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THE TONER LECTURES

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LECTURE VI.

SUBCUTANEOUS SURGERY:

ITS PRINCIPLES, AND ITS RECENT EXTENSION IN PRACTICE.

BY

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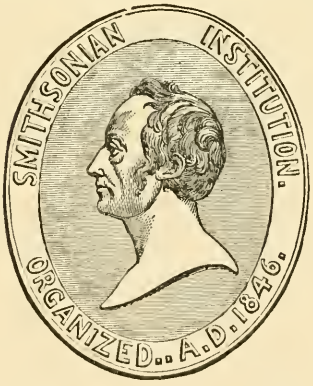

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LECTURE VI.

Delivered September 13, 1876.

ON SUBCUTANEOUS SURGERY: ITS PRINCIPLES, AND ITS RECENT EXTENSION IN PRACTICE.

By William Adams, M.D., F.R.C.S.

Gentlemen: Before commencing the subject-matter of the present address, I feel it to be my first duty, and one which I have the greatest pleasure in performing, to acknowledge the honor conferred upon me by an invitation to deliver in this city an address under the auspices of the trustees of the Toner fund; an endowment which one of your most distinguished physicians, Dr. Toner, was prompted by a noble spirit to make for the benefit of mankind, by encouraging efforts for the advancement of medical science.

The only hesitation which I felt in accepting an invitation, at once so honorable and gratifying to myself, was that I might not be able worthily to fulfil its requirements, and I could hardly hope to offer you an address sufficiently attractive in the novelty of its subject-matter. However, trusting to the indulgence of my audience, I will proceed to offer some observations on a subject which has for many years engaged my attention, viz., the principles and recent extension in practice of subcutaneous surgery.

There are a considerable number of surgical operations which owe their immunity from inflammation, and absolute freedom from danger, to the fact of their being performed in such a manner as effectually to exclude the admission of air. These operations are performed by puncture instead of external incision, a very narrow-bladed knife being used, for most

purposes only an eighth of an inch in width. The puncture must always be made at a little distance from the structure to be divided, so that a subcutaneous track exists between the cutaneous puncture and the structure divided. These operations are all governed in their mode of performance, the nature of the reparative process, and their terminations, by the same general law, and may therefore be grouped together and spoken of as subcutaneous surgery.

It must not, however, be assumed that the exclusion of air offers an absolute immunity from inflammation under all circumstances, and independently of the amount of damage done to the deeply seated structures, or of the constitutional condition of the patient.

When the subcutaneous method is applied to the performance of operations of unusual magnitude, such as division of the neck of the thigh-bone, division of the shaft of the femur or humerus, it would be unreasonable to expect the uniformity in favorable results which follow the subcutaneous division of tendons, because the conditions upon which the safety of the subcutaneous method depends, cannot all be with certainty fulfilled.

In these large operations the air may be effectually excluded, but the injury to the deeply seated structures may be excessive, either from cutting or lacerating by the saw; deep-seated suppuration, therefore, will occasionally follow such operations, although the rarity of such a result has astonished every surgeon who has practised such operations. As we recognize the importance of the amount of injury inflicted on the deeply seated structures, in addition to the exclusion of air, it will be obvious that much will depend upon the skill of the operator; and the conditions which must coexist to render the subcutaneous operations exempt from inflammation may be stated to be as follows:—

1. That the knife and other instruments used be of small size.

2. That the operation must be performed quickly and neatly, with decision rather than force, and with as little disturbance to the soft parts as possible.

3. That the wound must be immediately closed, and a compress and bandage applied so as to support the part and prevent the effusion of blood under the skin.

4. That perfect quiescence to the part be insured for three or four days, and the dressing remain undisturbed.

When all these conditions are strictly observed, it matters little whether large muscles, tendons, ligaments, or bones are divided, or even whether the large joints of the body are opened; there is no better established fact in surgical practice than that subcutaneous wounds seldom inflame or suppurate when the above-named conditions are fulfilled.

