

5-1-1933

Para nasal sinusitis : a problem for the general practitioner

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PARA-NASAL SINUSITIS
A PROBLEM FOR THE GENERAL PRACTITIONER

by

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Presented to the Faculty of
The College of Medicine in the University of Nebraska
in Partial Fulfillment of the Requirements
for the Degree of Doctor of Medicine

1933

Omaha, Nebraska

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INTRODUCTORY AND HISTORICAL

The paranasal, or accessory sinuses of the nose, are associated with the general health of the individual just as closely as are the tonsils, the teeth, the gall bladder, or any other of the commonly accepted foci of infection in the human body. And yet, while diseased tonsils are recognized and removed in most wholesale fashion, while patients are advised to see their dentists at least twice a year, and symptoms of gall bladder disease are almost classical in their recognition and treatment, -- yet to the average "general practitioner" of today the question of the paranasal sinuses seems most vague, -- a problem for the "specialist".

In view of this state of affairs, it will be the purpose of this paper, not to introduce new material to the field of science, but rather to introduce to the general practitioner, the problem of paranasal sinusitis.

Some conception of the presence of the accessory nasal sinuses must have existed at a very early date (Schall)³⁶. For Hippocrates (400 B. C.) was apparently describing a case of purulent sinusitis when he said, "In a person having a painful spot in his head, with intense headache, pus or fluid running from the nose removes the disease". Moreover, Galen, several centuries later, wrote of the porosity of the bones of the head and probably knew of the sinus cavities. However, the first definite references were made by Berenger of Bologna and by Fallopius in the Sixteenth Century, while the first read de-

scriptions were made by Julius Casserius (1612), Nathaniel Highmore (1651), and Andre Versalius (1691). Casserius described the maxillary sinus, Highmore a case of suppurative disease of the maxillary, while Versalius wrote of the individual sinuses.

Little of significance was written from this period until the latter part of the Nineteenth Century. During this period an article by Charles Stedman Bull (1879) was published in American literature on "Inflammation of the Frontal Sinus", while shortly after numerous articles dealing with the ethmoid and maxillary sinuses appeared. At the same time European investigators began a rather intense study of the sinuses. Billroth studied the frontal sinus, Workes "Necrosing Ethmoiditis", Killian, Chiari and Jeanty "Empyema of the Antrum".

However, it was Zuckerkandl (1893) who discussed in detail the anatomy of the sinuses and nose, and by so doing is given credit for "Initiating the study of modern sinusology". Other contributors of this period were Ferreri, Grunwald, Tilley, and Luc. Luc is the originator of many operative procedures, some of which are still being used in the modern operating room.

Of the recent investigators should be mentioned the late Ross Hall Skillern, Proetz, Knowlton, McGregor, Hilding, and Myerson.

ANATOMICAL DISCUSSION OF NOSE AND ACCESSORY NASAL SINUSES

Resulting from the work of the investigators mentioned above, we have our modern conception of the paranasal sinuses and the problem of sinusitis. According to this conception these sinuses are cavities in the interior of certain of the skull bones, namely the frontal, the ethmoid, the sphenoid, and the maxilla. They all communicate either directly or indirectly with the cavity of the nose. They are lined with mucous membrane which is continuous, round the lips of the apertures of communication, with the mucous lining of the nose. The walls of the sinuses are composed of compact bone, and are lined with endosteum which is blended with the mucous lining. They act as resonating chambers for the voice, and by means of them the bones containing them, without increase of weight, gain increase of bulk and superficies necessary for the formation of the walls of the cavities of the nose, mouth, and orbits.

Due to their connection with the nose, in order to understand the accessory sinuses, it must first be necessary to know something of the structure of the nose itself.

The nose consists of two chambers, open anteriorly on the face at the nostrils, and which communicates posteriorly through the posterior nares with the nasopharynx. The two chambers are separated from each other by a mesial vertical septum, composed in its greater part of the central part of the central plate of the ethmoid bone, the vomer, and the septal cartilage, covered by the nasal mucous membrane.

The roof of each cavity is very narrow, and is formed anteriorly by the nasal bone, and nasal spine of the frontal bone, both directed downwards and forwards, its central portion consists of cribiform plate of the ethmoid, which lies horizontally; while, posteriorly, the roof has a downward and backward inclination, and is formed partly by the sphenoidal spongy bone or anterior wall of the sphenoidal sinus, and in part by the inferior surface of the body of the sphenoid bone.

The floor is formed from before backwards by the palatal plates of the superior maxillary and palate bones.

The outer wall of each chamber is very irregular, and has opening on it the accessory sinuses, namely frontal, ethmoidal, maxillary and sphenoidal. In front the bony wall is composed of the nasal process of the superior maxilla, with the posterior margin of which the lachrymal bone articulates. In the middle region is the lateral mass of the ethmoid bone above, with the inner surface of the body of the superior maxilla and the inferior turbinated bone at a lower level. Posteriorly, the vertical plate of the palate bone and the internal pterygoid plate of the sphenoid complete the outer nasal wall. Its surface is covered by mucous membrane.

The irregularity in the outer wall of the nasal cavity is due to the convoluted arrangement of bone known as the superior, middle, and inferior turbinated bones (conchae), or considered, in association with their mucous covering, turbinated bodies, or turbinals.

The space which intervenes between these three turbinals

and the nasal septum from roof to floor is the common meatus. The portion of the common meatus between the medial turbinal and the nasal septum is the olfactory sulcus. Overhung by each turbinal is a well-marked channel or meatus named according to the bone immediately above it, -- superior, middle, or inferior meatus. These channels correspond in length to the turbinal beneath which they are situated. The superior meatus is confined to the posterior third of the outer nasal wall, its anterior end terminating in a cul-de-sac. The middle meatus runs forwards for two-thirds of the extent of the nasal wall, and is visible from the anterior nares, although not reaching that opening. The inferior meatus, in relation to the floor of the nose, extends from anterior to posterior nares, anteriorly forming the opening of the naso-laryngeal canal.

Considerable importance must be attached to these meatuses, from the fact that the accessory nasal sinuses communicate through them with the nasal chamber. Both on anatomical and clinical grounds, the sinuses form two groups; -- First is the anterior group, -- maxillary, frontal and anterior ethmoidal cells. Second is the posterior group, -- the posterior ethmoidal cells and sphenoidal sinus. This anatomical grouping is based upon the relative positions of the orifices of these cavities. The air sinuses of the anterior group communicate with the middle meatus below the line of origin of the middle turbinated body, while those of the posterior group open into the superior meatus, -- that is, above the level of the middle turbinate.

The middle turbinal has a free lower border and the anterior end of the free portion is sometimes hollowed out into a small air space called the turbinal cell or "hiatus semilunaris", communicating by the "infundibulum" with the opening from the anterior ethmoid cells in 50% of the cases, and in 50% extending upward as the naso-frontal duct to the opening of the frontal sinus.

THE MAXILLARY SINUS

The maxillary sinus (formerly often called Antrum of Highmore) is a cavity of varying dimensions occupying the body of the maxilla. At birth the antrum exists merely as a slit-like indentation upon the outer wall of the nasal chamber, with a vertical diameter of about 3 mm., a transverse diameter of 2 mm., and an antero-posterior diameter of 7 mm. There is at birth no maxillary sinus beneath the orbit. The growth of the body of the maxilla, and with it an increase in the size of the face, takes place by the formation of a mass of cancellous or spongy bone between the alveolar process and the orbital plate of the maxilla, the alveolar process along with the teeth thus becoming separated from the orbital plate. Coincident with the increase in the cancellous tissue upon the facial and dentary aspects of the bone, a process of absorption apparently takes place upon its nasal and orbital surfaces, thus causing an increase in the size of the antrum. This simultaneous process of growth and absorption continues until the eruption of the third

permanent molar or wisdom tooth, at or about the 25th year of life. At that time the antrum reaches its complete or adult form.

