

Dental anaesthesia : painless tooth extraction by congelation / J. Richard Quinn.

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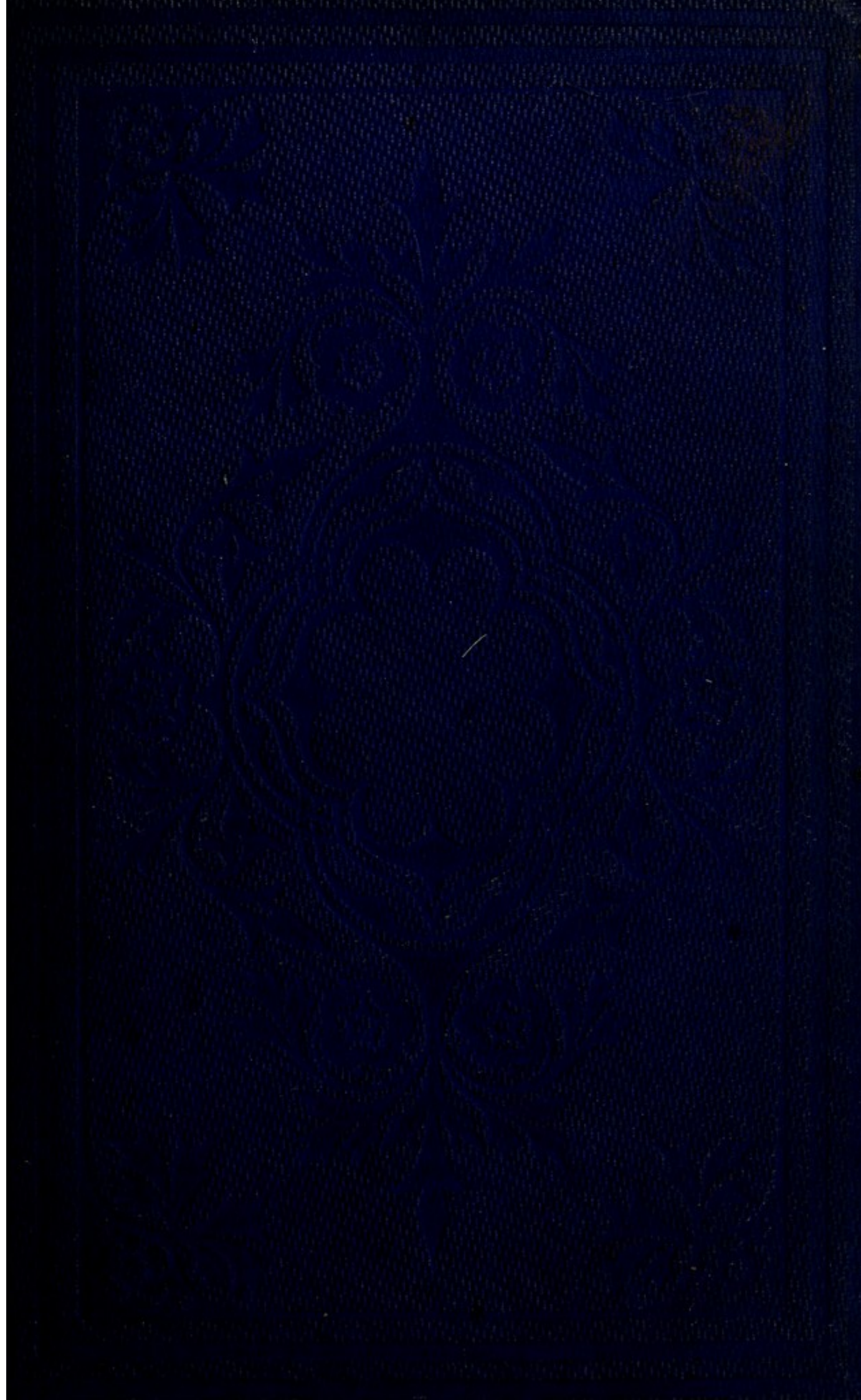
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DENTAL ANÆSTHESIA.

PAINLESS TOOTH EXTRACTION

BY

CONGELATION.

BY

J. RICHARD QUINTON.

Fourth Edition, Enlarged.

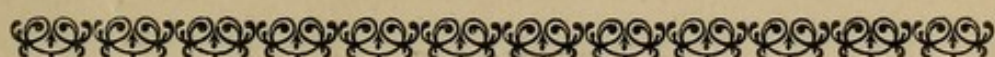
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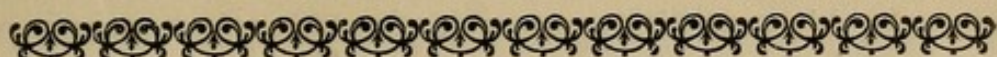
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A.

The Application of Cold to produce Insensibility
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The Power of Cold to relieve Toothache - iii.



P R E F A C E .

THE distinguishing characteristic of modern surgery is its humanity. The day has dawned, in the light of which we have begun to regard the *infliction of pain* in surgical operations, with horror as great as that with which we revert to the heated irons, the chafing-dishes, and other surgical cruelties of an age gone by. Man, through all time, has shunned pain. Wherever in the past his footsteps have trodden,—in the tropics, or among the wilds of Siberia, on the mountains of the far West, or in the valleys of the East, on the broad plain, or in the Isles of Polynesia,—narcotic plants, from which he can express ingredients to soothe human cares, and allay human sufferings, have grown around his dwelling. These have served man, and still serve him for ordinary life. But the antidote for the more trying emergencies of surgical manipulation, our own day, and in some sense, our own land, have the glory of realizing.

If we except the apocryphal virtues of the Memphian stone, which, “when bruised and spread over parts to be cut,” was alleged by the ancients to produce in them

a state of insensibility, anæsthesia,—from the time of Galen, Dioscorides, and Pliny, downwards,—has only been acquired by the inhalation of the vapours of narcotic herbs, acting through the circulation on the nervous centres. Ether and Chloroform in our own day, have taken the place of the soothing mandragora of the ancients. But the herb, or chemical agent, which can produce an efficient *local* insensibility in the part to be operated upon has not been found.

The following brochure is written in advocacy of a method of producing a most efficient *local* anæsthesia ; —viz., BY THE APPLICATION OF COLD, which has been found eminently serviceable in surgical practice in superseding Chloroform in a great variety of minor operations, or where narcotic agents are contra-indicated. Among such minor operations, those of *dentistry* are, perhaps, the most frequent. To the illustration of its efficacy in them, the following pages are devoted.

In the enthusiasm engendered by new discoveries, a tendency to exaggeration is often manifested. It has been my aim to steer clear of this, by demonstrating the general and particular physiological effects of the agent in question ; and while commending its virtues, I have avoided the error of ascribing to it omnipotence.

Many scientific details, and minute experimental researches, inappropriate to a work which lays claim

to no more than a popular character, I have reserved for a separate treatise. Nevertheless, sufficient grounds I trust have been shown, to inspire confidence in a method of local anæsthesia,* whereby the sufferings of a much dreaded and repulsive operation may be avoided.

J. R. Q.

18, ORCHARD STREET PORTMAN SQUARE,
LONDON.

* This word is sometimes spelt indifferently *anæsthesia* and *anæsthesia*. Strictly speaking, the latter is the correct rendering of ἀνασθησία, but the former method having accidentally been used in the first sheets, it has been retained throughout the work with the exception of the title-page.

ERRATUM.

Page 113, first line : Insert after 'century,' 'may smile
in their turn.'"



PAINLESS TOOTH EXTRACTION.

A LONG the shores of Arctic Siberia, and by the banks of those tardy rivers which roll across its desert plains, where eternal winter banishes the arts and social life, lonely companies of human beings here and there are seen, in pursuit of commercial enterprise. They are not nomadic fishermen in search of daily subsistence. They are men sent out to burrow from that frozen soil, the dental relics of the elephant and the rhinoceros, which animals, in an age anterior to the human epoch, traversed those northern climes.* The

* "In 1799," says Cuvier, "A Tongouse fisherman observed on the shores of the Arctic Ocean, near the mouth of the Lena, among blocks of ice, a shapeless mass which he could not make out. The following year, he perceived that this mass was a little more loosened, but he could not yet guess

result of their toils, is by no means an inconsiderable commerce. It is remarkable in a region where vegetation is now stunted and trees become dwarfish,—where the white bear, the rein-deer and the cormorant live,—where the waters never sparkle with fish of varied hue, and where a bird of brilliant plumage never adorns its dusky heavens,—that there should be found the remains of animals, whose present abode is among the richest of terrestrial vegetation,—where lofty palm trees rise,—where the brightest of plumage clothes the bird, and where a burning sun tinges with its triune beauty all that its rays fall upon. But this circumstance records the history of a mighty change in the phenomena of our globe.

what it was. Towards the end of the following summer, the entire flank of the animal, and one of its tusks were quite freed from the ice. It was not till the fifth year, that this enormous mass came ashore on a sand bank. In the month of March, 1804, the fisherman removed the tusks and sold them for fifty roubles, &c." [Abridged from the account in the Philosophical Transactions.] This was the commencement of the Siberian Commerce in Ivory.

The same writer in his 'Discours sur les Revolutions du Globe,' refers to "an astonishing discovery by Pallas of an entire Rhinoceros buried in the sand on the banks of the Wilugi," a branch of the Lena.

The great Naturalist, Buffon, was first led to conceive the idea of *extinct races*, by an enormous tooth brought to him from the banks of the Ohio, together with the Elephants' tusks and Hippopotamus' teeth from Siberia and Canada.

These relics of animals, whose structure and habits are adapted only to tropical climes, lying buried there beneath that Siberian soil, reveal to us this : that in fact, the time was, when the climate of those deserted regions was similar in temperature to what the tropics are now ; that the temperature of those northern regions has undergone a considerable change. How far back in the physical history of the globe this may take us, I presume not to determine. We may not reckon it by the brief period of the human era,—we may not speak of it by thousands or tens of thousands of annual cycles :—we refer to it only as succeeding to that chronologically indefinite geological epoch of the mammoth, the mastodon and other huge mammalian life. Yet through all these years,—through all these geological cycles, the teeth of these animals have preserved their original freshness, untouched by the corroding hand of time. Down among those other strata too, every perpendicular inch of which counts its long ages, often a solitary tooth alone remains to indicate the form of being of which it once formed part. Time has destroyed all other vestiges of its former life,—the skeleton included,—while the tooth, hard and firm,—gives to the palæontologist the history of the earth's ancient life. Such are examples of the *enduring* nature of the materials of which teeth are composed.

But coming down to the human era, and viewing the same organs in another species, which came later in the great drama of terrestrial being, and that species—man, how marked the contrast of conditions with which we are presented. While the buried tooth of ages gives proof of its *durability*, the teeth of the busy multitude who swarm our great cities, and crowd the area of civilized life, give as signal evidence of their *perishableness*. The human tooth, ever bathed in an ocean of living blood, whose history is encircled only by months or a few years, nevertheless, speedily corrodes and disappears; and, buried in the mouth, unlike those buried in the earth, easily succumbs to those destructive agencies, which the luxuries or refinements of civilization have introduced. It may indeed be true, that among those savage races of mankind whose whole world exists within their native hills, and whose only festive board is that which nature lays before them, the teeth preserve their soundness and integrity. Limited, like the lower creation, to certain geographical boundaries, their physical constitution through successive generations, becomes harmonized with those productions with which the earth supplies their restricted wants; and their teeth, like those of animals, fail not during the whole of life. It is otherwise with man in a state of civilization,—whose range of

territory is the broad globe itself. His immediate alliance with the soil is limited. He sits not down to the simple table of nature. Not a plain bill of fare satisfies him. Not a few things appeal to his tastes. His range of gratification is ever widening. To whatever class of feeders his natural conformation—his teeth, stomach, intestines—may consign him; whether frugivorous, herbivorous, or carnivorous, by the power of his intellect which has discovered the properties of fire, and the use of implements, he is truly omnivorous. He sends his ships across the oceans to fetch him the produce of other lands. The East and the West, the North and the South, contribute their fertile produce to the well spread table of modern civilization and refinement. Nor is this all; what nature gives, art serves up in a thousand varied forms. The modern *cuisine* is pampering, tantalizing, seductive. It is more—it destroys the very frame it feeds; as water wears away the solid rock, it wears away the hardest structure in the human body. In its savoury juices it carries death to those parts originally made for subservience to life. It is thus, combined with other manifold deteriorating influences which run parallel with the advancing progress of civilization, that the civilized man loses his teeth, while the savage keeps them. In the one they are enduring—in the other they are perishable. Our

Celtic and Anglo-Saxon ancestors, it would appear, knew little of that dental suffering so common to their posterity. Among the numerous skulls of our forefathers, which the labours of archæologists have exhumed, nothing is rarer than to find diseased teeth. Their teeth, as Mr. Charles Roach Smith informs me, are indeed sometimes much worn by the peculiar materials which constituted their food,—but they are very rarely met with in a state of decay ; soundness is the rule, disease the exception. My friend, Mr. Akerman, the Secretary of the Royal Society of Antiquaries, has kindly shown me several Anglo-Saxon skulls, in which the teeth are remarkably free from disease. The exceptional cases of decay, traces of which sometimes appear, he not unjustly, I think, attributes to an excessive indulgence in their favourite *mead*, which affords an illustration of the destructive property of certain articles of food.

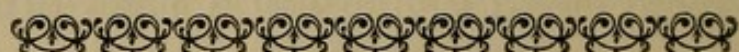
Modern society cannot compare with such immunity from dental disease in those ancient times. Doubtless the onward march of civilization has left in its train many other diseases equally unknown among the ancients ; and it may be even now sowing the seeds of other forms of disease at present unknown to ourselves, but which time will surely develope. Yet, viewing the subject under the contrast of the old and new conditions under which

society has existed, it seems impossible to reject the opinion, that with all the elevating, humanizing, and beneficent influences which advancing civilization spreads among mankind, it nevertheless exercises a disturbing and abnormalizing influence over the alimentary system of man, and hence, upon one of the most important set of organs of that system,—the teeth. It is rare, in these times, that a man can say, as Cornaro said at the age of *ninety-five*,—“*my teeth have not changed since my youth.*” Dental disease is no longer the exception. From having been sporadic, it has become endemic. It has so firmly established itself as to become recognised as one of the inevitable ills of our common lot, from which no one expects to escape. The dweller in the lordly hall, is no more secure against its intrusion, than he whose home is within bare cottage walls. The man of pleasure cannot stem its invasion of his joys, more than the son of toil his labours. The stalwart man falls as meekly at its approach, as does the tender infant. It follows man, step by step, in his passage from the cradle to the grave; and in the circumstance of man, ripened with years, going out of the world much as he came into it—*sans teeth*, we read the history of the dental sufferings and pains, which have cast their unwelcome shadows over the sunshine of his life.

With this universal implantation of dental disease in modern society, has arisen the demand for a special science and art, and an especial exponent of such science, or practitioner of such art. Dentistry, whatever may have been its early history, must now be allowed to take equal rank with any other branch of surgery. If the universality of any profession be any claim to high position, it can surely be no mean rank which must be allotted to dentistry. If, in its earlier career, it has been assumed by incompetent men, it has only shared the fate of its sister art—medicine, as when its arcana were the property of druidical priests. But like its sister art, it has developed itself out of crude elements into a recognized science. Few special branches of surgery, are more complete and perfect than that relating to the human mouth. Its pathology is microscopically minute ; and its operative manipulation is based on the soundest principles of anatomical and mechanical science. The enlightened dentist of this age is no mere *tooth-drawer*. He alone can claim to be an enlightened practitioner of dental surgery, who can bring to his practice an intimate acquaintance with the principles which govern the human body ; and through whose mind, light gleams from every region of science, concentrating its force on the special object of his adoption. It is he, —

the anatomist, the pathologist, the physiologist, the man of science, and the natural philosopher—who alone can adequately comprehend those idiopathic diseases of the teeth, which, while they may only be immediately confined to a small investing membrane, yet may overpower and derange the whole nervous system. It is he, who is fortified against those deceptive appearances which so often mislead the general practitioner. It is he, whose judgment can best determine when operative aid is required, and he can best exert that operative power, though it be without the brilliant flourish and *eclât* of a capital operation. Specialist though he be, he no less belongs to the enlightened fraternity of the healing art; and it is no insignificant department of that art which, by common consent, is committed to him. His art is intimately allied with the vegetative life of man. The human teeth are among the most important organs, and subserve the most prominent functions of that vegetative life. In administering to the integrity of these, he exercises a beneficent influence over a long series of nutritive processes in the living body. It is here that his efforts become akin and consentaneous with those of the physician, and it is this which redeems them from all insignificance. That life, which it is the physician's aim to preserve, it is the aim of the dentist's art to cherish;

and though he may not exercise his art by administering pills, draughts, and mixtures, he yet does a work as surely, and as certainly tributary to the physical well-being of mankind.



II.

PECULIAR PAINFULNESS OF DENTAL DISEASE AND OF ITS REMEDY.

ONE most prominent feature of dental disease and of its radical extirpation, is the amount of *pain* accompanying both. It is a singular provision which has brought together in the same organ, materials so hard, unyielding, and insensitive on the one hand ; and others so exquisitely susceptible to pain on the other hand. As organs of touch, it may indeed be said, that the teeth equal in exquisiteness of adaptation, the nerves of any portion of the surface of the human body. Though it ranks at present among the mysteries of anatomy, yet it is an universally appreciated fact, that a double power resides in their hard materials,—of communicating to the nervous system the contact of the most delicate substances, and of crushing without pain the crudest materials of our food. Analyse the action of the different teeth during any of our common meals ; observe how the food, in its progress, is

passed over one set of teeth to the kind offices of another, it will at once be seen how greatly we are indebted to this wondrous unknown power—this “intelligence” of the teeth—for many of the enjoyments of our daily life. They are, as Dr. Graves says, so many “fingers fixed within the mouth,” whose delicate nerves can discriminate the touch of a feather, or the passing between them of a spider’s thread. In those portions of the tooth on which devolve its high function of mastication, the creative hand has stored up the hardest material which is found in the human body, in order that the tooth may stand the rough wear and tear of constant attrition; while in those portions of the tooth which form the connective with the entire body, the most delicate of human fibres enters, in order that it may be duly responsive with the whole system. While, therefore, the tooth is an organ which presents, what in one aspect may be called an insensitive surface to the insensitive alimentary material it has to act upon, it presents to the body it thus works for, and helps to build up, a sensitive surface akin to its structure. It is here lies the secret of dental suffering and pain—in the peculiar vital connections of the teeth with the general system. They are organs to which firmness and fixity are indispensable. This involves a peculiarly close attachment of their relative surfaces; and these again bring

about a minuteness of adaptation of the various parts composing the teeth, which do not admit of variation in their normal action or position with impunity. Every region of the tooth is accurately fitted and filled up with its component parts. It is firmly, immoveably imbedded in an investing socket of a certain form and dimension, the walls or sides of which, being osseous, are unyielding. Its interior is nourished by an artery and an accompanying nerve, which enter the apex of the fang by a very minute aperture accurately circumscribed to their calibre. The abnormal enlargement of any of these vessels or nerves, by any of the thousand causes which may induce inflammation, sets up pain. And that pain is rendered more excruciating than pain in the softer textures of the body from the circumstance, that these enlarged vessels and nerves press, as with hydrostatic pressure, against bony masses that will not yield. It is this which gives to dental pain its most poignant sting, and hangs upon the calibre of a mere thread of nerve our pleasures or our pains.*

In like manner, the same mechanico-vital fixity, nicety of adaptation or adhesion, &c., give to dental *surgery* its peculiar painfulness. Considering the

* See Appendix B.

anatomical relations of the teeth, it is by no means difficult to account for that excessive pain, which makes the operation of tooth extraction the object of greater dread than other more extensive surgical operations. It were beyond the purport of the present popular essay, to enter upon any minute description of the anatomy and physiology of the parts connected with the human teeth. Otherwise it might easily be shown, how a combination of ordinary phenomena are interfered with, and how a delicate net-work of nerves is invaded and deranged by operative procedure. We turn with involuntary horror from the intentional dislocation of any of our limbs; yet a dislocation has to be effected before a tooth can be removed. We shudder at the idea of detaching a finger-nail from its firm attachments; yet the fangs of a tooth must be torn away from their powerfully investing periosteal membranes. We turn pale at the excision of blood-vessels and nerves; yet a vast net-work of both must be rent asunder, and one larger nerve and one larger vessel in particular must be torn across, ere a tooth can be liberated from the mouth. When the peculiar structure of that particular nerve is considered; and how impressions are conducted along its ramifying branches to the great central cerebral mass, a good reason is given for the overwhelming character of the pain. Let

all these come to pass simultaneously in any other part of the human body ; let there be a violent dislocation, a tearing asunder of bony plates, a sudden fracture of blood-vessels and nerves, as an accident, and it would at once assume the character of a serious catastrophe. Yet it is all these combined (on a small scale, it is true,) which constitutes the operation of tooth-extraction. Is it matter of surprise that the pain accompanying such revolting circumstances should be so acute and exhausting ?

What adds greatly to the severity of the pain attending dental operations, is the circumstance, that ordinarily these operations are deferred by patients till the *last endurable moment*. It is generally when the nervous system has become exhausted and enfeebled by a long continuance of acute suffering, that a patient becomes willing to submit to a fate he cannot avert. So much of the living force as has been expended in fruitless attempts to cure the incurable, is lost now in the hour of greater need. The supersensitive nerve-strings vibrate too keenly to the slightest touch ; and the exhausted brain too readily magnifies the impression conveyed along its telegraphic wires. Procrastination is, in such case, the thief of so much manly vigour as is given to us for the hour of trial. It sends man to the dental surgeon, a wreck of courage ; and in that weak and feeble state, what-

ever of pain must come, tells upon him with a ten-fold power.

