

easily be left in place for the necessary time, six, eight, and even ten days.

By its exact application and adhesion collodion gives a first and very important result. It protects the wound and the rest of the fracture from contact with the air, the presence of which leads so easily to decomposition of the blood and exuded products, an alteration which inevitably causes suppuration. It satisfies two other capital conditions, that of keeping the edges as exactly together as possible, and that of immobilizing them by preventing any slipping or folding of the skin.

For we have to obtain permanent reunion as well as occlusion, in order to reach the great result which we seek.

We have to choose between two methods of applying the collodion.

The first consists in cutting a certain number of strips of linen, half an inch wide and from two to three inches long, and in dipping each one successively in a mixture of collodion and castor oil, the so-called elastic collodion, which is less irritating than the ordinary collodion. The leg being well placed in the trough or fracture-box where it is to remain, an assistant brings with two fingers the edges of the wound together, and while he holds them in contact the surgeon applies the first collodionized strip. He places a second over the first in the form of an X, then a third parallel to and covering about two-thirds of the first, a fourth parallel to the second, and so on, so as to cover the wound itself and about an inch of the surrounding parts with a sort of collodionized cuirass. When the dressing is completed the strips are very tightly applied, close the wound, and confine the skin all around it.

The second method consists in covering a piece of goldbeater's skin about an inch and a half in diameter with collodion, sticking it upon the wound, and placing a second over the first.

I have used both methods and prefer the first. The separate bands are better than the goldbeater's skin, for the latter sometimes leaves a gap which might favour the displacement of the edges of the wound, and it compels the use of a larger quantity of collodion, which sometimes causes phlyctenæ.

I applied upon our patient the collodionized and imbricated strips of linen, after having satisfied myself again that reunion had been well made, and I completed the dressing with the anterior splint, cushion, and straps. I placed him upon the mechanical bed, and I advised him, even more strongly than usual, to avoid every kind of movement. During the following days I shall examine the leg, press upon the cuirass to see if this pressure causes a pain which might indicate inflammation, or if it causes the issue of a few drops of sanguinolent or purulent serosity. If, as is very probable, I find neither pain nor oozing, I shall leave the dressing in place for ten days; at the end of that time I shall remove it, and I can tell you beforehand that the little wound will be cicatrized, and that the fracture, transformed into a simple one, will heal after the usual lapse of time. During the last four years I have used this dressing a dozen times in cases where, as

in this one, the wound was not very much contused and was not half an inch long, and in no case did suppuration of the bone ensue.

Consider it then as certain that this mode of treatment is superior to any other, and relieves you from having to make use of antiphlogistics, continuous irrigation, and ice, the success of which is much less probable.

While speaking of these recent small wounds which heal under the occludent dressing, I wish to remind you of a patient whom you saw a few months ago in our wards. He was a man 30 years old, who, in consequence of a fall from some high place, had a fracture with irreducible displacement. We made every effort to reduce the fracture, but without success, and the upper fragment pressed strongly from within against the skin. In spite of all our efforts to prevent it, the skin, although not compressed by any part of the apparatus, was at last perforated. Fortunately, this took place twenty days after the accident; consolidation had already begun, and this late wound had no unfortunate consequence. The seat of the fracture, undoubtedly protected by the callus, did not suppurate, but the skin and the superficial part of the denuded bone did suppurate, and left a cicatrice slightly adherent to the bone.

II. *Compound fracture with a large wound.*—We have in No. 5 a man 40 years old, who offers an example of compound fracture. This lesion also is below the middle of the leg, and nearly at the place of election. It was caused by a fall from a height of two or three yards, in consequence of the breaking of the ladder on which the patient was standing. I do not think a direct cause intervened in the production of the fracture. The upper fragment of the tibia, which has not the form of a V, projected at the time of the accident through a slightly oblique wound which was an inch and a half long, the reduction was easily made; the fracture does not seem to be comminutive, but there is a wound of considerable size which evidently communicates with the seat of this fracture.

