

**Observations on ligature of arteries on the antiseptic system / by Joseph Lister.**

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Lister, Joseph, Baron, 1827-1912.  
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**Publication/Creation**

Edinburgh : Edmonston & Douglas, 1869.

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OBSERVATIONS  
ON  
LIGATURE OF ARTERIES  
ON THE  
ANTISEPTIC SYSTEM.

BY

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*From the LANCET April 2 1880*

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VARIOUS attempts have been made, both in the early part of the century and more recently, to improve the ligature, or to supersede it by other methods. Nevertheless, for obstructing the calibre of an arterial trunk in its continuity, no means hitherto devised have proved superior to a small silk thread tied in a secure knot, with the ends left projecting from the wound. Yet, as is implied by the numerous efforts at improvement, the ligature in this form is far from perfect. The internal and middle coats are ruptured by the constricting noose, while a portion of the tough external coat is pinched together and deprived of its vitality. The dead tissue, becoming contaminated by the putrefaction which occurs in the interstices of the silk fibres, acts, together with the septic ligature, as a cause of irritation to the neighbouring parts of the arterial wall, which consequently degenerate into an imperfect structure, inadequate to withstand the powerful cardiac impulse; and even before the slough separates by suppuration, the blood breaks through the feeble barrier, unless it be fortified by a firm plug of internal coagulum. Hence, if a considerable branch takes origin close to the part tied, the formation of a clot being prevented by the current of blood, secondary hæmorrhage is the inevitable consequence; and thus the ligature is inapplicable in situations otherwise eligible for it, such as the femoral artery near Poupart's ligament, the origins and endings of the iliacs, and the innominate.

Even when the thread is distant from any considerable branch,



the terrible risk of hæmorrhage cannot be said to be altogether absent. The degenerate structure of the vessel near the ligature, unlike the arterial wall in its normal condition, is prone to ulceration, and the organising coagulum is similarly circumstanced; so that an unhealthy state of the wound may open up the calibre of an artery tied in the most favourable situation.\*

Again, when the parts about the vessel communicate with loose cellular interspaces in important regions, as is the case with the iliac arteries or the subclavian, diffuse suppuration is frequently a cause of death. Finally, the cure is always rendered tedious by the time required for the separation of the ligature; while the presence of an external wound during the period thus protracted involves a risk, by no means inconsiderable in some localities, of hospital gangrene or erysipelas.

The Antiseptic System, however, places this branch of surgery, like most others, in a new light. One point which it has brought out in striking relief is, that a portion of dead tissue is not necessarily thrown off by suppuration, but, unless altered by putrefaction or artificially imbued with stimulating salts, serves as pabulum for the surrounding living parts, which remove it by a sure process of absorption. Hence, the death of a portion of the external coat included in the ligature does not of itself render it a cause of suppuration. And I conceived that if a silk thread, steeped in some liquid capable of destroying the septic organisms in its interstices, were tied round an artery, and left with short-cut ends in a wound dressed antiseptically,† the foreign body, soon losing, by diffusion

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\* It has been long since noticed that hæmorrhage occurs more frequently from the distal than from the cardiac end of the vessel. This seems at first sight contrary to what might be expected, since the cardiac end is subjected to much greater strain. The explanation is, I believe, afforded by some facts which I had occasion some years ago to point out. (See the Croonian Lecture on the Coagulation of the Blood, Proceedings of the Royal Society, vol. xii., No. 56.) It was then shown that a perfectly undisturbed coagulum resembles healthy living tissue in failing to induce coagulation in blood near it; but that, on the other hand, while a clot is, from its softness, peculiarly liable to laceration and other disturbance, a disturbed coagulum acts like injured tissue in impressing upon neighbouring blood a coagulating tendency. Hence, when a ligature has been tied round an artery, although a minute clot necessarily forms upon the injured internal and middle coats, it would undergo no increase if the blood in the vessel were absolutely quiescent. But the pulsations of the artery operate as a disturbing cause to the clot already formed, which consequently increases in proportion to the degree of the disturbance; and as this is much greater at the cardiac side, the clot grows more quickly there, and forms a more secure barrier against the pressure of the blood.

† In using the expression "dressed antiseptically," I do not mean merely "dressed with an antiseptic," but "dressed so as to ensure absence of putrefaction."



into the circulation, the stimulating salt with which it was saturated at the outset, and being in its own substance as unstimulating chemically as a pellet of lead from a fowling-piece, would either remain, like the latter, permanently encapsuled, or itself experience absorption together with the dead tissue in its grasp. In either case, being destitute of irritating properties, it should leave the primitive strength of the arterial coats unimpaired; when the objection to tying near a large branch would cease to exist. The wound meanwhile would, under proper management, close rapidly, without any deep-seated suppuration, and would be efficiently protected against the evil influences of impure atmosphere. In short, the ligature of an arterial trunk in its continuity would be brought to a state of perfection.

I have subjected these theoretical views to the test of experience; and though the results have not turned out in all respects exactly as I had anticipated, yet those finally arrived at appearing satisfactory, I now present to the Profession an account of all that I have done in the subject.

