THE BOSTON MEDICAL AND SURGICAL JOURNAL.

VOL. XCIX. — THURSDAY, DECEMBER 26, 1878. — NO. 26.

LECTURES.

CLINICAL OBSERVATIONS UPON ABDOMINAL ANEURISM, WITH SPECIAL REFERENCE TO TREATMENT.¹

BY J. M. DA COSTA, M. D.,

Professor of the Principles and Practice of Medicine in the Jefferson Medical College, Phila.

GENTLEMEN: Embracing the opportunity afforded me by the presence in our wards of several cases of aneurism of the abdominal aorta, I shall take up this subject for clinical discussion, this morning, bringing two of the patients before you; and supplementing the records of these hospital cases with the notes of others observed by me here and else where, in order to form a group, by the examination of which we may bring into bold relief some of the more important points in the clinical history of this grave affection, that may hereafter serve as elements of diagnosis and prognosis. We shall also endeavor to establish, if possible, some general principles of treatment, through which this unhappy condition may be ameliorated if not improved.

Before looking at the clinical phenomena, let us inquire whether abdominal aneurisms differ in their anatomy from those of other parts of the body. What constitutes an aneurism? An abrupt, asymmetrical increase in the calibre of an artery, tending to the formation of a supplementary cavity, pulsating synchronously with the primary vessel, is an aneurism, no matter where it is found. We need not dwell upon the very various nomenclature applied to different forms of aneurisms, to describe peculiarities of shape or position, since for clinical purposes the anatomical division, long ago proposed by Scarpa, into true and false aneurisms is sufficient. The first class comprises those whose walls retain the three original coats of the arterial tube, a condition extremely rare in a large aortic aneurism; the second includes those formed by a rupture of the middle and inner coats, leaving the aneurism covered by condensed connective tissue, which is the ultimate variety of abdominal aortic aneurism. Should the blood suddenly escape from the vessel, it may separate the layers of areolar tissue, and form what is

¹ Delivered at the Pennsylvania Hospital.

termed a dissecting aneurism ; a remarkable instance of which, with the autopsy, I shall presently bring to your notice.

The pressure of the blood upon the inner surface of the large arteries, you will remember, is in health about four pounds to the square inch, a factor in the production of aneurism which should not be overlooked. The power of resistance of the vessel to this force may be diminished through impairment of the integrity of its structure, either from disease or by mechanical injury. However just an ætiological classification into spontaneous and traumatic aneurisms may be as applied to the smaller arteries, we nevertheless find that in aortic aneurism it is, at least from a clinical point of view, untenable. While a vascular degeneration may progress unsuspected until its mischief is revealed by the yielding of the walls under a slight increase of strain which would not injure the normal vessel, on the other hand a force sufficiently powerful to rupture the healthy aorta would almost inevitably be immediately fatal from shock or hæmorrhage ; an injury far less in degree, however, might lead to certain inflammatory changes, followed by softening or ulceration and the ultimate development of an aneurism. Therefore, while the division into traumatic and spontaneous appears to be a natural one, we find that, clinically speaking, it will not apply to aortic aneurism, in which these causes are generally coexistent and inseparable.

It is understood that simple hypertrophy or symmetrical enlargement of the calibre and coats of a vessel does not constitute aneurism. This is to be distinguished, however, from cylindrical dilatation, with thinning of some of the vascular coats, which constitutes a true cylindrical or fusiform aneurism, and which is not infrequently encountered in the course of the thoracic and abdominal aorta. The question may arise, Does hypertrophy of the heart ever give rise to aortic aneurism ? Many cases of cardiac hypertrophy have been before you in which no aneurism ever appeared ; and there are cases of abdominal aneurism of considerable extent, in which the heart's impulse is weakened and the organ not increased. An aortic aneurism, moreover, does not constitute such an obstruction to the circulation as would necessarily give rise directly to hypertrophy. Yet while this condition never causes the aneurism, we observe at times the aneurism associated with it, and having led to it.

