

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

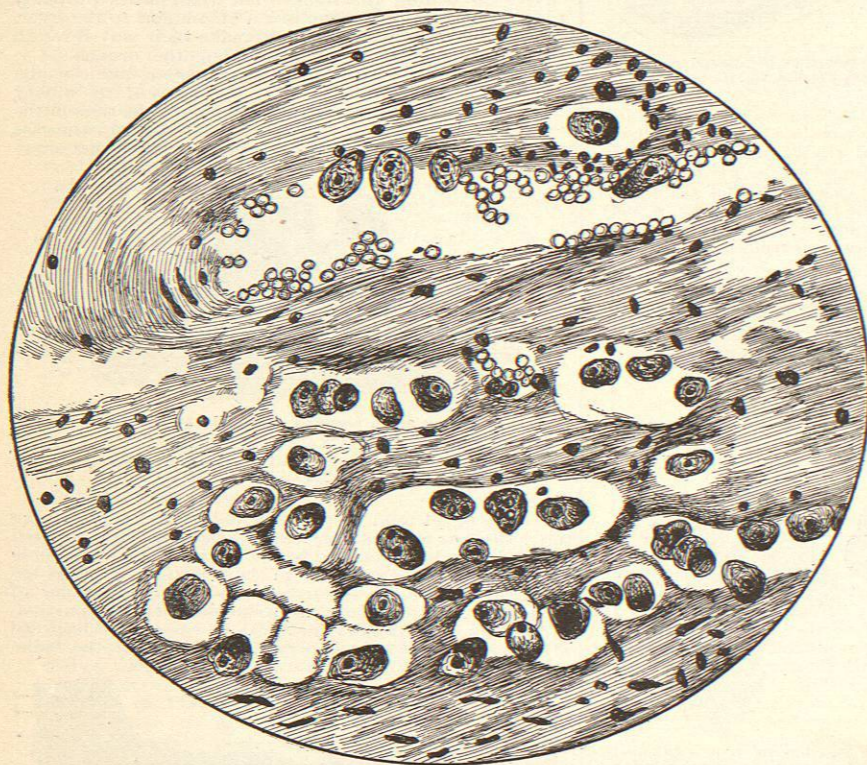


FIG. 117.—Section of Intestine Just Below Ulceration. Beck one-quarter, ocular 3. In upper portion of the field a large vein is seen; the wall of the vessel which is nearest the ulceration is being infiltrated with small cells and is breaking down; both red and white cells and amoebæ are seen within 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 μ 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 μ 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 μ 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 μ 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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Beyerinck: Centralbl. für Bakteriologie, Bd. xix., S. 253.
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Osler, W.: Centralbl. f. Bakteriologie, 1890, Bd. vii. S. 736.

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-

tion of a bleeding vessel in an open wound had been likewise perfected, particularly in view of the facts that Archigenes had introduced the tourniquet, that every writer of the Greek and Arabian schools makes repeated reference to the use of the ligature for the relief of hemorrhage, and that torsion of bleeding vessels was advised under certain circumstances by Galen, Rhazes, and Paulus Ægineta. It is quite certain, therefore, that the proper management of hemorrhage was not entirely lost sight of even in the darkest period of the history of medicine. Indeed, the indications for amputation seem to have been more elucidated for a time after the labors of Celsus. Thus Archigenes enumerates, among the circumstances which require amputation, "the presence of intractable disease, such as gangrene, necrosis, putrefaction, cancer, certain callous tumors, and sometimes wounds inflicted by weapons" (Syd., "Paul Ægin.", vol. ii., p. 410). Nevertheless, the advanced position occupied by this writer was soon receded from. For a thousand years from the time of the latter authority retrogression was the fate of amputations as of surgery in general. Where recourse to amputations was unavoidable, the most barbarous methods were resorted to. The Arabians operated with red-hot knives. Throughout the dark ages the actual cautery was applied to the bleeding stump, or this was covered with boiling oil, or molten pitch, or sulphur. More cruel than any other was the practice of Guy de Chauliac, who in the fourteenth century bound a cord with sufficient force around a limb to insure its removal by gangrene. While amputations were thus dreaded, until within the last three centuries, alike by surgeons and patients, it is certain that this operation was not called for so frequently as it is now. Lacerations as terrible as those produced by machinery and firearms, which for the most part force the amputating knife into the surgeon's hands, could hardly have been often encountered prior to the discovery of gunpowder and steam.

