

Franklin Bucke.



INAUGURAL THESIS,

ON THE

TREATMENT OF EXPOSED DENTAL PULP,

PREPARATORY TO THE OPERATION OF FILLING:

FOR THE DEGREE OF DOCTOR OF MEDICINE,

SESSION OF 1843-4, IN THE JEFFERSON MEDICAL COLLEGE.

BY J. D. WHITE, M. D., D. D. S.

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TO THOMAS D. MUTTER, M. D., *Professor of the Principles and Practice of Surgery, &c., &c., in the Jefferson Medical College of Philadelphia* :—

As an humble token of respect for your many virtues, and the high place you occupy in the estimation of the public and the profession, for the valuable improvements you have introduced into the medical art, and the profound judgment which marks your very brilliant career as a *teacher* and *practitioner*, this paper is gratefully dedicated, by

Your faithful and obliged friend, J. D. WHITE.

Franklin Bache, Esq. 9 1/4.

INAUGURAL THESIS.

A proper method of treatment of the dental pulp, when exposed by decay of the bone, is a branch of the healing art so full of interest to every individual, and especially to the physician and dental practitioner, as to need no apology from me, for selecting it as the subject of the present essay; and as it is a subject both intricate and interesting, it will not be surprising to find methods of treatment numerous and contradictory in proportion, urged too, with considerable parade by the empiric as well as the better learned, and that withal, neither have settled upon any thing sufficiently certain to commend itself to the suffering patient.

As an accurate knowledge of the anatomy, *physiology* and *pathology* of the teeth is indispensable to a proper understanding of the treatment, I will proceed to their consideration in as concise a manner as the nature of the subject will allow.

THE ANATOMY OF THE TEETH.—Anatomists have divided a tooth into three parts, viz: a *body*, or *crown*, a *neck*, and a *root*. The body is that portion which appears above the gum, and is indispensable to the proper performance of the function of mastication. It is protected by a semi-transparent crystalline and insensible substance, the enamel. The neck is embraced by the gum; it is about a line in breadth, and intervenes between the cessation of the enamel and the margin of the alveolus. The remaining part is the root, which articulates by the *gomphosis* articulation with the alveolar processes of the maxillary bone. "The teeth are composed of an *organic* and of an *inorganic* substance, are sparingly supplied with blood-vessels and nerves, from which they derive vitality and nutrition, and an exquisitely modified degree of sensibility."

"There are three different textures entering into the composition of the structure of a tooth; two of these are peculiar to this organ, viz: the *ivory*, which forms the body and root, and the *enamel*, which invests the crown of the tooth. The third texture, the *cementum*, is analogous to the *crusta petrosa* in the teeth of animals, and bears a very close resemblance to true bone in its structure."

STRUCTURE OF THE IVORY.—“The ivory of the tooth, both in man and animals, shows it to consist of a series of minute fibres, which give off branches from point to point, and terminate in an exceedingly delicate arborescent ramification. They are believed to be tubular. The larger ends of these tubular fibres open upon the surface of the cavity of the tooth, while the smaller and ramified extremities terminate at the surface of the ivory; the inter-tubular spaces being occupied by a transparent and very dense ivory, in which the minute branches of the tubuli find room to ramify.”

STRUCTURE OF THE ENAMEL.—“When the enamel fibre is closely examined, it appears marked at pretty regular distances by transverse lines, the interspace between each of these lines being occupied by a minute crystalline hexagonal block, and the entire fibre being composed of a continuous series of such blocks. These transverse lines are composed of the proper *enamel membrane*, which bind together all the crystalline fibres of which the enamel consists. It is also a bond of union between the enamel and the ivory.”

STRUCTURE OF THE CEMENTUM.—“The cementum is a later production than the two preceding textures; it is absent in the early periods of the formation of the tooth, and is developed only as age advances. Two opinions are received with regard to its mode of formation. According to the first, it results from ossification of the investing membrane of the root of the tooth; and, according to the second, it is due to a true secretion from this membrane. The cementum forms a thin layer, which invests the entire root of the tooth, from its neck to the extremity of its fang, where it is thicker than at the neck, and as age advances, it is deposited upon the surface of the dental cavity. This deposit commences at the upper part of that cavity, and gradually increases with the years of the individual; in very old persons it so completely fills the dental cavity, as to leave behind no rudiment of its previous existence.”

THE BLOOD-VESSELS OF THE TEETH.—“The arteries which supply both the upper and lower jaw, and which transmit branches to the teeth, have their origin from the *internal maxillary* branch of the *external carotid*. This vessel, after giving off small branches to the ear and the sphenospinal artery, to be distributed to the dura mater, parts with the inferior and superior maxillary branches, which passes downwards between the pterygoid muscles, to the posterior maxillary foramen. In its course through the canal of the lower jaw, it sends branches to every tooth beneath which it takes its course, and sending forward others to the incisors, it emerges from the bone at the mental

foramen, and is ultimately distributed to the chin and lips, where it anastomoses freely with the branches of the facial."

"The upper teeth receive their supply of blood from two branches. The molares from the *alveolar* or *superior maxillary*, which, taking its rise behind the antrum, enters the posterior part of the bone, by the foramina of its tubercle, and its branches are distributed to the three molar teeth, to the posterior part of the membrane of the antrum, and to the substance of the bone. The infra-orbital branch arising behind the orbit, passes through the infra-orbital canal, sending branches, in its course, to the bicuspides, cuspidatus and incisors, as well as to the antrum maxillare and adjacent parts. It makes its exit at the sub-orbital foramen, and finally ramifies over the cheek, where it also communicates with the branches of the facial artery. The veins by which the blood is returned from these parts, after following the course of the corresponding arteries, form the internal maxillary vein which terminates in the external jugular."