The prognosis is much graver, and the treatment will be more difficult than in the preceding case.

I shall try occlusion again; but although the edges are not much contused, I do not hope for immediate union of the whole wound, and suppuration of the bone seems inevitable. I shall leave the collodion dressing in place until I am warned by spontaneous pains and those excited by pressure that pus is collecting under it and should be let out. As soon as the presence of pus becomes incontestable I shall continue to keep the limb as immovable as possible in the trough, which will be lined with oiled silk so as to avoid a contamination which would compel us to raise the limb too often in order to maintain the indispensable cleanliness; the dressings will be renewed morning and evening. How will these dressings be made? We have to choose between several methods. Those which are most used today are alcohol and carbolic acid (1 per mille solution). To use it we begin by carefully removing with sponges all the pus which has collected upon the sides of and behind the limb; sponges are not used for the wound itself, we content ourselves with carefully wiping it

with lint soaked in one of these liquids, and we exert pressure about it so as to favour the escape of the pus which might collect in some neighbouring pouch. If we find any of these pouches, which are not too far from the skin, we open them, and, if possible, pass drainage-tubes. In these ossifluent suppurations which threaten pyæmia it is important that the pus should not remain, for then it stagnates, decomposes, and may furnish for absorption the putrid materials which engender purulent infection.

When the wound has been cleaned, balls of charpie soaked in common alcohol unmixed with water, or in the carbolic acid solution, are introduced into it, and into its cavities if they are accessible. Over them are placed one or more compresses soaked in the same liquid, the whole is covered with oiled silk, and then the apparatus destined to keep the limb immovable is completed.

Are there any reasons for giving the preference to one or the other of these agents? I prefer alcohol during the first fifteen or twenty days, because its effect is to diminish suppuration, and the less abundant the suppuration the less does the patient weaken, and the fewer the materials susceptible of putrid decomposition. It is also possible, but it has not yet been demonstrated, that alcohol, by coagulating certain albuminous principles of the pus, modifies them in such a way that their putrid alteration is rendered more difficult. Perhaps also the alcohol, by its astringent action, obliterates some of the lymphatics and bloodvessels which might furnish passage to the putrid poisons. All these opinions have been uttered with a certain enthusiasm by the partisans of alcoholic dressings; but only one of them has been proved by clinical observation, that one is the diminution of suppuration. For this reason alone alcohol should be used during the first days. You will rarely see me continue its use after the twenty-fifth or thirtieth day, for if it diminishes suppuration, it also retards cicatrization. By long contact with it the granulations become small, the wound grows pale, and becomes painful sometimes, and does not dry over, if not in all cases, at least in a certain number.

I shall then begin with the alcoholic dressing; then if, at the time when purulent infection is less to be feared, I find that cicatrization advances too slowly, I shall substitute carbolic acid, which, without increasing the suppuration, generally maintains on the surface of the wound that rosy colour which indicates the regular work of repair. Of course, during the dressings, I shall examine from time to time with a probe to see if there is not some loose splinter to be removed. All the abscesses which form will be opened freely, and a general treatment with tonics prescribed. After the twelfth or fifteenth day I shall give the patient a drachm of phosphate of lime morning and night in his soup: he will also have five drachms of brandy daily, and all the nourishing food which he can and will accept, and which we have at our disposal in the hospital; finally, we shall try to obtain the best possible aëration of the ward. In this respect we are not as well provided for as I could wish. This patient is one of those for whom an isolated, well-ventilated, well-warmed room is necessary, or for whom, during the hot season, permanent or intermittent quarters in a

tent or cabin like those which have just been built at St. Louis, Cochin, and Lariboisière, would be of the greatest use. Remember this, that of all the means preservative against purulent infection, immersion of the patient in a very pure atmosphere is by far the most important.

