CEPHALIC BRUITS IN CHILDREN
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The discovery of an intracranial murmur during the routine physical examination of an apparently healthy infant or young child may startle the examiner and alarm the parents. This is particularly true in recent years because cerebral auscultation has practically ceased to be a part of the clinical physical examination in adults and children, and, therefore, the significance of these bruits may not be appreciated.

Although in the past much has been written on the subject of intracranial bruits in infants and young children, this interesting material actually has been collected in only a few places, and it seemed of value to record a review of the writings of earlier physicians concerning the significance of intracranial bruits in infants and young children.

Writing in the American Journal of Medical Sciences in 1838, Fisher stated that 5 years previously he had read a paper on the cephalic bellows sound and considered that this physical finding might play an important role in the diagnosis of cerebral diseases as well as thoracic diseases. He described cephalic sounds associated with the heart, with respiration, with the voice and with deglutition as they are developed in normal children at rest or asleep and prior to closure of the anterior cranial fontanelle.

The cephalic bellows sound (cranial bruit), Fisher observed, was related to "simple congestion of the cerebral organs," chronic hydrocephalus, acute inflammation of the brain, suppuration (brain abscess) and induration of the brain accompanied by effusion into the ventricular system and at the base and also by immediate pressure on the brain.

In 1839 Smyth reported a case of chronic hydrocephalus relieved by tapping and stated that in a former paper, written in 1837, he had alluded to the cranial systolic murmur of chronic hydrocephalus.

The observations of Fisher were quickly picked up by physicians in Europe and many reports and ideas were contributed mainly by French and German physicians.

Versini, in 1839, translated Fisher's observations into French, even to citing Fisher's conjecture that the "bruit de souffle" had its origin in the arterial trunks at the base of the skull where the caliber of the intracranial arteries is compromised by the skull itself.

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In 1841 a treatise on auscultation was written by Barth and Roger\textsuperscript{1} who although they accurately summarized Fisher's work, even to his conclusion that the cephalic bruit did not exist in a normal state and was pathologic in import, commented that to that time no trained observer in France had been able to confirm his results.

Whitney\textsuperscript{40} reported that he had encountered this cephalic systolic bruit in association with eight conditions. He listed an aneurysm of the basilar artery, and mentioned a statement by Tweedie\textsuperscript{38} to the effect that probably many times use of a stethoscope in cases of aneurysm would reveal a bruit (bellows murmur) and would facilitate diagnosis. This might have been the beginning of the misconception, so aptly denied by Beadles\textsuperscript{2} at a later date, that intracranial aneurysms frequently are accompanied by a bruit.

The early dispute over the significance of intracranial noises was not without its humorous side, for Kühlbrandt,\textsuperscript{17} in 1846, reported the case of a woman who was using her lower jaw and tongue to cause noises which were heard in the head and which had caused much concern among the local physicians and had deceived many of them.

One of the earliest definitive articles from Germany, perhaps the first and, according to some, the most complete, was contributed by Wirthgen\textsuperscript{41} in 1855. He suggested that there was an anatomic-physiologic reason for the intracranial bruit in some children and that the bruit was the shock of the carotid pulse transmitted along the great vessels of the skull. The skull bones increased the resonance and this was the cause of the intracranial bruit. Wirthgen stated that the reason a bruit may not be heard in very, very young children is that the bones are too loosely united to provide resonance.

Hennig,\textsuperscript{12} writing a year later, was of the opinion that the source of the cephalic blowing sound was in the arterial system, but he did not think the sound was the result of vibration of the arterial walls themselves, or of the noise they communicate to the cephalic mass or to the walls enclosing the cephalic mass. He concluded that if the arterial system is the source of the noise, it must be the intracranial venous system that transmits it.

