**On the sounds afforded by substernal aneurisms / by William Henderson.**

# ON THE SOUNDS

AFFORDED BY

# SUBSTERNAL ANEURISMS.

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However difficult it may be to subscribe to the doctrine "dans le diagnostic consiste toute la medecine," no physician who is desirous of avoiding perplexity and diffidence in the discharge of his professional duties can be indifferent to the study of even the most intractable diseases. Although an intimate acquaintance with their phenomena may conduce little towards alleviating the sufferings by which they are accompanied, yet it is often capable of yielding instruction useful to the practitioner of medicine, and interesting to the physiologist, by affording to the former the means of decision in his prognosis, and to the latter illustrations of the healthy functions of the body. The subject of this essay may claim attention on both of these accounts; and should have especial attractions to the physician, because the phenomena connected with it are both very various and dissimilar, in different cases, and are not unfrequently the sources of doubt and difficulty, even to the most experienced and observing.

The following remarks have been derived chiefly from cases which were of a sufficiently obvious nature, and which were studied with the purpose of acquiring means to detect the more obscure instances of the disease by a consideration of the anatomy and signs of the more apparent. A few of those cases I shall give in detail.

The signs of substernal aneurism are subject to variety from the influence of form, position, and the presence or absence of *coagula*. That part of the *aorta* which includes the arch and the ascending portion of the vessel is liable to be affected differently from the other arteries of the body, by acquiring a large size from nearly uniform dilatation, and is also subject, like them, to the sacculated form, resulting from more or less rupture of the inner and middle coats. The external coat and the membranous substances that invest it may be distended to a very large size, while the communication betwixt the cavity of the aneurism and the *aorta* may not equal half an inch in diameter. It is indeed remarkable through what a small aperture a fluid power may be directed capable of causing enormous distention of the outer coat. Scarpa quotes from Palletta a case of aneurism of the thoracic *aorta* which had attained a great size, while the opening that led from the vessel was incapable of admitting a substance larger than a pea. The communication is, however, in the majority of cases, much larger, so large, indeed, in some, that the sac may have a diameter at its mouth equal to that at any other point of its extent. The relative size of this opening seems to have a material influence on the sounds emitted by the aneurism.

Aneurismal sacs may or may not contain *coagula*. When present these many be arranged in concentric laminæ within the aneurism, so as to present no obstacle to the free passage of the blood through the contiguous part of the vessel, or they may project into the vessel, and oppose themselves to its current, a remarkable instance of which is afforded by Case I. Sacculated aneurisms of considerable size are not commonly altogether void of *coagula*. One of this kind I had an opportunity of witnessing, in which the sac was as large as an infant's head, and the opening leading into it but two inches in diameter; yet it contained no deposition of fibrine. It had produced death by the discharge of its fluid contents through a small slit into the cavity of the right *pleura*.

The ascending *aorta* may yield in any part of its circumference so as to produce aneurism. The direction of the enlargements is most commonly towards the right side.

I have enumerated most of the essential causes of variety in the phenomena of these aneurisms; others will fall more conveniently under consideration in the sequel. These phe-

nomena, though not difficult to detect, demand a careful analysis. A too prevalent omission of detailing them with accuracy, and of investigating the morbid conditions found in connection with them, is chiefly to be blamed for the discredit still attached to the diagnosis of substernal aneurisms. M. Bertin, and after him, Dr Hope, have thought no such discredit applicable to the subject. Yet a very moderate course of observation will suffice to show that neither has described all the varieties in the signs, nor has been altogether accurate in his instructions for the diagnosis.

A substernal aneurism may give rise to two successive sounds corresponding in point of time to those of the heart, or may occasion but one sound, synchronous with that of the ventricles. These are to be understood as originating in the aneurism, and require for their production that it should be altogether or nearly without *coagula*. The sounds which are heard over the aneurism, when filled with coagulated fibrine, are different both in their nature and in their origin; they are transmitted by, but do not originate in, the aneurism. In one sense, therefore, it may be said with truth, that substernal aneurisms are either with or without sound.