All pain indeed is to be mitigated, for all pain is repulsive. In its end pain is moral. Our varied pains and sorrows have a grand purpose to accomplish for us. They are sent to discipline us to a higher and better physical life,—to teach us, that the individual and social happiness of our race, consists in the atuning of our outward and inward life to those laws of nature, which no human power can change, no human thought improve, no human being escape from—laws which are sternly beautiful and mercifully irrevocable. Physiologically, pain is but the sentinel of nature, reporting along the human electric telegraph to head quarters, the aberrations of our organic life. But its power is not all-mighty. Its lawful tenure of office is but brief. When it has knocked at the door of our human organism and proclaimed danger there; when the electric dial-plate reads off, ‘an enemy hath entered the gates of life,’—its intended work is done; if it be longer persistent, it is because either the moral ear is deaf to its warning voice, or the intellectual grasp is unequal to the contest. But, to chase away the plaintive murmur, which steals upon us, as we yoke under this common law of sentient existence, let it be remembered, that pain is antithetic of a wider-spread beneficence—

of a universal pleasure ; the law which gives us one pain, gives us a million delicate enjoyments of sensational life. Not a moment flits along the current of our terrestrial life, but it brings us untold enjoyments, from untold and untelling sources in this human machine. And though it be that a plaintive interlude may now and then steal upon those joyous moments, yet withal, human life is not *all* sorrow, *all* pain. The good, the joyous, the pleasurable, predominate over the evil here, as they do in universal nature. Such is what we may call *normal* pain.

Pain exists also as a *disease*. It does so always when it goes beyond its designed boundary of a warning. It is a wise appointment that has made the progress of pain to be in itself anormal. Unheeded, it will prey upon the life it at first came forth to preserve. This is the point of vigorous interference—the field for human ingenuity. We are bound to combat it with the appliances of our art, as we would any other disease which may befall the human frame. Our intellects are peremptorily summoned before the tribunal of human beneficence, to search out the means of annihilating all that excess of pain which comes to be disease. Pain, moral before, becomes purely physical here, and appeals to moral sympathy in the energetic use of professional skill. It passes

from its relationship to the individual into the domain of medical science.

A broad distinction lies between pain as a law essential to well-being, and that excessive development of it, amounting to disease. A still broader line of distinction separates this latter from that *artificial pain*, which our own hands inflict in curative surgical treatment. The one is disease by excess of action, which our negligence or ignorance has not superseded. The other is disease by the mechanical interference of rude knives, grating saws, and wrenching forceps. Disease often lies beneath a sound and healthy exterior, the integrity of which must be invaded ere the seat of it is reached. That exterior retains all its perfection of sensibility, as the guardian of that which it covers. And thus in opening up these portals by surgical interference, it in no way differs, except in the mode of performance, from the ruthless destruction of delicately organised structures. That which is sound and healthy, has to be sacrificed to that which is unsound and diseased. There is unquestionably an obvious beneficence in the existence of this kind of pain. Its manifest purpose is to preserve the integrity of the system in its parts, as in its entirety. In its absence, the human body might be made the sport of rude interference : instead of a beauteous temple, in which the music of all nature may resound, it might

become a mutilated piece of mechanism at variance with all harmony of form, and perfection of structure. Pain is that guardian angel with sword turned every way, protecting, at the peripheral extremity of every nerve, the great human temple from the entrance therein of aught that shall recklessly despoil its beauty, or unharmonize its world-responding chords. Surgery has to bid defiance to this protector. That which it protects is of more importance to be saved, than aught that can come by way of punishment from this stern unyielding protector. Surgery must accept the one evil in order to overcome the greater. I do not misname the pain which surgical interference produces by calling it an evil. Good, in its appointed use as a corporeal protector from external injury, it becomes, by virtue of that which makes it good, an evil in surgical manipulation. It is an evil because it is an *artificial pain*. It is exhaustive of the living force; it is destructive. It often insidiously carries death in its torturing train, stronger than the might of our art. It has been statistically announced that by the introduction of etherization, death has slackened its pace, or wholly absented itself, in many surgical operations, of which it was once such a grim unwelcome companion. And this because etherization had deprived death of one of its most efficient ministers—pain. It is surely an age of great

benignity in which we live, when in the composure of a profound sleep, our suffering humanity can have limbs lopped off and tissues incised, and by that same resurgent sleep, keep off the deeper sleep of death.

Such pain, artificially induced—neither the result of individual negligence, nor of conscious violation of natural law, but coming to man as the consequence of a disease whose invasion he could not control—it is a work of mercy, as it is a moral duty to mitigate or abolish. It must surely be a cruel obliquity that can find good in such suffering. Pain never had its advocates till the power of its abolition came. The nobler soul recoils from such advocacy. Not only does physical good follow in the train of its abolition ;—but it has this moral pre-eminence, that it harmonises with the highest sentiments of the soul—the best emotions of the heart.

That the pain of dental surgery is of a character to lay a high, if not an equal, claim to abrogation with other surgical operations, I have already dwelt upon. There are those whose heroic natures would disdain to shrink from suffering of any description. They are in number few, very few. We have read of stolid heroism among our Crimean wounded, in their indifference to pain ; but the stimulus of war has been present to blunt the scalpel-edge. We revert with reverence to those

noble martyrs, whose nerves were steeled against their tortures by that mighty power of conscience, that soul-absorbing devotion, which dominated over all physical endurance. Cranmer could hold his hand in burning flames, because he was all obedient to a higher law. But the martyr is not the man of common life. No great stimulus, no lofty soul-absorbing motives, brace up the nerves of him who submits his mouth to be robbed of its dental constituents. It is a law of necessity which is laid upon him, and that law bears ungraciously. Thus it is, that those who would unflinchingly and proudly stand to a battery's fire in the heat of battle array, holding in martial contempt all suffering and pain, willingly accept a painless dentistry in the cool and quiet moment of a perverse necessity. Many of our bravest soldiers have told me they could stand to be shot at, but they shrink from a pair of dental forceps.

Yet, ordinarily, the operation is but *brief*. This to some minds is sufficient apology for rejecting anæsthesia. The brevity of a pain and its results are not, however, always of equal balance. I have seen a comparatively slight, a very momentary pain, lay prostrate the stoutest and bravest of men. The list of sequences to the mere withdrawing of a tooth which might be quoted, from simple exhaustion up to epilepsy and paralysis, sufficiently

demonstrate, that mere brevity does not give certain immunity from more durable consequences. That vital fluid, which courses with quicker than lightning speed along the million wires converging on the brain, like that electric fluid which gives man omnipresence, may vary in individual cases, and in differing circumstances of the individual being. In one individual the vital battery-force may be feeble; in another it may be powerful. At one time, the strokes it gives may be weak, while at another it may light up all the latent fires in the human body, and concentrate in a moment the agonies of a lifetime. What is thus an unpleasant sensation to one, is torture to another. The prick of a needle may be as the thrust of a sword. The sensation may be brief, but without bounds. And, such is not exceptional, as I have already said, in dentistry. The ordinary effect of dental disease, is indeed to increase the polarity of the vital battery, and thus to magnify impressions of sensation. The whole nervous system is in a state of supersensation. The very atmosphere, which at other times is balmy and grateful, reports itself in painful waves upon the brain. The gentle zephyr becomes a rude and ruthless blast. Those beautiful provisions of nature which ever bear us so much good, are distorted into hostile forces by the exaggerations of excited nerves. How much more imminent, under such

circumstances, those surgical appliances requisite to remove the disease. Be they ever so delicate, they will be felt as cruelly severe ; be they as brief as the moment which no sooner is than it has gone, they will be protracted in the imagination into a long endurance, as are the moments of our dreams, into which are crowded the eventful histories of years. Shall it be deemed an object unworthy the aspirations of the professional man, to arrest that supersensation, before which the boldest heart quails? Or, shall it be thought beneath the dignity of that human courage given to us for the hour of trial, to make a compromise with the humaner progress of art, or with the beneficent powers which modern science unfolds? We think not. We think rather, that viewing the wide domain of dental disease in modern society; and the incalculable amount and intensity of the suffering which it entails, either as disease, or in its process of cure, and the peculiar circumstances which crowd their unwelcome presence around it, that no department of surgical or medical art, so imperatively demands the attempting those sufferings, and the mitigation or abolition of those pains. In this assertion, I do but give utterance to that too deep to be voiceful prayer, of the million hearts oppressed by the agonies of dental surgery : I do but make audible that sup-

pressed sigh which has so long heaved the breast of a suffering humanity.



III.

ANÆSTHETIC AGENTS.

THE question arises, what are the means placed at our disposal by nature, science, or art, for the abrogation of pain? The range of our available anæsthetics is limited. It is a department of science in which few aspirants have been successful. A vast domain in it remains yet void,—a wilderness that wants the magic touch of the seer of science to make it blossom.—Speaking in general terms, the progress of anæsthetic science has been marked by two modes of inducing insensibility to physical suffering:—one, by so acting upon the entire nervous system as to supersede all consciousness; the other by topical applications alone to the part to be operated upon. The *general* anæsthesia being produced by the inhalation of ether or chloroform; and the *local* anæsthesia by cold, ethereal vapours, or other less useful appliances. These are the common property of dental and general surgery.

That was a happy day for the human race, when the bright sun first shone upon a suffering mortal asleep beneath the surgeon's knife. A new era had

begun—the era of a compassionate surgery. It was ushered in too, be it observed, by a dentist; and the first painless operation of our age, was the *extraction of a tooth*. An old world of horrors passed away on that day. The murky cloud which had hovered for so many ages over surgical art, began to roll itself up as a scroll and disappear. Benignity beamed forth in the human sufferer's heaven, which has carried a solace to the soul for the hour when life's casualties fall heavily. As words are inadequate to utter forth the tortures which surgery entailed, so no pen can describe the unbounded beneficence which flowed to human homes and hearts, out of that first Lethean cup that was offered to mortal lip. At the rising of a wave of ether, pain, as by a fairy spell, was made to vanish from its wonted haunts.

Fable tells us that the Vampyre-Bat fans its victim into sleep, and then feeds upon its blood. So, it is by sleep—a sleep profound—that pain is banished from the human frame by ether. It is not the sleep that nature brings to restore its exhausted powers. It is the artificial sleep of a narcotic drug: evanescent, it is true, but like all such sleeps, liable to misdirection or excess. And this has sounded out a great alarm. It is the first cloud that has darkened the horizon. In the unconsciousness of chloroform, what may come? In

that sleep there may be dreams:—the waking up may be out of space and time. Shall I come back again from that sleep to my work of time, and to my friends?—that is the question so predominant among us just now. Like children afraid of darkness, the mere fear of oblivion enthrals us. The very going to sleep at night, if haply we do but feel it, terrifies us. We shrink from unconsciousness. The outward is our great fact. We know not what wandering paths the mind (which is, after all, our real self,) may stray into, when the body is deprived, however transitorily, of its connecting links therewith. These are very natural fears floating on the surface of facts. They are very pardonable, even if unfounded; and not unwise where danger may exist, and while life is precious. Premature death is never welcome. Sudden death in life's full vigour is as little welcome. The possibility of a sort of suicide to save us pain, is a grave contingency. Such are the arguments which always come uppermost in English society upon the subject of chloroform.

I say not that it is impossible that the wave of ether which wafts away pain, may not also overwhelm the life. It can do it. It has done it. We know why it has done it in many cases. A whale or any lung-breathing animal may be drowned by immersion in water;—man may be asphyxiated

by the exclusion of air. An excess of opium, or prussic acid, will as surely kill as an excess of chloroform. Shall opium, therefore, never be used to allay pain? A single grain of opium, administered by an eminent physician, lately killed a lady. Shall every lady in the United Kingdom be deprived of the good effects of opium, because of that one unfortunate case? Nay, more, the Registrar-General informs us, that no fewer than *three hundred deaths occur annually* from the administration of opium alone. This number might be greatly augmented by including the fatal effects of other equally potent drugs, owing to the idiosyncracies of certain constitutions. Shall chloroform be denied the nine hundred millions of the human race all over the world, because in one little island, or in one fractional country, a few of that race are affected with an idiosyncrasy which cannot breathe its vapour and live? It were ignoble and ungenerous thus to argue. The real mortality from chloroform has been greatly exaggerated by the natural shock of the suddenness of its death. My experience—and it is considerable,—leads me to entertain none of those fears of chloroform which seem to appal so many minds. I have seen too much of suffering destroyed, to wish a retrograde movement into a merciless surgery. The infant sleeping on its pillow—the old man dreaming of his former

days—woman peacefully reclining on her parturient bed,—while knives and instruments are doing their cruel work, are sights not to be exchanged for the agonies of a former age. Fear is not to make war with mercy. Beneficence must not give place to prejudice.

Nevertheless, it must be admitted that the true anæsthetic has not yet appeared. The vapours of ether and chloroform demand as their price the *abolition of consciousness*. We cannot perfectly reconcile loss of consciousness, with absolute immunity from danger. I believe the day will yet dawn, in the which an anæsthetic will be discovered, that will deprive the nerves of sensation of their functions, without abrogating consciousness. A few such prophetic cases have already occurred. Operations have been performed upon patients in full possession of their intellectual faculties, but deprived of all feeling and of all voluntary power. We wait for the seer who shall disclose the arcanum. Meanwhile, we gladly accept such anæsthetics as we have, as welcome contributions to the noble work of beneficence and mercy, under the assurance that the perfect and true one is in course of development.

Is it desirable, in ordinary dental operations, to administer an anæsthetic which can only abolish pain by extensively affecting the nervous system?

Insensibility by the inhalation of chloroform, cannot be obtained without exciting an abnormal condition of the circulation. The whole body must thus be made to suffer (however temporarily) for the one part which is at fault. Every globule of blood flowing through the capillary vessels must be vitiated; every nerve-fibre must be deprived of its ordinary function; and the great central mass of all human forces—the brain—must yield up the reins of government. For what? That such a fractional constituent of the body as a tooth, may be taken painlessly from the mouth. Viewed in this light, the end gained would appear too trivial to compensate for the magnitude of the means. Such, at least, is an opinion very commonly entertained, and that without any under-estimate of the severity of the operation.

But when to this want of harmony between the means and end,—when to this artificial vicarious suffering of the whole body for its smallest parts, there is added the circumstance, that danger may creep in unawares—another aspect of the question is opened before us. Sympathizing but little with that wholesale condemnation of chloroform which an unfortunate casualty every now and then excites; impregnable (I hope without any undervaluing of human life) against those fears, which occasionally so fiercely assault professional courage; yet it must

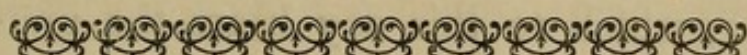
be admitted that some degree of risk—however small in experienced hands—does attend the process of etherization. A patient, submitting to a dental operation under chloroform, becomes the subject of that risk; that is, if it be administered so as effectually to *abolish* the pain itself, and not the mere *memory* of it. Should, it is asked, human life be suspended on such a gossamer thread? Is it right to deliver ourselves over to such an uncertain destiny, for anything short of a capital operation, or of an unendurable suffering? It may indeed with some justice be alleged that the great mortality attending many capital operations, so reduces the value of life, that the addition of the anæsthetic risk is a matter of comparative indifference. The value of a life, under such circumstances, may be as only 1 in 2, 4, or 6, and so on. It is far otherwise in dental operations. A life loses none of its value by the loss of a tooth. It still retains the average of the community. Death and the dentist are not familiar acquaintances. A just appreciation of those mighty interests which crowd in upon the life of every individual; and a lofty regard for those destinies which wait upon it, may make us pause before submitting it, for any trivial regards, to a condition which perchance may usher it into a sphere beyond the limits of mortality. It is this grave reflection which has given birth to

the popular sentiment, that chloroform, in ordinary dentistry, is not desirable—some would affirm, not justifiable.

This sentiment extensively pervades the dental profession. It is rare indeed to find a dentist whose *habitual* practice is to administer chloroform. I do not believe one such is to be met with in the great metropolis of the world. When etherization was first introduced, no class of practitioners gave it a heartier welcome than dentists. But the glad prospects of a benignant dentistry, which then opened up in such brilliant vistas, have all vanished like the transient and delusive beauties of a mirage. The cry of torture still rings in the operating-room. Those mournful, moaning notes which its walls echoed in olden time, have all come back again. Wherefore? Has human suffering become less poignant? Are dentists less human-hearted than they were? Not so. Human life is held too sacred to weigh it in the balance with the pain—severe, but transient, of dental practice.

The condemnation of anæsthesia by chloroform in ordinary dental practice, it must be confessed is not altogether unjust. Exceptional cases may occur, wherein we should only be acting in accordance with refined humanity in resorting to it. Its condemnation rests upon the fact, that man must be shut in from all outward life to abrogate the sensory

functions of the nerves. A disturbance, though transient, must be wrought upon the whole system to remove the sensation of suffering from a very fractional part of the body. Now the ground upon which I affirm that it is no longer necessary to resort to chloroform in ordinary dentistry is this, that a *local anæsthetic can now be applied which obviates every objection to general anæsthesia, and for dental purposes, is even more efficient than chloroform.* The local anæsthetic to which I here allude, is the application of *intense cold.*



IV.

TEMPERATURE. ITS PHYSICAL AND PHYSIOLOGICAL EFFECTS.

A FEW mighty principles have presided over and regulated the movements, changes, and developments of universal nature. Foremost among these is the all pervading influence of *temperature.* Heat and cold* (the men of science tell us,) have been the accompaniments, if not the physical causes, of every change in the material creation, from the moment of its wondrous birth. Laplace fancied he could trace back the history of those planetary worlds

* Strictly speaking, cold is but diminished heat. Heat is real—absolute. Cold is comparative.

ever rolling in such silent majesty around us, to a common parentage in the sun. Herschell, with his space-penetrating telescope, saw floating in the remote heavens, masses of yet unorganized stellar matter, the materials out of which such suns were made; and that all-pervading power by which that star-dust was evolving into suns, and by which those suns should again give birth in space to planet-worlds, was by process of refrigeration.* Far back in the dark night of time, when the new earth was yet unclothed, it took on, geologists tell us, a rocky covering, which to this day bears the undisputed marks of fire. Our upheaved hills of granite are its monuments. The metamorphic rocks mark the commencing decline of the Plutonic reign. In almost every region of the globe we tread on lava beds of volcanic fury, now extinct. Though still within a few feet of the earth's surface, whither the sun's rays penetrate not, there is found a temperature from another cause, ever increasing the deeper we descend; and though still the lofty Andes in America, Vesu-

* The spell of this most ingenious *Nebular hypothesis*, has indeed been somewhat broken by Lord Rosse's specula:—the star-dust is resolved into stars. But the great facts supporting the common origin of the planets remain unrefuted. We wait yet for the other Newton who shall disclose to us the law of cosmical development, as has been disclosed to us the great law of universal order and preservation.

vius in Europe, and the Sunda Isles in Asia, give forth jets of the old pent-up internal fires, yet the geological history of the Globe, of its progressive strata, its forms of life, all tend to shew that the same process of refrigeration which was supposed to have given birth to planets, has been present in every stage of our world's development, from the primary granite to this day's Pliocene. Temperature has played an equally active part in organic as in inorganic nature; every species coming forth to tread the little theatre of its being as the enveloping atmosphere around the earth hath permitted it.* Last of all came man. He came not in that era of boundless forests which have buried fire within the earth to warm him, who then was not, but was to come—but when the environing air was balmy, and human lungs could breathe it and live. As the insect comes forth when there are genial rays to greet it, and blooming flowers to give it food, so came man. And what even is man—what is all animated nature without the vital stimulus

* "If," says Humboldt, "we penetrate into the interior of the earth, and search the cemeteries in which the plants and animals of the ancient world lie entombed, the fossil remains which we discover not only announce a distribution inconsistent with our present climates—they also disclose to us gigantic forms that contrast no less with those which now surround us, than does the simple heroism of the Greeks with the character of human greatness in modern times."—*Aspects of Nature*.

of heat?—What piece of work more noble, what organization can surpass, the human body, all perfect in its complexity? Yet, deprive it of heat, and it is nothing more than the marble statue which a Phidias may carve. Whether, therefore, we look to the heavens with their yet mystic history, or to the evolution of this third planet from the sun, our world, or to the varied forms of animated being which people it, the power of temperature runs parallel with all their histories, as the physical modifier, sustainer, solidifier, or developer of all things.

But we need not seek our illustrations alone in the pre-Adamic eras of the earth's history:—the physical geography of our own era, everywhere acknowledges the dominating power of varying temperature. Our subject being the relation of cold to vitality, let us ask, What are the workings of this principle in present *animated* nature which invite our study?

In the first place, let us look at the influence of varying temperature on terrestrial *vegetation*, dividing the earth into flower-gardens of every grade of beauty, from the simple Red-snow variegating the polar fields, to the rich Flora of tropical climes. It were needless to refer to that death-like torpor which comes over the vegetable kingdom, when the snow-white curtain of

winter enshrouds our temperate climates. It is *death-like*, but not death; for, if a genial, sunny day do but intervene, the vital powers are aroused, and the involucred leaf-buds pronounce themselves ready for the coming spring. Nor need I point to Chatsworth or to Kew, where beneath Paxton palaces of crystal, the tropical palm can brave our northern winter, and where our own indigenous plants blossom and give fruit, while their co-relations bow their heads in naked weakness in the open field. But it may repay to recall before us, the forms of vegetable life which flourish beneath the heat or cold of diverse regions. Passing from the equator to the poles, the traveller finds around him first, a vast proportion of leafy life. Every spot of equatorial earth is prolific. Wide countries present one mass of forests, whose greenness never changes to the yellow tinge of any autumn. The Palm, the Bamboo, and the Tree-fern, rear upwards in the air, with numerous Orchidæ drawing sustenance from the atmosphere, intertwining among their branches. It is there the Bread-fruit tree, ever yielding its copious sustenance, has decided the settlements of tribes of the human race; and still invites the Indian to erect his fragile hut beneath its shady branches. The Chilian pine, too, gathers around it the family of eighteen beings, whom it sustains from year to year, by its

abundant fruit. So also the Date, the Bananas, the Cocoas, and the Coffees, all yielding rich provision to the storehouse of human wants. Pursuing a northern course, the scene changes from perpetual verdure, to one where the leaf-fall of the tree is known. The Grape, the Olive, Citron, Orange, &c., hang from the branches. Farther yet, appear the Apple, Plum, Chestnut, Oak, Beech, &c. Beyond these, the trees, bearing fruit no longer, supply only their timber. Where these cease, forests of Firs arise, and the Birch and Willow gradually sink into a diminutive existence. Landed within the Arctic circle, the Mezereon, Water-lily, and Globe-flower, still shed some beauty on the wide wastes. But the latitude is reached where these rear not, and nought but a sparse Cryptogamia exists, to show that death holds not a universal sway.* Thus the journey commenced amid the richness of abundant life, ends in the dreary aspect of approaching death. That verdant floral robe which invests the naked earth, is thus of unequal

* In no class of plants is there greater endurance of cold than in the Cryptogamia. Humboldt tells us that in tropical regions the Cryptogamia bear a ratio of only *one-tenth* to the Phanerogamia, or flowering plants. In the temperate zone, between Lat. 45° and 52° , the proportion rises to *one-half*, with a gradual increase proceeding towards the poles, till between Lat. 67° and 70° , the number of Cryptogamic species equals the Phanerogamia.—*Carpenter*.

texture. In regions where cloudless heavens never intercept the glowing sun, it is rich and thick ;— in those climes where frosts destroy the opening buds of spring or the ripening fruits of autumn, it is thin.