In reviewing the causes of degeneration of the walls of the aorta, which is acknowledged to be the most frequent and predisposing element in the formation of aneurism, we find chronic endarteritis, or atheroma, occupying a prominent position. It is favored by many cachectic conditions of the system, such as syphilis, gout, rheumatism, or Bright's disease, and is also of frequent occurrence in advanced life. The condition may be due to an extension of an endocarditis, or it may arise primarily in the endothelium of the aorta in an inflammatory proc-

ess, leading ultimately to local fatty degeneration and the formation of an ulcer. Fatty degeneration may also occur in the middle or elastic coat of the aorta. Finally, simple atrophy or thinning of the aortic walls may appear, either as an accompaniment of advanced life, or, as suggested by Rokitsansky, from some affection of the vaso-motor nerves.

Atheroma also is favored by the intemperate use of alcohol; and Virchow has observed fatty degeneration of the *intima* accompanying cases of anæmia.

An aneurism of the aorta may attain immense size before causing death, but in its growth it gives rise to certain symptoms which are more or less characteristic. From pressure upon the vertebral column there is often set up a carious condition of the bodies of the vertebræ, leading to the production of bone pain, in addition to the neuralgia caused by pressure upon the sympathetic plexus and intercostal nerves. There are also the signs of pressure in the dyspnœa, fullness of superficial veins, and occasional ascites; even jaundice from reabsorption of bile may be produced by hepatic congestion and pressure upon the common choledoch duct. The physical signs upon which the diagnosis may be based are extended impulse, murmur and thrill, increase in percussion dullness, or, in brief, the signs of a pulsating tumor containing blood. Before considering the differential diagnosis, however, permit me to call your attention to this patient, as illustrating the ætiology of the disorder. He gives as clear a history of traumatism as could be obtained, but, as you will see, there are some reasons for believing that the vessel was not antecedently in a perfectly healthy condition.

CASE I. S. McK., forty years of age, born in Ireland, a coal miner, was admitted into our wards three weeks ago. He then told us that he had been a strong and healthy man until last April, when he was accidentally crushed by a car running down an incline. When taken out of the mine he was insensible, and bled from his mouth and nose, and subsequently vomited blood. After remaining in bed for eleven days he felt well enough to attempt to resume his work, but was unable to continue on account of pain in his back. After the first few days hæmatemesis did not recur, but he has been complaining of weakness and lumbago ever since the injury, and has not been able to work. In about six weeks after the accident he noticed a pulsation in his abdomen, which afterwards increased and became more heaving. After eating a full meal he felt particularly oppressed. His bowels generally tended to constipation, but the pain was not increased by efforts at defæcation. He had become subject to headache, and his eyesight was less good than before. When on his feet he had constant pain in the back in the lumbar region; he had also suffered from pain at night, especially after moving around during the day.

Upon admission we found localized heaving of the abdominal wall,

above and a little to the right of the umbilicus, without marked dullness on percussion. A murmur, synchronous with the ventricular systole, could be heard over the point of greatest pulsation, but it was not very harsh, and it was followed by the faintest indication of a second sound. The murmur increased in intensity in passing from any direction towards a point about three inches above the umbilicus; it was much more distinct upon the right than upon the left side. There was also a very faint murmur heard posteriorly, to the right of the lower dorsal vertebræ. No variation was detected between the radial and femoral pulses of the two sides. The liver dullness stopped abruptly at the border of the ribs, but its area was not materially diminished. No disease of the kidneys could be discovered after repeated examinations of the urine. There were no cardiac murmurs, and no marked condition of ventricular hypertrophy. Although he had a slight cough and mucous expectoration, there was nothing to show that this was due to anything more than a small amount of intercurrent bronchitis. In giving his history it should have been stated that although he denied the manifestations of syphilis, he acknowledged having had gonorrhœa several times, and confessed that he had been intemperate in his habits.

