Surgical drainage : a new method of subcutaneous drainage and irrigation / by George J. Robertson.

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With G. J. Robertson's Compliments

SURGICAL DRAINAGE:

A NEW METHOD OF SUBCUTANEOUS DRAINAGE AND IRRIGATION.

BY

GEORGE J. ROBERTSON, M.B.

[*Reprinted from* THE MEDICAL CHRONICLE, *October*, 1884.]

SURGICAL DRAINAGE:
A NEW METHOD OF SUBCUTANEOUS DRAINAGE AND IRRIGATION.

BY GEORGE J. ROBERTSON, M.B.

Before describing the method of drainage to which I wish to draw attention, it will be well to review the natural forces by which fluids are discharged from cavities, as well as to consider the merits of the various methods of drainage in use by surgeons.

Taking abscess as the type of fluid collections that require the attention of the surgeon, the natural forces that come into play in the emptying of the sac when an opening is made are :—

1. The elastic recoil of the tense sac and surrounding tissues upon the escaping matter.

2. Gravitation.

3. The natural processes of repair; granulation, contraction, adhesion, &c.

Artificial aids are atmospheric and mechanical pressure applied to the surface, and capillarity.

In tubular drainage, as ordinarily practised, the surgeon facilitates escape of pus (*a*) by making the channel of exit at the most dependent part of the sac, thereby securing as completely as possible escape of the contents by gravitation; (*b*) by introducing into the cavity through the wound a piece of perforated tubing. This maintains the patency of the opening, allows the fluid to percolate into its interior at various points, and affords a free, smooth channel for the passage outwards of present and subsequent contents. The defects of this method are :—

1. It depends for its efficiency upon gravitation of the pus to an opening made at the lowest part of the sac. Now the lowest part attainable is frequently, indeed generally, not the lowest actually. The latter can in many cases be reached only by tunnelling through healthy tissues. Take, for example, the recent proposal to cut through all the tissues of the back to drain a spinal abscess. The position of the opening relative to the sac varies with the posture of the body; thus the lowest point when the patient is in bed is not the lowest point when he is afoot. It sometimes happens that the escape of pus by gravitation is objectionable on other grounds; for example, drainage of the pelvis into the vagina, of the bladder into the rectum.

2. Air is freely admitted into the cavity to be drained. In most

abscesses of any size, when incision is made, part of the pus escapes with a spurt due to tension; the greater part escapes slowly with corresponding collapse of the sac, but there is a residuum, on the escape of which by gravitation, air enters to fill the space it occupied. Though the air is by antiseptic treatment rendered harmless in the way of exciting putrefaction, none the less is it a foreign body which by its physical properties delays the filling up of the cavity.

3. Discharges are deposited in close proximity to the healing parts. Fluid discharges in contact with a wound, be they pus or bloody *débris*, are hostile to healing by adhesion; they are very prone to decompose, and in turn set up putrefaction in the deeper parts. The prevention of putrefaction involves elaborate dressing. The removal of the discharges occasions disturbance of healing parts, pain and risk to the patient, and loss of time to the surgeon.

It is quite possible to exaggerate these defects. For instance, the inability of the surgeon to carry out his purpose of making an opening at the most dependent part often causes retention of the residuum, and, from first to last, air does not enter the cavity. By the application of external pressure fluid is expelled that would not escape by gravitation, and the walls are compressed temporarily, giving time for the filling up of the space by natural processes; while antiseptic methods of dressing and the use of absorbent materials render frequent interference unnecessary. Making full allowance for these and other modifying agencies, drainage by gravitation from the wound is defective to a serious degree, as well from inefficiency as on the grounds above stated.

Drainage by capillarity is efficient only when the fluid is small in quantity and of thin consistence.

The aspirator is free from the defects of the ordinary method of drainage. It does not depend upon gravitation; air is not admitted to the cavity; discharge is at once removed from the vicinity of the patient; and the opening made is small. But the discontinuous withdrawal of the discharge, the often too-violent emptying of the cavity, and the narrow channel of exit, are drawbacks that restrict its use.

The syphon possesses many of the advantages of the aspirator. The withdrawing force can be regulated with ease; once set agoing it is self-acting, and use can be made of a tube of sufficient diameter to afford free passage to all ordinary fluids. Its one great defect is that it is not adapted for continuous drainage. So soon as the fluid ceases to flow the contents of the descending arm begin to be replaced by air, so that in a short time syphonic action ceases, and with it discharge of fluid, unless by overflow.

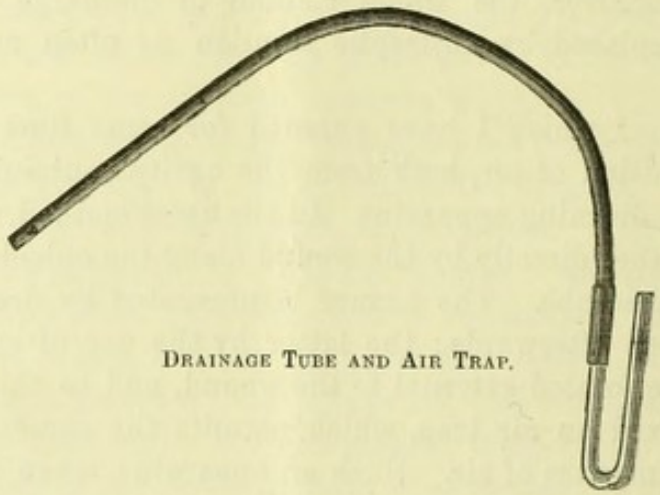
The drainage of the pelvis by Koeberle's glass tube is in striking contrast to the ordinary method. The point of exit for discharge, instead of being the lowest, is the highest of the cavity; or, rather, on a higher level than the cavity. The fluid rises in the tube against gravity by the pressure of its environment. The faults of the method are obvious, but it has some advantages of great importance. It is simple and eminently antiseptic. The fluid in the tube offers an effective barrier to the entrance of air, and the only part of it exposed to septic influence is its free surface, which is always in process of removal; moreover, the whole column of discharge can without trouble be replaced by antiseptic solution as often as is thought necessary.

