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TORTUOSITY OF THE INTERNAL CAROTID ARTERY AND ITS RELATION TO TONSILLECTOMY

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TONSILLECTOMY is probably performed more frequently and with less mortality than any other surgical procedure. StClair Thompson[1] records 10,000 tonsillectomies on children without a single fatality. That this is not due entirely to modern technique was borne out by De Santi[2] as early as 1894. This fact is all the more remarkable when we keep in mind that the operation is performed not only by the skilled surgeon but by practitioners generally. This immunity from fatal accidents is apt to lull the operator into a feeling of unwarranted security. That grave accidents may occur should be borne in mind and the most serious of these is fatal hæmorrhage.

Sebileau[3] states that it is impossible to remove the tonsil without provoking some hæmorrhage. The bleeding may be confined to the tonsillar fossa or arise from a vessel lying outside of the fossa. The former condition is usually easily controlled: the latter, though rare, is always serious and may rapidly become fatal.

The normal internal carotid artery lies about one inch posterior and lateral to the tonsil, and is out of danger in tonsillectomy if the surgeon confines his manipulations to the tonsillar fossa. This point is stressed by Thompson.[1] Campbell[4] states that "it is impossible to wound the internal carotid artery in tonsillectomy." Sir Frederick Treves[5] maintains that it is "in comparatively little danger of being wounded when the tonsil is excised." According to Groves,[6] "the danger of wounding the internal carotid artery is quite mythical since the vessel lies three-quarters of an inch away from the bed of the tonsil, the other side of the pharyngeal wall."

The teaching of anatomists and surgeons was until fairly recently that the internal carotid artery lies lateral to the tonsil. This error still persists in the minds of some and is present in the last edition of Buchanan's anatomy.[7] John Cairney[8] has given a fairly complete summary of the correct concept for English authors. He claims that the first correct statement of the relation between the internal carotid artery and the tonsil was made by Hart in 1853. Sebileau[3] in his review of the French literature on the vascular relations of the tonsil states that it was A. Zuckerkandl (1887) who first pointed out that the internal carotid artery lies 2 cm. posterior to the posterior pillar of the fauces. Zuckerkandl's researches were confirmed five years later by those of A. Rieffel.

We may aver that the internal carotid artery when normally situated is in very little danger of being injured in tonsillectomy. However, the artery may be abnormally placed. The conception of the earlier anatomist was that the internal carotid artery is usually sinuous in its cervical portion[25, 26, 27]; the modern teaching is that it takes a fairly straight course in the neck, but may be tortuous near the base of the skull.[28] Tortuosity of this portion may vary in degree, from a mild sinuosity to the formation of actual loops and coils. If the flexures are slight they may not reach the area of the pharynx which lies lateral to the tonsil, but in greater degrees of tortuosity segments of the artery extend so far forward as to lie directly lateral to the tonsil, separated from it by the superior constrictor of the pharynx and the capsule of the gland. In this position it is in great danger of being injured in tonsillectomy, and on examina-

tion can be palpated or seen as a pulsating tumour protruding into the pharynx.[11]

Fortunately, the anomalous coils or sigmoid formations are not always in relation to the tonsil. Out of 12 cases Cairney[8] examined, in 2 the tortuous segments did not come nearer to the tonsil than the normal artery. They may occur in either the coronal or the sagittal plane. The clinical appearance of the former is well illustrated in Figs. 1, 2 and 3; Figs. 4, 5 and 6 illustrate the latter. In Fig. 3 the artery is forming a direct lateral relation to the tonsil, in 4 and 5 it is situated above the level of the soft palate. Fig. 6 illustrates the various degrees of tortuosity which occurred in 10 cases collected by John Cairney.[8] The condition which we met with in a subject in the dissecting room of the Manitoba Medical College during the session of 1933 is described below. It was limited to the left internal carotid; the right artery was quite normal in its course and position.

The subject was a male, aged 72, very obese; the cause of death was dementia præcox. The coil in the artery occurred in the sagittal plane above the level of the soft palate. The artery arose from the common carotid, slightly above the level of the upper border of the thyroid cartilage. It ascended in a fairly direct manner for 35 mm., then it turned backwards