When two sounds originate in the aneurism, they always, according to my experience, possess more or less of the rasping noise; when one only has its rise in the tumour, it may have either this rasping sound, or may be pure, in some measure similar to the ventricular sound in health. I am aware that cases are on record in which two sounds totally free from rasping, and louder than in the region of the heart, have been heard in the site of the aneurism. The circumstance of the greater developement of these sounds in the situation of the aneurism has suggested the opinion, that there they must have been produced. Such an opinion is not well founded in so far as the second of the sounds is concerned; for it has been well ascertained that the second sound of the heart is often audible, considerably higher in the chest than the place occupied by that organ, in a greater degree than in the region of the heart itself, where no aneurism has been found to account for the fact. The clear first sound of the aneurisms in question most probably originated at the seat of the disease, in a manner that shall afterwards be mentioned; but that the second has had its source at the same place is rendered extremely questionable, by the circumstance that no reasonable conjecture can be formed of the way in which it could be produced there, and by the fact just referred to, that the second sound of the heart is capable of being better heard at a higher point than the position of the heart itself. The greater proximity of the *aorta*, in con-

sequence of its enlargement, to the anterior wall of the chest and to the ear of the observer, may afford one condition favourable to the better transmission of the second sound,—an idea which derives additional probability from the well founded opinion, that what is called the second sound of the heart is actually produced in the *aorta* where the sigmoid valves are attached.

In a former number of this Journal, I made a brief allusion to a case in which two rasping sounds were heard on the projections of an aneurism, which, the second in particular, were found to decrease as the examination extended towards the heart. The projections were on the right side of the *sternum*, and out of the direction of the ascending *aorta*. The loud and rough sounds corresponded with the rise and subsidence of the aneurismal swellings. On dissection the sac was found to be empty, elastic, capable of containing a quart of fluid, and to communicate with the *aorta* by a comparatively narrow opening. The sounds seem to have originated at the orifice of the tumour during the influx and retrocession of the blood, for the lower margin of the entrance to the sac was the sharp edge of a thin, elastic partition, which separated the *aorta* for the first inch and a half of its course, from the cavity of the aneurism, and which, from its projecting into the currents to and from the aneurism, was well fitted to be thrown into vibrations. The valves of the *aorta* were quite adequate for their functions, so that the rough second sound heard in the aneurism could not have resulted from reflux of blood into the ventricle. In certain cases of diseased aortic valves with permanent patency of the opening a double rasping sound may be present. Yet this can hardly be confounded with the case in which an aneurism gives rise to these sounds, as the latter is also distinguished by an impulse, and dulness on percussion, in the situation of the sounds, and, besides, the second *bruit* in the case of permanent patency has its greatest developement usually at a point corresponding to the situation of the sigmoid valves, while sounds emitted by aneurisms are loudest at the upper parts of the chest. All cases of sacculated aneurism do not cause a double *bruit*. In many the passage from the artery to the pouch may be so wide as to render the production of a murmur during the reflux of the blood impossible. Such pouches have but one proper sound, which accompanies the first of the heart, and may have a pure character like the latter. The sound peculiar to the contraction of the ventricles, when not converted into a rough murmur, is most audible in the region of the heart, so that we cannot consider the clear aneurismal sound in question as a reverberation of this, because it

is louder in the situation of the aneurism. We must therefore look for its cause in the latter place. I conceive that the stroke of the expanding sac against the *sternum* or ribs, or the sudden infringement of the wave of blood against these solid parts, affords a very probable explanation of the phenomenon, —at all events such actions are perfectly adequate to produce such a sound. This opinion of its origin derives additional support from the fact, that in ventral aneurisms no such pure sound is ever audible (there either being no sound at all in these, or one with more or less of the bellows murmur,) as the sac in the course of its expansion encounters no hard body to strike against. Other cases occur in which a sound thus produced is followed by another perhaps equally loud and pure. For the reasons already given, I am inclined to consider this as a transmission of the sound produced by the flapping of the sigmoid valves. The following case will show that a second sound of a loud character may be heard at a considerable distance from the valves, under circumstances which justify the opinion that it originated from their action.