*Case of ligature of the carotid artery in the horse with silk thread, on the antiseptic system.*—On the 12th of December, 1867, I tied the left carotid artery of a horse in the middle of the neck with a piece of "purse silk" steeped in a strong watery solution of carbolic acid, cutting the ends short and dressing the wound antiseptically. Healing took place without any suppuration, and with remarkable absence of swelling or tenderness. Nearly six weeks after the operation I investigated the parts. On laying open the vessel, I found at the cardiac side of the ligature a firm adherent clot an inch and a quarter long; but at the distal side coagulation had been entirely prevented by the reflux current of blood through a branch about as large as the human vertebral, which took origin as close to the ligature as was possible. Under such circumstances secondary hæmorrhage would necessarily have occurred, had the thread been applied in the usual way. Here, however, the artery appeared as strong at the part tied as elsewhere. The cul-de-sac showed indeed some irregularity, in consequence of the puckering of the internal and middle coats; but the surface appeared completely cicatrised, and presented the same character as the natural lining membrane of the vessel; and the ligature, which seemed as yet unaltered, was found lying dry in a bed of firm tissue; that within the noose being apparently a new formation in place



of the portion of external coat killed by the tightly tied thread; while, externally, the constriction necessarily caused in the first instance by the operation had been filled in by a similar compact structure.

Thus far experience had proved precisely in accordance with my expectations, so that I felt justified in carrying a similar practice into human surgery.

*Case of ligature of the external iliac artery with silk thread, on the antiseptic system.*—On the 29th of January, 1868, I tied the left external iliac artery in a lady, fifty-one years of age, on account of an aneurism of the upper part of the femoral, as big as a large orange, and reaching somewhat above Poupart's ligament. I was informed that it had existed for four years, growing more rapidly of late, and causing severe agony, which had made her keep entirely to bed for the last few weeks, and had deprived her of appetite and reduced her strength. A silk thread was applied, as in the last case, except that it had been steeped for two hours in undiluted liquid carbolic acid instead of the watery solution, to make sure of the destruction of all septic organisms lodged in its interstices. The wound, being dressed antiseptically, became superficial without suppuration, the patient meanwhile experiencing no febrile disturbance, her appetite returning as soon as the sickness from chloroform subsided. On the fourteenth day she sat bolt upright in bed without inconvenience. Four weeks after the operation, the superficial sore being completely cicatrised, she was allowed to walk about her room; and just six weeks from the date of the application of the ligature, she went down three flights of stairs and walked for some time in the streets, and then up again to her room without over-fatigue. The aneurism was free from pulsation, and much reduced in size.

She continued for about ten months in fair health and strength; but, in the latter part of November, she became affected with a peculiar spasmodic disorder of the respiration, and on the morning of the 30th of the month, while sitting up in bed, she suddenly exclaimed that something had given way within her, and that she was dying, and then immediately expired. Next day I made a post-mortem examination, when the idea which she had expressed proved correct—an aneurism of the descending part of the arch of the aorta having given way, and discharged an enormous quantity of blood into the mediastinal and subpleural cellular tissue. The parts



concerned in the operation having been removed and dissected, the following appearances were disclosed:—The aneurism was not entirely obliterated; but remained about the size of a cherry or large filbert, of somewhat fusiform shape. The upper two-thirds were solid, being occupied by firm coagulum incorporated with the sac. The lower third, situated just at the bifurcation of the common femoral, had been kept free from coagulation by the regurgitant stream of blood from the profunda into the superficial trunk. This part of the sac appeared constituted by the wall of the vessel, very slightly distended. The external iliac artery was considerably shrunk throughout, and tapered from each end to near the middle, where it was only about a twentieth of an inch in diameter. In the greater part of its length the structure of the dwindled vessel could be distinctly recognised, with adherent coagula in the interior, decolorised and otherwise altered. But at the narrowest part the artery was reduced to mere fibrous tissue, constituting a dense white band five-eighths of an inch long, from the middle of which was seen projecting at one side a round, buff-coloured appendage about a line in diameter, somewhat obscured by a trifling amount of inflammatory condensation of texture in the immediate vicinity. On scratching this little body with the point of a knife, I found it to be a very thin-walled capsule, containing the knot of the ligature, with two tapering ends, which were shorter than the thread was cut at the operation, while the noose had vanished altogether. The surface of the knot also showed clear indications of having been subjected to an eroding agency, similar, no doubt, to that exerted by granulations upon dead bone absorbed by them.\* Besides the remnant of the ligature, the tiny capsule contained a minute quantity of yellowish, semifluid material, looking to the naked eye like very thick pus. Under the microscope, however, pus-corpuscles were seen to form but a small proportion of its constituents, which were principally rounded corpuscles of smaller size, and fibro-plastic corpuscles, together with some imperfect fibres and granular material. In addition to these elements were some which at first puzzled me; but which turned out to be fragments of silk fibre, of various lengths, and of jagged, tapering, or otherwise irregular forms, and many of them greatly reduced in thickness, contrasting strongly

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\* See *The Lancet*, March 23rd, 1867.