In 1859, in a rather extensive article, Rilliet\textsuperscript{25} summed up much of the material on cranial murmurs and added some thoughts of his own. To that time, it was apparent that there was a complete divergence of opinion between American and German physicians on two points. Wirthgen\textsuperscript{41} and Hennig\textsuperscript{12} were certain that the cephalic blowing sound (bruit de souffle) in infants could be observed in healthy children, whereas Fisher,\textsuperscript{8} the American, was equally certain that the noise did not exist intracranially in a healthy young individual. The German physicians Wirthgen and Hennig claimed that the cephalic bruit disappeared as the intracranial pressure increased. Fisher,\textsuperscript{8,9} on the other hand, believed exactly the opposite: that the cephalic blowing sound in children was caused by increased cerebral pressure.

Then Rilliet\textsuperscript{25} added his opinion to the controversy and stated that increasing intracranial pressure caused the cephalic bruit to cease. He stated also that chronic pressure could cause the bruit to disappear and disagreed
with Hennig and Wirthgen that the cerebral tension needed to increase rapidly to have this effect.

Roger, writing at about the same time as Rilliet, that is, 1859–1860, analyzed some 300 observations on head noises and came to the following conclusions: that on careful auscultation of the head only a single noise, the cephalic blowing sound, would be detected. He did not feel that there was cerebral egophony, which might have been characteristic of either cerebral effusion or apoplexy, or any other intrinsic noise in the head. Furthermore, he expressed the opinion that no affection of the head could be accurately diagnosed on the basis of a bruit de souffle. He stated that the bruit de souffle is a noise frequently associated with chloro-anemia in very young patients, but rarely with cerebral disease. He also noted the common occurrence of this cephalic bruit in children having rickets, and emphasized the fact that rickets should not be considered as a disease of the skeletal system but of the blood; thus he conveyed his idea of the relation between cephalic bruit and anemia in infants.

In 1861, Henoeh stated that the important decision to make was whether or not a systolic blowing murmur in the head of infants was of pathologic import. After a review of the available material Henoeh decided that the cephalic bruit de souffle in infants was pathologic and did not represent a normal physiologic mechanism.

Somewhat later, in 1877, Jurasz concluded that the systolic murmur in the brain occurs in children from the third or fourth month of life until the fourth to sixth year. He considered that the bruit was in direct relation to the development of the base of the skull, especially that of the carotid canal and the foramen spinosum. Jurasz stated that these murmurs are physiologic in origin and only rarely have pathologic significance. For this reason, he did not consider systolic brain murmurs in children as diagnostic criteria in cranial disease.

One year later Epstein presented the view that brain noises in children were an expression of the carotid artery, and also of the noises arising from the large intracranial arteries. The most favorable age for the origin of the bruit was the last half of the first year of life and the entire second year. In his experience Epstein felt that the exceptional boundaries might include the third month to the sixth year of life. He stated that childhood, particularly the first year of life, offered an especially favorable chance for the origin of these vascular noises in the organization of the child's beginning. He concluded that brain noises were not a pathologic happening.

In 1880 Osler wrote his classic article "On the Systolic Brain Murmur of Children," which most subsequent reviewers on this subject have used as their basic reference. Osler wrote his article in an effort to redirect medical attention to auscultation of the head and its importance. He presented the varying opinions of many of the afore-mentioned authors, but did not venture a statement as to the explanation of the systolic murmur encountered in some young children.

A year later Tripier stated that one must, by exclusion, place the origin
of the systolic blowing intracranial murmur in the terminal portion of the internal carotid artery at the level of the point of entrance into the cranial cavity. In anemia resulting from hemorrhage, cachexia and chlorosis, the cephalic bruit is encountered while the symptoms of anemia are particularly intense and of long duration. He stated that a cephalic bruit without a murmur at the base of the heart and especially without anemia should cause the examining physician to consider the possibility of compression of the internal carotid artery at the level of its terminal portion.

It is important to distinguish between the cephalic blowing sound in which the bruit is continually being reinforced, Tripier stated, and that in which the bruit appears intermittently, produced either by communication of the carotid artery and cavernous sinus or by aneurysms of the carotid or ophthalmic arteries, because in all these cases he felt characteristic signs would be present in the orbit on the same side.

Somewhat later Rohde\textsuperscript{31} quoted much of the available controversial information, and listed Roche's\textsuperscript{28} eight points published in 1859 which seemed of interest.

