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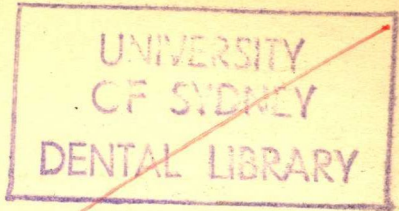


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INVOLVEMENT OF THE
MAXILLARY SINUS IN THE
PRACTICE OF ORAL SURGERY

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This critical review of the literature concerning the involvement of the maxillary sinus in the practice of oral surgery is submitted in support of candidature for the Degree of Master of Dental Surgery.

FRACTURES	
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CHAPTER ONE

ANATOMY

SYNOPSIS

1. Historical
2. Comparative Anatomy
3. General Configuration
4. Ostium
5. Anatomic Relations
6. Nerve and Blood Supply

It is felt by many dentists that the maxillary sinus constitutes a hazard in dental surgical procedures. Thus this region tends to be overlooked in diagnosis and treatment.

Before it is possible to appreciate any of the numerous pathological conditions of the antrum, it is essential to have a complete understanding of its anatomy. This, of

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1. HISTORICAL

According to Schaeffer (1920), Galenus (130-201 A.D.) had knowledge of the sinus. But the first detailed description of the maxillary sinus was made by Nathaniel Highmore (1613-1685), a 17th Century pioneer in anatomy and embryology (Wells, 1948). Highmore's attention was drawn to the maxillary antrum when a patient's tooth was removed, and the existing suppurative sinus condition drained through the antral perforation. He incorporated his sinus study in a general treatise which was published at The Hague in 1651; and since then this accessory air space has assumed great importance in the fields of rhinology and oral surgery. In the survey of the literature that follows, an attempt will be made to correlate all information which is essential for the successful diagnosis and treatment of oral conditions which involve the maxillary sinus; and to emphasise the effect of sinus disease on the teeth and their supporting structures.

It is felt by many dentists that the maxillary sinus constitutes a hazard in dental surgical procedures. Thus this region tends to be overlooked in diagnosis and treatment.

Before it is possible to appreciate any of the numerous pathological conditions of the antrum, it is essential to have a complete understanding of its anatomy. This, of

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course, applies to all aspects of surgery in general, as well as to the science of oral surgery in particular. Very often with pathology of the maxilla, the maxillary sinus is involved, and to be aware of the anatomical boundaries and variations in form is essential for successful diagnosis and the subsequent operative procedures.

2. COMPARATIVE ANATOMY

Negus (1958) presents a comprehensive picture of the comparative anatomy and physiology of the paranasal sinuses. He maintains that the maxilla itself was developed for the purpose of seizing prey, and not for purposes of olfaction and respiration. A considerable part of the upper jaw is solid in amphibia and reptiles (crocodiles, frogs and toads); and these genera have no true maxillary sinus. In some higher forms of life, elevation as against a flattened maxilla occurs, and this added height affords accommodation for a highly developed turbinal system serving the functions of smell and respiration; as, for example, in kangaroos, wallabies and many rodents and ungulates.

The size and distribution of the maxillo-turbinal bodies have a marked influence on the presence or absence of the maxillary sinus. "Man and the higher apes have short nasal fossae, but possess shrunken turbinals, and thus have larger maxillary air spaces." The work of Negus will be considered

() ant. - post depth ... 3 cms.

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later when dealing with the physiology of the maxillary sinus.

Marchi, quoted by Salinger (1950), sectioned seventy-one heads of mammals, and studied the conformation and relationship of the sinuses in cattle, horses, sheep etc. His studies showed the existence of accessory cavities communicating directly with the frontal and sphenoidal sinuses; the writer claims that a direct pathway from the frontal to the maxillary sinus is analagous in human beings, and this would explain a chronicity in certain infections with a simultaneous involvement of the two cavities.

3. GENERAL CONFIGURATION

All writers are in agreement as regards the general anatomy of the maxillary sinus. It is the largest of the paranasal sinuses and occupies the body of the maxilla (Cunningham, 1943); likened in shape to a pyramid with its base lying medially, and its apex in the region of the zygomatic process of the maxilla. It is conceded that the sinuses are frequently asymmetrical, larger on one side than the other. Jacobs (1948) states that the size is influenced by the growth and development of the alveolus and by heredity. He gives the average size as:

- (a) vertical height ... 3.75 cms. (opposite first molar)
- (b) transverse width ... 2.5 cms. being situated so
- (c) ant. - post depth ... 3 cms.

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Schaeffer (1920) states: "it follows in the main the shape of the body of the maxilla; the thickness of the walls varies 5-8 mms., but may be of paper delicacy it is not influenced by age; however it is slightly larger in the male but overall, sex affects the size little". This would seem to be in accordance with the view of Jacobs.

Barnhill (1940) claims that age influences the thickness of the sinus walls which may be of eggshell thickness in old age. Sicher's (1949) explanation for this is that after cessation of growth sinus enlargement occurs where the mechanical function and stresses have lessened, especially when teeth are lost and the masticatory apparatus is weakened.

Sicher gives three reasons for the narrowing of the sinus:

- (a) abnormal depth of canine fossa
- (b) the lateral wall of the nasal cavity may bulge inwards
- (c) lack of formation of the alveolar recess, so that the floor is at a higher level than the floor of the nasal cavity.

4. OSTIUM

The ostium permits a natural opening into the middle meatus under cover of the middle concha. This in turn allows natural drainage of the sinus, but being situated so

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high on the medial wall, it is small wonder that it is often ineffectual under inflammatory conditions, and that artificial drainage is resorted to through the inferior meatus. Sicher states that the position of the ostium is explained by the fact that when the development of the maxillary sinus commences, the greater inferior part of the body of the maxilla is occupied by the germs of the deciduous teeth, so that the pneumatisation of the maxilla necessarily starts in its uppermost part immediately below the orbital floor. While the maxilla grows, and the teeth move downward the sinus expands inferiorly, but the site of the first appearance of the sinus persists as the communication with the nasal cavity.

According to Jacobs (1948) the ostium is a canal in 80% of cases, 2-4 or 5 mms. in length. He describes it as a round ovoid or thin slit. Shapiro (1954) merely states that the size and shape vary.

The ostium may at times be duplicated. Eggston and Wolff (1947) claim that an accessory sinus occurs in 32% of cases. However, distinct cavities, each opening into the infundibulum, genetically represent true duplication and this is reported to occur in 1% of cases (Glass, 1952).

5. ANATOMIC RELATIONS

The sinus is related:

(a) superiorly to the orbit,

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- (b) medially to the nasal cavity,
- (c) posteriorly to the infra-temporal fossa,
- (d) below it is intimately related to the alveolar process and to the teeth.

The orbital surface of the sinus forms the bony floor of the orbit, and at times has a paper-thickness (Schaeffer, 1920). Through this floor runs the infra-orbital canal which may take the form of a ridge or sometimes a groove covered only by mucous membrane. At times, according to Schaeffer, the roof is divided into two plates separated by the ethmoid air cells. "This surface is thinnest at the centre (1-2 mms.) and becomes thicker at the infra-orbital margin." (Jacobs.)

The medial wall or base is related to the nasal cavity. Schaeffer writes: "It consists of the hiatus maxillaris, an irregular orifice in a disarticulated skull. It is partly filled in by the perpendicular plate of the palatine bone, unciniate process of the ethmoid, maxillary process of the infranasal concha and part of the lacrimal bone. In the living state nasal mucous membrane bridges over the defects in the osseous medial wall, and is continued into the sinus to form the rounded opening or ostium." As the sinus often extends to a lower level than the nasal floor (by 1-10 mms.), Barnhill points out that perfect drainage cannot be obtained by any type of operation. Accordingly the naso-antral wall

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must be removed until the floor of the nose and that of the sinus are as level as possible. This will be discussed at greater length in connection with Surgical Techniques.

However it may be noted here that anatomical observations by this author are well correlated with surgical procedure.

The Relationship of the Maxillary Sinus to the Maxillary Teeth:

Alveolar Surface: This surface is perhaps of the greatest importance to the dental surgeon as it follows the alveolar process, and alone bears relationship to the maxillary teeth. Detailed work has been contributed by Martensson (1950), who was concerned with the effect of surgical treatment of the sinus on the maxillary teeth. This author cites Von Bonsdorff who made a study of eighty-four Finnish skulls, and concluded that the second molar bore closest relationship to the maxillary sinus, especially if single-rooted, when it lies immediately below the floor or protrudes into the sinus. As a result of this study the following table was produced:

Distance of apices to the sinus and the percentage of cases showing how often the root apices of the different teeth are in the immediate vicinity (0.5 mms or less).

Second molar 1.3 mms - 45% of cases

Third molar 2.3 mms - 27%

First molar 2.6 mms - 30.4%

Second bicuspid 2.9 mms - 19%

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Cuspid7.1 mms - 5.3%
 First bicuspid7.6 mms - 0.0%

These results were confirmed by Paatero (quoted by Martensson) in 1939. It is generally conceded that the second premolar and the three molars are chiefly connected with the sinus. However there are individual variations when the cavity, because of extensive pneumatisation, may involve all the maxillary teeth, (Barnhill).

Prolonged argument in millimetres does not seem indicated from a practical point of view, especially when radiological examination is a prerequisite of exodontia or oral surgery.

The sinus often extends down between the roots of the first molar (Hutchinson, 1954), and after extraction of this tooth may occasionally be seen dipping down between the second bicuspid and the second molar until the alveolar border is almost reached. Furthermore, in edentulous patients the cavity extends to the alveolar border. Schaeffer contends that the intimate relationship between the sinus and the teeth is exaggerated in the literature. He states that the canine tooth is only occasionally in direct relationship, and agrees with Martensson that the second molar is more frequently related.

According to Schaeffer the thickness of the floor depends upon the degree of pneumatisation, and he concludes

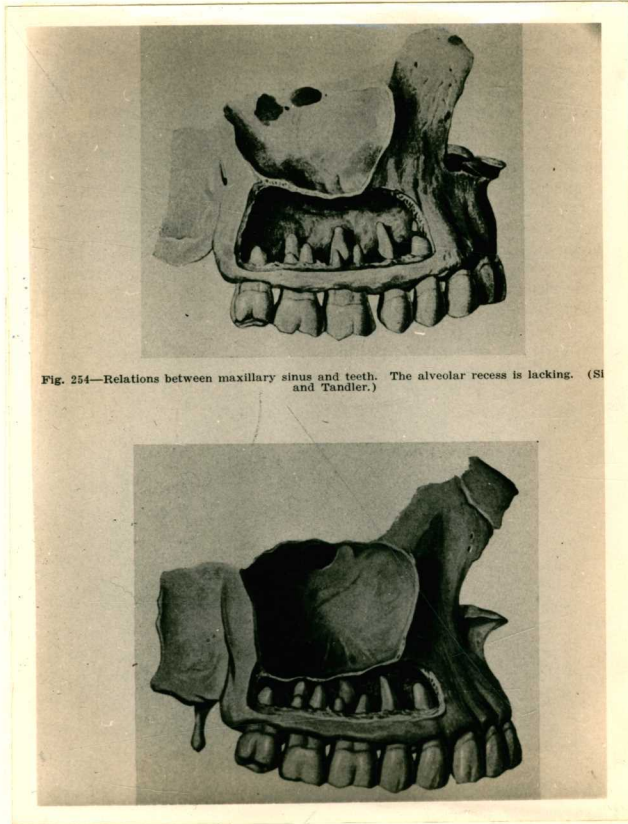


Fig. 254—Relations between maxillary sinus and teeth. The alveolar recess is lacking. (Sicher and Tandler.)

VARIATION IN PNEUMATISATION OF THE
SINUS AND ITS EFFECT ON THE
RELATIONSHIP TO THE ROOT APICES

AFTER SICHER



PNEUMATISATION INTO AN EDENTULOUS
SPACE

AFTER STAFNE

ANATOMY

that because of the variation on different skulls and on different sides of the same skull, the relationship between the teeth and the sinus is not constant. This author observes that age is an influential factor, direct communication between roots occurring more frequently in older people.

The Anterior or Facial Wall: This is related to the anterior surface of the maxilla, and in a large sinus can extend to the lateral incisor region (Jacobs). The canine fossa on the lateral surface of the anterior wall usually marks the most anterior extension of the cavity. Sicher states that the depth of the canine fossa and the size of the maxillary sinus are in inverse proportion. "Lateral expansion of the sinus may pneumatise into the zygomatic process of the maxilla, and may even extend into the zygomatic bone." (Sicher)

The Posterior or Infra-temporal Surface: The sinus forms the anterior boundary of the infra-temporal fossa below, and the pterygopalatine fossa above. This surface is convex, thin in the midportion, and thickest after the third molar has erupted to the maxillary tuberosity. (Jacobs)

Because of the important contents of the infra-temporal fossa, i.e.:

(a) the lower part of the temporal muscle,

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- (b) the pterygoid muscles,
 - (c) mandibular and maxillary divisions of the fifth nerve,
 - (d) the branches of the internal maxillary vessels,
- complications may occur through surgical mishap, viz:
- (a) haemorrhage,
 - (b) trismus,
 - (c) anaesthesia or paraesthesia (Jacobs),
 - (d) facial fractures, when there may be a spread of infection through to the infra-temporal fossa with serious complications. (Rowe and Killey, 1955).

Barnhill explains that the faulty eruption of teeth, such as occurs with the third molar, is due to the failure of the developing sinus to extend far enough posteriorly, so that one or more developing molar teeth may be impacted in a position above the alveolar process, and thus lie wholly or partly in the sinus.

Barnhill describes the sinus boundaries thus:

- (a) alveolar,
- (b) palatine,
- (c) tuberosity extensions.

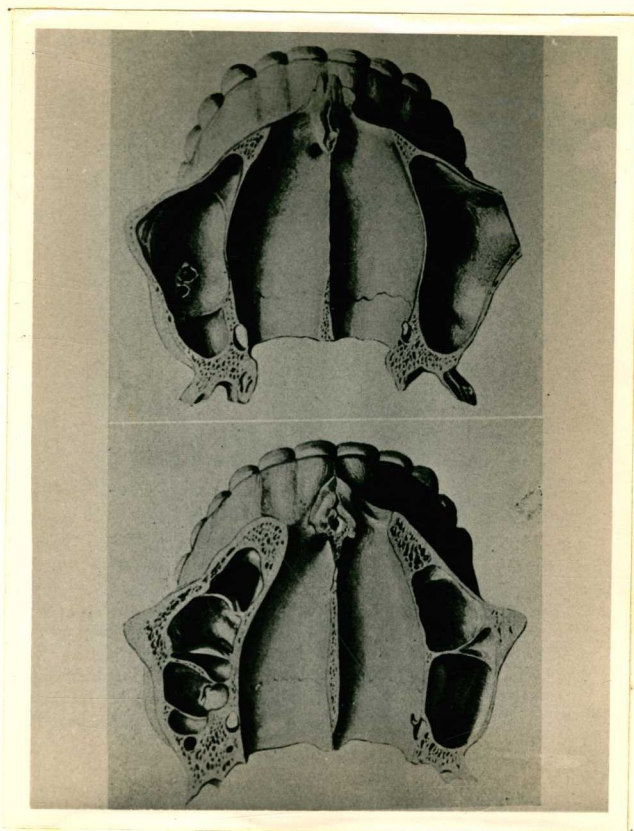
He emphasises the tuberosity extension which he mentions, is common and surgically important as the walls

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of the maxillary tuberosity become thin and there is a likelihood of fracture of the process during the removal of the third molar. Because of this fact Sicher condemns distal force with an elevator.

Compartmentation of the Sinus: Internally the cavity is not smooth and flat walled, but has ridges, projections and septa (Schaeffer) which tend to form pockets and recesses of varying depths, placed either buccolingually or mesiodistally. In an examination of 120 cases Schaeffer found that 58 cases showed minor ridges and large crescentic projections. Schaeffer attributes their presence to uneven resorption of bone during sinus development.

Sicher describes sickle-shaped partitions of the alveolar recess of the sinus. Occasionally these projections are replaced by septa completely dividing the sinus into two separate compartments, not communicating with each other, but having separate openings into the nasal fossa. Zucherhandle, Bruhl and Gruber are quoted by Schaeffer as recording unilateral duplication - Glass (1952) maintains that this is very rare. According to Schaeffer accessory sinuses are more often posterior ethmoidal cells, which have extended beyond their normal boundaries into the body of the maxilla. This view is supported by Glass. This compartmentation of the cavity is significant as it may prevent successful



TRANSVERSE BONY SEPTA WITH ROOT
ENDS PROJECTING INTO THE SINUS

AFTER SICHER



RADIOGRAPHIC APPEARANCE OF SINUS SEPTA

AFTER STAFNE

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irrigation of the sinus, and aggravate inflammatory conditions, as secretions may accumulate in the recesses.

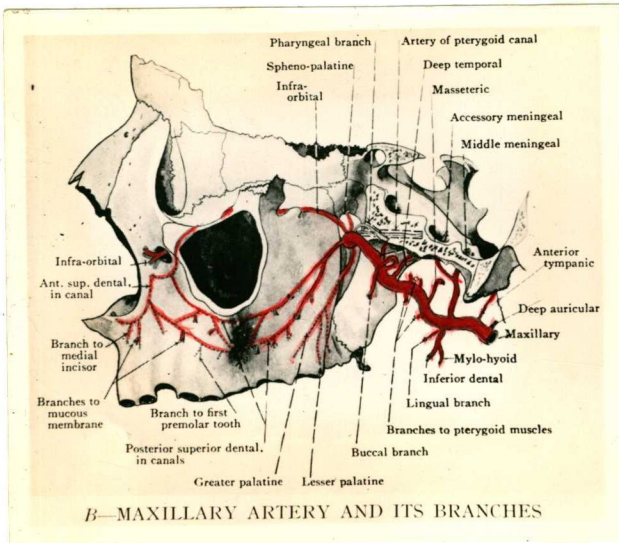
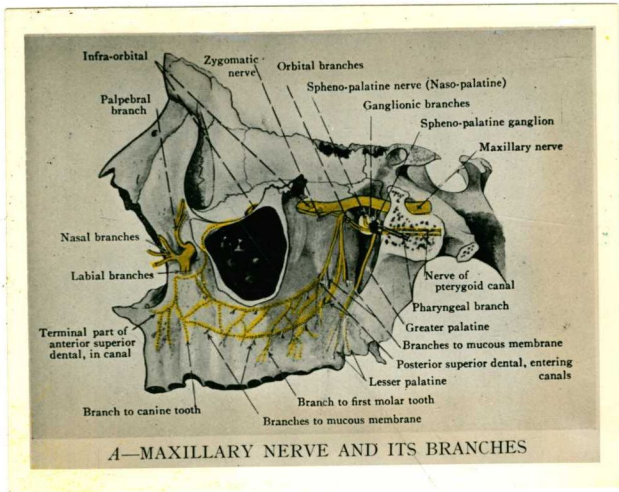
6. NERVE AND BLOOD SUPPLY

It is necessary not only to study the nerve supply to the sinus itself, but also to consider the position of the nerves and vessels which are in close relationship to the sinus walls as they pass downwards to the maxillary teeth. Surgical procedures are often responsible for the damage and destruction of the nerves which supply the incisor (more commonly) and the posterior teeth (Martensson). As stated earlier the infra-orbital canal passes through the roof of the sinus, and at times is covered only by mucous membrane.

Anatomists agree that the infra-orbital nerve releases three sets of branches as it passes through the infra-temporal fossa into the infra-orbital groove; and further anteriorly when the groove is covered to form the infra-orbital canal, from where the nerve emerges at the infra-orbital foramen. The branches are the superior alveolar (dental) nerves, anterior, middle and posterior.

(a) Anterior Superior Dental Nerve

Five to eight millimetres behind the infra-orbital foramen the anterior superior dental nerve leaves the inferior orbital nerve, runs at first downwards and laterally, and then curves medially and divides into two sets below the



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inferior orbital foramen (Sicher). One set runs downwards and medially to the region of the anterior nasal aperture; the other traverses down and back to reach the alveolar process in the vicinity of the cuspid. Twigs from the anterior superior dental nerve supply the sinus.

(b) Middle Superior Dental Nerve

The middle superior dental nerve is not always present; when so it comes down from the infra-orbital nerve in a narrow canal adjoining the sinus. It is often directly in the mucous membrane (Martensson). The mucosa of the sinus is also supplied by twigs from this nerve which continues to the bicuspid teeth. In its absence these teeth are supplied by the posterior superior dental nerve (Sicher).

The Posterior Superior Dental Nerve: This branch arises in the infra-temporal fossa and moves downwards to enter the posterior surface of the maxilla at about the centre. The nerve divides into smaller branches again, generally on the posterior surface and enters by a series of bony canals into the postero-lateral wall of the maxillary sinus. Twigs innervate the sinus mucosa and finally reach the base of the alveolar process to supply the molar teeth. According to Sicher sinus extensions may erode the narrow walls containing the nerves in the posterior and anterior wall of the sinus so that they are only covered by mucous

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membrane. Barnhill claims that one of the nerves may swing across the sinus like a rope in space - this is not confirmed by other authors. All three nerves form a common superior dental plexus above the apices of the roots of the maxillary teeth, and the mucosa of the sinus is supplied from twigs of all three. Negus adds that twigs from the sphenopalatine nerve entering through the ostium also play a part in supplying the sinus. Shapiro offers this close relationship of the alveolar nerves to the sinus walls as the explanation of referred pain to the teeth and face in inflammatory processes of the sinus.

Because of the effect of surgery on the maxillary sinus and the consequent damage to the facial wall of the maxilla, it is important to follow the innervation of the teeth or the termination of the superior dental plexus just described. Sicher, in a lucid description, states that the terminal branches of the superior alveolar nerves, accompanied by their corresponding arteries, emerge from the plexus in two sets.

The first set consists of the dental nerves, their number corresponding to the number of roots. Each dental nerve enters an apical foramen and branches in the dental pulp.

The second group comprises the interdental and inter-radicular nerves. The interdental nerve supplies branches

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to the periodontal membrane. These branches perforate the alveolar bone proper, and emerge to supply the interdental papillae and labial or buccal gingiva. The inter-radicular nerve courses the inter-radicular septum, and sends branches to the periodontal membrane of the bifurcation.