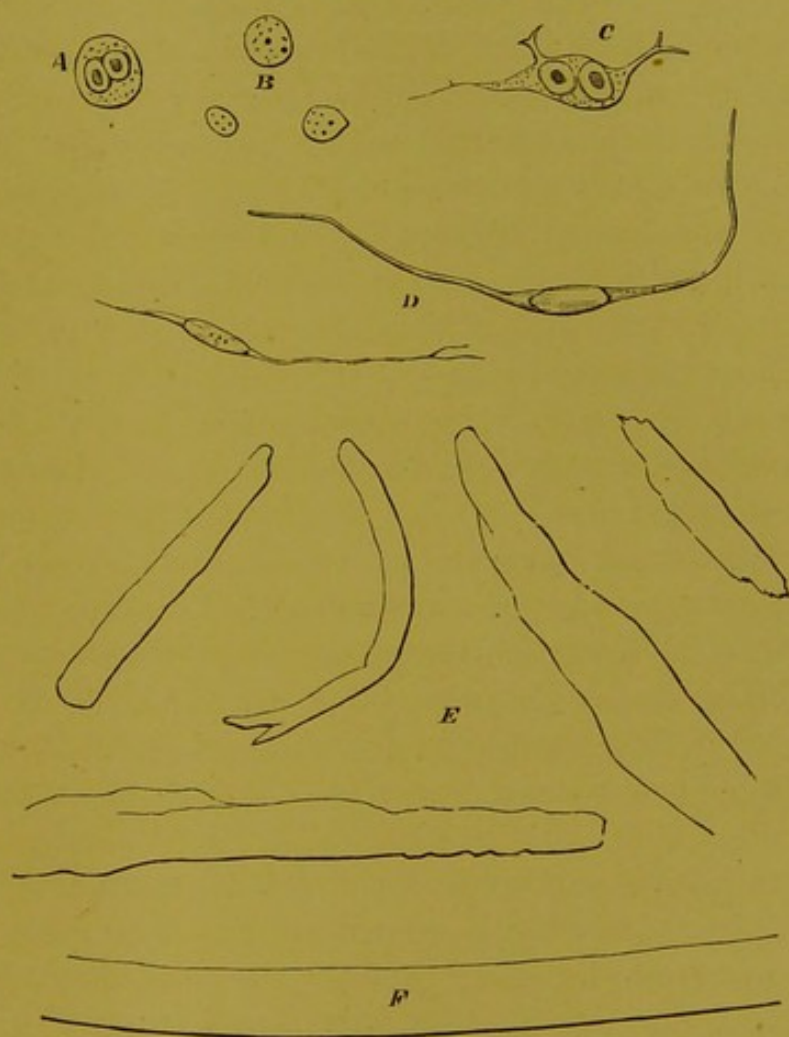


with the uniform bands of a fresh piece of silk from the same reel that had furnished the ligature (fig. 1).

Mingled with the puriform fluid were also some delicate filaments of silk, visible without the microscope; and these seemed to retain their natural elasticity. Nor was there anything about the more minute pieces into which the fibres had been so strangely chopped up, to indicate that they were undergoing a process of solution or softening by the fluid that soaked the thread. They had rather the appearance of having been superficially nibbled, so to speak; confirming the impression conveyed by the naked-eye characters of the knot, that the silk had been eroded by the absorbing action of the surrounding parts. Indeed, considering the organic origin of silk, the remarkable thing seems to be, not that it should be absorbed by the living tissues, but that it should resist their influence so long.

Why it was that the parts in immediate contact with the silk should have assumed so imperfect a structure is a difficult question, but one of great interest: because, although that structure could not be called pus, it was certainly a very near approach to it; and it is impossible to say that we had not here an incipient abscess. There can be no doubt that the presence of the thread was in some way or other the cause, and I think we can hardly be wrong in assuming that, in order to give rise to such degeneration of tissue, it must have operated as a persistent, if trifling, source of abnormal stimulation. Now, as putrefaction is here out of the question, and as the substance of silk is not chemically stimulating, we seem shut up to the conclusion that the thread must have occasioned disturbance of a mechanical nature. Further, the effect in question seems to be essentially connected with the disintegration of the silk. For in the horse's carotid the silk ligature, having remained unaltered during the six weeks that had passed after the operation, was found surrounded on all sides by compact tissue; and in the present case, so long a period as ten months having elapsed before the puriform condition was observed in an apparently incipient stage, it is probable that the thread had lain for a long time inert, producing irritation only when partially absorbed. If, then, we inquire how the disintegrating silk could prove a source of mechanical irritation, it seems not improbable that it may have been from the sharp and jagged fragments of the fibre perpetually fretting the elements of the living tissue around them. This view, if correct, would explain

FIG. 1.



Constituents of the incipient abscess (?) around the remains of the silk ligature. Magnified 500 diameters. From a camera lucida sketch. A, A pus-corpuscle. B, Rounded corpuscles of smaller size. C, Fibro-plastic corpuscle with endogenous cell-development. D, Ordinary fibro-plastic corpuscles. E, Irregular fragments of silk fibre partially absorbed. F, A piece of fresh silk fibre introduced for comparison.



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the curious fact observed by Lawrence and others, that when fine silk ligatures had been left with short-cut ends in a stump, though the wound might heal without their separation in the first instance, they were liable to make their appearance subsequently, sometimes at so late a period as seems to exclude the idea of putrefaction having occurred from organisms introduced in the threads. Indeed, such ligatures occasionally showed themselves encapsuled in little nodules in the cicatrix, without suppuration occurring at all.\* In other words, the apparently soft silk, instead of remaining, like a smooth leaden pellet, permanently imbedded in the place where it was first introduced, made its way to the surface with or without suppuration, like a sharp spiculum of rigid glass; the silk being in its minute structure comparable to the pellet when in the primitive condition of smooth continuous fibres, and to glass spicula when in the form of jagged fragments as the result of partial absorption.

But whatever may be thought of this explanation, it is clear that if there is any chance of silk, though used antiseptically, giving rise, even in exceptional cases, to abscess in the vicinity of an artery tied with it, this is a serious objection to its employment; and as the near approach to suppuration in the present instance was undoubtedly occasioned by the persistent presence of the thread, the case, while interesting as affording evidence that silk is susceptible of absorption, suggests the expediency of substituting for that material some other substance which can be more readily taken up by the tissues.