Precisely the same transition of vegetable life may be met with even within the tropics, on the sides of lofty mountains, as are met with in various latitudes. Ferns, Mosses, Fungi, and Lichens, love the lofty hill bathed in the colder air. “ In ascending the Peak of Teneriffe, Humboldt remarked as many as five distinct zones, which were respectively marked by the products which characterize different climates. Thus, at the base, the vegetation is altogether tropical ;—the Date-Palm, Plaintain, Sugar-cane, Banyan, the succulent *Euphorbia*, the *Dracoena*, and other trees and plants of the torrid zone, there flourish. A little higher grow the Olive, the Vine, and other fruit-trees of southern Europe: there Wheat flourishes, and there the ground is covered with grassy herbage. Above this is the woody region, in which are found the Oak, Laurel, *Arbutus*, and other beautiful hardy evergreens. Next above is the region of Pines, characterized by a vast forest of trees resembling the Scottish fir, intermixed with Juniper. This gives place to a tract remarkable for the abundance of Broom, and at last the scenery is terminated by

Scrofularia, Viola, a few grasses, and cryptogamic plants, which extend to the borders of the perpetual snow that caps the summit of the mountain."—[*Carpenter.*] Taking, therefore, a comprehensive glance at the vegetable kingdom, the great lesson taught us is, that from the poles to the equator, organic life and vigour gradually increase with the augmentation of vivifying heat.

Similar illustrations may be gathered from the *Animal Kingdom*, though under somewhat varied phenomena. A direct relation exists between the richness of any fauna, and the climate. The distinguishing feature of *tropical* faunas, for example, is the immense *variety of animals* which they comprise, as well as the brilliancy of their coverings. The representatives of every principal type of animal are there found. Of the little humming-bird alone, there are no less than three hundred species. The tropical forests give shelter to the larger Pachydermata, and to the Felidæ: the elephant and the lion and tiger roam therein—while the Quadrumana and herbivorous bats, skip among the branches. There, also, are the toucans and the parrots, arrayed in garments of most glorious hue. The *Temperate* faunas, abound with animals of graceful form and animated appearance, and with the exception of the Carnivora, the Ruminants, and most active of the Rodents, they present an ever-

changing picture in their periodical migrations. Among the *Arctic* fauna *uniformity* predominates. The species are few—a vast increase in the multitude of *individuals* compensating for the numerous *species* of the tropics. Clouds of birds hover over the islands of the north, but a bright feather is never seen. Shoals of fishes throng the Greenland coasts, but not one of varied hue. The white bear, moose, reindeer, white fox, polar hare and lemming abound. The lowest of Mammals is there in the form of the whale. Also the lowest of birds are represented by the ducks, petrels, divers, gulls, and cormorants. Marine worms, and minute Crustaceans supply the place of the Articulata, and reptiles are not known. A traveller thus starting southward from the arctic circle on a zoological expedition, will first see around him, an ever-unvaried fauna composed of the same animals. Approaching the northern boundary of the temperate climes, he will behold a more varied fauna as well as landscape. Forests with their noisy dwellers spread before him. As he sojourns on, the world becomes more peopled with life of comelier forms. And at last, arriving within the tropics, ever new and varied forms pass before him, and he finds himself everywhere surrounded with an exuberance of life. The heavens resound with the melody of beauteous birds—the forests ring with chattering monkeys and roaring

beasts—the hum of insects vibrates in the air—and the very ocean glows with fires lighted up by untold myriads of animalculæ. Thus ends a journey, commenced amid dreary solitudes of humble forms of life, in a vast expanse of rich and glorious existence.

The higher classes of the Animal Kingdom possess, however, a wider range of climate than plants, in virtue of an internal calorifying power peculiar to them. The polar bear can live amid eternal ice and snow, because its power of generating heat exceeds that of the bear of temperate regions. But this power has its limits. The tropical animal transported to a northern clime quickly dies, unless sustained like plants by artificial heat. And the polar bear in our Zoological Gardens must be kept in a cool and shady place, with water in which it may constantly refrigerate itself. Every class of animals has a standard temperature consistent with its well-being. And the fact serves to mark the power of temperature on life, that in birds and mammals, a reduction of bodily temperature to the amount of 30° is ordinarily fatal. While, on the other hand, the vital functions of *hybernating* animals continue in their state of torpor under almost every degree of external cold. Some animals, again, appear to be invested, like man, with a universal climactic power. The Condor, for example,

will sometimes suddenly descend from a height of 23,000 feet down to the sea-shore, in its way passing through all gradations of climate. A butterfly, whose congenial home is among sun-lit flowers, rested on the shoulder of Humboldt on the snowy heights of Chimborazo ; and one fluttered around Saussure on Mont Blanc.

The facts which have thus passed before us in review, demonstrate the inter-dependence of life and heat ;—or that the absence of heat which we term cold, is repressive according to its degree, of the amount of life on the Globe. We may thus be prepared to note the effects of cold upon the *human* race. Man is formed to be the lord of the whole earth. Supplied with a heating apparatus within a naked body, he can, by a due adjustment of his clothing, subsist under any sky. He nevertheless ranges under the same thermometric laws as other warm-blooded animals. In studying the effects upon man we shall be able to comprehend the *rationale of the action of cold* in its various forms and degrees.

The vital powers of man reside in the brain and heart, or more generally in the nervous system, and in the circulation. Between these two systems and the atmosphere which bathes the world, there is a certain harmony,—though there be invariability in the one, and constant variation in the

other. The temperature of the human body, for example, is constant, maintaining its standard heat of 98° , amid all external variations. The maintenance of this equilibrium, is preserved by those compensative heat-producing and heat-diminishing powers common to all Mammalia. Taking thus a given temperature of the surrounding atmosphere, as the normal temperature of adaptation to the human body, every variation from that temperature, either from climactic differences or from changing seasons, is reduced to equilibrium within the human frame by the compensating powers therein residing. Thus man can be the denizen of any climate, each climate inducing variations in the physiological functions referred to.

In a similar manner, in temperate climates like our own, the human body has its seasonal transitions or variations, according with the alterations of external conditions. But the states of the atmosphere often outrun by their extremes, the progress of adaptation within the body. And it is under these circumstances that the effects of altered temperature become manifested. As the genial spring approaches, man quits his winter fire for the milder rays of the sun, and beneath their beneficence the morbid affections of the winter disappear; a magic energy steals over his frame with the increasing circulation; and the sensations

which have had their night of rest during the winter's cold, resume with keener force their work of day. As the sun, mounted up to Cancer, pours upon the earth more heat than the shades of night have time to balance, the heart and blood-vessels increase their motion;—pulses are strong, frequent, full, rather soft than hard; and affections of a stimulant character annoy man. At length the winter's reverse comes, the play of the circulation abates, the pulse is less frequent—and in northern climes is infrequent and slow—reduced among Greenlanders, says Blumenbach, to thirty or forty beats per minute. At this season depressing affections insinuate themselves around our very hearth. The cold contracted surface shuts in the life, driving it back into interior regions, where its over-accumulated force begins a work of disorganization, decay, and death, taking away an average of 1000 additional lives in the great metropolis alone, whenever the mean temperature of the twenty-four hours remains a degree or two below the freezing point. And how many an infant being, born amid winter's snow, lingers upon its earth but a transient day, then quits its inhospitable clime for a genial spirit-home in yonder skies. It is thus that winter comes to us as the veritable symbol of death; and if its cold do not petrify human flesh like the fabled Chilian winds, none

the less surely, by continuance and time, does it fix the mortal stamp upon our being.

The direct action of cold upon the *surface* of the human body is well known in the phenomena of bathing in water at a temperature of 54° . A healthy man exposed naked to the air, with the thermometer standing at 32° , would present similar symptoms. A general horripilation seizes him, the skin contracts, forming the *cutis anserina*, or goose-skin, from the hairs erecting themselves in their bulbs ; the capillary circulation is retarded ; the surface grows pale ; superficial veins disappear ; coldness and insensibility increase, with some disturbance of the general functions. Withdrawn from the cold, re-action declares itself in redness of the skin, with renewed and increased energy of the organic functions. If not withdrawn, the cold reigns paramount over the vital powers, and those more serious symptoms supervene, which so often result from exposure to the intenser cold of northern climes. As it has been expressed by one whose eyes have seen thousands sink beneath icy blasts,—“ shiverings, puckerings, coldness of the skin, livid spots, muscular flutterings, are symptoms of the shocks given to the vital forces. The person feels syncope approaching ; his stiff muscles contract irregularly ; his body bends and shrinks ; sometimes lassitude and languor invite him to repose ;

sometimes a feeling of weight and general numbness retards his steps ; his knees bend, he squats down and falls ; he then feels an invincible propensity to sleep ; everything grows strange to him ; his senses are confused ; a thick veil darkens his view ; his mind grows dull ; his ideas become incoherent ; he stammers and raves ;—if he be free from suffering, he is often not so from agitation. Should you try to prevent him from stopping and sleeping—should you strongly represent to him the danger he exposes himself to, he looks at you coldly and stupidly ; if he has not lost all consciousness, he pronounces with difficulty a few words, entreating to be allowed to go to sleep ; his relations with all surrounding objects quickly cease ; he slumbers ; parts of the body distant from the centre of circulation become cooled ; respiration, at first interrupted, becomes slow ; the contractions of the heart become feeble, quick, hard, irregular, sometimes painful ; the pulse becomes smaller progressively ; the central heat is extinguished ; the brain is stupefied ; the pupil dilated ; and finally, a deep and mortal coma ushers in the almost inevitable death.”

Extreme cold continuously applied, is thus a *powerful sedative*. It depresses and paralyzes all the bodily powers, and even overcomes the power of *generating heat*, assuming to itself undivided

sway. Sir Astley Cooper, we are told, upon plunging kittens into ice-cold water, observed that the change which ordinarily takes place in the blood, when animal heat is present, did not supervene,—“the arterial blood did not become venous in the veins.” Chossat also “found in animals killed by cold, arterial blood in the left cavities of the heart.” To this arrest of the heat-producing power by cold, must be attributed the failure of the human body to resist cold, though every usual condition for generating that heat be complied with, as recorded in various instances, and particularly the memorable case related in Dr. Hawksworth’s edition of Captain Cook’s Voyages.* How many a frozen

* “At the time when Captain Cook lay off Terra del Fuego,” writes Dr. Hawksworth, “Mr. Banks and Dr. Solander, with other ten men, went on shore with a view to penetrate as far as they could into the country, and to return that evening. After various hardships, and after having travelled through swamps for a considerable way, the weather, which had been very fine, became gloomy and cold, with sudden blasts of a piercing wind, accompanied by snow, [always the most perilous times to mountaineers and Arctic voyagers.] Before they had accomplished their object, the day was so far spent, that it was found impossible to get back to the ship before next morning. This being their situation, it was proposed to push through a swamp that lay in their way into the shelter of a wood, and there to build their wigwams and kindle their fire. It was now eight o’clock in the evening, and Mr. Banks undertook to bring up the rear. Dr. Solander, who had more than once crossed the mountains which divide Norway and Sweden,

mountain traveller, overtaken by the ruthless storm, has sunk to rest in snowy graves on the lofty Alps ! What mean those old crosses planted in the moun-

and who well knew that extreme cold, especially when joined with fatigue, produces a torpor and sleepiness that are almost irresistible, conjured the company to keep moving, whatever pain it might cost them, and whatever relief they might be promised by an inclination to rest. ‘ *Whoever sits down,*’ said he, ‘ *will sleep, and whoever sleeps will wake no more.*’ Thus admonished and alarmed, they set forwards ; but they had not gone far before the cold became suddenly so intense as to produce the effects that had been most dreaded. Dr. Solander was the first who found the inclination against which he had warned others, irresistible, and insisted upon being suffered to lie down. Mr. Banks entreated and remonstrated with him in vain ; down he lay upon the ground, though it was covered with snow, and it was with much difficulty that his friend kept him from sleeping. One of the black servants began to linger in the same manner. After much persuasion and entreaty they were dragged on a little way ; but they again both declared that they would go on no farther. The black servant was then told, that if he did not go on he must be frozen to death ; but to this his answer was, that he desired nothing but to lie down and die. The Doctor said he was willing to go on, but that he must first take some sleep, though he had but a short time before told the company, that to sleep was to perish. They were both suffered to sit down, and in a few minutes they were in a profound slumber. After Dr. Solander had slept about five minutes, Mr. Banks endeavoured to awake him, and happily succeeded ; but it being impossible to make the servant stir, two people were left along with him to bring him forward as soon as he could be roused. Of the three thus left in this situation, only one survived, and that one only by speedily leaving his charge and joining the company.”

tain solitude, but that there, above the hum of human strife, and beyond the reach of human succour, the adventurous traveller, sheltering himself in icy crevices from the wilder elements, has sought a fatal repose, and found a mountain grave. By the side of those crosses, Christian charity has now raised the welcome *hospice*; and in the sound of its tinkling bell, as it calls to matins or to vespers, the weak and weary hear the voice of succour.

The depressing effects of cold are, however, more perceptibly manifest when the tone of the general system is altered, either by over-stimulus, or over-fatigue with deficient food. The abuse of alcoholic stimulants under severe cold is often fatal. In the retreat of the French army from Moscow, those who indulged most in stimulants were the first to sleep and die. We are told, that at a fête given once at St. Petersburg by a farmer-general of distilled spirits, fifteen hundred persons "who committed excess in spirituous drink, perished miserably from cold in the squares and streets of that capital."

The combined influence of extreme cold, and deficient food, with fatigue, has been lamentably exemplified in the histories of many military campaigns. When Alexander carried his army across the Caucasus to subdue the Scythians, his troops were sadly decimated by hunger, fatigue, and cold.

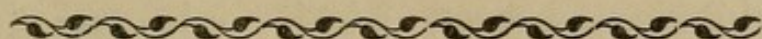
Menschikoff's "best generals, Janvier *et* Fevrier," so impotent against the mighty alliance of the West, did once nearly humiliate the ambitious conqueror of the world. In 1719, seven thousand Swedes perished in the snows of the Dovrefield on their way to besiege Drontheim. In the retreat of Prague, four thousand of the French army died from cold beneath the open sky of Bohemia. The sufferings entailed by Napoleon's Alpine bivouac in 1793 are well known. And who can forget the famous retreat from Moscow, unparalleled in history. Four hundred thousand strong, that devoted army rushed like a torrent into the heart of Russia. Buoyant with hope they approached the walls of Moscow—but only to gaze on devastating fire before and death-like snows behind them. No winter was ever so rigorous as that of 1812. It threw its white mantle thick upon the earth, and became a greater enemy than Russian gun or bayonet. Toiling and struggling amidst snow and death, that once impetuous band, with the muffled footfall of despair, recrossed the Niemen only thirty thousand strong. The frozen ashes of the rest lay strewn along the ravines, or sunk beneath the Russian soil.*

* An eye witness of this suffering army writes :—"The cold came on with exteme severity, the north wind blew impetuously in our faces, incommoding many, who saw no more:—

In all these cases where cold has been applied to the general surface, the fatal effects have been produced by an intropulsion of the blood upon the vital organs. Congestion has been set up—the power of the nervous system diminished, and the heart stopped. Cold may, however, be applied to the human body without any of these effects being

they strayed, fell in the snow, and miserably perished. In three days the army was dissolved, and those not destroyed travelled on day and night. Ultimately they were obliged to stop, and complaining, shivering, to lie down in woods, on roads, in ditches at the bottom of ravines, often without fire, and if with one they slept without delay. The first hours of sleep offered, then, alas! but deceptive delight, precursor of the grave that yawned for them. The fire was at length extinct. And far from finding safety in the sweets of sleep, they were seized and benumbed by cold, and never saw daylight more. Some persons came to the burning houses to warm themselves. I have seen them sad, pale, despairing, without arms or caps, staggering, scarce able to sustain themselves, their heads hanging to the right or left, their extremities contracted, setting their feet on the coals, lying down on hot cinders, or falling into the fire, which they sought mechanically, or as if by instinct. Others apparently less feeble, and resolved not to suffer themselves to be depressed by misfortune, rallied their powers to avoid sinking; but often they quitted one place only to perish in another. Along the road, in the neighbouring ditches and fields, were perceived human carcasses heaped up and lying at random in fives, tens, fifteens, and twenties, of such as had perished during the night, which was always more murderous than the day. Such a sight, renewed at every step, was well fitted to freeze with terror, and excite serious reflections. It destroys the whole éclat of a campaign that had seduced the imagination rather than the heart.”—*Beauprè*.

produced, as in cases of its *local* application, the phenomena of which more especially belong to our subject.



V.

PHENOMENA OF COLD LOCALLY APPLIED.

IT is well known that blood-vessels are composed of several layers, or tunics, or walls. In these walls resides a vital power of undergoing contraction, when certain stimuli are applied to them. Cold is one of such stimuli. If, for example, the web of a frog's foot be placed under a microscope, and a drop of cold water be placed upon it, the vessels conveying the blood will be seen to diminish in their calibre. Schwann, the great physiologist, long since observed this contraction very visibly in the mesentery of a frog. And Hunter also noticed, that the exposure of an artery of any warm-blooded animal even to the cold air for some time, would occasion its gradual contraction. When a more intense cold is applied, as I have repeatedly seen in my experiments on frogs, on the wings of bats, and other animals, the vessels contract to obliteration. The circulation in the part to which intense cold is directly applied, is consequently arrested, from its ordinary arterial channels being closed up. Independently of this contraction, cold has the

effect of retarding the blood in the vessels by thickening the motionless layer of serum which lines them ;—thus, vessels usually admitting three blood-globules abreast, admit only one in the centre, and ultimately produce stagnation in the current ; while heat, on the contrary, increases the rapidity of the circulation, by producing a greater freedom of motion among the particles ; so that the property of cohesive attraction is superadded to the other effects I have named. All soft parts participate in this contraction under the stimulus of cold. It is particularly observable in the skin. The peculiar numbness in the fingers and extremities of persons of feeble circulation after bathing, is due to this closing up of the arteries. The skin loses the suppleness and softness imparted to it by its natural heat ; and, under a long continuance of severe cold, the cellular tissue beneath becomes condensed, and the underlying fat quite solid.

The next effect of cold locally applied, is the *arrest of the conducting power of sensation in the nerves*. Physiology has not yet explained, upon what this conducting power of the nervous system depends. But the fact remains, that the nerves, spreading over every inch of the human body, are like so many million electric wires ever at work, either conveying sensational life from the cerebral battery,

or carrying back to it the ever-recurring sensations excited by man's connection with the external world. Doubtless there is a great interdependence between the conducting power and the integrity of the circulation, for, destroy the circulation, and sensation departs. Whenever, from any cause, the circulation through a part supplied with sensory nerves is retarded, sensibility is diminished. If that retardation amounts to stagnation, entire insensibility is an inevitable consequence. When, for example, the main artery of a limb is tied for aneurism, and the blood is consequently arrested in its progress through the wonted channels, the temperature, and correspondingly with it the sensation of the limb, undergoes diminution until the new channels are formed by anastomosis. So also, if the four arteries supplying the brain be closed up, a state of suspended sensation ensues. Deprive the nerves of their accompanying capillary currents by cold, and the same insensibility is produced. Their power of producing an impression either of pain or pleasure is taken away. And, as already hinted, the influence of cold in thus destroying nervous sensibility is the greater, inasmuch as it exerts a depressing influence upon the vital powers of the nerve-vesicles themselves,—it temporarily alters their condition. But this is not the only cause of the arrest of sensation by cold. For

animals can be reduced to a state of somnolency by being kept in the cold, without depriving the surface of the circulation to a sufficient extent to account for it. Cold has an immediate sedative influence upon nervous energy, and when combined with the deprivation of blood, produces an entire loss of sensation. There is in fact an arrest of the vitality of the part :—a death, for the time profound, but limited in space, and brief in duration ; and with it all the painlessness of death, so deep, that the surgeon may use his knife like a sculptor chiselling the Parian marble.

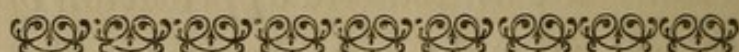
The great facts of diversified temperatures, of the extremes of heat and cold, with their physical and physiological effects, lie abroad upon the face of the earth, as it were, inviting man to use them all in promoting his happiness, or in alleviating his sufferings. But like as the planets moved through our heavens before Galileo came, so the man was wanting, whose deeper insight or far-seeing ken, should point out the nature-imprinted pathway to be followed.

Upon that barren rock in the wide Atlantic, on which was wrecked the ambition of a mighty conqueror, a physician turned his thoughts to the alleviation of human suffering. That man was Dr. Arnott. To him society is indebted for the first practical manifestation of the thought which had long

inspired him—*the anæsthetic application of cold*.^{*} The idea was wrought out—became a fact; and after passing through the usual ordeal of opposition and scorn, with which the infancy of every innovation is attacked, it has taken its place among those sober scientific realities which always outlive contempt. It is but a leaf taken out of Nature's great book, a true interpretation put thereon, and made applicable to human wants.

Many are the minor operations in surgery, which have now been performed as upon lifeless matter, by the benumbing influence of cold. The long wished-for object has been attained,—that a patient in full possession of his intellect, and with eyes undimmed by narcotic influence, may calmly gaze upon the surgeon's knife doing its deadly work upon his own body, without a pang to knit his brow. And thus Congelation has taken its place among the abolishers of human suffering, with this advantage, that, unlike its compeers, it demands not the surrender of conscious life,—a price which so many are still unwilling to pay.

^{*} The great John Hunter, so far back as the last century, did indeed excise portions of rabbits' ears which had been rendered insensible by freezing, without pain. Yet the idea never seems to have occurred to him, that the same agent might be useful in abolishing *human* suffering.



