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OBJECTIVE AND SUBJECTIVE SYSTOLIC MURMURS IN THE EARS.[1]

A CONTRIBUTION TO THE STUDY OF BRAIN MURMURS.

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H., a boy eight years old, of exceptionally fine intellect, well developed, and apparently in good health, with good ossification in general, and with a firmly ossified skull, was subject to occasional severe general headaches, during which he complained of what he called a "whizzing" in the ears. One evening, when thus complaining, his mother placed her ear upon his ear and distinctly heard the same sound, and Dr. Langmaid, the family physician, being summoned, although the boy was asleep on his arrival and during the earlier part of the examination, was able to hear the sound at a distance of several inches from the patient's head.

The next day, December 15, 1877, I saw him with Dr. Langmaid; he was then apparently in perfect health, complaining of nothing. The sound still continued, although not as loud as on the previous evening; it was musical, and was determined by Dr. Langmaid, who possesses a very delicate ear, as g''; it was intermittent, synchronous with the pulsation of the carotids, much louder in one ear than the other, but of the same pitch in both. It could be heard on placing the ear upon his auricle; better still by connecting my ear with his by the otoscope; and best by covering his ear with the small end of a Camman's stethoscope. It was located directly in the meatus; was not heard over any part of the skull or mastoid, nor below the ear in the neck. The sounds of the heart were normal, as were those of all parts of the chest; no abnormal distention of carotids or jugulars, and no murmur or thrill in them. Slight pressure over either carotid stopped the sound completely in the corresponding ear. There was no anæmia, no dizziness, and no constitutional disease.

[1] Reprinted from the Transactions of the American Otological Society for 1878.

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A subsequent examination, a few days after, with Dr. Langmaid, confirmed all of the statements, and also showed that at times the sound was entirely absent, and at times so low that it could only be heard with a Camman's stethoscope ; the sound when it existed was always of the same pitch.

A most careful examination showed absolutely no abnormal appearance in the ear, throat, or nose ; the hearing for watch and voice was perfect, and there was no distinction to be discovered between the ears by bone conduction.

When first examined, while lying in bed, by Dr. Langmaid, the sounds were objectively louder than at any other time ; at the subsequent examinations, the question of whether they were altered by the position of the patient was not investigated. The boy was remarkable in the family for his very ready and easy blushing.

June 15, 1878, C., aged fifty-nine, school-teacher, seen with Dr. Cornish, of East Boston : a large man, weighing 210 pounds, but not excessively corpulent; always blushes very readily, and this was very marked on his visit to me. Has always considered himself a healthy man ; has never had an ill day, and can endure a great deal of physical exercise ; remembers, however, that ten years ago he was refused by a life-insurance company on account of irregular action of heart, and has noticed occasional palpitation always with indigestion from some forbidden article of food, and on questioning acknowledges that he is rather careful in his diet on that account. Within the last year has not felt as strong as usual, and has noticed an occasional irregularity of the heart's action, *i. e.*, there is an occasional and irregular loss of a beat, but he is not certain that this is new. Some three or four months ago began to notice noises in the ears, and about the same time there was marked debility, loss of strength and appetite.

Since then the noises have become louder, on the whole ; are continuous, but variable in their intensity ; and recently they have interfered much with his sleep. To him the character of the noises varies very much at different times, but he could not compare them to anything ; they are, however, always inter-

mittent, *i. e.*, pulsating. Recently there has been occasional dizziness, never severe. The noises are increased in loudness to him on exertion, and also by positive pressure in the meatus, *i. e.*, by closing the passage by the finger or by laying on a pillow; they are not changed by position of the head. Patient says he "feels the sound come from the region of the heart," and when it is loud "he feels it all over."

After these sounds had continued for some two months he consulted Dr. Cornish, and requested him to listen to his head. On placing his ear to the patient's meatus the Dr. heard the sounds distinctly, and also thought he heard them over the skull. Some ten days afterwards I saw him with Dr. Cornish.

With a Camman's stethoscope over either ear the sounds were heard faintly, but undoubtedly; they were synchronous with the pulse at the wrist, and resembled more than anything else a rather high-pitched bellows-murmur. They were not heard when I saw him except in the meatus; neither on the vertex, occiput, or mastoid; nor was there any murmur over either carotid, as would have been expected if it was a transmitted sound from the chest. There was no distention or sound in the carotids and jugulars. Slight pressure over either carotid diminished the loudness of the sound in the corresponding ear both objectively and subjectively; deep pressure, enough to thoroughly compress the carotids, checked it entirely both objectively and subjectively.

The pulse showed an occasional and irregular loss of a beat; was otherwise without anything abnormal, seventy-eight per minute. The sounds of the heart were normal except the loss of a beat, as above.