Roche had stated that brain noises are very common in small children when they have anemia. During dentition and the first year of life anemia is common, and so, according to Roche, are brain noises. They are prominent also in whooping cough, but they are not common in rickets. As previously mentioned, Henoch considered brain murmurs to be symptoms of rickets.

A little earlier (1863) von Rittershin\textsuperscript{26} had explained that brain murmurs are found only in children with open fontanelles and therefore were not of any diagnostic significance. In his review Rohde finally concluded that fontanelle noises were pathologic occurrences.

It is of interest, however, to note that in his \textit{Lectures on Children's Diseases} Henoch\textsuperscript{14} stated that he and Wirthgen directed attention to the physiologic occurrence of this bruit between the twenty-second or twenty-third month of life at the time of closure of the fontanelles by ossification. Henoch, in agreement with Roger,\textsuperscript{29,30} stated the opinion that the so-called brain murmur was of no interest from the clinical point of view.

Until Beadles\textsuperscript{12} article in 1907 on aneurysms of the larger cerebral arteries, contributions by Richardson,\textsuperscript{24} Teleky,\textsuperscript{26} Robertson,\textsuperscript{27} Lane,\textsuperscript{18} Oliver\textsuperscript{21} and others were of some interest but added little to the over-all knowledge of the subject of brain murmurs in children.

Beadles' paper was of particular interest because he reviewed 555 cases of intracranial aneurysm. According to Parker\textsuperscript{23} he made the following statement: "I doubt if more than a couple of living physicians have ever seen a case (of aneurysm) in which a murmur has been audible, and in which the evidence is conclusive that the patient had a true aneurysm of a cerebral artery."

Some years later (1921) Still\textsuperscript{35} wrote on "Cephalic Bruits in Children." He stated that most textbooks passed over the subject of intracranial bruits in children, partly because the bruits had no recognized pathologic significance.
Cephalic Bruits in Children

Still reviewed much of the literature referred to in this report, but stated that his chief interest was centered on the bruit heard in children whose fontanelles were already closed. He mentioned that he was entirely unable to connect the cephalic bruit with any particular morbid condition among the 30 children in whom he detected it. In the 30 cases many diseases were represented: scurvy, epilepsy, achondrodysplasia, nephritis, asthma, congenital syphilis, congenital heart disease, acidosis and dyspepsia; four children did not have any disease at all.

Cushing and Bailey mentioned that they considered auscultation of the head, used to detect bruits in children, to be a lost art.

Hamburger's excellent paper on intracranial bruit was not published until 1931. He stated that cephalic murmurs in children prevail particularly during the second year of life, and during this period they occur about two and a half times as frequently as in the first year of life. Although anemia and rickets were pointed out as causative agents of head murmurs of infants, anemia, whether it was accompanied by rickets or not, was not a necessary part of the picture. These infantile bruits can be heard in entirely healthy children, and, according to Hamburger, there is no record that a murmur may have persisted until adult life.

Other types of murmurs that may be encountered are those of arteriovenous fistulous origin and those associated with rare cases of carotid aneurysm, occasional orbital neoplasms and still rarer cases of true aneurysm of the ophthalmic artery. Another variety of cephalic murmur of intracranial vascular origin discussed by Cushing and Bailey is that which accompanies cerebral aneurysmal angiomata.

In addition to these afore-mentioned bruits, murmurs have been heard in the presence of intracranial lesions, tumors, cysts and so forth.

Sears, in an extensive article published in 1938, considered the mechanism of the production of the cephalic bruit in childhood as unknown, but reiterated the following suggestions: that the condition is attributable to a temporary stenosis of the internal carotid artery in the carotid canal because of the increase in the volume of the rest of the artery that is out of proportion to the rate of growth of the bony canal, or a similar state of affairs causing an increased tortuosity of the artery at the base of the skull in childhood that tends to straighten out as the skull grows and thus abolishes kinking of the artery.