The method which I have pursued for some time aims at the absolute exclusion of air, both from the cavity containing the fluid and from the draining apparatus. In the usual method, air may enter the cavity, either directly by the wound along the outside of the tube, or through the tube. The former is prevented by dressing, which will be noticed afterwards; the latter by the use of rubber tubing which is unperforated external to the wound, and to the free end of which is affixed an air trap, which permits the egress of fluid but opposes the entrance of air. Such an apparatus, when it is applied filled with fluid and the dressing of the wound is completed, forms with the abscess sac a continuous space, whose contents are obedient to the laws that regulate fluids. The free end of the trap takes the place of the wound, and, being connected with the abscess by a flexible tube, it can be raised and depressed at will.

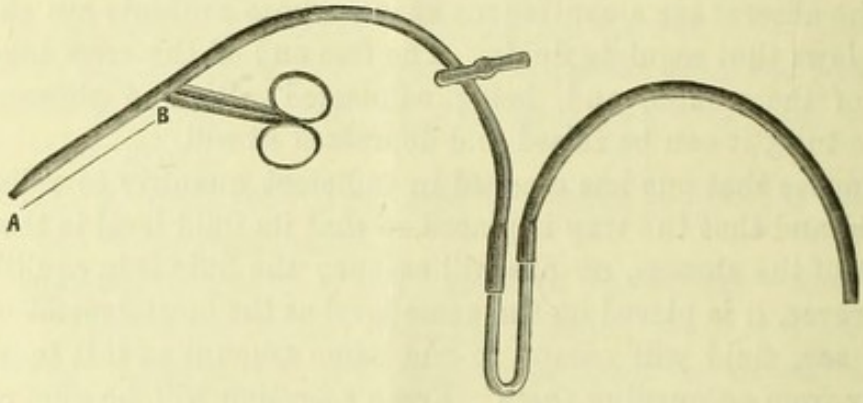
Suppose that pus has escaped in sufficient quantity to relieve all tension, and that the trap is placed so that its fluid level is the same as that of the abscess, no pus will escape; the fluid is in equilibrium. If, however, it is placed on the same level as the most dependent part of the sac, fluid will escape to the same amount as if it took place directly from an opening there. Fresh secretion will be removed as it forms, and the residuum is carried away, drop by drop, as the space occupied by it becomes obliterated. By placing the trap on a lower level than the abscess, there is superadded to such force as would be in action by an opening at its lowest part a constant draining power, which can be regulated and estimated with precision. The amount of the force depends in no degree upon size or length or tortuosity of the tube. It is determined by the perpendicular distance between the fluid level of the cavity and the fluid level of the trap. It is spent in the withdrawal of fluid so long as the walls contract or collapse. When the residuum is reached, the abscess may be regarded as a closed vessel filled with fluid, upon part of whose wall,

i.e., the area occupied by the tube, is exerted an outward pressure. According to the law of equal transmission, this outward pressure is transmitted as an inward negative pressure, acting equally and at right angles to every portion of the surface of the cavity. Hence a continuous force is distributed over the walls of the abscess and is exerted at all points in the direction required for its obliteration.

By this method the point to which the fluid gravitates is transferred from the opening made in the body, which is a fixed point, to



Drainage Tube and Air Trap.



Apparatus Ready for Application.

A—B. Portion of the Forceps hidden from view by Tube.

the end of the trap, which is movable. It is no longer necessary, and, as will be seen when we consider the dressing of the wound, it is not expedient to make the incision at the lowest point of the sac. The site for incision is chosen without regard to gravitation. Suppose an opening made at the highest point of the abscess, and through it the tube is pushed to the bottom of the cavity. By virtue of syphon action the contents will be removed just as if the opening were at the lowest point. The trap renders syphon action continuous. Hence

the immense advantage that fluid, wherever situated, can be removed, if it is within the reach of the tube. It can be drained from the pelvis through an opening in the abdominal wall as efficiently as from a superficial abscess.

The apparatus which I have used for this method is exceedingly simple and cheap—the materials being ordinary unperforated rubber tubing and glass tubing of various sizes.

That part of the tube which lies inside may be of rubber or glass; generally rubber is to be preferred from being less rigid; one or two holes should be made near its end. External to the body the unperforated rubber tubing is of sufficient length to carry the discharge to a convenient depôt, and to the end of it is attached the air trap.

This is a U-shaped piece of glass tubing of similar size to the rubber, each arm measuring from two to three inches. With a spirit lamp and file it can be readily made; it is most evenly bent if its lumen is filled with fine dry sand before it is heated in the flame.

The materials should be kept in antiseptic solution ready for use. The character of the coagulum formed by the action of carbolic lotion upon the fluids renders them difficult of drainage. For some time I have used corrosive sublimate solution (1—1000), and I think with advantage.