Case I. The patient was a man upwards of 50 years of age, and had been the subject of aneurism for above two years. From the left clavicle down to the sixth rib of the same side, and from the right side of the *sternum* as far to the left as the lateral curve of the ribs, there was complete dulness on percussion, and absence of all respiratory sound, except immediately beneath the clavicle, where a distant murmur was heard. In the left axilla also a faint respiratory murmur was audible, and occasionally a sibilous ronchus. On the right side superiorly, and in front, the respiratory sound was puerile. On the back, the right side gave a better sound than the left when percussed, and the sound of respiration, although not well developed on either side, was more distinct on the right. On no part of the space remarked as having been dull on percussion was any thrill communicated to the hand when the patient spoke. Over the whole extent characterized by this dulness an impulse was felt synchronous with the beat of the large arteries of the neck. It was distinct immediately within the coracoid process of the left scapula, and more so at the upper third of the *sternum*, and contiguous parts of the left ribs. In the latter place it was of a slow character, as if caused by a gradual effort from within. At the inferior part of the *sternum* the impulse was more energetic than elsewhere, though it did not raise the head leaning on the stethoscope more than at the upper parts. Over the superior half of the *sternum* and left side of the chest anteriorly, the sound which accompanied the impulse was barely distinguishable. After the slow

impulse in these parts had terminated, and while the heave of the chest produced by it was subsiding, a remarkably clear and loud sound was audible, bearing a very striking resemblance to the sudden shutting of a pump-valve in the immediate vicinity of the ear. This sound was of nearly equal intensity at all points where the impulse existed. The first sound was distinct only at the lower part of the *sternum*, and in the region of the left ventricle, yet even in these situations it was scarcely so strong as usual. Nothing like a rasping or bellows sound was anywhere audible. I did not remark either the impulse or sounds posteriorly, but both sounds could be heard on the right front. There was no prominence of the left side, except during the impulse, and then only to a slight degree. The voice was hoarse and husky.

He had anasarca of the body and lower limbs; and the left arm was œdematous. The pulse was imperceptible at the wrist; in the right arm the pulse was very small, of moderate rapidity, and regular. His respirations were not more frequent than natural. He could not lie on either side for more than a few minutes without oppressive dyspnœa, and was easiest when leaning forwards, the only position in which he could sleep. Death occurred six weeks after this account was drawn up.

*Dissection.*—The pericardium contained about four ounces of serous-like fluid. The heart was of the natural size, and lay, in consequence of pressure from above, more transversely than usual, so that a part of the base of the left ventricle lay behind the lower part of the *sternum*. A large aneurismal tumour rested on the heart, filled up the space behind the *sternum*, and extended across the chest towards the left, concealing the lung, and occupying the whole space from the clavicle to the fifth rib in front; it likewise extended towards the spine, and had caused caries of the bodies of several vertebræ;—it was not in contact with the ribs posteriorly. On laying open this mass it was found to consist chiefly of a sacculated dilatation of the left side of the ascending *aorta*, and the concave or inferior wall of the arch. The aneurism commenced at the distance of an inch from the aortic valves, and extended beyond the origin of the left subclavian artery. The convex surface of the *aorta* was also somewhat enlarged, but the great bulk of the aneurism hung downwards from the arch. The sac was occupied by numerous laminæ of fibrine, scarcely more compact at the sides than in the centre. A dirty grumous-looking fluid intervened between the layers. It seemed probable that the blood might reach the descending *aorta* by passing between the vertical layers of *coagula*. In the midst of these, there was one channel which appeared more in accordance

with the usual course of the vessel, and formed an irregular track from the heart to the artery beyond the tumour. The left subclavian artery was very nearly obliterated at its origin, and was stretched over the extreme left of the aneurism. The sigmoid and other valves were quite sound.