In its adult form the antrum may be likened to a pyramid, having a roof, a floor, and three walls. Average measurements are 35 mm. in height, 30 mm. in antero-posterior depth, and 25 mm. in width. It is the largest of the accessory sinuses. Its roof is a thin plate of bone which on its upper aspect forms the floor of the orbit. The infra-orbital canal, which transmits the superior maxillary nerve and infra-orbital vessels as they pass to the face, lies in the roof of the cavity, sometimes appearing as a well-marked ridge which projects into the cavity in the angle between the roof and the facial wall.

The floor of the sinus is formed by the alveolar or dentary border of the superior maxilla, and consequently bears an important relation to the teeth and their sockets. It lies in the same horizontal plane as the floor of the nasal chamber. The layer of spongy bone between the roots of the teeth and the floor of the cavity varies in thickness; not infrequently small elevations are formed on the floor of the sinus by the projecting tooth fangs covered with a thin layer of bone. As a rule the floor is thinnest above the socket of the first and second molar teeth. With a few exceptions, the three molar teeth maintain the most constant relation to the floor of the antrum, while the second bicuspid comes next in frequency.

The posterior wall of the sinus is a thin plate of bone formed by the posterior or infra-orbital surface of the maxilla,

which separates the sinus from the infra-temporal and pterygo-palatine fossae. The posterior alveolar canals, conveying the vessels and nerves to the molar teeth, are situated in the lower part of the posterior wall.

The inner or nasal wall of the antrum may be considered as divided into an upper and a lower part by the inferior turbinated bone. That portion of the wall which lies below the attachment of this bone consists of a thin osseous plate which forms the outer boundary of the inferior meatus of the nose. The plate is thinnest immediately below the attachment of the turbinate, and in that situation offers the least resistance to exploratory puncture of the sinus. Sometimes this part of the wall bulges into the antrum, and diminishes the size of that cavity. Above the plane of the inferior turbinate the nasal wall is partly osseous, but mainly membranous, where it forms the outer wall of the middle meatus. In this region is situated the orifice of the antrum, or ostium, the margins of which are partly osseous and partly membranous. It lies immediately beneath the roof of the sinus cavity, a position which does not permit free drainage from that cavity to the nasal chamber. It is usually somewhat oval in shape, presenting a vertical diameter of from 2 to 6 mm. and an antero-posterior diameter of from 3 to 9 or even 18 mm. In perhaps 10% of cases (Logan Turner)⁴³ there is an additional opening, present in the membranous portion of the nasal wall, varying in size from that of a small pin-head to an aperture having a vertical diameter

of 8 mm. or more. It is situated in the posterior half of the inferior turbinate, and communicates directly with the middle meatus posterior to and at a lower level than the ordinary ostium. Consequently, when it is present, the secretion from the sinus will drain away more readily and tend to pass backwards into the naso-pharynx.

The anterior or facial wall of the maxillary sinus is formed by the facial surface of the maxilla. It is quite thin; close to its upper margin, but subject to slight variations in position, is the foramen transmitting the infraorbital nerve and vessels to supply the premolar, canine, and incisor teeth. The average height of the foramen above the extremities of the teeth roots is 1.3 cm. The facial wall is limited externally^{by} the prominent molar ridge. In front, this surface is marked by the canine ridge, corresponding to the socket of the canine tooth; in an antrum of average dimensions this ridge indicates externally the line of union between the facial and nasal walls of the cavity. Between the canine and molar ridges lies the canine fossa, varying considerably in depth. Occasionally the facial wall is markedly depressed, thus the size of the antral cavity becomes greatly diminished.

THE FRONTAL SINUS

The frontal air sinuses are two cavities with an intervening bony septum, lying immediately above the root of the nose

between the two tables of the frontal bone. They extend vertically upwards for a varying distance, and in many cases also horizontally backwards between the two tables of the orbital plate. They are not present at birth; it is generally held that the sinus commences to develop at the end of the first or at the beginning of the second year of life, as an upward expansion of the ethmoid cell labyrinth. The diverticulum of mucous membrane from the ethmoid air space gradually invades the diploe upon the nasal aspect of the frontal bone. As it extends upwards and outwards, expanding the frontal tables in its growth, it reaches in the 6th or 7th year above the fronto-nasal suture and supra-orbital margin, and can be recognized as a distinct cavity above the root of the nose.

There has been difficulty in estimating either the rate of growth or the period at which the frontal sinus reaches its maximum development. It is conceivable that the maximum growth is reached in early adult life when the facial and cranial bones have been fully formed, but some anatomists affirm that the sinuses continue to increase in size up to old age. At any rate there are great variations in size, and also some variation in shape. However three walls may be recognized, -- an anterior, a posterior, and an inferior wall or floor, with an average size of 30 mm. in height, 25 mm. in transverse width, and 20 mm. in antero-posterior depth, with the two cavities separated from each other by an intervening bony septum, sometimes described as the internal wall of the sinus. This septum between the right and left sinuses is usually median inferiorly and bent to one

side above. The sinus is related inferiorly to the orbit, the nose and the anterior ethmoid cells; postero-superiorly to the cranial cavity and the brain.

The fronto-nasal opening, or frontal ostium, lies in relation to the septum of the sinus, and is situated in the lowest part of the floor, which favors drainage from the cavity. In 50% of the cases this opening leads directly into the nasal cavity as the naso-frontal duct; in the other 50%, one of the anterior ethmoidal cells is converted into a passage, called the infundibulum, by means of which the sinus drains into the middle meatus; for the upper end of the infundibulum opens into the sinus and its lower end opens into the upper or anterior end of the hiatus semilunaris.

Not infrequently supernumerary frontal sinuses occur. Schaeffer has found as many as six in one skull, while Eryer has reported five. These are usually explained by the fact that they are anterior ethmoid cells which have eroded into the frontal. Quite frequently an ethmoid cell develops in the floor of the frontal sinus and such cells may encroach upon the naso-frontal duct and make it very tortuous.

THE ETHMOID CELLS

The ethmoid cells are situated in the lateral masses of the ethmoid bone. These cells are irregularly placed, and are of irregular size and shape. They are divided into two main groups, the anterior and the posterior. All the cells which

communicate with the middle meatus of the nose below the line of origin of the middle turbinate bone, are anterior ethmoidal cells, while those that communicate with the superior meatus above the origin of the middle turbinate are posterior ethmoidal cells. The relative space occupied by each group in the lateral mass is not constant, nor is there any regularity in the number of cells which each contains. Thus, in one skull, the anterior group of cells may extend backwards, so as to be in close proximity to the sphenoid bone, in another the posterior cells may reach far forwards. Schaeffer has found that the number of cells in the anterior group is slightly greater than in the posterior group. He has shown the variation to be from 2 to 8 and 1 to 7 respectively. In size the posterior cells are somewhat larger on the average than the anterior.

The earliest indications of ethmoid cells occurs at about the 4th month of fetal life. They are small evaginations of the nasal mucosa which arise from the accessory furrows, or recesses; they sometimes develop directly from the lateral wall of the superior and middle meatuses. According to Schaeffer, in about 60% of skulls a sphenoid-ethmoidal recess is present, and in 74% of the cases, a posterior ethmoid cell develops from it. By the 7th month of fetal life the ethmoid evaginations have taken the form of small tubular outgrowths and at term these cells are considerably developed. Schaeffer takes the view that the measurements of the cells at this time average 5 X 2 X 3 mm. for the anterior group, and 5 X 4 X 2 mm. for the pos-

terior group. These cells gradually increase in size, and reach the adult condition at about the 20th year. It is quite common for these ethmoid cells to erode beyond the normal limits into the frontal, lacrimal, sphenoid, maxillary, or palate bones. Some of these cells may also invade into the middle nasal concha, the agger nasi, or the unciniate process, and form separate cells in these bones.

THE SPHENOID SINUSES

The sphenoid sinuses are two in number, and occupy the anterior portion of the body of the sphenoid bone; a verticle, mesial bony septum intervenes between the two cavities. Occasionally one or even both may be absent.