The following is the method of application:—Into a basin containing an antiseptic solution are placed first a little absorbent cotton and then the apparatus, which, having been entirely filled with the solution, is clipped near the middle with a pair of Wells' artery forceps to prevent escape of the contents on removal from the fluid. A second forceps of small size is applied to the free end in such a manner as to occlude the perforations in the tube and to serve as a guide in introducing the tube into the cavity. The skin is thoroughly cleansed; the site for the opening is chosen on general considerations of convenience; a narrow bistoury is passed into the abscess, making an opening just large enough to admit the tube; the lips of the wound are held between the finger and thumb while the knife is withdrawn, and by means of the forceps attached to its free extremity, as described above, the tube is passed through the incision down to the bottom of the cavity. The forceps is then freed and withdrawn. In doing this a little pus is apt to escape, but this is of no consequence. The cotton in the basin is wrapped round the tube where it emerges from the skin, thus serving as a temporary guard against the entrance of air. The trap is now placed below the level of the abscess, and, the clip being removed, a free flow of pus follows. When the abscess is emptied, or when sufficient quantity has escaped to permit the dressing to be proceeded with

without risk of the contents being forced out, the clip is reapplied and the guard removed. The skin having been cleansed, the lips of the wound surrounding the tube are securely packed and rendered air-tight by means of cotton-wool soaked in collodion; over this, enveloping the tube, are placed layers of absorbent cotton, retained in position by strips of adhesive plaster and gauze-bandage. Finally, to prevent accidental displacement of the tube, it is moored by thread to the ends of two safety pins fixed in the bandage, and placed about two inches apart with the tube between. The disposal of the discharge next engages attention. It may be effected in various ways. In small abscesses the pus is allowed to soak into coarse gauze wrapped round the trap; old curtain answers very well, ordinary lint or absorbent cotton, when it becomes sodden, obstructs the flow. If it is desired the trap may be dressed with full antiseptic precautions. In cases in which there is a copious discharge, the following plan will be found simple and cleanly. By means of a piece of rubber tubing the pus is conveyed from the trap into a bottle placed underneath, which has been thoroughly disinfected, and into which is poured half an ounce of carbolic oil. The tube extends a little beyond the neck of the bottle, which is plugged with cotton wool. The pus drops from the end of the tube on to the carbolic oil, through which it sinks. The oil floating on the surface protects the discharge from contact with the air and keeps it aseptic till the bottle is full. By the use of a graduated bottle the daily quantity of discharge may be noted. Whatever be the receptacle, the trap is pinned in an upright position to the clothing of the patient if he is afoot, or to the dressing round the affected part, or to any other convenient object, such as a pillow if he is confined to bed, at such distance below the level of the abscess as is considered advisable. The clip is now removed, the dressing being finished.

This arrangement may be left undisturbed for an indefinite period, the discharges being removed at intervals by the surgeon or by an unskilled hand. The glass trap permits the surgeon to see from time to time the nature of the discharge. In the case of a simple abscess of ordinary size the solid constituents of the pus gradually diminish, so that often at the end of twenty-four hours the trap is filled with a clear fluid with little balls of pus corpuscles floating in it. At a varying period, often in two or three days, it is a clear, limpid fluid, free from solid matter. After pus has ceased to form, it will be found wise to allow some time—a day or two—for the cavity to be filled up, before proceeding to remove the tube. Where the discharge has remained aseptic, and the length of the tube within the body is not more than one inch or two, and the calibre is not greater than a

No. 10 English catheter, the clip is applied, the tube is removed with the same precautions as are observed in withdrawing an aspirator needle, and a small cotton pad, soaked in collodion, placed on the wound. If the tube is large or long, or if the discharge is septic, then a sponge compress, or a pad of dry, absorbent cotton, retained in position by a firmly-applied bandage, answers very well.

The draining force is measured by the perpendicular distance between the fluid level of the cavity and the fluid level of the trap. The longer the distance the greater is the force. The amount that should be used will vary according to the rigidity of the walls of the cavity and the consistence of the fluid in it. For obvious reasons it will generally be advisable to provide for the latter by using a tube of sufficient size. When, as in an amputation, the walls readily lie in contact, all that is required for efficient drainage is to determine an outgoing current. A fall of an inch serves the purpose. In abscesses two or three inches to a foot may be employed so long as the discharge is free; as it abates the fall should be diminished; when the trap contains little or no solid matter, it should be placed so that its fluid level corresponds to the bottom of the abscess cavity; force in excess of what is useful is indicated by obstruction of the tube, due to the tissues being sucked into it. This is especially apt to occur in the drainage of amputations, and in the latter stage of the drainage of abscesses when the cavity is filled up with granulations. In other cases a more or less copious flow of pure or bloody serum shows that too much force is being employed. The recurrence of pus after the discharge has become serous is also an indication of the same thing, though it may be due to putrefaction having set up in the cavity. The value of this method hinges upon the question whether the wound can be dressed so as to exclude air from the cavity to be drained, for the entrance of it in any quantity would arrest the process. The difficulty on first thoughts seems serious, but very little trial will convince anyone that there is no valid objection to it on this ground. In making incision into the abscess its most dependent part should be avoided, the wound should be made, wherever possible, solely for drainage purposes, its size should be carefully proportioned to the size of the tube, and the cavity should be well emptied before application of the dressing. These conditions being observed, the contractility of the skin, without artificial sealing by collodion, will often suffice to prevent either air from entering or fluid from escaping. This accident is most likely to happen from mechanical violence. Even here, so far as my observation goes, air does not readily enter, unless the tube is dragged wholly or partly out of the wound. When air has access to the cavity the draining

process is completely stopped, and the apparatus has to be reapplied. The escape of matter around the tube occurred to a slight extent in a considerable number of my earlier cases in which I used glass tubing within the wound. With rubber tubing and careful dressing it is an accident that need not occur often. When it does occur there is no failure of drainage, but the discharge that has escaped will, unless removed, become septic and probably infect the parts inside. When there is reason to suspect leakage of discharge the clip should be applied before disturbing the dressing. This is a point that should never be omitted. The skin is cleansed and fresh dressing applied, as already described in the primary dressing.

In my very limited experience I have met with no case in which sepsis has travelled from the trap to the cavity, and there are many conditions unfavourable to contamination by this route. The surface of fluid exposed to septic influence is small—merely the area of the end of the trap—the fluid so exposed is continually in process of removal, putrefaction has to make its way against the current of the fluid, and the discharges, being removed from the body, are at a much lower temperature than when in contact with it (30°—40°), and are consequently less prone to decompose.

