

and represent neither the cases of dysentery which recover without liver abscess, nor those in which the patient has liver abscess and recovers. According to Kartulis, of 500 cases of dysentery, from 50 to 60 per cent. had liver abscess. Of 40 American cases collected by the writer some years since, 18 had liver abscess. I feel sure that this percentage is too high, for it is probable that cases complicated with liver abscess are much more liable to be recognized and reported than uncomplicated cases. Liver abscess may occur in the acute form of dysentery, but is more common in the chronic variety, when its course is often very insidious. The right lobe of the liver is the most common seat of these abscesses, and when the left is affected it is usually in conjunction with the right. The abscesses are usually seated in the upper portion of the right lobe; the lower portion of the same lobe, corresponding to the hepatic flexure of the colon, is next in frequency. In one case (Kruse and Pasquale) an abscess was found in the lobus quadratus. The abscesses may start near the surface or deep down in the organ. They are commonly single, but may be multiple; rarely, however, are there more than two or three. Occasionally they are small and multiple and distributed throughout the organ. Several small abscesses may be grouped about a large one. In size the abscesses vary from microscopic points to large collections of pus occupying as much as two-thirds, or even more, of the organ. The abscess contents usually consist of a reddish-brown, anchovy-sauce like material, which usually runs freely, but which may be of an almost gelatinous consistency. In some cases the material is grayish white and contains masses of necrotic tissue. The abscess walls are usually ragged and necrotic, and, when the process is of recent date, soft and irregular. In older abscesses, beneath the necrotic material, there is a translucent layer of gelatinous material, outside of which there is a fibrous zone of varying width and density. The surrounding liver tissue is compressed and indurated. Scars of healed abscesses may be found in the livers of individuals who have had dysentery. The liver may be of normal size or smaller than normal, but is usually much increased in size. The decrease in size is met with in chronic abscesses, with absorption of the purulent material, and secondary focal and diffuse cirrhosis. The fluid portion of the abscess contents is composed almost entirely of granular detritus, with surprisingly few cellular elements. Fewer cells in the state of granular and fatty degeneration may be seen in the pus of acute abscesses, but are usually absent in chronic cases. Red blood cells, well preserved as well as degenerated, are often numerous. A striking feature is the absence of leucocytes. When these are present bacteria are commonly found. Careful search practically always discloses amoebæ, which may, however, be missed in aspirated pus, which probably usually comes from the central and older part of the abscess. Councilman and Lafeur found amoebæ in the smallest abscesses. The earliest lesions are necrosis and liquefaction of the liver cells, with probably serous exudation from the blood-vessels; few, if any, leucocytes wander in, but red blood cells may be numerous. In larger abscesses, masses of liver tissue, chiefly portal systems, may be found. Amoebæ are numerous at the border of the abscesses in the necrotic material and but rarely extend into the surrounding tissues. They may be found in the capillaries. In larger and older abscesses three zones can be made out: an inner necrotic granular zone, a highly refractive reticulum, and an outer layer of granulation tissue, which varies very much in thickness. The inner zone consists of necrotic material containing amoebæ and a few cells, including fatty liver cells. The outer zone may be poor or rich in cells. Here the blood-vessels are dilated, the liver cells elongated, compressed, atrophied, and pigmented. The capillaries and central areas are often obliterated, and there is a more or less well-marked cirrhosis of the liver tissue about the abscesses. A very striking fact in connection with amoebic abscesses of the liver is the absence of leucocytic invasion, which never occurs unless there

is bacterial mixed infection. In general, it may be stated that pus with few or no leucocytes coming from a liver abscess is of amoebic origin. Councilman and Lafeur describe diffusely scattered areas of necrosis of the liver cells unassociated with the presence of amoebæ. In some of these areas, which were always at the centre of lobules, the necrotic cells preserved their form, while in others they were broken up into highly refractive masses, or even into small fragments. These authors attribute these areas to the action of soluble toxic substances formed by the amoebæ in the intestinal lesions, and brought to the liver by the circulation, while the necrosis and liquefaction of tissue in the abscesses are due, they think, to the direct local action of the amoebæ themselves.