According to Sears, evidence was not available to show that the bruit persisted until adult life. He concluded that the appearance of a cranial bruit in childhood in the absence of any other neurologic lesion is of no pathologic significance, but agreed with Still that it is useful to know of its occurrence and its innocence.

Dalsgaard-Nielsen based his report on the cases of 2,000 patients on whom systematic auscultation had been carried out. He stated that a vascular sound is heard in a good many normal children, and the maximal incidence is encountered in the age group from 6 to 16 months. After this the incidence rapidly drops and no vascular sound is heard in older children.
or adults. He stated that the frequency of vascular sound is slight in children less than 6 months of age, and in the author's series vascular sound was not heard in infants less than a month old.

Dalsgaard-Nielsen described the vascular sound as being heard on auscultation over the anterior fontanelle in children and the disappearance of the sound at the age when the infant's fontanelle closes. He described the sound as faint, soft and blurred without color or distinct limits. The sound also apparently is not permanent and not infrequently, according to the author, subsides during auscultation. He related that this cranial bruit is a physiologic vascular sound that is heard in healthy young children and does not arise in the arterial part of the cranial circulatory system but is derived essentially from the venous portion of the cranial vessels. On the other hand, he recognized that an intracranial vascular sound in older children or adults is definitely of pathologic significance.

Interestingly enough, Fay, in 1940, briefly discussed the diagnosis of intracranial disease by the use of auscultatory percussion of the skull, and then in 1941 Marie and co-workers reported the discovery of a tumor by auscultation in a child 2 years and 9 months of age.

A review of the literature on cephalic bruits was presented by Mackby in 1942. Ford, in 1944, discussed the subject of cranial bruits in childhood briefly, but drew largely on reports by Osler and Hamburger.

Ford stated that a number of different types of intracranial bruits may be encountered during childhood. Some of these are indicative of serious conditions and others are apparently without pathologic significance. He discussed the systolic murmurs of early childhood, stating that in his opinion anemia is the usual cause of these benign murmurs. He made an interesting point, however, in stating his hesitancy to give a good prognosis to the parents if the infant should have an intracranial bruit and normal hemoglobin.

The most recent contribution to the subject of auscultation and intracranial disease at the time of this writing is that of Burklund, published in June, 1953; this article reiterates many of the points already touched on in the articles mentioned herein.

CONCLUSIONS

On the basis of many detailed reports, several conclusions seem valid concerning the cranial systolic bruit encountered in infancy and early childhood. Through the years opinions have varied greatly as to whether these bruits are physiologic or pathologic, arterial or venous. The actual incidence among children is unknown, although conjecture has established the occurrence of this entity as both frequent and rare.

Certainly very little basic physiologic research has been reported to elucidate the mechanisms and significance of this phenomenon. Almost universal agreement exists, however, as to the age of occurrence and maximal incidence and length of duration. In addition there is wide accord as to the rarity of persistence of this cranial symptom until adult life.
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In the opinion of the reviewer, it seems likely that if auscultation is carried out in infants and younger children with the idea of detecting such cranial systemic bruits these sounds might be encountered more frequently. In the neurologically normal infant showing adequate progressive development the examiner might assume the benignity of the symptom, but should reserve his final opinion until time and growth have proved his assumption to be correct. Auscultation of the carotid arteries in the neck should always be done because sometimes the bruit may be heard here and transmitted to the head. Anemia as a contributing factor might well be remembered, but the presence or absence of this laboratory finding should not encourage or dishearten the physician in his over-all appraisal until continued growth of the child has elucidated the problem. Ford’s warning concerning the presence of a cranial bruit and normal hemoglobin seems worthy of reiteration.

The discovery of an intracranial systemic bruit in a neurologically normal infant or young child should be deemed worthy of notation and judicious observation, with the mental reservation on the part of the physician of a usually favorable outlook. Once again the words of Osler, Cushing and many others, that the art of cranial auscultation has been largely overlooked, bear repetition.

REFERENCES

26. Von Rittershin. Cited by Rohde.21
28. Roche. Cited by Rohde.21
37. Tweedie, A. Cited by Whitney.40

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