

case was similar in details and results; the third is too recent to admit of report as to results.

Outward displacement of the heel we have dealt with but once. This was a case operated on by one of us in 1903 for extreme upward, as well as outward, displacement. Operation was done two months after injury to relieve practically total disability due to extreme flat foot combined with pain from pressure underneath the flattened arch. In this case the operation done was Gleich's operation for flat foot. A cross section of the os calcis behind the joint was executed with a chisel through lateral incisions. Probably the Gigli saw, then not available, would work better. The heel was then displaced downward about three quarters of an inch, inward about the same distance. Tenotomy of the tendo achillis was done and the position retained by plaster. At the end of five weeks he was already walking better than before the operation and was discharged with the os calcis firmly united in its new position. We have been unable to trace him since and can give no further data.

#### CONCLUSIONS.

The points we would wish to emphasize in this preliminary paper are as follows:

Comminuted fracture of the os calcis is relatively common.

Nearly all cases are of *substantially* the same type.

The results are rather frequently so imperfect as to interfere seriously with work or to disable the sufferer entirely.

The cause of disability is not the fracture as such, but certain displacements, outlined above, which should be remediable or rather preventable.

The treatment ordinarily advocated and carried out is no treatment at all. We have all of us been guilty of what is very nearly criminal negligence in regard to these cases.

Certain measures are practicable in the treatment of fresh cases that will minimize, or often prevent, the special displacements which are the cause of disability. It is our duty to adopt a routine embodying some such measures along the lines of the routine above suggested.

Provided such measures have not been carried out, and provided disability is present, palliation is possible by apparatus in some cases, while in others operations of no great gravity or technical difficulty will insure decided improvement of function.

This paper is, then, a plea for more accurate study and more active treatment, a plea, in other words, for a *real* surgical treatment for this class of lesions.

THE first lecture in the Harvey Society course of 1908-1909 was given on Oct. 24, at the New York Academy of Medicine, by Prof. A. Calmette, of the Institut Pasteur de Lille, France, on the subject, "Intestinal Infection and Immunity in Tuberculosis."

## THE ETHMOID CELLS AT BIRTH AND THEIR DEVELOPMENT DURING FETAL LIFE.

BY E. J. CURRAN, M.D., BATHURST, AUSTRALIA.

(From the Laryngological Department of the Harvard Medical School.)

THE object of this paper is a study of the ethmoid labyrinth at birth and its development during fetal life, with regard to the number, size, position and state of development of its cells. In order to gain an adequate idea of the condition to be found, and to realize the importance of a consideration of the development of the air sinuses at this stage in connection with what they have been and what they will afterwards become, it is necessary to review briefly some points in the anatomy of these structures in the adult, and to follow certain stages of development in the fetus.

The ethmoid bone lies in front of the sphenoid and between the orbital plates of the frontal. Its outer walls, the ossa plana, help to form the inner walls of the orbit. The ethmoid may be said to consist roughly of three parts: Two lateral masses made up of air cells with thin walls and turbinates, and the vertical plate, lamina perpendicularis. These three are united above by the cribriform plate which lies in a plane at right angles to them. The vertical plate hangs down between the lateral masses and forms the upper part of the nasal septum. There is a prolongation upward into the cranium, the crista galli, to form an attachment for the falx cerebri. The lateral mass, when *in situ*, hangs down on either side of the septum and forms part of the outer wall of the nasal cavity. Each is an approximately wedge-shaped mass, honeycombed with many air cells, the walls of which are made up of very thin bone and lined with thin ciliated epithelium with a small number of mucous and serous glands. The long axis of this prismatic-shaped mass is antero-posterior, and the apex downward, the base being attached to the cribriform plate. Externally, the smooth orbital surface of the ethmoid, the os planum, roofs in some air cells. It articulates above with the orbital plate of the frontal, which also roofs in external air cells. In front, the os planum articulates with the lachrymal bone and below with the orbital surface of the superior maxilla. Posteriorly, it articulates with the sphenoid, and postero-inferiorly with the orbital process of the palate bone, both of which serve to roof in some of the ethmoidal cells.