While Gersdorff, of Strasburg, probably had used the ligature in amputation wounds for some years, it remained for the genius of Paré to give to amputations a comparatively firm position among surgical operations. After nearly thirty years of experimentation and practical test of the ligature, he published results which should at once have revolutionized the surgical practice of the time. With the retraction of the skin and soft parts above the site of operation, to insure sufficient tissue to cover the divided bone, and the use of a constricting band, Paré had adopted all the preliminary means which are deemed necessary to-day by many for making a circular amputation. Grasping the open mouths of the arteries with curved forceps, he closed them with a double thread, and the wound with three or four sutures. Likewise was Paré the first who clearly taught the value of the ligature *en masse* in refractory hemorrhages. "Inspired by God with this good work," it would seem that Paré should have speedily moulded the practice of his contemporaries. That this was not the case is evident from the great opposition encountered by him, and that it required nearly two centuries for the ligature to supplant the actual cautery as a hæmostatic measure. Although Fabricius Hildanus in Germany, Dionys in France, and Richard Wiseman in England (last half of seventeenth century) make mention of the ligature, they in nowise recommend it. It is not remarkable, therefore, that in the seventeenth century, Botal did not hesitate to perform amputation by means of two hatchets, one placed immediately below the member and the other loaded with leads let fall upon it (Velpéau, "Operat. chir."), and that even as late as 1761 W. Sharp saw cause for complaint at the restricted practice of ligaturing bleeding vessels. Indeed, it is questionable whether the ligature of vessels in amputation wounds could even then have obtained a firm foothold without the assistance given to it by the tourniquet. The origin of the latter is enshrouded in mystery. There can be no doubt that H. von Gersdorff made use of constricting bands. It appears that the idea of provi-

sional compression of the artery, as now practised, was introduced independently by two surgeons of different countries at about the same time. Morel, in France, and Young, in England, each devised a tourniquet for the arrest of the circulation. It remained, however, for the great J. L. Petit (1718) to elaborate the principles of arterial compression and to construct an instrument from which those now in use differ but little. Finally, with the introduction of digital compression and the use of the Esmarch bandage, the appliances for the control of hemorrhage appear as perfect as human ingenuity can make them.

The most dangerous feature of an amputation being controlled, attention could be directed toward the securing of a more rapid cure and a useful stump. When, in ancient and mediæval times, an amputation terminated well, a year elapsed before the wound had healed, and a conical stump usually resulted. In 1678 a friend of Thomas Young expressed his great surprise that larger extremities could be removed in such a manner that the wound was firmly cicatrized by first intention in three weeks. The circular incision for amputations being the one most quickly accomplished and intuitively resorted to by the earlier operators, was the one generally adopted. Although Celsus clearly indicates the necessity of completely covering the ends of the bone with the soft parts by dividing it upon a higher level, yet it was but rarely accomplished. This will not appear remarkable when we consider how the operation was described as late as the sixteenth century by Hans von Gersdorff, the great barber-surgeon of Strasburg: "And when you will cut him, order some one to draw the skin hard up, and then bind the skin with your bleeding tape tight. Next tie a simple tape in front of the other tape in such a way that a space is left between the two tapes of one finger's breadth, so that you may cut with the razor between them. In this way the cut is quite reliable, goes easily, and makes a perfect stump. Now when you have done the cut, take a saw and separate the bone, and after that undo again the bleeding tape and order your assistant to draw the skin over the bone and the flesh, and to hold it hard in front. You should have a bandage ready of two fingers' breadth; it should be moistened beforehand, so as to be wet through, then bind the thigh from above downward to the cut, that the flesh may protrude in front of the bone, and then bandage this too." Amputation by a single circular incision down to the bone has since been revived by Louis and Brünninghausen in the beginning of our century, and has been advised by Esmarch recently in emaciated and exhausted subjects.