The use of "animal ligatures," of cat-gut, leather, or tendon, was long since tried and abandoned as unsatisfactory;† but after the experience which the antiseptic system has afforded of the disappearance, without suppuration, of large dead pieces of skin and other textures, there could be little doubt that threads of animal tissue, if applied antiseptically, would be similarly disposed of.

And even if chemical processes should have been used in preparing such threads, it did not seem likely that this would interfere with their absorption; for I knew that the free action of carbolic acid on blood and sloughs had no such deterring influence, and I have long been satisfied that the injection of a strong solution of perchloride of iron or tannic acid for the cure of *nævi* produces sub-

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\* See Cooper's Surgical Dictionary, 7th edition, article Aneurism.

† Op. Cit., articles Aneurism and Ligature.



cutaneous sloughs, which are imbued with the ingredients injected, and yet disappear, as a rule, without the formation of pus.

In order to put the antiseptic animal ligature fairly to the test, I made the following experiment:—

*Ligature of the carotid artery in the calf on the antiseptic system, with threads composed of animal tissue.*—On the 31st of December, 1868, I tied the right carotid artery about the middle of the neck in a healthy calf a few days old, the animal being under chloroform. Ligatures of two different kinds were employed, at an interval of about an inch and a half, the sheath of the vessel being left undisturbed in the intervening part. The cardiac ligature was of home manufacture, composed of three strips of peritoneum from the small intestine of an ox, firmly twisted together into a threefold cord. The distal thread was of fine catgut, called “minikin gut” by the London makers. Both had been soaked for four hours in a saturated watery solution of carbolic acid, which swelled and softened them, so that the thread of my own making was too large to enter the eye of the aneurism needle except near the ends, where it was thinner than elsewhere. This substantial ligature bore the strain of tying well, but the fine catgut broke as I tightened the noose. I did not, however, remove it, but having a second piece at my disposal, passed it round at the same place, and with gentle traction completed the knot. There were thus two ligatures of the fine gut at the distal site. All were cut short, except one end of the catgut, which I purposely left about three-quarters of an inch long, to give a better opportunity of ascertaining what would become of the foreign material. The antiseptic arrangements were as follows:—Before the operation the hair of the part was cut short, and a solution of carbolic acid in four parts of linseed oil (preferred for its cheapness) was rubbed well into the skin, to destroy any putrefactive organisms lying amongst the roots of the hairs; for any so situated might escape the action of the external antiseptic dressing, and communicate putrefaction to the discharges, and thence to the interior of the wound. The sponges used in the operation were wrung out of a watery solution of the acid (1 to 40), and all the instruments introduced into the wound, together with the fingers of my left hand and the copper wire used for sutures, were treated with the same lotion, some of which was poured into the wound after the introduction of the last stitch, at one of the intervals left for the escape of discharge, to make sure



against the chance of any fresh blood which had oozed out during the process of stitching having regurgitated and taken living germs in with it. The external dressing was a towel saturated with the oily solution, folded as broad as the length of the neck, round which it was wrapped so as to extend freely beyond the wound in all directions, prevented from slipping backward and forward by being stitched to a halter round the head, and to a girth behind the forelegs, while a bandage rolled round it kept it applied accurately to the surface. A sheet of gutta-percha tissue, to prevent contamination of the antiseptic towel from without, and another roller, completed the dressing; and a "cradle" was placed upon the neck to check lateral movements which might disturb it. I have described these particulars because I am more and more convinced of the necessity for scrupulous attention to details such as the germ theory dictates, in order to attain anything like uniformity of successful results.

A few ounces of the oily solution were poured daily over the towel for the first week, after which the dressings were left untouched for three days, and then entirely removed. The wound was found quite dry and free from tenderness, and the cloth showed only a superficial bloody stain. The stitches being taken out, a drop of pus escaped from the track of the suture next the head; but this was the only appearance of suppuration in the case from first to last, and on the separation of the scab, a few days later, a sound cicatrix was disclosed. A month (thirty days) after the operation the animal, which had continued in perfect health, was killed, and the soft parts of the neck below the spine were removed for examination. On dissection I was struck with the entire absence of inflammatory thickening in the vicinity of the vessel, the cellular tissue being of perfectly normal softness and laxity. On exposing the artery itself, however, I was at first much disappointed to see the ligatures still there to all appearance as large as ever. But had I borne in mind what I had observed in some of my earlier cases of compound fracture treated antiseptically, I should have been prepared to find these threads present in appearance, though absent in reality. It may be well for me to quote from the account I have before given of one of these cases.\* It was a compound fracture of the leg, produced by direct violence, with a wound of consid-

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\* See *The Lancet* for March 16th, 1867, p. 328.



erable size, and a great deal of extravasation of blood into the limb. In accordance with the practice which I then followed, a piece of lint soaked with undiluted carbolic acid had been placed over the wound, and had formed with the blood a firm crust. "Nearly three weeks after the accident I was detaching a portion of the adherent crust from the surface of the vascular structure into which the extravasated blood beneath had been converted by the process of organisation, when I exposed a little spherical cavity about as big as a pea, containing brown serum, forming a sort of pocket in the living tissues, which when scraped with the edge of a knife, bled even at the very margin of the cavity. This appearance showed that the deeper portions of the crust itself had been converted into living tissue. For cavities formed during the process of aggregation, like those with clear liquid contents in a Gruyère cheese, occur in the grumous mass which results from the action of carbolic acid upon blood; and that which I had exposed had evidently been one of these, though its walls were now alive and vascular." Thus the dead, but nutritious mass, had served as a mould for the formation of new tissue, the growing elements of which had replaced the materials absorbed, so as to constitute a living solid of the same form.