The Blood Supply of the Maxillary Teeth: These are supplied by the superior alveolar arteries, which are fine branches of the internal maxillary artery (Martensson, Sicher, Cunningham). These small arteries follow the same paths as the nerves described above.

Petren, quoted by Martensson, states that the intra-alveolar artery supplies the alveolar septum, the gingiva and periodontal tissues, whilst the dental artery enters the floor of the alveolus, thence to the pulp canal through the apical foramen.

Negus includes the sphenopalatine artery, fine branches of which enter the sinus through the ostium and supply it, together with irregular perforating branches.

In addition to detailed knowledge of the anatomy of the maxillary antrum, the paranasal air sinuses in their entirety must be recognised by the dental surgeon, since all have communication with the nasal cavity, and may therefore have a direct effect on the maxillary sinus itself. This will be considered in further detail in the succeeding chapters.

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CHAPTER TWO

By nature of their drainage rather than by anatomical position the paranasal air sinuses are divided into two groups:

(a) the anterior group comprising:

- (i) the frontal sinus
- (ii) the maxillary sinus
- (iii) the anterior ethmoidal cells

(b) the posterior group comprising:

- (i) the posterior ethmoidal cells
- (ii) the sphenoidal sinus

The anterior group drain into the middle meatus; and the posterior into the superior meatus and the sphenoethmoidal recess (Simson Hall, 1948).

In emphasising the variation of the maxillary sinus, Prendergrass et al (1958) state that it is more in keeping with the actual anatomy of the sinuses to approach them from the viewpoint of normal anatomic types and variations within the norm. They conclude that errors in diagnosis are less likely if the accent is not placed upon the normal sinus.

CHAPTER TWOEMBRYOLOGYSYNOPSIS

1. PRIMITIVE GERM LAYERS:
 - (a) Paranasal Sinuses
 - (b) Maxilla

2. DEVELOPMENTAL STAGES:
 - (a) Foetal Stage
 - (b) Childhood Stage

EMBRYOLOGY

1. PRIMITIVE GERM LAYERS

(a) Paranasal Sinuses: The lining of the paranasal sinuses normally develops from ectoderm (Hamilton et al., 1945 and Cunningham, 1943), an epithelial layer which is continuous laterally with the flattened amniotic ectoderm. Also derived from this germ layer are the epithelium of the mucous membrane and the glands of the vestibulum oris, the anterior part of the mouth and the nasal cavities. It is interesting to note that the lining of the remainder of the respiratory tract is derived from endoderm which forms the roof of the yolk sac in the early somite stages.

(b) The Maxilla: The maxilla itself is developed from mesoderm, being ossified in membrane in the wall of the oral cavity from one centre which appears in the sixth week, above the germ of the canine tooth. Ossification spreads rapidly in different directions to form the body of the bone and its processes. The infra-orbital nerve is at first placed considerably above the orbital surface of the maxilla (Cunningham), and comes in contact with it only in the second month by forming a groove on the bone. The groove is converted into the infra-orbital canal and foramen. In the early stages the alveolar part lies close below the infra-orbital groove. Later, however, they are separated by the maxillary sinus.

2. DEVELOPMENTAL STAGES

Schaeffer (1920) describes foetal, childhood and adult stages of the development of the sinus. For convenience the first two are included in this part, while the adult stage has been dealt with in the chapter entitled Anatomy.

(a) Foetal Stage: Primitive evagination or pouching of the mucous membrane of the floor or lateral wall of the ethmoidal infundibulum occurs on about the 70th day of foetal life. It is a slit-like cavity, but by simultaneous processes of resorption of the surrounding bone and growth of the maxillary pouch, the primitive cavity gains more capacity and "sinks" into the body of the maxilla.

The dimensions of the sinus at term are:

- | | | |
|--|-----|----------|
| (a) in ventro-dorsal plane approximately | ... | 7-8 mms. |
| (b) central plane | ... | 3-4 mms. |
| (c) height | ... | 4-6 mms. |

Extension of the cavity into the maxilla takes place "paraparsu with the growth of the face." Schaeffer makes the following observations:

(a) Duplication and extensive pouching of the primitive sinus is in accord with the adult conditions.

(b) Initial doubling of the maxillary sinus explains some of the duplication of the adult ostium, and in some instances fusion of the double maxillary pouch takes place distally, leaving points of initial outgrowth which become the duplicate ostium. This doubling of the primitive maxillary sinus pouch

may explain some of the rare adult maxillary sinuses, each with an independent ostium in communication with the infundibulum of the ethmoid.

Salinger (1946) in a review of the literature, cites Monti who studied the conformation of the lateral nasal wall to determine the embryonic origin of the sinus. He concludes that early formation of the sinuses is not due to the invagination of the nasal mucosa into the cartilaginous capsule of the primitive meatus, but to the invagination of the cartilage itself, where it terminates below at the level of the inferior turbinate. Here, it bends inwards in a line with the upper border of the turbinate with which it is directly continuous.

(b) Childhood Stage (birth to puberty): Prendergrass et al. state that the sinus is sufficiently advanced at birth to be of clinical importance, and is occasionally demonstrated radiographically. At birth it has the appearance of a slit-like recess, approximately 4 mms. above the nasal floor. However, Sicher states that it is an insignificant cavity the size of a pea. Schaeffer made a thorough study of a large number of still-born babies, and states that the size and shape vary considerably. He criticises measurements given by writers without stating the plane of measurement, leading to error and apparent discrepancy of results.

By the end of the first year the cavity has extended beneath the orbit, but not below the level of the infra-orbital canal. By the twentieth month it has extended ventro-dorsally to above the rudimentary first permanent molar tooth.

During the third and fourth years the sinus grows extensively in a medio-lateral plane (width). Jacobs explains that this rapid growth is due to the close relationship of the developing teeth to the orbit; while Schaeffer states that age, sinus growth and dentition proceed in proportion to each other; and Sicher maintains that the development of the primary and permanent dentitions is essential before sinus growth can proceed. It seems plain that until the teeth erupt and the alveolar process develops, there is no room for the sinus.

Jacobs explains development after birth thus: that pneumatisation following bone resorption is dependent on variation in air pressure, particularly expiration.

By the seventh year the measurements are:

(a) ventro-dorsally	...	27 mms.
(b) supero-inferiorly	...	17 mms.
(c) medio-laterally	...	18 mms.

The sinus develops downwards and backwards with the development of the permanent teeth at eight to nine years. It takes place at the same level as the nasal floor, and commences to penetrate the body of the zygoma. By the eleventh to twelfth

years the inferior meatus is enlarged and the sinus has grown sufficiently towards the alveolar process to be accessible for puncture in the usual adult site - the inferior meatus. Surgical approach endonasally or by the canine fossa must take into account the narrow transverse diameter of the sinus in the young age group (Schaeffer). The alveolar process is not fully pneumatized by the sinus until the eruption of the permanent teeth. Development ceases after the age of fifteen years, except for the postero-inferior angle which descends after the eruption of the third molar (Schaeffer, Jacobs).

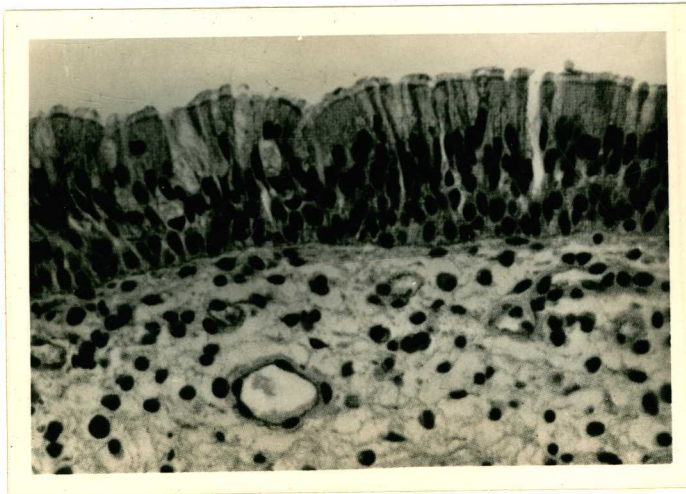
Developmental abnormalities of the maxillary sinus are not mentioned in the literature. Willis (1958) discusses the failure to fuse of the various parts of one or both of the maxillary processes, and the medial and lateral nasal portions of the fronto-nasal process. Apparently there is no detrimental effect on the maxillary sinuses.

CHAPTER THREE

HISTOLOGY

SYNOPSIS

1. THE EPITHELIUM
2. THE CILIA
3. MUCOUS SECRETION



PSEUDO-STRATIFIED CILIATED COLUMNAR
EPITHELIUM

HISTOLOGY

THE EPITHELIUM

The mucosa of the maxillary sinus is lined with respiratory epithelium similar to that of the nose, but containing fewer and smaller glands, (Maximow and Bloom, 1937).

The antral mucosa of the sinuses is very delicate and cannot be differentiated as a separate layer from the periosteum of the bones to which it is usually adherent. The epithelium itself is of the pseudostratified ciliated columnar type.

In this type of epithelium there is more than one layer of cells, all of which are not contacting the basement membrane (Schaeffer, 1943). The ciliated cells are usually columnar in shape, and instead of the ordinary striated border which is found in ordinary columnar epithelium (e.g. the intestines), the free surface here is surmounted by fine tapering filaments or cilia, which move spontaneously to and fro during life, and serve to produce a current in the fluid which is covering them (Schaeffer).

THE CILIA

The individual cilium is approximately 0.7μ long and $0.1 - 0.3\mu$ wide (Proetz, 1944). Each consists of a protoplasmic rod with the denser core when viewed under an electron microscope (Fawcett and Porter, 1954). "Each cilium contains longitudinal filaments in a cylindrical column of protoplasm which in turn is surrounded by membrane." In cross

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section nine pairs of filaments are arranged in a circle with a pair in the centre. The centrally paired cilia are in the same plane, which causes all of the cilia to bend in the same direction and not to strike one against the other. The filaments are thought to be contractile elements with active movements, both in the forward lashing stroke, and also on the less active return stroke. Each cilium rests on a basal capsule, anchored by rootlet fibrils. The number of cilia on a columnar epithelial cell only 5μ in diameter is between 150 and 200.

Below the epithelial layer is the *membrana propria*, which is usually of hyaline character, and is thickest on the medial surface, especially near the ostium. It has an abundant blood supply, some lymphatics, and numerous sensory and sympathetic nerve fibres. The *propria* layer provides space for the nutrient and sensory and lymphatic supply. It also binds the epithelium to the bony and cartilaginous retaining walls (Cowdry, 1950).

MUCOUS SECRETION

So essential for the proper functioning of the ciliated epithelium, it is supplied by:

- (a) the sero-mucinous glands of the submucosa, the ducts of which penetrate the *propria* layer (Cowdry).
- (b) the goblet cells of the epithelium, these are present in greater numbers than in the nose (Woodson, 1950),

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and are dispersed through the columnar epithelium, increasing in number when the mucosa becomes irritated (Eggston and Wolff).

(c) Bowmans and Racemose glands (Negus, 1958).

CHAPTER FOUR

PHYSIOLOGY

SYNOPSIS

1. PHYSIOLOGICAL ACTION OF THE CILIATED EPITHELIUM.
2. PHYSIOLOGICAL FUNCTION OF THE SINUS.

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PHYSIOLOGICAL ACTION OF THE CILIATED EPITHELIUM

By experiments involving the use of indigo-carmin and lamp-black, Thomson and Negus (1955), were able to follow the mucous and drainage pathways from the maxillary sinus. They found that the track passes along the upper part of the middle meatus, and then downwards in front of the Eustachian tube and into the nasopharynx, thence to the stomach by swallowing movements. Here the bacteria are destroyed by the gastric juices. The cilia are covered by a blanket of mucous, and drainage then takes place by means of spiral motions, converging at the ostium. At this point the deepest mucous layer passes into the middle meatus, and some of the superficial layer may slide back into the sinus cavity. The viscosity of the mucous is important as it must be sufficiently tenacious to adhere to foreign matter, but not over-viscous so as to clog and prevent adequate passage through the narrow ostium.

The passage of air through the nasal fossa, according to these writers, causes an exhaust effect, thereby assisting the cilia in drainage of the antrum. Proetz, however, states that while the blowing of the nose causes increased pressure in the sinus, and sniffing reduces it, suction to the nose is ineffective in removing secretions.

Negus gives a detailed and comprehensive account of the physiological aspect of the functions of the sinus. He

states, initially, that the functions of the cilia are:

(a) a cleansing function - almost all of the surfaces of the nasal fossae and the sinuses are protected by ciliary activity. The dragging action of the viscous covering of the mucous removes debris and bacteria.

(b) humidification - the moisture supplied by the various glands is distributed by ciliary action, and maintains the health of the nose, the sinuses and the lower respiratory tract. The cilia cease to function if the mucous membrane becomes dry, and it is the absence of air currents which causes evaporation of the surface of the moisture.

Factors Influencing Ciliary Activity:

(a) Atmospheric Changes: High altitudes or steam-heated rooms, for example, cause a greater need for the secretory functions, as the air is drier under these conditions. Temperature itself, however, unless it is extreme, has little effect on the ciliary functions.

(b) Osmotic Pressure: Solutions introduced into the sinus must be isotonic in order to maintain its normal functions. Hypertonic saline or distilled water inhibit activity.

Conditions which produce disordered functioning of the sinus are:

- (a) drying
- (b) irradiation

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- (c) swelling of the epithelium
- (d) mechanical obstruction

PHYSIOLOGICAL FUNCTION OF THE SINUS

According to St. Clair Thomson and Negus there is very little known positively on this subject, although several theories have been advanced. These are that the sinuses:

- (a) serve as resonating spaces for the nose.
- (b) serve for the secretion of the mucous.
- (c) assist to direct inspired air towards the olfactory region.
- (d) are vestigial accessory organs of the nose.
- (e) help to diminish the weight of the skull.
- (f) are residual organs primarily concerned with olfaction, and now serve to supply secretion.
- (g) may act as a non-conductor, maintaining the temperature of the blood in the nasal mucous membrane.

Bourgoyne (1948) also mentions points (a) and (e).

Proetz considers that the sinuses have been left as spaces between the tables of bones where downward and forward growth of the face has occurred for stronger jaws and increased breathing space.

Negus alone offers critical comments on the various functions of the sinus:

- (a) Phonation. The sinuses, by acting as resonators, modify the sounds produced by the glottis. Negus claims that

there is no relationship between presence or absence or size of the sinus and the voice. He bases his argument on his extensive studies of comparative anatomy. He states, for example, that the domestic cat which has a loud voice of extensive range, has no hollow sinuses. However, the giraffe, which is usually silent, has huge frontal sinuses. And again, man who has sinuses of variable sizes, does not seem to be affected by this variation.

(b) Conservation of Heat. Proetz suggests that the cavity might act as an insulator to prevent loss of heat from the nasal fossae. But Negus points out that this would be far more effectively achieved by large maxillary turbinal bodies filling the anterior part of the snout (as in the rabbit), than by hollow air spaces.

(c) Respiratory Exchange of Air. This exchange, through the sinus, providing a supply of warmth to the air stream, is not feasible, according to Negus. The narrow ostium prevents a current of air in and out of the sinus, and except in rare cases, the presence of only one ostium precludes the possibility of air circulating to any great extent, although there is a very slight exchange of air from the sinus. This view is confirmed by Proetz. Davis (1950) maintains that a rise and fall in pressure in the nasal cavity during respirations causes a synchronising rise and fall in pressure within the antrum. Admittedly this is obvious when viewing an antral perforation during surgery.

(d) Lightening of the Skull. It is thought by many that the sinuses have been designed to reduce the weight of the cranium and the work of the neck muscles. According to Negus this is fallacious reasoning. He writes: "Because the skull would be heavier if the sinuses contained bone it does not follow that they have been purposely evolved to lighten the skull." In supporting this argument he points out that all primates except man have a forward and slouching attitude, whereas man of course is upright; and perhaps more important still, modern man has his head more or less balanced on occipital condyles instead of at its posterior extremity as do most quadrupeds. The latter, unlike man, have muscles to hold the head in all positions. Negus further emphasises his argument with this statement: "If the sinuses served no other useful purpose than supposed reduction of weight, then the obvious alternative would be the apposition of two tables of bone that form their walls: for example, baboons who eliminated the necessity of the maxillary sinuses by incurving the cheeks."

It is the conclusion of both Negus and Proetz that the sinuses appear to be nothing but unoccupied and unwanted spaces which are present merely as the result of chance. It is one of the ironies of nature that a seemingly superfluous anatomical entity should be susceptible to inflammatory

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disturbances, thus assigning to it a clinical importance which by nature is not justified.

CHAPTER FIVE

INFLAMMATION

SYNOPSIS

1. PREDISPOSING CAUSES OF SINUSITIS
 - (A) Non-odontogenic
 - (B) Odontogenic
2. FORMS OF SINUSITIS
 - (A) Acute Sinusitis
 - (i) Bacteriological Considerations
 - (ii) Histopathology
 - (iii) Signs and Symptoms
 - (B) Chronic Sinusitis
 - (i) Predisposing Causes
 - (ii) Histopathological Types
 - (iii) Signs and Symptoms
 - (C) Allergic Sinusitis
3. DIAGNOSIS
 - (A) Diagnostic Tests
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4. COMPLICATIONS
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1. PREDISPOSING CAUSES OF MAXILLARY SINUS INFECTION

(A) Non-odontogenic Causes: Hutchinson states that any condition which interferes with the free passage of air renders the sinuses liable to infection.

(i) The most common cause of sinusitis is acute rhinitis (Cecil and Loeb, 1953). However, infections of the lower respiratory tract where the nasal chambers are sprayed by coughed-up pus, may in time produce sinus infection (Prendergrass et al). Thoma (1954) states that infectious diseases such as Scarlet Fever also predispose to sinusitis. Cecil and Loeb say that sinusitis is often a complication of the exanthemata in children, and this is confirmed by Hutchinson, who adds that the condition is aggravated by extensive nose-blowing.

(ii) Sinusitis may result from direct infection during swimming and diving (Cecil and Loeb, Davis).

(iii) Hutchinson includes anatomical abnormalities, such as a deflected nasal septum, which narrows the nasal passage in the region of the middle meatus. Then an accumulation of secretions causes an early blockage of the ostium. Davis names as associated factors:

- (a) overhanging ethmoid bulla.
- (b) high uncinate process.
- (c) small ostium.

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(iv) Infection from other sinuses can be a cause, because, as stated in a previous chapter the accessory nasal sinuses drain into the nasal cavity, so that infection can spread from the frontal and other sinuses. In this regard Shapiro states that a collection of pus from the frontal and ethmoidal sinuses occurs in the middle meatus, into which the maxillary sinus opens.

(v) Osteomyelitis of the Maxilla: According to Hutchinson children are more commonly affected; whilst Bauer (1943) states that the sinus membrane constitutes an efficient barrier against this destructive process, but because of the large number of cavities in the maxilla which weaken the resistance of the bone, once the lining membrane becomes infected the route for the spreading of the condition is open. Cecil and Loeb hold that this condition constitutes a complication of sinus disease rather than a cause, and can be produced by trauma and sinus surgery.

(vi) Allergy is a most important predisposing factor to infection. According to Harrison (1954) allergic reactions, with one or two exceptions, are immunological processes, and occur as a result of contact between a foreign substance called the allergen, and a specific antibody to it. This antibody is induced by repeated exposures to the allergen and resides in tissue cells.

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Swinberne (1951) states that the mere existence of the allergic state does not in itself constitute disease; however, the biochemical products released when antigen and sensitised tissue cells unite, does constitute disease.

Any organ or mesenchymal cell may be affected by this condition, the respiratory tract being one of the commonest sites. Because of the inhaled antigen - e.g. dust, pollen, fumes, gases - contacting the surface of the nasal passages and accessory nasal sinuses first, these areas become sensitised, and the greatest concentration of specific antibodies occurs here. Swinberne names these "shock tissues". The allergic forms of sinusitis will be considered in more detail later in this chapter.

(B) Odontogenic Causes: These are of great significance to the dental surgeon, and although these are not among the most common causes of sinus infections, they must be readily diagnosed and treated when they are present. One not infrequently sees sinus treatment prolonged, when the cause, dental in origin, is overlooked by the rhinologist. Flemming (1953) enumerates odontogenic infection as follows:

- (i) Infection by way of the pulp canal produced by the untreated infected tooth.
- (ii) Periodontal disease via the periodontal membrane.
- (iii) Residual osteitis or cystic areas which have become infected.

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(iv) Infection following trauma to the teeth and supporting structures.

(v) Trauma constitutes a most important predisposing cause of sinus infection, from the aspects of:

(a) fractures of the maxillae.

(b) damage to the sinus wall from surgical procedures, or mishaps during exodontia.

Both these factors will be discussed more fully later.

(vi) Berger (1939) includes the anatomic relation of the roots of the maxillary teeth as a predisposing cause, but states that the periodontal pocket would have to extend beyond the root to involve the sinus. He mentions cysts and granulomas which, being structurally circumscribed, give some protection to the surrounding bone. He describes them as invaginating the approximating sinus wall without actually perforating the antral membrane. Larger cysts may become continuous with the sinus membrane.

Incidence: Thoma states that sinusitis is frequently of dental origin, whilst Hutchinson estimates that there is a 12% incidence following acute and chronic periapical infection. Even when radiographically negative the devitalised tooth is a potential source of infection when in close proximity to the antral floor.

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Thoma cites Brophy in claiming an incidence of 75% dental causes. This seems to be an exaggerated view in light of present knowledge. Bourgoyne also makes this exaggerated claim. Flemming states that dental infection is not the chief factor in up to 20-30% of cases.

Infection of the maxillary sinus, according to Thoma again, either from an infected tooth or from perforation of the antrum during exodontia, occurs in both the acute and chronic forms. Hempstead (1939), in a review of 385 cases of chronic maxillary sinusitis, found that many of the patients were able to trace the cause of infection as being dental in origin. In 22.5% sinusitis occurred after removal of abscessed molars. Martensson (1952), from a study of 1792 cases over a ten-year period, reports 12.4% from dental aetiology. Of the 223 cases due to dental pathology, 42% were caused by apical abscesses, and 27% by oro-antral fistulas following complicated extractions.