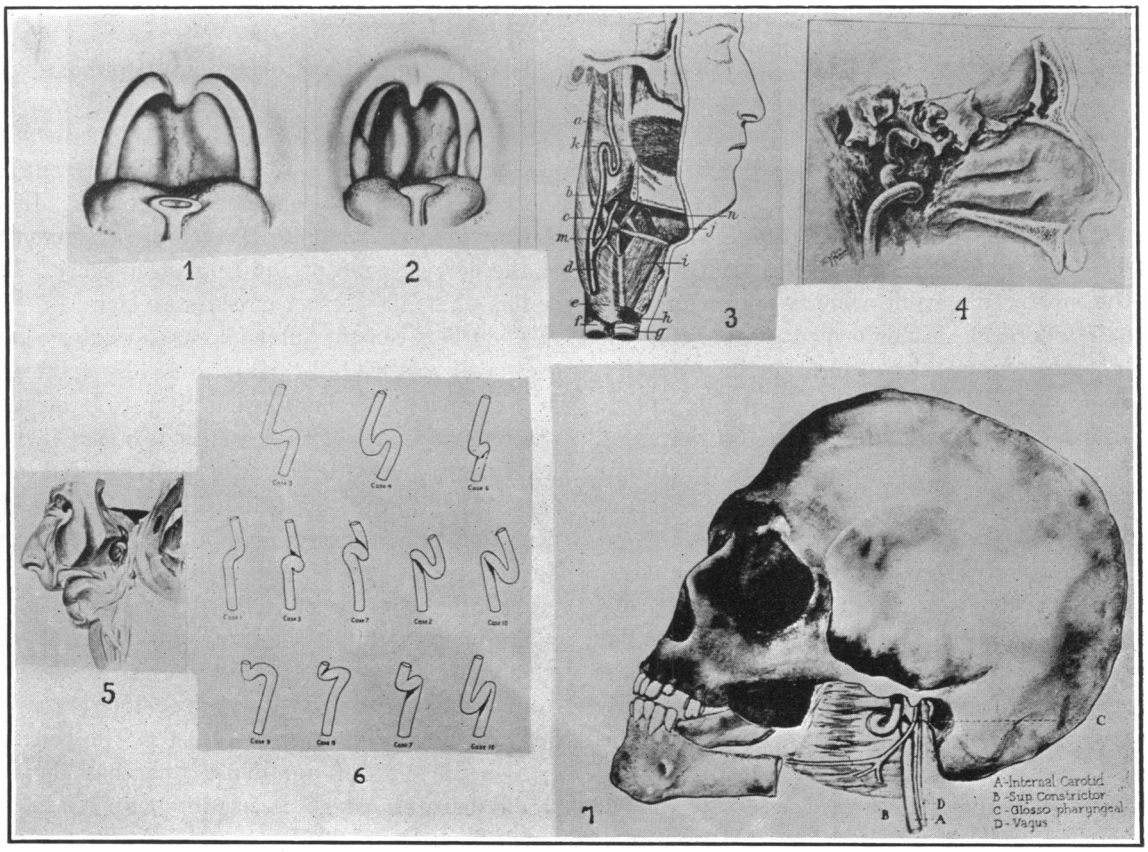

FIG. 1.—(Brown Kelly). Very prominent artery on both sides of the pharynx.

FIG. 2.—(Brown Kelly). Prominent vessel on right side passing over posterior wall, and on left side bulging lateral wall of pharynx.

FIG. 3.—(Fisher). Tortuosity of the internal carotid lies in the sagittal plane. The unshaded area on the superior constrictor muscle covers the area of the inner surface occupied by the tonsil. a, superior constrictor; b, internal carotid artery; c, middle constrictor; d, common carotid artery; e, inferior constrictor; f, œsophagus; g, trachea; h, crico-thyroid muscle; i, thyreo-hyoid muscle; j, mylo-hyoid muscle; k, buccinator muscle; l, tensor tympani; m, external carotid artery; n, hypoglossus muscle.

FIG. 4.—(Skillern). Sigmoid tortuosity of the left internal carotid artery. Pharynx removed but relation to the palate can be seen.

FIG. 5.— (Cadarso and Goyanes).

FIG. 6.—(Cairney). Tortuous internal carotids in the adult (seen from the front). Upper row, cases in which the first bend is medial; all specimens from the right side. Middle and lower rows, cases in which the second bend is medial; middle row are specimens from the right side; lower row from the left side.

FIG. 7.—Tortuous left internal carotid artery forming a complete coil which is situated on the superior constrictor muscle and above the level of the soft palate.

and slightly medially for 4 mm., to pass forwards and slightly upwards for a distance of 10 mm. Then it continued a curved course for 13 mm., twisting at first laterally and downwards, then upwards and backwards, thus forming a complete coil. From this point it bent upwards and ascended in line with the lower cervical segment to the base of the skull, where it disappeared by entering the carotid canal.

The majority of the cases described have been met with in the dissecting room,[8, 9, 10, 12, 13, 23, 24] but a fair number have been observed clinically. We believe that Farlow[15] was the first to recognize and describe this condition in the living subject. In 1887 he presented 5 cases, 3 of which were in girls 4, 13 and 18 years of age respectively, and 2 were in women, 23 and 30 years of age. In his remarks he says "This condition must be rare, for I find no mention of it in the literature." He thought, however, that the aberrant artery was the ascending pharyngeal. He gives this warning, "In all cases where possible it is advisable to examine with the finger, before operating, to see whether an artery of abnormal size or situation is present."