I have not raised, gentlemen, an important question which is discussed by all our authors in the chapter of compound fractures, that of amputation. Why have I not mentioned amputation to this patient? Because, in my opinion, he may get well and preserve the leg, and indeed his chances of dying are a little less than if I should now make an amputation, which would belong to the category of *primitive amputations*, that is, those which are made before the appearance of traumatic fever.

Notice first that the dangers from which I should wish to protect him are exactly those to which he would be exposed after an amputation at the place of election. His wound exposes him to a traumatic fever, which may be severe and even fatal, that is true, but amputation exposes him to the same. His wound exposes him especially to purulent infection, but that also is what we fear the most after an amputation. His wound exposes him in a certain degree to traumatic erysipelas and to a consecutive hemorrhage. But would amputation preserve him from them? Would it not rather expose him even more to secondary hemorrhage? His wound may perhaps leave him with an infirmity and a limp, but would not the necessity of wearing an artificial leg also be an infirmity?

Amputation would be justified only if I was certain that he was more likely to die by the injury than by the mutilation, through one of these complications. Now, upon this point I am in the most complete ignorance. I see in the regularity, which is still considerable, of the wound, in the presence of a fracture but slightly comminuted, in the very moderate disorder of the soft parts, conditions which make me hope for a cure; I recognize that my hopes do not go very far, I will even admit that the chances of death are greater than those of recovery.

I should like to show you by figures the proportion which exists between these two chances, but I have not recorded all the facts which have passed under my observation with sufficient exactitude to offer you the figures. I know that in my hospital practice I have seen more patients with compound fracture of the leg with large wound die than recover. In my private practice, on the contrary, of six patients of this kind four got well and two died, one of them of tetanus, and I am convinced that when the conditions of aëration in the hospital become the same as in private practice, we shall have the same results. Furthermore, I do not think I am mistaken in assuring you that, even with these good hygienic conditions, the mortality after primitive traumatic amputation is a little greater than after attempts to preserve the limb.

Notice that this mutilation adds one cause of purulent infection to those which exist in consequence of the wound itself, I refer to the serious moral perturbation. The man who, in full health and unexpectedly, is obliged to suffer the loss of a limb, without having been

led to it progressively by long sufferings and a wretched existence in a hospital bed, as is the case with those whom we amputate for suppurating white swellings, without having been led to consider this mutilation a relief, is very much affected thereby. Now you may be sure that this great moral shock is a powerful cause of the accidents which follow amputation. Our patient, seeing that we have a strong hope and desire to preserve his limb which he knows is dangerously injured, is in this respect in better conditions, and for that reason I think he is less likely to die than if I should amputate.

I recognize none the less that in the present state of surgery this problem will not receive a rigorous solution until we learn from the statistics of a great number of observations in what proportion patients affected with such wounds as we have before us recover, and in what proportion they die, so as to compare these proportions with those given by primitive traumatic amputations. These statistics are very difficult to establish, because no single surgeon has enough personal facts to be demonstrative, and because in statistics comprising facts furnished by different surgeons, we can never be sure that the observations are identical, that, for example, they do not include fractures with much and with little shattering and those with small as well as large wounds. Moreover, success depends very much upon the care which is given to the patient and upon hygienic conditions. Now if they place in the same statistics patients who have not been properly dressed, or who have breathed a vitiated air, and those who have been subjected to the opposite conditions, the general result is not what it ought to be. In the lack of these rigorous proofs I act according to the reasons which I gave, and I advise you, whenever you meet with a compound fracture with a moderately large wound like the one I now speak of, but without much crushing of the soft parts and the bones, to do conservative surgery. I advise this particularly if you practise in the country, in small towns, in small hospitals, that is to say, in an atmosphere which is not vitiated by crowding.

I do not mean to proscribe absolutely primitive amputation in all cases of compound fracture of the leg.

If, contrary to my expectation, I saw gangrene appear in a few days, especially gangrene with emphysema, I should not hesitate to propose amputation. I do not think it will happen in this case, for the fracture is by indirect cause, and in such cases gangrene is much less common than when the fracture is by direct cause.