According to Schaeffer the sphenoid sinus or its antigen may be first seen at about the fourth month of fetal life. At this time it is the sinus terminalis, and is a small recess in the posterior and dorsal part of the cartilaginous nasal capsule. The capsule must first be eroded before the sinus terminalis can come in contact with the sphenoid bone. Usually by the end of the third year of life, the sinus is surrounded by bone, except for a small constricted portion of its ventral wall which is subsequently destined to become the ostium.

At birth, the sinus terminalis is about 2 X 2 X 1.5 mm. in size. Growth after this time takes place gradually until the adult size is reached, which usually is around the 20th year. The size of the adult cavity is subject to a certain amount of

variation in different skulls, and irregularity in its dimensions on the two sides of the same skull is not infrequently seen. These variations depend upon the amount of absorption which takes place in the cancellous bone in which they are formed. Thus the cavities may be limited to the anterior part of the body, or may reach as far as and even into the basi-occipital behind, and extend laterally into the bases of the great wings, and superiorly into the lesser wings of the sphenoid. Consequently the larger the size of the cavity, the thinner are its walls, and vice versa. Logan Turner found the average diameter of the sinus to be 20 mm. vertical height, 21 mm. antero-posterior depth, and 18 mm. transverse breadth, the left sinus being larger than the right most frequently.

Each sphenoid cavity has six walls, -- a roof, floor, anterior, posterior, internal, and external boundary. The roof approaches the horizontal plane, though with an inclination downwards and backwards. The plate of bone forming it is usually thin. It may measure less than half a mm. in thickness or as much as 2, 3, or more mm. It is related to the following intracranial structures, --

(1) Frontal lobes of the brain, and the olfactory tracts, lying on the anterior part of the body of the sphenoid.

(2) The optic chiasm, lying above the optic groove.

(3) The hypophysis cerebri (pituitary body), lying in the hypophyseal fossa.

(4) The pons and the basilar artery, lying on the clivus.

The floor of the sinus forms the most posterior part of the roof of the nasal chamber, and is related inferiorly to the cavity of the naso-pharynx and the naso-pharyngeal meatus. The bone is not of the same uniform thickness throughout, and may vary from less than $\frac{1}{2}$ mm. to more than 2 mm.

The anterior wall occupies mainly the vertical plane, but in its lower part it inclines somewhat backwards and downwards to meet the floor. The sphenoidal spongy bone by which this wall is formed is extremely thin, and measures as a rule less than $\frac{1}{2}$ mm. It is in this wall that the ostium is found and it may open into the superior meatus or into the sphenoidal recess. This ostium varies somewhat in its position, but in the majority of cases it is situated in the upper half of the anterior wall; that is, it lies nearer the roof than the floor of the sinus, and consequently cannot serve as an efficient drain. In size it varies from $\frac{1}{2}$ X 1 mm. to 4 X 4 mm. The cavity is related anteriorly to the upper part of the middle section of the cavity of the nose and the posterior ethmoidal cells.

The posterior wall of the sinus has no important relations and needs no mention.

The external lateral wall of the sinus is formed of a very thin plate of bone and is related to the following structures: --

(1) The optic nerve in the optic foramen, and the apical part of the orbit.

(2) Behind the above, the cavernous venous sinus, in the

walls of which the internal carotid artery, the 3rd, 4th, 6th and ophthalmic nerves are embedded.

(3) The maxillary nerve, as it runs forward along the lower border of the cavernous sinus and as it passes through the foramen rotundum.

The internal lateral wall or septum lies vertically between the two cavities, and occupies the mesial plane. It is bony throughout, and usually complete. Deviations from the mesial plane are sometimes met with, and when marked, give rise to considerable irregularity in the size of the two cavities.

NORMAL HISTOLOGY

The sinuses are all lined by a delicate vascular muco-periosteal layer, continuous with the mucous lining of the nose. Normal mucosa or a mucous membrane without signs of pathology in the sinuses is one containing a relatively thin connective tissue stroma, with few elastic fibers. Blood vessels are quite numerous, especially just beneath the epithelium. The epithelium consists of a layer of pseudo-stratified ciliated columnar cells, resting upon a thin basement membrane. Goblet cells occur scattered here and there among the ciliated cells. As a general rule, the ethmoidal cells contain a greater number of goblet cells than do the other sinuses (Schall)³⁶.

ETIOLOGY AND INCIDENCE OF PARANASAL SINUS INFECTION

As may be seen by a study of the anatomy of the sinuses with their connection with the mucous lining of the nose, it may be said that probably every case of acute rhinitis is accompanied by acute infection of one or more of the accessory sinuses. Of course the expected course of this infection would be a clearing up with the curing of the rhinitis. However, in many cases the sinus condition persists, to become a chronic infection.

Moreover, acute rhinitis or the common cold is but one of many etiological factors resulting in sinusitis. Any condition which interferes with free nasal ventilation and drainage acts as a predisposing factor. Hypertrophic nasal and pharyngeal mucosa resulting from enlarged infected tonsils and adenoids, pale boggy mucosa associated with allergic conditions, enlarged and malformed turbinates, septal deviations, ridges or spurs, cleft palate (in infants), traumatic deformities of the nose, foreign bodies, and obstructing tumors all must be considered.

Then there are general predisposing causes, as endocrine disorders, metabolic disturbances, and lowered resistance from unbalanced or deficient diets. Cody¹⁰ has shown by extensive investigation that vitamins A and B are necessary to maintain proper nutrition of the nasal, aural, and tracheal mucosa with

proper resistance against disease. Wherry⁴⁷ has shown that variations in tissue hydration and dehydration have an important bearing upon susceptibility and immunity. Allergic manifestations in the nose and sinuses are most certainly often important predisposing factors, if not the actual causative agent. That is, allergy is fundamental in the individual and consists in the capacity to develop hypersensitiveness to foreign substances. Sinus disease may then be a manifestation of allergic disease in the sinus membranes.

Other predisposing factors are lack of sunshine, unfavorable climatic conditions, swimming and diving.

Finally, sinusitis may develop as a complication or sequel to acute colds (already mentioned), acute tonsillitis, measles, scarlet fever, whooping cough, pneumonia, influenza, acute specific fevers, injuries, operations, injudicious douching, or dental disease.

Bacteria are invariably present in cases of sinus disease. Kistner²⁵ in a study of cultures taken from 400 diseased sinuses, found a mixture of bacteria in practically every case, although in chronic cases he seldom found a pure culture. He found Streptococcus to be most constant, present in 94.5% of the cases. 33% of these were hemolytic B, 33% hemolytic green producing or A, 14% Streptococcus Viridans, and 18% non-hemolytic or gamma type. In addition to and in combination with the Streptococci he found in order of frequency: (1) Staphylococci; (2) Micrococcus Catarrhalis; (3) Pneumococci; (4) Friedlanders

B; (5) Influenza B.; (6) Colon B.; (7) Diptheroids; and (8) Streptothrix.

Logan Turner⁴⁶ states that about 60% of individuals have chronic sinusitis. Perhaps this is rather an extreme statement, but at any rate the high incidence of sinus disease is borne out by Frankel, Hark, Kiaer, Lapelle, and Wertheim. (Turner)⁴³ They performed post mortems upon accessory sinuses in individuals dying from various causes, with the sole object of ascertaining the frequency of suppuration in these cavities at time of death. Kiaer, in 195 cases of adults, found pus in 88 cases, with the maxillary involved most frequently, then the sphenoid, ethmoid, and frontal. Lapelle, in 169 cases, found affection of the sinuses in 55 cases, with the maxillary first, sphenoid second, ethmoid third, and frontal last. The others showed quite similar results, which bears out the fact that if the affection had not risen in connection with the fatal illness, then many individuals had gone about during life with some affection of these cavities.

These same investigators found a combination of infected sinuses frequent. Here are their conclusions:

- (1) The maxillary is most often involved by itself.
- (2) The most frequent combination is frontal and ethmoid.
- (3) A combination of frontal, maxillary, and ethmoid involvement is frequent.