Liver abscesses may communicate with various organs and cavities, the most common secondary invasion being through the diaphragm into the right pleural sac, or into the lower lobe of the right lung. When there is sudden rupture of a liver abscess through the diaphragm, or when the amoebic process extends rapidly, the pleura rather than the lung is chiefly affected. When the perforation is gradual, and adhesive inflammation binds the visceral and diaphragmatic pleurae together, hepatopulmonary abscess results. Thierfelder collected 170 cases of liver abscess, of which 76 opened into the lung and bronchi, 23 into the abdominal cavity, 32 into the intestine, and 13 into the stomach. Of Aghetti's 131 cases, 38 ruptured into the lung. Of 6 cases of which I have records, 3 opened into the right pleural cavity and 2 into the right lung. Hepatic abscesses may rupture into the gall bladder, and when the right kidney forms one wall of the abscess the pus may reach its pelvis and appear in the urine. Kruse and Pasquale found in one case of liver abscess, multiple small pus collections in the spleen, distributed along the branches of the veins. They attributed these to the backward flow of pus from the liver through the portal vein. Flexner has reported a case of perforation of an amoebic abscess of the liver into the inferior vena cava.

(c) *Pleura*.—Amoebæ reach the right pleura probably only by extension of liver abscesses through the diaphragm, either by rupture or by gradual extension of the inflammatory process. The pleural inflammation is probably always purulent, and the membrane becomes thickened and covered with a ragged, necrotic material, containing amorphous and fibrillated fibrin, red blood cells, and a variable number of leucocytes. The latter are very numerous if there is bacterial mixed infection. Amoebæ are usually numerous. This amoebic empyema is usually chronic, and the retracted lung is bound down by the thickened and adherent pleura. Pneumo-thorax is rare. The pleural cavity may be distended with pus, which may rupture into the lung or bronchi, into the pericardium or through the chest wall.

(d) *Lung*.—The right lung, as previously pointed out, is frequently affected by invasion from the liver. Inflammatory processes of the pleura may also extend into the lung. The lesions in the lung are similar to those in the liver, but Councilman and Lafeur have shown that the changes in the interstitial tissue are more marked in the former than in the latter. The abscesses are usually single, but may be multiple and are generally confined to the lower lobe. The abscesses may open into one or more bronchi, by which they are drained. In this case amoebæ are present in the sputum in large numbers, and in two cases I have been able to make a diagnosis of unsuspected hepato-pulmonary abscess by examination of the sputum. When the left lung is affected, which is rarely the case, it is probably due to aspiration of pus from the bronchi. It is difficult to see why amoebæ are not frequently carried to the lungs from the liver by the hepatic vein; but if this occurs, the amoebæ apparently die before lesions are produced. In the rare cases in which liver abscesses have ruptured into the vena cava, death has occurred before metastatic abscesses could form. Amoebæ, as far as is known, never pass through the pulmonary circulation and cause abscesses in distant

organs. Pulmonary and hepato-pulmonary abscesses may heal both with and without drainage.

(e) *Pericardium*.—The pericardium may be invaded in two ways: (a) by direct opening of a liver abscess into the pericardial sac, or (b) by extension of the inflamma-

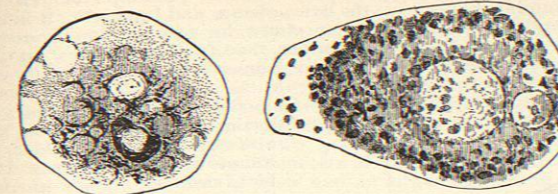


FIG. 113.—Amoebæ from a Section of Intestine. (Adapted from Councilman and Lafeur, Johns Hopkins Reports, vol. II., plate VII.)

tory process from the pleura or lung, as occurred in one of my cases. This is the only case in which amoebæ have been found in the pericardial cavity. The pericardial lesions were similar to those found in the pleura.

(f) *Peritoneum*.—In a few cases localized peritonitis occurs opposite the seat of the ulcers; this may or may not lead to the formation of adhesions. The exudation is sometimes abundant and widespread, of a peculiar

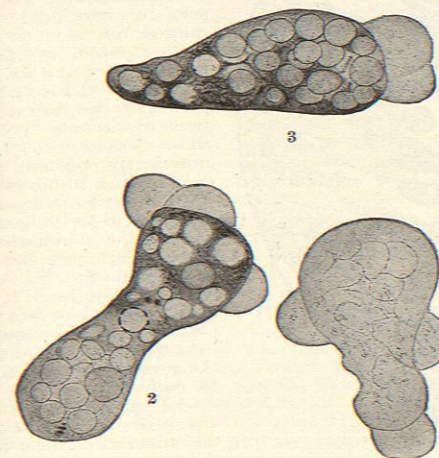


FIG. 114.—Motile Amoebæ. Showing Pseudopodia from a Dysenteric Stool. No. 1 has homogeneous endosarc. No. 2 contains a number of vacuoles and a few red blood corpuscles, and No. 3 contains great numbers of the latter. (Kruse and Pasquale: Zeitschrift f. Hygiene u. Infektionskrankheiten, 1894, Bd. xvi., Plate VI., Figs. 1, 2, 3.)