This case possesses interest from the corroboration which it affords to M. Rouanet's theory of the second sound of the heart. This organ itself was healthy, and therefore not capable of causing the clear and loud second sound mentioned in the foregoing narration. Nor was there any thing in the form of the aneurism to justify the supposition that the sound under consideration was entirely new, and dependent on the disease in the vessel. A brief review of the probable action of the aneurism will throw some light on the subject. Each wave of blood from the ventricles must have encountered much difficulty in finding its way through the maze of *coagula* contained in the tumour. The result would necessarily be, that these would be compressed, and their containing sac dilated, by the force of the ventricular contraction, on the cessation of which force the elastic *coagula*, aneurismal walls, and elevated ribs, would conspire to throw back with energy a large portion of the blood on the valves of the *aorta*, by which their descent would be rendered more vigorous, and their sound consequently louder. The solid contents of the aneurism would serve to conduct the sound thus produced to the remotest portion of the tumour. Independently of this medium of transmission, the second sound of the heart is rendered audible by aneurisms, at a considerable distance from the valves; one instance of which is narrated by Bertin (page 95.) He states that in a case of aneurism as large as the fist affecting the ascending *aorta*, in addition to other signs, the second sound of the heart (or sound of the auricles, as he calls it,) was well heard towards the clavicles, and without murmur, while it was less distinct in the region of the heart.

Of the sounds accompanying general enlargement of the calibre of the ascending *aorta* and arch little need be added to what has already been said of sacculated aneurisms with a very wide passage leading from the *aorta*. When complicated, as it sometimes is, with disease of the aortic valves, and permanent patency of the aperture surrounded by them, this kind of aneurism may present two rasping sounds along the *sternum*. In order to distinguish this state of disease from the sacculated aneurism, at the orifice of which two rasping sounds are produced peculiar to itself, it will suffice to remember what has already been said regarding the second sound in cases of permanent patency, and that in mere dila-

tation the impulse is much less on any part of the *sternum* than immediately above this bone.

The presence of a hoarse rasping sound in the carotids is characteristic of the several forms of substernal aneurism which have not been consolidated by *coagula*. It is likewise occasionally met with in these vessels in cases of considerable narrowing at the mouth of the *aorta*, especially when complicated with greatly increased power of the heart. The state of percussion and the absence of preternatural impulse in the course of the *aorta* will enable these cases to be distinguished. The pathological conditions necessary for the production of these sounds in the vessels beyond the aneurism are merely the existence of a considerable expansion beyond a part of much more limited capacity,—conditions which are characteristic both of aneurisms and of the valvular disease referred to. Roughness of the inner surface of the aneurismal dilatation, or of any other part of the apparatus, does not seem to be requisite, as the following case will declare. The patient was a man affected with popliteal aneurism of the left leg, who died about a fortnight after the femoral artery had been tied. The tumour pulsated strongly, and had attained the size of a hen's egg. A distinct thrill was perceptible at the surface of the tumour near its centre. At the upper boundary of the tumour there was a moderate *bruit de soufflet*, which gradually increased until it acquired, at the centre, a rough and superficial rasping noise. Beyond the centre this noise continued, but less distinctly; and for three inches below the tumour, in the direction of the posterior branches of the vessel, a deep-toned, hoarse, and distant noise was heard, exactly resembling the sound in the carotids of persons affected with the above mentioned forms of substernal aneurism. On inspection after death the popliteal artery was observed to open abruptly into the tumour at its upper extremity, and to lead from the aneurism by a canal of the natural size, at the distance of more than two inches from the superior opening. In aneurisms that become filled with *coagula*, the conditions necessary for producing the sound under consideration are no longer present, and the phenomenon ceases.

Aneurisms contiguous to the heart may become passive instruments for the transmission of the two sounds which originate at the latter. The change which they undergo in order to acquire this property is their conversion into solid masses, by the deposition of coagulated fibrine in their interior. They are thus fitted, intervening as they do betwixt the base of the heart and the surface of the chest, to conduct sounds from

that organ to the ear of the observer. I subjoin two cases in illustration of these statements.