Kiaer found that in 13 cases of frontal, the maxillary

on the same side was involved in seven cases.

Lapelle found that in 5 cases of frontal, the maxillary was involved in three.

Jansen found in 8 cases of frontal that the ethmoid was involved in all 8 cases.

Milligan found that in 15 cases of frontal, one or more of the other sinuses were involved in 14 cases.

Walker Downie found that of 6 cases of frontal, 5 had in addition ethmoid.

Grunwald found that in 45 cases of sphenoid involvement, only 9 cases were sphenoid alone.

It is a mistake to consider sinusitis a disease of only the adult. Davis¹² has written an excellent paper on Sinusitis in Children, in which he states that from earliest infancy paranasal pneumatization is sufficient to make sinusitis a condition to be considered clinically, not only in cases with readily demonstrable infections, but also in many cases with obscure symptoms and uncertain etiology. He believes that the majority of sinus infections in children occur between the fourth and ninth years. But he cites cases of proven maxillary sinusitis in infants as young as 13 days.

PATHOLOGY OF PARANASAL SINUSITIS

According to Turner⁴³, paranasal sinusitis may be acute or chronic, and is characterized by such changes as are usually associated with inflammation of a mucous membrane. These vary with the severity of the infection, and are modified according to the patency or occlusion of the orifice of the cavity.

In acute inflammation, the mucosa is congested, infiltrated with round cells, and swollen, while a serous exudation is poured out, constituting an acute catarrh of the membrane. This exudation may become purulent, or sero-purulent, or muco-purulent. If the ostium is blocked by the swollen mucous membrane, exudation is retained under tension, and clinical symptoms and signs are aggravated. With this acute process there may be a spontaneous cure, or the process may become chronic.

The present conceptions of chronic sinus pathology are based largely on material removed at operation. The process is considered to be an inflammation with epithelial hyperplasia. A number of histopathological classifications are given. Runge considers chronic inflammation of the sinuses as chronic catarrhal and chronic purulent, both hyperplastic. (Dunn & Dunn)¹⁴ The latter he sub-divides into (1) an edematous or hypertrophic type, (2) a granulomatous or papillomatous type, and (3) a fibrotic type. Eggston¹⁵ gives another

classification as follows:

(1) Hypertrophic or polypoid sinusitis, which is characterized by thickened and edematous changes in the mucous membrane and periosteum and is usually associated with polypoid masses of the soft tissue and rarefaction of the bone.

(2) Atrophic, fibrotic, sclerotic, or arteriosclerotic sinusitis, which is characterized by an increase in the fibrous connective tissue in the stroma, thinning of the mucous membrane, and metaplasia of the surface epithelium, associated with thickening of the periosteum and condensing osteitis.

(3) Mixed type, which results from a combination of the hypertrophic and fibrotic changes in the same patient, or even in the same sinus cavity. This type is characterized by rugae and sulci, with the production of a papillated type of membrane.

Whichever of the above classifications is accepted, it seems evident that the various types described are merely different reaction patterns in the same pathological process. Dunn and Dunn¹⁴ bring out the fact that the multiplicity of pictures observed are conditioned by varying tissue responses to irritants, by the number, character, and duration of acute infections, and by varying degrees of swellings and unswellings, which may profoundly change the reaction patterns in relatively brief intervals of time. Thus one may obtain sections from a single sinus which run all the histopathological patterns described by various men as different types of hyperplastic disease.

The question of regeneration of normal sinus mucosa after it has been destroyed by pathological processes or by surgical removal is under dispute. Gorham and Bacher¹⁷ say that they found complete regeneration of the maxillary lining, including ciliated columnar epithelium in from three to five months following surgical removal. Coates⁹, Morrison, Ersner, Knowlton & McGregor²⁶ found similar results. However, Kistner²⁴ argues to the contrary. He has studied the problem most extensively and his theory would be one to consider most seriously. In 400 cases of biopsy he has not seen a single case of regenerated glands and ciliated epithelium. In one case out of 15 he has found regenerated squamous epithelium. He believes that repair is simple scar tissue covered with stratified columnar epithelium and shows complete absence of glands. The assumption of other men to the contrary would be due to lack of adequate microscopic study.

SINUS INFECTION IN RELATION TO SYSTEMIC DISEASE

There has been considerable argument as to just what significance the paranasal sinuses may have as foci of infection. However, information of the present day seems to leave no doubt as to a definite connection between paranasal sinusitis and systemic disease. That sage old English authority, Herbert Tilley⁴², with a life-work of scientific investigation back of him, made the following statement just last year, "A focus of sepsis in the higher sinuses has a close anatomical relationship with the brain and the meninges, and with the contents of the orbit; the purulent discharge may find its way into the larynx, trachea and lower air passages with evil results; it may be swollen with a sequence of gastro-intestinal disorders; it may be carried by the blood-stream, or lymphatics; its organisms or toxins may produce lesions in joints, in the Central Nervous System, or may cause mild general toxemia."

And Herbert Tilley's statement is borne out by case after case of illustrative disease. Intra-cranial complications may occur secondary to suppuration in any of the sinuses, though not so often with the maxillary. This occurs more frequently following chronic infections, but may occur in acute stages. The secondary infection may result from caries or destruction of the sinus wall, causing direct communication with the cranial cavity, or it may spread inwards

through the venous channels or lymphatic vessels. Some cases pass from the orbit along the ophthalmic veins to the cavernous sinus.

Perforation of the posterior wall of the frontal sinus, or of its roof may be followed by extradural, subdural, or cerebral abscess; purulent basal or general meningitis, thrombosis of the cavernous, petrosal or superior longitudinal sinuses may result from destruction of an ethmoidal or sphenoidal wall.

An ever-increasing number of such cases with fatality are being recorded. Often it is found only at post mortem that the sinuses have been the real cause for the intracranial complications. Davis¹² reports a case of suppurative maxillary sinusitis in a 13 day old infant, with bone destruction so rapid that spontaneous perforation of the anterior maxillary wall occurred, with death resulting from pyemia, multiple metastatic brain abscess and septic pneumonia; he reports another case of ethmoiditis in a 6 weeks old infant resulting in death from orbital abscess and meningitis. Implication of the orbit with temporary or permanent injury to the eyeball and its annexa not at all infrequently occurs.

Worthy of note is certain original work brought forward by F. A. Pickworth³¹, together with evidence from the literature, showing that the cerebral arteries may be adversely affected by contiguous sepsis of the sphenoidal sinus and naso-pharynx. The mechanisms by which this takes place may be diffusion of toxic substances, centrifugal spread of or-

ganisms, and irregular constriction or dilatation of cerebral vessels due to involvement of the sympathetics.

Probably the most extensive study of the relation of sinus infection to systemic disease has been made by Jones and Kistner²². They made an analysis of 750 cases of patients upon whom radical sinus operations had been performed for varying diseased states. From this analysis they concluded that the following groups have a definite etiologic relationship between their sinuses and the particular systemic disease, and are thus benefited by radical sinus operations:

- (1) Chronic bronchitis and asthma.
- (2) Chronic septic arthritis.
- (3) Chronic anemia.
- (4) Organic heart disease.
- (5) General malaise.
- (6) Neurologic group as mobility disorders, toxicoses, chorea, epidemic hiccup, and periodic hyperpnea.

Potts³³ supports Jones & Kistner regarding the question of asthma by stating, "In reviewing the literature on asthma of the past three or four years, one of the outstanding facts is the swing of opinion back to the nose and nasal accessory sinuses as a contributing factor, if indeed not the seat of the nervous reflex, that causes the spasms we call asthma." Potts gives five case histories supporting his contention, and concludes,

"This series of cases serves to illustrate the point I

wish to make, which is simply this; that asthma secondary to nasal infection requires for its relief the same complete removal of infection in the nose and nasal accessory sinuses which has been so ably advocated by the leaders of the profession for diseases due to focal infections."