So, too, when the injury is accompanied by a considerable crushing of the marrow, by extension of the fracture to the tibio-tarsal articulation, and imminence of suppuration in this joint, it is hardly to be doubted that the patient will be carried off by intense traumatic fever or by purulent infection, and that the chances of recovery are a little greater after amputation. This then should be proposed to the patient. Gunshot wounds caused by large projectiles and with considerable shattering, direct fractures by a heavy body, such as the wheel of a wagon, and certain V fractures, sometimes cause lesions which authorize us to expect no good from conservative surgery.

Some of you saw me last year perform amputation the day after the accident upon a patient the lower part of whose leg had been caught under the wheel of a heavily laden cart and presented a comminuted fracture with laceration of the muscles and tendons and opening of the tibio-tarsal articulation.

I made another one at the same time in the environs of Montargis for a similar fracture with enormous shattering caused by the point-blank discharge of a fowling piece.

Both patients succumbed.

Let us suppose now that our patient in No. 5 has had only a moderate traumatic fever, that suppuration has set in regularly, and that from twenty to thirty days have passed without purulent infection, does that mean that he would be safe and that consecutive amputation might not become necessary?

You know, gentlemen, that suppurating osteitis takes in these cases the form of necrosis. Now, if this necrosis should invade a great part of the bone, if, in consequence, exfoliation should be very slow, if suppuration, having become very abundant, should undermine the patient's strength, if it was accompanied by continuous fever, with exacerbation at night, loss of appetite and of flesh, sweats, diarrhoea, if finally the patient seemed in danger of dying of hectic fever, amputation would be indicated. It would be indicated all the more because, if, by chance and against all expectation, the organism should resist this drain, the patient would recover with fistulæ, a more or less painful hyperostosis, fresh necroses, more or less frequent attacks of inflammation, rebellious ulcers, in short, the whole series of permanent and recurring complications which we see about large necrosed bones. He would not be able to walk, and would lead a miserable existence, from which amputation would certainly save him.

Notice, too, that we should no longer have to fear, as at the beginning, the moral effects of which I have spoken. The patient would see that the limb would not get well, the surgeon would show him little by little the impossibility of preserving a useless limb, and would lead him to accept amputation as a benefit. But it is probable that it would be necessary to amputate the thigh instead of the leg; for the suppurative osteitis would undoubtedly have invaded the whole of the tibia, and it would be better to apply the saw to the healthy femur than to the diseased tibia.

No one would think to-day of discussing the question of amputation conformably to the prize subject proposed by the Académie de Chirurgie in 1755, under the title: "*Amputation being absolutely necessary in wounds complicated with crushing (fracas) of the bones, determine the cases in which the operation should be performed immediately, and those in which it is proper to defer it.*" Faure, who obtained the prize,¹ did not answer the question as it was asked, and applied himself only to proving, in a general way, that secondary amputations were more successful than primitive ones.

Modern statistics have not confirmed Faure's opinion; but it is not

¹ Faure, Prix de l'Académie de Chirurgie, tome iii. in 4to. p. 489.

the less true that, in practice, the problem cannot and ought not to be stated as the Académie de Chirurgie stated it.

I rejected primitive amputation because it was not indicated, and because I could hope that it would not become necessary; I rejected it, and did not postpone it. If later I propose amputation, it will be because complications which I knew to be possible, but the appearance of which could not certainly be foretold, have arisen and have caused an indication which might possibly have remained absent.

In a word, in these great traumatic lesions we propose amputation when it becomes necessary; but we are never free to say in advance that we shall perform it at any one period of the disease rather than at another.

(The patient who was made the subject of this lesson suppurred for more than six months, lost three large fragments, and recovered finally with a solid callus, consecutive to the bony transformation of the granulations, and with a hyperostosed tibia. He left us, walking with crutches, he came to see us twice during the following three months, still unable to do without crutches; since then we have not seen him.)