gelatinous consistency, and contains numerous amoebæ, with or without bacteria. When intestinal ulcers perforate into the peritoneal cavity, widespread peritonitis occurs, with large numbers of bacteria, as well as amoebæ, in the exudation. Liver abscesses, especially when situated in the lower portion of the right lobe, sometimes rupture into the peritoneal cavity and cause diffuse peritonitis with a gelatinous exudation containing amoebæ. Chronic adhesive peritonitis about the liver; between this organ and the diaphragm, abdominal wall, omentum, and the transverse colon is common. The stomach may be bound to the liver, and abscesses of this latter organ may open into the former.

(g) *Changes in Other Organs*.—Fatty degeneration of the heart in amoebic infections has been described by Flexner and by myself. The changes in the kidneys are limited to cloudy swelling and fatty degeneration, except when the right kidney forms part of the wall of a liver abscess. The spleen is usually enlarged, is some-

times soft and sometimes firm, the latter state usually being associated with chronic passive congestion. Reference has already been made to pus collections in the spleen in the case of Kruse and Pasquale.

(h) *Modes of Transmission of Amoebæ*.—It is very generally believed that amoebæ reach the liver by means of the portal veins. They are often found in the veins in the intestinal lesions, and, in some cases at least, the hepatic abscesses are widespread and along the distribution of the portal veins. Councilman believes that the organism most commonly reaches the liver by means of the peritoneal cavity, after passing through the intestinal walls, being carried like other foreign particles in this cavity up behind the liver. The lymphatics probably play no part in the transmission of amoebæ to the liver, though the organisms probably make their way through these channels in the intestines and in other organs.

Kruse and Pasquale suggest that amoebæ, like coccidia oviforme, may invade the liver by means of the biliary tract. This would explain the mode of infection in the cases of so-called idiopathic liver abscess. In the case of the idiopathic liver abscesses, it is possible that amoebæ

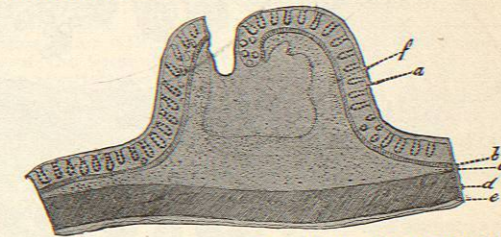


FIG. 115.—Section of an Elevated, Deeply Excavated Ulcer. Illustrating Abscess Formation in the Submucosa. a, Mucous membrane; b, muscularis mucosae; c, submucosa; d, muscularis; e, peritoneum; f, area of cellular infiltration near the ulcer. (Councilman and Lafeur: *Ibid.*, plate I., Fig. 1.)

have penetrated the mucosa and submucosa, causing no lesions or at least very slight ones, and have entered the veins and been carried to the liver. Another possible explanation is the presence in the intestine of lesions too insignificant to cause diarrhoea and other symptoms of dysentery. It must also be remembered that constipation is not infrequently met with in cases of widespread dysenteric ulcers. It is very significant that the "idio-

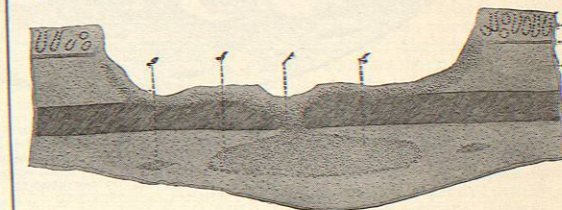


FIG. 116.—Section of a Deep Ulcer Extending Down to the Muscular Coat. The cellular infiltration g has extended through the muscular coat at f. (Councilman and Lafeur: *Ibid.*, plate I., Fig. 5.)

pathic" liver abscess is most frequently met with in the same countries and conditions in which the dysenteric liver abscess is most common.