This method of drainage is antagonistic in no respect to the fulfilment of the other conditions of repair; in many respects it is an ally. It has a special bearing on antisepsis, inasmuch as air is excluded, instead of being purified, and the discharges are at once removed instead of being preserved in an aseptic state in contact with healing parts. Its chief features are that fluid can be drained whatever be its situation; the wound in the skin is small, and its site is chosen without regard to gravitation; drainage is continuous, and thus tension is avoided; the draining force can be increased and diminished at will; air is excluded from the cavity, and dressing of the wound becomes unnecessary. While it is applicable to all cases in which drainage by the ordinary method is practised, its special merits will be most strikingly manifested in spinal and pelvic abscesses, compound fractures, diseases of joints, and empyema. Illustrative cases will be given in a subsequent paper, which will also contain a description of a method of subcutaneous irrigation employed in conjunction with subcutaneous drainage.

A. Ireland & Co., Printers, Manchester.

SURGICAL DRAINAGE:

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BY GEORGE J. ROBERTSON, M.B.,

Oldham.

Listerism is not a substitute for, but a magnificent addition to the principles which have long regulated surgical practice. Ever since it was announced, opinion has varied greatly as to the comparative value of the method based upon it and of drainage. The question is not easy to solve nor is it of any practical importance. It is sufficient to know that both are essential, and that each has its special function. Antiseptic dressing to the exclusion of drainage does not fail in preventing putrefaction, it fails to avert the evils arising from tension; so drainage without precautions against sepsis may be quite successful and yet the patient die of pyæmia. It belongs to the Listerian method to prevent as well as to arrest putrefaction; drainage is concerned with the removal of fluids from the body. Between the two, however, there is a close relation. For example, in the absence of putrefaction in a wound there is less discharge, and consequently less need for drainage, by which, moreover, fluid is removed before fermentation has time to begin. There can be no doubt, also, that the defects of open drainage are obviated to a remarkable degree by antiseptic dressings.

The indications for the use of drainage vary according to the nature and quantity of the fluid, and the influence which it exerts upon the tissues that surround it. Pus is effete matter which has to be expelled from the body with or without artificial aids. The surgeon in treating an abscess makes a virtue of necessity by choosing the proper time and site for incision, and by determining as far as he can the conditions under which the fluid is to be removed. It is so in the case of infiltrated urine, and so, also, when the symptoms arising from tension or from pressure upon an important organ are urgent. In chronic effusions, *e.g.*, of joints, the question of drainage is one of expediency. The risk attendant upon it has to be weighed against present evils, keeping

in view whether there is a reasonable prospect of the fluid being in time absorbed, leaving a useful although impaired organ. In this class of cases aspiration is safe but not very successful. Continuous drainage, though frequently indicated, has been little tried even with the safeguards of the antiseptic method. Effusion of serum or blood after operation, as in an amputation, separates tissues that ought to be in contact, is liable to cause tension, is very prone to putrefaction, and may or may not be absorbed. Hæmostatic agents and pressure are applied to prevent it, drainage to remove it.

It may be observed that the successful working of this method of drainage largely depends upon the care and judgment with which the draining force is regulated. Next in importance to the regulation of the draining force is the subject of obstruction of the tube. Drainage may be obstructed (*a*) by external pressure upon the tube. With ordinary care in arranging its position this will not happen; any part specially liable may be protected from compression by a piece of glass tubing applied either inside or outside the rubber; (*b*) by suction into the holes of the tubing of granulation, muscular or other tissues, an occurrence obviated by regulation of the draining force; (*c*) by the tube becoming blocked by drainage matters, such as thick pus, blood clot, tissue débris. This accident may be prevented by using a tube of sufficient calibre, and by well emptying the cavity when the contents are thick and difficult to drain. It is of great importance to detect obstruction early before any leakage by the wound has occurred. Local pain and rise of temperature along with sudden cessation of discharge, or in the case of abscess, cessation of discharge before it has become serous, ought to arouse suspicion of obstruction; while rise of temperature with marked increase in the quantity of discharge, points to sepsis. When there is evidence of obstruction, the first thing to ascertain is its site, and this presents no difficulty. For practical purposes it is sufficient to know whether it exists in the part of the tubing external to the body or in the part within it. On gently compressing between the finger and thumb the tube as it emerges from the dressing, the fluid will rise in the trap if obstruction is internal to the point compressed, but, if it is external, no motion of the fluid will be observed. Obstruction externally is removable in either of two ways. Clip the tube close to the dressing and strip it between the finger and thumb towards the trap, thus expelling the contents, then immerse the trap in antiseptic solution and relieve the tube from pressure; it will become filled with solution as far as the clip, on the removal of which drainage is again established. Or, having applied the clip as before, divide the tube a little external to it. Having then cleansed and refilled the tube, connect the divided ends by a piece of

glass tubing, taking care to expel the air. Either of these expedients occupies but a minute or two, and apart from obstruction may be resorted to occasionally for the purpose of "flushing" the tube with antiseptic solution. Obstruction in the part of the tube within the body is not quite such an easy matter to deal with. Milder measures failing, the tube has to be removed and re-applied in the way already described. Before resorting to this step, sudden compression of the tube between the finger and thumb may be tried, or gentle aspiration effected by stripping the tube towards the trap. The following procedure might also be tried: Apply the clip close to the dressing, divide the tube an inch or two external to it, attach to the free end a small funnel such as an ear speculum, and having filled it with fluid remove the clip and catheterize the course of the tube. It is worthy of mention that lessening or altogether stopping the drainage force by raising the trap so that its fluid level is the same or even a little above the level of the cavity will often be sufficient if the indications of obstruction are but slight. These artifices have to be considered, and if necessary put in practice, fortunately only in exceptional cases.