The ears were normal: each membrana tympani was normal in appearance and of normal movement by Valsalva's inflation; hearing perfect for watch and voice; tuning-fork on forehead equal in the two ears; w. r. $\frac{84}{84}$: l. $\frac{60}{84}$; but closing one ear increased the subjective noises so much that this probably produced the apparent difference in the two ears. Voice, a low whisper, was heard twenty-four feet in each ear.

June 29, another examination was made, confirming in every

particular the above results; the sounds were, however, less loud than on the 15th, but still distinctly heard in both ears. Dr. Wadsworth was kind enough to examine the eyes on June 29, and found a little conjunctivitis of the right eye, and some astigmatism in both. Vision in the right, with + 36 cylindrical and + 48 spherical, was $\frac{1}{1}\frac{4}{5}$; in the left, with + 42 cylindrical, $\frac{1}{1}\frac{4}{5}$. The fundus was normal in each eye. On being questioned he said that three or four years ago, before any of his present trouble was felt, he had noticed that he could not see as well with the right as with the left eye.

[Since writing this report I have heard from both patients. The boy has had no return of the noises now for some months. In the man the noises still continue, have increased in intensity, and it is asserted that they can now be heard distinctly over the whole skull; the general health is fair, he says better than in the spring: he has become accustomed to the noises, so that they do not trouble him as formerly.]

In both of these cases I think we are justified in asserting that the sound was in the arteries near the ear, in direct and very close connection with the carotids; it could be heard only in the meatuses, and nowhere else; it was certainly diminished or checked entirely by pressure which diminished or checked the flow of blood through the carotids; it was heard in both ears and must have been due to some cause which existed on each side, for deep pressure upon one carotid checked the sound entirely, both objectively and subjectively, in the corresponding ear, but had no influence upon the sound in the opposite ear; it was not heard in the course of the large vessels of the neck nor in the chest, and therefore was not a transmitted sound. As the blood-vessels of the meatus, tympanum, and labyrinth are all of a minute size, it is impossible to imagine any possible condition, in a healthy ear, where any of these would be capable of giving any sound approaching in intensity that which existed in these cases, and which in the boy was occasionally so loud that it could be heard several inches from the ear. The internal carotid artery, however, lies in very close relation to the tympanum, being separated from

that cavity merely by a very thin plate of bone, and moreover for about one inch runs through a firm osseous passage, the carotid canal of the petrous bone; thus furnishing favorable conditions, from its close proximity to the ear, for the easy transmission of vibrations from it to that organ; and also its osseous surroundings furnish an unusually favorable medium for the transmission of these vibrations, while the meatus and tympanum afford an easy passage for the vibrations to reach the external air without being absorbed by soft tissues. I should therefore seek for the source of the sound in the carotid artery within the petrous bone. The total absence of the sound in the neck and chest is conclusive against its being transmitted from any distant part of the circulation, for although it is true the soft tissues do not afford a favorable medium for the transmission of vibrations, still the arteries of the neck lie so superficially, and those of the chest are so large, that any sound of the intensity existing in these cases must of necessity have been heard.

The pitch of the sound differed in the two cases, being much higher and of greater intensity in the boy than in the man; in both it was distinctly pulsating and synchronous with the pulse, as has been said; in both it varied in intensity at different times, but was always of the same pitch; in the boy it was frequently absent for days; in the man from its beginning it had been constantly present. In the man closing the meatus increased the intensity of the sound very decidedly to him, as would have been expected in the case of any sound which originated within the head; in the boy it was impossible to learn that any such change was noticed.

In both there were certain abnormal conditions which were noticed when the sounds were present: in the boy the sounds were always complained of during and after general headaches which could only be classed as nervous, as they came on after violent or exciting play, and were apparently independent of any digestive trouble; in the man the sounds appeared just about the time he had begun to notice a loss of strength and appetite, when in fact there was some debility. The peculiarity of the heart's action in the man I think we can exclude as of

any influence on the murmurs, as it had existed for a long time, probably for years, and was certainly present long before the ear symptoms were felt. One peculiarity in both cases is worthy of special mention: that is the extreme sensitiveness of the vaso-motor nervous system, as shown by the intense and rapid suffusion of the face on the slightest excitement or surprise, — a condition to which both were subject, and which had been often noticed by their friends.

In both cases we have, then, systolic murmurs heard both subjectively by the patients themselves, and objectively by any ear connected with the patient's meatus; in all probability these murmurs arose from the carotid arteries in their courses through the carotid canals of the petrous bones. In both cases there existed pathological conditions, which apparently caused the sounds.