Cooksey and Middleton (1959) say that sinus perforation from periapical infection is very rare, but drainage occurs through a sinus, through the alveolar bone, and into the vestibule. Thoma (1947) supports this statement. Cooksey and Middleton illustrate a unique case where periapical infection arising from a maxillary first molar formed an antro-dento-facial fistula. The patient had consulted a plastic surgeon

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for what appeared to be a sebaceous cyst on the cheek. Repeated excision resulted in a recurrence of the condition. Dental examination and x-ray revealed a small radiolucent area around the apex of the first molar; and large x-rays of the sinus demonstrated opacity in the sinus on that side. This case is cited to emphasise the previously stated conclusion, namely that because there is a relation between the tooth and sinus infection, it is essential clinically to investigate these possibilities before a diagnosis can be made with confidence.

2. FORMS OF SINUSITIS

(A) Acute Sinusitis: This condition, the causes of which have been discussed, occurs when there is an acute inflammation of the lining membrane of the sinus cavity. However, because of the relatively larger size of the maxillary sinus and the opportunity which exists, therefore, for resolution to take place, acute maxillary sinusitis is less frequently encountered than in the other sinuses (Simson Hall).

(1) Bacteriological Considerations: Salinger claims that acute suppurative maxillary sinusitis is due to anaerobic streptococcus. The writer cites Björkwall who states that the anaerobes are present in foul smelling pus, but mostly haemolytic streptococci are present in sinusitis with purulent discharge. Both writers make the point that the healthy

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sinus is sterile, and even with mucoid discharge few pathogens are present.

Stones (1948) states that the mucous secretion of the glands of the mucosa is bactericidal and bacteriostatic. As a result of this and the mechanical action of the ciliated epithelium, the maxillary sinus is normally sterile.

Different types of organisms have been found either in pure or mixed culture:

- (a) staphylococcal aureus or (rarely) staphylococcal albus,
- (b) haemolytic and non-haemolytic types of streptococci and also pneumococcal strains,
- (c) neisseria catarrhalis is often present after coryza in children,
- (d) bacillus alkaligenes bronchiosepticus and other species of the genus alkaligenes have been reported.

(ii) Histopathology: According to Thoma in many cases of acute sinusitis there is only localised inflammatory oedema of the sinus membrane, without serous or purulent exudate. Coryza or an ordinary cold may cause such changes. Until the septic dental focus, if present, is removed, however, the condition may resist treatment. In other instances, acute sinusitis occurs with a purulent discharge. The usual features of acute inflammation occur; more specifically the membrane of

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the sinus becomes hyperaemic, with occasional haemorrhages into the submucosa which becomes oedematous with the membrane sometimes filling the entire cavity. There is marked leucocytic infiltration with localised abscesses forming.

The purulent discharge fills the space not occupied by the swollen membrane. Simson Hall states that initially there is increased ciliary activity, but later as infection becomes more established ciliary action becomes ineffective and the cilia may be destroyed.

Thickening of the sinus membrane, mentioned by Thoma, occurs to such an extent in some cases that the entire cavity may be filled with oedematous membrane. In cases of long standing suppuration the mucous membrane may be similar to granulation tissue, and organisms are found in the submucous tissues or in the bone. At times, all the paranasal air sinuses on one or both sides may be affected - this condition is known as pan-sinusitis.

Swinberne outlines the stages by which suppuration is reached:

- (a) Ischaemia,
- (b) Hyperaemia,
- (c) Extravasation of serum and exudation,
- (d) Increased mucous secretion from seromucinous glands in the submucosa, and from the epithelium

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itself, shown by the appearance of numerous goblet cells,

- (e) Mucous membrane becomes oedematous and polymorphs appear between the epithelial cells,
- (f) Surface cells become loose and are detached, epithelial cell loss being proportional to the degree of infection,
- (g) The mucosal swelling interferes with the natural drainage of exudate from the sinus, by occlusion of its ostium, leading to the retention of purulent secretion, with its associated complications.

Dimond divides acute sinusitis as follows:

- (a) acute catarrhal sinusitis associated with a common cold,
- (b) acute purulent sinusitis, frank pus replacing mucoid secretion,
- (c) acute allergic sinusitis with a straw coloured exudate.

(iii) Signs and Symptoms

(a) Pain: Because the mucous membrane of the nasal passages and accessory nasal sinuses is innervated by the trigeminal nerve, the pain of sinus infection is most commonly referred to the area of its distribution. Maxillary sinus pain is usually localised over the affected sinus. There is

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a throbbing sensation in the cheek and a fullness below the eye on the side affected (Simson Hall). The region just lateral to the alae-nasi is frequently tender, and also posteriorly in the maxillary tuberosity area. Pain may be referred to the ear, opiates giving no relief (Thoma).

The pain is more superficial than that of ethmoidal and sphenoidal sinus infections, and the relief of the condition occurs with the subsiding of the inflammation or drainage of secretion through the ostium. It is influenced by posture, being more severe when the head is lowered, as pressure is built up; and relieved by lying down. Jarring on the heels also aggravates the pain. Couch (1956) describes the pain as persistent, dull and pulsating. Needless to say the maxillary teeth may be quite tender and painful to percussion, and this is often the first clinical sign (Shanasy, 1949).

As regards tooth pain Martensson states that the pain is usually referred to the molar teeth. It is interesting to note that studies by this writer reveal that neither in chronic or acute sinusitis, not surgically treated, is there any disparity of threshold response between the teeth of the involved and those of the healthy side.

(b) Unpleasant odour in the nose.

(c) There are general symptoms of headaches, chills, fever, nausea and malaise (Thoma). However, as these symptoms

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arise with every acute infective process, especially in the more advanced stages, they can hardly be classed as diagnostic of this condition.

(B) Chronic Sinusitis: Unlike the acute condition, chronic sinusitis develops gradually without the obvious symptoms (Thoma). Simson Hall describes an insidious onset, and says that extreme awareness is necessary to diagnose this condition.

Swinberne lists predisposing causes as following:

- (i) hypertrophied adenoid tissue
- (ii) chemical irritation
- (iii) constitutional disturbances such as renal disease, cardio-vascular disease, hepatic lesion and diabetic diathesis.

The exciting cause appears to follow incomplete resolution of the acute stage, where damage caused to the mucous membrane has destroyed ciliary function, and the lining assumes a thickened or polypoid nature (Simson Hall). Swinberne states that it follows a latent low-grade sinus infection, the cause of which as previously stated may be dental or nasal in origin.

Histopathology of Chronic Sinusitis: Swinberne discusses in some detail various forms of chronic sinusitis, depending on the varying histopathological pictures.

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(i) Simple Chronic: This is characterised by:

- (a) catarrhal inflammation,
- (b) serous secretion with an increase in goblet cells,
- (c) swelling and bogginess of the epithelium, and sub-epithelial tissues.

(ii) Chronic Hypertrophic: This is an end stage of simple chronic, where the long standing inflammation has caused an increase in the fixed tissue elements in the sub-mucosa and epithelium.

(iii) Chronic Purulent: In this case a purulent secretion issues from the ostium, and in the writer's opinion sub-acute seems a more appropriate term than chronic purulent. Here, a metaplasia takes place in the pseudo-stratified ciliated columnar epithelium to stratified columnar or even squamous. In addition, there is a large number of actively secreting goblet cells and round cell infiltration of the epithelial layer. An increase of glands in the sub-mucosa leads to cystic changes due to the blocking of the ducts. Swinberne classified under chronic purulent the following:

(a) Polypoid Type: Polyps or localised oedematous areas of a hypertrophied mucous membrane occur. These may be sessile or pedunculated, jelly or grape-like masses covered by ciliated columnar epithelium.

(b) Sclerosing or Fibrotic Type: Here a varying degree of fibrosis occurs in the tunica propria.

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(c) Glandular or Adenomatous Type: Here there is an increase in glandular tissue - seromucinous glands.

(d) Papillary Type: This is reported to be a rare condition by Eggston and Wolff, usually confined to the maxillary sinus. There is a capillary cauliflower-like growth of the surface epithelium, and the cellular proliferation extends deep into the tunica propria. However, the basal cell layer remains intact. The writers state that an incorrect diagnosis of malignancy has been made for this condition.

(e) Atrophic Type (synonyms are ozoena, rhinitus sica): This condition is reported to occur to a lesser extent in the sinus than in the nose. It is characterised by offensive-smelling crusts, and follows a break-down of ciliary activity, and crusts form from dried-out secretion.

(iii) Signs and Symptoms:

(a) An indefinite neuralgia or sometimes no pain at all, according to Simson Hall, who further states that pain referable directly to the sinus is extremely rare in the chronic form, and the condition is manifested more as a heaviness in the affected part of the face.

(b) There is an unpleasant odour in the nose, due to a periodic purulent discharge which is frequently foetid when the condition is due to dental infection.

(c) A nasal drip of pus or a polyp extruding from the ostium or lying in the middle meatus. However, as the

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dental surgeon is neither equipped nor experienced in the examination of the nasal fossae the patient may be questioned as to the existence of a post-nasal discharge, or the naso-pharynx may be examined for same.

(d) There are general signs and symptoms, when the patient may complain of frequent head colds and their tardy resolution; and there may be a history of fever and toxaemia. (Ballenger and Ballenger, 1957). Poor general health and loss of appetite are factors which may initiate the investigation.

(C) Allergic Sinusitis: As previously stated allergy is a common cause of sinus inflammation. It must be understood, however, that clinically there is no differentiation between a sinusitis of an allergic nature and one due to other causes.

Histopathology of Allergic Sinusitis: Here the condition is unique by virtue of the following:

(a) There is a bluish-grey boggy appearance of the oedematous mucous membrane, and frequently that of the nose, the naso-pharynx and the conjunctival sac have a similar appearance.

(b) The condition may be reversible, as contact with the antigen is stopped, or otherwise a tissue hyperplasia appears with eventual polyposis.

(c) Eosinophils infiltrate the basement membrane and granular layer, most of the oedema occurring in this layer (Swinberne).

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(d) Superimposed infection by secondary bacterial invasion produces a red and engorged mucosa, and a serous discharge changes to a purulent discharge (Swinberne).

3. DIAGNOSIS OF MAXILLARY SINUSITIS

Apart from observing the clinical signs and symptoms there are various diagnostic tests which may be employed to confirm the diagnosis.

(1) Transillumination: It is felt that the inclusion of this diagnostic test at the head of the list is justified because it may be carried out quickly and effectively in the surgeon's own rooms, and further investigations often depend upon its results. This method provides a convenient way of demonstrating inflammation of one or both antra. A bright electric bulb is placed in the patient's mouth in a completely darkened room. Holding the light in the midline, the patient's lips are closed and the light shines through the facial bones equally on both sides, showing a crescent of light under each eye in the normal case. In sinusitis, however, either with a swollen membrane or with mucous or purulent discharge in the cavity, there will be a diminution of light and thus a dullness corresponding to the affected sinus (Simson Hall; Blair and Ivy, 1951). It must, however, be remembered that this method is not completely reliable, as either one sinus may be smaller in size as compared with the other, or one antral wall may be

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thicker than the other. Thoma states, however, that with a negative transillumination there is probably no serious sinus infection. Bourgoyne's claim that transillumination will reveal masses of polypoid tissue by the dark-appearing side is misleading, as the difference in light intensity may arise from many other causes.

(ii) Posture Test: While this is a simple means of diagnosis to the rhinologist, it is hardly suitable for the dental surgeon. Pus is wiped away from the middle meatus and the patient is asked to lower his head, so that the ostium of the affected sinus is in the lowest part. After a few minutes the middle meatus is again examined, and if pus is present this is evidence that there is a purulent collection in the maxillary sinus (Simson Hall).

(iii) Diagnostic Proof Puncture: This is frequently carried out by the rhinologist to determine the contents of the sinus. A trocar is inserted through the anterior and lateral wall of the nose, about one inch behind the anterior end of the turbinate. The trocar is pressed inwards, until it impinges upon the posterior wall of the sinus, when it is withdrawn and removed, leaving the cannula in place. The contents of the sinus can then be aspirated, and sensitivity tests can be carried out if purulent material is present (Simson Hall).

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(iv) Radiographic Examination: This is indispensable for the accurate diagnosis of sinus infection, and to help verify whether its source rises from dental infection.

Due to the irregularity and convolutions of the sinus it is at times difficult to distinguish what may be an unusual radiographic appearance from true pathology. The difficulty is also increased as the sinus membrane may be radiographically transposed over the roots of the maxillary teeth, making them appear to be actually projecting into the sinus, when in many cases this illusion is due to faulty x-ray techniques. Wakefield (1950) mentions some precautions to be observed when taking intra-oral x-rays of the maxillary teeth. These precautions are concerned with the position of the tube:

(a) When too vertical there is a greater transposition of structures and a foreshortening of the teeth. The film appears very radiolucent as the rays have passed through the zygoma, often hollowed out by the sinus cavity, through to the thin compact palatal bone.

(b) When the tube is too horizontal the rays must pass through the entire thickness of the buccal bone, and a very radio-opaque picture is produced as well as elongating the teeth. Petersen (1956) states that the most accurate x-rays of the maxillary sinus region are made with the lowest practicable inclination of the rays, these being almost perpendicular to the long axis of the tooth. The maxillary

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sinus, he points out, changes its position on the film, according to the point where the x-rays are tangential to the upward slope of the sinus wall. Kerr et al. (1959) name the anatomical landmarks which must be recognised.

Firstly, there are the sinus septa, which appear as radio-opaque lines dividing the sinus. A "Y" is formed where the anterior part of the maxillary sinus separates from the nasal cavity in the cuspid region, and this must not be confused with a maxillary cyst to be discussed later.

Secondly, the zygoma which appears as a "U" shaped radio-opaque band in the first molar region, and is frequently superimposed on the roots of the maxillary teeth. With the head vertical and the central ray close to the horizontal, this superimposition can be reduced to a minimum.

Thirdly, the coronoid process, particularly when the mouth is wide open appears as a finger-like projection at the lower part of the film in the second molar region.

Finally, the hamulus of the medial pterygoid plate can be seen as a small projection posterior to the maxillary tuberosity.

Extra Oral Radiographic Diagnosis: Thoma rates x-rays as the most reliable guide, claiming that even slightly abnormal linings can be diagnosed by x-ray. Not only is it essential for the dental surgeon to be able to interpret x-ray films correctly, but he also needs to be familiar with

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the specific views required when radiographic investigation of the sinus is carried out. Only with experience together with the knowledge of the normal radiographic appearance can a degree of competence be obtained.

Ballenger states: "It is illogical to suppose that a diagnosis can be made from films alone ... which are essentially a shadow transposition of the differential densities of the bones of the skull as modified by certain diseases or conditions". Some of these conditions may be enumerated as follows:

- (a) age - determining size, shape and development,
- (b) sex - men, heavier and thicker bones of the face and skull,
- (c) asymmetry of the sinus,
- (d) altered mucous membrane, either from infection or as a result of surgery,
- (e) inflammation or suppuration of tissues adjacent to the sinus,
- (f) tumour formation,
- (g) angle of exposure - where the petrous temporal bone, the vertebrae or the base of the skull may be projected in line with the sinuses and obscure the correct reading. Because of this factor the position of the patient's head and the direction

of the film must be so related that this will not occur. When carrying out x-rays, views are taken to demonstrate the condition of all the paranasal sinuses.

X-Ray Views: Hutchinson mentions the following views as necessary for adequate investigation of the maxillary sinuses:

(a) Occipito-mental View: The orbito-meatal line makes an angle of fifteen degrees with the horizontal, the head being tilted backwards and the central ray $1\frac{1}{2}$ inches above the occipital protuberance. This would correspond with Water's Position where the head is placed with the chin resting on the table and the nose resting on a cork about one inch high. The sagittal plane is vertical and the antra are over the centre of the cassette. The central ray is vertical and emerges through the upper centrals. This view is important for investigating infection, cysts, tumours, fractures of the maxilla, malar and the zygomatic arch.

(b) Thirty degree Occipito-Mental View - here the head is placed in the same position, but the tube is angled down thirty degrees from the horizontal, the central ray passing through the point of the chin.

(c) True Lateral View - where the sagittal plane of the head is parallel with the Potter-Buckey diaphragm, and

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the central ray is horizontal and passes through the occlusal plane of the first upper molar. Hutchinson points out that the head must be erect, in order to demonstrate a fluid level if present.

(d) Submento-Vertical View - the head is extended backwards so that the vertex rests against the diaphragm, and the central ray passes at right angles to the orbito-meatal line, with the tube centred below the mental process of the mandible. This is more specifically for the sphenoidal sinus.

Schaeffer claims that Laminography is indispensable when surgical procedures become necessary in children.

Radiographic Interpretation: To assist in the correct interpretation of radiographic findings Thoma suggests that a comparison be made with the orbit on the same side and the maxillary sinus of the opposite side:

(1) Acute Sinusitis - the sinus has a ground glass appearance, and the swollen mucosa appears as a hazy rim around the periphery. The bony walls are not affected. Hutchinson states that at this stage the condition may return to normal. However, in a more advanced stage it may appear more dense and opaque with the bony walls showing signs of osteoporosis. There appears to be some disagreement regarding the decalcification of the bone, which is shown as a blurring or a lack of definition. Prendergrass et al. claim

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that this occurs in allergy, due to an increase in osteoclasts and widening of the medullary spaces. It represents merely resorption but not necrosis or caries. Dimond, as already stated, claims that there is little difference between the radiographic appearance of infection and allergy; but cites Hodgson who maintains that the hyperaemia of infectious sinusitis causes a degree of decalcification of the bony walls. Pus gives an evenly fogged appearance. Thoma concludes that it is very difficult to determine the character of inflammatory changes from an x-ray.

(ii) Chronic Sinusitis: Here the mucosa may be as opaque as the surrounding bone which in long continued irritation may show signs of sclerosis, and this may persist long after the infection has been controlled (Prendergrass et al.). Dimond states that the mucous membrane is thinner than in the acute stages, but more dense. The effusion which occurs if the ostium is occluded produces a homogeneous opacity (Hutchinson).

The following points are made by Ballenger:

(a) When sinusitis is of an allergic nature, generally changes appear radiographically in all the sinuses. When one sinus is affected, however, it is more likely to be due to infection.

(b) A fluid level is evidence of active disease.

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Polyps may present a spotted radio-opacity which may involve only the floor of the sinus (Thoma).

4. COMPLICATIONS

Extension of infection to neighbouring structures such as the eyes, ears, throat and nose, and the tracheo-bronchial tubes is commonly observed (Cecil and Loeb).

Thoma discusses upper respiratory tract infections caused by the spread of infection from the purulent discharge tracking down into the nasopharynx:

- (i) pharyngitis
- (ii) tracheitis
- (iii) bronchitis
- (iv) gastro-intestinal symptoms
- (v) secondary disease from toxæmia or metastatic infection
- (vi) secondary anaemia with moderate leucocytosis
- (vii) asthma is regarded by many rhinologists as a result of sinusitis
- (viii) retention of pus can cause otitis media when the normal function of the Eustachian tube is interfered with.
- (ix) osteomyelitis
- (x) septicaemia or pyaemia

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- (xi) retrobulbar phlegmons associated with optic neuritis (Bourgoyne, Thoma, Simson Hall).
- (xii) cavernous sinus thrombosis may occur from involvement of orbital veins and the backward spread of the septic thrombosis may cause thrombosis of the cavernous sinus.
- (xiii) meningitis - due to direct extension of the infective process into the meninges or to infective thrombosis of the venous channels which communicate with intracranial blood spaces. This applies more to frontal and ethmoidal infections.

Complications 4 - 13 are indeed rare, and it presents a rather distorted picture to state that they follow a maxillary sinus infection. It must be remembered that the maxillary sinus is only one entity in the network of paranasal sinuses which would all be affected (pansinusitis) to cause such distressing and serious complications.

Moreover the modern use of antibiotics has made these conditions, which were at one time not an unusual occurrence, something of a rarity in clinical medicine.

5. TREATMENT

When sinusitis is of dental origin it becomes the responsibility of the dental surgeon to recognise this fact, and to remove the offending tooth or other pathological cause. Apart from this however the treatment of sinusitis

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belongs in the main to the speciality of rhinology. Ideally, teamwork will provide the satisfactory treatment for the patient. The treatment of sinusitis, depending upon histopathological changes, may be surgical or medicinal.

(1) Acute Sinusitis: Swinberne recommends surgical drainage and lavage of the affected sinus to alleviate the clogged cilia. The non-purulent return from this procedure is utilised to carry out culture and sensitivity tests for the selection of the most effective antibiotic. Thoma adds that in all cases the dental cause, if any, should be removed and often when the offending tooth is extracted pus will drain from the socket. Irrigation through the socket wound with warm saline is suggested only if the ostium is patent. If not, irrigation should be abandoned until isotonic vasoconstricting nose drops and inhalations have reduced the mucosal swelling of the ostium. I am in agreement with Wakefield who contra-indicates surgical interference when the antrum is acutely inflamed. Rather the condition should be treated with antibiotic therapy and antral lavage. The removal of the infected focus can be achieved when the acute phase has passed.

Alfaro (1931) condemns the alveolar approach to antral lavage, claiming that it predisposes to oro-antral fistula, and should be only a method of necessity and not one of first

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choice. This view is strongly supported by Boyes Korkis (1958) who states that the tooth socket should be left alone, and that the surgeon should refrain from probing, curetting or irrigating through it. He prefers an intranasal polythene tube inserted via the inferior meatus for suction and not irrigation in cases of suppuration, and advises an acrylic plate which should be retained for ten days to cover the defect if present. Even Thoma places drainage by puncture in the nasoantral wall as the more reliable method. He describes the trocar cannular technique already discussed when dealing with proof puncture. However, he prefers irrigation with saline following the aspiration of the pus. Mead (1954) claims that the inferior meatus is the safest, easiest and surest way by which adequate drainage and effective irrigation can be carried out. He estimates that in 50% of cases lavage through the natural ostium is effective. However this technique can be very difficult as the ostium is extremely painful and often occluded as a result of the acute inflammatory process.