THE NERVES OF THE TEETH.—"The *fifth pair* of nerves consists of two distinct parts; a *sensitive* and a *motor* portion, is the grand medium of sensation to the head and face. Its sensitive part leaves the semi-lunar ganglion in three great branches—the *ophthalmic*, the *superior maxillary*, and the *inferior maxillary*. There is a fasciculus which passes by the ganglion, and unites with the third division, constituting the true motor portion of this nerve. It is only the *second* and *third* divisions of this nerve which I shall consider. The *superior maxillary nerve*, after distributing small branches to the orbit, the skin of the temple, and of the cheek, gives off the *spheno-palatine*, the *vidian*, the *palatine*, and the *alveolar*, whilst the trunk is continued under the name of *infra-orbital*. The vidian nerve forms the means of communication by its deep seated branch, with the great sympathetic nerve. The palatine branch is distributed to the palate, the membrane of the mouth and the gum, besides small branches to the nose, and others to the tonsils, &c."

"The *ALVEOLAR* branch of the superior maxillary, after giving branches to the cheek and buccinator muscles, enters the maxillary bone by small twigs through the little foramina in the tubercle, and supplies the whole of the superior molares. The trunk of the nerve, assuming now the name of *infra-orbital*, passes through the canal of that name, and whilst in its passage, gives off the branches which supply the incisors, cuspidatus and bicuspides, after which it emerges through the infra-orbital foramen, and is spread out upon the cheek, constituting the principal sensitive nerve of that part of the face. The

third division of the fifth pair, the *inferior maxillary nerve*, after distributing small branches to the neighboring muscles, &c., divides into two important nerves. The first is the *gustatory*; the second, the proper inferior maxillary nerve. A branch of the gustatory, by traversing the petrous of the temporal bone, in a retrograde direction, unites itself with the portio dura of the seventh pair, forming the *chorda tympani*. The trunk of the inferior maxillary nerve, entering the posterior maxillary foramen, passes through the whole length of the canal, giving branches to all the teeth under which its course lies; arrived at the mental foramen, it sends a branch forward to supply the incisors, and, emerging upon the skin, is distributed to the integuments and muscles of the neighboring parts."

THE FORMATION OF THE TEETH.—“About two months after conception, if the jaws be examined with care, an extremely soft jelly-like substance is found lying along the edge of each maxillary arch. At the third month this has assumed rather a firmer consistence, and is contained within a shallow groove of bone, which constitutes the first step towards the formation of the external and internal alveolar plates. At this period the pulpy substance becomes partially divided into distinct portions, and corresponding filaments of bone are seen shooting across from one side to the other of the bony groove, to form the future transverse divisions of the alveoli. These pulps are the rudiments or bases upon which the teeth are formed. At this time they lie upon the vessels and nerves which run along the bottom of the groove, and each is partially enclosed in a membrane or sac.”

“At the fourth month, a small point of ossification is found upon certain of the pulps, and this is the commencement of the formation of the bony substance of the teeth. The ossific matter is secreted from an extremely delicate, thin, vascular membrane, which covers the surface of the pulp, and is closely attached to it by vessels. This membrane, which is termed the proper membrane of the pulp, is a propagation of the periosteum of the jaw. The sac which envelops the whole is thick in its texture, and consists of two lamellæ, which are easily separable after a short maceration. These lamellæ are both vascular. This membrane is not attached to the pulp, except at its base, where the vessels enter; nor originally to the bony rudiments of the teeth, but only loosely surrounds them; its external part is, however, most intimately and inseparably connected with the gum, from which source it is supplied with its vessels and nerves, whilst the pulp and its proper membrane derive *their* organization immediately from the dental branches. The bone is first deposited on the points of the teeth, and

assumes by degrees the appearance of a thin shell, covering the pulp and its proper membrane, which retire, as it were, as the bone continues to be deposited. It is obvious, therefore, that the bony shell is interposed between the pulp with its membrane, and the investing sac. When the shell of bone has proceeded so far as nearly to cover the original form of the pulp, the alveolar processes having become more developed, and consequently the alveoli deepened and more perfectly separated by the growth of the transverse plates, the pulp elongates at its base to form the root. It will be seen by the foregoing, that the outer lamina of bone is first completed, and that after lamina is deposited one within the other, the pulp still receding, until at length there remains only the permanent cavity of the tooth, lined with its proper membrane and filled with the remaining portion of the pulp, which now serve as the bed upon which the vessels and nerves ramify, previously to their entering the bony substance of the tooth."

THE FORMATION OF THE ENAMEL.—“When the bony shell has extended as far as the neck of the tooth, the external membrane or sac attaches itself closely to this part, though still loosely investing its body. At this time a remarkable alteration takes place in its substance, which becomes thickened and much more vascular, particularly the inner layer, over the whole internal surface of which the vessels may be seen obviously enlarged, and capable of receiving a much more perfect injection. The object of this change in the condition of the membrane is to produce the increased supply of blood required for the secretion of the enamel. It now begins to pour out from its internal surface a thickish fluid, which is speedily consolidated into a dark chalky substance, and afterwards becomes white and hardened by more perfect crystallization. This is the enamel. It is first deposited on the points at which ossification had commenced, and by degrees covers, in one continuous layer, the whole crown of the tooth.”

ENUMERATION OF THE MEMBRANES OF THE TEETH.—“The membranes which have been described, may be divided into *deciduous* and *persistent*. The deciduous membranes are the two lamellæ, which, forming the sac which envelopes the rudiments, secretes the enamel from the internal surface, and then becomes wholly absorbed. The *persistent* membranes are, first, the internal periosteum of the dental cavity, which, during the formation of the tooth, had performed the office of secreting the bone; and the periosteum of the root, which doubtless is a reflection of (3d,) the periosteum of the alveolus, of which that of the cavity just mentioned, is also most probably a production, according to the views of Dr. Blake. Thus the periosteum of the maxillary bones must

be considered as the origin from which these three persistent membranes are derived."