Hence it might have been anticipated that the ligatures of peritoneum and catgut placed on the calf's carotid would, after the expiration of a month, be found transformed into bands of living tissue. Such was, in truth, the case, as was apparent on closer examination. They had, indeed, a deceptive resemblance to their former condition, from the persistence in their substance of the impurities of the original materials, the dark adventitious particles being of mineral nature incapable of absorption, so that they had remained as a sort of tattooing of the new structure. Nevertheless, a marked alteration in colour had taken place, especially in the distal ligature, where the dirty-grey of the softened catgut had changed to a dirty-pink tint. The two pieces of catgut which had been tied round the vessel at that part had become, as it were, fused together into a single fleshy band, inseparably blended with the external coat of the artery. The knots were nowhere discoverable, and the only indication of the end which had been left long at the time of the operation was the presence of a black speck here and there upon a delicate thread of cellular tissue in connexion with the vessel. The cardiac ligature was in like manner con-



tinuous in structure with the arterial wall. The short ends had disappeared; but the massive knot was represented by a soft smooth lump, which appeared at first entirely homogeneous, except that it was speckled with dark particles, as before referred to. On section, however, I discovered in the interior of the mass, and lying close to the wall of the artery, a small residual portion of the original knot, of comparatively firm consistence, and with the three-fold twisted character of the cord plainly visible. It was quite distinct from the living tissue that surrounded it, so that it could be readily picked out from its bed with a pair of needles. A slender and irregular remnant of the noose was also found lying in a sort of tubular cavity, extending about half round the vessel.

Thus the process of organisation had not yet quite invaded the entire thickness of the foreign solid, and it was a happy circumstance that the thread had been so constructed that the distinction between the old structure and the new could be plainly recognised.

Ample as was the evidence afforded to the naked eye of the organisation of these ligatures, it was satisfactory to find it confirmed in the clearest manner by the microscope. A bit of the residue of the peritoneal thread, having been teased out with needles in a drop of water, presented, like a fresh piece of peritoneum, the wavy bundles of parallel fibres characteristic of perfectly developed fibrous tissue. Adhering to the surface of the remnant of the ligature was some soft opaque material, readily washed off with water, consisting of corpuscles of different forms, most of them caudate or fibro-plastic, but some spherical, though not resembling those of pus; and here and there fragments of the original peritoneal tissue, affected more or less with interstitial cell-development. At a short distance from the remains of the old thread, the fleshy material which had been formed at its expense proved to be a most beautiful example of fibro-plastic structure, the coarse fibres which mainly constituted it being composed of very large elongated cells, often containing several nuclei, and presenting in their course branchings and thickenings of various forms, as represented in the sketch (fig. 3). Here and there were some fibres more perfectly formed, and also cells of a more rudimentary character. Again, the band which had resulted from the organisation of the two fine threads of catgut, which, from the smallness of their bulk, had no doubt vanished early, having had longer time to perfect its structure, was a



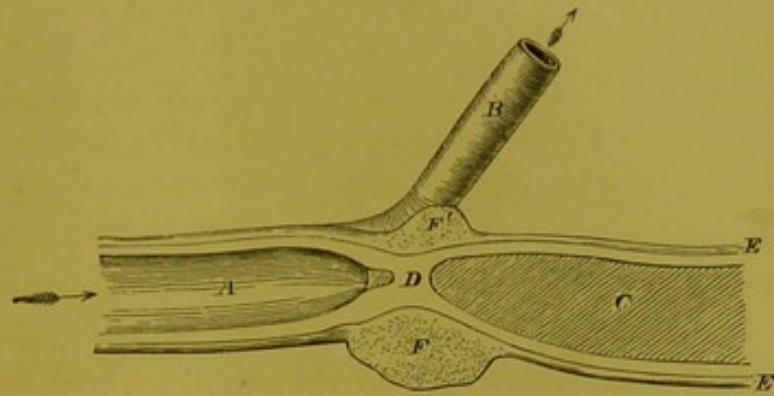
comparatively well-developed form of fibrous tissue, consisting of coarse fibres rather than of elongated cells, being thus intermediate between the merely fibro-plastic material of more recent growth and the completed texture of the original thread. For it is to be remarked that a piece of catgut exhibits under the microscope abundance of perfect fibrous tissue. A more favourable period for the investigation, with a view to establishing the nature of the change which ligatures of animal tissue experience under antiseptic management, could hardly have been selected.

Between the parts tied the calibre of the artery was occupied by adherent coagulum, which was for the most part decolorised, and exhibited under the microscope fibro-plastic cells of irregular forms. A similar clot was present between the distal ligature and a small branch that arose about a quarter of an inch beyond it. But between the proximal ligature and the heart the formation of a coagulum had been entirely prevented by a large vessel taking origin immediately above the part tied, which had thus borne for a month the full brunt of the cardiac impulse. Yet the vessel, so far from showing any sign of giving way, as it would inevitably have done had it been tied in such a situation without antiseptic precautions, appeared to have derived additional strength from the operation. The encircling ring of new tissue incorporated with the arterial wall must have had a corroborative effect; and within its grasp the inner coats, which seemed to have been but imperfectly ruptured by the soft and substantial ligature, were considerably thickened, and had coalesced so as to form a strong cul-de-sac, the irregularities of which had been smoothed over by a little fibrinous deposit, which had assumed the characters of a firm fibrous tissue, and presented a free surface undistinguishable from that of the lining membrane of the artery (fig. 2).