VI.

ANÆSTHETIC EFFECT OF COLD APPLIED TO THE
TEETH.

SIMILAR general phenomena to those I have described as resulting from the local application of cold to any surface of the body, take place in its application to the region of *the teeth*. The only modifications or differences which arise, being from differences in anatomical structure. A brief reference to the special anatomy and relations of the teeth may elucidate the action of this new anæsthetic in dental operations. The lower portion or portions, —fang or fangs,—of a tooth, rests in an enveloping socket fixed in or upon the jaw. Between the tooth and its socket there is a firm connection by vascular membranes. The interior of the tooth itself is composed of a cavity, ordinarily called the pulp-cavity, from its containing a nerve and blood-vessel, which nerve is the dental branch of the fifth pair of nerves lying at the base of the brain, and which blood-vessel is a branch of the internal maxillary.

The tooth is thus every way surrounded with a vital medium. In the interior, its natural heat and vitality are sustained by an ever renewing supply

of blood through the artery entering the apex of its fang ;—and its keen sensibility is maintained by the accompanying nerve, while all around the exterior of the fang numerous blood-vessels ramify so as to bathe the tooth in the ever-warm vital fluid. Externally, around the socket enclosing the tooth, there rests the soft cellular tissue of the gum, with its mucous membrane continuous with that of the rest of the mouth. From this description will be seen the manner in which cold operates to render the parts around the tooth insensitive to the pain of extraction.

First :—By passing a current of cold all around the tooth to be extracted, the tissues of the gum become perfectly congealed. Every particle of blood is driven out from the vessels which contract to obliteration. The soft tissues become hardened. The heat is all abstracted from them, and their natural red colour is changed into a tallowy whiteness. At the same time the power of the minute superficial nerves is arrested. The gum is indeed temporarily dead, and hence wholly *insensitive*. In this state it may be pierced, cut into, or lanced, without producing the slightest sensation. The forceps may be placed upon the tooth, and made to cut their way down to its neck under the gum, without the patient feeling the contact of any instrument, and generally in perfect ignorance of what

is being accomplished. This is the uniform testimony of all who have been operated upon under this process. My own experience endorses the same. When, myself, undergoing the extraction of a molar tooth for experiment under the influence of cold, I was perfectly unconscious from any sensation that the extracting forceps had been applied. A happy ignorance this! For, who does not shudder at the merciless grip of the cold steel, from which there is no escape? The spasmodic clutching of the chair, or of the operator's hand—the features distorted with terror, which ordinarily accompanied this first step in the operation, give place to that composure which can only reign where suffering is unknown.

Secondly :—The same current which congeals the gum, flowing in close contact over the crown of the tooth, abstracts all heat from the tooth itself. The dense substance of the tooth becomes a conductor of the cold—slowly, it is true, but surely. As the influence of the cold passes downwards into the socket, it contracts the minute blood-vessels ramifying upon the periosteal membrane which invests the tooth, driving the vital fluid out of it. The continued action of the cold proceeds to ex-sanguinate the walls of the socket itself, which is greatly assisted by the lateral extension of the cold through the gums. So that not a

particle of blood rolls round the tooth, which before was bathed in its warm and vitalizing ocean. The pabulum of life being thus withdrawn, not only from the outward gum, but from the socket itself, and from the investing membranous attachments of the tooth, a local death reigns paramount all around.

Thirdly :—While this process is continuing on the outer sides of the tooth, the influence of the cold is simultaneously descending into its central portion, where lie enclosed the nutrient blood-vessel and nerve. As the cold approaches this cavity, the artery shrinks, and, in contracting, becomes deprived of its blood. And—

Fourthly :—With this arterial contraction, the conducting power of the nerve is destroyed. This loss of sensation, I have reason to believe, where the cold is efficiently applied, extends down to and beyond the juncture of the dental offshoot with the main nerve, so that in very truth it may be said, that all communication between the tooth and the nervous system or the brain, is thus cut off. I may also add, that the dentinal tubes being emptied of their contained fluid or substance, (which may possibly help to endow the tooth with the sensibility so peculiar to it, of which I have before spoken,) adds still further to the insensitiveness of the tooth under the influence of cold.

Thus, not only all around the tooth is vitality suspended, but also within it. And it is this death-like state, local as regards the body, but universal as regards the individual tooth, which must be brought about to ensure a perfect immunity from pain.

That such are the phenomena attending the use of cold to the teeth, I have had many opportunities of convincing myself, both from experiments on animals, and from casual circumstances arising in the course of practice. Having, for example, frozen down the tooth of a dog, as ordinarily applied to the human subject, and rapidly cutting away the enveloping gum, it has come off bloodless, hard, and crisp. Then, cutting away the outer wall of the socket so as to expose the fang of the tooth, no blood exuded from the torn vessels; and afterwards, upon removing the tooth, a pale and bloodless socket remained, the animal all the time being free from pain. In cases, on the other hand, where the influence of the cold was only allowed to be of very short duration, the vitality was more or less intact, blood flowed freely, and the animal suffered pain.

In the course of practice, I have had occasion to apply congelation to the posterior one of two teeth standing alone in the mouth. The anterior tooth, by mere contact with its neighbour, has

become a conductor of the cold when the following has occurred :—At first, a very delicate white ring encircled the edge of the gum bearing on the tooth. This ring gradually widened, till a large portion of the gum of this anterior tooth was also blanched, though without the direct application to it of the congealing current. This has shewn me, that the mere application of cold to the crown of a tooth will, by conduction, expel all blood and vitality from its investing membranes, and, of course, much more efficiently when the congealed gum itself adds to the power of this depressing agent.

Experience has further shewn, that the happiest and most successful cases are those, in which the sockets are pale and bloodless for a few seconds after the tooth has been removed. The following case is illustrative of this :—A lady from a distant county, whose restoration to health no medicines had the power of accomplishing, was entrusted to me by her physician, with the view of ascertaining if the severe symptoms from which she suffered were in any way connected with a diseased condition of the teeth and jaws. Upon investigation I found considerable disease in the upper jaw, and only two or three sound teeth in her mouth. I had no doubt of the cause of her acute, but patiently borne suffering. There was but one

remedy,—the removal of every diseased portion, which I accordingly advised, and which was at once acceded to. My patient was of strong intellect, but her powers of endurance had been reduced by years of suffering. She was willing in mind; but her every nerve vibrated to the slightest alterations imperceptible in health. The endurance of protracted suffering had weakened the functions of the heart; and though it was of the greatest moment that her nervous system should receive no shock from sudden pain, yet her physical condition contra-indicated the use of chloroform, to which she had an insuperable objection. It was, therefore, with a glad heart she hailed the intelligence that I could remove the pain for her without abolishing her consciousness. Several teeth were removed without the slightest suffering. Upon the removal of two other teeth, some pain was present, though trifling. The secret at once revealed itself. Blood issued forth instantly. From some debilitating effect of the disease in the jaw, the blood-vessels had not contracted as usual under the stimulus of the cold. The sockets were not pale and dry, nor were the fangs free from blood. All the remaining teeth were extracted while the sockets were pale, bloodless, and dry, with perfect immunity from pain. Altogether, fifteen teeth were removed from this lady's mouth, in sets

of two and four at each freezing ; besides the diseased portions of jawbone, which were likewise removed under the influence of the cold. A temporary set of artificial teeth replaced the absentees, and she returned home, bearing glad news to her friends, that the horrors of dental surgery were abolished. When this lady returned to have the temporary set of artificial teeth substituted by a permanent gold set, it was pleasing to witness the marked improvement in her health. To use her own words, she "had been painlessly born into a new life."

When all the phenomena of local congelation occur in due succession, no fear need be entertained of a successful issue. The tooth must come out without pain, as hundreds have already done. And scepticism will be silenced by actual experience. A gentleman from Belgium waited upon me a short time since, candidly professing an utter absence of the slightest faith in the possibility of extracting a tooth without pain, by cold :—an opinion which has been as strongly entertained by some of our best London surgeons. He attempted to argue its impossibility upon anatomical and physiological grounds. Here we joined issue ; and as he had two neighbouring molar teeth, useless to him for mastication, I proposed to decide the dispute by an appeal to the wisest judge,—experience. His scepti-

cism would not allow of a stipulation for more than one of the teeth to be removed. He was quite sure that one extraction would be enough. Undaunted by the fears engendered by scepticism, I took the opportunity of freezing both the teeth at the same time. When the first was extracted without even a passing cloud over his features, I told him that the other was also frozen. He immediately said, "Out with it, if you please, for I have no feeling." He afterwards had a third removed, with equal success; and then agreed with me, that an appeal to experience was the best antidote to scepticism.

A somewhat more humorous gentleman waited upon me not long since,—a true representative of a different class of sceptics from the former, the *reductio ad absurdum* predominating over rational consideration of possible facts. He was a tall, stout, powerfully built, plethoric gentleman. Upon entering my consultation room, he said he had come from Paris to have a tooth taken out, and *put into his waistcoat pocket without knowing it*. Confident how light ridicule would weigh, balanced against experience, I proceeded with the case. Insensibility was secured by the cold; the tooth was extracted; and my sarcastic patient acknowledged the success of the operation in the not unusual words—"Is it really out, sir?" The scornful

sceptic was transformed into a true believer. The *true* thing can withstand all ridicule.

Another class of individuals, with a firm faith in human progress, and taught by the onward march of modern science and art, that old impossibilities vanish away in the light of every new-coming age, subject their ideas, not to the moulding of antiquated pre-conceptions, but to the test of experimental induction. I confess myself a member of this class. Accordingly, in order that I might have personal experience of the virtue of this new agent to abrogate pain, I resolved upon sacrificing a tooth for that knowledge. It was a large upper molar tooth (three-fanged). The operation was unusually long and severe. The operator was compelled to use immense force to detach the tooth, owing to the somewhat rare occurrence of the curving inwards of the extremities of the fangs, firmly locking it in the jaw. A more severe case can scarcely happen in practice. Throughout the whole proceeding, from the moment the cold was applied to the removal of the tooth, *I suffered not the slightest pain*. I was conscious that the tooth was withdrawn. I knew the fangs had left their sockets, for I experienced a sensation as of tearing paper, which I believe was caused by *hearing* the tooth give way. But there was no pain. Professional gentlemen were present, who closely watched

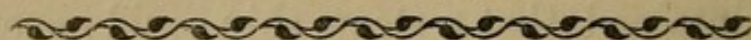
my countenance ; they avow that not a feature changed. And though it was almost past belief, that such an operation could be performed without considerable suffering, yet they acknowledged that, however great man's power of endurance, such composure of every lineament of the face, could not have been sustained under the crushing wrench of such an operation, except in total freedom from pain. I am by no means insensible to pain. From that moment the theory became to me an irrefutable fact.

I could adduce numerous instances as convincing as the above. But truth wants no credentials. It will ever outlive mere theory. It will eventually silence every form of scepticism. The man who objects upon misconceived principles, or incorrect information, will come at last to do homage to it,—as in the first case I have named. The man who thinks all novelty ridiculous, will come to have his laughter sobered down, by truth's stern realities,—as in the second case referred to. And the man who waits with patience for truth's own witnesses, will have the rich reward, which truth alone can give, as in the third case related. Truth always meets with the same reception. The phases of scepticism, like lunar changes, must prepare for the coming fullness. Science has had its martyrs, and Art too. A well known philosopher, not many years

ago maintained, that a steam ship could never cross the mighty Atlantic. He lived to be borne in one to the American shores. And now, how many a proud vessel steams away over the Atlantic's crested waves. Shall we place limits around the possibilities of human intellect?

To attain the anæsthetic effects of cold in dentistry, science and art, have been brought to the aid of natural phenomena. Chemistry gives us its various freezing mixtures of every degree of intensity. Natural philosophy gives the laws of action of fluids. And Mechanics give the special principles of the apparatus adapted for the purpose in view. It is unnecessary to enter into detail on this point. It may however be remarked, that certain failure must attend attempts to apply cold to the teeth, without an apparatus specially adapted to the exigencies of the case.

A new era in dentistry may now be said to be in progress. Pain—that enemy to human peace, defiant of our best resolves; the merciless jailer of manly courage,—has itself come under the control of the human will. Its reign of tyranny may now be ended;—the spell of its oppressive power be broken; and those devastations it has made among the fairest of creation's works, be arrested.



VII.

PAINLESS METHOD OF APPLYING COLD.

AN important question here arises:—*Is not the application of intense cold attended with excruciating pain?* In a previous page, I have referred to that peculiar endowment of the teeth, which gives them a keen susceptibility of any changes to which they may be subjected. That same power which enables them to distinguish a rose-leaf from a piece of paper, makes them keenly sensible of thermometric variations;—and in some persons this power is so exalted, even in the absence of any perceptible disease, that they may be said to carry about with them so many thermometers in the mouth. The intensity of any of our sensations is closely related to the degree of change produced on the nervous system; and any very sudden change from the unexpected or violent excitement of any sensation is generally ungrateful, if not positively injurious. The sudden transition from total darkness into even moderate light, as in emerging from a railway tunnel, or out of a dark room, makes a disagreeable and painful impression upon the sensorium. The injurious, and sometimes fatal, effects of a sudden fright, or of the reception of bad news, are similiar illustrations of the

repugnance of the nervous system to rapidly-induced changes; though it will allow the same changes to transpire gradually, or by habit, with perfect impunity, as when persons becoming accustomed to the roar of a waterfall, can sleep not unless the roaring continue. It was the sudden plunge into the Cydnus, that nearly arrested Alexander the Great, in the midst of his ambitious conquests.

In like manner, the change wrought upon the cerebrum by the sudden abstraction of the natural heat from the region of the teeth, would be attended with unendurable agony, as I well know from various experiments I have instituted on my own mouth, proving the aphorism of Hippocrates,—*"Frigus nervis inimicum."* This pain, no doubt, is the result of shock to the nerves, by some alteration in their conducting power, which becomes arrested by cold. The ever effluent life, of which they are the channels, seems to roll backwards, concentrating itself in parts already abundantly supplied. The rapid contraction of the blood-vessels, as I have already explained, under the stimulus of cold, doubtless contributes to produce these effects. But however the phenomena may be explained, we seize upon the fact, supported by the analogies of other sensations, that it is the *suddenness* of the application which has to be avoided.

The obvious indication presented to us in these

phenomena is, to *graduate* the application of the cold. The means of accomplishing this are very various, and in practice must necessarily accord with the method of congelation adopted. If, for example, the process resorted to, be a current from a freezing mixture, nature again, in her ever patent lesson-book, teaches us the true principles to act upon. It is well known that as the temperature of water decreases, its density increases, that is, down to $38^{\circ}. 8'$, at which the maximum density of water is attained. To the operation of this law, are owing some of those grand oceanic phenomena, which sustain the equilibrium of the economy of nature. Now, if a large collection of water, such as any of our oceans, seas, or lakes, by constant exposure to cold, have its superficial stratum reduced in temperature, a series of interesting results occur. The superficial stratum being increased in density, volume for volume, by the reduction of its temperature, must necessarily sink down, and displacing the strata of inferior density underlying it, will cause it to ascend. But this is not all. The uprisen warmer strata becoming themselves cooled, and, in consequence, more dense, will in their turn sink, and in this wise, produce a continual succession of downward and upward currents. These will continue until the entire mass becomes uniform in temperature, or

so long as the superficial stratum shall be rendered heavier, volume for volume, by the diminution of its temperature. From this cause those two great currents perpetually wend their way from the two poles to the equator, which so often bring into temperate regions the floating ice of Arctic climes; and with a multitude of other currents, keep the waters of the vast ocean in unceasing activity. It will thus be seen that by the mutual diffusion of diverse temperatures, combined with simultaneous displacement, a current may be obtained, graduated at will, from any degree of intensity. A special apparatus may be used to accomplish this object, with certain modifications for the purpose for which it is intended, but which, in its leading principles, is but a transcript of nature.

By means of such an apparatus, a fluid of about the same temperature as that of the region of the tooth, is, in the commencement, brought in contact with the part to be operated upon. And then, by establishing the reducing currents upon the principles explained, an insensible gradation of the temperature ensues, down to any degree of cold which the nature of the case may require. But why is it an *insensible* gradation? Simply because, in the first place, the implicated nerves become, as it were, habituated to the presence of a cooling application, and their conducting power imper-

ceptibly yielding, accommodates itself to the increasing force, until completely overcome. And in the second place, because it promotes at first, only a gentle contraction in the walls of the blood-vessels, and a correspondingly gradual diminution in the quantity of blood flowing through them. This primary gentle contraction is succeeded by more active contractions, duly proportioned to the stimulus received from the increasing cold. Till at last, the calibre of the blood-vessels is diminished, and to all appearance they are obliterated. If such a graduated current be applied to the web of a frog's foot, these phenomena may all be beautifully seen through a microscope, as I have repeatedly demonstrated. There is no rude intrusion of an unwelcome stimulus. No violence is done to the laws of nervous action ;—and hence, no pain.

Such a graduation is of the highest importance wherever it is requisite to resort to the anæsthetic effects of cold in a part which, like the mouth, sustains the normal temperature of the body. For, the higher the temperature to which congealing cold is suddenly applied, the greater is the corresponding shock ; our sensations being governed by the previous condition of the parts. This has been amply shewn by experiments on warm and cold-blooded animals. Chossat, for example, found “ that the temperature to which the bodies

of animals killed by cold had been reduced before they died, was considerably various, and always higher as the reduction of temperature had been more rapid, and therefore more injurious." And it may be further illustrated by the common experiment, of holding one hand in hot water and the other in cold, and then transferring them both into tepid water,—which will feel cool to the one hand and warm to the other. The natural temperature of the human mouth is about 98°. The *sudden* application of a temperature from 90° to 100° lower than such standard, would inevitably cause a revulsion by no means accordant with the normal action of its tissues. While, the same reduction of temperature, and even to a considerably lower degree, may be effected gradually without interfering with their integrity.

It will now be understood, how the application of such a degree of cold as is necessary to produce an anæsthetic effect, may be accomplished without pain, shock, or injury. I do not profess that a *sensation* of cold is not experienced for a short time,—for it is impossible to avert that until abolished by the cold inducing the anæsthetic condition of the part. But it never exceeds a mere sensation; makes no approach to pain; and is never complained of.

Considerable experience in the application of

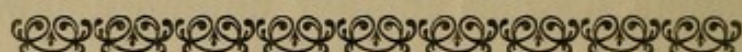
cold in dental operations has convinced me, as it has those who have been the subjects of them, that this fact is one of the most interesting features of the method. Few submit to it at first without a lurking scepticism, that the "remedy is as bad as the disease,"—or that one pain is only to be abolished by the substitution of another, and, perhaps, greater. But they almost invariably become true believers in the fact. I say *almost* invariably. Are there any exceptions? Is not the application uniformly painless? Out of a large number of patients, I have only met with three or four exceptional cases. In these, it was as difficult to account for the exceptional action, as it was for the astronomer to account for the reverse revolutions of the satellites of Uranus, before Leverrier and Adams, by the sole light of mathematical calculation, announced that an outer planet was the disturber,—and which planet came to us in the light of Neptune. So far as I have been able to ascertain, these anomalous instances seem due to a general hyperæsthesia of the nervous system, or to some peculiar influence of certain very rare diseases of the dental regions. Occasionally, a patient has complained of a slight but transient increase of the toothache, from the contact of the cold. And very rarely a pain is produced, which, however, no sooner is, than it is gone again. These idiosyncratic excep-

tions, are very considerably fewer than those idiosyncracies to the action of certain medicines, with which the physician meets in his daily practice. We are not, however, to be guided by, or to reason upon, exceptions. Between Mars and Jupiter, a space intervenes at variance with the laws of planetary distances, as expounded by Bode. Within that space, some forty fragment-like worlds revolve in orbits of complex eccentricity, at varying distances. But the law is none the less true for the other planets, because another unknown law is in operation within those ethereal spaces.*

No domain of art, science, or nature, is free from what appears to us exceptional modes of action. The rays of yonder solar orb, under ordinary circumstances, radiate warmth proportional to their illuminating intensity;—but let those same rays be transmitted through a certain green glass, and their heat, it is said, departs, while their brightness continues. The analogy holds in the case before

* A popular explanation of these phenomena has been found in the supposition, that the Asteroids are only the fragments of an *exploded world*, which once revolved there in common with the primary planets of our system. At best, this can only be termed a fanciful hypothesis, without the shadow of an analogy to substantiate it. The phenomena will doubtless one day be explained by the discovery of a now unknown law, which will restore our conceptions of planetary order, as the great law of Newton has done long before, for the wider universe.

us. Cold, gradually applied, will, under ordinary conditions, deprive the human tissues of sensibility, without precedent pain ; but a state of super-sensation is possible to exist, wherein the normal action is superseded. It is fortunate that such exceptions are rare—very rare ;—leaving to the great mass of the community a means of escaping, without dread of concomitant suffering, from those painful processes which the finger of disease and the touch of decay entail upon humanity.



VIII.

POPULAR FALLACIES RESPECTING CONGELATION : SUPPOSED INJURIOUS RESULTS.

ANOTHER apparently formidable, and somewhat popular objection to the use of congelation for anæsthetic purposes, is urged from the supposed *unfavourable or injurious results* likely to ensue. It can be no matter of surprise that such an opinion should be generally entertained, having been given birth to by those few facts recorded in popular works and sayings, or by some of the winter phenomena of temperate climes, to which alone the great majority have access. The occurrence of *frost-bite* and its consequences, extending from a slight inflammation to mortification and gangrene, are patent

facts to cavil upon. But, as we shall presently see, such occurrences are in no way necessarily connected with the application of intense cold. All the benefits of cold as a sedative or anæsthetic may be derived without the supervention of any such consequences. It may be well to remove these misconceptions ; to which end, a review of the recorded phenomena presented to us in the endurance of severe cold by the various kingdoms of animated nature may contribute.

