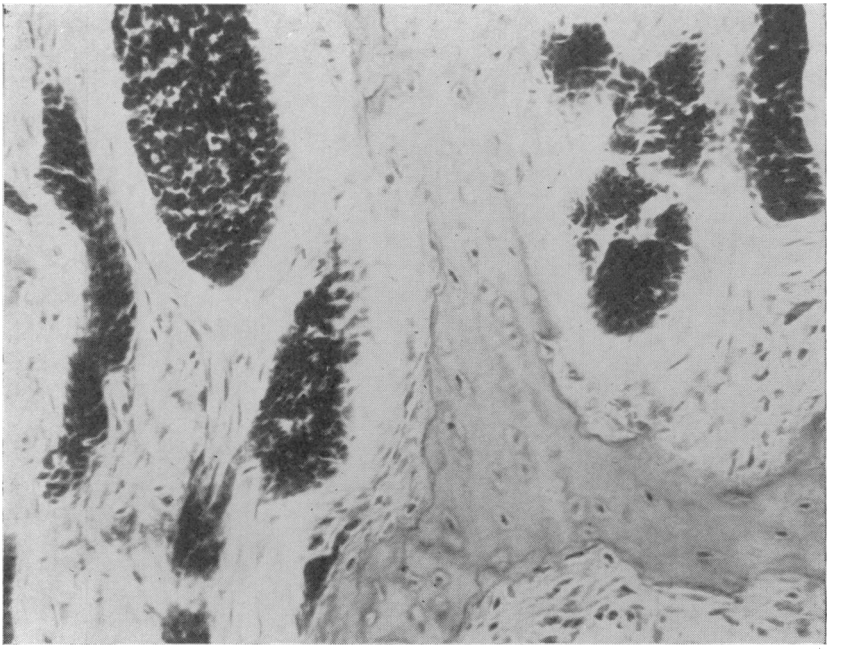

Fig. 16. Basal-cell carcinoma infiltrating bone.

Geschickter and Copeland (1949) state that the tumour originates from undifferentiated basal-cells, which may differentiate either into squamous epithelium, or into enamel epithelium. They state further: "The islands of basal-cells may resemble adenocystic basal cancer, or in more characteristic fashion may surround an area of stellate reticulum."

Ward and Hendrick (1950), while giving an excellent account of adamantinoma, discuss separately the so-called "central adenocystic basal-cell epithelioma"; at the same time, they state that there is a close relationship between adenocystic basal-cell epithelioma, salivary tissue tumours, and ameloblastoma, from an embryological standpoint. It is interesting to observe that the pathological diagnosis in one of their cases reads as follows: "Ameloblastoma (adenocystic basal-cell type) of jaw."

A clinical point worth remembering is that a biopsy wound over an adamantinoma or basal-cell carcinoma will always heal, contrasting with that of the squamous carcinoma.

One finding which makes it difficult to believe that adamantinoma does not originate from the enamel organ, is the presence of enamel in the tumour. This is, however, a very unusual finding and indicates the odd

