

# THE KINKED CAROTID ARTERY THAT SIMULATES ANEURYSM

BY

JOHN PARKINSON, D. EVAN BEDFORD, AND S. ALMOND

*From the Cardiac Department of the London Hospital and the Electrocardiographic Department of the Middlesex Hospital*

[ Received August 21, 1939

During the last fifteen years we have observed a number of patients in whom there was a pulsating vascular swelling at the right side of the root of the neck which at first sight suggested a carotid or innominate aneurysm. Subsequent investigation enabled aneurysm to be excluded and proved the vascular swelling to be a tortuosity or kinking near the origin of the right carotid. Often the pulsating tumour was the main or the sole complaint, and sometimes surgical treatment for aneurysm had been contemplated.

## HISTORICAL

Coulson (1852) described a woman, aged 82, " who for some years before her death had a pulsating tumour, of the size of an orange, just above the right clavicle, in the situation of the carotid. The swelling had not of late increased in size and caused no inconvenience ; the woman died from natural decay. The vessels arising from the aorta were elongated and considerably dilated ; and the tumour, which was considered before death to be aneurysmal, consisted of a reduplication of the right common carotid. The interior of the vessels was highly vascular and there was considerable atheromatous deposit."

Hulke (1893) described a case like that of Coulson's, but without necropsy. She had " a conspicuous pulsating swelling which projected the sterno-mastoid muscle " and was thought to be an aneurysm of the common carotid artery. He concluded that the swelling was formed by a long loop of the carotid artery, comparable with the tortuosities found in more superficial arteries.

Douglas Powell (1909) reported upon a female, aged 78, with a pulsating tumour presenting the character of an aneurysm about the size of a walnut. It was defined as a widened, bent, and slightly twisted carotid artery. It proved to be a high division of the innominate artery, with a twisted kinked [*sic*] condition of the carotid, the walls of which were atheromatous and partially calcareous. At necropsy, " The right carotid was tortuous and considerably displaced. It was twisted to the right, forming a marked curve, about one-third of a circle ; it also showed antero-posterior deviation as well. The right

subclavian was likewise tortuous and directed at first somewhat backward, so that the innominate appeared to be slightly twisted. The left carotid and subclavian were normal in course. The aorta, right carotid, and subclavian all showed marked signs of atheroma" (Fig. 1). In the same paper he also

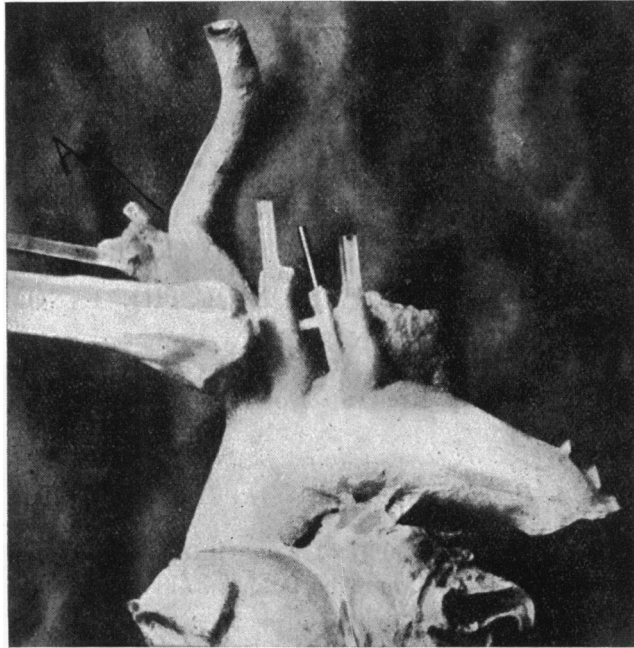


FIG. 1.—Sir R. Douglas Powell's specimen of kinked carotid, showing high bifurcation of the innominate. (*Middlesex Hospital Journal*, 13, 2, 1909.)

referred to a woman, aged 60, whom he had seen fifteen years previously. She had a "degenerated, bent, and throbbing carotid artery which had simulated aneurysm, but it was clear on careful manipulation that the condition was a bent artery with locomotor impulse."