His treatment consisted mainly in the free administration of iodide of potassium. I shall not at present do more than mention it. As he has been under our care for three weeks, I will now make another careful examination into his physical condition.

You see in him a well-nourished, muscular man, whose face shows the ruddy hue of health, and disarms any suspicion of disease. But let us examine him. The pulse is full and rather strong. Auscultation of the heart is rendered a little difficult this morning by the presence in the adjacent lung of some coarse râles of bronchitis, which we have before noticed, but there are no cardiac murmurs, and the impulse is of considerable strength. The soreness he complains of in the epigastric region is not materially influenced by pressure, although he stated that this locality was tender a short time ago. The pain itself is now much relieved. Indeed, all his symptoms have ameliorated while under treatment, including headache and indigestion. We should not overlook the fact that one of the prominent features of the case from the beginning has been the pain radiating from the right epigastrium to the back and to either side, but never downwards.

The occurrence of severe abdominal pain in a man apparently healthy, in whom there is no disease of the stomach or liver, suggests urinary difficulty, and we have accordingly examined his bladder, and have found no evidence of a stone or other disease either of bladder or kidney. We are now led to study the condition of the great vessels, since we know that there is no intestinal disorder to account for the symptoms. Uncovering the abdominal surface, you observe that considerable beat-

ing is still present above the umbilicus, strong enough to move my hand, placed over this area. With the stethoscope I can hear a harsh murmur in this locality, also faintly perceptible in the back, to the right of the spine, on a level corresponding with that in the front. Upon percussion I am still unable to elicit the evidence of marked dullness.

We have in this case a history of a severe crush followed by epistaxis and hæmatemesis, and eventually by throbbing of the abdominal aorta, accompanied by a murmur and pain. It is true that the latter symptom has immensely improved since he came into the hospital, but although the pain has subsided the pulsation and murmur persist.

I shall now invite your attention to a case of abdominal aneurism in which the occurrence of a strain and heavy lifting appeared also to warrant the idea that traumatism was the sole cause of the disorder, until we inquire into the history, from which we learn that this patient has also been intemperate, and now labors under constitutional syphilis. It might furthermore be stated that the degeneration of vessels that is known to follow the essential fevers may also enter into the explanation, as he had a severe attack of small-pox attended by considerable lumbar pain some time previous to the appearance of the abdominal throbbing.

CASE II. Frank McC., a laborer, fifty-two years of age, a native of Ireland. No inherited disease, and naturally robust and strong. He has been a drinking man, and eleven years ago contracted syphilis, followed by secondary symptoms, and his wife has had a number of miscarriages. Nine years before admission he had an attack of small-pox, attended by great pain in the back; after this he was in good health until three years ago, when, following exposure to bad weather, he had severe lumbago, which did not yield to treatment. A year later this symptom had become so aggravated that he was obliged frequently to sit up at night, the pain being unbearable in the recumbent position. It should be stated in this connection that at that time, and previous to it, he had been working very hard at heavy labor and lifting. About six months after this his attention was attracted to a beating in the stomach, accompanied by constant pain, increased after eating. He had also orthopnoea, which prevented him from sleeping in bed for weeks at a time. He never had rheumatism of the joints, nor any lancinating pains anywhere, but this aching in the back sometimes extended around upon each side, giving the impression of having a tight cord around his waist. If we add to this brief outline the fact that his bowels had been generally constipated, we have a fair idea of the previous course of the disease.

Physical examination of this case also revealed marked pulsation, more evident in the erect posture than when the patient was lying down, but no thrill was detected in either position. By percussion we

found that the area of dullness outlined a tumor in the epigastric region, occupying mainly a central position, but extending rather more to the right side than to the left, and from the ensiform cartilage to the umbilicus. To the right the impulse was more expansive than toward the left. With the stethoscope, over the centre of this area, a short, rather harsh murmur was distinguished; and in the back, at the same level, the murmur was even more marked than in the front. Listening to the heart I found the evidence of a certain amount of dilatation, with a faint systolic, mitral murmur. Thus far the previous record of the case. Let me now add that after placing him upon the same line of treatment as the preceding case, for less than two months, I can now show him to you with the tumor much reduced in size, the throbbing scarcely discernible, and all pain and inconvenience gone. The treatment shall be continued for a few weeks longer, in order to confirm this good result, at which time he will, I think, be able to resume his ordinary occupation.