During the last eighteen months I have made use of this method of drainage in nearly a hundred cases, of which a large number has consisted of ordinary abscesses in various parts of the body. The results have been encouraging. Hitches have occurred, but with increasing experience in details they become less frequent. With few exceptions drainage has been efficient and uninterrupted. Leakage to a small extent has been the most common accident. When it has been detected fresh dressing has been applied round the tube. The need for this step, as it arises solely from the risk of putrefaction, might be obviated by the use of antiseptic in place of ordinary absorbent cotton for the dressing of the tube.

The time required for the drainage of abscesses has varied from four to eight days, according to the size of the cavity. Even a shorter time will often suffice if the parts can be kept entirely at rest. Care has always been taken to make the incision through sound skin. It is worthy of mention that in no case has the attenuated skin sloughed after the opening of the abscess. If the patient is allowed to walk about, it will sometimes be found necessary to change the position of the trap to suit the recumbent posture. As its action depends upon its being kept upright, the gauze pad surrounding it should be pinned to the clothing at two points, above and below, in order to prevent inversion.

In a case of acute inflammation of the bursa patellæ with serous contents, the tube was removed at the end of four days. There was no suppuration, and the cure was permanent.

In another case, the bursa patellæ having much increased in size

and become painful impeding the movement of the joint, drainage was tried. The contents of the sac were blood and serum forming a black syrupy fluid. Drainage ten days, during which time no pain and no interference with the dressing. Before removal of the tube the fluid in the trap was quite clear. Cure without suppuration. Case, seen two months later, quite well.

I have used drainage in a considerable number of accidental wounds and of minor operations, including excision of a large fatty tumour near the anus, and of an enlarged bursa patellæ with cartilaginous walls. The almost invariable result has been efficient and uninterrupted drainage, and therefore no interference with the first dressing unless for the purpose of removing sutures, and union without suppuration. Every care has been taken to keep the instruments, tubing, &c., "surgically clean," but no antiseptic or other lotion has been applied to freshly-cut healthy tissues.

I shall now mention more in detail a few cases in which drainage has been carried out with satisfactory results.

Case I.—Jas. B., æt. thirty-five, deep perineal abscess, forming a large fluctuating mass, extending from the anus to the pubic arch, and occupying the left side of the perineum. During the past day or two a slight gleety discharge had appeared.

Nov. 30th, 1883. Incision made under the scrotum and two inches of rubber tubing passed into the sac. A large quantity of pus was withdrawn before the dressing was applied, which was retained in position by a T bandage, the vertical portion of which consisted of two pieces of elastic bandage. Tube carried in front of the thigh. Trap in gauze pad pinned to bed sheet. Drainage fall about three inches.

Dec. 3rd. Free discharge during past three days; trap now filled with clear yellow fluid; patient not seen again until

Dec. 7th. Contents of trap, limpid fluid. Tube removed, no leakage, collodion dressing applied to wound. On examining parts several days after found wound quite cicatrised.

Case II.—Mary W., æt. three, convalescent from measles. Large abscess in the left loin, deep-seated, and filling up the space between the iliac crest and lower ribs. Child restless and feverish.

April 6th. In order to apply the tube accurately I put the child under chloroform, made incision near the outer boundary, and introduced into the cavity over two inches of rubber tubing about the size of a No. 12 catheter, having two side holes, removed three ounces of thick pus of a dirty grey colour before applying the dressing. In order to protect the tube from pressure it was carried forward along the soft abdominal wall to the groin, and freely enveloped in cotton wool, over which and round the body a bandage and several long strips of adhesive

plaster were applied; where it emerged from the dressing it was securely attached to the bandage. From this point to the trap its length was two feet; this was necessary to permit of the ordinary movements of the body. The child was placed in a cradle, between the side of which and the mattress the trap wrapped in coarse gauze was deposited. Drainage fall about three inches.

April 12th. Feverish symptoms almost disappeared. For six days the discharge was copious, it then rapidly diminished until the 15th, when the contents of the trap were clear.

17th. Tube removed, and over the wound a pad of dry absorbent cotton; a dry stain, the size of half-a-crown, upon the collodion dressing showed that slight leakage had occurred; child allowed to be dressed and walk about.

22nd. Adhering to the wound, which was quite cicatrised, was a dry crust of serous discharge. The dressing was never disturbed until the tube was removed; beyond daily removal of the gauze round the trap no interference was required. In this case, though the tube was necessarily placed in a dependent position, the contractility of the skin, aided by the dressing, was sufficient to prevent leakage of any moment.

Case III.—Helen G., æt. twenty-four, scrofulous disease of left leg and foot, November 6th, 1883. Amputation of the thigh in the lower third by antero-posterior flaps, vessels secured with catgut ligatures. No antiseptic solution or fluid of any kind was applied to the surface of the flaps; blood scraped off with a small paper-cutter, drainage apparatus filled with carbolic solution. Three inches of rubber tubing within the wound, placed in contact with the end of the bone and emerging at the outer angle; edges brought together by twenty-one carbolised silk sutures and smeared with collodion; dressing, absorbent cotton, and bandage so applied as to permit removal of tube by itself; limb placed on a pillow to which the trap, surrounded with gauze, was pinned about three inches below the wound. 9 p.m., pulse 80, temperature 99°; sickness severe; free discharge of blood (3—4 oz.).