Brown Kelly[11] collected 150 cases presenting pulsation in the pharynx. In 85 cases it was bilateral, in 65 cases it was unilateral. Ninety-one were in females, 59 were in males. The age-grouping was as follows: 3 were children under 5 years of age; 27 were under 15 years of age; and 22 were over 60. The condition occurred more often on the right than on the left side. Sack[16] describes the condition in a girl 10 years of age, whose only symptom was a tickling in the throat. On examination of the pharynx the author states that he saw in the left pharyngeal wall an arch-formed strongly pulsating vessel, 5 to 6 mm. thick. Other cases have been reported; Connolly[17] in a boy aged 5; Wood,[18] a girl aged 5 and a boy aged 7; Demme, reported by Skillern,[13] in an examination of 10,000 patients observed pulsations in the pharynx in 2 per cent.

Fatal hæmorrhage following tonsillectomy due to injury of the internal carotid artery, though rare, should always be kept in mind by the operator as a possibility. De Santi[2] states that it is almost unknown. Sebileau[3] describes 6 cases of death from fatal hæmorrhage following operations upon the tonsil, all of which were performed by skilled surgeons. A case of death following tonsillectomy described by Hamer and reported by Connolly[17] occurred in the Metropolitan Hospital. At the post-mortem which followed it was found that "the girl had two complete coils in the internal carotid arteries, and these coils pushed in towards the middle line, under the posterior wall of the pharynx; in cutting off the tonsil one of the coils had been completely removed." In the Paris letter of the *Journal of the American Medical Association*[19] the reporter states that Dr. Sebileau described the death of a young girl from hæmorrhage following tonsillectomy performed by an expert surgeon, who had performed more than 500 tonsillectomies. At autopsy a large tear was discovered in the internal carotid artery. Skillern gives this timely warning, "Before operating the surgeon should Stop, Look and Listen. A thorough ocular and digital exploration of the pharynx for arterial pulsations should never be omitted."

The etiology of this abnormal condition of the internal carotid artery is by no means entirely clear. Three theories have been advanced: (1) That it is due to atherosclerotic changes in the artery itself; (2) that it is a regressive phenomenon, and is perfectly intelligible in the light of comparative anatomy; (3) that the cause is embryological.

In support of the first theory Moorehead[9] says "Tortuosity is, I believe, the result of atheroma or of arteriosclerosis, and the internal carotid artery presents the twist in a marked degree because it is firmly fixed above in a bony canal." Rowlands and Swan[12] also incline to this explanation, because in their cases the arteries were generally atheromatous. Fisher,[10] on the other hand, claims that the artery in the case he described showed but slight atheroma. Cairney[8] is of the opinion that in his cases arteriosclerosis was insufficient to cause the change. In the case we have described above there is on microscopic examination of both internal carotid arteries considerable atherosclerosis present, but this is not more marked in the tortuous artery of the left side than in the normal artery of the right side. The fact that the condition has been recognized and described so frequently in children[11, 14, 16, 17, 18] is a strong argument against the arteriosclerotic theory. Yet in the face of all this evidence to the contrary, Adachi[20] is of the opinion that the condition is a senile change.

According to Fleming[21] the anomaly can be explained on the grounds of comparative anatomy. In discussing the rete mirabile, which is a

plexiform arrangement of the internal carotid artery found in some grazing animals, he says "The same object is sometimes attained by great tortuosity, as we have already seen in the description of several arteries. Perhaps the most marked example, however, is to be found in the carotid artery of the seal, which is nearly forty times longer than the space which it has to traverse." Cadarso and Goyanes[14] examined the internal carotid artery in ten seals, to test the accuracy of Fleming's statement, and found that the artery in the seal is "noteworthy for the directness of its course." They further point out that the literature does not substantiate Fleming's statement. According to the opinion of these investigators and others[20] the condition is not due to a reversion to type.

The most likely explanation, it seems to us, is the embryological one, which has been advanced by Kelly.[11] As is well known, the internal carotid artery is formed from two embryological arteries. The lower part of the vessel is from the third aortic arch and the upper part is from the dorsal aorta. Where these two parts become continuous a bend in the vessel occurs and at this point it is crossed superficially by the glossopharyngeal nerve. Due to the development of the lungs there occurs a descent of the heart and this usually straightens out the bend. If, however, as Kelly points out, there is a greater relative growth of that part of the artery which arises from the third arch this angulation may persist. Since this portion of the artery is surrounded by loose areolar tissue, it is free to assume as age advances the various formations which we have described. It is noteworthy, and in support of this theory, that these flexures always occur in that part of the artery crossed by the glossopharyngeal nerve.