THE ORGANIZATION OF THE TEETH.—On this subject there is a wide difference of opinion among authors, consequently it will be difficult to arrive at a positive conclusion; but the majority of physiologists at the present day, contend for the vascularity of the teeth as the only true view which can be taken, explanatory of the diseases to which they are liable. Still, however, many believe, with the celebrated Hunter, that they are entirely devoid of vascularity. This eminent writer rests his opinion principally upon the fact, that "he could not succeed in injecting them with coloring matter; neither could he trace vessels from the pulp to a growing tooth." "In growing animals fed upon madder, he found that the portion which was formed previously to the commencement of this diet retained its primitive color; whilst the part formed during the administration of the diet was affected by it, and turned red. Again, if the animal were permitted to live some weeks after the madder was suspended, to the preceding condition would be superadded a new layer of white." An eminent writer of this city, Professor Horner, affirms "that these experiments, which are confirmed by my own observation, prove satisfactorily the total absence of blood-vessels in the texture of the teeth, and that the coloring matter, when fixed in them, does not depend upon a circulation, but upon its being deposited as the teeth grow, and left there permanently. The teeth are consequently not subjected to a commutation of particles, and to being continually remodeled as the bones are; but when once formed they remain in the same state without change."

Mr. T. Bell, on the other hand, asserts that "the coloring matter used for injecting hitherto, is composed of particles too gross to pass into vessels of such extreme tenuity as those of the teeth must necessarily be;" and as a proof observes, first: "I frequently examined the teeth of persons whose death had been caused by drowning or hanging, and invariably found the whole of the osseous part colored with a dull, deep red, which could not possibly have been the case if their structures were devoid of a vascular system." Second: "In many instances on purposely breaking a tooth immediately after extraction, where the pain and inflammation had been severe, found *distinct red patches in the very substance of the bone.*" He further observes: "It often happens that, in consequence of the use of mercury, or from dyspeptic affections, the gum and the edge of the alveolar process recede from the neck of a tooth, which thus becomes exposed, and if this part be then touched with a hard instrument, pain is immediately produced, which is always

increased when the part is inflamed. It is obvious that the *periosteum* is not the seat of this pain, as that membrane is also absorbed to the same extent as the gum and the alveolar process are lost, and the bone of the tooth is in all these cases absolutely denuded."

Again, he says: "In filing the teeth, no pain is experienced until the enamel is removed, but the instant the file begins to act upon the bone, the sensation is exceedingly acute—the result certainly of the actual presence of nerves in the substance of the tooth itself."

Indeed, every dentist must be familiar with the fact, that the necks of many teeth become exceedingly sensitive when embraced too tightly by metallic bands for retaining in the mouth a partial sett of artificial teeth; and every dentist in successful practice, in attempting to plug teeth, must daily meet with an extremely tender condition of the bone in the teeth of young persons, and even in some who are advanced in life, immediately beneath the enamel, and sometimes through the whole substance of the bone, which is so acutely sensitive to the touch, as to render it impossible for the patient to bear the part to be properly prepared for the operation of plugging, until the sensibility by some means is removed, which, if properly managed, is very easily done without the least pain, or injury to the pulp, and then the part can be cleansed of all decayed particles without exciting the slightest painful sensation; a fact, in the absence of all other proof, conclusive of the presence of nerves. Some contend, (Goodsir, Lintott and others,) that the tooth-bone, or ivory, receives its nutrition by the imbibition of fluids through tubuli, which commence by open mouths upon the walls of the dental cavity, and not by the passage of blood-vessels. It is probable that very dense and insensible teeth of *adults* are only nourished by the above process; but it does not seem probable that the teeth of *young* persons are also free from a vascular circulation.

PATHOLOGICAL CONSIDERATIONS.—When the pulp of a tooth becomes exposed to the air and fluids of the mouth, by a loss of a portion of the bone, it exists but a short time without becoming subject to active inflammation, and generally, too, of a very high grade, giving rise to acute pain, which may extend sympathetically to neighboring parts—the tongue, ear, temple and palate, and not unfrequently producing high febrile excitement of the whole system. Sometimes acute inflammation travels along the entire course of the pulp, passes out of the foramen at the apex of the root, and attacks the external membranes, the jaw and gums, occasioning intense pain and throbbing in the parts, when it produces what is termed "alveolar abscess." At this period the whole of the pulp sloughs at the apex of the root.

Indeed, so extensive are the injuries done to a tooth in such a case, that it rarely ever becomes useful in mastication, especially if it be one of the molares; for there is either a permanent thickening of the membranes of the alveolus left, which renders it tender on pressure, and extremely liable to re-attacks of acute inflammation, (and more so in some patients than in others,) or a *pyogenic* membrane is formed over the apex of the root, which keeps up a continual secretion of pus, requiring a fistulous opening in the gum for its exit, which is very annoying, if not injurious to the health of the patient; and if the abscess remains for any length of time, it will excite absorption of the alveolus and adjacent parts, and sometimes produce deformity of the face, and in irritable temperaments it may likewise occasion disease of a malignant character, which cannot be cured. This is certainly the most violent form of inflammation that can possibly attack a tooth; yet, withal, some recover in good constitutions, and become very useful in mastication, but in mild attacks of inflammation and sloughing of the pulp, without involving to any extent, the external membranes and neighboring parts, the inflammation may subside, and the tooth exist without occasioning any irritation of consequence, and if firmly plugged with some pure metal, may subserve all the purposes for which it was by nature intended, for many years. Taking a hint from this, it is no more than rational, nay, the duty of the dentist, to endeavor, by remedial means, to render every case a mild one, or accomplish the same result in all cases where decay of the bone has extended so far as to expose the pulp. It is the least of two evils to resort to a destruction of the pulp. But we are told by the experienced and well educated of the profession that the destruction of the blood-vessels and nerves of the teeth should never be attempted in any case, for the purpose of plugging; for a loss of the internal pulp renders a tooth a dead substance and foreign body.* I cannot, and for several reasons, among which are the following, understand how this conclusion can be just.