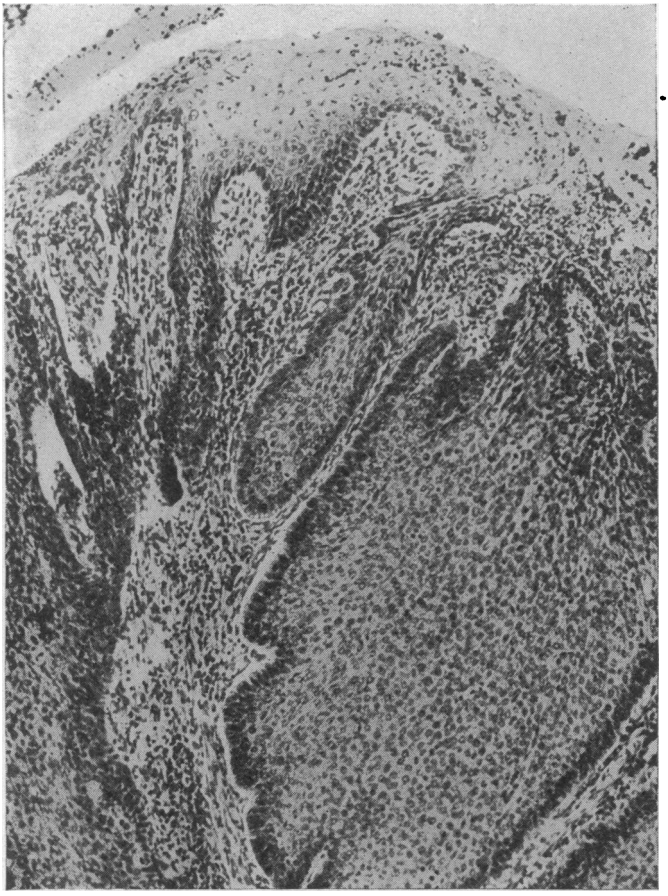

Fig. 17. Basal-cell carcinoma of the jaw, showing the continuity of the growth with the basal-layer of the oral epithelium.

case of final differentiation into enamel-forming cells. Ewing (1928) states that small portions of enamel may be found, and this is confirmed by Hampp (1942).

According to personal experience, the arbitrary division of adamantinoma into " solid " and " cystic " types is unnecessary and confusing. If a whole tumour is carefully examined, both solid and cystic areas will probably always be found. Solid tumours often possess micro-cysts; are they to be classed as the " cystic " type? The division is of no practical value. Pathologists state that the " solid " type is more malignant than the " cystic " type. This may or may not be so, but it is in any case better to judge malignancy in each case by the cellular changes observed.

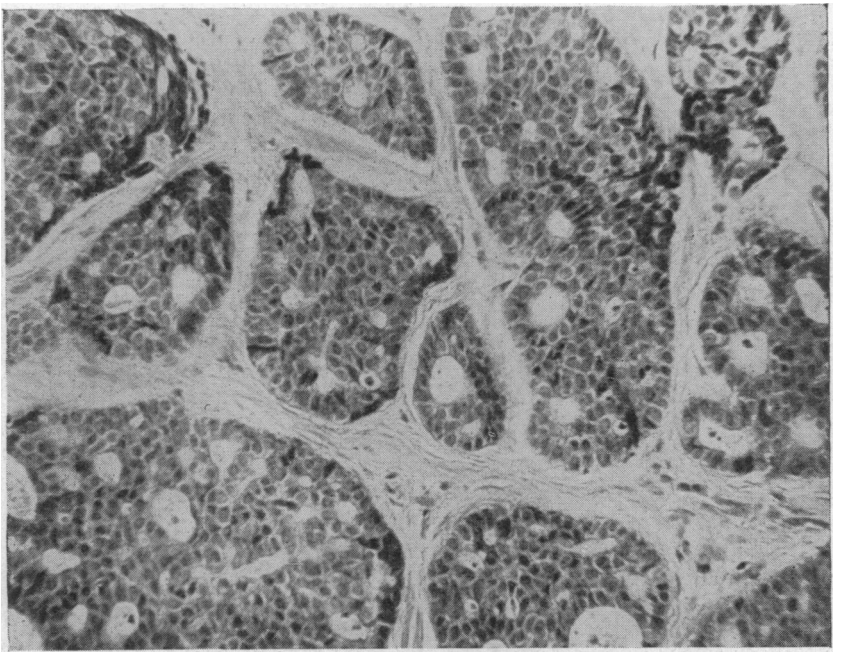

Fig. 18. Adamantinoma (basal-cell carcinoma) of the mandible, which metastasized to the lungs.

Although there is probably not sufficient evidence to state that adamantinoma is a basal-cell carcinoma, there are so many similarities in appearance and behaviour, that one might venture the suggestion that this type of growth now be known as " primary basal-cell carcinoma of the jaw " (or any other bone, as the case may be). *A suggested definition of this type of tumour would then be* : " *A malignant epithelial tumour, basal-cell in origin, character and behaviour, which may metastasize.*"

SUMMARY

1. A large number of names have been applied to the tumour generally known as " adamantinoma." It is felt that the term " adamantoblastoma " is probably the most correct. The tumour has so many characteristics of basal-celled carcinoma, however, that it may be pathologically more correct to name it " basal-celled carcinoma of the jaw."