Stadler and Albracht (1911) attributed a similar swelling at the root of the neck to sclerosis and dilatation of the innominate artery. Hirschfelder (1918), in describing a case where a tortuous subclavian artery presenting its convexity in the supra-clavicular fossa had previously been diagnosed as aneurysm, noted the simulation of aneurysm by a tortuous carotid or subclavian artery. Balfour (1898), in a chapter on the simulation of aortic aneurysm by malposition of the aorta due to rickets, gave details of a woman, aged 46, who had severe dorsal scoliosis with convexity to the right and some kyphosis. She had noticed a throbbing swelling in her neck "as large as a hen's egg." In the lower part of the neck, just over the suprasternal notch, a pulsating tumour was felt crossing the trachea and dipping beneath the right sterno-mastoid muscle. At necropsy the heart was tilted up and the great vessels were displaced. The ascending aorta passed outwards to the right more than usual and continued into the transverse part at a somewhat acute angle. The innominate artery

was two inches long and twice its usual diameter. It came off from the aorta farther to the left than usual, coming to the surface at the left sterno-clavicular articulation and then crossing the trachea in the lower part of the neck to the edge of the right sterno-mastoid muscle, beneath which it dipped and divided.

Brown and Rowntree (1925) drew wider attention to the condition by publishing a series of five cases, all women, with pronounced pulsation of the lower right cervical region beneath the sterno-mastoid muscle. All their patients had hypertension. They attributed the condition to kinking or buckling of the right common carotid artery caused by the adjustment of a lengthened carotid artery to the decreased distance from the aorta (which is elevated) to the skull. They concluded that this kinking depends upon hypertension and does not result from arteriosclerosis alone.

Beardwood (1931) described two cases of hypertension, one a male, with this type of pulsation. He attributed the kinking to the fact that the carotid is fixed to some extent at its distal end, and that the aorta in enlarging pushes up the innominate artery almost out of the chest cavity. Additional examples, all women with hypertension, have been reported by O'Malley (1924), Eastwood (1927), Stolkind (1934), and Holst (1934). Recently Torrens and Horton (1938), in describing two more cases, state that none has yet been reported without hypertension. White (1937) refers to this pulsation, which he attributes to two factors—firstly vascular dilatation and secondly elevation of the great vessels by cardiac enlargement and a high diaphragm.

A somewhat similar condition due to elevation of the subclavian artery, especially the right, was described by Faure (1874) as a sign diagnostic of a dilated aorta. He described six cases, three with necropsies, in which there was elevation of the innominate artery with tortuosity of the subclavian. Barié (1912) also refers to this sign. The abnormal pulsation is at the root of the neck on the right side, but external to the sterno-mastoid. Norris and Landis (1933) also attribute "marked pulsation just above and to the right of the sterno-clavicular joint" to lifting up of the subclavian artery as the result of dynamic or passive dilatation of the arch of the aorta.

#### CLINICAL FEATURES

The typical patient is a woman, middle-aged or elderly, often stout, and affected by kyphosis and scoliosis. A pulsating swelling is seen and felt behind the sternal head of the right sterno-mastoid, often extending beyond the inner or the outer border or even both borders of that muscle. A drawing of the neck showing a common position of the swelling is shown in Fig. 2. The pulsation is expansile and forcible, and the excursion to the right may attain 1–2 cm. The swelling is either rounded or ovoid, with its long diameter more or less vertical. In favourable cases, careful palpation with the finger-tips shows that it consists of a vascular loop—a bend or kink in the course of the right carotid artery. The size of the swelling is little affected by posture, though it may be a little more noticeable when the patient lies down. It varies in size

from time to time and may increase with rise of blood pressure or with tachycardia. There are no local pressure symptoms beyond the throbbing.