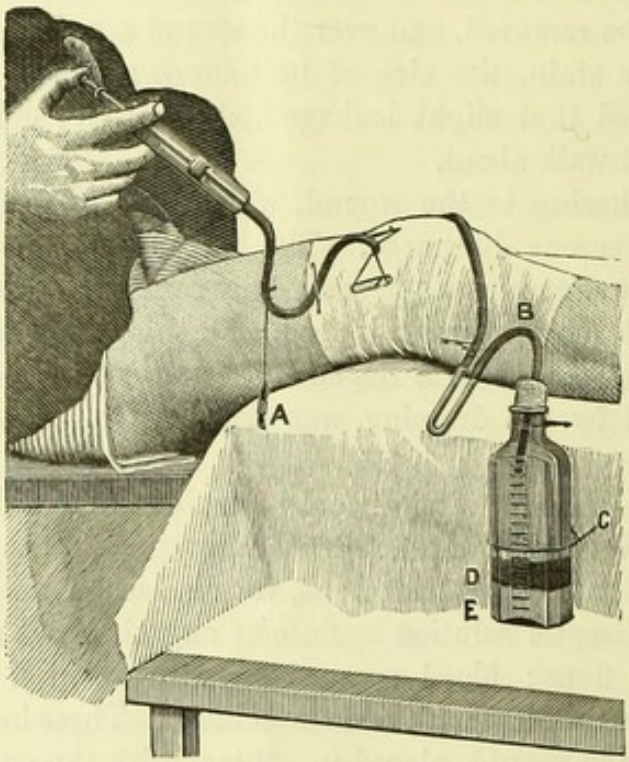
Nov. 7th. Discharge much diminished and chiefly serous; trap raised to be nearly on a level with the wound. Evening temperature 99·8°, after this it gradually fell to normal.

Nov. 8th. Little or no discharge; contents of trap mostly serous; tube removed; found partially obstructed by blood clot. There was, however, no escape of pent-up discharge on its removal; dry absorbent cotton placed over opening.

9th. Removed cotton in contact with drainage opening; it contained a small amount of serous discharge; no blood or pus.

12th. Exposed the wound for the first time; no discharge on the dressing except little crusts of blood where the wound had been in contact. Union complete except at two points, caused by faulty apposition; all stitches removed.

Six days later I again examined the stump and found it healed. In this case there was no escape of discharge by the wound, consequently there was no need for antiseptic dressing; the discharge being at once removed, the application of fresh dressing was not



DRAINAGE AND IRRIGATION OF THE KNEE JOINT.

A. Dieffenbach's artery forceps used as a clip.
B. Drainage level. The escape tube should be of large size or have a small opening at B.
C. Fastening of bottle.
D. Carbolic oil.
E. Pus.

required. In large flaps with irregular surfaces, localised collections of fluid are apt to exist. Such situations might be drained to one of the openings in the tube by a few catgut threads according to the method of Prof. Chiene, of Edinburgh.

CASE IV.—Lucy J., æt. thirteen months, suffered previously from superficial abscesses in various parts of the body, believed to be due to congenital syphilis. First seen by me on February 1st, 1883, for pain and swelling in left knee joint, which was treated in the first place by application of mercurial ointment and extension by weight; afterwards the limb was encased in plaster of Paris; for some time the patient seemed to improve.

In the middle of March increase of pain and swelling, and the supervention of feverish symptoms necessitated removal of the dressing.

On April 1st four ounces of pus were withdrawn by aspiration, and again a similar quantity on April 6th.

April 9th. Joint greatly distended; skin red, tense, and glistening. With patient under chloroform, the limb was extended and fixed on a back splint, two small glass tubes 1½ inches in length with rubber tubing and traps attached were passed into the joint, one on the inner side of the patella, the other two inches higher. The tubes were carried in front of the limb over the side of the crib, the traps hanging free in the air about a foot below the joint. The discharge dropped into a basin containing carbolic lotion placed underneath.

April 18th. Copious discharge during the past nine days; all fever disappeared; child eating well and sleeping soundly.

29th. There has been gradual diminution of discharge; little or none for several days past. Tubes carefully removed, cotton and collodion pads applied over the wounds, splint retained; from neither tube had there been any leakage.

May 3rd. Drainage openings healed. Joint free from inflammatory symptoms. Kept the limb on the splint for some time longer.

March, 1884. Child in robust health; movements in left knee joint as free as in the right. Two slightly depressed points of the skin where the tubes had been applied, and slight crackling like that felt in a rheumatic joint, were the only traces of the disease.

This was the second case in which I practised subcutaneous drainage. The joint was never disturbed till the tubes were removed, unless to apply a bandage over the existing dressings. The draining force was excessive, and the tubing much too small for the pus, which was very thick. I "flushed" the tubes occasionally with strong carbolic lotion, and thereby increased the risk of obstruction. From the fortunate circumstance that two tubes were used, and by carefully making use of the expedients already mentioned, when the flow ceased, I had the satisfaction of observing a result in every respect gratifying.

In surgical treatment there are two distinct objects in maintaining a channel of communication with internal parts. The first is to afford escape of matters from the inside—drainage; the second is to permit of irrigation, or the introduction of liquids from the outside. Subcutaneous irrigation is the subject of the following remarks. As in the case of drainage, so here it will aid description to consider it, in the first place, in relation to abscess, and to begin by making a cursory review of present methods. An

incision having been made, the ordinary method consists in discharging fluid into the cavity through the nozzle of a syringe, catheter, or other tube, the outflow taking place directly by the wound. There is no objection to it on the score of efficiency. Its chief defect lies in the fact that at each repetition of the process the dressings have to be removed and the healing parts disturbed. By the use of the aspirator the cavity can be emptied and filled with fresh fluid repeatedly; but for many reasons, among others, that the application of the instrument is not devoid of pain, it is unsuitable for general purposes. The siphon is successfully employed to wash out distensible organs like the bladder and stomach, and also abscesses at the time of incision when the walls are flaccid. In this way I have used the subcutaneous drainage tube, which is, however, quite worthless for irrigation after a time when the tissues have contracted and the process of granulation has commenced. Appreciable alteration in the quantity of the liquid contents is then impossible without doing violence to the tissues which enclose them. If the irrigating process is started by increasing the quantity, the walls of the cavity are injured by violent distension and the granulation tissue is damaged by pressure, while the fluid probably makes its exit by forcing the dressing round the tube. Diminution of the contents, on the other hand, would cause excessive suction upon the tissues, giving rise to effusion of blood and serum into the cavity and destruction of the granulations. The walls of an abscess, a little time after tension has been relieved, being neither expansible nor contractile, it is an essential condition of the employment of irrigation in combination with subcutaneous drainage that it be done without alteration of the quantity of the contents. This condition can be satisfied by restricting the drainage tube to its use as an outflow tube, and by applying another as an inflow or irrigation tube.