The main points in the diagnosis according to Kelly are: (1) a smooth and not very pronounced bulging, pulsating synchronously with the heart and covered with healthy mucous membrane; (2) its situation in the posterolateral region of the pharynx and mainly on a level with the tonsil; (3) its frequent bilaterality; (4) the absence of symptoms attributable to it; (5) its identification as the internal carotid by palpation and pressure; (6) its unchanging size over periods of months and years.

While sinuosities of the internal carotid artery are fairly common, tortuosities to the extent of forming a complete coil, as that in the dissection herein described, are relatively rare, there having been reported, so far as we can ascertain, only four cases.[13, 14, 17, 23]

Although the internal carotid artery and other aberrant arteries which may occur in the region of the tonsil may lead to fatal hæmorrhage in tonsillectomy if not recognized beforehand, their detection is so easy that if ordinary care is taken no fatal accidents from hæmorrhage in tonsillectomy should ever occur.

SUMMARY

1. Fatal hæmorrhage following tonsillectomy is usually due to the injury of an aberrant internal carotid artery in the region of the tonsillar fossa, and it is an eventuality which the operator should not disregard.

2. The normal position of the internal carotid artery is ¾ to 1 inch posterior and lateral to the tonsil, and not lateral to the tonsil as has been taught in the past.

3. An examination of the literature shows that the internal carotid artery is frequently sinuous in its cervical portion, to such an extent as to form complete coils which may be situated in the sagittal plane and extend as far forward as the tonsil or in the coronal plane, and extend to the middle line of the posterior wall of the pharynx.

4. Such anomalies of the internal carotid may be unilateral or bilateral.

5. A dissection of the left internal carotid artery which formed a complete coil in the sagittal plane above the level of the soft palate is described.

6. Examples from the literature representing this condition both in the cadaver and in the living subject are given.

7. The cause of the anomaly herein described is probably embryological, and not pathological or regressive, as some investigators have maintained.

8. A correct diagnosis is formed on a consideration of the situation of the pulsating tumour, the healthy appearance of the mucous membrane, and a determination of the fact that the tumour is a part of the internal carotid by palpation and pressure.

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SKIN INFECTION DUE TO ALTERNARIA TENUIS

(WITH THE REPORT OF A CASE)

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CLINICAL DATA

THE patient was a Roumanian Jewess, 36 years of age, the mother of two children, both of whom are alive. Sixteen years ago, while scrubbing her verandah, she ran a splinter into her left hand. It was immediately removed and tincture of iodine applied. On the following day a group of pustules formed on the skin of the dorsum of both fore-arms and hands. The condition on the right limb disappeared spontaneously in a day or two. The condition on the left persisted and has persisted. She also had a pustule on the back of the left heel. This also disappeared entirely. The patient had never been free of the condition in the left fore-arm and hand. During the last few months it had been particularly painful. On the application of water at any temperature considerably more pain was experienced.

The patient when seen on December 3, 1932, had a number of dark, ulcerating macular and papular lesions on the left fore-arm and hand, from which a sero-purulent fluid could be expressed. On the fore-arm the lesions extended quite deeply into the scarf-skin but not into the corium. On the hand, particularly, in the region of the knuckle the papules extended almost to the fascia. The lesions were dark brown or black in the centre and were quite scaly. There were also a considerable number of scars where former lesions had been. Clinically, the lesions had the typical appearance of a fungous infection.

The lesions tended to heal spontaneously, only to reappear in another region of the fore-arm and hand. At one time, approximately seven years ago, she was apparently without any sores for a period of two weeks at the end of which time fresh ulcers re-appeared. She had been treated off and on during the entire period of the condition.

MICROSCOPIC AND CULTURAL DATA

On December 3, 1932, when the patient was first seen, a number of scales were digested with 10 per cent solution of potassium hydroxide. Under 10 x 10 magnifications a long branching septate mycelium was seen intercellularly. The hyphæ did not invade the individual cells. There was no indication of spores or spore-formation. No bacteria or other organisms (yeasts) were found. A number of stained specimens (using Wright's solution, carbolfuchsin, methylene blue) revealed the same type of organism; bacteria and yeast bodies were absent.

A smear of the pus showed a considerable number of lymphocytes, some pieces of mycelium, but no spores. The same slide treated with Wright's solution revealed the same under oil-immersion lens with a 95 x 10 magnification. The pieces of the mycelium contained spherical bodies. No yeast-like or bacterial bodies were found. The mycelium was easily stained, but no particular advantage was obtained by staining. The scales, pus and sero-purulent fluid were negative for acid-fast bacilli.

Culture 1.—The infected area was washed well with soap and hot water and the area disinfected with denatured alcohol. Some pus was taken up in a sterile Pasteur pipette which had previously been autoclaved at 15 pounds pressure and 250°F. The pus was transferred to a flask containing a medium of agar and beef broth whose pH was 4.7. This at no time showed any growth.

Culture 2.—In the same medium in a culture tube a scale was placed. This immediately sank