Our series comprises forty cases of this condition of kinked carotid, all being women with hypertension or arteriosclerosis or both. In addition, we

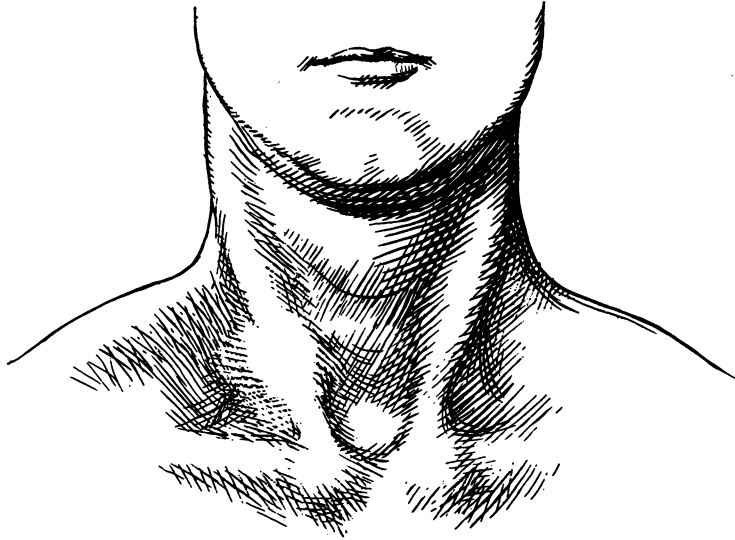


FIG. 2.—Drawing of neck to show a common position of the swelling due to kinked carotid.

have occasionally observed an almost identical vascular swelling in association with aortic incompetence and also with coarctation of the aorta ; these are separately considered.

*Group I. With Hypertension or Arteriosclerosis (40 cases)*

All were women ; the youngest was aged 41 and the oldest 79, the average being 59 years. The build and appearance were noted in 26 cases, and though 16 of these were obese, 6 were thin. Scoliosis, with the main thoracic convexity to the right and combined with some degree of kyphosis, was almost the rule. Ten of these 40 sought advice solely because of the local pulsation and swelling ; 13 mentioned it in addition to other symptoms.

Hypertension was present in 30 cases (75 per cent.), the blood pressure exceeding 160/95 mm., and in 24 of them the systolic pressure was above 200 mm. In 10 (25 per cent.) the blood pressure was never found raised. Thickening and tortuosity of the radial and brachial arteries were noted in half the cases. None showed evidence of syphilis and in 22 with a recorded Wassermann reaction there was only one positive finding.

There appears to be only one male with kinked carotid on record (Beardwood, 1931) and we also have seen one but have no notes of it. In two of our patients a similar (though less prominent) pulsatile swelling to that on the right was seen in the same position on the left side.

The cardiographic feature was left axis deviation, as would be expected

from the frequency of associated hypertension and a raised diaphragm. Bundle branch block was noted twice and auricular fibrillation twice.

The *X-ray* appearance of the aorta was notable. In 32 cases it was lengthened and uncoiled ; in the remaining 8, 2 were not X-rayed, 4 were inadequately reported, and 2 only showed no abnormality. In 16 the summit of the aorta reached the clavicle and in 2 it extended above the upper border of the clavicle. The heart was commonly enlarged, especially to the left, as expected with hypertension. In a few cases a shadow encroached upon the inner side of the apex of the right lung (Figs. 3 and 4), when it coincided with the area of the pulsating swelling as felt during radioscopy.



FIG. 3.—Radiograph showing an abnormal shadow at the apex of the right lung due to a kinked carotid. (Case 2 in Appendix.)

The prognosis depends on the cardiovascular disease and is not affected by the presence of a kinked carotid. One patient, first seen in 1923, was alive and well when re-examined fifteen years later at the age of 78. Two others have been under observation for eight and five years respectively, and in several others the swelling had been noted for as long as five to twenty-five years ; even over such long periods there seemed to be little or no increase in the size of the swelling.



FIG. 4.—Radiograph showing a high aortic arch and an abnormal shadow at the apex of the right lung due to a kinked carotid. (Case 4 in Appendix.)