Case II.* On the 3d of August 1835, I examined the subject of this case; he died on the 5th. He was about 45 years of age. His cough was frequent, and he required to lean forwards constantly in bed, as his respiration was much embarrassed, and became worse on his assuming the recumbent position; voice natural. At the upper part of the chest and on the right side close to the *sternum*, there was a prominence of considerable size involving the sternal ends of the three first ribs and their cartilages. At this projection there was a distinct impulse, not, however, of a powerful nature, and less than the synchronous impulse in the region of the heart. Two sounds were audible at the situation of the tumour, coincident with those of the heart, and similar in character. The impulse of the heart was preternaturally strong, and its sounds free from murmur and roughness. The stooping posture, which the patient was obliged to maintain, rendered a more careful examination impossible, and the uneasiness he suffered on sitting erect made any change in his position for the purpose of extended exploration in front unjustifiable. I did not ascertain whether the sounds were less loud at the tumour than in the region of the heart,—the difference, if any, must have been slight. Behind there was dulness of percussion at the upper third of the right side; and, at the same place, especially close to the spine, a moderate impulse. At the inferior angle of the scapula, and towards its inner side there was very strong tracheal respiration and tracheal voice. In the other parts of the same side posteriorly were imperfect respiratory murmur and catarrhal rattles, while percussion gave a rather better sound. On the left back the percussion was good, the respiration natural, and a slight impulse perceptible superiorly. Immediately beneath the right clavicle, and for a short distance downwards, there was tracheal respiration and bronchophony. There was no sound in the carotids. Pulse at the wrists nearly equal in both arms, regular, and somewhat accelerated. The examination could not be made more minute in consequence of the annoyance the patient appeared to feel.

*Dissection.*—6th August.—The heart was invested with an adherent pericardium; the medium of connection consisted of thick meshes of lymph, of a soft consistence, and gelatinous appearance. The heart was flaccid; its left cavity dilated a little; the walls of natural thickness. The aortic valves presented very trivial thickening at their bases. The right ca-

* For permission to publish my reports of this and the preceding case, I am indebted to Dr Shortt, in whose Clinical Wards the cases occurred.

vities were natural. About half way betwixt the valves and the origin of the *arteria anonyma* the *aorta* presented an opening, on its right side, of an ellipitcal form, the greatest diameter of which was an inch and a-half. This hole was bounded by a sharp margin; at one place the margin was formed by the edge of a bony plate. This opening led into a large sac, fully the size of a newly born child's head, occupied by firm masses and layers of coagulated fibrine. The tumour adhered strongly to the *sternum*, and to a space two inches long of the second rib of the right side. The upper part of the right lung covered with its anterior margin a considerable portion of the tumour. The latter had pushed the rest of the lung downwards, and intervened between it and the right bronchus, in such a manner that the tube was stretched over the back of the tumour, and was flattened betwixt it and the angles of the ribs, while the lung lay for the most part beneath and in front of the aneurism. The position of the bronchus corresponded with the place at which the tracheal respiration had been heard posteriorly. The left bronchus and trachea were dragged a little to the right of their usual situation. The *aorta* was a good deal studded on the inside with yellow thickened patches. All its branches were pervious. About five pounds of serous like fluid were in the cavity of the right *pleura*.

Case III.—The subject of this case was a woman above the middle age. No dissection was allowed; yet it cannot be doubted that the aneurism was rendered solid by *coagula*, as in the preceding case. The whole *sternum*, and especially its upper part, was more prominent than usual. Between the first and second right cartilages a tumour projected, equalling in size two-thirds of a hen's egg, and of a conical form. The colour of the skin over the tumour was natural. No pulsation could be distinguished in the tumour by the eye, but on pressure with the fingers a distinct but moderate impulse could be felt. There were two sounds audible in the projection, without any murmur or rasping, similar to those in the region of the heart, but not so loud. These two sounds were heard also along the space which intervened between the tumour and the region of the heart, and gradually increased towards the situation of the latter. At the aneurism the second sound was rather louder than the first. There was very little impulse in the situation of the heart, where the sounds were moderate and natural, but they were more distinct than usual along the right side of the *sternum*, and neighbouring part of the chest. There was no sound in either carotid, nor thrill anywhere. The pulse was moderate. Percussion was dull on the projecting parts, which are tender to the touch, tolerably good below the clavi-

cles; bronchophony below the left clavicle, and also behind, at the supra-spinal fossa; respiration was pretty distinct on the back, imperfect under the left clavicle; catarrhal rattles on both sides of the chest; cough extremely harassing and frequent, with considerable expectoration, and dyspnœa sometimes great. She died about a month afterwards; and, on examining the exterior of the chest, the tumour was found still nearly as large as during life; it felt solid, and, when pushed back into the chest, left a considerable aperture between the ribs.