Richardson, in his work on the diseases of modern life, in speaking of the functional diseases arising from the abuse of alcohol, describes subjective noises in the ears as one of the symptoms accompanying alcoholic dyspepsia. These are produced, he says, by a reduced vascular tension, especially of the internal carotid artery, which allows the walls of the artery to lie in direct contact with the osseous walls of the canal in the petrous bone, and thus permits the transmission of the vibrations of the blood directly to the osseous structures in close connection with the ear. He does not speak of these vibrations as ever being heard objectively, but if his explanation is the true one the noises are positive, in contradistinction to the subjective irritations of the auditory nerve, which are purely sensational; and this being the case the perception of the sounds objectively, *i. e.*, by another person, must merely depend upon their intensity. This explanation of Richardson's it seems to me is very possibly applicable to these two cases, for in both there were pathological states which could have induced a reduced vascular tension. Unfortunately, any experimentation to determine this was impossible.

The study of brain murmurs in children has of late excited considerable interest, the subject having been revived by the

work of Jurasz,[1] and since then investigated by Epstein[2] and Hennig.[3]

Jurasz examined sixty-eight children of all conditions of life; the youngest of these was five months old, the eldest four years; in twenty-six of these, murmurs were heard in the brain by auscultation of the skull. His conclusions were that these murmurs were not dependent on the constitution, health, state of ossification or peculiarity of the skull, but were influenced, as has been asserted by other authors (Fisher, Rilliet-Barthez, Roger, Wirthgen, Hennig, Steffan, Henoch, Von Ritter, and others), by the age of the child. In regard to their cause, he says, "The systolic brain murmur is caused by the fact that the gradually enlarging carotis interna (and probably also the meningea media) is relatively disproportionate to the unyielding osseous canal, and thus the artery is partially stenosed till the pressure of the pulse-wave gradually enlarges the canal. The systolic brain murmur is therefore only a physiological phenomenon, in no direct connection with pathological conditions. It can therefore never be of value as a means of diagnosis."

His examinations, he claimed, showed that from birth up to the age of six months the entrance and exit of the carotid canal of the petrous bone are unaltered; from the age of six months to six years they gradually enlarge; and at six years become of the full adult size. These five and a half years are the time when the brain is rapidly enlarging, requiring more and more blood for its nutrition; hence the enlargement of the carotid artery and the temporary physiological stenosis of the canal from the fact that the artery enlarges more rapidly than the canal.

Epstein studied twenty-two cases, not selected, and found that the brain murmur occurred preferably in rachitic children. Of these cases thirteen were boys and nine girls, vary-

[1] "Das systolische Hirngeräusch der Kinder." *Historische und Klinisch-Anatomische Untersuchungen.* Heidelberg. Carl Winter. 1877.

[2] "Beitrag zur Kenntniss des systolischen Schädelgeräusches der Kinder." *Prager Med. Wochenschrift,* Nos. 18 and 19, 1878.

[3] "Ueber die Kopfgeräusche bei jungen Kindern." *Med. Gesellschaft zu Leipzig.*

ing from five months to four years of age. In older children the brain murmurs were never found. In four of the twenty-two cases examined the skull was perfectly ossified; in eighteen the anterior fontanelle was open. Four of the children were healthy; eighteen suffered from rachitis. The intensity of the murmurs was variable: where the fontanelle was open the murmur was intermittent and distinct; where the fontanelle was closed it was continuous and weak; the tone was higher over the temporal bone at the spot corresponding to the arteria meningea media. In all of the cases examined a murmur was also present in the carotid, which corresponded in intensity and character with the brain murmur. In some of the cases the cruralis was likewise examined, but no murmur was found.

Epstein then examines the conditions which produce arterial murmurs, and defines them as follows: —

(1.) Enlargement of the arteries.

(2.) Increased swiftness of the blood-current.

(3.) Diminished peripheral opposition in the vessels.

(4.) Elasticity and thinness of the walls of the vessels.

All of these conditions, he says, produce diminished arterial tension, and all of them are united in childhood.

All of the arteries are relatively wider in children than in adults, and this is especially true of the arteries of the head. Increased swiftness of the blood-current in children is shown by their rapid pulse and diminished peripheral opposition in the vessels by their relatively large arteries, small heart, and the large size of the capillaries. The fourth condition is also present in children, the arteries not yet having become firm.

He says that the murmurs vary, probably from variable dynamic conditions of the circulation, and also that they can be checked by holding the breath, which produces an increased resistance in the brain from congestion. Rachitis he considers, although not a direct, still an important factor in their production. Anæmia, he says, does not in itself cause arterial murmurs, but is an expression of a general disease with which a diminished arterial tension is united. He acknowledges the existence of brain murmurs in healthy children. Hyperplastic

lymph-glands by pressure upon and diminution of the calibre of vessels may produce murmurs.

Epstein's conclusions are that : —

(1.) The brain murmurs originate in the carotid and larger intracranial vessels.