The influence of the exposure to air upon the reparative process in wounds seems first to have attracted the attention of that distinguished surgeon and physiologist, John Hunter, who, observing the vast difference as to the healing process in wounds exposed to the air and wounds not exposed to the air, was so deeply impressed with the importance of the subject, as to make it the basis of his classification of wounds and injuries. John Hunter, in his "Treatise on the Blood, Inflammation, and Gunshot Wounds," published in the year 1794, points out as a great fundamental principle, in reference to the healing of wounds, the difference between two forms of injuries, of which one is subcutaneous and the other open to the air. He says: "The injuries done to sound parts I shall divide into two sorts, according to the effects of the accident."

"The first kind consist of those in which the injured parts do not communicate externally, as concussions of the whole body or of particular parts, strains, bruises, and simple fractures, either of bone or tendon, which form a large division.

"The second consists of those which have an external

communication; comprehending wounds of all kinds, and compound fractures.

"Bruises which have destroyed the life of the part may be considered as a third kind; partaking, at the beginning, of the nature of the first, but finally terminating like the second.

"The injuries of the first division, in which the parts do not communicate externally, seldom inflame; while those of the second commonly both inflame and suppurate."[1]

Here there is a law of the reparative process in these two great classes of injuries. "In these sentences," observes Sir James Paget, "Hunter has embodied the principle on which is founded the whole practice of subcutaneous surgery; a principle, of which, indeed, it seems hardly possible to exaggerate the importance."[2] It is a remarkable fact that Hunter never applied this law to surgical practice, at least, so far as we are aware; but it is interesting to know that, in the experiments he performed on animals for the purpose of investigating the reparative process in tendons[3] (some of the preparations from which are preserved in the museum of the Royal College of Surgeons), Hunter divided the tendons subcutaneously in some instances, and by open-wound in others, for the sake of comparing the differences in the reparative process. In "The Life of John Hunter," by Drewry Ottley, it is stated that in the year 1767, Hunter ruptured his Achilles tendon, whilst dancing, and this accident led him to examine into the process by which divided tendons are reunited. "He divided the same tendon in several dogs, by introducing a couching-needle under the skin at some distance from it, and killed the dogs at different periods to see the progress of the union, which was found to be similar to that

[1] See "Hunter's Works," by J. F. Palmer, vol. iii. p. 240.

[2] "Lectures on Surgical Pathology," London, 1853.

[3] The Works of Hunter, with notes, by J. F. Palmer, page 34; London, 1837.

of fractured bones where the skin is not wounded." The illustrations given by Hunter, in proof of the general law adverted to, are sufficiently conclusive. No surgeon, he tells us, could have failed to observe the difference between a simple and a compound fracture, in reference to the progress and result of the case. How rarely is a simple fracture followed by suppurative inflammation, and how seldom does a compound fracture unite without suppuration, even when the wound is small and apparently insignificant! Here, then, we have two similar accidents produced in the same way, by the same amount of mechanical violence; or, it may be that the simple fracture is occasioned by a greater amount of mechanical violence than the compound fracture. The only difference is, that an external wound exists in the one case and not in the other; yet, how different the results! And who can suppose that the difference depends upon the additional injury to the soft parts, skin, and cellular tissue—which alone distinguishes the compound from the simple fracture? The exceptional cases in which suppuration occurs after simple fracture or dislocation are undoubtedly very rare. I have only seen three cases of this kind, and in each of them the injuries were associated with an unusual amount of deep bruising, and this, I believe, sufficiently explains the occurrence of suppurative inflammation, the liability to which Hunter described in the class of bruises, or contused wounds.

Two of these cases were the result of railway accidents; one a fracture of the humerus, which seemed to progress favorably, but suppuration at the seat of fracture occurred, and the individual died of pyæmia on the tenth day; several ribs were also fractured, and he had sustained other injuries.