She had laboured for three years under symptoms of disease in the chest, and the tumour had appeared nine months before death.

Cases of this kind cannot be confounded with that very different form of aneurism in which the sac is still capable of admitting blood at each contraction of the ventricles. In the latter, it is true, there are two sounds, both of which may be free from murmur, but the first is louder than that of the heart, and most likely results, as has been said, from the shock of the sac or its fluid against the *sternum* or ribs, while the second can be accounted for only on the supposition that it is transmitted from the valves. Besides, aneurisms not filled with *coagula*, have a much stronger impulse than the others.

In aneurisms not consolidated, the second sound, as heard in the tumour, and at the heart, is subject to considerable variations, some of which are difficult to account for. Thus the second sound in some cases may become gradually louder until it has its maximum at the base of the heart; while in others it may be heard much more distinctly near the top of the *sternum* than at the heart. Bertin gives one instance, already mentioned, of the latter variety, in which the tumour was as large as the fist, and consisted of a dilatation of the ascending *aorta*. The first sound was, at the upper part of *sternum*, a very distinct murmur, while the second was heard without murmur, and well developed, towards the clavicles, but very confusedly in the region of the heart The left ventricle was three times as large as the right. What effect this state of disease might have had on the transmission of the second sound over the region of the heart is not determined; usually, however, dilatation of the heart is attended by increased developement of both sounds, at the situation of the organ, as well as over the greater part, or whole of the chest.

Whether any cases occur in which the second sound is nearly absent from the tumour, and situation of the heart, at the same time, I cannot venture to assert. But I am inclined to think that there may be forms and conditions of aneurism

near the centre of the circulation calculated to weaken the forces which are concerned in the production of the second sound, and thereby to render the latter much less distinct than natural, both at, and in the vicinity of, the heart. The very imperfect notes which I have preserved of the examination made of the following case, while the patient lived, afford perhaps a probability that this conjecture may prove correct. The exploration of the chest was confined to the region of the heart, and therefore the condition of the second sound in the course of the *aorta* was not ascertained.

Case IV. The patient was a man about 30 years of age. I saw him first in January 1833, suffering from a severe attack of pneumonia. In October of the same year, I learnt that soon after the illness referred to had subsided, he began to be annoyed by palpitations, and subsequently by dyspnœa, both of which had gradually increased to a very distressing degree. I found the impulse of the heart increased in degree and in extent. A distinct but not strong bellows-sound attended the contraction of the ventricles, the second sound was without this complication, and so faint as to form a very indistinct click, inaudible on the right edge of the *sternum*, where the murmur of the first sound was more obscure. There was double pulsation in the jugular veins, and even in the small veins of the skin at the top of the *sternum*. Face livid; body required to be constantly preserved in an elevated posture, owing to the excessive dyspnœa; pulse full, sudden, and about 86.

He survived until the middle of November. On dissection both ventricles were found very much enlarged, but the walls of the right alone were increased in thickness. The auricles, the right especially, were dilated, and their columnæ much developed. The right auriculo-ventricular opening would admit the extremities of five fingers at once with ease. The mouth of the *aorta* was of its natural size; its valves were affected at their bases by a small but preternatural deposition of cartilage. At the point where the *aorta* crossed the pulmonary artery, there was an aneurismal pouch that might have contained an ordinary egg. The walls of this pouch had coalesced with those of the pulmonary artery, and at its *fundus* there were two openings into the latter vessel; one, the larger, admitted the extremity of the little finger. The walls of the sac were thinner than those of the *aorta*. A little beyond the aortic valves the whole circumference of the vessel was enlarged, but inconsiderably, and one or two moderate concavities or partial dilatations existed along the ascending portion of the vessel. The origin of the *arteria anonyma* was considerably dilated The inner surface of the ascending *aorta* and

arch was covered with yellow, somewhat elevated, patches with here and there an earthy plate. The interior of the pulmonary artery around and beyond the aneurismal apertures exhibited some steatomatous deposition, but was not otherwise diseased. There was no external tumour.