(2.) The most favorable age for their existence is between six months and two years of age ; the extreme limits bring three months and six years.

(3.) Childhood offers proper conditions for their development, more particularly a diminished arterial tension.

(4.) Constitutional diseases, especially rachitis, which interfere with the development, predispose to them.

(5.) Swollen lymph glands may also produce them.

(6.) The skull murmur is not a physiological phenomenon.

Henning calls attention to the fact that brain murmurs were first investigated by Dr. J. Fisher, of Boston, in 1832, but claims that he himself was the first to demonstrate that they were merely a physiological phenomenon. He disagrees with the assertion of Jurasz that the murmurs are uninfluenced by position, as he found them louder when the subject was in the erect posture ; he also says that Jurasz's explanation that the murmur is caused by compression on the carotid, owing to incomplete enlargement of the carotid canal, does not hold good in all cases, as they are found in cases where ossification is well advanced, and where, therefore, it is reasonable to suppose that the carotid canal is fully developed.

In the "Monatsschrift für Ohrenheilkunde" for April, 1878, Poorten reports the case of a man who suffered from spinal irritation, neuralgia, and other nervous symptoms, on whose left side a systolic murmur could be heard eight inches from the ear ; this had followed a blow on the left parietal bone. The murmur could be heard in the left side of the neck on the level of the thyroid cartilage, and from that point increased in intensity as the ear was neared, was loudest in the meatus, and then diminished in intensity towards the occiput, but could be heard even to the seventh cervical vertebra ; it could not be checked by compression of the common carotid, although the

account states that such compression could not be borne more than two seconds; it was diminished by positive pressure in the meatus, and increased by negative pressure. The heart was normal. Poorten gives a *résumé* of other cases of objective murmurs which have been described: the first of these was checked by compression of the arteria auricularis posterior, and is referred by Grüber to an aneurism of the basilar artery, and by Von Troeltsch to "peculiarities in the branches of the posterior auricular artery, and changes in the parts to which this artery is distributed;" in the second case there was a systolic murmur in both heart, ear, and head, which was probably a transmitted sound from the heart; in the third case there existed an arterio-venous aneurism between the internal carotid artery and the cavernous sinus; other cases are given of aneurisms of the orbit, which were accompanied by murmurs heard more or less distinctly over the head.

All of these authors except Poorten discuss only brain murmurs in children; Poorten's and my cases show that such may also exist in adults.

Although at first sight it would seem that all of these authors differ widely in their opinions, close examination will show that many of their statements can be reconciled. Jurasz considers the murmurs as a physiological phenomenon due to the stenosis of the carotid artery referable simply to the age of the patient; he does not acknowledge a pathological murmur. Epstein asserts that they are more common with open fontanelles, when, therefore, the ossification is imperfect, and the stenosis of Jurasz would be much more likely to exist; that they are louder over the arteria meningea, but he seems not to have tried the meatus, and cannot say whether they were still louder at that point; that they were heard also in the carotids, of the neck, but if this was the case, it is no proof that they originated there, for if they arose from the petrous canal they could have been transmitted to the neck, as in Poorten's case; that they were not heard in the other large arteries, as the cruralis, and were therefore certainly not dependent

on any peculiarity of the blood, and probably not on any condition of the arteries alone, but rather on the condition of the arteries together with certain peculiar relations of the arteries to other parts. Epstein asserts that the murmurs originate in the carotid and large intracranial vessels, and suggests particularly a diminished arterial tension as their cause ; he thus seems to regard them as chiefly pathological, although he acknowledges that they are sometimes found in what seem to be healthy subjects. He brings forward no facts to prove or disprove Jurasz's physiological stenosis of the canal.

Diminished arterial tension of itself would hardly produce a murmur, certainly not one to be perceived objectively, but such reduced tension in an artery with the anatomical relations of the internal carotid in the petrous bone would allow the vibrations of the arterial walls to be communicated to the bone, thence to the ear of the patient, and through the auditory meatus to another person.

Poorten's own case could readily be referred to this reduced tension of the internal carotid artery ; at least, there is nothing in the history to militate against this theory. The other cases quoted by him are most of them so distinctly aneurismal, a condition which is well known to produce murmurs, that they need not be considered in this connection.

The direct cause of arterial murmurs in general, whether due to vibrations of the blood or to vibrations of the vessels' walls, need not be discussed here ; the facts are that in certain persons murmurs do exist in the vascular system of the head, which can be heard both subjectively and objectively.

It seems probable that these murmurs may be divided into three classes : —

Physiological murmurs in the internal carotid, dependent on partial stenosis of the carotid canal.

Pathological murmurs in the internal carotid, probably caused by a reduced vascular tension, dependent upon disturbances in the vaso-motor system.

Pathological murmurs from aneurisms of the vessels of the head.