(1) *Continuous Irrigation.*—Take an abscess in which, from some circumstance or other, irrigation may be useful. A second tube is inserted at a convenient site apart from the drainage tube, *in the same manner and with the same precautions as the latter was applied.* If it is to be used solely for irrigation it need not be so large, nor need it project into the cavity for more than a short distance. In place of the glass trap the tube with a small funnel attached is turned in an upward direction, so as to form a second arm, which should be two or three inches longer than the corresponding arm of the drainage trap. The bend of the tube being placed on the same level as the bend of the drainage trap, on removal of the clip, the fluid in the funnel and irrigating tube sinks, until it reaches the level of the fluid in the drainage trap from which, at the same time, fluid proportionately

escapes. The same result is observed if more fluid is supplied to the funnel, either in a small stream or in drops after the manner of external irrigation. In this way a continuous current may be established through the abscess without danger of air being carried with it. The apparatus as applied resembles and acts on the principle of the Wurtemburg siphon described in books of physics.

It is probable that the continuous motion, at least of fluid at the ordinary temperature, while useful in subduing inflammation, would be detrimental to the growth of tissue. Be that as it may, in the great majority of cases all the benefit of irrigation can be gained by its occasional employment, and this is the way in which I have for the most part made use of it.

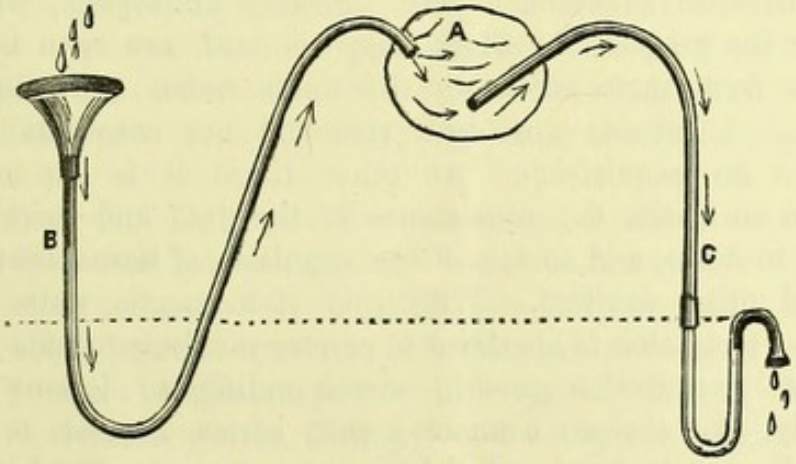


Diagram of Continuous Irrigation.

A. Abscess.
B. Irrigation tube with funnel.
C. Drainage tube.

(2) *Occasional Irrigation.*—The tube is clipped close to its free end and inserted as before. In this state it remains until irrigation is required, when it is immersed in fluid in a vessel slightly above the abscess. On removal of the clip, the process begins. If the pus is very thick, the outflow may be stimulated by gentle aspiration towards the trap. The clip is reapplied before the tube is removed from the fluid. An ordinary glass syringe may be used to supply the fluid. When it is charged, the nozzle is introduced into the end of the irrigating tube, and, the clip being removed, the piston is pushed gently "home." Before removing the syringe to refill the clip is applied. Instead of two separate tubes, it will in some cases be advantageous to pass a single tube through the abscess sac, one end being for drainage, the other for irrigation, the portion of it that lies in the cavity having side holes. Entrance of air is prevented by accurately sealing the points of entrance as already described, and by keeping the irrigating end clasped, unless when in use. A trap

is, of course, attached to the drainage end. Subcutaneous irrigation conducted by any of these procedures entails no violence to the tissues by distension. Employed occasionally, it occupies but a minute or two, and can be practised with any degree of frequency without disturbance of the parts affected, and without removal of the dressings. Owing to the facility with which it can be done with the use of antiseptic fluids, the command over putrefaction is complete.

Great as is the value of irrigation, it should not be resorted to without some definite purpose. If tension and putrefaction are prevented, granulation will probably in most cases proceed as vigorously in contact with pus as with any artificial substitute. It is commonly used to check putrefaction, the irrigating fluid being a solution of some antiseptic substance. The ordinary antiseptics, while efficient for the purpose for which they are used, are open to serious objection from their rendering the fluids much more difficult of drainage. A reliable antiseptic that did not coagulate albumen would be an acquisition. At other times it is the object of irrigation to lessen the consistence of the fluid and thereby make it easier to drain, and to aid in the expulsion of tissue *débris*, blood-clot, and other matters. With this view aseptic water is very suitable. Irrigation is also used to convey medicated fluids intended to modify granulation growth, corresponding to lotions applied externally. In abscess connected with caries, necrosis or foreign bodies, disorganised joints, and in many cases in which suppuration is associated with some condition that requires operative interference, tension and putrefaction are two important factors in the production of the symptoms from which the patient suffers. By the preliminary use of subcutaneous drainage and irrigation the injurious effects of tension might be considerably modified, and putrefaction might be arrested *before operation*, with the additional advantage that incision would ultimately be made into a cavity containing an antiseptic solution instead of inflammatory products, and with a surface already protected from the danger of exposure.