At the situation of the distal ligature the structure of the vessel seemed entirely unaffected. The middle coat was seen in longitudinal section as a pink streak between two white lines, representing the external and internal tunics, neither thicker nor thinner than in neighbouring parts. The catgut threads had been tied too gently to produce rupture of the internal and middle layers, and their presence and the constriction which they occasioned, whatever may have been their effect in the first instance, had left no permanent marks of disturbance; while the fleshy band that had replaced them, though in time it would doubtless have



FIG. 2.



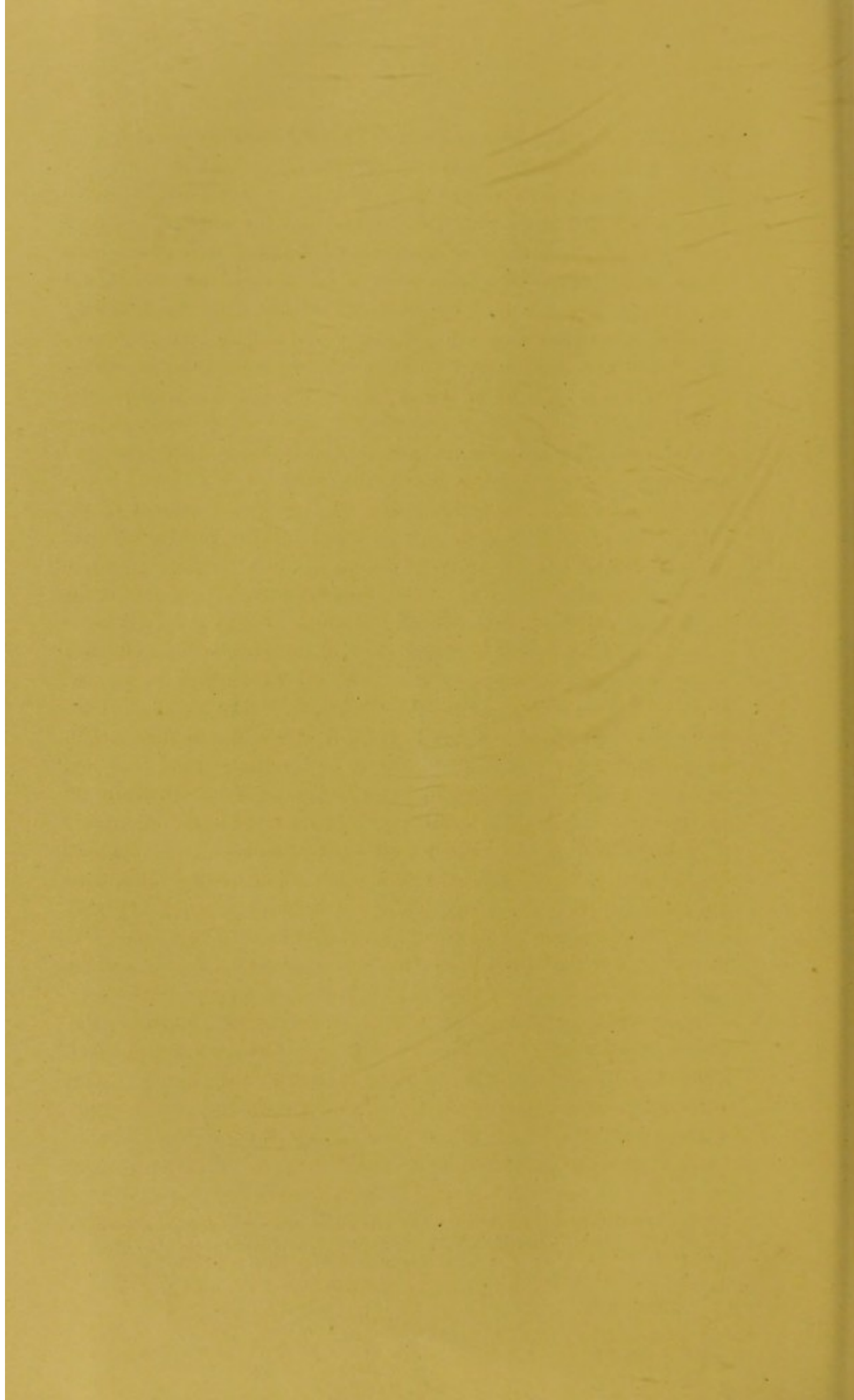
The vessel seen in longitudinal section, magnified three diameters. From a camera lucida sketch. A, The artery to the cardiac side of the ligature, kept free from clot by the stream of blood through the branch, B. C, The coagulum filling the artery to the distal side of the ligature, F F'. F being at the situation of the knot, is thicker than F'. D, The middle and internal coats, somewhat thickened, and blended together within the grasp of the ligature. E, The external coat, continuous in structure with the organised ligature.

FIG. 3.



Above are shown, magnified 500 diameters, some of the elements of the fibroplastic structure of the organised peritoneal ligature, at the knot r. From a camera lucida sketch.







dwindled down to an insignificant filament, was at least a temporary addition to the strength of the artery.

These appearances at the distal ligature are calculated to revive under a new aspect the old question whether it would not be better always to avoid rupture of the internal and middle coats, which could easily be done by using a pretty thick piece of catgut softened by steeping it in a watery solution of carbolic acid. In this way the wall of the vessel would be left from first to last entirely intact. This, however, is probably a matter of indifference. Indeed, judging from the condition of the artery at the cardiac ligature, the injury done to the vessel at the outset by tight tying seems to lead to changes which increase its power of resistance, which was certainly severely tested in the present instance.