I have said that this is a case of abdominal aneurism. In truth I cannot see any reason to question this diagnosis. Let us now return to the preceding patient, and determine to what class his case belongs. In looking for an explanation we have two possibilities to consider, — abdominal aneurism, and aortitis; and I confess that when we have discussed the matter it will still not leave my mind entirely free from doubt; because there is no condition more difficult of positive diagnosis than abdominal aneurism in its earliest stages. In favor of the view first suggested we have the history of injury and the persistent pain. To the latter symptom I am inclined to attach much weight. Abdominal aneurism is always accompanied by pain in the back, chiefly from mechanical causes: the progressive interference with the solar plexus of the great sympathetic; the impinging upon the intercostal nerves at their origin; and, finally, the erosion of the vertebral bodies by pressure, thus producing bone pain in addition to the nerve symptoms. Another element, which might be considered distinctive of aneurism, is the definite location of the murmur in the aorta, and the localized throbbing. Thus far everything is in favor of aneurism. What is there against this view? First, there is very little throbbing; secondly, there is no evident lateral pulsation; and thirdly, and this is most important, there is no dullness on percussion, — at least there is no marked dullness.

Let us for a moment consider the other view, that of aortitis or inflammation of the aorta. In this affection we may also have pain, pulsation, and murmur, more distinct at first, less so afterwards. Indeed, a strong case can be made out for inflammation, but I am nevertheless inclined to believe that the weight of testimony is in favor of aneurism. The amount of pain was too great and persistent to be due simply to in-

flammation. The pain of aortitis is transitory and not very severe ; here it was continuous, and was so marked that it was actually for relief from this symptom that he sought admission into the hospital. A small aneurism of the abdominal aorta does not generally give marked physical signs ; it will not, for instance, produce a decided impulse, nor murmur and thrill, yet very early in its course we find aching pain in the back to be the chief source of complaint. The termination of a certain proportion of cases of aortic inflammation in softening or fatty degeneration, that is to say, the conditions which we have found to predispose to the formation of aneurism, warns us of the importance of prompt recognition of this morbid state and the necessity of its treatment upon those principles which I will lay down in the conclusion of this lecture, in speaking of the regimen to be pursued in cases of abdominal aneurism.

What adds to the difficulty of the diagnosis of incipient abdominal aneurism is the fact that extended impulse may be due to mere sympathetic or nervous palpitation, especially in excitable young women, where it may be found to exist in even a more marked degree than in either of these patients before you. Such cases may be distinguished by the absence of persistent murmur, thrill, and increased percussion dullness. It is true that an anæmic murmur may complicate the case, and be all the more readily heard if strong pressure be made with the stethoscope, but the character of the sounds and their presence in the vessels of the neck and elsewhere will furnish the clew to their true meaning. Moreover, the age and sex of the patient will put you on your guard ; aneurisms belong, as a rule, to middle and advanced life, and are rare in women, — especially rare among those who perform no laborious or heavy work.