On the mesial surface, we have two, and sometimes three, turbinates (the inferior turbinate does not belong to the ethmoid bone). If there are two turbinates, there are also two meati, the middle meatus and the superior meatus, but if there happens to be a third turbinate, the space under it is called the meatus supremus. In the superior meatus, there are openings for the posterior ethmoidal cells and the sphenoidal sinus. If the meatus supremus is present, the sphenoidal sinus enters it, but if not, it drains into the vestigial fossa of this meatus.

The ethmoidal cells are divided into two groups, namely, (1) the posterior, which drain into the superior meatus, or into the space above the

superior meatus; (2) the anterior, which drain into the middle meatus. In a general way, cells lying in front of the superior turbinate drain into the middle meatus and, therefore, are called anterior ethmoidal cells, and those which lie behind the anterior end of the superior turbinate usually empty into the superior meatus and are, therefore, called posterior ethmoidal cells.

In the grouping of the ethmoidal sinuses, it is, however, necessary to have in mind the basal lamellæ of the ethmoidal prism. According to one authority, there are seven basal lamellæ. Of these, five form turbinates, the other two becoming lost in the growth. The inferior turbinate is a separate bone and is not connected with the ethmoidal prism other than it articulates with the middle turbinate.

The first of the basal lamellæ forms the unciform process, a crescentic process with a sharp edge facing upward and lying under the anterior two thirds of the middle turbinate.

The second lamella becomes the bulla ethmoidalis.

The third lamella becomes the middle turbinate, and the fourth and fifth fuse together to form the superior turbinate. A failure to fuse gives the fourth turbinate, made by the fifth lamella.

The sixth lamella is the sphenoidal turbinate which, like the seventh, is vestigial. The spaces under the turbinates are known as meati. We then have the superior meatus, the middle meatus, and, when the fourth turbinate persists, we have under it the meatus supremus. The space between the unciform process and the bulla is called the groove of the unciform, and that between the bulla and the root of the middle turbinate is the groove of the bulla. These grooves are important, for it is from them that the budding of the mucous membrane takes place and pushes out through the cartilage and bone, when the latter is there, to form the antrum, anterior and posterior ethmoidal sinuses.

While this may be a convenient plan to follow for classification, I have examined different stages of development of the nasal cavities from the earliest fetus and have found nothing which would agree with such an arrangement of lamellæ. In the cases I examined, I found that as the ectoderm grows back, it begins to fold on the outer wall, and at the end of one and a half months of fetal life there are three folds. The ridges of these folds become the inferior, middle and superior turbinates. The inferior fold is the largest. This folding goes on and the inner invagination takes an upward direction until some time between the second and third months when the turbinates are completed. The turbinates at this time are of the same shape and occupy the same position, relatively, as in the adult. Immediately on the completion of the turbinates, under the middle turbinate another folding backwards begins—two folds this time, one for the unciform process and its groove and the other for the bulla ethmoidalis and its groove. The next step is a pitting back of the mucous membrane to form the cells, so we have a continuous process

beginning with a pitting backward of the ectoderm to form the nasal cavity, a folding of the ectoderm to form the turbinates and unciform process and bulla ethmoidalis, and finally a growing or pitting backward into the substance of the lateral mass to form the cells.