*Group II. With Aortic Incompetence (4 cases)*

Corrigan (1832) in his original paper *On Permanent Patency of the Mouth of the Aorta, or Inadequacy of the Aortic Valves* stated: "If the arch of the aorta and arteria innominata approach more nearly than usual to the notch of the sternum, the visible pulsation at the root of the neck becomes so prominent as to lead to a supposition that there is aneurysm, and even of considerable size at this part." And again: "So strong were the pulsations for years in the region of the arterio-innominate that until the examination after death there was never even a doubt expressed that the case was not aneurysm."

Hare (1886) reported a girl, aged 17, with rheumatic aortic incompetence "and an egg-shaped protrusion in the suprasternal notch, very expansile and bulging at each systole of the heart"; he considered it to be a small fusiform aneurysm, combined with general dilatation of the aorta and innominate artery. This case is of further interest in that Osler (Osler and McCrae, 1908) personally examined Hare's patient on several occasions and stated: "It was not a case of throbbing of the innominate and the right carotid during ventricular systole, but there was a prominent dilated tumour to be grasped between the fingers just above the sternal notch. . . . At the post-mortem it was not a surprise to find the condition had been one of simple dynamic dilatation."

We have notes of four cases of aortic incompetence in which, besides the

usual carotid throbbing, there was a localized pulsatile swelling at the root of the neck on the right side. The swelling was rather more mesial than was that described as a typical kinked carotid, lying partly in the suprasternal notch and partly behind the right sternomastoid. Here the swelling appeared to be formed by the innominate artery, the origin of which was displaced to the left, so that the vessel crossed the episternal notch from left to right, in front of the trachea. Of our four cases, three were women aged 59, 60, and 67, and one was a man aged 55. All had hypertension and in three the Wassermann reaction was positive.

*Group III. With Coarctation of the Aorta (3 cases)*

In this congenital anomaly the subclavian arteries are often enlarged and pulsate excessively, but the carotids are not usually affected. We have, however, seen three cases of coarctation with abnormal pulsation in the suprasternal notch or at the root of the neck, not unlike that described under kinked carotid. Two were males, aged 14 and 25, and one was a female, aged 54. The swelling is probably due to elevation and dilatation of the aortic arch and a resultant high bifurcation of the innominate, though another possible explanation is an anomalous origin or course of the vessels springing from the aortic arch. Weber and Price (1912) described a female patient, aged 56, with aortic coarctation, in whom there was "a pulsating aneurysmal swelling on the right side of the neck, in front, just above the clavicle, about the average size of a hen's egg." If coarctation is suspected, confirmatory signs such as the diminutive femoral pulse and the collateral vessels should be sought, and X-rays may reveal an abnormal configuration of the aorta and the characteristic erosive notches on the lower borders of the ribs (Roesler's sign). When a vascular swelling of the root of the neck is found in a male or any young subject with hypertension, in whom the common form of carotid kinking is almost unknown, coarctation is the most likely explanation for it.

*Group IV. With Other Congenital Vascular Anomalies*

Tortuosity of the internal carotid artery has long been recognized by laryngologists as a developmental abnormality, occurring in the young and often bilaterally. The internal carotid artery originates from the third aortic arch and the dorsal aorta, and at the junction of the two component parts a distinct bend is formed. Kelly (1924) attributed the persistence of undulation or tortuosity to the fact that the normal straightening out of the artery is incomplete. It is manifested by a symptomless pulsating bulge in the lateral part of the pharynx. Kelly reviewed a series of 150 cases which included 21 over the age of 60 (these were believed to be arteriosclerotic) and found that females preponderated. Where the condition was unilateral, it was commoner on the right side.

Freyberger (1898) reported a female patient, aged 26, in whom "a pulsating swelling was visible above the right sterno-clavicular articulation; its centre was covered by the sternal and clavicular insertions of the sterno-mastoid

muscle (the swelling measured  $1\frac{1}{2}$  inches from side to side, and about 1 inch from above downwards)." The clinical diagnosis was aneurysm of the innominate artery. At necropsy, the findings were a bulging body caused by an abnormally wide truncus brachiocephalicus into which were inserted the thyroidea ima and left common carotid artery. This short common trunk was in front of the trachea and measured half an inch across. It gave off the right subclavian, right common carotid, thyroidea ima, and left common carotid arteries. The left subclavian artery was in its normal place and position.