A more difficult differential diagnosis is that between abdominal aneurism and an overlying tumor pressing upon the aorta and transmitting its pulsations. This would give increased percussion dullness, extended impulse, and perhaps a blood murmur ; but the early history and course of the disease will be of great assistance in deciding upon the diagnosis. One point, however, should be borne in mind : recalling the statement made a few moments ago, you will remember that one of the most constant signs of aneurism is pain in the back ; with which you will often find associated spinal tenderness from vertebral disease. Do not forget this fact ; inquire into the character of the pain, and see if tenderness exists when pressure is made upon the spinous processes. In aneurism of considerable size you would also expect to find a harsh murmur, heard most distinctly in the back, somewhere along the course of the aorta. In regard to the presence or absence of thrill, or fremitus, but little importance can be attached to it. While it frequently accompanies abdominal aneurism, there are cases which attain a large size

without it. The absence of thrill is therefore not conclusive evidence on either side. In malignant growth overlying the aorta you will generally find, besides vomiting and digestive disorder, a certain amount of cachexia, which does not occur in aneurism, except, indeed, from pressure upon the thoracic duct, as in a case which came under my observation in private practice some years since.

I have brought before you two unusual illustrations of the successful termination of abdominal aneurism, or, at least, of its arrest. Had I time I could give you, from my own experience, several more cases: one in particular, a man of about thirty-four years of age, was under my care for sixteen months, when his recovery was so perfect that thrill and impulse disappeared, and abdominal, percussion-dullness only was left. In another case the man remained more or less continuously in bed for eight months, with the greatest improvement in his condition. In a third, a clinical case, which I saw at intervals of several months for a period of about a year, a remarkable change in the physical signs and general condition took place; but while the aneurism could always be detected, it had greatly diminished in size, and pain had all gone, and no longer interfered with the patient's pursuing his occupation.

I wish I could tell you that these results were always to be obtained by due management of abdominal aneurism. Unfortunately, sooner or later, this affection is apt to prove fatal, though it is astonishing to observe with how little impairment of the general health it may be associated, even when the physical signs are marked. I could of course read you the notes of many cases illustrating the usual progress of the disease, and refer to much post-mortem evidence that I have had the opportunity of inspecting, even in cases in which the symptoms have been latent; but this would make my discourse this morning too long. You will, moreover, find numerous cases on record, though proportionately far fewer of such favorable terminations than I have this morning called your attention to. The following is an instance of the unfavorable termination of the disease. I will very briefly state to you the clinical history and notes of the autopsy of this patient, who was lately in the wards, and whose case is an excellent illustration of the rare form of dissecting abdominal aneurism.

CASE III. A leather cutter, of American birth, forty-two years of age, of temperate habits, and claiming to be free from inherited or acquired taint, was seized, on the morning of admission, with pain in the right hypogastric region, extending backward to the sacrum, down the back of the legs, and involving the right testicle. He never had experienced such an attack. The pain was so severe that he could not walk nor stand, and nearly fainted on the street, and in this condition he was found and brought by his friends into the hospital. His bowels had been freely moved half an hour before; he had not eaten anything

unusual, nor had he been engaged in any hard work. He stated that for a number of years, while at his occupation, he had been in the habit of leaning against the cutting board, pressing it into the right hypochondriac region. There was a reducible inguinal hernia upon this side, and also a tendency to ventral hernia.

The patient was not emaciated, but was sallow and anæmic. The heart was excited : first sound weak, second distinct ; pulse feeble. There was no swelling of the feet, and no ascites.

Without stopping to give the detailed physical signs, I may state that there was evidence of an irregular mass overlying the aorta and receiving a heaving impulse from it, occupying the whole of the right umbilical and inguinal regions, merging into the hepatic dullness at a point two inches from the middle line, filling the right half of the umbilical region, and extending a little beyond the centre. The mass was resisting and somewhat tender. No murmur and no fremitus could be perceived, but the sounds of the heart were transmitted : the first sound was dull, low-pitched, and murmurish, yet there was no decided murmur ; the second sound was accentuated and distinct. He had retention of urine, requiring the constant resort to the catheter. After a week's treatment no material change could be detected, except that the patient was sinking into a low state ; he had a dry, brown, and fissured tongue, and a more cachectic appearance. Auscultation of the back could not be attempted on account of faintness brought on by any change of position. The bowels had been freely moved, yet the dullness remained as before. On the eighth day the patient died in collapse. He had not complained of any more attacks of acute pain, but had more or less aching in the back during the treatment, requiring small doses of anodynes.