And First,—*as to the alleged injurious consequences of intense cold.* I need not re-numerate the phenomena presented by organized tissues, under the influence of congelation. In a previous page, I have referred to the depressing influence exerted by extreme cold on vital activity ; but a wide distinction exists between the depression which amounts only to a *suspension* of vital power, and its total destruction. Cold, *per se*, however intense, applied to the human body, is not *necessarily* destructive. Repressive it may be, but it must be remembered that, under the degree of cold employed for the purpose of tooth-extraction, vitality is not destroyed, but *suspended*. Many instances abound to prove, “that a complete cessation of vital activity is quite compatible with the preservation of organized structure in a condition perfectly unchanged, and in consequence, with

the continuance of its peculiar properties ; so that these properties may be again called into operation when the temperature shall have risen." Even in the vegetable kingdom instances are not wanting of the presence of vitality, under severe cold, though dormant. The leaf-bud which the falling leaf of autumn leaves at its axillary juncture with the branch, does but fold its involucred cloak around it, and sleep, till the more genial morning of spring shall bid it greet the re-creating sun. That minute fungus, *Torula Cerevisiæ*, so delicate in form, so mysterious in its germination, so rapid in its growth, and so wondrous in its chemical powers as a constituent of yeast, holds on its existence in a temperature of 76° below zero. Cryptogamic plants, as I have shewn, do not bow their heads even beneath the Boreal blasts of the poles. And there is every ground for concluding, that those larger plants, the life of which succumbs to the power of cold, are destroyed, not so much by any direct effect on their more solid tissues, as by the congelation of their fluids ; the accompanying expansion distends, lacerates, and even bursts their delicate cell walls, wherein lie their functional powers, like as, during the severe winters of Scandinavia, large trees burst asunder with a loud explosion.

In the *Animal Kingdom*, still more striking

examples are afforded of retained vitality without injury, under severe cold. The phenomena of *hybernating* animals are too well known to need any comment. Near the Cape de Verd Isles in the broad Atlantic, showers as of yellow sand-dust occasionally pour down like rain. That revealer of invisible things—the microscope—has shewn these minute particles to consist of *siliceous-shelled animals*, which, tossed about, it may be for years, in the higher strata of the atmosphere in a state of suspended animation from the cold, become revived in their descent into the lower strata towards the surface of the earth. *Siliceous-shelled Polygastrica*, and even *Coscinodiscæ*, have been found alive enveloped in masses of ice, only 12° from the pole. And the small black *Glacier Flea*, (*Desoria Glacialis*,) and *Podurellæ*, inhabit the narrow tubular holes examined by Agassiz, in the Swiss glaciers. “In one of Captain Ross’s Arctic voyages,” says Dr. Carpenter, “several caterpillars of the *Laria Rossii* having been exposed to a temperature of 40° below zero, froze so completely, that, when thrown into a tumbler, they chinked like lumps of ice. When thawed, they resumed their movements, took food, and underwent their transformation into the chrysalis state. One of them, which had been frozen and thawed four times, *subsequently became a moth*. The

eggs of a slug have been exposed to a similar degree of cold, without the loss of their fertility. It is not uncommon to meet, in the ice of rivers, lakes, and seas, with fishes which have been completely frozen, so as to become quite brittle ; and which yet revive when thawed. The same thing has been observed in regard to frogs, newts, &c. ; and the experiments of freezing and subsequently thawing them, has been frequently put in practice. Spallanzani, kept frogs and snakes in the ice-house for three years ; at the end of which they revived on being subjected to warmth." At the foot of Kiringa in Siberia, where, in the month of December, the thermometer has been observed to sink so low as 123° *below zero*, the sparrows and magpies fall apparently lifeless to the ground, but their dormant vitality can be restored by the genial influence of gradual warmth ; and their voices are often thus made to gladden the heart of man in those inhospitable climes, where the snow-white pall of death is spread on all around. Bernard Valentine relates having seen a cat frozen with cold, so apparently lifeless, that it was trodden under foot as dead, and committed to a dunghill ; but that two days afterwards, it re-appeared in full possession of one of those nine lives, proverbially allotted to that animal. M. Prunelle sent frozen animals from

Savoy to Paris, packed up like minerals, which on their destination, were revived by stimuli. In Russia, it is not unusual for fish, rendered "stiff as sticks by cold," to be transported to great distances, and then restored to life. Eels, we are told, motionless and frozen, but not lifeless, are even in that state brought into the market. And M. Gaimard found, that toads could be frozen so completely, as that every trace of life disappeared, and yet they could be revived by a gradual renewal of the temperature. It is not therefore in the lowest members alone of the animal kingdom, that these curious phenomena are met with, but also among the higher—fish, reptile, bird, and even, though rarely, mammal. And I have already alluded to the renewal of life at the Poles, on the re-appearance of their long day, where, no sooner does the sun peep above the horizon it has so long left, than over fields of breaking ice, the insect's hum is heard.

Owing to the peculiar provision for the constant supply of heat in the human subject, the cases are rare in which similar phenomena have occurred to to an equal extent with the above. Cases, however, have been recorded in which, under the influence of cold, the human frame has presented a perfect image of death for several days, and afterwards risen again to mortal life. Dr. Kellie relates the case of a lad

of sixteen years of age, who was found lying in the stern of a boat in Leith harbour, cold and insensible, from exposure to the chilling air without food. "The powers of sensation and muscular action were," he says, "completely suspended, the respiration obscure and insensible. After some hours of unremitting labour to restore him, he awoke as from a most natural sleep, spoke to his father, complained only of thirst, drank a basin of tea, and again slept for a few hours." Dr. Reeves (if I remember rightly) mentions the case of a woman, who was lost in a storm of snow, which drifted over her about six feet deep, under which she lay buried for eight days without food, and with a prostration of all her vital powers; yet, when dug out of this her wintry grave, it was to her a resurrection morn to a long temporal life. In the "*Journal de Medicine*" an account is given of a man, who in crossing the Pyrenees, was overtaken by a mountain-storm and buried beneath the snow. He became benumbed;—fell into a profound sleep. For four days he lay lifeless. On the morning of the fifth, a burning thirst re-awoke his consciousness. Gazing around and above, he found himself entombed in a snowy vault, alone on that mountain top. The sunlight, sobered by its reflection through the layers of snow, lit up that solitary chamber, which looked as pure as the purest marble. Help came. A

human form stood beside that grave, and rolled away its covering. It was like an angel coming to convey away the tenant of a tomb to the better life. But life had not quitted the temple, though its outer doors were closed against all sense and feeling. When the ministering hand was placed upon his body, he felt it not. When raised from his icy seat, and taken to a more genial home, it seemed as though some unknown power, defiant of the law of gravitation, were transporting him from place to place. Sensation had so completely departed, that he could not feel the human hands and arms which carried him. Yet, he was restored. Sensation returned, and he lived to tell this tale of his mountain cenotaph. In Russia, and other northern countries, we are told, on credible authority, that many instances have transpired of persons, either buried beneath the snow, or overcome by cold, having remained many days apparently dead, and afterwards restored to life. The vital principle, slow to depart under such circumstances, concentrates itself within, and as it were, becomes a nucleus, from which new life may emanate to revivify the body, when, under the excitement of stimulus, its temporary torpor is chased away.

The somewhat analogous manifestations of the Indian Fakeer, afford additional illustrations, if they are to be relied upon as veritable occurrences,

that vitality may be suspended for a considerable period in the human subject, without the actual separation of the living principle from its corporeal tenement.*

The *sudden application* of intense cold simultaneously to the entire naked body, has been known to prove fatal by the *severity of the shock to the general system*. One of the most revolting cases of this kind, which would make one ashamed of human nature, were it any part of humanity, is recorded

* The power possessed by the Dervish or Fakeer, of suspended vitality, was put to the proof by some European officers and residents. After voluntarily casting himself into a state of insensibility, he was placed, we are told, in a linen bag which was sealed with Runjeet Sing's own seal. Thus wrapped up, he was placed in a deal box, which was locked and sealed. The box containing him, was then buried in a vault, over which earth was thrown and trodden down, and a crop of barley sown on the spot. Sentries were stationed to watch the place day and night. Thus buried by General Ventura in presence of Maharajah and his principal Sirders, he remained in the vault ten months, when he was disinterred by Captain Wade. No pulse was perceptible, and his eyes were glazed like those of a corpse. By means of various appliances to his body, he returns, as he says, unwillingly to life. Every precaution was taken against imposture, which has never yet been detected. This curious instance of the Fakeer, reminds me of the tale related by Pliny, of Hermotinus, who is said "to have wandered in spirit over the world, whilst his body lay apparently dead. At length, his wife taking advantage of this absence of his soul, burnt his body, and thus intercepted its return."

as having happened at Lyons. "A man and his wife were tried for the murder of their daughter, a girl aged eleven, under the following circumstances. On the 28th of December, at a time when there was a severe degree of cold, the female prisoner compelled the deceased to get out of her bed, and place herself in a vessel of ice-cold water. The child cried, and endeavoured to escape from the bath ; but she was compelled by violence to remain in the water. The deceased complained of exhaustion, and dimness of sight ; the prisoner then threw a pail of iced-water upon her head, soon after which the child expired." * In such cases, not the external functions of the body alone, but the very centre of vitality is attacked.

If, however, the recorded instances of a general cessation of vitality, not resulting in organic disintegration in the human subject, are few, they are fully compensated for by the numerous cases of *partial* loss, or suspension of vitality, by local congelations. These have now become familiar to all, by the interesting details of the different Arctic voyages. Parry relates an incident of the kind, which occurred, among many others, during his second voyage. An excursion party had left the ships to explore the neighbouring land.

* Ann. D'Hygiene, 1831.

After being compelled to spend a night in a cavern, which they dug for themselves out of the snow, the morning found them overtaken by a heavy gale and drift, in the midst of which they lost their bearings. With only a few pounds of bread, a little rum, and a spade, this suffering little band set out upon their pathless wanderings among icy hummocks. Cold, fatigue, and anxiety, every hour increased their bewilderment. The charmer—sleep, was there, wooing them to lie down to that Arctic rest which knows no rising. They struggled with its charms, and reeled like drunken men. Their faces and toes became frost-bitten, and their benumbed hands would obey the mandate of the will no longer. Sergeant Speckman in particular, was repeatedly warned by his comrades that his nose was frozen, but, owing to the stupefaction which had come over him, he heeded it not. "The frost bite," the narrative adds, "now extended over one side of his face, which was frozen as hard as a mask; the eye-lids were stiff; and one corner of the upper lip so drawn up as to expose the teeth and gums." Yet from this deplorable condition he recovered, without injury to the vitality of the parts.

A somewhat similar, but more ludicrous incident, occurred to a friend of mine while travelling in the north of Norway. He received

an invitation to an evening party at the house of a friend. The toilet finished, he started forth in a sledge across a few miles of intervening country on the destined visit. It was one of the bitterest nights of the last winter. Anxious to interfere as little as possible with the arrangements of his dress, he somewhat disregarded those precautions as to clothing, which such a northern climate requires. The house reached, he was quickly announced in the drawing-room. But his entrance gave rise to an indescribable expression on the countenances of all assembled,—a suppressed laugh, with a tinge of contempt. His host received him coolly, with an air of offended dignity. He was a shunned man. After a few moments of such mystery, a friend drew him aside and suggested the impropriety of his appearance. He protested innocence; but, on catching an image of himself in a mirror, he beheld a nose of tallowy paleness, a narrow white band stretching across his forehead, and two circular white patches on the centre of his cheeks, surrounded by a florid hue,—the *tout ensemble* being that of a clown rather than of a gentleman. He placed his fingers on the spots, but no sensation remained; and with an exclamation that he was *frost-bitten*, he rushed from the house amidst the merriment of the company, and remained in the open air rubbing

the parts with snow, until the circulation was restored, and he was able to rejoin the company. No bad results ensued ; though, had he remained long in the heated room in the state he entered it, the results would ultimately have been anything but satisfactory to his personal appearance.

The great anatomist, John Hunter, instituted a series of experiments on local congelation on the bodies of rabbits, frogs, coxcombs, &c. In one of these, he kept a rabbit's ears in a freezing mixture of ice and salt for the period of one hour. They became hard and stiff. When cut into, he says, "they did not bleed, and a part of one being cut off by a pair of scissors, flew from between the blades like a hard chip,"—the animal, meanwhile, being unconscious of the loss it was sustaining for the advance of science. Yet, no devitalization of the tissues ensued. I have myself made, and am still pursuing, many similar experiments to elucidate the phenomena of cold, which will be published hereafter. It may further be remarked, that local congelation has been extensively employed as an anæsthetic in surgical operations, and without any injury to the tissues.

Now, it will be clearly seen from all these cases, that though through mere intensity of cold, the vital *functions* may be caused to cease, or to be suspended, either entirely or in part, yet the destruc-

tion of the *vitality itself* is by no means a necessary consequence. A tissue congealed is not killed. And there is abundant analogy to show, that a local suspension of the vital functions, may be continued for a very considerable period, without the deprivation of the vital power itself.* The organs of life are not destroyed. The tissues are still there with their normal cells for its development. And the capillary channels are there, too, to reconvey the living tide. It is then but a fair inference, that the application of cold to so limited a portion of the body, as is necessary for dental operations, cannot be attended with any serious injury, especially when it is considered that the degree of cold ordinarily required, is considerably less than that endured in the above instances; that it is applied *secundam artem*; and that its influence is exerted only for a few brief minutes.

The power of the human body, indeed, to endure,

* The period, for example, during which the vitality of some seeds has remained dormant, is very striking. Professor Lindley has raised raspberry plants from seeds taken from the stomach of a man buried in an ancient barrow, in the reign of the Emperor Hadrian, sixteen or seventeen hundred years ago. Wheat has been raised from seeds found wrapped up with Egyptian mummies, fully three thousand years old. And even seeds, belonging to the ancient sea-shores of geological periods anterior to the human epoch, have produced their fruit, after whole cycles of ages have passed away.

with impunity, extremes of temperature, either of cold or heat, is very remarkable. Our dauntless Arctic expeditionists, again, furnish us with illustrations. Thus, in Sir John Franklin's first land expedition, we are told, that on opening the rum casks, to distribute the New-Year's-Day portion to the men, "the spirits, which were proof, were frozen ; but, after standing at the fire for some time, they flowed out, of the consistence of honey. The temperature of the liquid, even in this state, was so low as instantly to convert into ice, the moisture which condensed on the surface of the dram-glass. The fingers also adhered to the glass, and would doubtless have been speedily frozen had they been kept in contact with it ; yet each of the voyagers swallowed his dram without experiencing the slightest inconvenience, or complaining of toothache." In Franklin's second expedition, the thermometer stood at 58° below zero ;—"A bulk of lamp-oil stood like a yellow sandstone roller for a gravel walk." Mr. Back travelled eleven hundred miles on foot amidst the polar snows, with the thermometer often ranging from 40° to 57° below zero. Frequently, he was compelled from want to go without food for several days ; and his only covering during the night, was a blanket and deerskin. In the land journey undertaken by the same gentleman in 1833-5, in search of Ross, we read

that on the 17th of January, the thermometer stood at 70° below zero. "Such, indeed," says Back, "was the abstraction of heat, that with eight large logs of dry wood on the fire, I could not get the thermometer higher than 12° below zero. Ink and paint froze. The sextant cases and boxes of seasoned wood, principally fir, all split. The skin of the hands became dry, cracked, and opened into unsightly and smarting gashes. On one occasion, after washing my face within three feet of the fire, my hair was actually clotted with ice before I had time to dry it." Dr. Kane, in illustration of the intensity of the cold, states in his diary that, "in walking to-day, my beard and moustache became one solid mass of ice. I inadvertently put out my tongue, and it instantly froze fast to my lips. This being *nothing new*, costing only a smart pull and an abrasion afterwards, I put up my mittened hands to 'blow hot,' and thaw the unruly member from its imprisonment. Instead of succeeding, my mitten itself became a mass of ice in a moment; it fastened on the upper side of my tongue, and flattened it out like a batter cake between the two disks of a hot griddle. It required all my care with the bare hands to release it, and that not without laceration."

Man rises above circumstances. He can be cheerful amid surrounding gloom. In those remote and

desolate regions, mantled by the long dark night of an Arctic winter, the sounds of music carry the patient traveller to his far-off home. Surrounded with

“ Winter’s eternal palaces built by Time,”

he raises a *Theatre Royal*, to show, that joy departs not even beneath the sable curtain of nature. Theatrical performances made merry the Arctic Christmas. The coldness of the weather, proved no bar to the performance of Sheridan’s “ Rivals,” and other plays. It was no enviable task for the performers, who were selected from the ships’ companies. During Parry’s second voyage, referring to one of these occasions, Captain Lyon writes :— “ In our green-room, which was as much warmed as any other part of the theatre, the thermometer stood at 16°, (in some cases at 30°,) and on a table which was placed over a stove, about six inches above it, the coffee froze in the cups. For my sins, I was obliged to be dressed in the height of the fashion, as *Dick Dowlas*, in the ‘ Heir-at-Law,’ and went through the last scene of the play, with two of my fingers frost-bitten !” Thus have our adventurous men passed away the time, as they waited and longed for the dawn of another Arctic morning ; and what is so surprising, with so little inroad of disease and death among them, though

an atmosphere of 70° below zero was frequently rushing through the bronchiæ to the lungs ! We cannot indeed read these tales without astonishment, at the power of the human frame to endure intense cold—tales which read more like the fictions of romance than unvarnished realities. We can understand how Charles the XII., absorbed with the siege of Frederickshall, should sleep harmlessly at midnight on a plank, exposed to the assaults of cold. We can understand how that poor female maniac, cruelly driven from the shelter of her parental home, wandered naked like a savage, but more mute and sorrowful, amid the snow-capped rocks and precipices of the Pyrenees ; for, in her madness, external sensibility was abolished. We can understand how the fanatic, to mortify his flesh, should make himself a bed in the snow,—as the Indian Shunyassi, with the same object, roasts himself in a ring of fires. We can understand how the Russian goes reeking from his hot stove bath, and with an excited skin, rolls himself in the snow. We can understand how, by the modifications of cutaneous sensibility, produced by hereditary transmission in northern climes, or among the Swiss mountaineers, tender infants sport about on the snow and ice ; or how, with breast uncovered, the Norwegian goes to his daily toil ; or how the Russian peasant wraps but his

pelisse around him, and sleeps full length upon the snow, though the temperature be 91° below zero. But that men of Temperate climes, should come home unhurt by a long imprisonment in Arctic snows, where other animal life disappears, only proves the impunity with which the power of human endurance may be attacked by severe cold, and the superior right of the human being to call the whole world his home.

En passant, it may be remarked, that man is also able to bear extraordinary degrees of *heat*. Humboldt registered the thermometer at the Orinoco, in South America, at 115° . Sir Joseph Banks, Blagden, Solander, and Dobson, successively remained some time in rooms heated to a degree, that 'eggs on a tin plate were roasted hard in twenty minutes, and beef-steaks cooked in thirteen minutes.' Tillet and Duhamel relate, that a young female servant of a baker at Rochefoucault, went *habitually* into ovens heated to 276° , *i.e.* 64° above the temperature of boiling water, and remained without inconvenience for twelve minutes. And physiological writers further tell us, that man can endure a heat of 500° . This power of enduring high temperatures is due, it is true, to the compensating powers of the skin. But, what peculiarly characterizes the human constitution, is, the quality of compensatory forces;—the one providing for

extreme heat, the other enabling the body to endure refrigeration, long continued and intense, as we have seen, without material injury to its vital forces.

Having thus disposed of the apparent objections to the application of cold grounded on its *intensity*, a few remarks are needed:—

Secondly.—On the power and influence of *reaction*. Though, as we have seen, cold in itself, is not productive of the injurious results attributed to it, yet it is not to be denied, that unfavourable consequences *may* arise from disobedience to the laws regulating the human economy under such conditions. Such injurious consequences are due to the excitement of *too sudden reaction*. The phenomena of daily life afford ample illustrations of this evil. The morbid effects which ensue from a rapid transition of almost fairy forms of lightly clad beauty, from the crowded theatre or ball-room, into the cold air of a winter night, are results of sudden reaction. Not a few of the diseases which attack the human frame acknowledge this identity of origin. Our island home itself, *in its ever varying sky*, waves the scythe of grim death over its busy population. Look at those wasted and wasting forms, ever migrating to more equable climes, in search of a longer tenure of terrestrial life than their native skies will grant them.

Survey our cemeteries,—read the tombstones,—and ask the graves, why one in every six covers up the ashes of youth and early manhood, the victims of that dire disease—consumption. Then look up to those clouds which hide the genial sun, and they give the response.

Similar phenomena, only on a more limited scale, result from local congelation, as from these atmospheric variations. Reaction invariably takes place, in virtue of the conservative power of nature to restore a weakened member. When the influence of cold is withdrawn from a part to which it has been applied, the suspended life struggles to return to its wonted dwelling-place. The effect of intense cold, as I have before shown, is temporarily to weaken, in some measure, the contractile power of the vessels; and, when *unheeded*, they are liable to yield too much to the expansive force of the life which comes bounding back into them. The consequence of this, is an exaltation of the heat above the natural standard. And the blood rolling on too impetuously, before that depression of vital power occasioned by the cold is recovered from, again destroys the equilibrium in the opposite scale, and hurries on the process of inflammation. It is this *excessive reaction*, and not the cold, which is the proximate cause of the more serious results of inflammation, which

occasionally arise under such circumstances. These unfavourable results are increased, in proportion to the *suddenness* with which reaction is induced ; many examples of which abound in instances of frost-bitten persons rushing to the fire, or applying a degree of warmth disproportioned to the vital energies of the part under those conditions. A patient, for example, was admitted a few years since into St. Thomas' Hospital, "who had been employed a whole day in January in handling raw cow-hides. In the evening, feeling his left hand excessively cold and stiff, he put it into warm water, and *held it to the fire*," which, from the severity of the reaction excited great pain and inflammation, with serious consequences to the limb. Another illustration of this, is given in the narrative of the battle of Eylau, by Baron Larrey. "During" he says "three or four exceedingly cold days that preceded the battle, the mercury having fallen so low as 25° below zero, and until the second day after the battle, not a soldier in the French army complained of any symptoms depending on freezing of the parts ; notwithstanding they had passed three days, and a great portion of five nights, in a most severe frost. The Imperial Guard, in particular, had remained upon watch in the snow, hardly moving at all for more than twenty-four hours ; yet no soldier presented himself at the *ambulance*. In the night

of the 9th and 10th of February the temperature *suddenly rose* ;—the mercury ascending to three, four and five degrees above zero. From this moment, many soldiers of the guard and line applied for assistance ; complaining of acute pain in the feet, and of numbness, heaviness, and prickings in the extremities. The parts were severely swollen, and of an obscure red color. In some cases, a slight redness was perceptible about the roots of the toes, and on the back of the foot. In others, the toes were destitute of motion, sensibility, and warmth ; all the patients assured me, that they had not experienced any painful sensation during the severe cold to which they had been exposed on the night watches. It was only when the *temperature had suddenly risen*, eighteen or twenty degrees, that they felt the first effects of cold. And, it is added, "*those who had warmed themselves at the fires suffered most.*"* Similar disorganizing consequences will even ensue, by a rapid alteration of the temperature of fruit congealed for preservation. If, in the frozen state, fruits be brought near the fire, or be plunged in hot water, the parenchymatous texture is quickly changed, becomes distended and torn, looses flavour, and undergoes rapid decomposition.