All the nasal sinuses are thus formed by outgrowth of mucous membrane. It grows outward for the antrum and upward for the frontal, backward into the sphenoidal turbinate for the sphenoidal and into the lateral mass for the ethmoidal sinuses. It has been generally stated that the antrum shows in the fourth month of fetal life, but in some dissections of fetuses of three to four months I have found the antrum and ethmoidal sinuses in an advanced stage of development. (See Figs. 2 and 4.) The beginning of the outgrowths for the sphenoidal and the frontal are also well shown at this period. It is important also to remember that the sinuses grow from the mucous membrane connected with the ethmoid bone, and for this reason, not only the frontal and the sphenoidal sinuses should be considered ethmoidal cells, but also the antrum, which is in reality a large anterior ethmoidal cell having pushed its way into the superior maxilla, just as some of the ethmoid cells have pushed their way past the ethmoid into the sphenoid and frontal bones. The ethmoidal mucous membrane begins to eat its way into the cartilage of the lateral mass by the agency of the chondroclasts, and afterwards, when the bone has been formed, by the agency of the osteoclasts. It keeps on expanding till it has traveled even through distant structures, such as the sphenoidal sinus growing into the great wing of the sphenoid, and frontal sinus growing around the orbit and the antrum into the malar bone and into the palate below, and often sending out a bud which outgrows the ethmoidal bud and outstrips it in the race to become the frontal sinus, so that this may explain the connection which one writer found between the frontal sinus and the antrum. In some animals the frontal sinus drains into the antrum; indeed, there seems to be no limit to its growth through bony structures excepting that it might be the age of the person. But wherever it grows, it is still ethmoidal mucous membrane and its growth has been simply a growth of mucous membrane, combined with a destruction and absorption of bony tissue; that is, the mucous membrane grows and the bone is destroyed and absorbed. Not only is the mucous membrane carried into these pits, but with it the nerves and the vessels, and although it has been generally stated that the antrum is supplied by filaments of nerves from the second division of the fifth nerve, through Meckel's ganglion, distributing branches to the inner wall of the antrum through bony canals, I think that this is probably not true but that the whole of the nerve supply enters through the ostia of the different sinuses, carried in by the mucous membrane. Such a distribution is the case with the arterial supply; but the sinuses receive, on account of the readiness of the arteries to anastomose, in addition to that which enters by the ostium, other branches from

surrounding bony tissue. I have tried to find evidence that the sinuses are supplied by nerves other than or in addition to those that enter by the ostia of these sinuses but have failed to find anything beyond the assertion that such is the case. In the absence of other evidence, therefore, I think it more reasonable to consider that the mucous membrane carries in its nerve supply with it wherever it spreads. The growth of the cells seems to depend upon the osteoclastic activity of the periosteum under the mucous membrane, and we thus have one cell growing fast and another slowly; one crowding out another and sometimes eating its way around it; but it is important to observe that they never eat through the dividing walls into each other. In an examination of a large number of skulls I have never found any to contain two ostia, not even a large frontal which spread from side to side with only a partial partition between; when this was the case there was only one drainage ostium into one side of the nose. This is proof that the cell grew from only one side of the nose. It is, however, possible to have adjacent cells broken down by pathological processes or trauma. Hence we have a thin bony partition between adjacent cells, but the position of this partition depends upon the quickness of one cell to outgrow another. This is shown well in the varied position of the septum dividing the two frontal sinuses. One nearly always outgrows the other, and notwithstanding the fact that the frontal bones are closed by a suture in the center which would seem to mark off the limit of each frontal sinus, yet one vigorously growing sinus finds no difficulty in trespassing on the area of the other and to such an extent that we find only one frontal sinus opening into one side of the nose, but so large that it completely crowds out the other, which in these cases remains an ethmoidal cell, and the septum which ought to be a frontal septum is in reality a frontal-ethmoidal septum. This is an important consideration.

The position of the ostia of these cells depends upon the place at which the mucous membrane begins to bud out, or pit. The favorite places for this are at the upper part of the unciform groove, at the upper part of the groove of the bulla and posterior part of the superior meatus. The pitting may begin at any part of the groove between the basal lamella, but these are the favorite places for the formation of the buds. If there is a meatus supremus, there will be a bud from this. If it is blended with the superior, the corresponding bud will be formed in the upper part of the superior. This often becomes the sphenoidal sinus; more often the presphenoidal cell.

Three accessory turbinates are described at the upper part of the unciform and three in the upper part of the groove of the bulla. I consider these to be nothing more than three bony partitions between outgrowths of the epithelium as they pit back into the ethmoid mass to form the cells.

In the unciform groove, between these so-called accessory turbinates, four cells push their way,—one into the agger nasi, another into the frontal

bone to form the frontal sinus, and the other two ethmoidal cells into the surrounding tissue. The groove of the unciform generally ends in a blind sac; Sieur and Jacob found it in one to four cases continuous with the canal of the frontal sinus.

In the lower part of the groove of the unciform is the ostium of the maxillary sinus,—antrum of Highmore.