1st. The alveolo-dental membranes receive their supply of blood from the periosteum of the alveolar processes. Mr. Bell asserts that the adhesion of the periosteum to the root is so firm as to prove its vascular connexion with the osseous substance of the tooth. If this be the case, then, just as long as this periosteum is in a healthy state, so long will there exist a healthy vital connexion between the root, alveolar process and gum.

2d. It has not been shown that ~~as~~ the dental artery, just before it passes into the foramen at the extremity of the root, does give off

*Bell, Goddard, Harris, and others.

all the branches which supply the periosteum of the root: and if it does not, what interruption can there be to the circulation of that membrane, when a branch only of the proper artery is destroyed within the dental cavity?

3d. We know that teeth will remain in the jaw for many years in a healthy condition, after the pulp has been dead, a circumstance which could not possibly happen if the vitality was materially interfered with.

A gentleman from Boston called on me last summer to consult with me about the health of his teeth. I found but one in his mouth the least defective, and that had been plugged thirty years ago by a distinguished dentist of that city, Dr. Flagg. The pulp had been destroyed entirely at that time, by thrusting a small probe down the root. It has never given the slightest pain since. Mr. E. Baker, of New York, says, in the *Am. Jour. of Dent. Science*, vol. 1, No. vii., p. 171, that, "there is seldom little, and often no inflammation in a tooth after being treated in this manner, and what is of very great importance, there is very seldom a gum-boil, provided the operation has been performed with competent skill. The late Mr. Hudson," he adds, "of Philadelphia, who certainly has not been excelled, if equalled, as an operator, followed this practice more than thirty years since, and teeth treated by him in this manner, remain to this time." If the tooth receives the greatest part of its supply of nutrition from the pulp, is there not as much reason to believe that the periosteum can supply sufficient to keep it in a tolerable state of health, as well as when the principal supply of blood is cut off from any other organ of the body, as, for instance, tying the femoral artery? As the dental pulp receives its supply of blood only from a filament of the dental artery, its circulation would seem to be almost as independent of the external membranes, as that of one finger of the hand is of another; and, to my mind, if a proper method of treatment be adopted, the success with which the pulp can be treated without necessarily involving the external membranes, is equal to that with which the skilful surgeon can treat a severe injury of one finger of the hand, without interfering with the health of either adjacent. But it may be said that the two cases are different, because one is more vascular than the other. We admit it; but the one requires a greater proportion of nutrition than the other to keep it in a vital condition, because the changes in the one ^{are} more rapid than in the other.

As an evidence that teeth do become foreign bodies, Mr. Bell alleges, that when gangrene has extended so far as to destroy the whole of the crown of a tooth, that the process seems to be arrested,

and the roots remain "dead extraneous bodies in the sockets for years, without undergoing any apparent change, and seem no longer subject to disease, and even supporting neighboring teeth, till one of three different actions is set up to effect their removal, viz:—1st. Absorption of the alveoli and gums occur to such an extent as gradually to loosen the roots, by depriving them of their support. At the same time, also, a deposition of bone takes place at the bottom of the socket, which, by degrees, forces the root into the substance of the gum, until it may often be seen lying horizontally embedded in that substance, without any attachment to the bone, or the slightest lodgment in the socket; and in the third place, the roots themselves undergo absorption at their extremities, so that at length a very small portion only is, in many cases, found to remain."

He gives a case where he found the roots had become entirely absorbed, the crown broken down by gangrene, and the neck still grasped by the gum. It is inexplicable upon physiological principles, how the gum could continue its attachment to a dead ring of ivory, as this must have been, according to the opinions of those authors whom I have cited; for the roots and crown were entirely gone. But, so far from its being a *loss* of vitality which renders the roots of teeth less liable to gangrene after their crowns have been removed by that process, the contrary, I think, will appear most evident. Mr. Bell asserts that the roots of teeth will sometimes be found lying horizontally upon the gum, without any attachment to the bone, or lodgment in the socket, which is entirely filled up with ossific matter. How can a root cling to the gum after it is displaced from the socket, unless the surface with which the gum is connected still retains a high degree of vitality? The deposition of bone in the bottom of the socket, is doubtless the result of long-continued inflammation of the periosteum of the alveolus, which, of course, would elevate the root, as it would afford a greater resistance than the soft and yielding attachments of that cavity. Now, if the roots in such cases are entirely "dead substances," or "foreign bodies," they will be cut off from their connection with the socket and gum, as dead portions of bone are in other parts of the body—*exfoliation* would be the inevitable result. The three different actions enumerated by Mr. Bell as means employed to get rid of the dead roots, are not actions set up to effect that purpose, but merely effects of a single cause, viz:—inflammation, operating to produce the same phenomena here as in other parts of the body similarly circumstanced.

Necrosis is the total death of a bone: it rarely occurs to the teeth, and the only difference between it and gangrene, according to Mr.

Bell, is, that *necrosis* is caused by a sudden destruction of the vitality of a tooth, and gangrene comes on gradually; or, in other words, that when the crown of a tooth is entirely destroyed, and the internal membrane by gangrene, it is entirely analogous to *necrosis*, and accounts for the *fact*, as he is pleased to term it, that the roots of teeth are exempt from gangrene, and remain, on that account, so long in the alveolar processes without undergoing any change. From what I have said before, I need scarcely add, that instead of it being a *loss* of vitality which puts a stop to the progress of disease, it is the high degree of vitality, together with the protection afforded by the gum and socket. From the action of external agents, we can observe roots decay, until there is only a thin cylinder of bone left in the socket, which the roots possess over that of the crowns, and almost independent, too, of the pulp. The pulp only gives vitality and sensibility to the crown and surface of the dental cavity, and if it were not for the air and fluids of the mouth which find their way through the foramen at the apex of the root, and producing inflammation of the external membranes, or inflammation continued to them from within,—when the pulp is diseased or destroyed, it would not interfere in the least with their healthy function. The pulp, when exposed, must forever remain in a pathological condition, and the object of the practitioner should be directed to promote the greatest comfort and safety to the patient.