* Larrey's Memoirs, tom. iii, p. 60.

It is needless to multiply instances. Those I have adduced, suffice to substantiate the principle I have laid down,—that it is neither the continuance nor the intensity of cold, which is calculated to produce results unfavorable to the integrity of the organism ; but the excitement of a too sudden reaction. Many of those inflammatory affections so common in the more variable temperate climates, arising from sudden changes of atmospheric temperature, are wholly unknown in northern countries exposed to a rigorous cold. Now, it may be thought difficult to avoid excessive reaction in a warm cavity like the mouth, on account of the great disparity between its standard heat and the temperature of the part congealed. But this is by no means the case. And, what greatly contributes to a more favourable termination, is the circumstance, that after operating, an issue of blood takes place from the wounded arteries, which, passing out of the mouth, tends to deplete the vessels, rather than to cause that expansion from a rebounding current, which, as we have seen, is the source of severe reaction. Nevertheless, it is prudent to follow out the indications which the possible occurrence of too sudden reaction points out—viz., First : To promote moderate reaction and restore the circulation and sensibility—and Secondly : To avoid excessive reaction. Both of these may be accomplished, by a

well-directed graduation of the temperature of the congealed part, up to the natural or standard heat of the mouth. We must, in fact, obey the laws of action of the tissues under their thus altered condition. The vital function of the congealed part, is, as we have seen, suspended; but the powers of action themselves remain as perfect as ever, only temporarily weakened. Heat alone is wanting for the renewal of their functions. But here lies the important indication, that the amount of heat must be proportioned to the amount of the returning vitality, i.e., the return of the natural warmth of the part, must not be allowed to outrun the returning power of the vessels and tissues previously congealed. John Hunter threw some light upon this subject in his experiments before alluded to. "If" he says, "an eel is exposed to a degree of cold sufficiently intense to benumb it, till the remains of life are scarcely perceptible, and still retained in a cold of about 40° , this small proportion of living principle will continue for a considerable time without diminution or increase; but, if the animal be afterwards placed in a heat of about 60° , then, after showing strong signs of returning life, it will die in a few minutes." In the same manner, birds are often "killed by human kindness," when taken from the chilling air of winter, and placed in a degree of warmth out of proportion

to the amount of their depressed vitality. The child of the north, who, leaping with joy at taking prisoner the bird lying benumbed on the snow, quickly and fondly clasps it in her warm bosom, hoping to hear its chirp revived ;—but, alas ! the little life there is goes forth,—no chirp is heard, the wings flutter no more,—the poor little bird is dead. The game, fish, meats, eggs, and fruit, preserved by congelation in the northern ports of Russia, on being prepared for consumption, are first placed in iced water, and then in different waters of graduated temperature until thawed, by which process they retain their flavour and edible qualities. M. Gaimard, in his experiments on freezing toads before alluded to (p. 81), found that if the temperature of the water in which they were placed to revive them, were *gradually* raised, they returned to life ; but if plunged suddenly in warm water, re-animation never took place—they died. Had the temperature gradually and imperceptibly risen during those fatal nights of February, the soldiers, at the battle of Eylau, would no more have sought the ambulances than on the previous days of severe cold ; because the equilibrium would have been preserved between the powers of life and external conditions. The gradually super-induced reaction, would have re-established the vital properties in all their integrity.

Various methods of preserving this equilibrium are in use among surgeons. No remedy for frost-bite is more commonly resorted to, or more generally enforced in all our best surgical works, than *frictions with snow*. It is with such appliances that the smitten cheeks, noses, and toes of our Arctic travellers are restored to their wonted functions. Snow is the most valuable constituent of the Arctic materia medica. In dental practice, I find the use of ices or of iced water—"the ambrosial drink" of Theocritus—more convenient and effective, because more capable of graduation. I can thus command the tonicity of the capillary vessels, and prevent that abrupt transition from one extreme of temperature to another, which might prove a source of some inconvenience. Nature everywhere abhors sudden transitions. Her smallest as well as her grandest works, from the blade of grass, to those geological strata which environ the globe, and even up to the very heavens themselves, are works bearing indubitable marks of progression. In graduating the returning functional activity of the part congealed, I do but follow again the teachings of nature.

I have not made these remarks, because any danger is to be apprehended from the employment of congelation in dentistry, but rather to show, that we have the power of perfectly controlling the

influence of cold, and hence of counteracting at once any tendency to abnormal action. For, my experience altogether ignores any injurious consequences whatever. It was to determine this, among other points, that I instituted experiments on the different surfaces of my own body, from the delicate and vascular mucous membrane, to the insensitive horny integument of the nails, none of which resulted in injury to the vitality of the part congealed. I am further entitled to speak definitely on this subject, from having undergone the extraction of a large molar tooth, with the sole object of ascertaining the value of congelation in dentistry, and its subsequent consequences. Although a great intensity of cold was employed, and that kept applied for a considerable time,—all vitality being suspended,—yet I suffered no greater subsequent inconvenience than is the inevitable sequel of the extraction of a tooth. Such also is the uniform testimony of patients operated upon under this method. The experience of Dr. Arnott, and of others who have employed congelation as an anæsthetic, fully corroborates my own as to its innocuity, when applied with a proper regard to the laws I have laid down. Moreover, several important circumstances must not be overlooked. First: The very brief period of time, during which it is requisite to continue the con-

gealing process in dentistry. The induction of a state of a temporary local insensibility is all that is needed; and that is obtained, sometimes in one minute and a half, and never exceeds a few minutes. Secondly : The very small superficial extent which is submitted to the action of cold,—being confined to the region in immediate proximity to the tooth to be withdrawn,—precludes the occurrence of any serious or extensive injury, even were it produced. But thirdly ;—The influence of cold is brought to bear upon parts, necessarily destined by the operation of extraction, to disappear. Absorption of the gum and of the remaining socket, is an invariable consequence of the removal of a tooth under any circumstances. Cold promotes absorption of the tissues ; and thus rather favours than impedes the healing process. All fears grounded upon alleged devitalization, must thus be referred to the chimerical region of fancy. Idealism is good in its place ; and even though it be wrought up in the form of theory, yet such theory, to be tenable, must be confined within philosophical limits : facts alone give the true induction. We must in this, as in all scientific enquiry, follow in the path pointed out by the immortal BACON.

It is to be expected that every alarm bell will be rung, when an invasion of "*established*" modes of practice is threatened. The alarm of *devitalization*

appears not to be the only one, which it has been thought either desirable, or politic, or convenient, to sound as loudly as possible in certain quarters. Of course, every one shudders at the idea of bleeding to death in a dentist's hands. This has given scope for a little rhetorical appeal to the fears of the nervous and timid. I find an opinion has gained some currency, that the use of cold in dentistry *provokes hemorrhage!* Of all objections this is the most singularly inconsistent. It runs counter even to our commonest experience. What remedy is impulsively resorted to in an attack of *epistaxis*, or bleeding from the nose? Is it not the *coldest water*? What arrests the floodings of parturient woman? Is it not the dashing of cold water? I can safely leave the objection to the verdict of *universal experience*; and consign the man who maintains that cold is not a powerful styptic, to a range of intellect inferior even to the instincts of some of the brute creation, from which he might learn a better lesson. Those polar bears, for example, in their life the enemy, but in their death the friend, of Arctic voyagers, rise almost to the power of reason in their use of cold. When wounded by the rifles of their Arctic pursuers, with a wonderful natural instinct they scrape up the snow with their huge paws, and plaster it upon the bleeding part to staunch the blood by

its styptic effects. What less do they, than every enlightened surgeon does to arrest hemorrhage?

It may well be asked, how comes such an objection to be advanced? Simply, I believe, from persons attempting to accomplish that of which they do not understand the principles. Suppose, for example, that a dentist envious for a scientific reputation not belonging to him, were to thrust within a patient's mouth a bag of ice and salt, at the temperature of zero, applying a succession of them, until the insensibility was supposed to be produced;—what would result? Simply, in the first place, his patient would impulsively spring out of the chair, and pace the room in a state of excruciating agony, worse than that produced by the thumb-screws of China or the tortures of India. And this *has* happened. But, in the second place, suppose the patient possessed of more than ordinary fortitude, were, after enduring this severe ordeal, to submit to the operation of extraction, what would result? Possibly the operation itself would be unattended with pain. And we are told, even under these conditions, this too *has happened*:—an important admission—inasmuch as it yields independent testimony to the anæsthetic power of cold in dentistry. Suppose further, that the operator leaves the parts he has thus congealed, to the retributive powers of nature,

which, as I have shewn, are liable to over-step the boundary of standard heat, and to pass into a state of, as it were, indignant severe reaction. What would result? By having, in the first instance, most unscientifically applied a direct and instantaneous degree of cold of great intensity to a heated surface, a shock would have been produced, instantly destructive of that tonicity of the vessels on which the integrity of their functions depends. Having thus lost their contractile power, relaxation would take place, until unable further to resist the force of the rebounding circulation upon their enfeebled walls, they would rupture and give rise to hemorrhage. And this, too, it is confessed, *has happened*. It can easily be comprehended, that all these results arise from applying a remedy in ignorance of its properties, and in direct violation of the physiological laws of the parts congealed. But results thus arrived at, have no greater authority, than would the astronomical conclusions of a child, peeping at the stars through an opera-glass, as compared with the august revelations of Lord Rosse's gigantic specula. In like manner, a dentist might undertake the administration of chloroform, with an utter disregard of its effects upon the respiration and circulation, and proceed to operate upon his patient without giving pain, because, alas! the spirit that once animated that human form, has in

the lethean sleep, taken flight to the regions where spirits only dwell. And this, too, *has happened*.

My experience, entitles me to assert that the objection of a recurrent hemorrhage under a proper application of cold, is as ideal as the former one of devitalization. *I have not met with a single case of hemorrhage.* On the contrary, I maintain, that cold, judiciously administered, is repressive of hemorrhage. Statistics prove that, under the ordinary method of operating, hemorrhage would have repeatedly occurred in the same number of cases. And I hesitate not to affirm, that the hemorrhagic diathesis, or disposition to excessive bleeding, which exists in some persons, I can, under the controlling power of this agent, hold in perfect abeyance to my will.

It has been further alleged, not upon ignorant assumption, but by scientific men, that *parts once congealed, lose more or less of their natural power of sustaining heat.* The experiments I have made on my own body do not justify this opinion; every portion once frozen retaining an equal power of sustaining heat with those which were not frozen. I presume the opinion is founded on the debilitating influence of cold suddenly applied, but which, upon the graduating principle, if it exist at all, is of very transient duration. Or, the conclusion may have been arrived at, from

observing the effects of cold after severe and unchecked reaction. No complaint of this kind has ever been made to me by my patients, nor can I discover any perceptible difference in their ordinary sensation, either upon interrogation, or upon applying heated substances to parts previously congealed. I can, moreover, confidently state, that no such alteration of functional power, has supervened in the part of my own mouth which was congealed for the purpose of tooth extraction. Nor, even were the objection valid, would it be of any consequence on the very small scale in which it could occur in dental operations. And the less so, inasmuch as an entirely new surface invariably supplants the old one, which has been infringed by operative interference. Such an objection, therefore, even were it theoretically correct, could never outweigh those higher advantages to the general system gained by immunity from pain.

Opposition to new inventions is to be expected, so long as scepticism holds its place in the human mind, and so long as there remain *vested interests* to be interfered with. That opposition which is the result of predominant fear, is excusable. That arising from ignorance, is pitiable. That which springs from vested rights, is selfish. That which owes its origin to mere love of combating, is odious. The alarms which have been sounded

about congelation, take their value and historical place, with the kindred alarms respecting all past improvements. During the reign of the Stuarts, the functions of the human fingers were interfered with by the introduction from the continent of metal *forks*, to seize our food and convey it to the mouth. Yet this refined innovation was denounced from the English pulpit, "as an insult on Providence not to touch our meat with our fingers." Towards the close of the reign of Charles the Second, considerable improvements were introduced in travelling from London to the principal towns. Flying carriages were put upon the roads, which, to the amazement of our ancestors, accomplished a journey of fifty miles per day in summer, and thirty in winter. But there were enemies to such rapid travelling, who clamorously upheld that "it would be fatal to the breed of horses, and to the noble art of horsemanship :—that saddlers and spurriers would be ruined, and the numerous inns deserted, &c. . . . Petitions embodying these opinions were presented to the King in council, from several companies of the city of London."* In the reign of the same monarch, a London delivery of letters was introduced amid equal opposition. "An enterprising citizen of London," says

* Macaulay's History of England, vol. i., p. 377.

Mr. Macaulay, "named William Dockwray, set up at great expense, a penny post, which delivered letters and parcels six or eight times a day in the busy and crowded streets near the Exchange, and four times a day in the outskirts of the capital. This improvement was, as usual, strenuously resisted. The porters complained that their interests were attacked, and pulled down the placards in which the scheme was announced to the public. A cry was raised, that the penny post was a popish contrivance. Doctor Oates, it was affirmed, had hinted a suspicion, that the Jesuits were at the bottom of the scheme, and that the bags, if examined, would be found full of treason. The utility of the enterprise was, however, so great and obvious, that all opposition proved fruitless." * In the last year of Charles' reign, another improvement was advanced, the development of which, in later times, has perhaps been more effectual in suppressing crime than the most rigorous laws, though upheld by the terrors of the hulk and gibbet. It was *the lighting of London*. Yet there were those who derided the attempt to interfere with the natural succession of day and night, and, with a peculiar pertinacity, saw advantages in the continuance of the darkness ; as there are those who, opposed to innova-

* Ibid, p. 385.

tions simply because they are innovations, endeavour to persuade themselves into a belief that pain is highly useful and very desirable.* “We smile at these things,” says Mr. Macaulay. “It is not impossible that our descendants, when they read the history of the opposition offered by cupidity and prejudice to the improvements of the nineteenth

* “An ingenious projector, named Edward Heming, obtained letters patent conveying to him for a term of years, the exclusive right of lighting up London. He undertook, for a moderate consideration, to place a light before every tenth door on moonless nights, from Michaelmas to Lady-Day, and from six to twelve of the clock. Those who now see the capital all the year round from dusk to dawn, blazing with a splendour compared with which the illuminations for La Hogue and Blenheim would have looked pale, may perhaps smile to think of Heming’s lanterns, which glimmered feebly before one house in ten during a small part of one night in three. But such was not the feeling of his contemporaries. His scheme was enthusiastically applauded, and *furiously attacked*. The friends of improvement extolled him as the greatest of all benefactors to the city. What, they asked, were the boasted inventions of Archimedes, when compared with the achievement of the man who had turned the nocturnal shades into noon-day? In spite of these eloquent eulogies, the cause of darkness was not left undefended. There were fools in that age, who opposed the introduction of what was called the new light, as strenuously as fools in our age have opposed the introduction of vaccination and railways—as strenuously as fools of an age anterior to the dawn of history, doubtless opposed the introduction of the plough, and of alphabetic writing. Many years after the date of Heming’s patent, there were extensive districts in which no lamp was seen.”—*Macaulay’s History of England*, vol. i., p. 361.

century. The introduction of Vaccination by the immortal Jenner to diminish the mortality of a disease, which, fifty years ago, swept away annually from this country thirty thousand human beings, and which still causes savage tribes to disappear where the white man puts his foot, was for years received with ridicule and violent opposition. And even to this day, the monument to that noble martyr has not arisen, though the lancet of Jenner we are told, "has saved far more lives than that of the first Napoleon destroyed." "Who knows," asked one of the opponents, "but that the human character may undergo strange mutations from quadrupedan sympathy, and that some modern Pasiphæe may rival the fables of old?" In Blair's *Vaccine Contest*, the case of a lady is mentioned, "who complained that since her daughter was inoculated, she coughs like a cow, and has grown hairy all over her body." Cases of its discontinuance are recorded, because the "inoculated bellowed like bulls." The windows of picture-shops in those days were filled with "faithful representations" of children who had thus undergone various bovine transformations. And, prefixed to the work of Dr. Rowley, is the coloured portrait of "a cow-poxed, or ox-faced boy," with two scrofulous abscesses, which were at one time alleged to indicate sprouting horns; and of whom Dr. Rowley observed, "This boy is gradually losing the human

lineaments, and his countenance is transmuting into the visage of a cow." Not less violent has been the opposition to Chloroform in parturition ; having been denounced as an unwarrantable interference with a physiological process, and a direct intervention of heaven's curse upon woman ! when to her

" Pain is perfect misery, the worst
Of evils, and excessive, overturns
All patience."

So has it been with congelation. These and similar instances reconcile us to opposition ; for, in all, the true thought, and the effort of genius, at last predominate ; human prejudice and passion become surmounted by indubitable facts. The great world-drama is one of universal progression. And as all science and art are pouring forth their treasures at the feet of our common humanity, in obedience to the evolving laws of beneficence, so shall surgery progress in its humaneness, though checked by party feud and petulant animosities. Obstacles and opposition are but stepping-stones to that coming reality, when the infliction of pain in surgical operations of every kind, shall take rank with the brutalities of barbarism.



IX.

IS CONGELATION AN INFALLIBLE ANÆSTHETIC
IN DENTISTRY?

AN important enquiry may here urge a claim. Does congelation possess in itself the elements of invariable success? Is the process infallible with *all persons*, and *in all cases*? That it is fully capable of perfect success, can admit of no doubt, if the principle of its action, which I have before announced, be rightly comprehended. If failure arise, it is rather due to want of experience and of insight, or to some deficient appreciation of casuality on the part of the operator, or to the unavoidable absence of foresight which is common to us all, than to the agent itself. Success is always attainable. But human imperfection demands a little license. The harmony between the will, and the work of the hand, may be interfered with in many and unexpected ways. Allowing for these, we say, it may be uniformly successful.

As to *persons*;—there are, of course, individual differences of susceptibility to the action of cold, as various as the differences in the power or force of the circulation. Where the circulation is weak,

the susceptibility is the greater, or rather the end is more easily arrived at. On the other hand, the strongest circulation cannot withstand its continued influence. The Nettles and Mallows in our gardens will sink into a state of torpidity, beneath a degree of cold, in which the Chickweed and the Groundsel will be full of life and flourishing. So the pale anæmic female, or the tender infant, may more *readily* succumb to the power of cold, but not more surely than the plethoric, robust and stalwart man. It is merely a question of time and intensity. A delicate female sojourning in the Arctic regions, would more quickly fall a prey to their cold icy blasts, than the man, who, in virtue of a more vigorous circulation and warmer blood, is more capable of resisting the outward cold. But even the strong Franklin knew what it was to be laid prostrate by the icy touch of that clime; and his companions, the brave Richardson and Hood, once felt life and reason vanishing in the face of those blasting Arctic winds. What one hour could not do, a day accomplished,—and what evils a day did not bring, a week produced in all their terrors. So in this process,—minutes must accomplish the work, if seconds fail. And thus by a nice adaptation of time to the need, the infant and the old man, the delicate female and the robust man, may alike be brought under its influence.

Then, as to its success *in all cases*. It is very rarely that a failure awaits the application of the congealing process. But I pretend not to say, that failure is an impossibility, and simply for the reason, that dentists are not more infallible than other men. The application is one, as we have seen, requiring the exercise of judgment on the part of the administrator. That judgment may err. It must be remembered, that operative dentistry is often very much working in the dark. There is no difficulty in making a diagnosis of what is *seen*, and even of inferring, upon certain recognized principles or symptoms, the state of that which is *unseen*. But the visible portion of a tooth, is not an invariable index of its invisible parts. The crown of a tooth, for example, may present nothing unusual, while the fangs may be the seat of disease and deformity. Those fangs may take an abnormal direction,—curving inwards or diverging outwards, so as to resist extraction without the exercise of considerable force. Or, as often happens, as an effect of dental caries, an exostosis or enlargement of the extremity of a fang may exist, securely locking it in the jaw. Or ankylosis,—a bony union of the tooth with the jaw itself,—may have taken place; and various other abnormal developments which lie buried and invisible in the enveloping socket, may

occur, all of which greatly increase the difficulty of the dental art. Had the dentist that *clair-voyante* eye, which could see through this "too solid flesh" as a transparent mirror, it would forewarn him of those unseen difficulties. Gifted with only the aqueous, crystalline, and vitreous humours of an ordinary eye, what is revealed to him through that, he prepares for;—for the unseen, he must wait. If the degree of congelation equal to the painless extraction of an ordinary tooth, be applied to a tooth with any of the foregoing abnormalities, there may be experienced more or less of pain, if the operation be at once proceeded with,—though even such pain would be trifling compared with the extraction without any anæsthetic application. When such a difficulty arises, a remedy is at hand, in the continuance of the congealing process. We are thus brought back to the question of time or degree,—only, the time and degree required are subject to the operator's judgment, *which may err*. The hope of a painless dentistry has brought an unusually large number of these abnormal cases under my notice, from all parts of the country and from the continent. Most of these have terminated successfully. It will not be thought any disparagement to the process, that, in a few, the same errors of judgment should have been fallen into, which

had previously awaited the efforts of the highest practitioners in Europe. And I affirm, that whatever may be the nature of the case, if it can only be truly precognized, so as to adapt the process to the demand, the pain of the operation may always be reduced to a mere bagatelle if not entirely abolished. For, with an agent at our command powerful enough to suspend the vitality of the whole body, there can be no impossibility in suspending the vitality of such a limited region as that occupied by a tooth.