It appears from the preceding description that the *aorta* must have lost much of its elasticity, and was therefore little fitted to throw the blood with much force against the sigmoid valves, after the contraction of the ventricles had ceased. It was very evident, from the position and size of the aneurism, that when it was distended it must have so compressed the pulmonary artery as to have prevented the blood from traversing that vessel freely. The right ventricle and auricle seem to have acquired their increased size and strength probably from this cause. The distended aneurism would also have had the effect, from its projecting into the pulmonary artery so near its origin, of retarding the recoil of the blood that had once passed it, from reaching the valves, hence, in all probability, another source of feebleness in the second sound, especially at the right side of the *sternum*. Had the second sound in the aneurism really been well developed, it may be supposed that it might have been heard pretty distinctly in some part of the region of the heart, when it is remembered that the aneurism was situated within half an inch of the base of this organ. Supposing the second sound of the heart really to depend upon the descent of the sigmoid valves, as there are the strongest reasons to believe, we should expect that any modification of the usual condition of the parts concerned in producing the requisite action of these valves would cause an alteration in the degree of the sound, whether by increasing it as in Case I. or by rendering it feebler, as in the last case. Mere rigidity of the *aorta* contiguous to the heart may not be enough to weaken the second sound, because the large branches arising from it may be capable of causing a recoil against the valves in consequence of there existing between them and the latter a tube incapable of yielding, and because the fluid medium by which their systole exerts its power is incapable of compression. How far these opinions may serve to explain the different degrees of intensity by which the second sound is characterized in different cases of aneurism, and other diseases of the *aorta* in the vicinity of the heart, has yet to be determined.

I think the following conclusions have been established or rendered probable, either in this paper or in other essays.

1*st*, That aneurisms of the ascending *aorta* may or may not have sounds originating from themselves.

2*d*, That when two sounds *originate* in the aneurism they are produced at the opening by which it communicates with

the *aorta*, and that only sacculated aneurisms can originate two sounds, and these of a more or less rough character.

3*d*, That, when two pure sounds, *i. e.* sounds free from morbid murmurs or rasping, are heard in the situation of an aneurism, one only originates at the tumour, the other being communicated from the sigmoid valves.

4*th*, That the second sound of the heart is susceptible of increase, and probably of diminution, from diseases of the *aorta* capable of modifying the energy with which the blood recoils upon the sigmoid valves.

5*th*, That aneurisms near the heart, consolidated by the formation of fibrinous concretions in their interior, transmit the sounds of the heart, and that these sounds diminish on being thus transmitted.

6*th*, That it is immaterial in the diagnosis of substernal aneurisms whether the first sound be rough or pure. See Dublin Journal, Vol. v.

7*th*, That it is equally immaterial in the diagnosis of these aneurisms whether the second sound be rough or pure; that, if the former, it can be the result only of one of the two following conditions, either of a sacculated aneurism *originating* two sounds, or of permanent patency of the aortic opening. —See Edinburgh Medical and Surgical Journal, No. cxxii.

8*th*, That it is immaterial in the diagnosis of substernal aneurisms whether the second sound (if pure) be heard more, or less, distinctly in the region of the heart, than nearer the seat of the aneurism.—See Bertin, p. 95; Hope, Lond. Med. Gaz. 1829, &c.

9*th*, That, although certain preternatural sounds at the upper part of the *sternum*, or on the superior part of either side of the chest in front, together with dulness on percussion and morbid impulse at the same places, afford means of detecting the great majority of substernal aneurisms, yet it is possible for an aneurism consolidated by *coagula*, and without external tumour, to exist without our being able to distinguish it from other solid masses alike capable of conducting the two sounds of the heart, and communicating its impulse.