Most of the anterior ethmoidal cells open into the upper part of the groove of the unciform, the remainder into the groove of the ethmoid bulla. In the upper part of the groove of the bulla are the so-called accessory turbinals; there are three, and between each two springs a cell, three in all usually, one being the cell of the bulla which is almost constant. Into the superior meatus there are usually four cells opening, but if there is a fourth meatus there will be one, rarely two, openings into it and one less in the superior meatus. All ethmoidal cells in growing out may become branched, with partial partitions between them, and lead one to imagine that instead of one there were many present.

#### THE ETHMOIDAL CELLS IN THE FETUS AND AT BIRTH.

The lateral mass at birth is a thin plate of cartilage and bone with ossification proceeding from the os planum and probably other smaller centers. It carries the superior and middle turbinate processes, which are ossified at this time, as are also most of the walls of the cells in the ethmoid. Although at this age the entire ethmoid is narrow, it almost fills the nasal cavity. It has been usually stated that there are no ethmoidal cells present at birth; Keith says they do not begin to bud out till the third year; Lothrop puts the beginning of their development at the fifth year; Mosher says that a certain number are present at birth. In the fourteen babies' heads that I have dissected, about the same number of cells were present that are found in the adult. There were no cells which one could say were certainly sphenoid cells, but in every case I could easily find the future frontal sinus growing up into position. Not only were the cells in numbers ranging from nine to fourteen found in the 18 dissections, but I found a similar number and arrangement in a fetus of three and a half months, one of four months, one of five months and one of six and seven months. In all of these cases they were in a sufficiently advanced stage of development to enable a good classification to be made. Owing to the difficulty to dissect them in the ordinary way, and to their likelihood of being plugged, it is quite easy to see how they were overlooked by former observers. Exact drawings of these sections are shown here. In the series will also be noticed the gradual tendency of the upper turbinates or folds to disappear as growth goes on. The disappearance takes place by the merging of two or three into one. Sometimes this merging does not take place and we thus have the extra turbinates in the adult. Fig. 4 shows a head with the extra turbinate persisting. Whether these folds do disappear, or whether there were more or

fewer of them present originally, is questionable. In some fetuses of two and a half to three months I found only three turbinates, whilst in older ones there were more. There were also more in some at this age. So I have come to the conclusion that no straightening out of folds takes place. Under the extra turbinate opens a cell (see Fig. 12), which looks more like a budding sphenoid sinus than any of the earlier specimens shown. The superior meatus receives the openings of three posterior cells. There are three cells opening into the groove of the unciform, the highest budding up for the frontal sinus and one small one into the groove of the bulla.

All of these dissections were done from the orbital side. The mucous membrane being carefully dissected from the cell walls, and the bone broken off bit by bit, the whole of the antrum and cells were exposed. The mucous membrane peeled off easily, and with care it was possible to have it stand out uninjured and in the same shape that it was when held by its bony or cartilaginous walls. In this way it could be easily seen into which meatus the cell opened, as each cell was held into the nasal mucous membrane by its stalk-opening, so that it stood out like a grape. The best results were obtained from formalin preparations.



**Fig. 1**



**Fig. 2**

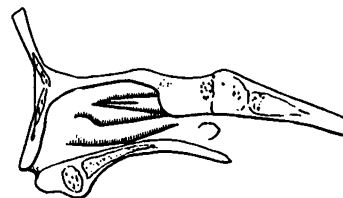
**FIG. 1.** View of outer wall of nasal cavity of a fetus of three and one-half months, showing exact size and position of turbinates.

**FIG. 2.** Ethmoidal cells of same dissected from the orbital side, showing only the cells.

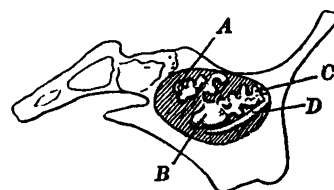
A. Probably sphenoidal sinus. B. Antrum of Highmore. C. Frontal sinus growing up into position. D. Lachrymal duct.

These figures are natural size drawings of a dissection of a fetus of about three and a half months. Fig. 1 is the outer wall of the nasal cavity showing the turbinates at this stage; Fig. 2 is a dissection of the same part from the orbital side. B shows the antrum of Highmore fairly well developed, like a small pocket, hanging over the entrance of the lachrymal duct. D. Four anterior ethmoidal cells are shown; the uppermost, C, will probably become the frontal. The posterior ethmoidal cells, two fusiform and two

round, are also seen well. There is also a suggestion of a bud at A which will probably become the sphenoidal sinus.