(i) *Association of Other Organisms with Amoebæ*.—In the intestinal lesions, as one would expect, various bacteria ordinarily present in the intestine are found. It seems probable that, in certain cases at least, bacterial invasion of the ulcers and abscesses materially alters the character and augments the severity of the lesions. Certain other animal micro-organisms, such as *Trichomonas intestinalis*, etc., are sometimes present with amoebæ in the stools. Bacteria have been found in a lung, pleural, and liver lesions by several observers.

Of 13 liver abscesses, Kartulis found the *Staphylococcus pyogenes aureus* in 2, the albus in 1, the *B. pyogenes fetidus* in 1, and *B. proteus vulgaris* in 1. Councilman and Lafleur found bacteria in the sections of 3 out of 6 liver abscesses. In 7 cases of liver abscess Kruse and Pasquale found streptococci in 3 and staphylococci in 2, and with these they often found typhoid-like bacilli (*B. coli*?). Flexner found streptococci in 1 case. In one of my cases the *Staphylococcus aureus* and *B. coli communis* were found in the pleura, pericardium, and liver. Flexner and Barker found the *Staphylococcus citreus* in a liver abscess in the Philippines. Kartulis found the *Staphylococcus aureus* in 4 cases and the

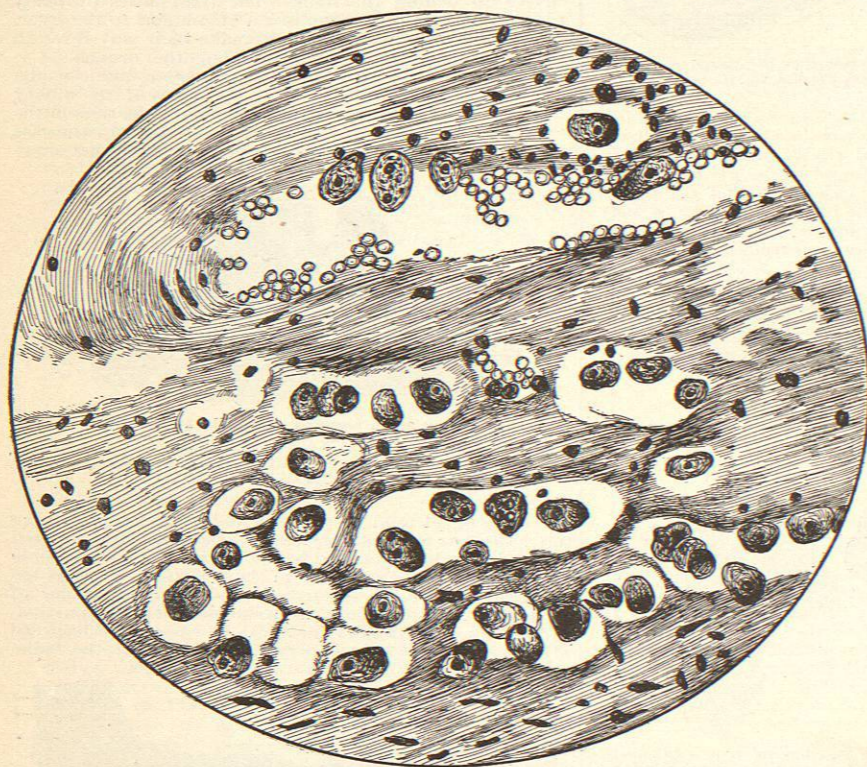


FIG. 117.—Section of Intestine Just Below Ulceration. Beck one-quarter, ocular 3. In upper portion of the field a large vein is seen; the wall of the vessel which is nearest the ulceration is being infiltrated with small cells and is breaking down; both red and white cells and amoebæ are seen within the lumen of the vessel. In the lower portion of the field many amoebæ are seen, some in the tissues, and others in the lymph spaces and lymph channel. (After H. F. Harris, by permission.)

*Staphylococcus albus* in 1 case of "idiopathic" liver abscess, without amoebæ. In 7 cases of this form of liver abscess Kruse and Pasquale found *B. pyocyaneus* in 2, *Staphylococcus aureus* in 1, *Staphylococcus albus* in 1, and typhoid-like bacilli in 1. Amoebæ have not been demonstrated in the so-called "idiopathic" liver abscess, with the exception of Buxton's doubtful case, already referred to.