2. In the pathogenesis of the tumour, four main theories are discussed :—

(*a*) Residual epithelial rest theory.
(*b*) Enamel organ origin theory.
(*c*) Origin from mucous membrane of the mouth.
(*d*) Origin from odontogenic cyst epithelium.

3. Extra-oral adamantinoma may occur in the pituitary region, ovary, femur, ulna and tibia. It is felt that its presence in these regions can be adequately explained by postulating a basal-celled carcinoma nature; it cannot originate from enamel organ tissue in these situations.

4. The tumour must be regarded as always malignant as it is always locally invasive. A number of cases with lymph gland and hæmatogenous metastases have now been described. Metastases occur late however.

5. Cases published as " basal-celled carcinoma of the jaw " run a clinical course very similar to adamantinoma. Even histologically a similarity may be noted. It may be worthy of consideration to abandon the term " adamantinoma " and its synonyms, and to indicate these tumours by " primary basal-cell carcinoma of the jaw."

6. Analysis of 88 cases of adamantinoma studied in South Africa shows a great preponderance of the growth in the Bantu.

7. Treatment should always be by radical excision. Radiotherapy has little effect, while conservative operation such as curettage is wrong in principle, and is usually ineffective.

REFERENCES

ADIB-CHASIN, Quoted by PETROV and GLASUNOW (1933).
ANDERSON, C. E. and SAUNDERS, J. B. (1942) *Surg. Gynec. Obst.* **75**; 351.
BAKER, A. H. and HAWKSLEY, L. M. (1930) *Brit. J. Surg.* **18**, 415.
BELL, A. L. (1942) *Brit. J. Surg.* **30**, 81.
BISHOP, E. L. (1937) *Sth. Med. J.* **30**, 571.
BRITISH DENTAL ASSOCIATION (1914) *Report on odontomes.* John Bale, Sons and Danielsson, London.
CAGNOLI (1947) Quoted by HALPERT and DOHN (1947).
CHONT, L. K. (1943) *Amer. J. Roentgenol.* **50**, 480.
CRITCHLEY, M. and IRONSIDE, R. N. (1926) *Brain.* **49**, 437.
DE NAVASQUES, S. (1941) *J. Path. Bact.* **53**, 437.
DEW, H. and MILLER, D. (1931) *Aust. N.Z. J. Surg.* **1**, 343.
DOCKERTY, M. B. and MEYERDING, H. W. (1942) *J. Amer. Med. Ass.* **119**, 932.
DRUMMOND, W. A. D. (1938) *Proc. Roy. Soc. Med.* **32**, 200.
DUFFY, W. C. (1920) *Ann. Surg.* **72**, 537 and 725.
DUNNE, R. E. (1938) *New Engl. J. Med.* **218**, 634.
EVE, F. S. (1883) *Brit. Med. J.* **1**, 1.
EWING, J. (1928) *Neoplastic diseases.* W. B. Saunders Co., Philadelphia, 3rd Ed.
———— (1940) *Neoplastic diseases.* W. B. Saunders Co., Philadelphia and London., 4th Ed.
FISCHER, B. (1913) *Frankfurt. Z. Path.* **12**, 422.
GESCHICKTER, C. F. and COPELAND, M. M. (1949) *Tumours of bone.* J. B. Lippincott & Co. 3rd Ed.
GRIMES, O. F. and STEPHENS, H. B. (1948) *Ann. Surg.* **128**, 999.
HALPERT, B. and DOHN, H. P. (1947) *Arch. Path.* **43**, 313.
HAMPP, E. G. (1942) *J. Amer. Dent. Ass.* **29**, 1,819.
HAVENS (1939) *Arch. Otolaryng.* **30**, 762.
HEATH, C. (1887) *Lectures on certain diseases of the jaws.* J. & A. Churchill, London.
HEBBEL, R. (1940) *Surgery* **7**, 860.
HOLDEN, E. and GRAY, J. W. (1934) *J. Bone Jt. Surg.* **16**, 401.
HORSLEY, J. S. (1924) *Ann. Surg.* **79**, 358.
KROMPECHER, E. (1900) *Beitr. Path. Anat.* **28**, 1.
LEWIS, D. D. (1910) *Surg. Gynec. Obst.* **10**, 28.
LOVE, J. G. and MARSHALL, T. M. (1950) *Surg. Gynec. Obst.* **90**, 591.
MALASSEZ, L. (1884) *J. Conn. Med. Pat. Paris*, 3rd series, **7**, 98 and 115.
MCCALLUM, W. G. (1941) *J. Mt. Sinai Hosp.* **8**, 798.
MCFARLAND, J. and PATTERSON, H. M. (1931) *Dent. Cos.* **73**, 656.