No cases, perhaps, are more unpromising than those in which the patient has for a considerable time indulged in excessive recourse to alcoholic stimulants, and to the depressing effects of tobacco. It is impossible that the mucous membrane of the mouth should retain its integrity of function under the incessant excitement of powerful stimuli. Place a drop of brandy on a frog's foot when under the microscope, and its blood-vessels will be seen to collapse as they do under cold or other stimuli. By repeatedly renewing the same irritation, those tonic contractions will give place to dilatation, and insensibility to stimulus. In fact, a degree of chronic inflammation will be produced. That which thus takes place in the frog's foot, has its correspondence in the mouth, stomach, and alimentary canal of those to whom the pure water of the foun-

tain has no charms, or to whom a rational use of stimulants is too tame and slow. The blood-vessels become unimpressed by stimuli except to increase their weakness and relaxation ; and thus the contracting power of cold appeals to them in vain. In like manner, the sedative effect of excessive indulgence in the meerschaum or cigar, tends to weaken the contractile power of the vessels, and to keep up a state of relaxation ; while the impressibility of the nerves is equally injured. Chemists tell us that alcoholic articles of diet are food for combustion—that they light up within us those animal fires which burn so brightly at the terminal points of the capillary circulation, and thus their appropriate name, “fire-water.” Just so much unnecessary fire as is thus thrown into the system,—just so much additional power as the heart is thus endowed with, adds so much resistance of temperature to be overcome. My freezing mixture is not made to congeal brandy and wine, but natural human tissues whose normal state ignores them. On several occasions I have been called upon by gentlemen whose manly courage has been toned down by alcoholic dissipation, to save them the penalties which pernicious habit with imperious sway inflicts. But owing to the irrevocable retribution which violated nature ever seeks, I have not always succeeded so satisfactorily as when nature’s laws

are inviolate. The worshipper at the shrine of Bacchus,—the “fast” young man, as the world reputes him,—whose happiness is consummated in the survey of dead bottles on the floor, is not the happiest subject for congelation. Still even for him there is *mitigation* of pain.

Frequent opportunities have been afforded me of testing the *relation between the amount of pain abrogated and the degree of congelation employed*. In some of those more difficult and painful operations for example, already referred to, such as a tooth being firmly locked in the jaw by exostosis, it has occasionally happened that the same patient has required other teeth to be removed at the same sitting. I have only employed that amount of cold which would be sufficient to render the extraction of an ordinary tooth painless,—thus subjecting the patient to some measure of suffering, and which amount the imagination generally increases twofold. Disappointment has then lowered the visage, which in cases of perfect success, beams with a grateful joy. I have then persuaded the patient to have the other teeth removed *without* the previous application of the cold. But my persuasion has never been equal to more than one such attempt; for in that attempt the real value of the application has been perceptibly revealed,—the extraction of that one *ordinary* tooth, though

momentary, being inexpressibly agonizing as compared with the first far more severe, but under the influence of the cold, far less painful, operation. The amount of pain thus saved has become palpable by comparison. And the uniform testimony in all such cases has been, that an effectual and unmistakable power does reside in this process of destroying pain. I feel no hesitation in affirming that the process must always *mitigate*, if it do not *abolish*, pain. It may be, that in rare cases, only fifty or sixty or eighty per cent. of the suffering is removed ; still a sensible amount *is* saved, even in the most severe and exceptional cases, which suffices to indicate the value of the method itself. It is something even to *mitigate* suffering where we do not annihilate it. But I repeat, this falling short of the full anæsthetic effect is due to no inherent defect in the agent employed, but to that want of *prevoyance* and of infallibility which dentists share in common with mankind.

There are, however, four circumstances which occasionally make perfect painlessness exceptional, and which no *prevoyance* can prevent. The first is, *a certain peculiarity in the structural components of some teeth*. To give a popular definition of this peculiarity of dental development is not easy, though it may be easy enough to recognise the fact, that as there are individual differences in

the osseous development of the body, so there are special degrees of hardness or density of the teeth. Whether it arise from the absence of fatty matter, or from other causes, certain teeth possess a degree of consolidation which interferes with the perfect conduction of cold to their fangs ; and hence with the requisite exsanguification of the investing membranes, though the gums yield aptly to the congealing process. In these, fortunately infrequent, cases, mitigation of pain is all that can be attained.

The second opposing circumstance is due to *peculiarities in the conformation of the mouth*. The angles of the jaw in some individuals are so contracted, and the teeth in proximity thereto are so buried as it were, that only a portion of their surfaces can be surrounded with the congealing current ; and hence so much in proportion is the anæsthetic effect diminished.

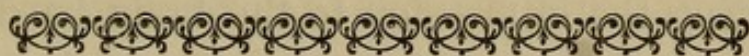
The third unfavourable element arises from *the articulation of the lower jaw*. When a large molar tooth happens to be firmly imbedded in the lower jaw, the resistance it opposes to extraction will occasionally produce a strain upon the whole jaw owing to its moveable character, which, despite every effort to fix it, cannot always be avoided. The tooth itself indeed may be extracted without any sensation of pain in its immediate neighbourhood ; but the general strain on the jaw which so

frequently terminates in a swelled face, may still be unavoidably present. Congelation cannot supersede peculiarities of anatomical structure. What is due to the anatomy of the mouth, must not be regarded as derogatory to congelation. This also is only an occasional occurrence.

A fourth counteraction arises from the *sympathetic action of the nerves*. Cases occur, though rarely, in which, from long-standing dental disease and irritation, the main dental nerve becomes affected with a degree of supersensation *at some distance* from its junction with the offshoot to the affected tooth. In such instances, the traction which is made upon the nerve in removing the tooth, by throwing it into a state of vibration, will cause a peculiar sensation along its course. The effects vary in individual cases. At times,—in accordance with the physiological law of sensation being produced at the terminal filaments of nerves, a disagreeable impression is experienced in the other teeth, as when the inflammation of one tooth produces sensitiveness in many. At other times, a dragging sensation is complained of below the ear. These various symptoms are more manifest in cases where the hysterical diathesis is strongly developed. In these instances, the tooth itself is removed without any of the ordinary sufferings attending ex-

traction ; the unpleasant sensation of a vibrating nerve being an unavoidable superaddition.

But, all these instances, I must repeat, are *exceptional* complications ; and hence, no more detract from the value of congelation in dentistry, than other complications in general surgery, detract from the value of some of the most beneficent operations. It would be as unjust to infer from such anomalous coincidences, that congelation is inefficient in the great majority of cases, as it would be to infer, that every world in the universe is surrounded with four luminous rings, because one, or perhaps two, planets in one planetary system, happen to be surrounded with such appendages.



X.

COMPARISON BETWEEN CONGELATION AND CHLOROFORM.

IN a former page (p. 31) I have hinted that the insensibility produced by cold may be deeper and more effectual than that produced by chloroform. Dr. Wood, of the United States, adopted congelation in minor surgical operations, in preference to chloroform, because, he says, "the anæsthetic effect is more complete than is ordinarily obtained by chloroform, and is fully equal to the most over-

whelming dose." This sentiment may certainly be echoed as regards dental operations in particular. For, as I have shown, the region of the tooth to be removed, is for the time deprived of its vitality. The mind becomes cognizant of the sensation of pain, through certain changes wrought upon the sensorium. Three physiological stages belong to every sensation ;—"first, there is the impression made upon the extremities of the sensory nerve ;—secondly, there is the conduction of that impression along the trunk of the nerve to the sensorium ;—thirdly, there is the change excited by that impression in the sensorium itself, through which sensation is produced." Now, if the trunk nerve conducting the impression to the brain be divided, the communication being cut off, no change will transpire in the sensorium, and no mental sensation will arise. This is, in effect, what is accomplished by cold. When the tooth is frozen, every particle of blood being driven out, no life remains ; the superficial nerves are paralyzed ; and the main nerve communicating through the fang of the tooth with the trunk nerve from the brain, becomes like a thread of dead matter, alike unable to feel or to conduct sensation. The electric wire is broken. It is a death commencing at the circumference and travelling some little distance toward the centre.

It is otherwise with chloroform. In the degree of etherization within the limits of safety to life, the communication between the brain and the peripheral nerves about the head remains unbroken. And the conducting functions of those nerves passing from the tooth to the sensorium remain intact. Some diversity of opinion exists as to the progressive mode of action of chloroform upon the human body ;—one class maintaining that its effects are produced centrifugally, the other, centripetally. It is highly probable, say some, that the painful impressions of surgical interference *are* conducted to the brain ; but that the narcotic influence of the chloroform interferes with the changes produced upon the brain, so as to prevent the sensation being recognized by the mind. All the effect upon the intermediate nerves is thus allowed full play. Their vital functions are not suspended ; and though it is true the power of sensation is destroyed in this case as in the case of cold, yet there is this great difference, that, under chloroform, it is destroyed by effecting a change in the great mass of the brain ; while under cold, it is destroyed by effecting a change in a portion of the body, of very trifling superficial extent ;—the latter change being, moreover, one of *vital suspension*, while the former is but a change of the consciousness. But even if the opinions of those be correct who maintain

that the capillary circulation is first effected by the chloroform, and that the insensibility travels from the peripheral nerves onwards to the brain, the aspect of the question, as regards dentistry, is not greatly improved. For experience has demonstrated, that absence of feeling under chloroform commences in the inferior or lower half of the body, or such parts as are under the immediate influence of the lower portion of the spinal nerves. Operations may thus be performed upon the foot or leg, before the deep anæsthetic influence has reached the nerves of the head or brain. To produce insensibility in the fifth nerve, and in the brain generally, requires a degree of chloroformization, attended with positive danger to life. Now the dental nerve is *a branch of that fifth nerve*. To destroy its sensitiveness and that of its complex ramifications, would thus require, to be effectual, that the chloroform should be pushed to a stage in which the patient is delicately balanced between life and death. To such an extreme it would be a moral delinquency to resort in dentistry, except under very exceptional circumstances ; and, consequently, such an extreme, dentists universally avoid. Congelation, on the contrary, when applied to the teeth, *at once* suspends the sensibility of the extreme dental portions of the fifth nerve. On these grounds it may be said truly, that the anæsthetic

effect of congelation is greater than that of chloroform.

There are those who think that the only change produced by chloroform is exerted upon the *memory*, in effecting an *utter obliviousness* of all that has transpired while under its influence. It is regarded as a psychological, rather than as a physical, agent. Dr. Arnott is of this class. He speaks of it as an erroneous inference to suppose, that from mere *forgetfulness* the patient suffers nothing. He is, however, unquestionably wrong in the assumption, that the full influence of chloroform is only to effect obliviousness; for there can be no doubt that the change it operates is in effect to diminish or destroy the perfect *rapprochement* of mind and matter. But it is nevertheless unquestionably true, that in the manner in which chloroform is ordinarily administered for dental purposes, it does little more than obliterate the memory. The patient is subjected to its influence; the lull and stupor of intoxication come over him; the forceps are placed upon the tooth; *he shrinks from their grip, and puts up his hands to pull them away*. The tooth is taken out; he recovers perfect consciousness; and he knows nothing that has transpired. Yet pain was as surely suffered, as if no anæsthetic had been used. It is a mere mockery to call that *painless dentistry*. All the injurious

effects of pain are allowed full scope ;—the nervous system is not saved from shock. Fearful of his boasted agent, the dentist pushes his ether only to the stage of oblivious excitement, instead of inducing a state of perfect immunity from pain or sensation. But in those very fears do we not read the want of such an anæsthetic as I have in these pages advocated, by which, in the full possession of memory, thought, and expression, but with absence of feeling, a dreaded suffering is abolished more effectually than by a fairy dream, or the enchanting obliviousness of Oberon.

The purely *local* influence of congelation, gives it a significant advantage over chloroform in other respects besides the facility and efficiency of its anæsthetic effects. Diseased states of the system generally receive fresh impetus, and are attended with increased irritation, from a vitiated condition of the blood ; some diseases ordinarily latent, become suddenly developed under such circumstances. Chloroform can only produce its anæsthetic effects *by a vitiation of the circulation*. Consequently it is unfavourable to many diseases already manifest in the system, and brings to light, (but unfortunately when too late,) organic affections never suspected. Hence, the latest writers on etherization, in summing up the teachings of experience, have substituted *ominous cautions* for those glowing

descriptions which abounded in its earlier history. We are now told that chloroform is dangerous in "diseased states of the spinal column interfering with the due performance of the reflex functions,—in lesions of the vascular system, such as atheromatous deposit in arteries,—in cases where the pulse is intermittent,—in hysteria,—in epilepsy,—in fatty degeneration of the internal fibres of the heart,—in *ramollissement* or softening of the brain and of any of the spinal nervous centres, and other nervous affections," and also in a great variety of instances in many of which I confess I have found it harmless. Without indulging in the expectation which is the favourite theme of many, that ultimately chloroform will be found incompatible with every disease known or unknown, and as incompatible where no disease exists at all, still these fears have not been engendered without good cause. In most of the few instances I have quoted, the caution is undeniably appropriate. But the aggravating circumstance is this, that some of these incompatible affections may exist and yet defy our powers of diagnosis. The revelations of the scalpel afford little consolation when a few whiffs of chloroform have, with almost lightning speed, transformed a living man into a lifeless corpse. No such diseases can, as far as I am aware, be adduced as incompatible with congela-

tion. I have employed it for dental purposes under the existence of almost every variety of organic affection, and with equal success and equal safety as when no organic disease has been present. Thus far, congelation is less restricted in its usefulness than chloroform, embracing within the sphere of its beneficence those on whom disease has fastened its defacing fingers, as those who proudly boast of vigour and of health.

Congelation possesses another advantage over chloroform, in that it *leaves no troublesome or unpleasant effects behind it*. It is no uncommon occurrence for the administration of chloroform to be followed with sleeplessness and headache, accompanied with distressing nausea—arising from congestion of the sinuses of the brain. And other disagreeable consequences have been loudly lamented. I do not presume that our Idiot Asylums have been much inconvenienced by that mythical crowd of miserable victims whose intellects were to fall a prey to chloroformization, either as they were being born or afterwards, as wise prophets presaged. Nor have heavy contributions been laid upon our Lunatic Asylums for those raving maniacs, whom chloroform, it was prophesied, would drive to their doors like wild beasts into dens? These were fancy's myths, destined never for real dramatic development. But those lighter ills that *have* followed in the wake of

chloroform, have deprived many a poor tortured victim of that elysium of the mind, which others have revelled in while their bodies have been under the stroke of the surgeon's knife. Those ecstatic dreams, too, that I have heard patients relate as experiencing while undergoing severe dental operations, too often leave behind them hours and days of melancholy dejection. With *congelation* there is no hurrying on of the circulation to be succeeded by depression,—no congestion of the brain,—no ecstatic dreams to end in gloomy melancholia,—no nausea to disgust,—no headache to be feared. The stream of the heart's life in which no anchor can be cast, flows on smoothly and undisturbed; and the bark, though so frail, that waves of ether may strand it, floats lightly, joyously, and unhurt upon its surface.

Old age and childhood have been pointed out as beacons to warn etherizers of danger :—the one, because of unsuspected latent diseases, the other, though less exceptional, because of its slighter tenacity of life. But in both, congelation is unexceptionable. To the aged, whose courage has been moderated by the wear and tear of years now declining, it is as great a happiness to us to save pain, as it is a comfort to them to be freed from it. To the child, against whose merry life pain stands in such repulsive contrast, and whose every little

suffering reflects itself in hundred-fold intensity in the mother's breast, it is more precious than all the cordials in which invention has been so fruitful. The twofold pain is saved. In cases of irregular development of the teeth, this is of considerable importance. No mother's anxious eye watches with eager solicitude and doubtful expectation, the re-awakening of her child from the sleep of narcotism. Under congelation it sleeps not. Its little eye peering in confidence to its mother, tells her it is happy, though undergoing what otherwise would be distressing to witness.

The same spirit of caution which has been provoked by years of accumulating experience in etherization, has prompted its later advocates strenuously to urge the importance of *preparatory manipulations and auxiliaries*. It is now held that a due regard for our patients' lives, should impel us to institute an enquiry into the historical development of morbid affections which may at any past time have been present. Nor content with this, we are called upon with almost pertinacious scrupulosity, as a matter affecting moral character and professional position, to satisfy ourselves of the presence or absence of any abnormal actions by a personal examination. To quote the words of a contributor to the Dublin Quarterly Journal of Medical Science, "a stethoscope should al-

ways be run across the chest, and percussion also tried," before venturing to place a patient under chloroform. It certainly would be something novel in dentistry, when a lady presented herself for the removal of an aching tooth, that she must make bare her bosom in order that the dentist should just run a stethoscope across, and manipulate it with the gentle percussion of his fingers! Others urge that the "patient's medical adviser" should be present; and that a cabinet should be at hand containing "sponges and cold water,—diffusible stimulants,—jars of oxygen gas,—galvanic batteries," &c. It is further urged, that an etherizing dentist should serve a due preliminary apprenticeship in "etherizing the lower animals," and noting in them that "debility," that "asphyxia," and that "melancholy re-action," which at any moment he may be called upon to witness in the human subject. Now, if when any one of thirty-two teeth turns rebellious, a cabinet council must be held, composed of patient, the patient's doctor, and the patient's dentist;—if the patient's history is to be recounted, and long-forgotten maladies raked up; if the pulse is to be anxiously noted by the finger; and the bosom laid bare that the heart may be investigated by the stethoscope, and the lungs be auscultated and percussed, in order that a dangerous narcotic may be employed with some hope of

safety, but which after all, despite family doctors, stethoscopes, oxygen gas, and galvanic batteries, may still kill, common sense must surely decide in favour of congelation which, in its application, is perfectly simple, in its appropriateness is universal, in its safety is undeniable, and in its anæsthetic effect is supreme.

However great be the efficiency and value of this local anæsthetic, on the considerations I have advanced, they are eclipsed by the vastly higher estimate which the popular mind places upon the *retention of consciousness*. The compulsory loss of consciousness is, to many minds, revolting. Natural sleep, stealing over the frame in all harmony with the laws and constitution of the human body, is indeed most grateful,—but in the artificial sleep rapidly induced by a narcotic vapour, it is difficult to divest the mind of fear. We wrap the drapery of our couch around us at night with unshaken trust in nature's uniformity, that as suns have never failed to rise, so will our eyes re-open to behold the light of the coming day. But if we force the brain to untimely somnolence when the powers of nature require no rest, by a narcotic agent, not by the operancy of ordinary laws, there is no natural uniformity to rely upon; and who dare be certain that those closed eyes shall not be sealed by the mortal

grasp of a fatal coma? Weakened as this argument has been by the extensive employment of etherization for ten years past, and especially lately in the Crimea, in which the re-awakenings may almost be said to have been as sure as the uniform renewal of nature's phenomena, yet the bare possibility of a failure has not been shorn of its terrors in the public mind of this country. These fears have just received a powerful accession, from the lamentable occurrence of two fatal cases from chloroform in Scotland in dental practice. In one of these instances, the patient had inhaled chloroform on four previous occasions for the purpose of tooth extraction. On the fifth occasion, the lady inhaled it but *one minute*, and then, with quicker than lightning speed the destroying angel came, and in the presence of her husband *she sank dead upon the floor*. Three thousand times had the same dentist administered chloroform without a similar deplorable termination. But he had no clairvoyant eye that could survey an incompatible condition of the vital organs, otherwise unrevealed; nor to detect an idiosyncrasy which would convert a wave of ether into a minister of death. It is the painful uncertainty engendered by such cases as these, which, in a minor operation like tooth extraction, will ever give preference to a dangerless local anæsthetic, until a new age brings us the new an-

æsthetic, which will universally abolish sensational power, without depriving the intellect of its functions.

In dentistry, more perhaps than in general surgery, the retention of consciousness with sensation locally abolished, has peculiar advantages. It is of very considerable advantage to have the volitional power of the patient intact, for keeping the mouth open and the body steady. On the other hand, the power of the mind to *create sensations*, for which extremely nervous patients are notorious, is sometimes a disadvantage, as regards the subject of pain. All local anæsthetics have this drawback in common, that the perfect retention of consciousness allows the mind to be *under subjection to a dominant idea*. Few psychological phenomena are more curious and interesting than the operancy of the mind upon itself in the creation of sensations, whether of pleasure or of pain. The dominating idea, in the mind of a patient, (especially one who has had a tooth extracted in the ordinary way,) is that of intense suffering. The mind knows the "*horrid wrench*," and idealizes it, even though it be not present. Pain is thus endured by the mind, which has no existence in the body. I have witnessed this mental suffering, in some instances, when the existence of physical suffering was impossible. Occasionally, it has happened that an extremely hyperæsthetic patient,

thus under the influence of prepossession, conscious,—only from sight or motion, not in any way from feeling,—that force is about to be used when the instrument is being adjusted on a tooth, imagines the sufferings of extraction, though no such force be applied. Happily, cases are rare in dental practice in which the control of the will is thus wholly abandoned to the power of internal suggestion. The history of mankind, however, furnishes many such examples. The Pythonic inspiration of the Delphic priestess,—the extatic revelations of visionaries, to them so real, so true,—the belief in witchcraft, and other of the thousand vagaries to which religious enthusiasm in every age has given birth,—may perhaps not unjustly be placed under the same category. Every physician and every surgeon too well knows the influence he has often to contend with, in the sensory impressions being determined by ideas which have gained full possession of the consciousness. Professor Bennett, of Edinburgh, relates in his lectures a striking instance of the endurance of intense pain, purely as the result of mental operancy, without any *physical* lesion to give rise to it :—“A butcher who had a shop in the market-place at Edinburgh, in trying to hang up a heavy piece of meat upon a hook above his head, lost his footing in such a manner that his arm

was caught upon the hook. On being taken down and carried into the house of a neighbouring surgeon, he expressed himself as labouring under the most acute agony; and the paleness of his countenance, and the almost entire absence of pulse at the wrist, were unmistakeable indications of the reality of his torture. His arms could not be moved without causing excessive pain, and he frequently cried out while the sleeve of his coat was being cut off; yet when the arm was exposed, it was found quite uninjured, the hook having only penetrated the cloth of the sleeve, and the skin being scarcely even grazed!" It is much more excusable that the mind should delude itself into suffering, when the unrelenting grasp of an instrument seizes upon a tooth, and extracting it, leaves behind a physical lesion.