The following cases are selected to illustrate the mode of treatment described :—

Case I.—Thomas E., æt. twenty-three, consulted me for disease of the tarsus. He had also numerous scrofulous sores and scars in various parts of the body.

July 16th, 1884. The part of the left foot in front of the malleoli was greatly swollen, the skin red and boggy. In the sole there were two sinuses in the region of the internal cuneiform bone, a third sinus occupied the middle of the dorsum, a little external to which was an abscess at the point of bursting. The superficial tissues behind

the internal malleolus, as far as the ankle-joint, were the seat of strumous inflammation.

Operation.—The foot having been thoroughly cleansed, three longitudinal incisions were made, one on the inner side of the foot, another through the sinus on the dorsum, and the third through the abscess. Through these openings, by means of the gouge, I removed the three cuneiform bones, the scaphoid leaving intact its articulation with the astragulus, the cuboid, a considerable portion of the os calcis and the bases of two of the metatarsal bones. I then passed a large drainage tube from the inside to the outside of the foot. Other two tubes were also introduced, but as they were unnecessary they need not be again referred to. Redundant tissues round the sinuses having been removed, the parts were thoroughly irrigated and the wounds closed by sutures. Incision was also made through the superficial tissues behind the inner malleolus as far as the ankle-joint. Dry dressings were applied to the wounds and sinuses, and the limb was placed on a splint.

The subsequent history of the case must be told in a few words. The large space created by removal of bone was drained and irrigated subcutaneously throughout. Irrigation was daily employed for some time, and was of special service in expelling pieces of bone and dead tissue that could not have been withdrawn by simple drainage. After the first ten days the discharge was surprisingly small, and, accordingly, little or no draining force was used. In the middle of August the tube, becoming blocked by granulation tissue, was replaced by a smaller one. It was not considered prudent to dispense entirely with drainage till September 20th. After completion of the operation all inflammatory symptoms subsided, temperature remaining about 99°, unless on one occasion when it rose to 102°.

October 7th. The foot is not much larger than normal, and is free from any appearance or symptom of bone disease. Incision through the skin behind the inner malleolus has resulted in a large ulcer, which, after the manner of scrofulous sores, has repeatedly almost healed and then given way.

In respect of the utility of the foot the result of the operation has yet to be determined, but the case is complete in so far as it illustrates the successful application of subcutaneous drainage and irrigation.

Case II.—John J., æt. eleven, acute osteomyelitis, attacking simultaneously the lower epiphysis of the femur, the upper epiphysis and shaft of the tibia, and giving rise to profuse suppuration behind the bones of the leg. On May 2nd, without known cause, pain began suddenly.

May 9th. Patient first seen by me on this date. I made three incisions down to the bone along the shaft of the tibia, producing sero-purulent discharge in small quantity. Two days later two incisions were made in the region of the tibial epiphysis, one on the inner side, the other on the outer. The joint at this time was somewhat swollen and very painful.

May 15th. With the usual precautions a tube was introduced into an abscess above the joint on its inner aspect, in the belief that it was into the joint. Drainage fall, two or three inches; discharge copious, received into a bottle containing carbolic oil.

May 25th. Fluctuation discovered behind the bones of the leg; two tubes introduced through separate openings near the middle of the inner border of the tibia, one passing upwards for three inches, the other a similar distance downwards.

May 29th. Large collection of pus along the outer side of the lower third of the femur; tube inserted at the highest point. Such were the means taken to relieve tension and to provide for drainage.

The tube applied above the knee on May 15th was used for drainage until June 26th, a period of six weeks. Afterwards, on discovering that it and the tube on the outer side of the thigh were in reality draining the same space, it was employed only to irrigate for a further period of four weeks, during the whole of which time the dressing round it was not once disturbed. The tube on the outer side of the thigh, applied on May 25th, acted without interruption until July 11th, when it was found to be partly expelled from the wound; it was again inserted, not to be disturbed until it was finally removed on Aug. 5th—one dressing in ten weeks.

The varying course of the disease in the tibia contrasted strongly with its uneventful progress at the femoral epiphysis, numerous complications occurring to endanger life and limb, for the details of which space is not available. Although the incisions afforded passing relief, severe pain and violent inflammatory fever continued until eventually two abscesses formed, one on the inner side of the leg, the other behind the head of the fibula. On making incision into these, I succeeded in passing tubes behind the bone; efficient drainage was thus established and contributed largely to a good, though somewhat tardy, result at the end of four months.

The retraction of skin and periosteum left portions of the shaft in each wound exposed; from these sites small pieces of bone were from time to time discharged.

In the middle of October there was little or no induration of the tissues above the joint; round the upper end of the tibia it existed to a marked extent; the patient could bear his weight upon the limb, which

was quite healed; movement in the joint was considerable, with a good prospect of being ultimately restored. It is probable that the early use of the trephine to the tibial epiphysis would have been advantageous by making efficient drainage possible. I regret that I did not make small openings for drainage along the shaft and through these divide the periosteum and other dense structures. Had I done so, the treatment of the case from beginning to end might have been conducted subcutaneously.

It is deserving of notice that during drainage by this method repair takes place under similar conditions to those that exist in subcutaneous wounds. The growing tissues are in contact with their natural dressing; uniform support and an equable temperature are secured. They differ, however, in these respects that the risk of tension is averted, while the risk of putrefaction is incurred. Subcutaneous irrigation, beside being a valuable aid to drainage, will be found, I venture to think, to be a convenient method of applying antiseptics.

A. Ireland & Co., Printers, Manchester.