(j) *Presence of Amoebæ in the Lesions. Stools.*—In a large proportion of the cases of dysentery with the peculiar clinical history of "tropical dysentery," amoebæ are readily found in the stools. In a small number of cases they are infrequent, and are found only after prolonged and repeated search, while in a few cases they are not found. Their number and the constancy of their presence must, of course, depend in large measure upon the stage and severity of the lesions. They are readily

recognized by their size, peculiar appearance, and movements. In studying the stools, small yellowish-gray particles of gelatinous mucus should be picked out. A warm stage is often of advantage, but is not necessary. Warming the slide carefully over a flame will often stimulate sluggish forms to send out pseudopodia. In examining pus from the liver, pleura, and lung, etc., it is important to obtain the specimen for examination from the wall of the abscess rather than from the centre, for the amoebæ are always more numerous about the walls of abscesses. As a general rule, the more acute the process the larger the number of amoebæ present. Amoebæ are found in a very large proportion of dysenteric liver

abscesses and of other lesions secondary to amoebic dysentery. They are sometimes missed, especially in chronic cases. Flexner and Barker remark upon their failure to find them in certain cases of dysentery and liver abscess in the Philippines. In the sputum of cases of hepato-pulmonary abscess, amoebæ are usually numerous. In one of my cases numbers were seen in every field of the microscope.

(k) *Relation of Amoebæ to Dysentery and its Complications.*—The chief proofs of the causal relation of amoebæ to these lesions are (1) its practically constant presence in such numbers and in such intimate anatomical relation to the lesions, and (2) the elimination of other micro-organisms as etiological factors. For dysentery, at least, it can be said that there is a special and peculiar anatomical variety associated with the presence of the amoebæ coli. The disease is a distinct anatomical entity, and in its lesions we find the amoebæ coli in a relation so constant and so intimate that we are forced to the conclusion that the former are caused by the latter. Inoculation experiments sometimes give positive results, but they are far from constant. Kartulis produced dysen-

tery in cats by rectal injections of amoebæ-containing stools. Kruse and Pasquale produced well-marked ulcerations of the colon of cats, with numbers of amoebæ in the lesions, by rectal injections of amoebæ-containing stools and of the amoebæ-containing but bacteria free pus of a liver abscess. Quincke and Roos produced fatal dysentery in cats by rectal injection of the amoebæ-containing stools of one case of dysentery. These results are not, however, constant, and objection has further been made that these stools, at least, were not bacteria free. Up to the present time no one has been able to produce dysentery by the inoculation of pure cultures of amoebæ grown on artificial media. Although absolute logical proof of the etiological relationship of amoebæ coli to the lesions in which it is found is lacking, the evidence is almost conclusive, and one is morally convinced of such relation.

(l) *Amoebæ Oris Hominis.*—According to Braun, amoebæ have been found in the human mouth by Gros (*Amoeba gingivalis*, 1849), Sternberg (*Amoeba buccalis*, 1862), and Grassi (*Amoeba dentatis*, 1879). It is extremely doubtful if any of these were of any pathological significance. In 1892 Flexner (*Johns Hopkins Hospital Bulletin*, 1892, p. 104) reported the case of a man sixty-two years of age, previously healthy, who developed a large, tense abscess of the jaw communicating with the mouth. Microscopical examination of the stinking pus which was evacuated by operation showed, besides a variety of bacteria, large numbers of large amoebæ, many of which were actively motile and were not to be distinguished from amoebæ coli. To quote the author: "In view of the fact that the characters of the amoebæ present in the pus of this abscess and in larger number in the necrotic material found in the pus, resemble in so many respects the amoebæ dysentericæ, . . . we are led, in the absence of definite means of distinguishing forms which may have much in common but yet be totally unlike, to regard these as allied species, if not identical." Kartulis (*Zeitschrift f. Hygiene und Infectious Krankheiten*, 1893, Bd. xiii., S. 9) reports a similar observation. An Arab, forty-three years old, who had never had dysentery, developed a submaxillary abscess and osteomyelitis of the right inferior maxilla. The mucous membrane of the mouth and gum was swollen, and there was a small fistulous opening into the mouth. The apparent infection atrium was through the alveolar process, where two molar teeth had been lately lost. Pus and sequestra were discharged from the abscess. In the pus, along with numerous bacteria, there were amoebæ with coarsely granular endosarc containing a small nucleus, vacuoles, and red and white blood corpuscles. The pseudopodia were long and finger-shaped. The amoebæ were numerous and measured from 30 to 38  $\mu$  in diameter. It is evident that we have at present no positive means either of identifying these amoebæ with or of separating them from amoebæ coli.