THE TREATMENT OF THE DENTAL PULP.—The treatment of the exposed pulp has given rise to great difference of sentiment among well educated dentists, but mainly about the *means* which should be employed for that purpose, agreeing pretty generally, that it is bad practice to destroy it entirely, or even a portion of it; but as well might we expect to procure a healthy function of the *rete mucosum*, when denuded of the *epidermis*, by substituting one of our own invention, as to procure a healthy function of the pulp when deprived of its natural protection—the bone. The various modes of treatment which have for their object the preservation of the pulp, must be of that order. When the pulp becomes exposed by decay or any other cause, the delicate vessels which ramify upon its surface are soon ruptured, as well as those which passed into the bone which has been destroyed; they pour out blood and serum, which must have exit through an external opening, or inflammation supervenes, and in a very short time establishes a suppurating surface. Any attempt to remove this pathological condition by medical or mechanical agents, must, of necessity, prove ineffectual. Notwithstanding this is the language of reason and experience, it is the object sought to be obtained by most practitioners

in dental surgery. *So long as the artery conveys blood to the pulp so long will there exist the necessity for an external opening and suppuration surface, unless the inflammation is so violent as to produce a slough of the whole pulp.*

ASTRINGENTS AND CAPPING.—This is a mode of treatment much extolled by some dentists. Dr. Fitch, in a work which I have before me, says: "I think the best practice will be, and is, to unite both, as I am in the habit of doing, which is, use the astringents for some time, and then cover the nerve with a cap of lead or gold plate, and complete the filling of the cavity with gold. If this practice be adopted by the dentist he will often save the tooth." Yet he frankly admits "in many cases it entirely fails." Now, if the cap could not save the tooth before the astringents were applied to the pulp, how can it do so afterwards? The therapist teaches that the effect of an agent that does not destroy the vitality of a part is of very short duration. Astringents do not in these cases destroy the vitality of the pulp, or the cap would not be used to protect it from pressure. Then, of course, it may return in a very short time to the very same condition in which it was found before the astringents were used, and give rise to all those evils which would have followed the application of the cap in the first instance. Professor Harris, of Baltimore, in speaking of the above method of treatment, says: "It is not recommended as infallible; and while I declare it has been more successful than any other that I have tried, candor compels me to add, that it has failed in more instances than it has succeeded. Indeed, I regard the propriety of plugging a bicuspid or molar after the nerve has been exposed, as so extremely doubtful, that I think I hazard nothing in asserting that however correct the preparatory treatment may have been, it will not be successful in more than about one case out of four." This is the experience with which the writer has met in adopting the above treatment, *or any other method which has for its object the preservation of the vitality of the pulp.* As great a proportion as this may be saved without any preparatory treatment whatever, if the pulp be not actually pressed upon by the stopping.

CAUTERIZATION.—This has been highly recommended as a means of destroying the pulp by some.* The author last cited observes, in a work which I have before me, "We have pursued this plan for fifteen years with uniform success." I believe the reason why Mr. Maury met with so much success is, that in the use of the cautery in any form, the nerve is destroyed and mostly removed as

* Koecher and Maury.

far as the instrument is passed into the cavity, and the further the better; for, if only the minute extremities of the artery, vein and nerve be left, the artery will contract with more energy than numerous small branches; hence, when the membrane only is exposed, blood and lymph will ooze out for days, defying astringents; but if the nerve be removed far down in the root, the bleeding will cease in a few minutes, or hours at farthest, and it matters not whether this be done by thrusting into the roots a cold or a hot instrument; the pulp is destroyed in both instances, and this is the principal indication to be met in the treatment of the pulp. We can, and justly too, compare the exposed pulp to a small and extremely vascular tumor, the mere puncture of which would establish an irrepressible hemorrhage; but cut away the whole mass, and one single act of *torsion* upon the main trunk would immediately arrest it. From my experience, the *actual* cautery is the best means of destroying the pulp where it can be properly applied, as in the roots of the front teeth, where it needs but one or two applications to remove the whole pulp, and I can affirm with Mr. Maury, that I always succeed in my treatment of a tooth where I can apply it properly; but I never use it now, except in the front roots, preparatory to setting teeth on pivots, and the gum does not swell after the operation, as is common when this method of supplying teeth is adopted. Inflammation does not often follow the use of the actual cautery, if it is not too large, and applied too often; but if it come in close contact with the parieties of the internal cavity, and be retained for an instant, it will exalt the heat of the root so much as to inflame the alveole-dental membranes, (and, of course, abscess *may* be the result;) it therefore requires great care in its application. Some merely "*touch lightly*" the pulp, so as to produce an *eschar*; in so doing, the whole pulp in many cases becomes inflamed, and causes intense pain; but if in such cases the entire pulp be destroyed, the pain immediately ceases. Mr. Bell deprecates the use of the actual cautery as well as all corrosive acids. He says: "The first and speedy effect of their application is to produce extreme inflammation in the membrane, with such intense suffering as often to demand the immediate removal of the tooth." He abandons the use of any agents, therefore, which have a tendency to destroy the pulp, as improper, and recommends the following mode of treatment, by