The other case was one of dislocation of the hip-joint, which we were not able to reduce; other injuries existed, and I had previously amputated the opposite leg. The efforts at reduction could not be continued in consequence of the sinking condition of the patient, who, however, survived eight days,

and then it was found that suppuration in the hip-joint had taken place. The third case was also one of fractured humerus in an old gentleman over seventy years of age, a tall and heavy man, a colonel in the Indian army, who fell down a stone staircase. No other important injuries were sustained, but the bruising was extensive, and a large amount of extravasated blood existed at the seat of fracture, where suppuration occurred, and he died from exhaustion; his general condition precluded amputation.

The occurrence of deep bruising by which the vitality of the tissue is seriously impaired, together with the presence of extravasated blood, which, under such circumstances, will sometimes break down, is, I believe, a correct and sufficient explanation of the occurrencë of suppuration in these subcutaneous injuries. The suppuration in these cases is clearly independent of the admission of air, and therefore does not admit of explanation by the germ-theory so strongly advocated by Professor Lister of Edinburgh. Professor Lister, indeed, thinks that we should effectually guard against the occasional suppuration which is known to occur after subcutaneous operations, by adopting the antiseptic method, and operating under the carbolic or antiseptic spray. My belief is, however, that the antiseptic principle superadded to the subcutaneous would afford no additional protection, and to me it seems like gilding pure gold. Although I admit the great value of Prof. Lister's antiseptic method, especially when carried out by himself with all the attention to the minutest details which he bestows, and have no hesitation in stating that when in Edinburgh, a year ago, I witnessed a larger number of good results after capital operations, such as amputations, excisions, ligature of arteries, etc., than I have ever seen before under any other treatment, I cannot but think that the only cases at all connected with the class of operations we are now considering, to which it would be applicable,

are those of an imperfectly subcutaneous character, such as a case of osteotomy in which the gimlet and chisel are used, and repeatedly introduced, and reintroduced during a prolonged operation. In this class, additional protection would probably be afforded by the addition of the antiseptic method.

Within the last few months I have been present at two operations for subcutaneous osteotomy, in London, one by Mr. Willett, at St. Bartholomew's Hospital, in which he divided the neck of the femur upon the method recommended by myself; and one by Mr. Croft, at St. Thomas's Hospital, in which he divided the shaft of the femur just below the small trochanter, according to Dr. Gant's method; and the antiseptic method was carefully employed in both these operations, yet deep suppuration occurred in both instances. I have now given a few general illustrations of the subcutaneous law of the reparative process, and have alluded to the exceptional cases in which suppuration occurs, without any fear that the truth of the observations made by Hunter, that subcutaneous wounds seldom inflame, and that wounds exposed to the air commonly both inflame and suppurate, will be doubted by any scientific surgeon.

We now approach another and extremely interesting part of these inquiries in a scientific point of view, viz., the physiology and pathology of the subject in reference first to the *modus operandi* of atmospheric air in the production of inflammation; and second, the differences observed on microscopical examination, in the mode of development of the material effused during the reparative process in subcutaneous and open wounds, corresponding to the differences in the clinical history of these two classes of injuries. The first question is then, how does the air act in exciting inflammation? First, is it merely the presence of the air acting, *quoad air*, by virtue of its chemical constitution—the action of its

oxygen upon the blood and cut surfaces producing chemical changes? Or, second, does the injurious action of the air depend upon the presence of minute organisms floating in it, and when brought into contact with cut surfaces, acting like the yeast-plant in the ordinary process of fermentation, and producing irritation and decomposition of the organic elements of the tissues with which they are brought in contact—in short the so-called germ-theory of putrefaction, fermentation, and disease? Third, is the mere contact of the air with divided surfaces, but without external wound, sufficient to produce inflammation? Or, fourth, is it necessary that the continued exposure to the air which external wounds generally involve, should exist as an essential condition to the production of inflammation?