**Fig. 3**



**Fig. 4**

**FIG. 3.** Outer walls of nasal cavity of a four months' fetus. Natural size.

**FIG. 4.** Dissection of ethmoidal cells of same dissected from orbital side.

A. Probably sphenoidal sinus (?). B. Antrum of Highmore. C. Probably frontal sinus. D. Lachrymal duct, emptying under inferior turbinate.

Figs. 3 and 4 are drawings, natural size, of a dissection of a fetus of about four months. Fig. 3 shows the position and size of the turbinates. In this case there were four ethmoidal turbinates, two more than are usually found in the adult. Note the relation that the cribriform plate bears to the palate, converging to the posterior, while in the adult they are usually parallel. (See Fig. 11.)

Fig. 4 shows the dissection from the orbital side. The ethmoidal cartilages and orbital plate, etc., are dissected away from the nasal mucous membrane and the mucous membrane lining the ethmoidal sinuses and antrum. The plate shows the exact number and size of these budding sinuses, and below is the antrum, the largest bud. The posterior ethmoidal cells are pulled slightly away from the anterior to show more clearly which are anterior and which are posterior. It will be seen that the antrum really belongs to the anterior ethmoidal cells and at this stage shows little separation from them. In this fetus there are two anterior cells opening into the groove of the bulla by one common opening and there are four cells opening into the groove of the ensiform by two openings besides the opening of the antrum. The highest of these belongs to a group of three which open by a common opening and must be the future frontal sinus. In front of these cells is the lachrymal duct. The posterior cells open under the three upper turbinates. Two open into the superior meatus and one under each of the highest tur-

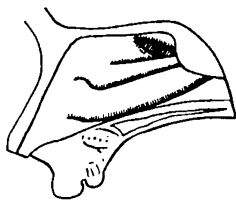
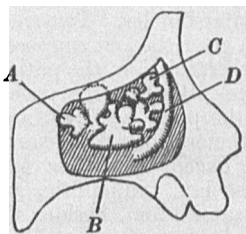
**Fig. 5****Fig. 6**

FIG. 5. Outer wall of nasal cavity of a fetus of five months. Natural size.

FIG. 6. Dissection of cells of same from orbital side. A. Sphenoidal sinus. B. Antrum of Highmore. C. Frontal sinus. D. Lachrymal duct.

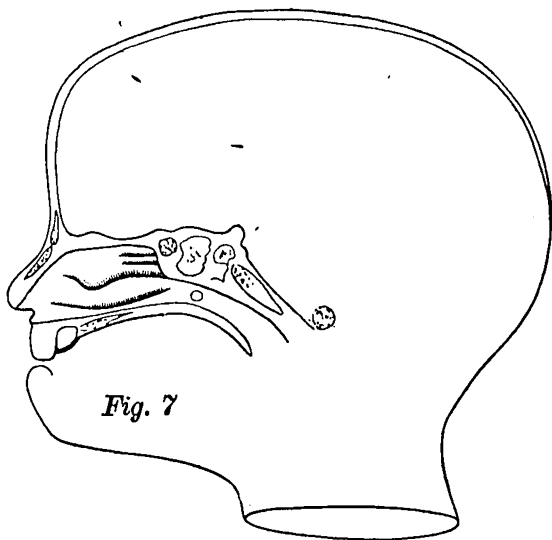
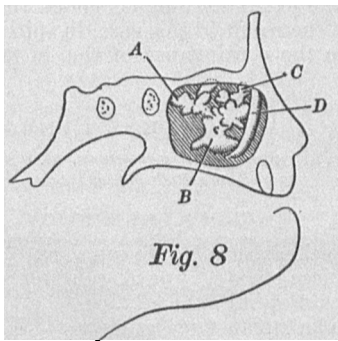
**Fig. 7****Fig. 8**

FIG. 7. Outer wall of nasal cavity of a six months' fetus. Natural size.