It appears, then, that by applying a ligature of animal tissue antiseptically upon an artery, whether tightly or gently, we virtually surround it with a ring of living tissue, and strengthen the vessel where we obstruct it. The surgeon, therefore, may now tie an arterial trunk in its continuity close to a large branch, secure alike against secondary hæmorrhage and deep-seated suppuration—provided always that he has so studied the principles of the antiseptic system, and so carefully considered the details of the mode of dressing best adapted to the particular case in hand, that he can feel certain of avoiding putrefaction in the wound. For my own part I should now, without hesitation, undertake ligature of the innominate, believing that it would prove a very safe procedure.

Catgut, manufactured from the small intestine of the sheep,\* may be had at a very low price, from the thickness of a horse hair upwards. In the dry state it is objectionable from its rigidity, and also from a tendency of the first half of the knot to slip before the second half is secured. Water renders it perfectly supple, and as little liable to slip as waxed silk. But if a watery solution of carbolic acid is used for the purpose of making it antiseptic, the protracted immersion requisite to ensure completeness of the effect makes the finer kinds too weak and the stouter too clumsy. The method which I have found to answer best is to keep the gut steeping in a solution of carbolic acid in five parts of olive oil, with a very small quantity of water diffused through it. A larger propor-

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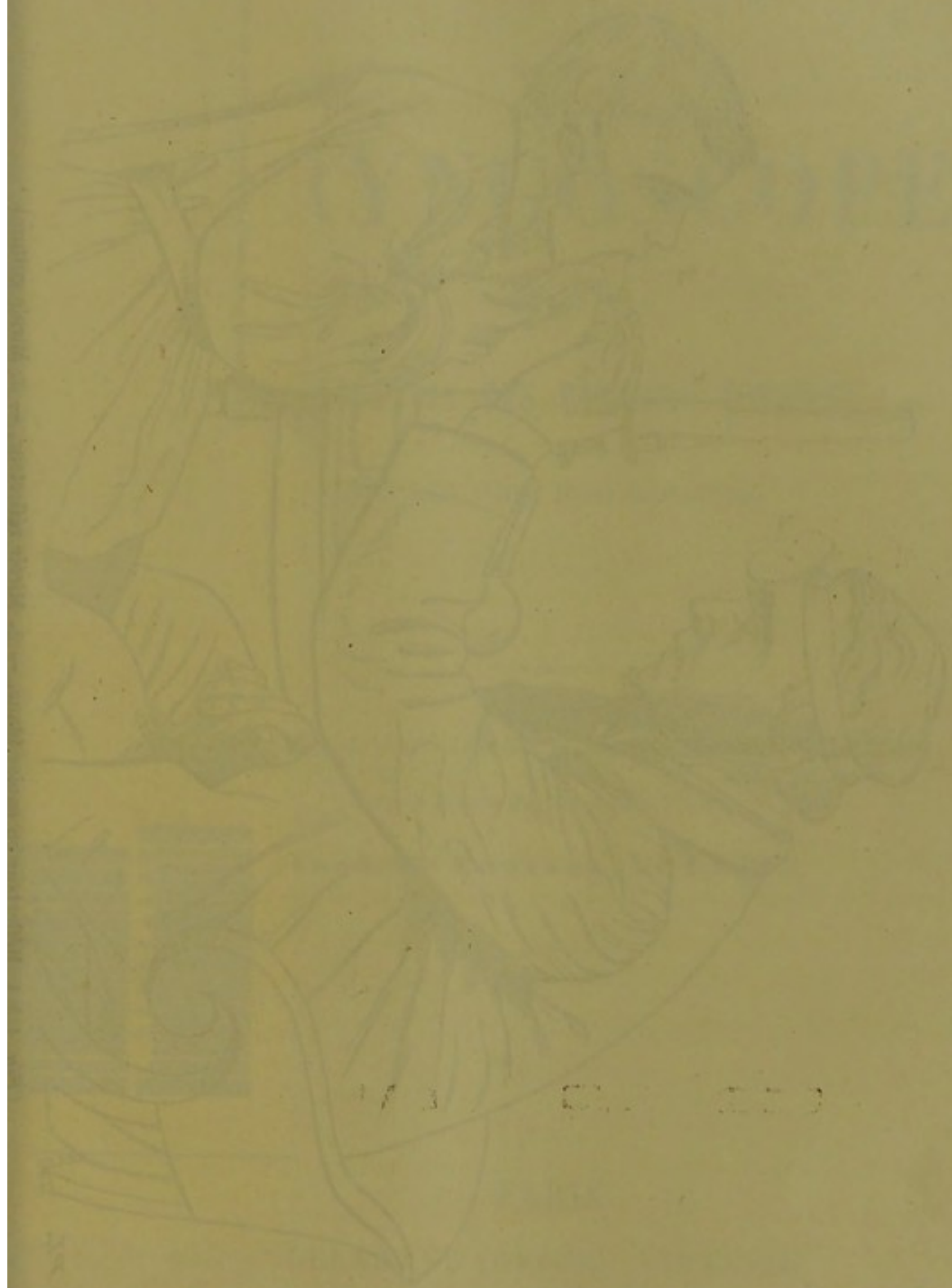
\* I need hardly remark that catgut is of a totally different nature from so-called silk-worm's gut, which is in reality unspun silk.



tion of the acid would impair the tenacity of the thread. If a mere oily solution is employed, the gut remains rigid, the oil not entering at all into its substance. But a very small quantity of water, such as the acid enables the oil to dissolve, renders the gut supple without making it materially weaker or thicker. And, curiously enough, the presence of this small amount of water in the oily solution gradually brings about a change in the gut, indicated by a deep-brown colour; after which it may be placed in a watery solution for a long time without undergoing any change; whereas, if it has been kept in a simple oily solution, it soon swells and softens when wetted. Gut prepared in the way above recommended may therefore be transferred at the commencement of an operation from the oil, which is unpleasant to work with, to a lotion such as is used for the sponges; where it will retain its suppleness without impairment of its strength.