Smith⁴¹ states that Louis reported 39 cases of asthma, all having chronic hyperplastic ethmoiditis as a cause, Bishop 50 cases, and Brown 27 cases. Louis reported 35 cases of cure from radical ethmoid surgery alone in 39 operated cases; Bishop reported 40% complete cures, improvement in 56% and no result in 2% of 50 operated cases. Brown reported 6 complete cures, 12 marked improvements, 7 slight improvement, and 2 with no result in 27 cases. Smith himself reports that a large majority of his cases of asthma were cured and all the remainder markedly relieved by radical sinus surgery.

Watson⁴⁵ argues for the sinuses as a focus of infection.

Davis¹³ states that the number of chorea patients with sinus infection in the Doernbacher Hospital has been 25% of the total number of chorea patients, and he cites case histories showing complete cure by radical sinus operation.

Mullen²⁸, in a review of sinus-chest infections shows a definite connection between sinus and chest disease.

Carmack⁷ presents four cases of bloodstream infection, recovery occurring only after sinus surgery.

Campbell⁶ states that in 1929 Fowler found that in 100 cases of diseases of the ear in children, 86% had an involvement of the sinuses.

Finally, Dunn and Dunn¹⁴ list the symptom complexes which they have seen associated with sinus disease, and in which they seem reasonably certain sinusitis is a determining or aggravating factor:

- (1) Headaches, acute and recurrent.
- (2) Eye strain.
- (3) Febrile states, simulating typhoid, endocarditis, low grade sepsis.
- (4) Toxic conditions -- athrepsis, marasmus, debility, certain anemias.
- (5) Bronchitis, acute and chronic (occasionally misdiagnosed as tuberculosis), bronchiectasis, lung abscess.
- (6) Allergic troubles -- asthma, hay fever.
- (7) "Fog", "thick-head", asthenia, neurasthenia, mental disorders.
- (8) Focal complexes, such as arthritis, myalgia, nephritis, myocarditis, neuritis, herpes, colitis, etc.
- (9) Tic, convulsif, spasmodic torticollis, athetoid conditions".

So we must conclude that without doubt, the paranasal sinuses have a definite relationship to systemic disease. In some cases to be sure, the relationship may be that of having a common etiological factor; but in the vast majority of cases the sinus condition is the etiological factor itself, with the systemic disease occurring secondarily.

SYMPTOMS AND DIAGNOSIS OF PARANASAL SINUSITIS

Acute inflammation of the paranasal sinuses often accompanies an acute coryza or common cold. It is characterized by a feeling of fullness of the head, or tension, with slight aching, often aggravated by stooping, straining, coughing, or pressure.

If it involves the maxillary sinus or sinuses with the ostium occluded, there may be swelling of the cheek, edema of the lower lid, with partial closure of the palpebral fissure, and great tenderness over the maxillary area. Involvement of the frontal sinuses gives supra-orbital pain, headache, and ocular pain, with possibly conjunctivitis and photophobia. Involvement of the ethmoid and sphenoidal sinuses gives an aggravated form of nasopharyngeal inflammation, with frontal or vertical headache, and pain behind the eyes. In the nasal cavity, even though there is not an acute rhinitis accompanying the sinusitis, there will still be a region on the wall adjacent to the ostium of the infected sinus, which presents an inflammatory appearance.

As before stated, it has been estimated that about 60% of individuals have chronic sinusitis.⁴⁶ It may follow directly in the wake of an acute infection, with definite clinical symptoms, or it may develop insiduously with symptoms often masked. Frequently there is increasing poor health, sleeplessness, inability to concentrate, headache, malaise,

or more of the symptom complexes mentioned under Pathology. In addition there may be local symptoms as a typical headache syndrome, persistent nasal discharge, especially unilateral in type, post nasal discharge, and a characteristic stuffiness of the head, or inability to breathe freely through the nose.

To establish the presence of chronic sinusitis the following factors are to be considered.

(1) Clinical History.

Under clinical history it is well to consider the following sinus factors. (Dunn & Dunn)¹⁴

- (A) Any of the "sinusitis complexes" appearing as systemic disease.
 - (B) Facies, "dull, puffy, weary eyes", "swollen nose and face", mouth-breathing, nasal twang.
 - (C) History of onset with a remote or recent "flu", with repeated colds, or following dental extractions, or undue sweating and chilliness.
 - (D) History of chronic catarrh with nasal discharge, or or pharyngeal drying.
 - (E) Lateral pharyngeal lymphangitis, with visible mucoid, muco-purulent, or purulent secretions in the nasopharynx.
 - (F) Cervical adenopathy, especially of posterior chains.
- (2) The present condition of the mucous membrane of the nose; the discharge, where it comes from, its character, how quickly it reforms after cleaning out, etc.
- (3) X-ray findings. (Well taken, and carefully interpreted.)

The X-ray, has, of later years, developed from merely an agent to ascertain the size and contour of the sinus cavities to one of considerable worth in determining their internal pathological conditions. Herman B. Philips³² has written a splendid article upon the value and qualifications of X-ray or Roentgen examination of the paranasal sinuses, in which he stresses the following points:

(A) A minimum of six exposures is essential for a comprehensive roentgen study of the the paranasal sinuses, permitting each sinus or group of cells to be studied in at least three projections.

(B) Variations in technic are outlined to standardize and popularize these exposures.

(C) The fronto-antral exposure must be made in the erect position with the elimination, whenever possible of superimposed shadows of the petrous temporal and posterior fossae of the skull.

(D) Films showing traces of motion or faulty posing must be rejected.

(E) Anatomic variations must be given proper consideration in the interpretation of the roetgenograms.

(4) Transillumination.

By transillumination we refer to the passage of rays of light through the walls of a cavity from one surface to another. The rationale of this diagnostic method (Skillern)³⁹ is to place a small electric light (6 - 8 Volt) in such a

position that the rays of light will penetrate the sinus, thus permitting one to obtain an idea of the internal conditions. For this purpose an absolutely dark room is required.

For the maxillary sinus the light is placed in the patient's mouth and the current applied until the face is luminous. This will also illuminate the maxillary sinuses. If one sinus remains decidedly darker and the other light, we assume that some affection is present in the dark sinus which excludes, to a greater or lesser degree, the light. The dark shadow is, of course, in direct ratio to the density of the affection. In addition to direct transillumination of the anterior sinus wall, light in the pupil, translucency of the infra-orbital region, and susceptibility of the patient toward light of the lamp, on the sound side are diagnostic signs. Pathology preventing the passage of the light may be pus in the cavity, thickened membrane, or solid antral growth.

For transillumination of the frontal sinus, a metal or rubber cover is placed over the lamp so that the rays will escape only at the tip. The end of this is applied firmly against the floor of the frontal sinus at the inner angle of the eye, care being taken to exclude all light from escaping. The best instrument to use is the double lamp, so that comparison can be made without changing. The current is applied and the two sides compared. If one appears considerably lighter than the other, it is presumed that the side remaining dark is diseased.

Logan Turner⁴³ concludes that transillumination is not only a test of very considerable diagnostic value in determining maxillary disease, but that it also further assists in arriving at a knowledge of the progress of the case towards recovery. That is, when a diseased cavity has been previously opaque, and then after treatment, is found to illuminate, we have evidence of the restoration of its lining membrane towards a more normal condition. However, Turner draws somewhat different conclusions regarding transillumination of Frontal Sinus disease, as follows:

(A) One or both sinuses may be absent, and when this condition exists, there is opacity on one or both sides of the skull.

(B) A certain proportion of healthy sinuses fail to illuminate; this may occur on one or both sides of the skull.

(C) The sinus on one side may illuminate with less brilliancy than its fellow, although both are perfectly normal.

(D) Many sinuses contain pus, and still illuminate.

However, transillumination of the frontal sinus should be practiced, to be used in addition to other diagnostic aids. Moreover, it may be used as a very valuable pre-operative practice, to dispel any doubt as to the existence or non-existence of the sinus, and to map out the dimensions of the sinus walls.