LECTURE XIV.

FRACTURES OF THE LEG.

- I. Compound fracture of the lower third of the leg with small wound and emphysema. Distinction between primitive or aërial emphysema, and consecutive or gangrenous emphysema. II. Fracture with large vertical wound and commencing gangrene. Imminence of dangerous septicæmia—Amputation.

GENTLEMEN: I. *Fracture with small wound and emphysema.*—We saw this morning a man who was admitted yesterday with a compound fracture, the wound being a small one, below the middle of the leg very near the place of election, of which I have so often spoken. It is one of those cases in which we have a right to expect recovery without suppuration, by means of occlusion with collodion. I call your attention to-day to a peculiarity which is not often seen. Placing your fingers over the fracture and pressing lightly you feel the fine crepitation which characterizes emphysema. Light percussion by snapping with one finger, gives sonority. We have then here an infiltration of gas about the wound. This complication, or rather this coincidence, was pointed out for the first time by Velpeau in 1839,¹ was well studied by one of his students, Dr. Boureau, in 1852,² by Morel-Lavallée,³ and lastly by M. Demarquay.⁴

¹ Velpeau, *Traité de Médecine opératoire*, 2d édition, tome ii. p. 321.

² Boureau, *Thèse de Paris*, 1856.

³ Morel-Lavallée, *Gazette Médicale*, 1863, p. 520.

⁴ Demarquay, *Traité de Pneumatologie médicale*, p. 289.

Whence comes this gas, and what is its signification in the prognosis?

Opinions varied upon the first question because it is difficult to give a rigorous demonstration of the way in which this emphysema is produced. I admit, with M. Demarquay, that it might arise in two ways, either by the infiltration of the external air into the subcutaneous cellular tissue, or by the spontaneous production of gas consecutive to a perversion of nutrition causing either a decomposition of the tissues, or an exhalation similar to that which takes place in the stomach and intestines of nervous people. I think that here we have to deal with the first variety, infiltration of external air, and that this air was introduced through the wound by muscular contractions which during and since the accident have caused a sort of aspiration about the little wound, according to the mechanism so well described by Morel-Lavallée. It is then a primitive and not a consecutive emphysema, as it would be if it resulted from the spontaneous formation of gas in the tissues.

I base this opinion upon two reasons: 1st. The emphysema appeared early, for twenty-four hours have not yet passed since the accident. Emphysema by decomposition and exhalation rarely appears before forty-eight hours. 2d. Its appearance was accompanied by no serious general symptom; neither chill, nor quickening of the pulse, nor augmentation of the temperature, nor delirium, etc. Emphysema by decomposition, preceding traumatic gangrene, is accompanied by grave general symptoms which announce a speedy death.

For the second question, that of the clinical signification, I hesitate no more than for the first. This emphysema indicates nothing serious. Velpeau and Boureau, in saying that it indicated approaching death from which the patient could be saved only by prompt amputation, committed an error which it is easy to understand. Writing at a time when no one had yet spoken of this phenomenon, they remained under the impression of the facts which they had witnessed, in which the injury ended promptly in death. They were led into error by one of these circumstances: either the death was caused by the wound itself, without the emphysema having added anything to the gravity of the situation; or instead of a primitive emphysema by the entrance of the outer air, they had perhaps to deal with a consecutive or gangrenous emphysema, which they were not able to distinguish from the first.

To-day we are perfectly informed upon this point by the observations of the clinicists, and by the experiments of M. Demarquay upon animals. Infiltration of air giving rise to this primitive emphysema without fever is in itself not dangerous, adds in no way to the gravity of the wound, and by no means indicates amputation.

Watch this patient carefully, and I can assure you that if, as I hope, the small wound cicatrizes without suppuration, the infiltrated air will be slowly absorbed, the emphysema will disappear in four or five days, and the fracture will behave like a simple one.

(These predictions were verified, and the patient left the hospital three months after his admission.)