#### ANATOMY, PATHOLOGY, AND CAUSATION

##### *Anatomy*

The innominate artery is the first and largest branch of the aortic arch, arising at the level of the upper border of the second right costal cartilage and passing upwards and slightly outwards to bifurcate behind the right sternoclavicular joint. According to measurements cited by Krause (1868) its usual length is 2.5–5 cm., but in 16 of 219 cases from Quain it exceeded 5 cm. and might even exceed 7 cm. Burns (1809) observed instances of the innominate ascending in front of the trachea well above the top of the sternum before dividing, and mentions a cast in his possession showing the right carotid crossing the trachea two and a quarter inches above the sternum. The right common carotid artery arising from the innominate passes directly upwards in the neck as far as the thyroid cartilage, where it divides to form the external and internal carotid arteries; no branches are given off. Its course is indicated by a line drawn from a point midway between the angle of the jaw and the mastoid process to the sterno-clavicular articulation.

##### *Pathology*

Necropsies were obtained in two of our cases summarized below, and in addition we have notes of a third necropsy in which a sketch of the tortuous innominate artery was made.

(1) *Case 37.*—An obese woman, aged 41, admitted with shortness of breath, failing vision, and vomiting. A pulsating vascular swelling occupied the right half of the suprasternal notch and extended to the right beneath the right sterno-mastoid muscle. B.P., 235/140; gallop rhythm; extensive albuminuric retinitis; W.R., negative; blood urea, 455 mg. per 100 c.c. Death two weeks later.

*Summary of necropsy. Renal insufficiency. Nephritis repens. Considerable cardiovascular hypertrophy.* The carotids upon exposure showed no curvature. The innominate artery measured 1.05 cm. in diameter; the right common carotid, 2 cm. from its origin, 0.65 cm.; and the left 0.6 cm. The subclavian artery was slightly widened just beyond its origin (Fig. 5), but unfortunately its diameter was not recorded and no portion was taken for microscopic section. The heart was removed with the neck organs for the illustration and was not returned for weighing.

Longitudinal sections were taken from the proximal and distal parts of each common carotid artery and from the innominate artery, aortic arch, and abdominal aorta. Paraffin sections were stained with hæmatoxylin and eosin, Weigert's iron hæmatoxylin, and Ponceau S, Weigert's fuchsin, and neutral red for elastic fibres, and thionin according to Hoyer's method for mucin.



In the media of the *proximal portions of the right and left common carotid arteries* the elastic content was normal, the collagenous stroma was slightly increased, and there was mucous degeneration, which for the most part was confined to a zone beneath the intima but in one segment of each artery extended almost to the ad-