Diathermy, according to Swinberne, is beneficial only as an adjunct to the routine forms of treatment. However, its use in acute empyema alone, without measures to establish drainage, is futile if not dangerous, the immediate effect being an increase in tissue fluid and blood content, causing increased congestion.

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(ii) Chronic Sinusitis: Surgical intervention in chronic sinusitis depends upon the condition of the sinus membrane, changes in which are generally proportional to the duration of infection. It is indicated when polyposis and cystic degeneration of the mucous membrane have occurred, so that the diseased tissue be removed, thereby permitting a return to normal function. When the maxillary sinus infection is of dental origin and is confined within the sinus infection it is reasonable to anticipate complete cure by removing the oral focus and pathological tissues within the sinus itself (Berger, 1939). Berger also states that because a sinus undergoing repair after surgery is prone to infection and complications, conservative methods should be attempted before surgical intervention is undertaken.

The writer has very often seen that lavage and vasoconstrictive nose drops combined with effective antibiotic therapy have afforded a great improvement in the sinus condition, particularly when it is allergic in origin. In this case antihistamine therapy is also indicated. Miller (1958) claims that surgery should be performed only when conservative methods have failed.

When there is chronic suppuration of the sinus caused by an infected tooth, Blair and Ivy advise irrigation through the socket with solution of potassium permanganate, 1:4,000 daily until all signs of suppuration have disappeared; unless

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it should persist for from three to four weeks, when nasal drainage should be carried out. These remarks are certainly not in accordance with the accepted therapeutic measures. To continue with daily irrigation for three weeks through a tooth socket would almost certainly irritate the mucosal lining, and prevent healing of the alveolar tissues. This could well lead to reinfection from the mouth, and encourage fistula formation.

Surgical Procedure: Most authors describe the various surgical approaches which are intranasal or intraoral. Of interest to the oral surgeon is the intraoral approach to the maxillary sinus. Thoma (1958) discusses the Caldwell-Luc and Denker operations, both of which provide good access and visibility to the interior of the cavity. Two separate openings are made, one in the anterior wall to gain access to the sinus, and the other in the nasointral wall for drainage. Ballenger and Ballenger discuss the various surgical approaches to the maxillary sinus:

(i) Alveolar Approach: This was formerly a popular procedure, but it has been abandoned due to the danger of fistula formation. The sinus was entered by enlarging a tooth socket. Daily irrigations were carried out with a solution of warm saline and penicillin instillations.

(ii) Kuster Operation: In this case the anterior wall of the sinus is removed, usually limited to an area of thin

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bone in the canine fossa. The opening should be large enough to admit the index finger. An incision 1" - 1½" long is made to the labiogingival junction; the infected mucous membrane is removed and a gauze wick is inserted into the canine opening to prevent closure. When there is marked suppuration present, the cavity is irrigated daily and a wick of gauze introduced to promote the drainage. The gauze is removed when the acute condition has passed, and the labiogingival opening is allowed to close. This method is advocated by Arnott (1959) who suggests the use of a counter-irritant such as camphor, chloral hydrate, menthol and chloroform in equal parts, (by weight) if oedema is considerable. The saline lavage is also advised 48 hours after surgery, by use of a Higginson syringe through the flap. Two pints of saline should be washed through the sinus; and the lavage is repeated if necessary. However, routine daily lavage is contra-indicated. Discussing this method Mead suggests that the wound heals too quickly, before adequate drainage has taken place.

(iii) Caldwell-Luc: Thoma and Mead concur in selecting this as the most satisfactory method. It is similar to the Kuster method, but an additional opening is made in the naso-antral wall, through the inferior meatus, for drainage. The sinus is gauzed and the packing is brought out through the nose and removed on the first or second day. The incision

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in the canine fossa is closed at operation - according to Thoma the incision should be in the form of a "U", and designed so that it is larger than the window to be cut in the bone. It extends from the apex of the canine down to near the gingival margin and back to the second molar. The opening may be extended posteriorly if necessary, but great care should be taken to avoid the infra-orbital foramen, the nerves and vessels contained in the retracted flap, and the roots and blood supply to the adjacent teeth.

Examination of the sinus generally shows granulomatous tissue on the floor if an abscessed tooth was the cause of the sinusitis. This tissue may be removed by curettage. However Thoma advises removal of the membrane in toto if it is entirely thickened or hyperplastic or changed by cystic degeneration, or when polyposis has occurred. Haemorrhage, which may occur from the posterior wall is arrested by use of adrenalin gauze. Co-operation with the rhinologist is necessary for counter-drainage through the inferior meatus (Magnus and Halliday). Thoma suggests the use of a nasal rasp through the nostril introduced below the inferior turbinate; a more refined method is to cut the nasal mucosa on three sides, leaving it attached only at the floor of the nose so that it can be folded back into the antral cavity. A vaseline gauze pack is preferred as it can be easily

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removed. Thoma recommends the removal of the gauze at the end of the third post-operative day.

(iv) Denker Operation: This operation provides better access to the sinus (Mead). The junction of the anterior and nasal walls of the sinus is removed at its lower part - in other words the perforation in the canine fossa is extended medially to include the pyriform aperture, thereby removing part of the lower turbinate and making a common opening between the nose and sinus. Halliday follows a modified Denker approach and does not include the pyriform bony margin or removal of the lower turbinate. Thoma (1958) criticises the Denker approach on the grounds that it frequently interferes with the innervation of the teeth and destroys an important anatomic structure, i.e. the pyriform process.

(v) Canfield Method: This is an intranasal approach. An opening is made in the antero-inferior angle of the sinus, making it possible to inspect the greater part of the cavity by anterior rhinoscopy. This method does not provide the unobstructed view of the cavity as do the Caldwell-Luc and Denker operations.

Post-operative Considerations: As suggested by Thoma and others, these are as follows:

(1) Rest in bed, especially after general anaesthesia;

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although Arnott claims that regional anaesthesia in the form of a maxillary block is equally suitable.

- (ii) Replacement of fluids, if there was considerable blood loss during the operation.
- (iii) Cold application to the side of the face to prevent swelling.
- (iv) Sedation for pain.
- (v) Antibiotic therapy should be continued for at least three days following surgery; and it may be considered advisable to give one or two days antibiotic cover as well.

Mead offers some interesting points which would promote the prevention of maxillary sinus infection:

- (i) Periodic X-ray examination.
- (ii) Elimination of infected areas bordering the maxillary sinus.
- (iii) Careful study of the anatomic relation and forms of the teeth, root formation and any irregularities.
- (iv) The elimination of allergic factors.

CHAPTER SIXSPECIFIC INFECTIONS INVOLVING THE SINUSSYNOPSIS

1. TUBERCULOSIS
2. SYPHILIS
3. ASPERGILLOSIS
4. MUCORMYCOSIS

1. TUBERCULOSIS

Tuberculosis of the paranasal sinuses is rarely observed (Cecil and Loeb). Thomson and Negus state that a few cases only are described and the infection usually spreads to the sinus through the bony walls or from a neighbouring focus. Ingberg (1957) described thirty cases in the literature, twenty of which were prior to 1907 occurring in men usually in the maxillary and ethmoidal sinuses.

(i) Aetiology: The author claims that the disease is usually from haematogenous or lymphogenous pathogenesis, and usually the human strains of the bacillus are the cause.

(ii) Histopathology: The mucosa of the sinus undergoes polypoid thickening and the formation of granulomatous tissue, and sometimes small ulcerations.

(iii) Symptoms: Anosmia, nasal obstruction, epistaxis, nausea and vertigo.

2. SYPHILIS

This may occur in the form of syphilitic osteitis which may involve the sinus. Thomson and Negus report a case where malignant disease resembled tertiary syphilis. Cecil and Loeb state that gummatous lesions of the skeletal system develop in approximately 5% to 10% of patients with late syphilis, the most frequent sites being the naso-palatine bone, the tibia and skull. The syphilitic processes may involve the periostium, cortex or the medullary cavity.

3. ASPERGILLOSIS

According to Cecil and Loeb certain species of Aspergillosis, especially *Aspergillus Fumigatus*, produce inflammatory granulomatous lesions in the skin, the external ear, the vagina, the nasal sinuses, the orbit, the bronchi, the lungs and occasionally the bones and the meninges. Infection may be suspected from the greenish or brown colour of the discharges. Aspergilli are frequently secondary invaders, and the diagnosis should not be made exclusively on the appearance of the organism on culture, but mycelial forms should be demonstrated directly in the discharge. Thomson and Negus have recorded several cases affecting the maxillary sinus. However the aetiology of the conditions attending the growth of this particular fungus in the antral mucous membrane is not known.

4. MUCORMYCOSIS

This is a rare disease with clinical characteristics resembling those of Aspergillosis (Cecil and Loeb). It is caused by certain fungi (*rhizopus*), a common laboratory contaminant which is not ordinarily pathogenic (Faillo, 1959). It enters the nose and produces sinusitis, and the disease may give rise to the following complications:

- (i) Orbital cellulitis
- (ii) It may penetrate the arteries causing a massive thrombosis

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(iii) It may later invade the veins and the lymphatics.

Faillo (1959) states that so far the condition has occurred only in susceptible patients who suffer from uncontrolled diabetes or leukemia, or who have been over-treated with antibiotics or cortisone. He gives a case report in which invasion of the paranasal sinus occurred with later extension to the orbit. Features of the condition are:

- (i) Considerable necrosis and tissue destruction of the hard palate
- (ii) The maxillary sinus filled with foul, greenish necrotic substance at operation; thrombosis of large arteries noted on resection of the maxilla.

CHAPTER SEVENORO-ANTRAL FISTULASYNOPSIS

1. ROOTS FORCED INTO THE MAXILLARY SINUS
2. FRACTURES OF THE ALVEOLUS AND PERFORATION OF THE FLOOR OF THE SINUS
3. FISTULA FOLLOWING EXTRACTION OF A TOOTH INVOLVING THE SINUS
4. OTHER CAUSES
5. TREATMENT OF THE ACUTE FISTULA
6. TREATMENT OF THE CHRONIC FISTULA
7. ABNORMAL ERUPTION OF MAXILLARY TEETH
8. THE EFFECT OF SINUS SURGERY ON THE MAXILLARY TEETH

ORO-ANTRAL FISTULA

This condition most commonly occurs from sinus complications of exodontia which are:

- (i) Roots forced into the maxillary sinus.
- (ii) Fracture of the alveolus and perforation of the antral floor.
- (iii) Fistula following extraction of a tooth involving the sinus.

1. ROOTS FORCED INTO THE MAXILLARY SINUS

Owing to the proximity of the sinus to the apices of the posterior maxillary teeth, it is often impossible to avoid involvement; consequently the forcing of fractured roots or root apices into the sinus cavity is not an unusual occurrence. The treatment of the complication should resolve itself into the most efficient and speedy method of removing the foreign body, removing the fistula and restoring the sinus to a normal healthy condition. All efforts should be made to avoid a chronically infected sinus and fistula, the effects of which are often long-lasting and extremely distressing to the patient.

Commonly root-tips are fractured as the tooth is luxated during exodontia, and following slight manipulation they are moved from the alveolus to the antrum. I believe that this occurs after injudicious use of elevators which are used with an upward force in a narrow socket, often under conditions of poor visibility and access; and this, combined with ineffective

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leverage, results in the instrument forcing the root fragment through the very thin bony floor of the sinus, or in some cases where even this is deficient the muco-periosteum of the sinus is perforated, and the root apex disappears into the cavity. Once this has happened it is the operator's responsibility to recover it, or if he is not sufficiently skilled or experienced, to refer it to somebody competent to do so.

The time in which this is accomplished is all-important, and Clark (1955) states that the normal and intact antrum is sterile, unlike the oral cavity. Thus contamination of the sinus by surgical trauma or mishap can very quickly bring about a suppurative sinusitis. When the irritating effect of even dust or smoke on the ciliated columnar epithelium is observed, it is not difficult to comprehend the harmful consequences of a foreign body. Then with drainage occurring at the lowest part of the cavity fistula formation is the logical outcome.

Operative Procedures: According to Thoma (1958) it should be ascertained whether the root is actually in the antrum or has slipped between the outer wall of bone and the periosteum, not an infrequent occurrence in the case of first premolars, and the buccal roots of the first molars. Again, it may lie between the intact antral membrane and the bony floor, and surgical entry in these cases into the antrum would

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be for nothing (Cooksey et al., 1953). Thoma suggests several procedures, as preliminary methods of removing tooth roots from the maxillary sinus:

(a) The patient blows with the nostrils closed, and the perforation is carefully watched for the appearance of the root.

(b) By suction in the socket, especially if the root is only partly projecting into the perforation.

(c) Half-inch ribbon gauze may be packed through the socket into the antrum. It is then pulled out in one stroke, and this may remove the root by friction or by adhering to the gauze.

Mead makes some additional suggestions:

(a) The patient shakes the head in an attempt to dislodge the root.

(b) Irrigation of the sinus is carried out in an attempt to wash the fragment out through the perforation.

I am of the opinion that these procedures in the vast majority of cases serve little purpose, and indeed, especially when there are prominent bony septa which sometimes divide the sinus into small compartments, the root fragment may be lodged in a more inaccessible location. It may also become wedged high up in the bony ostium. A further disadvantage is that even though the operator is extremely careful and watches for the fragment to appear, it is often concealed by blood clot

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or become lodged in the soft tissues, or it may disappear down the aspirator usually held by an assistant; and a momentary shifting of the eyes, even to pick up an instrument, may cause the operator to be completely unaware of a change in location. Wakefield (1950) is opposed to irrigation on the grounds that it spreads infection and produces bogginess of the epithelium.

I am in agreement with the final method advocated by Thoma, where a muco-periosteal flap is reflected on the external surface of the jaw, and after the perforation is enlarged to give sufficient access, the root is seen and removed with an instrument. I would add that the anterior incision should extend into the labio-gingival fold superiorly, and along the distal edge of the cuspid tooth in the dental papilla inferiorly. By doing this, greater extension along the anterior wall of the sinus can be carried out if necessary. As will be readily seen, an unsatisfactory result would follow if this incision were made close to the site of perforation, and further access is required. This is in general agreement with Mead, who prefers direct vision of the field and an approach from above and the side, rather than through the tooth socket. This ensures an adequate covering of mucous membrane to avoid fistula formation.

Clark advises attempted removal through an enlarged socket if the root is immediately adjacent to the site of entry;

however it is very difficult to know the exact whereabouts of the tooth.

Holland (1948) is of the opinion that attempts to recover the root fragment by an enlargement of the socket should be discontinued, and this opening should be closed immediately; the root should then be removed by a Caldwell-Luc approach. This seems to be an unnecessary waste of time, and the advantages of lessened fistula risk are outweighed by the danger of increased likelihood of infection.

Wakefield states that the root should not be removed through the original point of entrance, and even if the socket is enlarged visibility and accessibility are still not achieved. This author approves a Caldwell-Luc approach, and in the main Cooksey et al. support this view.

Wakefield suggests:

- (a) The use of an antral sucker.
- (b) A loop-type curette, which is also helpful in exploring the antral floor.

Once the root has been removed from the sinus, the defect must be closed, and the flap margins closely approximated (Thoma). The larger the flap the more readily this can be done.

2. FRACTURE OF THE ALVEOLUS AND PERFORATION OF THE FLOOR OF THE SINUS

This generally occurs, according to Clark, if uncontrolled force is used to remove an upper molar, resting against an

extensive and thin-walled sinus. Should this occur the author advises that every effort should be made to conserve the bony framework of the sinus, provided that the blood supply is not destroyed, and Thoma advises that bone adhering to the periosteum should be carefully replaced and retained in position with sutures.

A fracture of the tuberosity may occur when there is extensive pneumatisation into this area, and excessive force is used for exodontia. Sicher (1949) claims that backward elevation of the maxillary third molar is contra-indicated, as fracture through the posterior wall of the maxilla may be the outcome. Since the tuberosity and bone over the maxillary third molar are part of the floor of the sinus, the removal of this area produces a perforation of appreciable size. Tearing the mucosa must be avoided, since all the available tissue is necessary for adequate closure. Thoma advises that an incision be made at once along the crest of the tuberosity extending forward well anteriorly, and a flap is extended to expose the fracture section. After all soft tissue is completely reflected the bone segment and involved teeth are removed. Debridement of the wound is carried out, and the gingival margins are trimmed so that their edges approximate neatly. The sutures are removed after ten days.

3. FISTULA FOLLOWING EXTRACTION OF A TOOTH INVOLVING THE SINUS

At times an oro-antral fistula results in spite of adequate surgical treatment of an extraction wound. Ballenger and

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Ballenger claim that in most instances the root is infected and an odiferous sinusitis results from a persistent oro-antral fistula through the socket. Generally speaking the causes are:

(a) Infection

(b) Packing of the socket with a drain or gauze after the floor of the sinus has been perforated during exodontia. In view of this fact it is surprising that both Bourgoyne and Fickling (1957) advocate the use of a gauze plug. Berger states that natural closure should be encouraged and not retarded or prevented by unnecessary packings into the tooth socket, as there may be the complication of these being carried into the sinus. Barton (1949) found opaque and non-opaque foreign bodies (gauze etc.) in eight out of twenty-nine cases of oro-antral fistula.

Signs and Symptoms:

(a) Escape of blood into the nostril.

(b) Escape of air from the tooth socket into the mouth.

(c) Frothy bleeding from the socket.

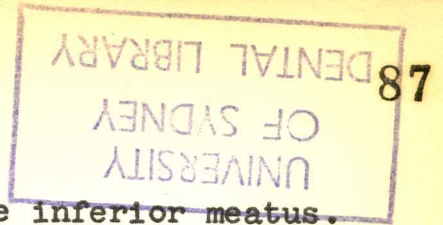
(d) Liquids taken into the mouth escape into the nostril.

(e) A sudden onset of an odiferous nasal discharge is characteristic as infection usually develops within 24-48 hours after extraction. The patient, according to Hargrove (1955), may return in seven to ten days complaining of a foul taste, and on examination pus can be seen discharging from

the fistula or in the floor of the socket.

Confirmation that a fistula is present is made by x-ray of the antrum, which may be opaque with or without a tooth remnant present. Hargrove suggests diagnosis by injecting thin lipiodol into the sinus by a cannula inserted into the inferior meatus. If the lipiodol does not run out through the fistula methylene blue may be used. Confirmation of diagnosis by probing should not be done at this stage. Although this would seem an effective method it hardly seems necessary in order to establish a diagnosis of fistula. Holding the nostrils of the patient who exerts moderate pressure in the nose is generally sufficient. In addition, x-rays and information afforded by the patient will assist in giving a true picture of the condition.

(f) In a large number of cases there will be a sinusitis on the affected side (Ballenger and Ballenger), and this to a great extent influences the treatment planned; for if sinus infection is eradicated first, this alone may permit the fistula to close if it is of fairly recent origin. Waller (1952) claims investigation of the sinus is the first requirement for successful treatment, notwithstanding Fickling's remarks that if the mucosal lining of the sinus is not normal it will return to the normal state after closure of the fistula. I am of the opinion that this happens only in very few cases. Lurie (1941) advises for this condition



antral lavage by perforation through the inferior meatus.

However, in long-standing chronic inflammations a Caldwell-Luc operation is necessary.

4. OTHER CAUSES OF ORO-ANTRAL FISTULA

(a) Defects due to trauma - gunshot wounds and dentures with suction caps.

(b) Defects resulting from syphilis. Ballenger and Ballenger name osteomyelitis and necrosis, especially in children.

(c) Defects due to excision of tumours of the maxilla, and of the maxillary floor of the sinus.

(d) Packing open of the maxillary sinus from an incision in the canine fossa in maxillary fractures to support the floor of the orbit.

Importance of X-Rays:

I am of the opinion that while sinus involvement is impossible to avoid at times, the vast majority of the sinus complications of exodontia could be avoided by the intelligent use of x-ray. If aberrant root formation is present, or if the palatal roots of the upper molars appear excessively long and in close relation to the sinus, or again if there are periapical areas of infection which destroy the intervening bone, attempts should not be made to exert undue force or to remove the tooth by forceps alone. A muco-periosteal flap should be raised, and some of the obstructing alveolar plate

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should be removed with suitable chisels, and the buccal roots sectioned above the trifurcation of the roots. The crown, with the palatal root intact, may very often be removed in toto, and the buccal roots may then be removed without difficulty. The extra time required for carrying out this procedure is more than justified by the elimination of widespread trauma.

Radiographic examination of the sinus is required to reveal the presence of roots and other foreign bodies. However particles of food and gauze remnants etc. may only be recovered on surgical exploration by the Caldwell-Luc method. Extra-oral rays are required to determine the condition of the sinus itself.

Post-operative Care

Herd (1950) suggests:

- (a) The patient should refrain from blowing his nose for two weeks.
- (b) Antibiotic therapy should be carried on for from three to five days.
- (c) Sutures should be removed after five days.

Thoma advises that irrigation is contra-indicated, and that vaso-constricting nose drops should be prescribed to facilitate the drainage of blood clots into the nose. I am of the opinion that the patient should be seen every day, and that trans-illumination of the sinus should be carried out to

indicate the progress of the condition.

Hargrove states that the oro-antral fistula may be either acute or chronic, and the treatment of the condition is determined to a large extent by the length of time that it has been present.

5. TREATMENT OF ACUTE ORO-ANTRAL FISTULA

Reading et al. (1955) state that traumatic rupture of the antral mucosa gives rise to bleeding and hence clot formation which, if undisturbed and uninfected, may serve as a temporary seal on which spontaneous healing of the fistula may occur. Hargrove considers that an antral fistula, up to fourteen days from inception, should be considered acute. Ideally, however, repair should be undertaken immediately after its creation or at least within 48 hours, according to Reading.

Primary suture of a small recent clean fistula presents no great technical difficulty, but every effort should be made to preserve the clot intact. Mobility of the soft parts can be gained by elevation of the gingival mucosa and by removal of the palatal bone with rongeurs, so that there will be no tension of the soft tissues. The region is protected by an acrylic denture. However every precaution must be taken so that the impression material is not forced into the sinus. There are numerous references in the literature to this undesirable complication, and Reading describes a hard core of impression material leading to a severe antritis until it was eventually discharged into the mouth.