With the sphygmograph the right femoral artery was more feeble than the left, but neither was as strong as the radial at the wrists.

At the autopsy, the left ventricle was thought to be thickened, and it contained a fibrinous clot ; all the valves were healthy. The ascending aorta was dilated, the walls were thickened, and yellow spots of atheroma were seen upon its endothelial surface. The remainder of the thoracic aorta appeared to be healthy. The right lung in its lower part was deeply congested.

Upon inspecting the peritoneal cavity it was found that both flanks were filled with a doughy mass which extended, on the right side, down into the scrotum. Its color was reddish-black, seen through the smooth and shining peritonæum, which was stretched over it. The mass displaced the cæcum forwards, upwards, and inwards, thence extending upward into the hypochondriac region.

The aorta being divided along its posterior surface, a small sacculated dilatation on the anterior aspect was discovered, about three inches in diameter. The inner surface of the aneurism displayed several fissures, the

wall was thinned, and, at one point, a firm black clot occluded what had been a recent rent. The large mass was composed of tolerably firm black clot, which had escaped into the loose connective tissue, and had dissected the peritonæum from the whole posterior wall of the abdomen; its greatest volume was to the right of the vertebral column. The clot had crept around and completely enveloped the kidneys, the great vessels, and the right testicle, the right half of the scrotum becoming livid after death.

The aneurism was below the cœliac axis, in the neighborhood of the origin of the superior mesenteric artery, if, indeed, it did not include this vessel. Another small aneurismal dilatation was found on the right external iliac artery, which was about the size of a walnut; it was also filled with adherent clot, leaving, however, a passage for blood on one side.

Let us now return to some of the points in the pathology and treatment of the affection as presented by the cases we have been reviewing. In considering the cause of abdominal aneurism, we find that in none of these cases could we attribute it to senile change. They were too young to have atheroma from advanced age. In this connection let me broadly state that where abdominal aneurism occurs in early life or beginning middle age, it is generally due to syphilis. In fact, its prevalence among soldiers has been explained in this way. You must not, however, suppose that syphilis directly produces aneurism, but that certain changes of a chronic inflammatory and degenerative character take place, by which the muscular and elastic tissues are weakened and prepared to yield suddenly under an ordinary strain; or adjacent structures have their resisting power in like manner reduced, and gradually give way. Its agency in the production of atheroma has been particularly recognized by medico-military authorities. Syphilis, I regard as a very active and positive predisposing cause of aneurism of the aorta.

In a case of abdominal aneurism what should be the principles of treatment? The regimen I have pursued in these cases, and which has been singularly successful in my hands, has been absolute rest in bed, a plain, unstimulating, nutritious diet, and, finally, the persistent use of iodide of potassium. In the first patient this treatment has produced so much change in the short time that he has been under our care that you would scarcely recognize in him the haggard and suffering man who sought admission less than one month ago. This course is that which I have been accustomed to follow of late years, and I have seen, I think, cure resulting from it in undoubted cases. In the case of a gentleman, the superintendent of a factory in Delaware whose history I have already referred to, who came to me suffering from abdominal aneurism, and whom I kept in bed continuously for eight months, dur-

ing all of which time he took large doses of iodide of potassium, such a change was wrought that at the end of this period he seemed to be completely cured, and resumed his occupation.

The instructions must be positive to continue in the recumbent posture, while the treatment by the iodide is pushed to its full constitutional limit. If the stomach reject the remedy, or the patient become disgusted and nauseated, stop it for a time, and return to it in smaller doses, again steadily increasing as the stomach becomes accustomed to it. I generally commence with ten-grain doses, given thrice daily, and run it up to one hundred and fifty or even one hundred and eighty grains per diem; it is rarely necessary to go beyond this. It is also important to keep down the force of the circulation, so that the heart shall be at not over 75 to 80, by the administration of aconite or veratrum viride. By this means we favor the deposition of a laminated fibrinous clot on the inner wall of the aneurism, in the hope that it will gradually encroach upon the cavity until it becomes entirely obliterated.