Early in the last century J. L. Petit originated the first decided improvement upon the ancient method of practising the circular incision. With the first circular incision he divided the skin and subcutaneous cellular tissue alone, and after reflecting them divided the muscles upon a higher level by a second circular sweep of his concave knife. Cheselden and Sharp in England, and Heister in Germany, independently devised and became adherents of this improved operation, by which the end of the bone could be completely covered. To still further improve the stump Edward Alanson, after the customary circular incision through the skin, sought to give the wound a funnel shape by applying the knife obliquely and dividing the muscles in the form of a hollow cone. Subsequent operators finding, however, that the wound thus made was not conical, but spiral, and that it entailed conditions unfavorable to primary union, this modification failed to get a permanent foothold among recognized operations. A better and simpler means to produce a conical wound was produced by Desault, who, after division of the skin, divided the superficial and deep muscles on different levels by two separate sweeps of the knife.

Meanwhile flap operations had been devised. Although, according to Velpéau and Lacauchie, Heliodorus had described amputation of superfluous fingers by the double flap operation, the knowledge of this method was

entirely forgotten.* R. Lowdham, of Exeter, in 1679, introduced the flap operation for amputation of the leg by making a lateral flap on one side, a semicircular incision on the opposite side completing the operation. The incision was made from without, and included the skin and muscles of the calf of the leg. Although, as already indicated, Young (*currus triumphalis*) most highly lauded the results achieved by the new method, it was ignored until Peter A. Verduyn, of Amsterdam (1696), practised a similar amputation, transfixing the soft parts with a double-edged knife. Sabourin and Garangeot adopted the method by transfixion. Other modifications rapidly followed the first steps of the new method. H. Ravaton (1750) and Vermale (1767), surgeons of the Palatinate, recommended the formation of double flaps, while Charles Bell (1807) and the elder Langenbeck (Göttingen) again practically returned to the older operation of Lowdham. On the other hand, Sédillot, in 1841, and Teale, in 1858, greatly improved the double-flap operation. Sédillot formed two musculo-cutaneous flaps, in which only a small part of the flesh was included, and divided the remaining soft parts by a circular incision. A number of operators advised that the flaps be of unequal size, lest the cicatrix become adherent to the divided end of the bone. Finally, Thomas Teale, of Leeds (1858), devised the antero-posterior rectangular musculo-cutaneous flaps. Scoutetten, of Metz, in 1827, combined into what is termed the oval method a number of operations which had been previously employed by the elder Langenbeck, Larrey, Guthrie, and others. According to Scoutetten, this method, which is best adapted to disarticulations, is supposed to possess the advantages of both flap and circular operations. While, on the Continent, this operation has found a small band of followers, it has never met with general favor.

INDICATIONS.—Amputation has been termed the "last resource" and the "opprobrium" of the surgeon. Recourse to this radical measure signifies the surgeon's belief in his efforts to restore to usefulness an injured limb; it is his confession that, in the combat with disease, he has been conquered, or that his ability to rectify a congenital deformity is limited. To recognize the limits of his powers to save a part requires the keenest judgment of the surgeon, and it is remarkable how, in the history of amputations, this has swayed between the extremes of radicalism and conservatism. It is, of course, not remarkable that, prior to the introduction of the ligature, amputations were, for the most part, confined to the removal of parts which were all but removed by an accident itself, or were already the seat of gangrene. On the other hand, the multiplication of methods of amputation, during the last and the early part of this century, went hand-in-hand with the most reckless condemnation of limbs. The voices of Gervaise and Boucher, which were raised in defence of conservatism, were unheard, and even the remarkable reports of Bilguer were unable to stay the useless sacrifice of limbs. Bilguer, the father of conservative surgery, and surgeon to Frederick the Great, could report, in 1763, 169 compound fractures successfully treated by conservative methods. Among these were 9 of the femur, 42 of the leg, 19 of the ankle, 9 of the head of the humerus, 16 of its shaft, 22 of the elbow, 9 of the forearm, 3 of the wrist, and 3 of the hand. The distinction which these statistics brought to Bilguer was materially dimmed by the fact that he published his successes alone, and that for a while he denied amputations a place among justifiable operations. The incredulity of surgeons in these results and extreme views was one of the causes which prevented them for many decades from restricting the indications for an amputation. Faulty methods of treating wounds and an insufficient appreciation of the dangers attending major amputations were likewise potent factors in so frequently forcing the amputating knife into the hand