Fortunately there is a strong tendency for the recent uncomplicated fistula to heal spontaneously; and probably many close before the patient finds it necessary to consult either the dental surgeon or the rhinologist. Reading et al. observed 46 fistulae after one week from their inception. Of these:

- (a) Eight closed with no special treatment.
- (b) Twenty closed after simple suture of the gingival defect.
- (c) Eighteen required more extensive treatment.

In reference to point (b), I am of the opinion that this method is generally of little help, once a fistula is evident. There should first be purely supportive therapy aimed on the one hand at clearing the sinus, and on the other at protecting the alveolar opening; if this proves unsuccessful then a more extensive surgical approach is necessary. Compromise usually results in breakdown if the fistula has been established for any length of time.

Fickling is of the opinion that whether the fistula will heal without surgery depends on the width, depth and the original state of the sinus mucosa, rather than on the site or irrigation. This is a very debatable point, and the consensus of opinion is that the fistula is more likely to develop into a chronic state if continued irrigations of the sinus are carried out through the tooth socket.

6. TREATMENT OF THE CHRONIC ORA-ANTRAL FISTULA

This condition takes place after six months, according to Wallner (1952); yet Berger states that if the fistula has not closed within three to four weeks, surgery is generally required to effect a closure. Hargrove, Reading et al. in the main support this view. The condition occurs when an epithelialised tract forms through the alveolus to the sinus, which is usually chronically infected by anoerobic bacteria with a localised osteitis about the margins of the bony openings. The floor and area adjoining the fistula are sometimes covered by polypi and sometimes denuded of epithelium, and covered with sessile vascular granulations (Reading et al). An important feature in the clinical and pathological picture, according to these authors, is prolapse of the sinus mucosa into and through the fistula. For some days or weeks after the extraction, surgeon and patient may be quite unaware that anything is amiss beyond a delay in healing, until a swelling begins to protrude through the socket, and there appears an oedematous flaccid jelly-like mass, red to pink in colour. Reading et al. think that a mistaken diagnosis of malignancy could be made.

However, the previous history and the fact that it can be pressed back into the antrum, often liberating a flow of pus from the depth of the socket, serve to differentiate it from a new growth. These authors describe this phenomenon

as a herniation of the soft tissue lining of the antral floor. They state that the less it is damaged the better the prospects of closing the fistula, as it is capable of returning to normal structure and function and may be of value in closing the defect.

In general, treatment consists of eliminating sinus infection, and then closing the fistula by surgery.

Fundamentals Applying to all Techniques

(a) The flap must have a broad base to assure adequate blood supply and it must be freely mobilised to prevent tension.

(b) All poor tissue such as epithelialised granulation and scar tissue, is removed and the opposing edges freshened. However, all tissue of sound texture is preserved.

(c) All bone which promotes tension of the flap is reduced; a flap which is only just loose at the time of operation may become taut due to oedema or cicatricial contraction.

(d) Trauma and maceration of tissue will prevent primary union.

(e) Sutures must maintain relationship of the edges for primary healing to occur.

Reading et al. point out that it is customary in papers devoted to the repair of oro-antral fistulae to describe certain classical methods. For instance the soft tissues

needed for the repair may be derived from the hard palate, from the buccal mucosa or from a combination of both sources. Most of the procedures described in the literature have been evolved by surgeons of imagination and dexterity under the spur of technical difficulty. The tendency is for techniques to be copied from paper to paper and be portrayed as standard methods, whereas there should never be any method accepted as a standard, or the patient fitted to the operation. Rather, each case should be judged independently and surgical procedures carried out to suit the prevailing conditions. The success of plastic repair depends, largely, among other things, on the condition of the tissues, and no attempt should be made to carry out closure of the fistula whilst the tissues are sodden, infected and friable. However it is wiser to spend the time carrying out local treatment (tannic acid and glycerine are used by the writer) than to embark on spectacular but ill-timed surgery.

Techniques:

Berger prefers a sliding flap method, utilising the loose tissues in the buccal sulcus. Additional lessening of tension is achieved by horizontal incision high up in the periosteum. The advantages of this method are:

- (a) The palatal tissue is left undisturbed.
- (b) The buccal tissue can be regarded as an extension of tissue which normally surrounds the parts.

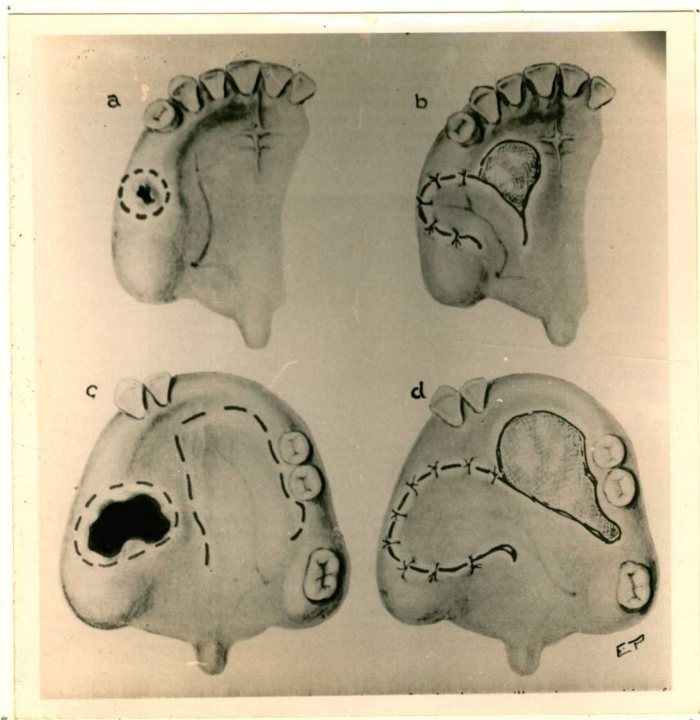
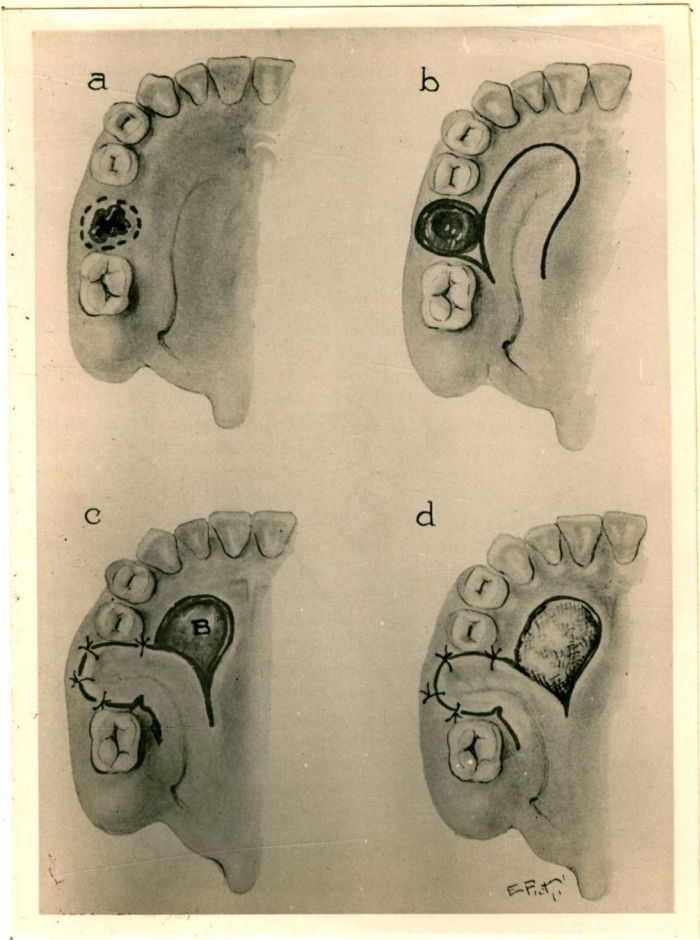
(c) No bony surface remains to granulate.

(d) The floor of the sinus is higher and nearer the ostium than before, and this may be helpful in cleansing the cavity.

Boyes Korkis (1958) advocates a more extensive surgical approach whereby the lateral wall of the sinus is removed together with the alveolar margin, all tissue being removed after extensively exposing the area.

Muco-periosteal flaps from the palate must contain the palatine artery to be successful. Ashley (1939) described a muco-periosteal flap from the palate denuding the anterior portion of mucous membrane, then plugged the opening with the denuded end of the flap.

Arnott (1959) recommends a palatal flap rotated across the defect, and the denuded end is tucked into a slot prepared by incision into the buccal sulcus. Thoma (1958) states that the fistula must be excised first and a funnel-shaped piece is cut out down to the alveolar bone. He warns against the temptation of conserving low-grade tissue, even if a large wound is produced by its removal, as there is a better chance of a good result if such tissues are removed. The flap should extend sufficiently far forward so that when turned it will neatly cover the defect, and a small "V" may be cut out of the lesser curvature to prevent folding. The tissues must be detached from the palate with the periosteum so that



CLOSURE OF ORO-ANTRAL FISTULAE BY ROTATION OF PALATAL FLAPS

ORO-ANTRAL FISTULA

it will contain the artery which lies very close to the bone. As an alternative to Arnott's method he suggests an undermining of the buccal tissue to facilitate the penetration of the entire thickness of the palatal mucosa in the suture line. As the donor site becomes a deep wound Thoma suggests lightly packing with iodoform gauze, which can be saturated with tinc. benz. co. after insertion. This tends to prevent the flap from returning to its natural position, relieves the tension on the sutures, and stops pain. This dressing should be left in place for from three to five days, when granulation tissue will have covered the bone. Arnott suggests the use of fine stainless steel sutures, for extra durability, and these are left in place for from five to ten days.

Hill (1944) turns back a flap from the gingival mucosa adjacent to the fistula, to form a lining for the opening, then covers the raw surface of the turned-back flap with a sliding flap from the buccal mucosa. However, this could not be used when there is a large defect and teeth are present near either end of the opening.

Hersh (1946) uses a variation of Hill's technique by rotating a large buccal flap 180 degrees on its longitudinal axis so that the epithelial surface is presented to the interior of the sinus, and the raw surface is turned outwards towards the oral cavity. The flap is sutured with fine silk,

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then a flap from the palate is sutured over the raw surface of the buccal flap. At the end of the third week the bridge of tissue created by the rotated buccal flap is severed along the outer edge of the alveolar ridge. The pedicle is then rotated back into its original position and sutured. It is doubtful whether such an involved procedure produces any better results.

Fickling claims great success with his Inkwell Operation. A circular incision is made around the fistula and the buccal flap extends from this point. The circular incision is deepened and the fistula tract is dissected from the bony margin, but is left attached at the deeper aspect. Two cat-gut sutures with knots on the inside of the fistula tract are tied and invert the fistula into the form of an unspillable inkwell. He claims the advantages of this procedure are that it provides a form of antral floor; that the ultimate suture line is not placed directly over the original defect; and that the raw surface is in contact with the periosteum of the new flap. It would seem that a lack of blood supply and a sloughing of the inverted tissue would be expected from Fickling's technique.

Cannon (1943) describes the use of pedicle or skin graft which may be transferred into the mouth if the defect is too large for the local flap to cover it; and Kostrubola (1950) also describes these procedures.

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Budge (1952) discusses the use of a tantalum plate for the closure of oro-antral openings; this is inserted under the gingival margins which are then replaced and sutured. The tissue grows across the plate and closes the perforation. Later the plate is removed, apparently not disturbing the tissues.

Proctor (1946) advocates the use of a plug made from preserved cartilage, which is sharpened with a pencil sharpener to make a smooth cone. He claims that the mucous membrane flap is brought over to cover the exposed cartilage, but is not essential to the healing of the fistula, and continues rather optimistically to treat suppuration of the involved sinus after the cartilage graft has healed. It goes without saying that this procedure violates all known surgical principles and it is interesting to note that this author presents no comprehensive post-operative results.

Cartledge (1955) describes the design, construction and retention of appliances used in the treatment of fistulae. He recommends insertion of a splint or denture at the completion of operation, and it is worn continuously until healing is complete. Teeth are utilised for retention, and when teeth are absent the post-operative appliance is incorporated in a modified Gunning Splint, and if necessary secured to a plaster-head cap, as the author considers that

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complete immobility is essential during the primary stages of healing. Seven to twelve days after operation orthodox dentures are fitted and mastication encouraged to consolidate the new scar tissue formed in the first week. In principle, the idea of protection of the closed fistula is basically sound, although it is difficult to see why existing dentures cannot be utilised, or a simple partial-type denture be constructed.

Hargrove converts the opening from a gravity draining fistula into a lateral fistula by removing the palatal bone as far medially as the nasal cavity, and the lateral antral wall is also reduced for a short distance. The palatal flap is sutured to the buccal flap, and the suture line does not lie over the fistula. The depth of the sinus is reduced to the level of the hard palate.

Palatal Perforation

Palatal perforations in the centre of the palate are considered by Thoma. Here the mucosa is thin, and if the defect is large he considers that they are better covered by means of a pedicle flap with its base at the palatine foramen. If the flap extends across the midline as is usually the case, blood supply from the incisive foramen must be eliminated. Large palatal perforations at the posterior part of the palate require all the remaining mucosa

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to cover the defect. Part of the soft palate can be detached from the musculature, turned into the anterior margin of the wound, then covered by the palatal flap.

Defects remaining from the excision of a tumour, in which case the contents of the palatine canal have been coagulated to arrest haemorrhage or to destroy tumour tissue, cannot be closed by the use of palatal flaps, but a labio-buccal flap must be rotated.

7. ABNORMAL ERUPTION OF MAXILLARY TEETH

According to Thoma (1954) the maxillary cuspids and third molars are the teeth most often concerned. These teeth may lie wholly or partly within the sinus cavity, with or without cystic changes in the dental follicle. This cystic change causes a migration of the erupting teeth; however they may be misplaced because of displaced tooth germs. Thoma reports a case associated with a third molar high up in posterior surface of the sinus.

Crich (1950) reports an aberrant maxillary cuspid with complications. The patient had a history of intermittent swelling and drainage in the buccal sulcus over a period of two years. Intra-oral films revealed a radiolucent area from the distal of the upper right central to the mesial of the upper left premolar. Extra-oral films, A-P view, revealed a cuspid tooth lying horizontally just below the orbital floor, and the right sinus showed a thickening of the lining due to chronic inflammation.

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A large muco-periosteal flap was raised from the midline to the first molar region, and the sinus was entered and the thickened membrane removed. The tooth was manipulated down and removed, and the counter-drainage was carried through the nose by rhinologists. This case history illustrates the importance of extra-oral x-rays, and the necessity for co-operation between rhinologist and dental surgeon.

8. THE EFFECT OF SINUS SURGERY ON THE MAXILLARY TEETH

Radical sinus surgery, when carried out from the intra-oral approach, effects the vitality of the maxillary teeth. Martensson (1950) carried out extensive investigations and arrived at the following conclusions:

1. Incidence of total anaesthesia: Anaesthesia of one or more teeth was apparent immediately after surgery, and lasted from the third to the tenth day in 98.5% of 66 operated maxillae. Both premolars were affected in all cases, and 63% of canines. The incidence was less with the incisors and molars, and least with the central incisors. The area of opening into the facial wall of the maxilla largely determines the extent of anaesthesia. This is borne out by the fact that there is greatest anaesthesia incidence in the premolar region. Also the premolars have the longest duration of anaesthesia, the longest time being two months. This is in accordance with the work of Dahm (1936) who is cited by Thoma, and who

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examined teeth of thirty patients following Caldwell-Luc operations for chronic antrum infection three to six months after treatment. Disturbances caused by interference with the nerve supply had disappeared. Miller et al. (1958) reported from the results of 43 Caldwell-Luc operations carried out for the removal of cysts, chronic suppuration of dental origin and oro-antral fistula and for the treatment of antral malignancy. Each case had 24-36 months follow-up. Only two cases had any post-operative sensory disturbance, and these became asymptomatic in four and six months respectively.

2. Relative Anaesthesia: Martensson observed rapid and retarded regression phases of threshold values:

(a) rapid regression phase - there was a rapid initial fall of threshold values, shortest for the premolars and longest for the incisors. Once the sensitivity had returned the premolar teeth tended initially to approach normal values more rapidly than the others.

(b) retarded phase - where an elevated threshold value was statistically demonstrable. The incisors were affected up to three years post-operatively, the canines up to six years post-operatively, premolars nine years. No lasting increase in threshold values was demonstrable with the molar teeth which seemed least affected by the operation.

3. Teeth of the Healthy Side after Operation: There appears to be some anastomoses between the nerves of the

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two sides, as the central incisor of the healthy side showed a rise in threshold value.

4. Histological Investigation: A considerable number of teeth were still affected several years after operation. However, there was no discoloration underneath, no root canal therapy had been done, no restorations in many of them, no subjective symptoms experienced; the teeth situated below the resection opening were most affected. In several cases, mechanical opening into the pulp was carried out without discomfort to the patient. However profuse haemorrhage occurred on exposure of the pulp, implying that blood supply was still intact, although the nerve supply had been damaged. In the affected teeth there were pronounced changes in the appearance of the individual nerve fibres and bundles. However in several cases there was a distinctly reduced number of detectable neurites. Nerve injuries are classified in two groups: transient and degenerative.

(a) The transient type occurs in -

- (1) post-operative oedema.
- (2) haematoma or ischaemia.
- (3) infection.

These factors produce their effect by tension in the tissues.

- (4) mild contusions of the nerves when resecting the facial wall or curetting the mucous membrane of the maxillary sinus.

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This effect lasts for a few weeks or at the most a few months.

(b) Degenerative type - occurs after -

(1) total severance

(2) severe crushing leading to degeneration of the peripheral parts.

The duration of this type may be several months or years.

Incisors: These are least affected at operation for the following reasons:

(a) the majority of anterior superior dental nerves are not severed at resection in the course of the Caldwell-Luc operation. However, with the Denker approach, due to the removal of the facial wall, there is extensive damage to these nerves with a resulting numbness of the central and lateral incisors and cuspid teeth.

(b) because of anastomoses with the nerves of the other side and from fibres of the middle superior dental nerve via the superior dental plexus, and probable connection from the posterior superior dental nerve.

Premolars: These are supplied by the middle superior dental nerves, all the fibres of which may be severed at operation.

Molars: Are mainly innervated by the posterior superior dental nerves, and are little affected.

Conclusion: Since a great number of injuries are caused by trephination of the facial wall the resection technique

must aim at reducing sensory disturbances to a minimum. This may be done by avoiding the apices of the roots of the teeth, the dental plexus and the major nerve branches. The nerve supply is least dense immediately below the infra-orbital nerve, so the entrance should be made as high as possible in the facial wall of the maxillary sinus.

Hasty removal of teeth which do not respond to vitality tests is to be avoided, as the condition may follow radical sinus surgery; and it must be remembered that vitality is not necessarily interfered with when neurility has been temporarily or permanently disturbed.

CHAPTER EIGHTCYSTSSYNOPSIS

1. CLASSIFICATION OF CYSTS
2. INCIDENCE OF CYSTS INVADING THE SINUS
3. DIAGNOSIS
4. TREATMENT
5. NON-ODONTOGENIC CYSTS ARISING FROM THE SINUS MUCOSA

CYSTS

Although it is not the purpose of this paper to discuss the pathology of cysts, but rather to survey the literature regarding the diagnosis and treatment of cystic conditions involving the maxillary sinus, a general cyst classification (Thoma, 1954) will assist to elucidate the overall picture.

1. CLASSIFICATION OF CYSTS

(A) Simple Bone Cysts

- (i) haemorrhagic - extravasation cyst
- (ii) latent extravasation cyst.

(B) Odontogenic Ectodermal Cysts

- (i) follicular cysts - from odontogenic epithelium
 - (a) primordial cyst
 - (b) dentigerous cyst - central and lateral
 - (c) multilocular cyst
- (ii) periodontal cysts
 - (a) apical
 - (b) lateral
- (iii) residual cysts.

(C) Nonodontogenic Ectodermal Epithelial Cysts

- (i) median cysts
- (ii) globomaxillary cysts
- (iii) naso-alveolar cysts
 - (a) incisive canal cyst
 - (b) cyst of papilla palatina.

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(D) Dermoid Cysts

(i) in branchial region

(ii) in sex glands.

2. INCIDENCE OF CYSTS INVADING THE SINUS

Radicular cysts are most commonly found to involve the sinus, and arise in the floor from a granuloma at the apex of the tooth (Thoma, 1958). These are closed epithelial sacs formed in periodontal membrane and adjacent structures, usually at the apex of a tooth, but sometimes along the lateral root surface. They derive their epithelium from remnants of the Sheath of Hertwig of the dental lamina. They generally invade the sinus from the buccal or lingual sides, producing a buccal or palatal swelling. In advanced cases there may be a bulging of the naso-antral wall, and the cyst is able to fill the whole antral cavity, displacing the sinus membrane without any outward sign.

Dentigerous Cysts: Occasionally these cysts involve the sinus. These are types of follicular cysts which are derived from the enamel organ of the developing tooth, and may be formed at different stages of the tooth development.

Primordial or simple follicular cysts are those which form through degeneration of the stellate reticulum in the enamel organ, before any calcified structures have been laid down. They are closed epithelial lined sacs formed about the crowns of the unerupted teeth or denticles. They

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originate from the breakdown of the stellate reticulum of the enamel organ. Thoma (1954) states that the central type of dentigerous cyst occurs where there is displacement of the involved tooth caused by contra-eruptive pressure exerted on the occlusal surface. In the maxilla the entire maxillary sinus may be occupied by the cyst with the tooth displaced as far as the orbit, and the cyst also affects a change in the position of the adjoining teeth by reason of pressure produced.

Large cysts from the anterior maxilla rarely encroach on the sinus. Those that do include group (C) of the classification - the nonodontogenic ectodermal epithelial cysts. Particularly globulo-maxillary cysts (Thoma).

3. DIAGNOSIS

Clinical Signs and Symptoms: As mentioned above there may be swelling of the palatal or buccal tissues, and at times a fistula may periodically drain the cystic content. Often however, the condition is only discovered on x-ray examination. Christiansen (1944) states that a normal antrum is occasionally opened because of cystic appearance on the x-ray. He suggests such safeguards as:

(a) Digital Examination: This is sometimes helpful as egg-shell crackling may be elicited from the expanded bone.