STIMULANTS.—"Under favorable circumstances, the sensibility of the membrane may be removed or its absorption produced so as to render it capable of receiving the stopping without pain or any subsequent inconvenience. Judging from my own observation, the continual

application of a moderate stimulus, such as *alcohol, spirits of camphor*, a solution of the nitrate of silver, &c., will be found a more safe, as well as efficacious mode of treatment than any attempt at destroying the membrane." He further adds: "It is not, perhaps, easily determined, nor is it of much importance, in what way these applications produce effect; whether by occasioning the actual absorption of that part of the membrane to which they are applied, or by gradually wearing out, as it were, its sensibility; it is sufficient that experience proves them to be efficacious." I think this is a subject on which it is of great importance to know upon what principle a remedy acts. If these applications only wear out the sensibility of the part in which they are in contact, they will often fail upon the same principle as the astringents do; but if they cause the absorption of the whole pulp, they succeed upon the same principle as that of the cautery, properly applied. Exposure to the air and fluids of the mouth for a time will often produce the same results, namely, "wearing out the sensibility," and absorption of the pulp, or sloughing, without any subsequent inconvenience for a long period. To prevent the evils which arise from the accumulation of fluids in the pulp-cavity, when the functions of the pulp have only been *suspended* for a time by astringents, &c., and the external cavity plugged, some have introduced the practice of penetrating the neck of the tooth with a small drill, where the margin of the gum overlaps the enamel, so that the fluids may have free exit. It is needless to say that this proves the uselessness of the first part of the treatment. Before I discovered that I could destroy the pulp without necessarily rendering the tooth a useless foreign body, and becoming itself a source of irrecoverable irritation, it was my practice to insert a small gold tube in some part of the stopping, believing it to be preferable to substituting one aperture for another. But this is never required if the pulp be properly treated.

THE CONCENTRATED ACIDS.—These substances have been highly extolled by some and deprecated by others. *Arsenious acid* is most commonly employed, and there exists great difference of opinion among dentists in regard to the manner in which it should be used; but I have as yet seen nothing satisfactory, as far as principle is concerned, as to the best mode of administering it. J. J. Greenwood, of New York, employs it thus: "Steep a lock of cotton in essence of peppermint, laudanum or alcohol; then dip a point of the lock in powdered arsenious acid, and apply it in close contact with the pulp." Dr. Ide, of Ohio, in a communication to the American Journal of Dental Sci-

ence, gives the following formula, which he has used with great success :—

R.—Arsenious acid, gr. iij.

Acetate Morphia, gr. ij.

Misce.

applied to the pulp on a lock of cotton. Dr. Spooner, of New York, in a work entitled "Guide to Sound Teeth," speaks of the use of arsenious acid in the highest terms. Dr. S. Brown, of New York, in the American Journal of Dental Science, says: "The arsenic should be applied on the extremity of a lock of cotton steeped in kreasote instead of water. The effect of the kreasote is to allay the pain which the arsenic alone would produce when acting on the living nerve." This method of using arsenic is practised by many dentists with whom I am acquainted, and with great success and less pain to the patient than is occasioned by it when used alone; but I think the reason assigned by Dr. Brown why it gives less pain when thus combined, is incorrect, and for the following reasons: 1st. The therapist teaches that arsenic destroys the vitality of living tissue by combining chemically with its constituents. 2dly. The chemist teaches that arsenic is largely dissolved in the essential oils, and sparingly dissolved in water. 3dly. The therapist teaches that if arsenic is not applied to a part in sufficient quantity to destroy vitality, it will be absorbed; and, 4thly, that if it is in a condition to enter into combination rapidly, and in sufficient quantity to produce a speedy slough, it is not absorbed. Now, kreasote dissolves the arsenious acid more freely, perhaps, than any other essential oil; it is therefore in a favorable condition to unite speedily and in large quantity with the pulp, and in proportion to the rapidity with which it unites and destroys vitality, will the pain be diminished. Taking this view of the subject, arsenious acid is, perhaps, the best agent that can be employed for destroying the pulp of a tooth, if it be properly combined with other substances; because it can be applied in all cases with equal facility, to the back teeth as well as to the front. A recent writer of this city (*Dr. Goddard*,) asserts that "The best plan is to clean out the cavity slightly, and apply to the pulp, as closely as possible, a very small quantity of pure *arsenious acid*. I say pure, because the common arsenic of the shops will not answer; and again, because many dentists are in the habit of using it with *sulphate* of morphia, to diminish pain, than which there cannot be a greater mistake, for the latter article both impedes the escharotic action of the arsenious acid and increases the pain. The arsenic thus applied not only destroys the vitality of the pulp, but it combines with

the animal matter of the pulp, and forms a compound incapable of putrefaction! It causes some pain for three or four hours, when it ceases, and in a day or two the tooth may be plugged." I have tried the above method of using arsenious acid, and sometimes fail to destroy the pulp by one application, but *never* fail to cause great pain. It is well known to dentists that arsenious acid when applied alone will not always destroy the vitality of the nerve, but will give intense pain, and produce acute inflammation, requiring the immediate removal of the tooth; and for the very reason that the arsenic is taken up by the absorbents, and excites inflammation of the whole pulp, without entirely destroying its vitality, and very frequently it is absorbed to such an extent as to produce intense inflammation of the alveolo-dental membranes and alveolar processes. Arsenious acid, applied in *any* form, pure or impure, if it cannot combine in sufficient quantity to produce a speedy slough of the part to which it is applied, will be absorbed, and do great harm, (and this is the reason why its use has been deprecated by the best dentists in this country;) and because it will not always destroy the nerve, but cause intense pain. That pure arsenious acid "combines with the animal matter of the pulp, and forms a compound incapable of putrefaction;" will not make it less objectionable than if the pulp be destroyed by any other substance; it will act as a foreign body in the internal cavity, and be a cause of continuing inflammation through the foramen at the end of the root of the tooth, and involve the external membranes. It may combine with any indefinite portion of the pulp; and if we produce the death of a part, it is indispensable to remove such portion, or it will itself become a cause of inflammation. It is found by experience to be so in the treatment of local diseases of other parts of the body, and I think the same facts will apply in the treatment of the pulp of the teeth, no matter what may be the nature of the compound of the dead tissue.

not
 Arsenious acid is undoubtedly the *destroying agent* in every form in which it can be used. A great many dentists use it combined with morphia, and with considerable success. I cannot understand why the preparations of morphia will obtund sensibility in some degree in the pulp of a tooth; they are employed with that view to other parts of the body,* and not without good effect. I know well that the sulphate of morphia alone will suspend pain in the pulp when it only arises from inflammation of that substance. I employ it constantly for that purpose, and sometimes combined with tannic acid, and always succeed

*They are applicable to all cases where the object is to relieve pain or allay nervous irritation in any shape.—*U. S. Dispensatory.*

in stopping the pain, even though it has been occasioned by the application of arsenious acid alone, if the external membranes are not much involved.