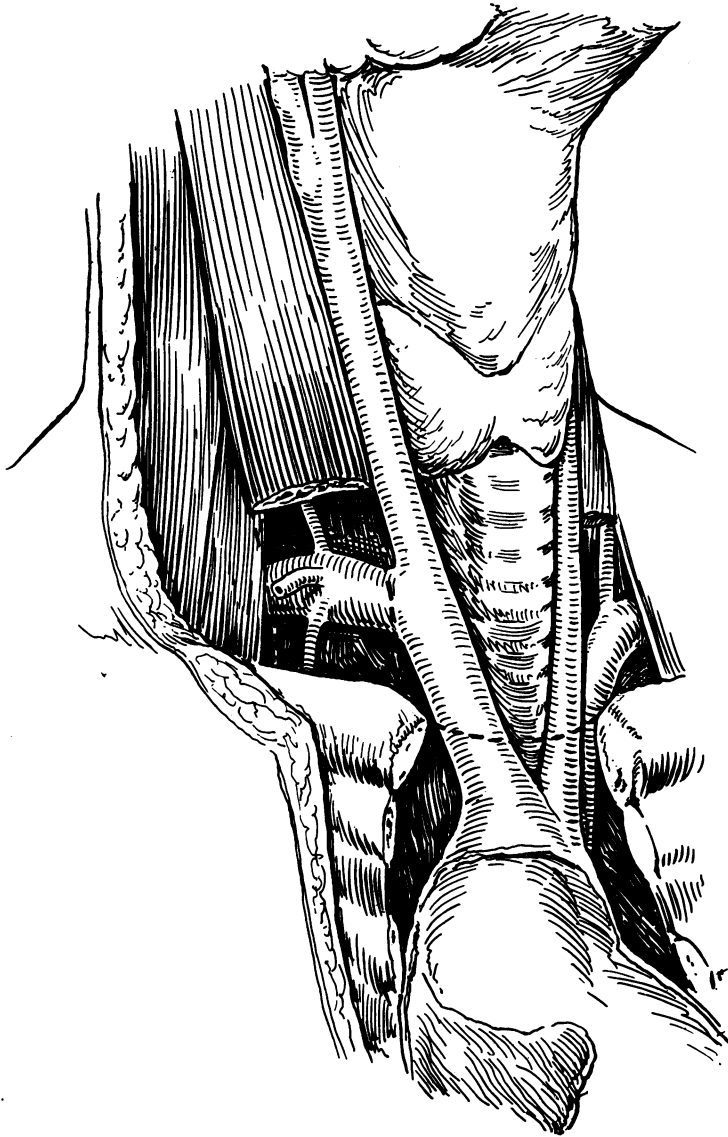


FIG. 5.—Drawing of aorta and great vessels in situ, post mortem, showing high bifurcation of innominate and slight localized dilatation of right subclavian (Case 37). Level of upper border of sternum indicated by dotted line.

ventitia. The degeneration was very slight upon the right side and moderate upon the left. On the other hand intimal hypertrophy was greater on the right side ( $1/15$  to  $2/3$  of the depth of the media as opposed to  $1/13$  to  $1/4$  on the left) and showed slightly more degeneration, three small areas of fatty atheroma being present. In the *distal portions* mucous degeneration was greater on the right side and involved

more of the media; it was not, however, severe. Intimal hypertrophy was much greater upon the right side, being from  $\frac{3}{4}$  to  $\frac{9}{10}$  of the depth of the media as opposed to  $\frac{1}{9}$  to  $\frac{1}{3}$  on the left. Further, the intima on the right side showed considerable mucous degeneration, while that on the left was free. In the *innominate artery* mucous degeneration of the media was very slight and patchy. In its depth and the amount of degeneration the intima was very similar to that of the proximal part of the left common carotid artery. In the *aorta*, particularly the abdominal portion, medial degeneration was greater than in the above arteries. In the *arch* the elastic was intact but there was a focal fusiform area in the centre of the coat in which muscle fibres were absent. There was considerable mucous degeneration, chiefly in the inner third. The depth of the intima was from  $\frac{1}{10}$  to  $\frac{2}{7}$  that of the media. In the *abdominal segment* the media was in general narrow, and it was very narrow at one spot where there were small areas in which the elastic fibres were fragmented or absent. There was a little mucus in the inner layers. The depth of the intima was two and a half times that of the very narrow segment of the media and half that of the media elsewhere. It showed much mucous degeneration in its outer part and a considerable number of foam cells.

The degeneration in the arteries was not greater than might be expected in view of the age of the patient and the persistent high blood pressure, which was known to have been present and very high for a year and a half and was doubtless of much longer duration. The degeneration of the media of the proximal portion of the right common carotid artery was not sufficient to have caused an aneurysmal dilatation appreciable clinically. It was, indeed, less than in the corresponding portion of the left artery.

(2) *Case 40*.—Well-nourished woman, aged 43, admitted with a view to operation for “innominate aneurysm.” Pulsating swelling in the suprasternal notch and under the right sterno-mastoid muscle in the adjoining supraclavicular region. B.P., 210/140; W.R., negative; blood urea, 285 mg. per 100 c.c. X-ray, great cardiac enlargement and pulmonary congestion. Death a fortnight later.

*Pathological summary*. Hypertensive failure. Uræmia. Myocardial hypertrophy. Severe uræmic changes in kidneys. Terminal suppurative bronchiolitis. Edema of lungs. Innominate artery branched at about two inches above the right sterno-clavicular joint; no kinking or dilatation noted.