(b) Aspiration Biopsy: This is carried out by inserting a large bare needle into the suspected area and aspirating the

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contents. The cystic fluid generally contains necrotic tissue and products of degeneration and abnormal metabolism, such as cholesterol crystals and almost always pus. This applies particularly to radicular cysts, which are formed on an infectious basis. The pus is due to leucocytes, which penetrate through the epithelial lining, or are given off from ulcerating surfaces where the epithelium has been destroyed by infection, (Thoma, 1954). This may also serve to differentiate between cysts and solid tumours.

(c) Adequate X-ray Examination: This is perhaps of prime importance as cysts are generally discovered only by x-ray, unless they cause facial or alveolar deformity. Radicular cysts are always in the tooth-bearing region, and as a rule they form from one tooth which shows destruction of its lamina dura, and generally there is evidence of pulpitis or root filling. An extensive cyst appears to involve several teeth, but this rarely happens, according to Thoma, who claims that the cyst is superimposed on the image of the roots which remain encased in the surrounding bone. Destruction of lamina dura and periodontal attachment are no doubt determining factors; I have often encountered extensive cysts where removal of two or three involved teeth is essential to successful treatment.

Hutchinson (1954) explains that the lateral wall of the nasal cavity and the medial wall of the sinus are the same.

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In the premolar region division of the wall takes place with one part continuing forward as the nasal cavity and the other swinging outwards and laterally in a curve to form the anterior wall of the sinus, or the facial surface of the maxilla. A typical radio-opaque "Y" formation is created and the fork of the "Y" is the alveolus which supports the first premolar, canine and incisor teeth. This must not be confused with the sclerotic lining of the cyst, nor must the septa or boundaries of the sinus, which due to variations and extent of pneumatisation, appear at first glance to be indicative of cystic appearance. Radiolucent lines crossing the sinus represent canals containing blood vessels which supply the muco-periosteum of the sinus and the maxillary teeth, and are not pathological areas.

Both intra and extra-oral x-rays are necessary for diagnosing and assessing the extent of the cyst. Intra-oral films alone are insufficient, especially in defining the superior boundary which may be demonstrated by Water's Position of the sinuses (see Inflammation), or the posterior extension defined by a lateral view. Cipes and Kenyon (1943) describe a case in point of a dentigerous cyst containing an unerupted third molar which involved the maxillary sinus. The patient complained of a foul-smelling discharge which emanated from the upper right third molar region. The patient was informed that the third molars were absent from

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evidence obtained from intra-oral films which were inadequate for this region, where superimposition of the coronoid process and the zygoma made correct diagnosis impossible.

On further consultation, A-P and lateral views showed marked cloudiness of both antra, especially the right, and also the posterior ethmoidal cells, and an unerupted upper right third molar and cyst were disclosed well up in the right maxillary sinus.

(d) Use of Radio-opaque Fluid: Hall-Morris (1948) states that it is essential to use a radio-opaque medium for demonstrating cysts in the sinus where radiographic projections superimpose either the maxillary sinus or the nasal cavity. He recommends sterile lipiodol or iodochloral (iodine plus oil compounds). The oil need not be removed from the cavity, as it is either resorbed or removed with the cyst sac, and causes no ill effects. Ballenger and Ballenger advise the use of a bland vegetable oil with 40% iodine content, which gives a sharply outlined picture of the cyst or can be used to judge the thickness of the mucous membrane in the sinus which may be chronically inflamed. The diseased tissue is shown by the unfilled zone between the oily mass and the bony outline.

Prendergrass et al., on the other hand, claim that the use of opaque media is grossly abused. Rapeseed, cotton seed and olive oils contain substances to which allergic

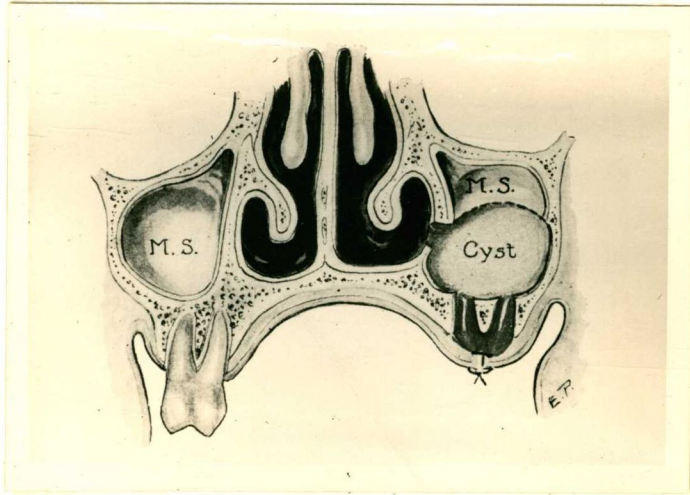
individuals may be sensitised. Paraffin oil, as a diluent, is contra-indicated, because of the effects in the lower respiratory tract, and the possibility of paraffinoma which may arise if the solution is injected into the surrounding soft tissues in error. These authors claim that with a good radiological technique and careful diagnosis this method should not be necessary for maxillary sinus disease treatment.

4. TREATMENT

Thoma (1958) outlines the following operations for various types of cysts:

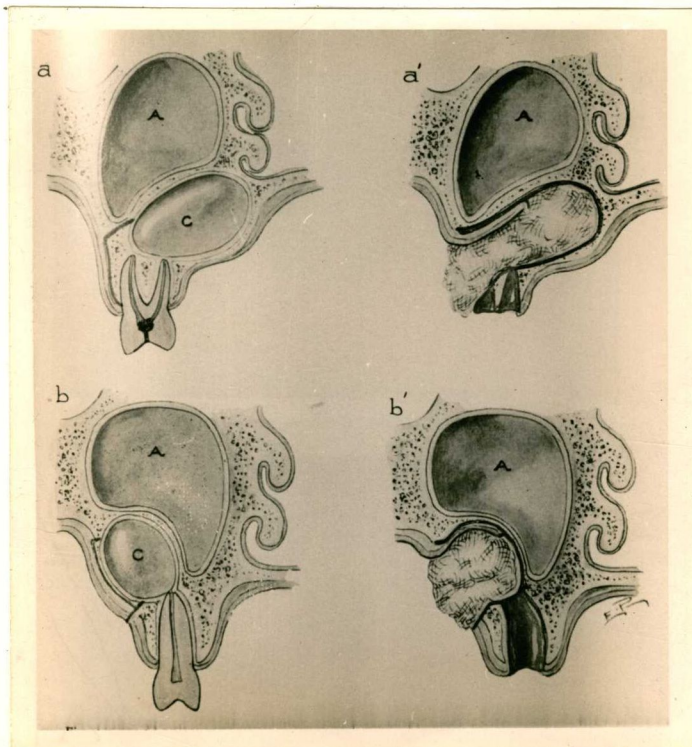
- (a) Enucleation and packing open with or without removal of the causative tooth.
- (b) Enucleation combined with a Caldwell-Luc Operation and primary closure.
- (c) Marsupialisation or Partsch Operation.
- (d) Waldron's Two-Stage Operation.

Enucleation Method: There is some difference of opinion as to the most efficient way of treating the extensive maxillary cyst which involves the sinus. Obviously there is no argument with the smaller cyst when treatment is complete enucleation, with either removal of the causative tooth, or if conditions are favourable, conservation of the tooth by immediate apicoectomy procedure. In surveying the literature it seems that most oral surgeons favour a technique which they themselves are able to carry out from start to finish without the



**ENUCLEATION OF THE CYST AND
COUNTER-DRAINAGE INTO THE
INFERIOR MEATUS**

AFTER THOMA



**ENUCLEATION AND PACKING OPEN OF THE
CYST**

AFTER THOMA

CYSTS

aid of the rhinologist, whereas the rhinologists advocate co-operation with the oral surgeon to provide the best possible treatment. Thoma is the notable exception and advocates complete enucleation of the cyst membrane by Caldwell-Luc procedure, and the establishing of drainage into the nose by a window in the inferior meatus.

Complete enucleation is preferred for the following reasons:

(i) The operation can be carried out without damage to the surrounding structures in most cases.

(ii) As the cyst membrane is a pathological structure the epithelium has neo-plastic potentialities, and if the entire sac is inflamed epithelial proliferation may occur.

(iii) There are often extensive deposits of cholesterolin contained in the connective tissues.

(iv) There is the possibility of ameloblastoma forming from the cyst membrane, beginning with a thickening of the cyst wall.

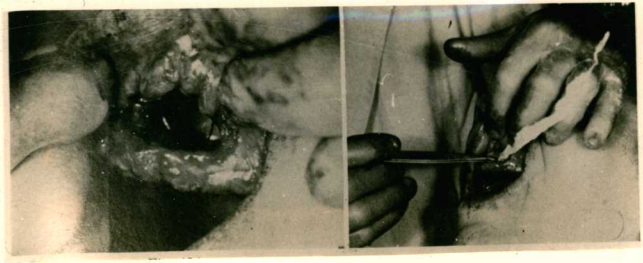
(v) Tumours may arise from epithelial cell rests which are detached from the surface layer.

The Partsch Operation: Archer (1957), on the other hand, advocates the Partsch Operation for the removal of cysts. He lists advantages of the method, most of which seem negligible:

(i) Contour of the mouth tissues is preserved practically intact. This would appear to be an inaccurate assessment,

MARSUPIALISATION : TECHNIQUE

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MARSUPIALISATION

- (i) SIX WEEKS AFTER SURGERY
- (ii) TEN MONTHS AFTER SURGERY



(i)

(ii)



AFTER THOMA

ENUCLEATION

IMMEDIATE CLOSURE
AFTER SURGERY



CYSTS

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when the patient is left with a gaping hole ~~which may take~~ months or even years to heal.

(ii) Teeth which appear involved radiographically are usually vital and are never removed, and if necessary root resection is carried out. This would not be indicated for the posterior teeth which are frequently involved.

(iii) Anaesthesia resulting from section of a large nerve is eliminated. This is not a complication of maxillary cysts.

(iv) By preserving the hard and soft tissues there is no problem of prosthetic devices. I consider the need for an obturator-type appliance, which is often necessary following this procedure, to be a prosthetic problem.

(v) The time element in healing cannot be advanced as a serious problem, and there are no complaints from the patient as very little attention is required. It is my opinion that daily irrigations for months to avoid food and other debris clogging an extensive cavity would constitute an appreciable disadvantage.

Surgical Procedure for the Partsch Operation: This operation consists simply of removing the roof of the cyst and aspirating the contents. The muco-periosteal flap is folded into the cavity and sutured to the cystic membrane. It is packed with iodoform gauze which is changed after 72 hours. After the initial healing an impression of the cavity is taken and an acrylic plug is made. This is supposed to stimulate

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bone deposit, and it must be reduced in size as the cavity fills in. Archer (1957) describes a modified technique when the bony covering is thin, and in this case the muco-periosteum, cortical bone and cyst membrane are removed in one piece. Archer commends the healing rate after ten months, but this should be compared with the appearance of the Caldwell-Luc Procedure in complete enucleation of the cyst immediately after operation.

Christiansen also advocates the Partsch approach. He advocates that the window should be left throughout healing for removal of the remaining membrane and inspection of the cavity. It would be interesting to know just what the writer wished to inspect. In addition he advises that involved or suspicious teeth be left in situ until sufficient bone regeneration has occurred to permit withdrawal without deformity. I maintain that there is no deformity when the alveolar ridge is preserved by entering into the cyst high up. This leaves adequate framework for the replacement of the periostial flap, and because of the destruction of bone by the cyst, removal of involved teeth, if done carefully, can be carried out without fracture of the alveolar plate. It seems wrong procedure to have to subject the patient once more to further surgery, and to have the additional worry of superimposed infection from non-vital teeth.

Cooksey et al. advocate packing of the cavity with vaseline gauze to maintain the surgical opening. Surely if a

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wound breaks down after operation that is the time to pack, and not be resigned to months of dressings and irrigations, and the necessity for an obdurator beforehand. Fickling at least describes the two methods of marsupialisation and Caldwell-Luc primary closure. He observes that patients treated by the second method healed rapidly and were free from all symptoms in one to two weeks. However, he still prefers the Partsch Technique where the cavity filled in 18-36 months. This is completely baffling!

Enucleation and Packing Open: Here the cyst membrane is completely removed. However, the cyst cavity is packed open with gauze, making it an accessory cavity which gradually becomes shallower and is finally eliminated. This seems a laborious and time consuming procedure.

To decide whether to proceed with complete enucleation or with the Partsch Operation, Newlands suggests the following procedure:

(i) A window is made into the buccal surface to expose the cyst, and its contents are removed.

(ii) The lining is examined for evidence of perforation into the nose, sinus or hard palate. This is done by probing with a blunt instrument. If all the surfaces are firm and resistant complete removal of the cyst wall is advocated.

With very small defects careful sharp dissection will separate the cyst wall from the mucous membrane. However if

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larger areas of mucous membrane are exposed, the cyst wall should be left in place and the Partsch Procedure should be carried out. If portion of the cyst wall is left, this author considers it essential for histopathological examination to be performed to rule out the possibility of ameloblastoma.

Some rhinologists treat the encroaching maxillary cyst as an infected sinus, and establish a large intranasal window into the cyst cavity leaving the lining intact and making the cyst what would virtually be an accessory maxillary sinus. This is not advised by Blair and Ivy who state that there is insufficient control over an extension of the disease, and prefer an opening through the sulcus and enucleation of the cyst membrane.

Post operative aims should be to achieve a cure with good functional results. Deformed alveolar ridges and the associated prosthetic problem should be avoided and correct soft tissue approximations will minimise adhesions and deformities, (Boyko, 1950).

Waldron Two-Stage Procedure: Waldron (1941) states that if inspection reveals the floor of the cyst to be lower than anticipated, and it extends into the palate under the nasal cavity, the operation is not completed at once; but the cavity is kept open by packing until some weeks later when the lower part of the cyst is filled in. Once this has occurred enucleation of the cyst may be carried out.

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Thoma (1947) describes a method which is essentially the same as marsupialisation and is based on the principle that, given constant drainage, a cyst will gradually decrease in size.

The technique for this procedure is to remove a small part of the cyst wall and insert a metal tube or solid dumbbell shaped metal drain. The tube is attached to the adjacent teeth by a loop of heavy wire. The appliance is removed every few days and cleaned, and the treatment lasts several months. Critical comment seems unnecessary.

According to Thoma marsupialisation is recommended only for the treatment of eruption cysts in young people and in dentigerous cysts in children when the tooth is in a favourable position for eruption. A further case where this treatment is indicated is for Ranula in the floor of the mouth.

5. NONDONTOGENIC CYSTS ARISING FROM THE SINUS MUCOSA

According to Wright (1946) these may be classified as follows:

(i) Non-secreting cysts which are thin-walled, filled with orange fluid, and are easily ruptured.

(ii) Polyp-like structures which are similar to the nasal polyp, being thin-walled myxomatous structures, having no tendency to rupture.

(iii) Secreting cysts which are pale, small and thick-walled, attached to a wide base, not movable like the other

CYSTS

types, and contain thick pale mucoid fluid. House (1948) describes secreting or retention cysts which occur in cases of chronic inflammation of the membrane of the sinus when cicatricial changes lead to cyst formation, as there is a narrowing of the glandular outlets and secretion is retained. He cites Tunis (1910) who studied 100 unselected heads shortly after death and found retention cysts in 13% of cases. Wright found round shadows in 5% of sinuses (78 cases) on full-mouth x-ray examination.

Mills (1959) suggests that all the cysts of the antral mucosa are secretory in nature, and those containing the thin orange or yellow fluid are due to an extra mucosal rupture of blocked mucous glands.

Millhon and Brown (1944) contend that the commonest type of cyst is non-secreting in character. These do not cause deformity as do the secreting cysts, but ordinarily rupture spontaneously before reaching a large size. Heatley (1952) agrees with this, and House explains their aetiology as being due to oedematous distension of tissue spaces.

Although there is some difference of opinion as to the nature of cysts of the sinus mucosa, the fact that bony destruction of the sinus walls is not common suggests a non-secretory character.

Radiographic Appearance: The cyst appears radio-opaque against a radiolucent sinus background. Though usually

dome-shaped, dental x-rays may show the cyst arising from a base to assume a half-moon shape. Out of 600 full mouth x-rays taken by Millhon and Brown, 24 had cysts in the sinus. Transillumination tests were positive for the mucous retention cysts.

Surgical Treatment: Wright treated 42 cases by Caldwell-Luc operation and found that most of the sinus membrane was normal. This author recommends radical antrostomy only when the membrane is extensively cystic and polypoid in nature; and advises counter-drainage through the nose.

CHAPTER NINETUMOURSSYNOPSIS

1. BENIGN TUMOURS
2. LOCALLY MALIGNANT TUMOURS
3. MALIGNANT TUMOURS
4. ADDITIONAL CASE REPORTS
5. TREATMENT - SURGERY & IRRADIATION

1. BENIGN TUMOURS

According to Thoma (1947), new growths may extend from the alveolar process into the maxillary sinus, and they are generally of osteogenic or odontogenic origin.

Halberg and Begley state that osteoma of the paranasal sinuses is a very rare condition, and has an incidence of approximately 0.43%. These writers studied 23 cases of osteoma and osteofibroma (ossifying fibroma) of the maxilla with extension into the sinus, and concluded that the tumour had originated in the anterior wall of the maxilla. Thoma (1947) states that the osteoma is usually attached to the wall of the sinus by a pedicle, and this is demonstrated by A-P and lateral x-ray views, the tumour giving a well-defined radio opaque object on x-ray. Heatley considers that osteomas are more frequent in the frontal sinus. Treatment consists of removal by Caldwell-Luc Operation (Halberg and Begley).

Ossifying fibroma, according to Thoma, is fairly common in the second and third decades, forming in the spongiosa, and gradually changing the entire architecture of the maxilla with expansion into the palate and alveolar process. Asymmetry of the face occurs as the tumour involves the zygoma and the maxillary sinus is usually obliterated. Cooke (1957) considers the sinus and molar areas of the mandible to be favourable sites. The latter author discusses ossifying fibroma and facial fibrous dysplasia.

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Ossifying Fibroma: This is considered to be a benign neoplasm of fibrous tissue directly associated with the skeleton; containing scattered areas of calcification, not occurring in normal membrane bone. It is considered subperiosteal rather than central in origin, and has a smooth lobulated surface. When cut it is grey in appearance like a raw potato and is well encapsulated. If left untreated it may reach enormous proportions.

Its microscopic appearance is that of closely packed whorls of fibroblasts with little collagen formation. In addition there are small globules of calcification termed 'metastatic', which may fuse together to form large irregular shaped areas. There are osteoblasts present.

The treatment consists of enucleation and curettage of the tumour bed which is sufficient to prevent recurrence.

Fibro-osteoma: This is considered a benign tumour of fibrous tissue and undergoes almost a full range of formation of bone in membrane. It is slow growing and appears as localised bony enlargements covered by normal mucosa. Bone formation is the prominent feature, and histologically and radiographically it may resemble a compact osteoma to which it may progress. Histologically it lacks the whorl pattern of ossifying fibroma, and radiographically it is well-defined, localised and shows varying degrees of maturation. Immature

TUMOURS

lesions are well-defined radiolucent areas with a definite bony margin. Mature lesions are a dense radio-opaque mass, always showing a radiolucent capsule, and outer opaque margin. Treatment consists of curettage of the tumour to prevent recurrence.

Facial Fibrous Dysplasia: This is characterised by fibro-osseous lesions which have a tendency to stabilisation with cessation of skeletal growth, and it is unassociated with any disturbance of calcium metabolism. There is a marked facial deformity when the upper part of the maxilla is affected, a fullness of the cheek and the eye at a higher level on one side. Exophthalmos and proptosis have been observed.

The radiographic appearance shows a typical orange peel pattern in intra-oral films, and a ground glass appearance in a lateral view. The occipito-mental view shows an homogenous opaque appearance, the sinus being obliterated, and the infra-orbital margin being convex upwards. There may be a smoke screen pattern of the bone or a coarse mottling with irregular radiolucent and opaque areas. However it is not as dense as the cottonwool appearance of Paget's Disease. Nevertheless skull and skeletal rays should be taken to differentiate between the two. The teeth may be separated and the occlusal plane altered. However, there is no absorption of the roots or hypercementosis, nor any thickening of the skull as in Paget's Disease.

TUMOURS

Microscopic examination shows original bone replaced by fibrous tissue. There are well-formed blood vessels, and long trabeculae of osteoid laid down in the fibrous tissues. This is calcified to form a typical pattern of coarse fibre-woven bone. The trabeculae then resorb, and the cycle is repeated.

The treatment consists most often of a simple paring down procedure after skeletal growth has ceased. Radical mutilating operations are avoided. Radiotherapy may be used; however the danger of telangiectases may lead to greater disfigurement than the swelling itself.

Van Alyea (1956) considers that benign growths are rarely seen in the maxillary sinus. He includes polyps and non-secreting cysts as the more common type of growth encountered.

Central Giant-Cell Tumour: The development of the giant-cell tumour is explained either on the inflammatory or neoplastic basis, and classified either as giant-cell reparative granuloma or benign giant-cell tumour.

The central giant-cell tumour forms in preference in parts of bone which are of cartilaginous origin. In the maxilla the canine fossa and ethmoid regions and often the entire maxilla becomes involved. The maxillary sinus may be involved and filled with tumour tissue.

Bulging of the palate and facial wall of the sinus may take place, a typical symptom being spacing of the teeth which

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finally become loose. If after extraction brownish tissue is seen in the socket, further investigation is indicated. (Thoma, 1954).

Giant-cell Reparative Granuloma: According to Austin et al. (1959) the true giant-cell tumour is very rare, and these authors found only two giant-cell tumours as against sixty-four reparative granulomas. This was over a fifty-two year period at the Mayo Clinic.

Apparently the tumour is in fact inflammatory and consists of resorptive new formations with cellular activity related to the occurrence of haemorrhage. It is generally of moderate dimensions associated with unerupted teeth and the resorption of deciduous teeth.

Differential Diagnosis of the Reparative Granuloma and Giant-cell Tumour:

Histological Examination: The reparative granuloma does not have as many benign multinucleated giant-cells, about a quarter the number, as the central giant-cell tumour and there are less nuclei.