ARSENIOUS ACID, KREASOTE, AND MORPHIA.—This is, perhaps, the best form of using arsenic that has yet been devised. I have not seen it spoken of by any authors; there is no difference in the rapidity with which it unites with the pulp when the kreasote only is properly combined with it; but the morphia will exert its narcotic influence, and lessen the pain; an effect which we cannot ascribe to kreasote; the kreasote cannot be regarded in any other light than a mere vehicle.

R.—Arsenious acid, gr. xxx.
Morphiæ sulphas, gr. xx.
Kreasote, Q. S.

Misce.

Put the arsenious acid and kreasote in a glazed mortar, and grind them till the arsenic becomes impalpable, (adding kreasote to keep the mass of about the consistency of cream;) then add the sulphate of morphia, and mix it well, still adding kreasote; it will dissolve in the paste. Prepared in this way, the arsenic is in a better condition to unite speedily with the pulp than the mere dry powder of arsenic, on account of the kreasote holding a large quantity of it in solution, and it becomes more minutely divided. Great care must be taken to cleanse out the external cavity of the tooth, so as to place the paste in immediate contact with the pulp. A pledget of cotton about the size of a small pin's head, steeped in the paste is sufficient. If the pulp bleed when the cavity is cleansed, we must wait till the bleeding subsides before we apply the paste: the cavity may then be filled with cotton, and left in from ten to twenty hours. If it be in the tooth of a young patient, the bone will, perhaps, absorb a sufficient quantity of the arsenious acid to inflame the alveolo-dental membranes, and of course it should be removed in such cases in a shorter time than it could be left with safety in the case of an older patient, or a dense and opaque tooth. The reasons why I prefer this form of using arsenic, are: 1st. It destroys the pulp in a shorter time, and without pain, in more cases than any other form in which I have used it. 2dly. It less frequently causes inflammation of the external membranes than when applied alone; and, 3dly, it produces a more extensive and perfect slough of the pulp, and of course I can take out the pulp far down in the roots; a matter which should never be neglected, for reasons which I have given in another part of this paper, and on which depends, in most

cases, the success and permanency of the operation of plugging. It would seem that dentists have pretty generally overlooked the necessity of removing the pulp, under a false idea that the tooth is thereby rendered inevitably a foreign body, and consequently becomes itself a cause of inflammation. I consider the practice described at page 15 of this paper, of removing the pulp, as preferable to the use of acids, if it were not for the intense pain it excites, and would apply to the molar teeth. I do not think it proper to plug a tooth immediately after the pulp is removed, on account of the bleeding which follows it, unless the actual cautery is used; though sometimes the bleeding will be stopped when the nerve is torn out by a simple wire, as it acts on the small extremity of the artery as the operation of *machure* in common wounds; but if the artery bleed after the tooth is plugged, the clot will act as a foreign body on the extremities of the vessels, and cause inflammation, which will pass through the foramen at the end of the root, and attack the external membranes. I therefore leave the tooth, after removing the pulp, from three to six days, taking care to instruct the patient to wear a pledget of cotton in the cavity, and avoid masticating with it. When I examine the tooth, if it be in a proper condition, I plug it.

It may not be uninteresting to give a list of cases which I kept during April and May of 1842. In one hundred successive cases, the pulps were destroyed in eighty-four without pain; the remaining number, sixteen, gave pain, the average duration of which was one hour. The pain was most severe, and of greatest duration in patients of a strong nervo-sanguine temperament; but even in those cases, if the pulp had been subject to frequent attacks of inflammation, it rarely gave pain when the paste was applied. Again, patients of a scrofulous diathesis rarely suffered pain, whether the pulp had been previously subject to inflammation or not. I have extracted six of the above one hundred cases since the spring of 1842, on account of the development of alveolar abscess. The paste should not be allowed to spread over the walls of the external cavity, especially when applied in the teeth of young patients. It should never be applied in teeth when there is, on account of the age of the patient, reason to believe that the roots are not fully developed. If the pulp be destroyed, the further formation of the tooth will be arrested. Intense inflammation will be produced in the external membranes and jaw by destroying the pulp outside of the incompletely formed roots.* I was solicited by a

* The notice of the profession has not been called to this subject to my knowledge.