FIG. 8. Dissection of cells from orbital side of same. A. Sphenoidal sinus. B. Antrum of Highmore. C. Frontal sinus. D. Lachrymal duct.

binates. One of these cells, the one that opens into the highest meatus, will probably become the sphenoidal sinus.

Fig. 5 shows the exact size and position of four ethmoidal turbinates beside the maxillary turbinate as in the previous picture of three and a half month fetus; but in this fetus (five months) the second turbinate from the top is folded up instead of down as the others are. The two highest take a direction leaving an angle with the superior turbinate, as shown in the picture. The palate converges posteriorly to the cribriform plate as in Figs. 3 and 4.

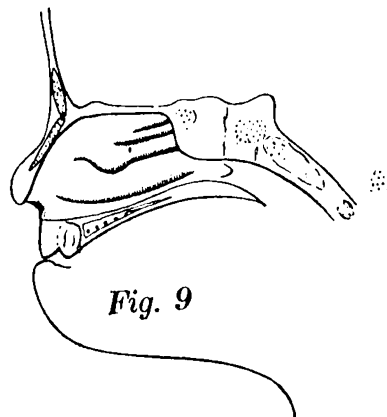
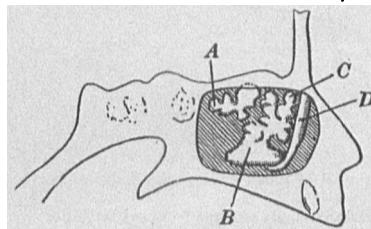
**Fig. 9****Fig. 10**

FIG. 9. Outer wall of nasal cavity of a fetus of seven months. Natural size.

FIG. 10. Orbital dissection of ethmoidal cells of same. A. Sphenoidal sinus(?). B. Antrum. C. Frontal sinus. D. Lachrymal duct.

Fig. 6 shows the size and position of the air sinuses; the dissection is from the orbital side. The bud for the frontal sinuses is growing higher. There are nine anterior ethmoidal cells—five opening into the groove of the ensiform and four into the groove of the bulla. The lachrymal duct is shown opening under the inferior turbinate. One of the posterior cells has grown large. This opens into the superior meatus and the other three open into the space between the two highest folds.

Figs. 7 and 8 show a dissection of a fetus of about six months. Turbinates, cells, etc., are of the exact normal size and position. These diagrams read with the others need no description.

Figs. 9 and 10 show dissections of a fetus of about seven months. Turbinates, cells, etc., are of actual size and position. In this diagram also the anterior and posterior cells have been pulled apart to show more clearly the separation of their origin.

Figs. 11 and 12 are exact drawings of a dissection of the cells and turbinates of a child at birth. In this case there are three ethmoidal turbinates, but in 14 of the 18 babies' heads which I dissected there were only two, as in most of the adults. Note the relation of the cribriform plate to the palate bone almost parallel now.

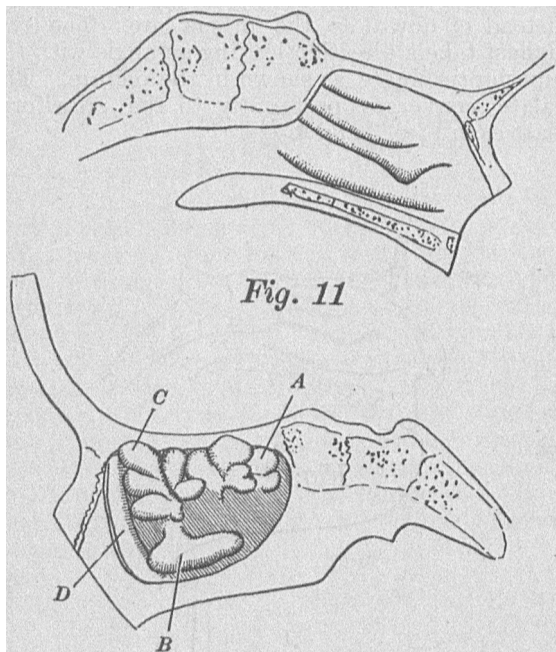


Fig. 11

Fig. 12

FIG. 11. Outer wall of nasal cavity of a baby at birth. Natural size.