Collagen formation is a feature of the reparative granuloma. Mitotic figures are present in fewer numbers.

Osteoid formation is present only in the case of reparative granulomas.

The giant-cell tumour affects an older age group and is not usually found in a person of less than twenty years; the reparative granuloma affects very young people.

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The all-important fact is that the treatment for the two conditions differs greatly.

The reparative granuloma being non-destructive and not recurring or metastasising, a simple shelling out process is required, and even irradiation is contra-indicated.

The giant-cell tumour on the other hand recurs in at least 50% of cases, and 10% become malignant. Surgical treatment involves complete exposure of the part affected with a painstaking search to reveal all extensions of tumour tissue, and the removal of all involved teeth. Removal of the outer cortex and entire spongiosa is indicated where there is extensive involvement of the maxilla. Radiation is found to be successful only in early tumours. (Thoma 1958).

Papilloma of the Maxillary Sinus: A case is reported by Klimpell (quoted by Salinger 1948). The patient suffered from headache and mucopurulent nasal discharge. A few small polyps were seen in the nose, and antral lavage yielded a sanguinous fluid. On operation, the antrum was found to be filled with numerous papillomas which extended into the middle meatus and ethmoidal sinuses.

2. LOCALLY MALIGNANT TUMOURS

Mixed Salivary Tumour: This, according to Fickling, is most likely to lead the surgeon into the sinus. The palatal aspect of the tuberosity is the common site, and it is sufficiently soft and rubbery to be mistaken for a cyst.

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However Thoma describes it as a slow-growing firm and painless mass which, after many years, may show malignant changes. If the sinus is filled with the tumour mass there is marked expansion of bone, pain, exophthalmos and diplopia. A wide oro-antral fistula is likely to follow operation, which should be radical due to the tendency to recur. The author advises covering the raw surface with a split skin graft.

Cooksey et al. state that involvement of the sinus by circumscribed lesions does not necessarily mean that the antral mucosa is perforated or invaded. The pathological condition can be removed without serious damage to the antral lining which then re-establishes normal integrity.

Ameloblastoma: This occurs more frequently in the mandible. However the sinus is soon involved if it occurs in the maxilla, with associated expansion of the facial and nasal walls and palate.

X-ray shows the polycystic nature of the tumour and the associated involvement of the antral wall. But biopsy is more reliable. Heatley states that the clinical picture is often mistaken for malignancy as the x-rays suggest destruction of the bony walls. The tumour may be associated with a dental cyst and is described as locally malignant. Solid and cystic types are described, the solid type being the one more commonly found in the maxillary sinus.

Heatley reports on two cases of ameloblastoma, where one patient was admitted with a draining oro-antral fistula from

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the left sinus. Twelve years previously the upper left third molar had been removed. The author remarks that many reported cases record preceding traumatic or irritative factors - e.g. dental extraction, injury to the jaw, impaction or infection. In this case the socket healed after four weeks. During the twelve months previous to consultation the patient had noticed a thin slightly blood-stained drainage into the mouth. There was no pain but an intermittent sense of fullness in the left cheek.

The clinical signs were:

- (a) Oro-antral fistula in the maxillary left third molar region.
- (b) Slight prominence of the left cheek.
- (c) Broadening of the alveolar ridge and the slight downward displacement of the adjacent hard palate and the anterior wall of the maxilla.
- (d) The left antrum was dull on transillumination.
- (e) There was no cervical gland enlargement.

X-rays showed considerable expansion of the antral walls and evidence of destruction of the anterior wall and floor. Heatley states that ameloblastoma involving the sinus is potentially malignant, and as post-operative irradiation is of limited efficacy, due to the radio-resistant nature of the tumour, frequent re-examination is necessary.

Plasmocytoma of the Maxillary Sinus: This is described by Bernier (1950). It is generally considered to be of extra-

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osseous origin, being more common in the upper respiratory tract, the usual sites being the nasal cavity and the nasopharynx. It occurs in the 30-70 year age group, more commonly in males than females, and is described as potentially malignant and often locally invasive.

Microscopically it is composed of plasma cells in mass formation, and the presence of these cells unassociated with inflammation is the important diagnostic criterion.

3. MALIGNANT TUMOURS

Although malignancy is by no means of common occurrence, and because the earliest signs and symptoms may direct the patient to seek dental advice, it is most important for the dental surgeon to be aware of and to recognise this condition when it occurs. Once the malignant condition has advanced it may be inoperable and early treatment will possibly prolong the patient's life.

(a) Incidence of Malignancy: Ward and Hendrick (1950) state that cancer is more frequently found in the maxillary sinus than in any of the other paranasal sinuses, in a ratio of 5:1. Men are affected four times as often as women, 55-70 years being the common age group. Wilson (1954) found 80% of cases between the ages of 55 and 70 years were associated in most cases with secondary infection of the nasal sinuses. In 1% of cases cancer was discovered during

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operation for the removal of polypi. Stockdale (1958) states that the condition is not uncommon in children under the age of 15 years.

(b) Types of Malignant Tumour: Grossman (1950) gives a histopathological classification of malignant tumours:

A. Epithelial Type

- (i) hornifying or non-hornifying squamous cell carcinoma
- (ii) transitional cell carcinoma
- (iii) cylindrical cell carcinoma
- (iv) basal cell carcinoma
- (v) lymphoepithelioma

B. Connective Tissue Types

- (i) spindle cell sarcoma
- (ii) osteoblastic sarcoma
- (iii) fibrosarcoma
- (iv) myxosarcoma
- (v) round cell sarcoma
- (vi) polymorphous sarcoma
- (vii) melanoma

C. Mixed Type (Salivary glandular type)

Squamous Cell Carcinoma. This is named by all authors as being the most common type to involve the sinus. Salinger reviewed work by Takashi who found that out of 72 cases studied 41 were of the squamous cell variety. According to

Thoma (1947) it may develop in the sinus and for a long period give no clinical signs. It may perforate the palate or alveolar mucosa in an edentulous area, or it may proliferate through a socket where a tooth has previously been extracted to relieve pain and soreness. On the other hand it may extend into the sinus secondarily from the alveolus. Two types are described:

(i) a poorly differentiated infiltrating type which may involve the sinus early and present no obvious surface lesion.

(ii) a well differentiated type which is slow growing and presents a bulky local growth which actually involves the sinus in the later stages.

Clinical Signs and Symptoms (Ward and Hendrick; Grossman et al.).

(i) Pain: Occurs over the sinus, under the eye, on the side of the face or in the cheekbone, beginning in the upper teeth and persisting after their removal. Wilson says that pain is referred to the teeth, usually the premolars and the cuspids; the first molar may be loose, and its removal is followed by copious haemorrhage. Boyes Korkis describes a dull persistent pain or an uneasiness in the face which is often worse on lying down. Paraesthesia or anaesthesia of the upper lip may be present when the second division of the fifth nerve is involved. Heatley describes a persistent pain in the maxillary sinus without definite dental cause.

(ii) Swelling: Is associated with tenderness over the canine fossa, and in the later stages swelling in the palate and protrusion of the eye. After destruction of the bony walls of the sinus there may be swelling of the nostril and the alveolar ridge. Nasal obstruction may occur as an initial symptom, but more frequently this comes later. Nasal discharge of foul pus or recurring epistaxis may be present, and Stockdale describes a purulent discharge mixed with blood. There may be protrusion of the neoplastic tissue from the tooth socket after extraction. There may be trismus with invasion of the pterygoid fossa; lacrimation due to obstruction of the nasolacrimal duct; earache, tinnitus, and blocked ear may occur as the growth proceeds posteriorly towards the nasopharynx.

(iii) There may be proptosis or palpable destruction of the inferior rim of the orbit, and the later complications of diplopia and ptosis may occur. Invasion may occur into the zygoma, the nasopharynx, the orbit, the other paranasal air sinuses, the infratemporal region or the base of the skull. The deep cervical lymph nodes are involved rather late in the disease according to Ward and Hendrick; the lymph of the superior maxilla passes posteriorly to join that from the nasal mucous membrane and the vault of the pharynx, and descends along the deep cervical chain. The first node to be affected is usually the deep superior

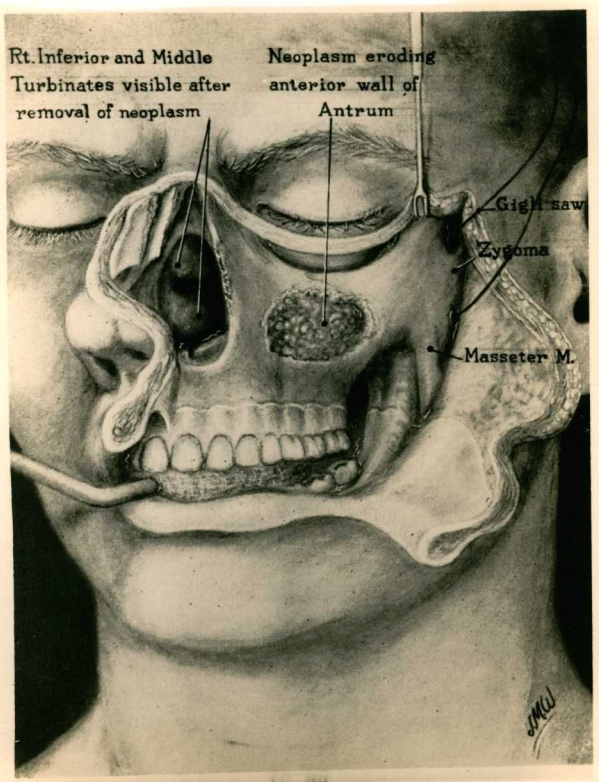
PROGRESSIVE STAGES
OF CARCINOMA OF
THE MAXILLARY SINUS

AFTER THOMA



A.

B.



SURGICAL APPROACH
FOR RESECTION OF
THE MAXILLA

AFTER WARD & HENDRICK

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cervical node, posterior to the angle of the mandible.

Metastases to the lungs and other vital organs take place.

Diagnosis: According to Capps and Williams (1950) the majority of patients seek treatment only when there is gross deformity or severe nasal obstruction. He states that pain is seldom an early symptom. However in a quotation from Henry Butlin it is stated that violent toothache may be the first symptom, and on removal of the tooth a fistula forms and the pain is not relieved. A probe passed into the sinus may encounter crumbling bone or may pass into a cavity filled wholly or in part with granulation tissue. The symptoms of early malignant disease are not unlike inflammatory conditions, and one-sided nasal obstruction and purulent secretion are seen.

Adeno Carcinoma: Thoma (1947) describes an adeno carcinoma which is less common than the epidermoid variety and resembles an ameloblastoma. It develops a highly specialised epithelium of the glandular type, and is locally invasive to a greater extent than the ameloblastoma, and less likely to remain encapsulated. It forms a bulky mass and can lead to extensive deformity. Of all the antral malignancies treated by Capps and Williams 70% comprised squamous cell carcinoma, adeno carcinoma and carcinoma of an unspecified cell type.

Sarcoma: Thoma states that fibrosarcoma and osteogenic sarcoma are rarely found to involve the maxillary sinus, and

to these are added round cell sarcoma and myxosarcoma by Ward and Hendrick. Osteolytic and osteoblastic types are described (Thoma). The osteolytic type is very malignant and contains much fibrous tissue, and the osteoblastic type consists of matured calcified bone formation centrally, and peripherally new bone formation presents the characteristic sunray effect on x-ray. Osteogenic sarcoma is a malignant neoplasm of bone forming mesenchymal tissue, the bone usually being produced directly from the tumour parenchyma, but some may be formed by cartilage. The condition occurs most frequently in the second and third decades, being relatively rare in older individuals except in patients with Paget's Disease (Atlas of Oral Pathology, 1956).

(b) Symptoms of Malignancy: Grossman et al. discuss symptoms of malignancy of the sinus under groups of inter-related findings.

Group 1. Symptoms referable to the Nose - these include:

- (a) unilateral polyps
- (b) nasal discharge
- (c) insidious but progressive nasal obstruction
- (d) nasal haemorrhage
- (e) parosmia and fetor.

Group 2. Symptoms referable to the Buccal Cavity:

- (a) paraesthesia or dental pain of unknown origin involving the upper jaw

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- (b) gingival ulcers which persist and progress in spite of local treatment
- (c) fungating tumours arising in this area.

Group 3. Facial Symptoms:

- (a) swelling of the cheek or in the area of the zygoma
- (b) fixation of the skin or frank ulceration with severe facial distortion.

Group 4. Orbital Symptoms:

- (a) lacrimation caused by infiltration of the tumour mass into the lateral wall of the nose involving and obstructing the naso-lacrimal duct
- (b) ectropion of the lower lid with widening of the orbital fissure
- (c) proptosis and limitation of orbital movements.

Mead states that orbital involvement with associated diplopia and proptosis are usually later signs, preceded by destruction of the infra orbital margin.

(c) Spread of Malignancy: Heatley states that malignant tumours, with the exception of sarcomata, metastasise relatively late.

(i) the first spread generally involves the deep superior cervical node behind the angle of the mandible.

(ii) It may spread anteriorly to the sub-maxillary and carotid bulb lymph nodes.

(iii) It may spread down and posteriorly to the deep jugular chain, or

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(iv) Via the blood stream to the lungs, liver or bones. This is relatively uncommon.

Twenty nine out of one hundred and twenty seven cases showed metastases.

Wilson classifies the direction of spread of malignant neoplasms arising in the various locations in the antrum:

(i) Malignancy involving the anterior group of sinuses is more common. Tumours situated in the roof of the sinus may spread forward into the cheek or upwards into the orbit.

(ii) When the growth is situated in the lateral wall it may produce a swelling in the mouth, the outside of the alveolus or cheek.

(iii) When situated on the floor the growth may extend downwards through a tooth socket and perforate the hard palate.

Wilson states that diagnosis of a primary growth of the hard palate is often made prematurely, when in reality there may be a small perforation into the sinus, and x-rays show a sinus growth with destruction of the lower part.

4. ADDITIONAL CASE REPORTS

Stockdale describes a transitional cell carcinoma, which he states is commonly seen in the oro or nasopharynx. It has rapid growth and is more malignant than other types. Metastatic spread is early, and may involve lungs and liver.

Vazirani and Bolden (1958) report an oral fibromyxosarcoma of the maxilla which invaded the maxillary sinus.

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Here a gradual swelling of the right cheek was treated as a tooth abscess, and on removal of the upper right first and second molars the sockets failed to heal and the patient was treated accordingly for some time. Eventually the tumour had grown downward to form a fungating mass and bulging of the palate; x-rays showed an oval osteolytic defect of the palate as well as involvement of the right sinus.

Stockdale (1959) reports an epidermoid carcinoma of the sinus where diagnosis was not made until after biopsy, almost three months after the commencement of the swelling. This delay was due to the complete absence of pain, and the early clinical picture which was more indicative of chronic sinusitis.

Waldron (1959) reports a carcinoma of the maxillary sinus which at first appeared to be an acute abscess involving the upper left cuspid. A fluctuating mass in the mucobuccal fold was incised and penicillin therapy commenced. Eventually the tooth was removed, and the adhering tissue on biopsy was found to be a poorly differentiated carcinoma.

Pastore et al. (1950) report on a rhabdomyosarcoma of the sinus which had seven years survival following surgical excision and radiation therapy. This is considered to be the most malignant form and presented as a cauliflower-like mass which bled profusely on palpation. The early symptom of

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toothache was treated by tooth removal.

5. TREATMENT

Ward and Hendrick suggest that dental attention take the form of:

(i) impressions prior to surgery
(ii) a supporting prosthesis applied shortly after the operation

(iii) a temporary appliance made of soft acrylic which may be necessary and is used until the edges of the defect in the maxilla have healed firmly enough to hold a permanent appliance. After very radical surgery retention may not be adequate to permit mouth feeding in which case tube feeding with a 3000 calorie liquid diet is carried out. These authors state that unless the primary lesion is small and can have adequate irradiation therapy, all cases should have radical resection of the superior maxilla following irradiation.

Heatley reviews surgical treatment as consisting of:

(i) a transantral approach (Caldwell-Luc or Denker Operations)
(ii) external approach or lateral rhinotomy.

Factors which would govern the choice of surgical procedures would be:

(i) General Health of the patient
(ii) The presence of metastases
(iii) Size and location of the tumour

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(iv) Grade of tumour

In old age palliative radiations and general supportive measures are indicated. However he concludes that surgery followed by irradiation is most satisfactory.

Irradiation

Thomson and Negus discuss treatment by irradiation:

(i) Deep x-ray therapy and teluradium - these alone are rarely successful. The difficulty in irradiating maxillary sinus malignancies is that the growth is enclosed in bony walls.

(ii) Intrabuccal radiation - this is used after operation as a complement to preliminary external irradiation. The technical difficulties of evenly distributed dosage by this method led to a preference for intra-cavitary irradiation.

(iii) Intra-cavitary irradiation of radium or radon - this is used extensively, alone or as an adjunct to external irradiation. The authors recommend removal of the upper alveolus and hard palate, and the radio-active material (15-24 mg.) is placed in a compartment in a specially constructed obturator. This enables the material to be held in accurate position at a sufficient distance from the walls to avoid radium necrosis.

Thomson and Negus recommend surgery followed by irradiation for the advanced type of case usually presenting.

Intra-cavitary insertion of radium or radon is used alone or as an adjunct to external irradiation. Radon has

TUMOURS

the disadvantage of a rapid fall-off in dosage without the even effects of radium.

Wilson had the best results after surgery combined with irradiation. Radical surgery is preferred even in older patients as partial clearance may give only transient relief and cause fatal haemorrhage.

The mode of action of irradiation is a selective effect on malignant cells during mitosis; thus actively malignant tumours respond more rapidly than the slow-growing tumours. However the final result is better with a well-differentiated and slow-growing growth.

Sarcomata have a greater radio-sensitivity than epitheliomata. Heatley advises combined surgery and irradiation, thus giving a more favourable prognosis than irradiation alone.

Because of the rapid and fatal outcome of antral malignancy, the dental surgeon must be aware of the early signs and symptoms of the disease. It is obvious from the numerous case reports that pain involving the teeth has been treated without adequate investigation. It should always be remembered that the nerves which supply the maxillary teeth may be affected before entering the apical foramina, and odontalgia is the result. It behoves the dental surgeon *who may be the first consulted in a case of this type to investigate thoroughly the background of the condition, and to refrain from the mere removal of teeth without adequate proof that the pain is odontogenic in origin.*

CHAPTER TENFRACTURESSYNOPSIS

1. GENERAL CLASSIFICATION
2. SIGNS & SYMPTOMS OF FACIAL INJURIES
3. SIGNS & SYMPTOMS OF MAXILLARY SINUS INVOLVEMENT
4. X-RAY DIAGNOSIS
5. TREATMENT
6. COMPLICATIONS

FRACTURES

1. GENERAL CLASSIFICATION

The fractures of the alveolar central region and zygomatic complex of the face are those which involve the maxillary sinus, enclosed in the body of the maxilla. Classification of these fractures is necessary as they occur in a great variety of combinations, and this paper will stress those which involve the maxillary sinus in their diagnosis and treatment.

Fickling, Rowe and Killey and Thoma (1958) all classify middle third fractures:

(a) Alveolar fractures: Occasionally during extraction of second and third molars fracture of the maxillary tuberosity and the floor of the antrum occurs (Rowe and Killey). Continued attempts to remove the teeth will result in evulsion of this portion of the bone and antral exposure. (See Oro-antral Fistula).

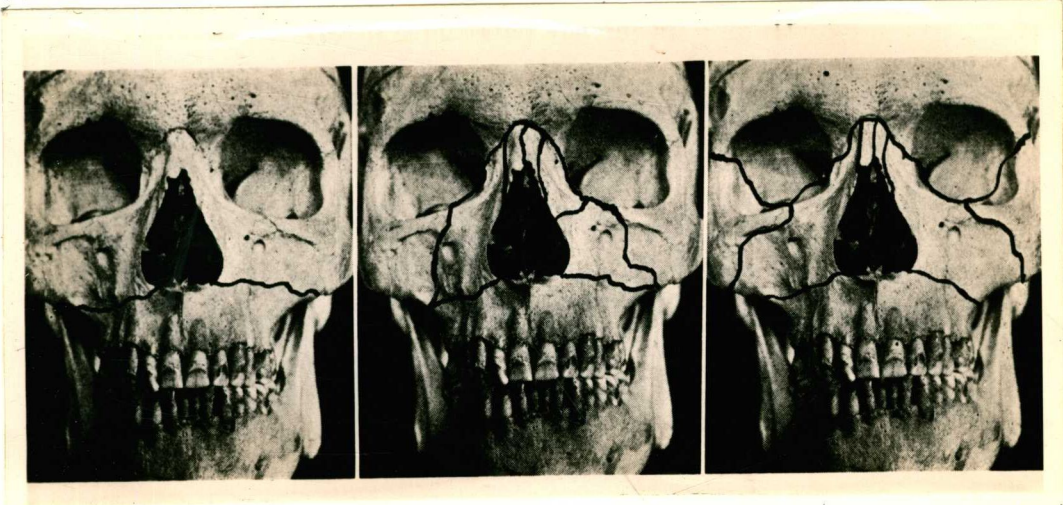
Trauma from an external impact may also fracture the alveolus which may be displaced in a palatal direction; or in the case of injuries from above and below, the section of bone and teeth may be displaced labially or in a buccal direction.