For tying an arterial trunk in its continuity, catgut as thick when dry as ordinary purse-silk will be found best. But for ordinary wounds, where, if one ligature happens to break, another can be easily applied, much finer kinds may be employed, and are convenient from their smaller bulk. For every-day use, a small oil-tight capsule may be carried in the pocket case, and this can be replenished from a larger stock as may be necessary. I have had a small silver bottle, with well-fitting screwed top, adapted to my caustic-case, and this contains two little rods of wood, with gut of two sizes wound upon them, with a few drops of the antiseptic oil; and now that torsion has almost entirely superseded the ligature in ordinary wounds, this small supply will probably last me for months.





ПИСЬМО КЪ МОНАХУ ВЪ СТОЛЫЦЕ

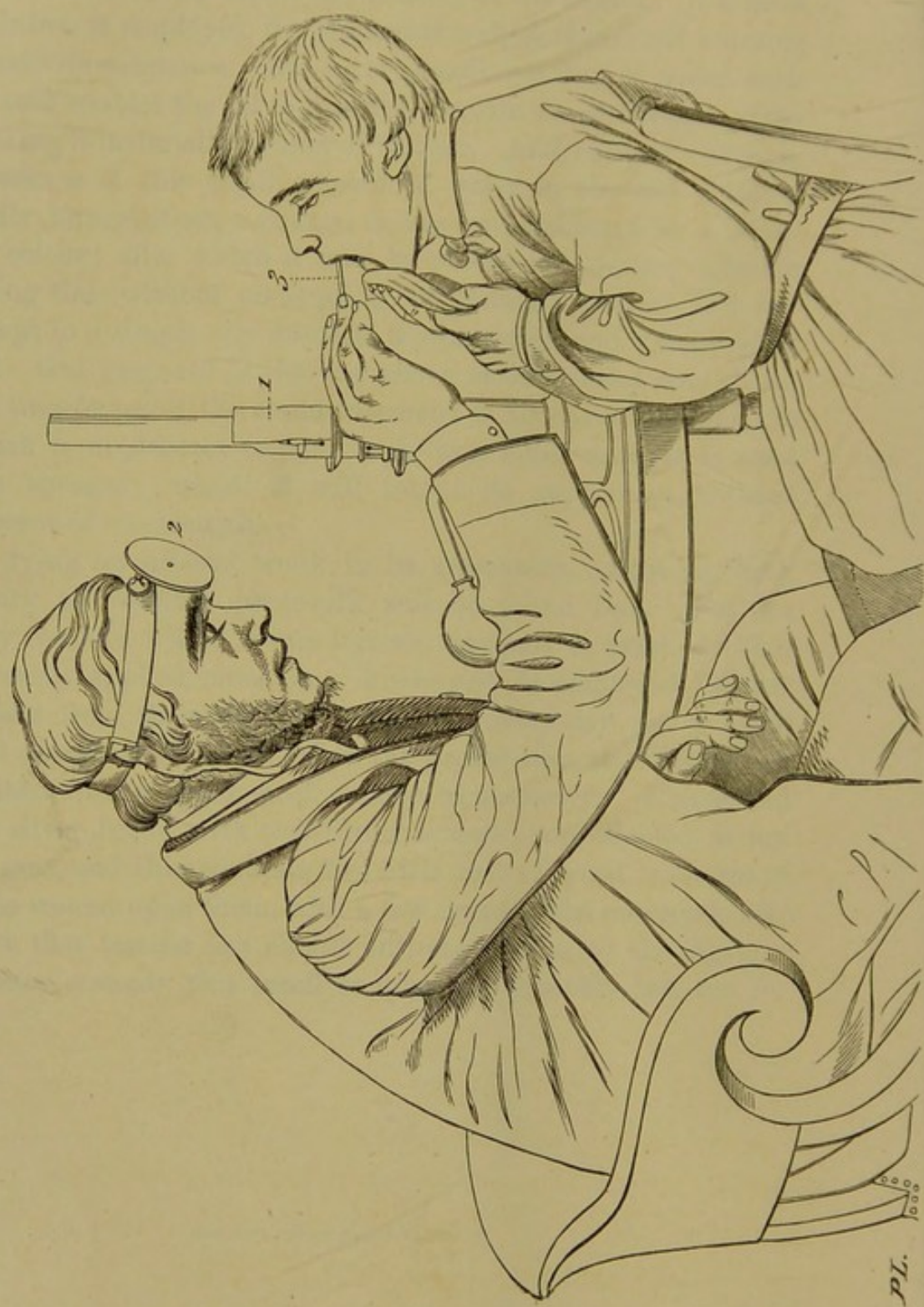
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С. 1

С. 2



EXAMEN LARYNGOSCOPIQUE PRATIQUE SUR UN ENFANT.



(Fig. 1) 1. Réflecteur en papier blanc. — 2. Miroir réflecteur. — 3. Miroir guttural.