* The importance of covering the end of the bone was patent to many—Barth, Magri, among others (Von K. Sprengel: "Gesch. der Chir.," vol. i., p. 408, Halle, 1805).

of the surgeon. The introduction of immovable dressings, the startling statistics of Malgaigne, published in 1842 and 1848, the favor with which excisions were received, and, above all, the advantage of antiseptic treatment in the widest sense, were the chief causes in finally determining the indications for amputations as they are now generally accepted.

In general terms, it is proper to resort to amputation when the sacrifice of a part, which is hopelessly diseased, is necessary to the preservation of life or the enjoyment of its various functions and duties. It is well to remember that "the vast majority of people would prefer living with three extremities to being buried with four." While in each individual case the danger and advantages of an operation are to be carefully balanced, conditions may arise which may make an operation imperative which but a few days before seemed uncalled for.

Contra-indications to amputation, either temporary or permanent, should also be clearly recognized. Among the former, particularly as to amputations for injury, should be considered extreme shock and exhaustion from excessive hemorrhage. As permanent contra-indications, such conditions should be recognized as will preclude the possibility of attaining the object of all operative procedure, viz., the restoration of the patient to health. Such indications are, first, so extensive an involvement, by disease, of a limb and contiguous parts that amputation will not suffice for its complete removal, and, second, complications on the part of important internal organs from injury or disease, under which circumstances an amputation would not only be useless, but would probably curtail life.

While it is an axiom that amputation should be resorted to only under circumstances in which no other means will avail, there is no little difficulty in determining the conditions that call for this extreme measure. They may be most readily investigated by considering them under the three general headings of injuries, non-traumatic lesions, and deformities.

INJURIES.—(a) When, from accident of any kind, a limb is entirely severed from its connection, or the soft parts so mutilated that it is attached by skin alone, or by it and pulpified flesh, an amputation is absolutely indicated. Wounds from circular saws, railroad accidents, extensive gunshot lacerations, afford numerous instances in which the amputation consists in nothing more than trimming off the ragged edges of the wound, levelling the inequalities of the protruding fleshy masses, and placing the stump in the best condition for speedy repair. To this class of injuries belong those cases, caused by railroad trains, heavily loaded wagons, entanglement in machinery, etc., in which the soft parts are extensively torn from the bone, the muscles being pulpified, the blood-vessels and nerves lacerated. It is remarkable that in instances of this character the skin itself may remain unbroken, while all that it covers has been practically crushed. The shock attending the tearing off of a leg or an arm is usually so excessive that a formal operation with attendant loss of blood must be dispensed with.

On the other hand, it is a well-established fact that fingers, portions of the nose and ear which had been almost completely and even totally separated by an incised wound uncomplicated by contusion, have been permanently replaced by the careful use of sutures.

(b) Extensive burns and circumferential lacerations of only the skin and subcutaneous cellular layers may, in rare cases, require the sacrifice of a limb. When, from the depth of a burn, it becomes evident that the reparative process must be suppurative in character, and continue for many months, and when finally ended leave a disfigured and practically useless member, it is usually better at once to amputate than to expose the life of the sufferer to the dangers of septic infection, amyloid degeneration, or exhaustion. Extensive stripping of the integument from a member may likewise impel the surgeon to operative interference. A most interesting case of this character is recorded by M. Schede (Billroth und