(5) Examination of the throat, to determine the presence of post-nasal drippings, or possible congestion associated with the sinus condition.

(6) Syndrome of headache.

The headaches accompanying sinus disease may present a definite syndrome. They are often characterized by a periodicity, occurring at the same time during the day, usually forenoon, and disappearing with night-fall (sometimes called sun headache). In certain other cases the patient may be relatively free from discomfort for days and even weeks at a time. The head pain is intensified by constipation, straining at the stool, stooping, sudden jarring, severe mental work, and loss of sleep.

The pains are mostly referred thru the various branches of the trigeminal nerve -- ophthalmic, superior maxillary, inferior maxillary, and occipital. The character of the headache varies between the sharp twinging of neuralgia and a heavy, full benumbed sensation. It is believed that individual sinuses show some predilection for causing pain in certain defined regions. Skillern³⁹ illustrates this by the following diagram

Schematic illustration of pain areas due to sinus disease.

1. Acute maxillary sinusitis. 2. Acute frontal sinusitis.

3. Chronic frontal sinusitis. 4. Chronic ethmoidal inflammations. 5. Chronic sphenoidal sinusitis.

Following are a few additional points to note in differentiating between the various sinuses or groups of sinuses.

Diagnosis In Anterior Group:

3 - 5% cocaine may be used to reduce the inferior turbinate and look for evidence by anterior and posterior rhinoscopy. Any pus or redness should be considered suspicious.

Maxillary Sinus Diagnosis:

Pus is usually back further between the middle and inferior turbinal when the maxillary sinus is involved than in frontal involvement.

The "posture test" is of value. In this test the middle meatus is cleansed, the head bent forwards with the cheek of the suspected side uppermost, and held so for 4 - 5 minutes. The reappearance of pus points strongly toward escape from the maxillary sinus.

An "exploration test" is often used with good results in the maxillary. This test consists of entrance into the suspected sinus in one of two ways; (1) Through the lateral wall of the inferior meatus or (2) through the membranous portion of the middle meatus.⁴⁶

In the first method, the equipment required is a proper syringe, a suitable trocar, and cannula (sterilized). 0.5%

cocaine pledgets are inserted in the nose for 5 - 10 minutes. The trocar is then applied backwards, upward and laterally to a point just beneath the point of attachment of the inferior concha (or turbinal), where the bone is the thinnest. The syringe is attached to the cannula, the head inclined over a basin, lotion gently injected, and its character noted as it escapes at the ostium.

In the second method a blunt pointed cannula is applied above the middle third of the inferior concha in back through the membranous portion of the middle meatal wall, then laterally and slightly downwards. A syringe is then applied to the cannula, using suction instead of lavage, and noting the contents of the removed fluid.

Frontal Sinus Diagnosis:

After determining in the first place the condition of the maxillary sinus and washing it out if affected, reappearance of pus in the middle meatus with the head maintained in the erect posture, associated with tenderness on pressure upon the floor of the frontal cavity, furnishes presumptive evidence of frontal disease. The distinctive shadow in the sinus area and the blurring of the outline (by X-ray) make the diagnosis extremely probable. Finally, if the cannula can be accurately passed into the sinus and pus blown or washed out, the diagnosis can be established with more or less certainty.

Anterior Ethmoidal Diagnosis:

Diagnosis here is largely by exclusion. Mental depression, inability to concentrate, and even impairment of memory are more typical here than in the other sinuses. There may be a loss of smell and a greater degree of nasal obstruction. Pus and polypi are significant; the polypi are pink or reddish, rather than gray. X-ray is important.

Diagnosis of Posterior Group:

Posterior ethmoid and sphenoidal disease is characterized by an accumulation of secretion in the back of the nose with the desire to clear the passages by drawing it back and hawking. This secretion has a tendency to dry and form crusts in the posterior nares and posterior wall of the naso-pharynx. This may cause a disagreeable odor perhaps, although unnoticed by the patient, due to anosmia. Localization of pain in the occipital, temporal or vertex region may be misleading. Close contact to the optic nerve, oculomotor nerve and maxillary nerve of the trigeminal may lead to visual disturbance, ocular paralysis and neuralgia. On posterior rhinoscopy pus in the superior meatus on the surface of the middle turbinal is a significant sign. By X-ray the size of the cavity, the thickness of the anterior wall and the proximity of the anterior wall to the floor of the cranial fossa may be ascertained, as well as haziness of outline.

Finally there may be another "exploration test". In

this test the middle turbinal is removed. With a tampon on the ostium, and the head bent forwards, pus on the posterior surface suggests sphenoid disease. With the head bent backwards pus appearing on the anterior exposed surface is suspicious of posterior ethmoidal disease. Diagnosis is certain when discharge is seen in the sphenoidal ostium or removed from the interior of the sinus or from the posterior ethmoidal cells (by suction, etc.).

TREATMENT OF PARANASAL SINUSITIS

Much indeed remains to be done in the way of determining successful treatment for sinus pathology. Radical surgery has its school of supporters, -- and indeed a most definite place in successful treatment of certain selected cases. But it certainly has most definite limitations as well. Far too frequently radical removal of sinus mucosa (a severe operation at best) has been attended by no permanent cure, but has been palliative only, with the return of all former pathology, or spread to other sinus cavities. The writer recalls the case of a friend, who has undergone thirteen radical sinus operations, with no better results than temporary relief of symptoms, for no longer than six to eight months time.

Herbert Tilley⁴² expressed the criterion for wise routine sinus treatment when, after expounding at length upon the dangers of sinus infection in relation to systemic disease, he stated, "But don't forget the existence of Nature's immunizing agencies, and her wonderful powers of defence. Conservatism!" And in this conservative treatment advocated by Tilley, Carter⁸, Leegard²⁷, Davis¹², and a host of others, two facts must be kept in mind.

First:-- A sinus cannot be healthy without free aeration.

Second:-- A sinus cannot be healthy without free drainage. So treatment should be directed to establish proper drainage, and good ventilation.

Acute inflammation of the sinus tends to heal spontan-

ously, and requires in the main, supportive treatment. The patient should be confined to bed or to his room, with little variation in temperature. His bowels should be kept open; he should be given aspirin and phenacetin at intervals. There should be no smoking. Hot fomentations are soothing. Alcoholic-menthol inhalations (10-20% menthol), 1 teaspoonful in a pint of water at 140 - 150 degrees F. for 10 minutes should be practiced three times a day. Also 5-10% cocaine pledgets, or 3-5% cocaine spray may be used. Heat may be applied over the surface of the involved sinus. A hot bath for 30-40 minutes up to 158-176 degrees every day is advocated to produce sweating. Fluids should be pushed for good elimination.

In chronic disease, the attempt is again made to establish and maintain proper drainage and adequate ventilation, along with steps to build up the individual's general resistance. If this can be done without surgery, fine; if not, surgical treatment should be employed.

Davis¹² outlines the following steps in the treatment of sinusitis in children. This would of course apply in main to adults as well.

(1) Regulate the diet. Liberal milk, cream, butter, eggs, vegetables and fruits, whole wheat cereals in moderate amounts. Other carbohydrates limited.

(2) Determine whether an allergic state exists, and eliminate if possible.

(3) Internal Medication.

Cod liver oil twice a day.

Iodide of iron.

Perhaps vaccines -- autogenous or stock.

(4) Local treatment.

Mildly astringent oil solutions alternating with 10% argyrol. Weak ephedrin solutions, followed by argyrol.

(5) Surgical procedures should be conservative. Endeavor is to secure ventilation and drainage with the least possible destruction of intranasal structures. Remove enlarged or infected tonsils and adenoids, and take care of diseased teeth.

(6) If after non-surgical treatment, polypoid tissue persists in the ethmoid area, it should be removed; also the anterior portion of the middle turbinate.

(7) If additional ventilation and drainage are needed, an opening may be made beneath the lower turbinate.