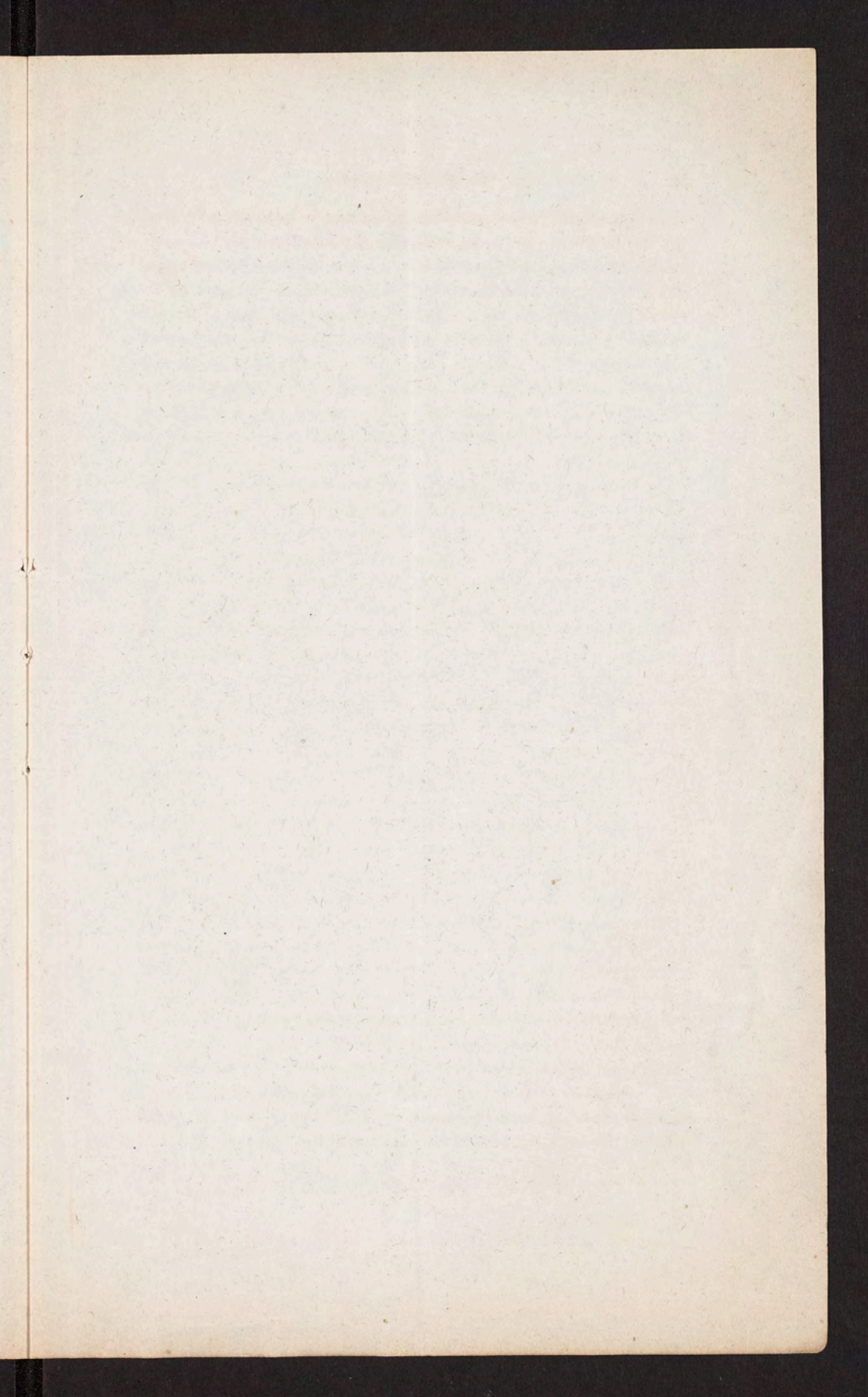
lady, about three years ago, to destroy the pulp of the first inferior molar for her daughter, who was between seven and eight years of age. I refused, for reasons given above, but not having confidence in my opinion, she sought advice elsewhere, and the dentist to whom she applied destroyed the pulp, as he said, and plugged the tooth; after which intense inflammation set in, the part was poulticed externally* to produce suppuration, and, as it was very extensively inflamed and swollen, it pointed outside opposite the tooth near the base of the jaw—the parent became alarmed, and applied to me again. I removed the tooth, as a matter of course, and found the roots of it incomplete, and the foramina large enough to admit a crow quill. There should, therefore, never be any attempt to save such teeth by plugging.

NOTE.—This thesis formed the basis of several articles already published, but it was never intended to see the light; still there is not a principle or mode of practice advanced in it, that subsequent reflection or experience has given any reason to suggest a change. The mutations through which the treatment of the dental pulp has passed, during the last twenty or thirty years, by many observers, and the apparent unsettled condition of the subject now, would not give any single one a very large share of credit for modifications or improvements up to the present time. Dr. J. R. Spooner, of Montreal, was the first, doubtless, to use arsenious acid as a substance to destroy the vitality of the dental pulp, but it has been rendered much more efficacious, by its proper combination with other substances suggested by other experimenters. The formula which has been given in the foregoing paper was suggested by the reflection, that the best solvent, the most powerful narcotic, and the most deadly poison properly combined, would be the most appropriate substance to best effect the destruction of the vitality of so sensitive an organ as the dental pulp. It is true that great care is necessary in its use, or it may prove troublesome or fatal to the health of the tooth. Dr. Robert Arthur, of Washington, in a series of articles on the treatment of deep-seated caries, in the "American Journal of Dental Science," remarks that his first attempts with it were unsatisfactory, and he threw it aside for some time, but taking it up a second time he was entirely successful, which he attributed to more care in its use and more knowledge of the subject, than characterized his first attempts. From the bungling manner in which it is applied, as we have frequent opportunities to observe, by many who are either careless or entirely

* When poultices are applied, they should invariably be applied to the gum opposite the tooth.

unacquainted with the properties of the substance, it is not surprising that their efforts should prove unsuccessful. From the extreme liability of the pulp to disease, and to give rise to prolonged suffering, even though it were subjected to the various modes of palliative treatment, first compelled us, in the early part of our professional career, to adopt the practice of extirpating the pulp.

Aug. 26. 1854.



MEMORANDUM

Reference is made to the report of the Committee on the
Administration of the Government Printing Office, dated
January 10, 1900, and to the report of the Committee on
the Printing of the Laws, dated February 1, 1900, and
to the report of the Committee on the Printing of the
Laws, dated February 1, 1900, and to the report of the
Committee on the Printing of the Laws, dated February 1,
1900.

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To Prof. Backe M. D.,

with compliments of the

Author