The explanation of the treatment by iodide you might think was suggested by what we have considered as the frequent cause of the trouble, — syphilis; but apart from this the iodide has been found to be an excellent remedy in internal aneurisms. This is not an old treatment; at least its value has not been appreciated until within a few years. Balfour,¹ in 1869 and 1871, reported several cases of aneurism cured by this therapeutic plan, but it had been previously recommended as early as 1859 by Bouilland. A number of successful cases have since been reported, of which I have published a few. The management by astringents, particularly tannic acid and the acetate of lead, has not met with much favor. Ergot, which has been administered in other internal aneurisms, I have employed, but have thus far failed to find it of any value in abdominal aneurism. A series of cases of cure of thoracic aneurism by electro-puncture have been reported by Ciniselli² and others, Dr. McCall Anderson³ having had very favorable results in two cases. For manifest reasons this plan is inapplicable to disease of the abdominal aorta, and I will not, therefore, devote any time to its consideration. The treatment by ligature or distal compression I need not refer to, as the subject is fully discussed in your treatises upon surgery, perhaps more particularly by Mr. Holmes in his lectures upon the surgical treatment of aneurism. Returning to the therapeutic consideration, we find that cases have been reported in which a cure has followed the postural treatment alone, with a restricted diet, but when we add to this the administration of the iodide of potassium and sedatives,

¹ Edinburgh Medical Journal, 1869 and 1871.

² Quoted by Quincke, Ziemssen's Cyclopædia, vol. vi., page 455.

³ Clinical Medicine, London, 1877.

we have, medically speaking, put our patient under the most favorable conditions for his recovery. Under the influence of potassic iodide the force of the heart's contraction and the blood pressure are both modified, — properties which are not possessed by the remaining iodine salts. I feel confident that by this regimen the prognosis of the affection is rendered less grave, and moreover permanent relief may be confidently expected in a large proportion of cases, particularly in the earlier stages of the disease, provided the treatment be faithfully carried out.

THE PHYSIOLOGY OF SLEEP.

BY E. P. HURD, M. D., NEWBURYPORT.

It is well to be cautious how we accept theories, for one stubborn fact, as Tyndall has said, will upset a whole freight train of theories. It once appeared to us settled that the proximate cause of sleep was anæmia of the cortical gray matter, — the centres of ideation, comparison, and volition. The theory worked very well. *A priori* it appeared quite probable that less blood should go to the brain during its quiescence than during wakeful activity.

Moreover, there were not wanting observations to suggest and confirm this view. During intense thought and passion did we not see the temporals swell and throb and the face become turgid, and during the insensibility of syncope, epilepsy, catalepsy, did not the external appearances favor the opinion that the brain was relatively anæmic? Must there not be relative anæmia during the insensibility of sleep also?

We had carefully read and noted Monroe's observations and conclusions as to the contracted condition of the arterioles and the pallor of the convolutions during sleep; these had been confirmed by Hammond and Brown-Séquard. Durham's investigations on the physiology of sleep had been published as early as 1860, and seemed to be exceptionally careful and accurate. Pierquin a little earlier recorded an interesting series of observations on a girl in Montpellier who had lost a large portion of her scalp and skull. "Her brain could be seen for a considerable extent of surface. When she was in dreamless sleep her brain was motionless and low within the cranium; but when her sleep was imperfect and she was agitated with dreams, her brain moved and beat, more blood was sent to it, the arteries were relaxed, and the brain protruded through the opening in the skull. When she was awake the same difference was observed, in accordance with the activity or quiescence of her mind."¹

Donders "made a cruel but striking experiment. He cut away a

¹ A. Combe's *Physiology*, page 147.