MEFFLEY, W. H. and NORTHUP, S. W. (1947) *J. Int. Coll. Surg.* **10**, 291.
NEW, G. B. (1938) *Amer. J. Surg.* **42**, 170.
OBERLING, M., VERMES, E. and CHEVEREAY, J. (1938) *Bull. Assoc. franc. cancer* **27**, 373.
PEET, M. M. (1927) *Arch. Surg.* **15**, 829.
PETROV, N. and GLASUNOW, M. (1933) *Arch. Klin. Chir.* **175**, 589.
RANKIN, J. O. (1939) *J. Bone Jt. Surg.* **21**, 425.
REHBOCK, D. J. and BARKER, C. G. (1938) *J. Bone Jt. Surg.* **20**, 186.
RICHTER, C. S. (1930) *Z. Krebsforsch.* **32**, 273.
ROBINSON, H. B. G. (1937) *Arch. Path.* **23**, 831.
RYRIE, B. J. (1932) *Brit. Med. J. ii*, 1,000.
SCHWEITZER, F. C. and BARNFIELD, W. F. (1943) *J. Oral Surg.* **1**, 287.
SHELDEN, C. H. and LOVE, J. G. (1939) *Proc. Mayo Clin.* **14**, 143.
SIMKEVIČ. Quoted by PETROV and GLASUNOW (1933).
SIMMONS, C. C. (1928) *Ann. Surg.* **88**, 693.
SPRING, K. (1932) *Z. Stomatol.* **30**, 455.
SUTRO, C. J. and POMERANTZ, B. S. (1939) *Arch. Path.* **28**, 199.
THOMA, K. (1944) *Oral Pathology*, C. V. Mosby Co., St. Louis, 2nd Ed.
THOMA, K. H. (1949) *Ann. R. Coll. Surg. Eng.* **5**, 143.
THOMAS, R. G. (1938) *Brit. J. Surg.* **16**, 547.
VORZIMER, J. and PERLA, D. (1932) *Amer. J. Path.* **8**, 445.
WARD, G. E. and HENDRICK, J. W. (1950). *Tumours of the Head and Neck.* Williams Wilkins Co., Baltimore.
WATERWORTH, G. E. and PULLAR, J. H. (1948) *J. Path. Bact.* **60**, 193.
WILLIS, R. A. (1948) *Pathology of Tumours*, Butterworth, London.
WOHL, M. G. (1916) *Ann. Surg.* **64**, 672.
WOLFORT, B. and SLOANE, D. (1938) *J. Bone Jt. Surg.* **20**, 1,011.
WORTH, H. M. (1939) *Proc. Roy. Soc. Med.* **32**, 331.
ZAJEWLOSCHIN, M. N. (1931) *Frankfurt. Z. Path.* **41**, 100.
ZEGARELLI, E. V. (1944) *Amer. J. Path.* **20**, 23.

LISTER MEDAL

The Lister Medal for 1951 has been granted to Professor Sir James Learmonth, K.C.V.O., C.B.E., F.R.S.Ed., F.R.C.S.Ed., Hon. F.R.C.S., in recognition of his distinguished contributions to surgical science. Sir James Learmonth will deliver the Lister Memorial Lecture in London, on Friday, 4th April, 1952, under the auspices of the College.

This is the tenth occasion of the award, which is made by a Committee representative of the Royal Society, the Royal College of Surgeons of England, the Royal College of Surgeons in Ireland, the University of Edinburgh and the University of Glasgow.