FIG. 12. Dissection of cells of same from orbital side. A. Sphenoidal sinus(?). B. Antrum. C. Frontal sinus. D. Lachrymal duct.

There are four cells opening into the superior meatus, one into the highest meatus and six into the middle meatus, two of which open into the groove of the unciform. The antrum is well developed but not more so than the other ethmoidal cells which contain about three times as much air space at birth as the antrum.

## A CASE OF COINCIDENT TUBAL AND INTRA-UTERINE PREGNANCY.

BY CHARLES M. GREEN, M.D., BOSTON.

(From the Gynecological Clinic of the Boston City Hospital.)

ON June 6, 1907, Dr. Ernest B. Young, first assistant visiting surgeon of the Department for Diseases of Women, reported a case of coincident extra- and intra-uterine pregnancy, and gave an interesting statement of the present knowledge of this rather rare condition, with an inclusive, recent bibliography.<sup>1</sup> This was the first case of this character that had occurred in the clinic. In October, 1907, a similar case came under my observation; and a brief report of the experience, and the interesting pathological findings seem worthy of record.

<sup>1</sup> BOSTON MED. AND SURG. JOUR., vol. clvi, No. 23.

H. E., aged thirty-three, born in Canada, married eight years, had had two children, in 1903 and 1905, with normal labors and puerperia: she had never miscarried. The menstrual history was not noteworthy, and the last period the patient said had occurred three weeks previously. The present illness began two weeks before entrance; during this time there had been sharp intermittent pain in the rectum near the anus, not aggravated by defecation, and a continuous dull ache over the entire abdomen. The woman had had one chill, and had vomited two or three times. Two weeks before there had been a similar attack, on which the patient remained in bed for two hours, and found relief with hot water bottles. Two months before entrance, and again after the last supposed menstruation three weeks before admission, the patient flowed intermittently for a week after the regular period had ceased.

On admission the pulse was 128, and the temperature 100.2° F. General physical examination showed no abnormality, except a cardiac systolic murmur. The abdomen was lax, tympanitic, and not tender; but bi-manual examination, besides the traumata of parturition, revealed a soft, cyst-like, median mass rising from the pelvis to within 6 cm. of the umbilicus. In the pelvis, to the right and posterior, was a soft, sausage-shaped, sensitive mass connected with what felt like a cyst. The uterus was not differentiated, and was thought to be concealed by a superimposed cyst. The white blood count was 13,000: the hæmoglobin test showed 70%. Neither the history nor the physical examination seemed to me and to several colleagues to warrant a diagnosis of pregnancy, either tubal or uterine; and the probable diagnosis made was ovarian cyst with twisted pedicle, with a supervening inflammatory process. In the face of this false diagnosis, however, the satisfaction remains that the treatment pursued was the most appropriate for the condition found.

On opening the abdomen the cyst-like mass was found to be the uterus, four months pregnant; and the supposed thickened and twisted pedicle was seen to be a pregnant tube surrounded with from four to six ounces of blood clot, forming a mass in which the vermiform appendix was involved. Taking especial care to disturb the uterus as little as possible, I removed the appendix and the tubal mass, and closed the incision. On the same evening the foetal membranes ruptured; four days later a slightly macerated, four months' foetus was cast off spontaneously, and the uterus was curetted. The subsequent convalescence was uneventful.

The intra-uterine foetus had apparently been dead two or three days, and if so, was alive at the time of the removal of the partly aborted tubal pregnancy. Young states<sup>2</sup> that "in a majority of the published records, the disturbance of one of the twin pregnancies, usually the extra-uterine, has ended the other"; and such was the result in this case, in spite of every effort to ensure the continuance of the intra-uterine pregnancy.

## PATHOLOGICAL REPORT.

BY ARTHUR B. EMMONS, 2d, M.D.,  
Senior Pathological Intern.

## GROSS DESCRIPTION.

The specimens are four in number: A fallopian tube, a small piece of soft, grayish, gelatinous tissue, a fetus and the vermiform appendix.

1. The fallopian tube measures 8.5 cm. in length. It has been opened by a longitudinal incision throughout its superior surface and has been stripped back from its contents.

<sup>2</sup> Loc. cit.