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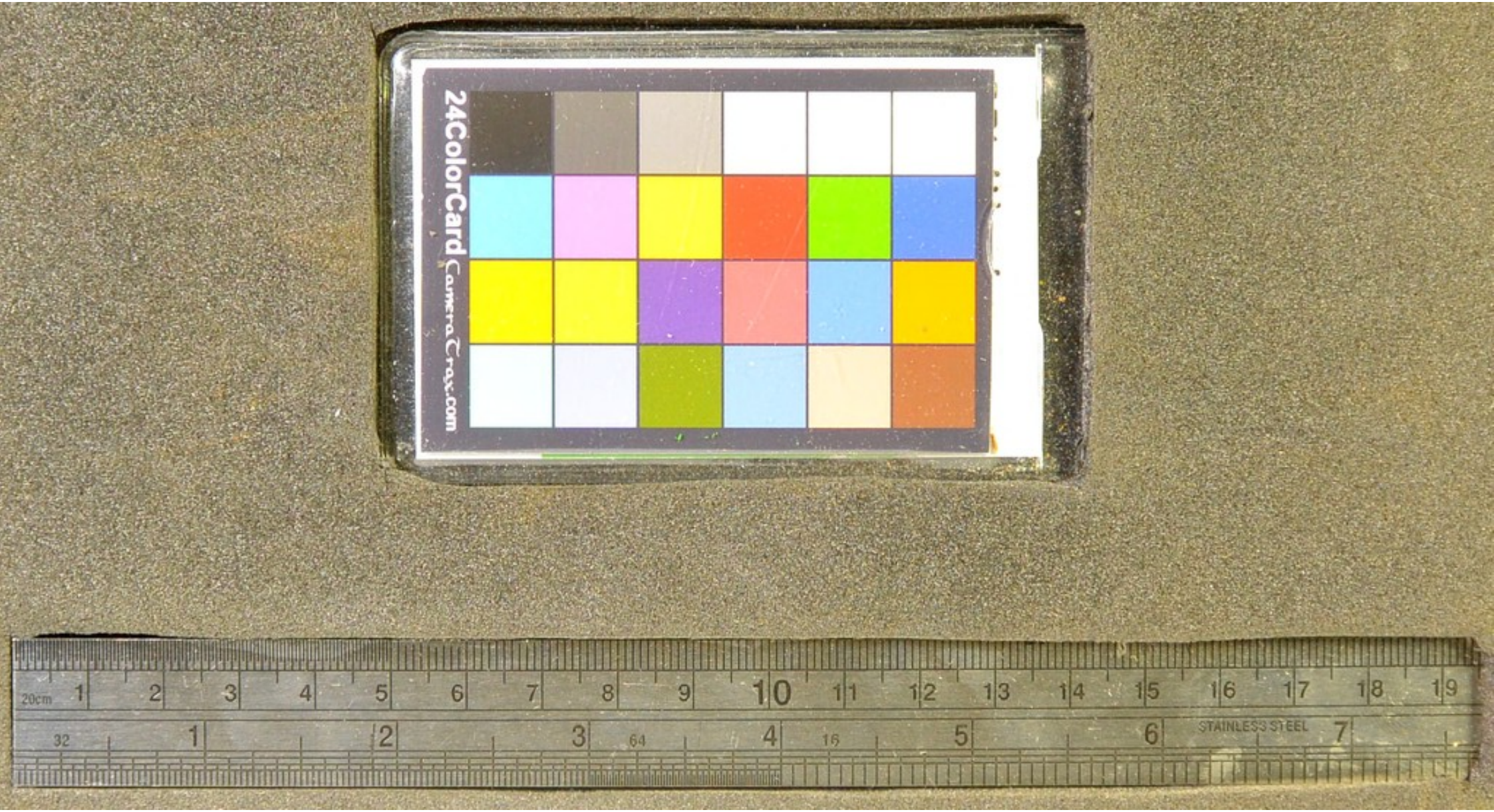
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