It is not however only the creation by the mind of painful sensations where none exist, but also the power of the mind *to concentrate itself upon sensations*, which may become perplexing. In proportion as the attention is concentrated upon a sensory impression, is the vividness with which it is felt. The mind, as it were, educates itself to feel more and more intensely, producing a state of hyperæsthesia. A comparatively trifling tooth-ache, which would easily pass away upon the withdrawal of the attention to any absorbing subject, becomes

only the more and more torturing as the mind is suffered to dwell upon it. Pains slight in themselves, or in the physical impression they make, are thus magnified into positive torture. In this view it is unfortunate that in dental operations, the whole consciousness becomes, as it were, driven towards one small region, upon which it spends its accumulated power in augmenting the acuteness of every sensation. A very trifling impression produced during an operation, is in this way liable to cause some little disappointment. A mere sensation may be felt as pain. It is an unquestionable inconvenience in surgery or dentistry. It is some drawback to local anæsthetics. In operating upon the mouth under congelation, an insignificant sensation may be excited by a variety of causes quite independent of the tooth extracted ; but it affords no good argument in favour of abolishing consciousness, that there are persons who, despite all our efforts, will *imagine* what they cannot *feel*. But what is an inconvenience in this respect is full of beneficence in others. For it is the same power of mental education by concentrated consciousness, which has given to poor Laura Bridgman, the blind, deaf, and dumb girl, of America, in the exaltation of her touch,—the charm of human sympathy amid her dreary darkness. It has given the savage to know the enemy's footfall, unheard by ordinary

ears. It has unfolded the realms of nature to those whose eyes are sealed, giving to the blind man to learn through his finger-ends of the world he lives in, and that spirit-world encircling him. It has endowed the musician with the keener discernment of tones, giving to Mozart and to Beethoven their thrilling and undying harmonies.

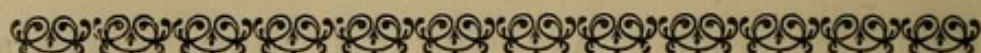
It has been urged, that the mind has equal power of realising the absence of pain when it is actually present, as it has of conceiving the presence of pain when it is absent. Unquestionably, states of the nervous system may be superinduced, in which the outward sensational life may be held in abeyance. The absorption of the mind in a given theme, plan, or object, may render it heedless of the outward senses, as the histories of holy martyrs, and heroic warriors can tell. The philosopher wrapped in profound meditation, may under such circumstances, have coolly replied to his servant who brought him news that his house was on fire, "go and tell your mistress ; you know that I never interfere about domestic matters." And the learned professor pursuing in his mind some profound analysis may, as it is alleged, "when he had run against a cow, have pulled off his hat, and apologised as to a lady for the mischance, hoping she was not hurt." It is, however, a matter not so easy, to persuade patients, that we possess the power of so subverting

the ordinary processes of nature, as to deprive the nerves of painful sensations. Their very scepticism itself is a powerful opponent. They have no faith in painlessness. It is the doubtful question, Is it possible? And, however dogmatic be the announcement, that, by congelation, we hold as it were a wizard's wand over every nerve, the spell-bound idea of pain is not dissolved, till the potent charm of experience bids it vanish.

The abolition by means safe and unobjectionable, of pain, especially of that pain from the infliction of which I have remarked so few escape, wears an aspect of twofold beneficence. The dread of operative interference stimulates to the endurance of a vast amount of prolonged suffering. Cumulatively, the amount of pain which such hopeless delays produce, far exceeds that of the one pain so greatly feared. Nor is this all. Pain has ulterior consequences. It induces constitutional irritation exposing the weaker parts of the body to the ravages of insidious disease. Without attributing to dental disease the origin of all those evils which sprung from Pandora's box, as specialists are often liable to do, yet it must in justice be confessed that not a few of the most prevalent ailments may be traced to some form of dental irritation. It were easy to show from the anatomical relations of the teeth with the great centres of organic life, how the

general system may sympathise with disordered conditions of the dental apparatus. It were easy to show how prejudicial to health, is the mere retention of diseased teeth and stumps within the mouth. And it were easier still to show, that the longer such are retained, and the longer the discordant sympathies of the body are excited, the more wide-spread, and the more potent will be the evil influences disseminated through the system. Yet diseases of the teeth are just those which, by far too general consent, are regarded as the least imperative, and the most repulsive to be remedied. Hence the dental deterioration so much to be bewailed. If diseases of the teeth could be cured by the mere touch of the finger, patients would crowd around our doors, as they crowded around the throne of Charles the Second, to be touched for the King's evil. But the painful ordeal which must precede the cure, provokes a procrastination which at last, becomes tolerant of what is erroneously supposed to be the lesser evil. Meanwhile, pain is doing its insidious work upon the system; manifold diseases appear in succession doing *their* special work; and the patient becomes the victim of nauseous medication; or perhaps in despair falls a prey to rapacious charlatanism, to get rid of that which one minute's consultation with an enlightened dental surgeon would have wholly prevented. Wanting in the

prophetic power themselves, such patients turn a deaf ear to the voice of true prophecy, until its fulfilment in their personal discomfort substantiates it. Then it is, disease becomes a reproach ; but is tempered by the dominance of that law which dooms us to suffering. As at the bottom of Pandora's box hope lay reserved, so anæsthesia once promised to interpose a greater than fairy spell to break the power of that law. But as regards dentistry, chloroform has proved but a deceptive hope ; the new fears it aroused being even more ominous than those it was designed to quell. Congelation takes higher ground. By the confidence it inspires, by the success it secures, delays become less frequent, and their consequences less lamentable. Hours and days of languishing may be replaced by those of healthful buoyancy ; and those mental perturbations concomitant on physical irritation from which there is no eloping, may be calmed down into serene composure. For congelation professes to achieve the same beneficent purposes designed by chloroform, with the manifest advantages of being as efficient yet free from danger, more rational because it is a local, not a general anæsthetic, more philosophical because accordant with invariable natural laws, and more comprehensive because unexceptionable.



CASES AND TESTIMONIALS.

CASE I.

THIS case cannot be better described than in the words of the patient himself, a medical gentleman, who has kindly favoured me with the following account.

“*London, 93, Hatton Garden.*

“I have great pleasure in bearing my testimony to the *perfect success* which attended the removal of my bicuspid tooth, under the influence of cold, applied by means of the freezing process. I consider it in every respect superior to chloroform, being *perfectly safe to the patient*, and under the control of the operator. I further consider it no small boon for the patient to possess the power of volition during the period of the extraction.

G. H. STRANGE, M.R.C.S.”

CASE II.

Conscious that prejudice is best subdued by personal inspection, it affords me great pleasure to be favoured with the presence of medical gentlemen during operations under this process. On the occasion here recorded so kindly by Dr. Rawson, several patients were operated upon in his presence. They had previously undergone similar operations. One of them has had at least five teeth removed

under the process. In another instance, the operation was very protracted, and under ordinary circumstances would have been excessively painful.

“Horbury Terrace, Kensington Park.

“I feel desirous of expressing the astonishment and pleasure I experienced a few days ago in witnessing, at your house, the extraction of several teeth, under the topical application of a freezing mixture immediately preceding the operation. Nothing could have been more satisfactory and convincing. It was quite clear to me that the operation was *wholly unattended with pain*; and yet in the case of one lady, from the nature of the tooth, and the difficulty of removing the stumps, the principle was put to a severe, yet most satisfactory, test. The previous application of the cold is *evidently painless, and quite free from danger*, and the reaction is secured in a perfectly safe manner.

T. E. RAWSON, M.D.”

CASE III.

I adduce this case as a type of an extensive class of patients to whom the employment of congelation has been invaluable. I give it in the authentic language of the patient's medical attendant.

“Doncaster.

“In thanking you for your kind attention to my patient, I am happy that the case enables me to give a most satisfactory tribute to the success of your safe and painless method of tooth extraction. My patient had been a long sufferer from hepatic disease, for which mercury had been administered in large quantities, resulting, as often happens, in a swollen and highly sensitive state of the gums, extensive decay of the teeth, and extreme nervousness of the whole frame. It was painful to think of the extraction of so many stumps and teeth as the irritated and inflamed condition of the mouth required. In

one so sensitive, with a liver so congested, and with such disturbance of the nervous system, I could not permit chloroform to be used. I had no scruples about congelation, for it is harmless, even if not so effective. At my suggestion my patient went to London, a distance of one hundred and sixty miles, consulted you, and had a large number of teeth and stumps extracted, which otherwise would have been impossible. My patient reports to me, on returning, *that no pain whatever was suffered from the application of the cold* (a point on which I had been previously somewhat sceptical); *that the teeth were removed without the slightest pain; and that there was no suffering in any manner afterwards; on the contrary, that the distressing exhaustion was saved, so usual in such circumstances.* Health rapidly improved. From this case (the worst, perhaps, that could be selected) it is right to infer that there is no danger, no pain, no after inconvenience from your peculiar method of congelation, and, consequently, that it is a great boon to the suffering; and its superiority over chloroform is immense, even where the latter could be used, which, in this case, could not be done without great danger to life.

GEORGE DUNN, M.D."

CASE IV.

The following history, as detailed by the patient, also a medical gentleman, renders further comment superfluous.

" University College, Hospital.

" Two years ago I was the unfortunate victim of an unsuccessful attempt to extract a molar tooth, which, resisting great force, at last broke, leaving the fangs in my mouth. These fangs gave no pain till a few months back, when, by their irritation, they caused frequent abscesses in the gum, attended often with a degree of pain, and always with awkward swelling. In consequence of this I applied to you for relief, and you promised me relief—and painless relief, too.

On this latter point, I confess, I was quite sceptical; but with how little reason will appear in the sequel. The stumps were examined, and it was evident that they were very tight—in fact, a very difficult case of tooth extraction; and I myself, knowing what tooth extraction was, from previous experience, could not but anticipate some pretty severe pain. Cold was applied gradually, until the gum was rendered bloodless and benumbed, *and this process caused not the least pain.* The forceps were introduced, and the stumps grasped and extracted. I felt no pain, *and certainly could not have believed the stumps to be out, until I saw them in the teeth of the forceps.* One was curved somewhat at its root, and dilated so as to get a very firm hold of the alveolus; this rendered its extraction longer than it would otherwise have been. The cavity *healed up with the greatest rapidity, in a perfectly healthy way.*

Such are the facts of the case, and I feel much pleasure in writing them out; indeed, I do feel it quite a duty to make them as public as I can, for the sake of individuals who have to undergo the notoriously painful operation of tooth-drawing.

JOHN C. THOROWGOOD, JUN.”

CASE V.

This case affords another illustration of that large class of patients, in whom it is of the utmost consequence to remove dental irritation, but where chloroform is inadmissible. I am permitted to quote a letter most considerately sent me by the patient's husband.

“*Castle Heddingham, Essex.*

“I am happy to certify that Mrs. Delacour had *fifteen* teeth and stumps extracted under your freezing process at two sittings. From the extreme irritability of the gums, it

would have been impossible for her to have undergone the operation by the old system. The anæsthetic use of cold in this case was invaluable and entirely successful. Abscesses had formed at the roots of the stumps; notwithstanding which, they, as well as the teeth, were extracted *without the slightest pain, or shock to the system, or any unfavourable results.*

E. DELACOUR."

CASE VI.

An emphatic answer is given by this instance to the allegation that the occurrence of painlessness under congelation is fortuitous; or that pain, if it be abolished at all, is abolished not by the congealing process, but by the power of faith or conviction on the part of the patient,—by, in short, a sort of electro-biological process. This patient, like many others, had been assured of the *utter impossibility* of a tooth being removed without pain by congelation. He however argued, as many argue, that experience was the only test, and that, if it failed, (as doubtless he thought it would,) he should be in no worse position than having his tooth out in the ordinary way, while there was the chance of its success. Amid much ridicule, contempt, and unbelief, he came to town, consulted me, and sends me the following as the result.

"*Belmont near Taunton.*

I have great pleasure in informing you that the operation performed a few days back, in the extraction of a double tooth for me by means of the freezing process, was perfectly successful, inasmuch as I was *entirely* free from pain. I will also say

that there was *no pain* while the tooth was being frozen ; and so satisfied am I with the results of my first visit to you, that I should not hesitate again to place myself under your hands.

JOHN MARSHAL."

CASE VII.

Another imaginary objection which has been raised against congelation, is met by this case, the type of many similar cases I have had under my care.

A patient of my friend, Dr. Williamson, of Brighton, had been suffering severely from neuralgia, &c., the effects of dental irritation. The hemorrhagic diathesis was manifest ; and he dreaded the removal of his teeth, not only on account of the pain, but also because on previous occasions he had suffered greatly from hemorrhage after the operation. A wisdom tooth and two contiguous stumps were removed without even the consciousness of the fact. A large wound was necessarily left where the teeth had been taken out ; but *no hemorrhage* as on previous occasions, or any other inconvenience, ensued. Dr. Williamson was present on the occasion.

CASE VIII.

Illustrates the value of congelation to those who are compelled to resort to *artificial teeth*.

My patient, a highly nervous lady, and peculiarly sensitive to pain, allured by specious advertisements, had a set of artificial teeth made and fitted on carious stumps. A few weeks afterwards, one of the stumps began to trouble her. This was followed in rapid succession by irritation in others ; and the artificial teeth were unavoidably put aside as useless. I found

no fewer than *twenty carious stumps* still within the mouth, ever liable to set up irritation. These were all removed without pain or inconvenience, and my patient now rejoices in the possession of dental proxies in a healthy mouth.

CASE IX.

The *pivoting of teeth*, an operation hitherto not much resorted to in this country, first, because of the intense pain of the operation itself, and secondly, because of the excessive irritation it sets up, promises to regain its reputation of being one of the neatest and most useful of dental operations. By congelation, the pain of the operation is abolished ; while, by a new method of pivoting, the subsequent mischievous effects are greatly prevented.

My patient, a clergyman of high distinction, consulted me respecting a decayed incisor tooth. Caries had eaten away too much of the crown to admit of stopping with gold. The fang being healthy, and the neighbouring teeth sound, I proposed pivoting, to which, after a little demur, he assented. The sensibility of the tooth was completely suspended by the freezing process. The diseased crown was cut off,—the pulp cavity was drilled out and enlarged,—and a new crown was pivoted on the old fang, without any of those indescribable sufferings ordinarily attending such an operation. No suppuration, swelling, or irritation followed, and the most inquisitive could not detect the artifice.

CASE X.

Regularity in the development of the teeth is of essential importance to personal beauty ; but it

is undeniable that in too many cases personal beauty is sacrificed to the mere dread of pain. Rather than suffer extraction how many yield to dental deformity for life. The obstacle is now, by congelation, removed. It is no longer painful for the mother to witness the requisite interference of the dentist in aiding nature in the development of her child's mouth. Neglect now is a folly, which the tenderest compassion cannot pardon.

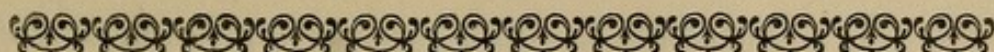
One of the most amiable, most tender-hearted of mothers, consulted me respecting her daughter a really handsome *brunette*, but with an unfortunate protrusion of the two canine teeth. The jaw was too contracted to allow of these,—the latest developed of the permanent teeth,—occupying their appropriate places in the mouth. Entreaty had been as vain to induce her to consult a dentist, as the mother's feelings had been compassionate. Nor until the assurance of friends had inspired confidence, could mother or daughter resolve upon the remedy of an evil so detrimental. It was necessary to extract two of the posterior teeth before the displaced ones could be brought down. This was done without the slightest suffering. By regulating their descent, the dental arch was filled up, and perfection of feature restored.

CASE XI.

There are instances in which necessity inspires fortitude. When a tooth is troublesome from obvious decay, resignation to the fate becomes more tolerable. But when a tooth is perfectly sound, and yet must be sacrificed on account of extraneous irritation, acquiescence is not so easy or congenial.

Cases ever and anon come under our notice, in which the extraction of sound teeth is imperatively demanded for the health of the patient. A patient was lately confided to me by one of our most eminent surgeons, who was suffering from a troublesome facial tumour, and in whose debilitated state it was of the utmost consequence to spare the nervous system of shock, but chloroform could not be used. Our opinions coincided, that the only desirable method of reducing the tumour was by sacrificing a tooth. This sacrifice was made in the composure of painlessness ;—the tumour was liberated of its contents through the cavity in the jaw, and forthwith disappeared. I have seen several such cases. But cases are more common in which, from some peculiarity in the wisdom teeth, severe facial pain and irritation are endured to exhaustion before extraction is resorted to.

A patient of Dr. Protheroe Smith lately consulted me respecting a long-continued severe pain proceeding from the wisdom tooth, and extending over the face, especially when in the reclining posture. The tooth was perfectly sound, but as it was useless in the mouth, I advised extraction. Nothing short of a painless operation could secure acquiescence. Of this I gave assurance, and the result fully confirmed it, the tooth, a very large one, being removed with entire freedom from pain. Dr. Hansom, of Mayfair, was present during the operation.



APPENDIX A.

THE APPLICATION OF COLD TO PRODUCE INSENSIBILITY TO THE PAIN OF STOPPING TEETH.

IN the foregoing pages I have dwelt on the anæsthetic uses of cold for the purpose of dental *extraction*. Modern dentistry, like modern surgery, has come to be *conservative* as well as radical. Not every limb that happens to be diseased only in part, is made to part company with its proprietor, as in olden times. So, not every tooth on which decay has fastened its corroding touch need be sacrificed. As in the one case, so in the other, the diseased portion may be excised, and a useful organ saved. The preparatory processes of stopping teeth, (as this conservative practice is called,) are not unfrequently attended with considerable suffering,—so much so as to be brought into comparison by many individuals with the pain of actual extraction. In consequence, various palliative measures are ordinarily resorted to by dentists in such cases, to bring the tooth into a fit state for surgical interference ;—which measures, always attended with delay, are sometimes painful, and at the best are very capricious. Even if the pulp cavity be *not* exposed, the osseous substance itself of the tooth is often so sensitive to the slightest touch,—nay, is such a delicate thermometer registering every waft of air, warm or cold, as to preclude the tenderest contact of excavating instruments. And if the pulp cavity *be* exposed, relief usually comes not to the patient under the ordinary process, without a previous ordeal of some hours' intense suffering, during which some vile escharotic is destroying its vitality.

It was in a case of the former kind that I first discovered the value of anæsthetic cold for the purpose of stopping decayed teeth. A lady had suffered considerably from a carious tooth, which was nevertheless not beyond conservation, provided the diseased portion could all be removed and the cavity plugged. Herein lay the difficulty. The slightest contact of an instrument was attended with excruciating torture. To attempt to stop a tooth so sensitive, is contrary to the rules of dental practice, for it is only doing that which must shortly after be undone with far greater difficulty. To reduce the super-sensibility by palliative measures for some days, is the usual practice in such cases. Instead of resorting to these ordinary palliatives, I submitted the tooth to the influence of congelation, and with the happiest results. After a few minutes' application, all sensation in the tooth subsided, and so completely, as to allow of the diseased portions of the cavity to be wholly removed by excavating instruments, drills, &c., and the cavity at once permanently filled, without the patient's consciousness of anything unusual being done. The tooth has remained to this day perfectly free from pain, and will probably not quit its present tenancy for many years to come. I could give the history of many similar cases of which this was the herald ;—it sufficeth to illustrate that one important class of dental operations, ordinarily eschewed by the dentist, and as much dreaded by the patient, is deprived of its repulsiveness and terrors.

Encouraged by frequent successes in the former class of cases, I immediately made use of cold to benumb the nerve itself in *exposed* cavities, so as to render it insensible to the destructive process necessary to be employed. This I have been enabled to accomplish, not by the tardy and painful process of escharotics, but by an immediate drilling out of the nerve from the cavity, or by instantaneously destroying it with the actual cautery, by means of a galvanic battery ; thus

accomplishing in a moment *without pain*, that which, under the ordinary process, takes hours to achieve, and these hours often spent in writhing agony.

In the *pivoting* of teeth, cold is equally serviceable. The sensibility of the fang into which the pivot is bored can be so destroyed, as that the operation may be freely proceeded with, without delay, and without pain.



APPENDIX B.

THE POWER OF COLD TO RELIEVE TOOTHACHE.

UNWILLING as I am, to appear to add to the proverbially innumerable nostrums for the cure of toothache, I must yet be permitted to advance the claims of congelation from experience,—more especially as it makes a confident appeal to reason. The first case of this kind arose casually on my own person. While trying some experiments with the congelation process on my own teeth, I was troubled with severe aching in one of them, and with which tooth I endeavoured to prevent the congealing process coming in contact. Despite my endeavours this aching tooth got frozen, and from that moment all pain disappeared in it, nor did the pain again return. Thenceforward I proceeded to apply cold in cases of simple toothache unconnected with extensive caries, and with the most gratifying results.

At p. 12, I have adverted to the peculiar severity of the pain of toothache, as arising mainly from the enlargement of vessels, &c., in a confined and unyielding cavity. At p. 51, and in other parts of this essay, I have explained the action of cold upon blood-vessels,—contracting and unloading them. It will thus readily be conceived, how a proper administration of cold will relieve or cure ordinary toothache. Whether the

pain arise from inflammation of the pulp cavity within the tooth itself, or from inflammation of the periosteal membranes of the socket encircling the tooth, the cold has one and the same antiphlogistic effect. It induces contraction in the vessels distended by inflammation, and disgorging them of their superabundant blood, enables them to regain their normal tonicity, whereupon the painful symptoms disappear.

I am satisfied that the forceps have too often done an irreparably destructive work. The anodynes in ordinary use for the relief of toothache, are confessedly ineffectual when the inflammation resides in the socket. They have no power to arrest the progress of the disease, and extraction is the only recognised resource. Cold, judiciously applied, *has* the power of at once checking the disease, and consequently of saving many sound and healthy teeth, which are usually sacrificed to an inflamed socket. I have, indeed, in practice found it very necessary to use great discrimination. Every tooth that a patient writhing in agony asks to be removed need not be sacrificed, With a curative power at hand, refusal of compliance, is discretion:—the pain vanishes under the sedative influence of the cold, and a useful tooth is saved. In this view, cold is redeemed from the insignificance attaching to toothache nostrums. It is no hypothetical medicine sealed up in boxes and delivered for thirteen-pence-halfpenny, but it is an agent, the curative virtue of which, rests in its harmony with physiological laws.

Other uses of this anæsthetic agent in dental surgery, remain to be developed. As lowly lichens form the first carpeting of uprising ocean islets, on which afterwards wave the forest-tree amid the melody of birds, so is the historical development of ideas into the region of fact. Many applications of congelation in dentistry, as yet problematical or but dimly foreshadowed, may be confirmed by the brighter sunshine of progressive experience. For these, let us be content to wait.