It would be impossible to enter at length into all the details necessary to the solution of these questions, if indeed they are yet capable of solution; but in reference to the first—I may state in favor of the direct action of the oxygen of the air, and on the authority of the late Dr. Snow, so well known for his early labors on the production of anæsthesia and the action and administration of chloroform and other substances, that, in a course of experiments performed by Jean Ingen Housz, a Dutch physician, in the latter part of the last century, it has been shown, that when a blistered surface is exposed to nitrogen gas, the pain is diminished, when exposed to the atmosphere it is increased, and when exposed to oxygen gas it is still further increased. Being desirous of verifying these experiments, I agreed with Dr. Snow to repeat them, and, on the 27th May, 1857, applied a blister, the size of a half-crown, on the outer side of my left arm, and on the 28th, the experiments were conducted by Dr. Snow, and the subjoined description written out by him from my account of the effects produced by the gases and vapors employed.

May 28, 1857: the cuticle was stripped off from the small blister which had been raised in the arm, and the raw and

inflamed surface was consequently exposed to the air; a sensation of smarting, heat, and pricking was felt. The blistered part was covered with a small glass jar, into which nitrogen gas was introduced from another jar communicating with it by means of a stopcock, and an elastic tube. In two or three minutes the smarting and pricking were removed, a sensation of comfortable warmth was experienced when the attention was directed to it, but at other times, there was hardly any sensation. The nitrogen was applied for twelve minutes, and the relief continued to the end of the application. The nitrogen gas was then displaced by oxygen from another jar. There was a little return of pricking at the moment when the gas was introduced. The oxygen was continued for ten minutes, during which time the pricking and warmth remained. The glass being removed, a current of oxygen was applied from the end of a tube and the part smarted a little more after this. The oxygen was applied again in the jar; it occasioned a sensation of heat to discomfort without smarting or pricking.

After the blister had been exposed for a short time to the common air, hydrogen gas was applied in a jar, in the same manner as the other gases; in the trial, smarting and pricking diminished.

After the blistered surface had been again exposed to the air for a short time, carbonic acid gas was applied. It caused decided increase of smarting, which changed to a sense of heat. In three minutes the smarting was quite gone, and the heat had subsided to a gentle warmth. The above experiments confirm the observations of Ingen Housz. They show that nitrogen, hydrogen, and carbonic acid gases relieve and prevent the smarting which atmospheric air causes on an abraded surface, the last of these gases, however, having an irritant effect in the first instance, before its soothing or narcotic influence is developed. Pure oxygen gas caused more pain than atmospheric air. Although these experiments were per-

formed nearly twenty years ago, I have a very lively recollection of the painful, smarting, pricking, and sensation of heat occasioned by the oxygen gas, and the soothing effect of the carbonic acid gas. The vapor of amyline and also chloroform vapor was afterwards applied. They both irritated and caused a burning and smarting sensation; the chloroform more so than the amyline. When the surface of the sore was touched with the finger after the application of chloroform, distinct sensation was found to be present. The smarting quickly subsided during the application of carbonic acid gas. I have always relied upon the explanation of oxygen and moisture as sufficient to account for the decomposition of animal and vegetable substances exposed to their influence, and therefore have always taken care to avoid as much as possible the exposure of wounds to air and water, and when cut surfaces are necessarily exposed to their influence for some time, as in surgical operations, I always, before closing the wound, wash the surface with some antiseptic lotion—with carbolic acid, one part in forty; or chloride of zinc lotion, one part in forty—which will prevent decomposition of fluids remaining in the wound, the exuded serum, and the water; and this practice I shall always continue to adopt, whether the explanation be purely chemical or upon the germ theory, as it undoubtedly promotes a rapid and healthy reparative process.