It would be interesting to make note here of Lyman Richard's study of 500 cases of sinusitis treated in the Children's Hospital in Boston (Davis)¹², in which he compares the success of medical versus surgical treatment of the sinuses. In this survey he found the following results.

Type of Treatment	Cured	Improved	Unimproved
Medical	44%	17%	39%
Surgical	34%	20%	46%

These results would lead one to believe in medical treat-

ment as opposed to surgical. However, the percentage of cures in each case is appallingly low, and the percentage of unimproved extremely high, which would lead one to the further assumption that successful treatment of sinus conditions should be first medical, and then medical treatment proving inadequate, the employment of surgery.

Surgical treatment, when necessary in acute cases, is as follows:-

Maxillary:-

Puncture the lateral wall of the inferior meatus, or membranous wall of the middle meatus as described under "exploratory test". One lavage may suffice, or consecutive lavages may be necessary.

Frontal and Ethmoid:-

(1) First remove the anterior end of the medial concha, open the anterior ethmoids, and pass a cannula to the frontal cavity. Irrigate.

(2) Intra-nasal frontal operation if above fails.

(3) External operation in signs of orbital abscess and intra-cranial complications.

Sphenoidal:-

Remove the middle turbinate, expose the anterior wall of the sinus, and establish drainage by enlarging the ostium.

Surgical treatment of chronic suppuration is as follows:-

Maxillary Sinus:-

Go into the lateral wall of the inferior meatus in one of two ways.

- (1) Thru the nasal cavity.
- (2) Thru the canine fossa wall (Caldwell Luc Operation).

To do either of these a general anesthetic or tracheal ether may be used, or a local may be given by blocking the maxillary nerve; submucous and subperiosteal injection into the canine fossa of 4-5 cc. 1-2% novocaine; 2 drops 1/1000 adrenaline with 10% cocaine gauze applied to the inferior turbinate.

(1) Intranasal route:-

Remove the anterior one-third of the inferior turbinate. Then make an opening in the lateral wall of the inferior meatus as far forward as possible. Use punch forceps and Luc's forceps to remove bone fragments, open fairly large and wash morning and evening with warm saline until the discharge ceases. If the discharge persists, weak iodine or silver nitrate may be used.

(2) Canine fossa route (Caldwell Luc).

An incision is made along the gingivo-labial fold, dividing the soft structures down to the bone, carried from the zygomatic process to the canine ridge. Avoid the infra-orbital nerve. Chisel out bone up to the union of the facial and nasal walls of the sinus. The canine wall sinus mucosa is removed, the sinus mopped out with H₂O₂. A rectangular

piece of bone between the nose and sinus is then chiseled out. The incision in the buccal mucoperiosteum may then be sutured, while the opening between nose and sinus is maintained.

Again, a third type of operation may be employed, similar to the Caldwell Luc, but "radical" in that it implies removal of the whole lining membrane of the sinus cavity. Here also, a window is left into the nasal cavity, giving better inspection of the cavity both during and after operation, as well as affording adequate ventilation and drainage.

Frontal Sinus:-

There are two methods of operation here.

(1) Intra-nasal drainage by enlargement of the ostium frontale, and removal of the ethmoidal cells situated beneath it.

(2) A more radical procedure, which entails an external operation, and perhaps complete removal of all lining mucosa.

Ethmoidal Labyrinth:-

An attempt may be made by the intranasal route for establishing free drainage, or exenteration of the ethmoidal cells. This offers a serious problem, due in part to the position which the ethmoidal labyrinth occupies in the nasal cavity, and in part to its extension beyond the boundaries of the ethmoid bone.

Sphenoidal Sinus:-

This is usually treated by the intra-nasal route. As

the aperture tends to contract, it must be made as free as possible. The interior of the sinus must never be curretted.

Before success may be obtained in operative sinus procedures a number of provisions must be observed.

1st. There must be proper operative procedures. The operator must be thoroughly skilled in his surgical technique.

2nd. If possible, operation should be delayed until the acute stage subsides and some immunity to the infection has been established. Many cases of complications following surgery have given a history of operation during the acute stage of the disease.

3rd. There must be a most careful selection of the type of operation for the individual case, with careful pre-operative study by X-ray, transillumination, etc. The clinical history must justify the operative procedure. Here "surgical judgment" acquired only by long experience and extensive training plays a most important part.

4th. If an attempt is being made to remove a focus of infection, real or potential, all of the diseased tissue lining the cavity must be removed, preferably intact -- possible only with the maxillary and frontal.

CASE HISTORIES

Following are six case histories, selected from patients entering the University of Nebraska Hospital at Omaha and from the literature, which illustrate certain points which have been stressed in this discourse.

Case No. I (Dunn & Dunn)¹⁴

E. S. L., single, 19, entered the hospital March 25, 1925, with a diagnosis of acute rheumatic fever and acute endocarditis. She gave a history of yearly recurrent attacks of acute rheumatic fever from the age of 5 until her tonsils were removed at 13. She was known to have a damaged heart, but her health had been reasonably good from that time until 3 weeks prior to her admission, when she contracted a cold, which was followed by a low grade fever. There was a profuse nasal discharge and she ached all over. Her knees became red, swollen and very painful, and she grew short of breath.

The physical examination showed a pale, young woman, orthopneic with acute rheumatic manifestations. The heart action was rapid. The apex was in the 5th interspace, 9 cm. from the median line. The heart was 12 cm. broad at the fourth interspace. From the heart findings a diagnosis of lesions at both mitral and aortic valves and of acute fibrinous pericarditis was made (the friction rub disappeared in 72 hours).

The urine examination was negative. The blood count showed

a hemoglobin of 80; red blood cells, 4,200,000; leucocytes, 12,700. The Wassermann test was negative.

The remittant fever continued uninterruptedly for three weeks and on account of the history, rhinological and roentgenographic findings, an attack upon the sinuses was decided upon, in spite of the desperate condition of the patient.

Exenteration of the infected ethmoids and intranasal drainage of the maxillaries and sphenoids on both sides was done. Pus was found in both maxillary sinuses. Five days after the operation the temperature reached and held the base line. Convalescence was uneventful. The patient has had no illnesses since and would be considered a perfect physical specimen were it not for the valvular heart lesions.

Comment:-

Here is a very striking example of a case of systemic disease, with primary disease of the sinuses acting as a causative factor, and illustrating the results that may be obtained in such cases by surgical treatment of the affected sinuses. Many similar cases are recorded. The diagnosis of acute infectious endocarditis, even in the presence of obvious heart findings, should not be made without excluding acute or subacute paranasal sinusitis. Failure in cure has sometimes occurred, to be sure. With such failure there has been reason to suspect that the exenteration has been incomplete, or the systemic conditions have seemed to become fixed, or the focal nature of the trouble has been questionable.

Case No. II (Carmack)⁷

P. H., a school girl, age ten, admitted to James Whitcomb Riley Hospital, March 8, 1929, with diagnosis of chorea and endocarditis. Family history negative. Personal history:- Measles, chicken pox, mumps.

For six years she had had frequent colds and continued nasal obstruction. Two years ago choreic symptoms appeared and at times were quite marked, particularly on the right side. After the usual study, a diagnosis was made of chorea and sub-acute bacterial endocarditis, involving particularly the mitral valve, and a marked secondary anemia. X-ray and clinical studies of the chest showed peribronchial disturbance, probably from upper respiratory infection; no evidence of T. Bc. G. I. tract and kidneys negative. Continuous daily temperature of 99° to 100°. R.B.C., 2,900,000. Hb. 68%. White count 16,000, with 65% granulocytes. Wassermann negative and at this time blood cultures were negative. Examination of the upper respiratory tract showed infected tonsils and suppurative bilateral maxillary sinusitis. After one month's rest in bed with both general and local treatment the tonsils and adenoids were removed and both maxillary sinuses were irrigated; both were filled with pus. Large naso-antral windows were made in them. Cultures from the nose and sinuses were positive for *Strept. viridans*.