(m) *Amoebæ Urogenitalis.*—In 1883, Baelz ("Ueber einige neue Parasiten des Menschen," *Berl. klin. Wochenschr.*, 1883, p. 237) found large numbers of amoebæ in the bloody urine and in the vagina of a twenty-three-year-old woman with lung tuberculosis. This amoebæ (which he called *Amoeba Urogenitalis*, n. sp.) was very active, and measured in the resting state about 50  $\mu$  in diameter, had a granular cell body and a vesicular nucleus. Jürgens (quoted by Braun and by Posner) has described a case of multiple cysts of the mucous membrane of the bladder filled with amoebæ. Kartulis (*loc. cit.*, S. 2, footnote) has reported the case of a man fifty-eight years old, living in Egypt, with profuse hæmaturia and a tumor of the bladder the size of an apple. The urine was dark red in color and contained, besides red blood corpuscles and bladder epithelial cells, a large number of small amoebæ (12 to 20  $\mu$  in diameter), which moved lazily and put out short pseudopodia. The endosarc was finely granular; vacuoles and a nucleus could be made out after staining with methylene blue. Posner ("Ueber Amöben im Harn," *Berl. klin. Wochenschr.*, 1893, No. 28, p. 674) has reported the case of a musician of Berlin who was taken sick with a chill and hæmaturia. The urine was dark red in color, and contained albumin, red and white blood cells, renal epithelium, hyaline, granular, and blood casts, and amoebæ. The latter contained one or more nuclei, vacuoles, and red blood cells, had a granular endosarc, and changed their shape slowly. They were from 28 to 50  $\mu$  in diameter. On one occasion forms suggestive of encysted amoebæ were seen. The patient recovered after a few days, and both blood and amoebæ disappeared from the urine. The attacks were repeated twice within five months. Examination of the blood and of the bladder was negative. Posner attributed the symptoms to the presence of the amoebæ, which he thinks reached the kidneys by means of the bladder.

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The list of references given below is not intended as

a complete bibliography, but includes most of the important articles.

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**AMPUTATION.**—Amputation (*amputare*, to cut away) is a term generally used to designate the removal by surgical operation of a portion or the whole of an extremity. In a wider application the word is still used with reference to separations of other prominent or projecting portions of the body, such as the mamma, penis, and cervix uteri. In this article amputations of the extremities alone will be considered. Older writers, and many of the present time in Germany and France, still further restrict the term amputation to the operative removal of a limb in its continuity, as in amputation through the forearm or thigh, while they designate as "disarticulations," "enucleations," the removal of a member in its contiguity (*i. e.*, through the joint). This distinction is properly ignored by English and American writers, since many operations present combinations of the two procedures (Syme-Pirogoff).

**HISTORICAL SKETCH.**—The helplessness of surgeons of ancient times to cope with profuse hemorrhage is generally accepted as the sole admissible explanation of the fact that, for nearly two thousand years, from the time of Hippocrates to that of Paré, amputations were practically limited to the removal by cutting through the dead tissues of gangrenous extremities. The only reference to amputations in the Hippocratic writings is as follows: "In case of fracture of the bones, when strangulation and blackening of the parts take place, at first the separation of the dead and living parts quickly occurs, and the parts speedily drop off, as the bones have already given way; but when the blackening (mortification) takes place while the bones are entire, the fleshy parts in this can also quickly die, but the bones are slow in separating at the boundary of the blackening and where the bones are laid bare. Those parts of the body which are below the boundaries of the blackening are to be removed at the joint as soon as they are fairly dead and have lost their sensibility, care being taken not to wound any living part; for if the part which is cut off give pain, and if it should prove to be not quite dead, there is great danger lest the patient swoon away from the pain, and such swoonings are often immediately fatal" ("Hippocrates," Sydenham, vol. ii., p. 639).

The anatomical labors of the Alexandrian school could not have been without influence on the status of surgery. This we see illustrated in the surgical writings of Celsus, who unquestionably was the first to suggest amputations in the living tissues above the line that separates them from the sphacelus. While he admits that patients frequently succumb during the operation from hemorrhage, there can be no question but that Celsus was acquainted with the great usefulness of the ligature. In his chapter on wounds, he advises that "if these [plugging the wound, compression, and mild caustics] do not prevail against the hemorrhage, the vessels which discharge the blood are to be taken hold of and tied in two places, about the wounded part, and cut through, that they may both unite together and nevertheless have their orifices closed."

It seems scarcely possible that the theory, if not the practice, of surgery could have developed to the position designated, unless a less difficult procedure for the liga-