With respect to the second question, as to whether the action of the air in producing inflammation is to be explained by the germ-theory, it is certain that amongst our best observers and scientific investigators, much difference of opinion still exists, and it will be long before the germ-theory of putrefactive fermentation in wounds will receive the general support of the profession. Nevertheless, the valuable and numerous experiments performed by Pasteur and Professor Lister on the action of filtered and unfiltered atmospheric air when

brought into contact with organic fluids of vegetable and animal origin, have carried the conviction of the truth of the germ-theory to many minds; and the practical application of it to surgical practice is undoubtedly spreading in the profession, through the untiring zeal and enthusiasm with which Professor Lister endeavors to instruct the profession in all the details and minutiæ which he has found to be necessary to the successful application of his method, both in operating and in the dressing of wounds.

Then with regard to the third question, which relates to the conditions necessary to the irritating influence of the air, it must be admitted that the mere contact of the air with divided surfaces, but without an external wound, is not sufficient to produce inflammation, or, at least, that it seldom does so. Of this we see evidence in ordinary cases of emphysema connected with fractured ribs, in which, as a rule, no inflammation of the cellular tissue follows, though the emphysema may be very extensive.

Abundant evidence of the same fact was supplied by Malgaigne, in the important discussion on the "Subcutaneous Method," as M. Guérin called it, which took place in the "Académie de Médecine" of Paris in the year 1857. M. Malgaigne brought forward a series of experiments on animals, first rendered emphysematous, and then subjected to various subcutaneous operations, so that the air was in contact with the cut surfaces, fractured bones etc.; no inflammation followed.

The explanation which the advocates of the germ-theory would probably give, would be that in emphysema, the extravasated air in contact with fractured bone or cut surfaces has undergone a process of filtration, and that the filtered air deprived of its germs is harmless.

M. Malgaigne came forward as the opponent of the extended

application of the subcutaneous method advocated by M. Guérin,[1] and furnished us with a historical *résumé* of the opinions of the older surgeons who have advocated, as well as of those who have denied, the injurious influence of the air upon the healing of wounds. In this *résumé* are included the most interesting points in the history of subcutaneous operations; but time will not permit me to enter upon this part of our subject.

With respect to the fourth query, as to the necessity of prolonged exposure to the air, as essential to the production of inflammation, there can be no doubt that the prolonged exposure of a wound to the air is invariably followed by inflammation and generally by suppuration, and there can be as little doubt that this was the condition to which Hunter especially referred; whilst, on the other hand, open wounds which are quickly closed proceed as favorably in the reparative process in a large majority of cases, as subcutaneous wounds. Prolonged exposure to air cannot, however, be regarded as an essential condition to the production of inflammation in wounds.

The next subject to which I would direct attention is the pathology, or I might call it the physiological pathology of the reparative process in relation to the subcutaneous method. M. Guérin[2] was undoubtedly the first to call attention to the perfection of the reparative process in subcutaneous operations, and what he called "the immediate organization," *i. e.*, the exudation and development of a reparative material independently of inflammatory products, which is utilized in the regeneration of tissue, such as tendon, nerve, bone, and cellular tissue, in the most perfect manner.

We see the reparative process in wounds, under various conditions, proceeding with or without inflammation. The

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[1] Bulletin de l'Académie Impériale de Médecine, vol. xxii. pp. 427–724, 1857.

[2] Essais sur la méthode sous-cutanie; Paris, 1841.

relation of the reparative process to that of inflammation has been most carefully studied by Sir James Paget, whose investigations, both experimental and clinical, concerning the general pathology of the reparative process in all its phases, are well known. It may, at the present time, be regarded as an established doctrine, deduced directly from pathological and clinical observation, that the reparative process in wounds, the result either of accident or surgical operations, is more perfect in proportion to the absence of inflammation, and that the danger arising from wounds very much depends upon the extent of the inflammatory complications.