No unusual reaction followed this surgery. The patient was kept in the hospital two weeks, and returned home. For

the following 18 months this patient was kept under constant observation and treatment by the out-patient pediatric department. There were periods of improvement, always followed by exacerbations, and in September, 1930, 18 months following the original hospitalization, the patient was readmitted to the Children's Hospital. At this time there was a loud systolic murmur over the apex of the heart. The afternoon temperature continued at 98° to 101°. Blood cultures were taken, the first two being negative. The third was positive for *Strept. viridans*. Further studies of the sinuses were made and primary X-ray visualization of the maxillaries indicated thickening with polyps or abscess formation in the mucosa on each side.

Radical maxillary surgery was advised and done. Both sinuses contained pus. The mucosa was tremendously thickened, was apparently necrotic in areas, and contained many small abscesses. Following the operation a decided reaction occurred, with an exacerbation of the endocarditis, lasting about three weeks. Absolute rest in bed was continued for ten weeks after the operation, at which time all evidences of active infection had subsided; temperature was normal; blood cultures were negative; general condition was good. There has been a consistent gain in weight and strength, the heart muscle has compensated for the mitral damage which persisted, and the patient is back in school in good health again.

Comment:-

Here is a second case of systemic disease, resulting from blood stream infection, secondary to sinus disease. The point to stress here is the failure to relieve the condition by medical or even conservative surgical treatment, while radical removal of all the diseased membrane has seemingly resulted in a cure.

Case No. III (Davis)¹³

R. M., female, aged 13 years, readmitted to the hospital Jan. 14th, for a third attack of chorea within the past 2 years. The patient was found to have chronic bilateral antrum infection. Treatment by irrigation was instituted. During this treatment both ears were abscessed, followed by right mastoiditis, which was operated upon Febr. 10th. Following the mastoid, choreic manifestations became more violent. The patient was placed in restraint, could neither take nor retain food. She lost weight rapidly; it was impossible to treat the antra during two weeks. March 4th, the general condition was found better, and, as the condition of the antra had not improved with drainage, on March 15th, a bilateral Caldwell-Luc operation was performed. Both antra were found filled with thickened polypoid membrane. A pathological diagnosis was made of "muco-purulent" cyst and "polypoid sinusitis". March 31st the patient was discharged. May 16th she was examined in the outpatient department. There had been no return of the chorea. August 29th the

patient reported and was found in excellent health.

Comment:-

Here we have a third example of the sinuses acting as a focus of infection, this time causing attacks of chorea, and perhaps also having an association with mastoid infection, as is not infrequently the case, the condition being cured by surgical removal of the diseased membrane.

Case No. IV (Potts)³³

Mrs. D. P., age 23. Asthma began in 1926 while in Idaho at an altitude of about seven thousand feet. The doctor there put her on an orange juice diet without relief. She later left Idaho and came down to consult Dr. Dunn, July 25, 1929. Asthma very severe, requiring several hypodermic injections of adrenalin daily. A careful examination reveals no evidence of any allergic reaction. Nasal examination -- marked purulent infection evident in both nares, polypi in left nares. Radiograph shows marked shading over right antrum (maxillary) and all the sinuses of the left side. August 23, 1929: Operation: Radical antrum and ethmoid, left side. Very free intranasal opening into frontal sinus; left middle turbinectomy. The antrum was completely filled with polypi and thick smelling pus. Sept. 12, 1929: Radical maxillary sinus operation. Right side antrum completely filled with polypi, moderate amount of muco-purulent secretion. Her asthma was completely relieved. The lungs have cleared up and she has remained free from any recurrence up

to the present time.

Comment:-

This case (with many similar cases) serves to illustrate the point that at least some asthma may be secondary to nasal or sinus infection, and as such requires for its relief the complete removal of infection in the nose and accessory sinuses.

Case No. V

J. M., 18 years, admitted to Uni. of Nebr. Hospital 2-19-32, complaining of pain in the chest, post nasal discharge, loss of strength and malaise.

Present illness: The patient had pneumonia one year previous, followed by empyema. He entered the hospital in February and was drained of empyema. In hospital six weeks, and wound continued draining until April. In June he began working, caught cold and pain and swelling occurred over the old empyema scar. This broke and drained until August, 1931. In November, the pain again occurred, and he went to the Alliance Medic Clinic, where he was again operated and the drain tube removed which had been present since the former operation. He was in the hospital here 14 days. The wound was closed by Sept. 1, 1931. Thanksgiving he caught cold and coughed up blood-stained purulent material. Since then he has had a tired, worn-out feeling.

Examination revealed a muco-purulent discharge from both nares, post-nasal discharge, a normal left chest, but the

right chest showed an old empyema scar with dullness below the scar, and excursion limited. Temperature, pulse, and respiration were normal. The teeth were in good condition. The tonsils had been removed. Blood and urine were negative.

The medical department could find no evidence of empyema. The patient was referred to Nose and Throat, and it was felt advisable to do a bilateral, radical antrum. Upon examination of the removed specimen, a diagnosis was made by the pathology department of "polypoid hyperplasia of maxillary sinuses with chronic inflammation". The patient made an uneventful recovery and was dismissed 3-14-32. In the year following he has complained of no return of chest symptoms, and has seemingly felt quite well and strong.

Comment:-

It would be unwise here to place a definite connection between the empyema and the sinusitis. At any rate, the sinus condition was a contributing factor in reducing the patient's general resistance, predisposing to the return of the empyema, and in causing the loss of strength and malaise; and the removal of the diseased sinus mucosa was the one factor needed to turn the balance for return of health and strength.

Case No. VI

F. B., male, admitted to the Uni. of Nebr. Hospital, 11-6-31, complaining of severe constant frontal headache,

periods of weakness, and nervousness. He has been quite nervous and has had considerable headache over a period of ten years. Before its onset he had "flu" in 1919. Childhood diseases:- Measles and mumps. Had tonsillectomy 3 years before. Following this he felt fine for about 6 months; then following a series of "head colds", headaches again started. After a vague history of gall bladder disease, he was operated in May, 1931, and his gall bladder and appendix removed. Later adhesions formed and he was again operated. In the months following he had almost constant head colds and would cough up material each morning. Physical examination was essentially negative except for some nasal discharge.

Temperature and pulse were normal. Blood and urine findings were negative. Neurologic findings were negative. X-ray studies of the sinuses showed the cavity of the left maxillary sinus small, with a filling defect along its anterior border and about its lateral border, with the bony outline of the left antrum also appearing smaller than normal. Diagnosis was made of hyperplastic bilateral maxillary sinusitis, and on Nov. 20th, a bilateral radical antrum operation was performed. There was an uneventful post-operative course. The patient was dismissed 12-2-31 in good condition, the headache having completely disappeared. However, just two months later the patient again complained of the return of his former symptoms.

Comment:-

This case tells a somewhat different story than do the

five cases presented previously. Whether the case was one of simple neurasthenia in spite of the negative neurological findings, or whether a condition of diseased sinuses did exist with surgical failure in complete removal of that sinus pathology, or whether other organic factors played a part, would be hard to say. At any rate, the case represents failure, and should teach us to temper our enthusiasm regarding radical sinus surgery.

CONCLUSION

The problem of paranasal sinusitis is one which should directly concern the general practitioner. Diseased sinuses are an extremely prevalent form of disease; their relation to systemic disease is established beyond doubt. To cope with the general problems of the human body, one must be able to cope with the problems of the sinuses.

The general physician should equip himself for making, without the help of the rhinologist, a diagnosis of sinusitis, either as a disease entity, or as the responsible agent for disease located elsewhere in the body. He should be able to treat the sinus pathology medically; conservative surgical procedures might perhaps be carried out effectively by his hand.

However, the sinuses are a large field in themselves. Many of the problems of their treatment call for particular technical skill, special insight and judgment, acquired only by years of specialized training and practice in the field of the sinuses alone. So, while the general physician should recognize sinus conditions and treat them in so far as his training and judgment permits, still he must realize his limitations, never hesitating to refer the particular patient to the proper specialist in the field of rhinology.

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