(b) Horizontal Fractures of the Lower Part of the Maxilla and Alveolar Process (also known as Guerin or Le Fort 1 Fracture): It extends through the maxilla between the floor of the maxillary sinus and the floor of the orbit. The entire

(i)

(ii)

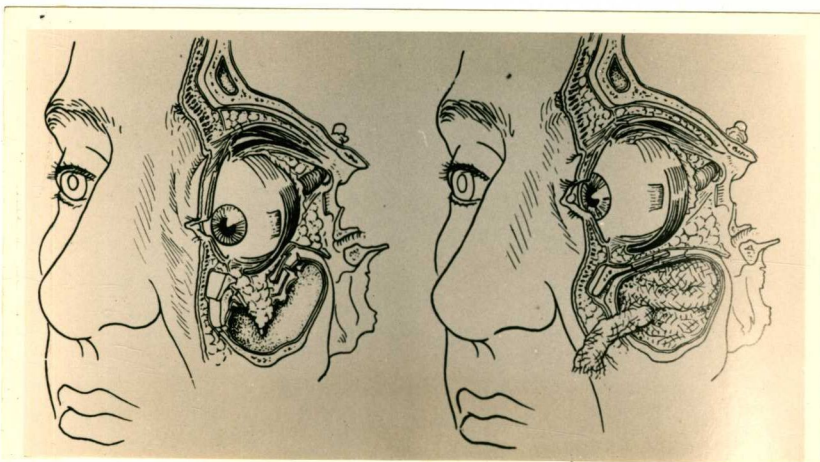
(iii)



FRACTURES

- (i) HORIZONTAL FRACTURE OF THE MAXILLA
- (ii) PYRAMIDAL FRACTURE OF THE MIDDLE FACE
- (iii) TRANSVERSE FRACTURE OF THE FACE WITH HORIZONTAL FRACTURE OF THE MAXILLA

AFTER THOMA



EYE-LEVEL RESTORED AND INFRA-ORBITAL MARGIN SUPPORTED BY A GAUZE PACK IN THE MAXILLARY SINUS

AFTER ROWE & KILLEY

FRACTURES

alveolar process, the hard palate and the floor of the sinus are detached from their base. It involves the sinus wall and the nasal septum. The entire maxilla is mobile, being held by the soft tissues of the oral, antral and the nasal mucosa.

(c) Pyramidal Fractures: The maxillary, lacrimal, ethmoid and sphenoid bones, and often the vomer and nasal septum are involved.

(d) Transverse Fractures: These involve the nasal as well as the malar or zygomatic bone, and a dish-shaped face results as the entire middle part of the face may be pushed back as much as half an inch. Haemorrhage into the palate, pharynx, antra and nose is frequent.

(e) Comminuted Fractures of the Middle Face: These occur frequently in civilian life, but are even more common in war. An extensive internal destruction may result.

(f) Fractures of the Malar Bone and Zygomatic Arch: These occur either together or frequently the zygomatic arch alone is fractured. They are recognised by a depression in the skin over the arch, and interference with the movements of the coronoid process of the ramus during mastication.

The zygomatic bone participates in the formation of the lateral orbital rim and wall, and thus forms an important section of the incomplete bony ring which protects the globe of the eye from injury. It will be apparent that the

FRACTURES

presence of the maxillary sinus readily permits displacement of the zygomatic bone into it because of its thin lateral wall.

The infra-orbital nerve and the anterior superior dental nerve may be involved in the line of fracture which runs through the infra-orbital foramen and adjacent to the zygomatico-maxillary suture. These nerves are commonly crushed or torn with resultant anaesthesia in the area of their distribution.

The position of the eye is also influenced by the periorbital fat, and comminution of the orbital floor will permit herniation of this fat to occur into the underlying sinus with a consequent drop in the level of the globe of the eye; and ultimately enophthalmos will occur and become evident when the oedema subsides.

Fractures passing through the inferior orbital rim interfere directly with the action of the inferior oblique muscle with a resulting depression of the ocular level, but clinical improvement takes place when the haematoma within the muscle is absorbed.

Types of Zygomatic Fracture:

- (a) Fracture of the zygomatic arch
- (b) Fracture of the zygoma without displacement
- (c) Fracture of the zygoma with a minimal degree of impaction into the sinus.
- (d) Fracture of the zygoma with a severe degree of

impaction into the sinus, and with associated comminution of the orbital floor, and/or interference with the movement of the coronoid process of the mandible. (Rowe and Killey).

2. SIGNS AND SYMPTOMS OF FACIAL INJURIES

(a) Deformity is due to swelling in most cases, and extravasation of blood may cause ecchymosis or haematoma. In other instances deformity is due to displacement of the fractured bone. However, the absence of deformity is not a reliable sign.

(b) Abnormal mobility of the bone at the site of fracture is disclosed by palpation. Care should be taken not to increase the damage caused by the accident or to rupture a blood vessel or a nerve.

(c) Crepitus is not present in incomplete or impacted fractures, and the soft tissue or muscular trismus may prevent it.

(d) Malocclusion is especially prominent if there is a fracture within the dental arch; however it may occur as retrusion of the maxilla which is common in horizontal fractures of the upper jaw.

(e) Trismus of the elevator muscles is a more common symptom of mandibular fractures. However it may be caused by functional interference due to impaction of fractures and displacement. This occurs with a depressed zygomatic fracture, preventing forward movement of the coronoid process of the mandible.

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(f) Neurological signs are of great significance and should be carefully recorded as the fifth nerve is frequently injured, and the area of anaesthesia should be noted.

(g) Pain is not generally present if the jaw is at rest, and can be used as a guide only if produced by manipulation or during mastication.

3. SIGNS AND SYMPTOMS OF MAXILLARY SINUS INVOLVEMENT

According to Simson Hall fractures of the paranasal sinuses may be diagnosed by inspection and palpation if the local swelling will permit, and above all by careful x-ray studies. Notes should be taken of any abnormalities in the nasal cavities and pharynx, and the sources of haemorrhage, and possible presence of cerebrospinal fluid.

Haematoma or haemorrhage may occur from the maxillary sinuses into the nasal cavity. Consequently the nasal passages may be blocked with clotted blood. Bleeding is by rupture of the infra-orbital and superior alveolar arteries, located in canals in the walls of the sinus. Spontaneous evacuation generally occurs through the ostium (Thoma).

Oedema of the overlying tissues is invariably present, and displaced fragments may be driven into the maxillary sinus.

Paraesthesia or anaesthesia of the cheek may be present due to injury to the infra-orbital nerve.

Diplopia with marked displacement of the orbital floor may be present.

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4. X-RAY DIAGNOSIS

Hutchinson states that diagnosis of fractures involving the facial bones is often difficult and too much reliance should not be placed on x-ray interpretation. He recommends the use of 30 degree occipitomenal views (or Water's Position) to show fractures involving zygomatic bones and arches, and the maxillary sinuses, particularly the lateral and superior walls. This ray also demonstrates the nasal septum, the lateral walls of the orbit, the frontal sinus region, and the coronoid process of the mandible. In addition A-P and lateral views are necessary. Of great diagnostic importance is a radiopacity of the sinus which is indicative of haemorrhage or blood clot in the cavity. Other clinical findings of radiographic significance are:

- (a) lowering of the orbital floor.
- (b) palpable abnormalities at the fracture line, due to:
 - (i) separation of the fronto zygomatic suture
 - (ii) a break in the region of the infra-orbital foramen
 - (iii) a separation at the junction of the zygomatic bone and arch.

Shea (1946) states that x-rays should be taken with the mouth opened and closed, so that the relative positions of the coronoid process and zygomatic arch may be better visualised.

5. TREATMENT

Fickling states that the sinus is regarded as a means of access and support - access to elevate the zygoma via the antral approach, and support which is given to the orbital floor by packing the sinus with ribbon gauze for from 10 to 18 days.

Disimpaction of Maxillary Fractures: Thoma states that in fractures extending through the middle of the maxillary sinuses and nose, there is often telescoping which makes it necessary to disimpact the fracture. This is accomplished by rocking the maxilla while pressure is applied downward, at the same time placing the left hand over the upper part of the head to steady it. If the maxillary sinus appears opaque in the x-ray view, indicating an accumulation of blood from haemorrhage of the superior alveolar vessels, the ciliated epithelium of the sinus may dispose of it without complications; on the other hand if pain combined with nasal discharge occurs, antral lavage is indicated.

Open Reduction of Horizontal Maxillary Fractures: This is used in cases of displacement where traction is ineffective either because of impaction or advanced healing. It may also be used in cases in which the walls of the maxillary sinus are comminuted and displaced (Thoma).

Operative procedure consists of exposing the outer surface of the maxilla so that the fracture line, extending

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from the pyriform aperture of the nose back through the outer wall of the maxillary sinus is visible. An instrument is forced into the fracture line, separating the fragments and mobilising them by leverage so that the fragment can be positioned gradually by extra-oral and intramaxillary traction.

Salinger (1950) reviews work by Seidel who discusses treatment of comminuted fractures. He suggests reduction of the fracture as soon as practicable with loose fragments replaced even though they may have only slender soft tissue attachments, as they often retain their vitality. Massive trauma to the upper jaw causing numerous fractures and injury to the soft tissues requires an exposure as for a Caldwell-Luc procedure and provision to be made for drainage. He advises that tooth roots projecting into the sinus should be left alone unless there is obvious presence of infection.

Open Reduction of Transverse Facial Fractures: This method is used in comminuted maxillary fractures or when the malar bones are grossly displaced or comminuted. Generally they are telescoped into the maxillary sinus and disarrange the floor of the orbit, the infra-orbital margin and the lateral wall.

Operative procedure consists of opening into the antral cavity, and aspirating the haematoma. The zygomatic bone is manipulated. Thoma suggests the use of a urethral sound into

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the antrum using it to reduce the fracture while palpating the infra-orbital margin and zygomatic arch. Loose fragments of the antral wall are then held in place by a strip of vaseline gauze. Packing is commenced at the posterior part of the cavity and fills it completely. The end of the gauze is brought out through the nose, and is removed after five to seven days. If the floor of the orbit has been comminuted the fragments must be replaced accurately, and the orbit elevated to correct the diplopia resulting from the downward dipping of the eyeball. Fixation is achieved by inserting a Penrose Tube bent upon itself, so that it touches the orbital wall, and turns down the posterior wall to the floor of the cavity. The ends protrude through the incision in the canine fossa. Iodoform gauze is then packed tightly through the loop of the drain until the level of the eye is normal. This pack serves to immobilise the fracture until sufficient fibrous tissue has formed to maintain a correct position.

In cases where the antral pack alone may not be sufficient for support, it may be necessary to restore the orbit by means of internal wiring. Similar fixation may be needed to close the distracted zygomatic frontal suture or to immobilise a comminuted zygomatic arch.

Other methods of fixation of middle face fractures may be external or internal. In external fixation rods or wires in most instances are extended from a type of skull-cap

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to immobilise the jaws or mandible in several ways.

Internal fixation is accomplished by means of wires. These methods are reviewed adequately by Thoma (1958), Rowe & Killey and Fry & Ward (1956).

Treatment of Zygomatic Fractures: Surgical treatment may be either extra-oral or intra-oral:

(a) Extra-oral reduction can be carried out by the Gillies Method which consists of elevation of the zygomatic arch by an elevator passed downwards and forwards under the temporal fascia. Usually the displaced fragments snap back into position and the facial deformity is eliminated.

(b) Intra-oral reduction would be used by most oral surgeons. It consists first of making an incision behind the zygomatic process of the maxilla, and passing the elevator up beneath the zygomatic arch until the fracture is reached. The displaced fragments are pressed outwards by lever action, a fulcrum consisting of rolled-up gauze or the operator's finger.

For treatment of zygoma and zygomatic arch fractures (Matthews, 1950) prefers Roger Anderson pins fastened to a headcap or appliance to packing the sinus; and Waggener (1947) treated a comminuted left malar bone through an oro-antral window. The sinus was packed, and a Penrose Drain or Tube (a rubber tube containing gauze) used to support the fragments.

Crowe (1959) treats zygomatic fractures which have orbital complications by packing the sinus to give support

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during healing. Nasal antrostomy facilitates the removal of the packing which is kept in place for twenty days.

Jackson et al. (1956) favour a balloon technique for fractures of the zygomatic bone. Treatment involves antrostomy followed by the insertion of a balloon into the sinus which is inflated with air to give support to the fragments. The authors list the following advantages:

- (a) The sinus does not have to be packed.
- (b) Positioning of the fragments is regulated by air pressure.
- (c) Cosmetic results are satisfactory.
- (d) Further alignment can be accomplished if necessary after the patient has recovered from the general anaesthetic.

The authors do not state the number of cases treated, and it would appear that the fractures must be in good position and the edges not comminuted.

Jarabak (1959) reports that displaced fractures of the zygoma can be reduced efficiently by the intra-oral trans-antral use of an inflated 30 cc Foley catheter. Occasionally, additional manipulation is required prior to inflation of the catheter which is kept in place for from seven to ten days. The catheter is removed easily at the termination of treatment, and the oro-antral opening usually heals rapidly. The author

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claims that the advantages of this approach are:

(a) There is direct visibility of the fractured bones and infra-orbital rim, and any impingement of the infra-orbital nerve can be observed.

(b) Trial attempts to position the fracture ends by inflating and deflating the tube can be done at the time of reduction.

(c) After reduction it can be supported by the inflated catheter.

(d) Constant drainage can be maintained through the catheter tube which is well tolerated. This facilitates the evacuation of a haematoma if present, and the sinus may be irrigated through the catheter when necessary.

6. COMPLICATIONS

Thoma states that maxillary sinus infection is not a common complication of middle face fractures in civilian practice. It may occur in transverse fractures of the face or in malar fractures involving the antrum, particularly if the patient has contracted a chronic maxillary sinusitis or ethmoiditis previous to the accident. A normal sinus may be infected, however, in compound and comminuted fractures with the entrance of a foreign body, an infected tooth, or the formation of a large haematoma (Ballenger and Ballenger).

Acute Osteomyelitis: is perhaps the most serious complication that may occur in fractures (Thoma). It always

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results in bone loss, often in non-union, and frequently produces deformity and interference with normal function. It is recognised by swelling, pain and tenderness; and x-ray is of great importance to expose the position of the bone and the formation of sequestra.

Chronic Osteomyelitis produces a fistulous tract into the mouth and more frequently to the skin. There may be acute exacerbations with swelling and increased pus discharge, but generally there is little pain and no systemic reaction. Bourgoyne states that the spread of infection to the orbit and paranasal sinuses threatens all cases of fracture of the cortical plate of the sinus; and once established there is no limitation of spread as in the mandible.

Cerebrospinal Fluid Rhinorrhea may occur in fractures involving the base of the skull. If the cribriform plate of the ethmoid is fractured haemorrhage or cerebrospinal fluid will escape from the nose; and in fractures involving the middle cranial fossa the fluid may be discharged from the ears. With C.S.F. discharge there is a great risk of intercranial infection, leading to such complications as meningitis and epilepsy (Lewin, 1954). C.S.F. is difficult to detect in the presence of severe nose bleeding and soft tissue damage.

Lewin found that in a selected group of 308 non-missile head injuries 23% showed C.S.F. rhinorrhea. Rowe and Killey

maintain that approximately 25% of people who sustain fractures which involve the paranasal air sinuses may be expected to develop the condition.

Subcutaneous Emphysema is one of the symptoms caused by fractures involving the nasal sinuses (Gottlieb, 1956). A well marked sub-cutaneous emphysema, Gottlieb claims, may be the only clinical sign of fracture of the facial bones. He reports that the condition occurred after the patients had blown their noses several hours after the accident, and subsided when nose blowing ceased. Presence of infection in the maxillary sinus makes nose blowing even more dangerous, and predisposes to phlegmon formation. In fractures involving the sinuses nose blowing is contra-indicated for three weeks.

DIFFERENTIAL DIAGNOSIS

Some diseases may exist and progress to an advanced stage, without being characterised by painful symptoms; this is generally true of neoplasms.

Pain however is generally the chief symptom of which the patient complains; and the reason for his seeking dental advice. A systematic accumulation of fundamental information concerning the distribution and character of the painful disturbance is essential to an adequate analysis of the condition.

The quality of pain may be pathognomic:

(a) throbbing or pulsating pain points to acute inflammation, especially when it is located within the bone or tooth.

(b) lancinating pain is characteristic of neuritis.

(c) sensitivity and soreness on light touch would suggest a superficial lesion.

(d) dull pain is more characteristic of a deep-seated condition.

The pain may be confined to the region affected; or it may radiate or be referred to other parts. This is particularly evident with pain of dental origin, due to the extensive distribution of the fifth nerve, when it may be referred to the eye, ear, nose, sinuses, temple forehead or occipital region. It is never referred, however, to the opposite side (Thoma, 1951).

Steps to Diagnosis(a) History:

Taking a complete history is as important as the examination itself. It should begin with the chief complaint and the patient should be permitted to explain it in his own words. The patient may be encouraged, however, by judicious questioning whilst guarding against the possibility of suggestion. It is important to enquire about the general state of mind as well as the general health. The history should provide information regarding:

(i) the location of pain

(ii) the quality of pain - aching, shooting throbbing etc.

(iii) time and interval between painful attacks; whether the pain is intermittent or continuous, regular or spasmodic; whether the pain occurs while eating or lying down, and whether a stimulus, thermal or otherwise, is necessary to initiate the condition.

(iv) the patient's method of relieving the pain.

(v) previous treatment and its effects.

(b) Physical Examination:

(i) General Inspection: This should commence with a general inspection of the appearance of the patient. The patient may look unwell and show signs of systemic disease by facial appearance, posture, speech, walk etc. Facial swelling may be noted, either unilateral or bilateral.

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(ii) Intra-Oral Examination: This is better carried out with the aid of artificial light to examine the appearance of the oral tissues for signs of inflammation or ulceration, swelling or other abnormalities.

Palpation: Systematic and orderly palpation of oral and facial structures reveals valuable information regarding changes in contour, texture, sensitivity, temperature, areas of pain and tenderness or conversely zones of paraesthesia or anaesthesia may be noted. Palpation is better carried out bimanually so that differences of the two sides will be apparent. Lymph nodes should be palpated, especially in the sub-mental, cervical and sub-maxillary regions. If nodes are normal they are generally not palpable. If affected, they may be either soft and tender as in acute inflammation, or hard in chronic inflammation.

(c) Radiographic Examination:

This is indispensable in establishing diagnosis; however this evidence alone without clinical corroboration is often misleading.

(d) Diagnostic Tests:

These are carried out in conjunction with x-ray evidence to determine pulp vitality or evidence of periapical or periodontal infection. Such tests include thermal, percussion, electrical, mobility and anaesthetic tests.

(e) Haematological Tests:

These are often called for in order to establish diagnosis of oral manifestations of systemic disease.

(f) Bacteriological Tests:

These are used to identify the organisms, and to assess their sensitivity to the various anti-biotics.

Signs and Symptoms Peculiar to the more Commonly Encountered Conditions Manifested by Facial Pain:

1. Maxillary Sinusitis:

(a) acute sinusitis

(i) frequently follows severe colds or influenza, or history of dental involvement.

(ii) sensation of fullness in the face, and a dull throbbing pain aggravated by jarring.

(iii) free discharge of pus through the ostium relieves the symptoms.

(iv) x-ray examination will reveal fluid level or oedematous membrane.

(v) transillumination tests positive.

(b) chronic sinusitis

(i) transillumination may be positive.

(ii) antral lavage discloses pus or mucous

(iii) x-ray examination most reliable - will reveal opacity of affected sinus; pus will give evenly fogged appearance; polyps show a spotted radio-opacity; and the lining membrane shows signs of thickening.

2. Other Sinus Infections:

These are differentially diagnosed by means of x-rays.

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Frontal sinusitis has the characteristic mid-day headache due to accumulation of fluid in the cavity.

3. Odontogenic Infection:

This may be present in conjunction with maxillary sinusitis; and indeed may have caused the latter condition:

(i) x-rays will reveal the presence of caries, periodontal or periapical infection.

(ii) vitality tests will show the presence of non-vital teeth.

(iii) percussion test will reveal the presence of periodontitis.

4. Cysts Involving the Sinus:

(i) x-rays will reveal the cyst outline and disclose the initiating periapical infection.

(ii) aspiration tests will reveal the cystic contents.

(iii) by injection of radio-opaque media diagnosis may be confirmed.

5. Tumours Involving the Sinus:

(a) benign:

(i) x-rays will show expansion of bone and obliteration of the sinus cavity.

(ii) may be no signs of infection or inflammation.

(iii) proptosis and diplopia in later stages.

(iv) biopsy will confirm diagnosis.

(b) malignant - differential diagnosis is difficult in early stages.

- (i) epistaxis
- (ii) ulceration through to the oral cavity
- (iii) x-rays show destruction of bony margins
- (iv) biopsy to confirm diagnosis.

5. Fractures Involving the Sinus:

- (i) history of trauma
- (ii) excessive mobility
- (iii) deformity
- (iv) x-rays showing radio-opacity of the affected sinus, and fracture of the bony margins.

6. Temporo-mandibular Joint Pains: (Bonica 1959, Schwartz et al. 1959)

- (i) limitation and pain of mandibular movement.
- (ii) deviation of the mandible toward the affected side.
- (iii) subluxation of the temporomandibular joint.
- (iv) condylar fracture.
- (v) spasm of the masticatory muscles.
- (vi) joints painful on palpation.
- (vii) auscultation reveals the presence of clicking or crepitus.
- (viii) x-rays show limited or excessive anterior movement of the condylar head.

(ix) the diagnosis is often confirmed by isolating the cause of the condition.

7. Unerupted and Impacted Teeth - commonly the cause of obscure neuralgia:

(i) x-rays

(ii) abnormal mandibular movement or joint disturbances.

(iii) it more commonly occurs when the teeth would normally develop - i.e. from 16 to 21 years, and with the third molars.

8. Facial Neuralgias - where pain involves a peripheral nerve distribution (Agnew, 1959; Epstein, 1950). It may be divided into primary and secondary. French (1945) classifies under major and minor.

(a) major - trigeminal neuralgia.

(i) pain is periodic and lancinating and of short duration.

(ii) older age groups.

(iii) absence of relief by removal of possible exciting causes.

(iv) unilateral distribution.

(v) excitability of attacks by peripheral stimulus.

(b) minor neuralgias which are secondary to disease of the various local structures:

(i) history of gradual onset.

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- (ii) pain is steady and prolonged.
- (iii) affected nerve branches are tender on pressure.
- (iv) relief is obtained when the cause is removed.

CONCLUSION

An attempt has been made to review the literature, and where possible to make some observations on sinus involvement. Under certain circumstances the maxillary sinus lies in the province of the rhinologist. However for affections of the maxillary sinus which are of odontogenic origin the dental surgeon is called upon to advise and to treat the conditions.

It must be apparent, after reading the subject matter presented in this paper, that a clinical knowledge of the maxillary sinus and the ramifications of oral pathology on the cavity is essential to the competent practice of oral surgery.

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