Microscopical examination of the material effused during the reparative process, in the two great classes of wounds—viz., the open and the subcutaneous—has confirmed the accuracy of the law, which expresses the difference in the mode of development—perhaps indicating differences in the nature of the material effused for the purpose of repair in these two classes of wounds. The observation of this fact is due to Sir James Paget, who states "that the materials produced for the repair of open wounds are not usually the same, or, at least, do not develop themselves in the same manner as those for the repair of closed or subcutaneous ones."[1] The general truth appears to be that the material of repair, for subcutaneous wounds of the soft parts, is developed through the formation of nucleated blastema; while that for repair by primary adhesion and by granulation, is developed through nucleated cells.

I need only observe that the process of development through large nucleated cells, which gradually elongate and form delicate filaments, is the process by which cellular adhesions are formed from inflammatory lymph as in inflammation of serous membranes etc., and by which granulation and cicatrization

[1] Lectures on Surgical Pathology, vol. i. p. 172.

take place in open wounds. When inflammation exists, therefore, this mode of development is always found, and it appears to be a less perfect process of healing than that accomplished through *nucleated blastema*, a material which Sir James Paget proposed to distinguish by the name of *reparative lymph*. In this material small oval and elongated nuclei are formed, which are easily rendered distinct by acetic acid, but the large nucleated cells do not appear. The ultimate disposition of these nuclei is uncertain; Sir James Paget thinks they shrivel and disappear; but Henle describes them as developing into fibres, and with this view I am disposed to agree, from my own observation in numerous experiments which I have performed on rabbits.[1]

The *nucleated blastema* is the material from which bonds of connection are formed after subcutaneous operations; divided tendons and muscles are thus connected. The process of development through *nucleated blastema* is found proceeding in all subcutaneous operations, in proportion to the absence of inflammation. When inflammation takes place in subcutaneous operations, the two processes may coexist, and their products mingle, but Sir James Paget observes "they bear an inverse proportion to each other, and the more manifest the signs of inflammation, the less the quantity of the proper reparative material and the slower in the end the process of repair."

Having thus shown that the reparative process after subcutaneous operations, proceeds more perfectly than that after open wounds, in the formation of a connecting bond of union between the divided structure, and to the perfect regeneration of structure where this is possible, as in tendons, bones, nerves, and cellular tissue, we can understand the importance attached

[1] See Trans. Path. Soc., vol. vi., for account of "a series of experiments illustrating the reparative process in the tendons of rabbits after division by subcutaneous and open wounds, read May 1, 1855; and also a work "On the Reparative Process in Human Tendons," by W. Adams, p. 87. J. Churchill, London, 1860.

by M. Guérin to what he describes as the "immediate organization."

The subcutaneous law in its full breadth and practical significance was more fully recognized by M. Guérin than by any other authority, and it is undoubtedly to him that we owe the first attempt to bring together in one group the facts observed in subcutaneous injuries and subcutaneous operations, and generalizing from the facts presented, to show that, for the immunity from inflammation which they enjoy, and the perfection of the reparative process, such wounds especially depend upon the same general law. Although I refuse to admit M. Guérin's claim to originality in the discovery of the subcutaneous law, which is purely Hunterian, there can be no doubt that for its development and surgical application we are principally indebted to the labors of M. Guérin.

If time permitted, it would be interesting here to pass in review, perhaps in chronological order, the surgical operations performed on the subcutaneous principle, but they are too numerous to admit of this, and I will, therefore, merely refer to the more important and familiar examples, such as subcutaneous tenotomy, the subcutaneous operations for the removal of loose cartilages from the knee-joint; a large number of operations in ophthalmic surgery; the subcutaneous operation for the radical cure of hernia, as well as those for ununited fracture, varicose veins, nævi, and also for the obliteration of depressed cicatrices; the subcutaneous method of opening abscesses and cystic tumors; the subcutaneous division of stricture; and also several operations of a more or less perfectly subcutaneous character, which have been performed in cases of anchylosis of the hip, knee, and elbow-joints, in severe rachitic distortion of the tibia, in severe knock-knee, and some other analogous affections. The last mentioned operations are collectively spoken of as subcutaneous osteotomy, and with very few exceptions they have proved to be as safe as subcutaneous tenotomy.