(3) *Case X*.—Male, aged 74, admitted with the clinical diagnosis of hypertension and congestive heart failure.

*Necropsy*. Heart weighed 14 oz. (397 g.). The aortic arch was dilated and its summit reached the level of the upper borders of the clavicles. The innominate artery was tortuous and dilated, forming a loop which arched across the suprasternal notch from left to right (Fig. 6). The left carotid and subclavian arteries were also tortuous. There was severe kyphosis.

Five published cases with necropsies have already been cited. In Coulson's case the aorta was dilated and elongated and the right common carotid “reduplicated”; in Douglas Powell's case there was atheroma, a high division of the innominate, and a tortuous or bent right common carotid; in Balfour's case there was scoliosis and angulation of the aorta with displacement to the left of the dilated innominate artery, which was two inches long. In Hare's case with aortic incompetence, in which there was an egg-shaped tumour in the suprasternal notch, Osler stated that the condition was one of dynamic dilatation. Finally, in Freyberger's case the vascular swelling proved at necropsy to be a wide and anomalous innominate trunk.

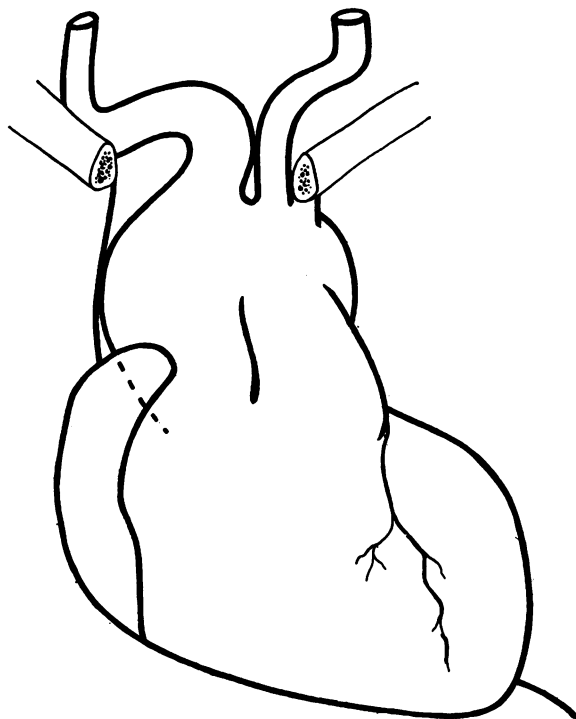


FIG. 6.—Outline drawing of the heart and great vessels in situ from a case of hypertension with kyphosis, showing high, tortuous and somewhat dilated innominate artery.

#### *Causation*

Available post-mortem observations show, therefore, that the vascular swelling in question is not due to aneurysm or localized dilatation of an artery, but to a tortuosity either of the right common carotid or of the innominate or of both, together with some degree of general dilatation of these arteries. Elongation and unfolding of the aorta with consequent displacement and elevation of the innominate is usually found. A high bifurcation of the innominate is due either to an unusual length of this artery or to elevation of its origin at the aorta or to both.

The frequency of hypertension is significant. Not only does hypertension produce uncoiling or unfolding of the aortic arch, often with some degree of dilatation, but it also accentuates the dynamic factor. When arteriosclerosis of the aorta is also present, as is usual, there is actual lengthening of the aorta. Thus the aortic arch becomes elevated in relation to the clavicles, and this elevation will be accentuated if the chest is shortened by kyphosis and by the high diaphragm of obesity.

The dynamic factor in these vascular swellings is clearly important, for the bulge seen in life usually disappears after death when the artery is no longer distended under high pressure. A tortuous or looped right carotid or innominate artery will receive direct the full force of a hypertrophied left ventricle, and at each systole an exaggerated movement is imparted to the arterial loop

comparable with that seen in a tortuous brachial artery when the forearm is bent. If aortic incompetence is added to hypertension, this dynamic factor will be reinforced.

As this abnormal pulsation occurs almost exclusively on the right side, an explanation should first be sought in the anatomical differences between the two sides. On the left side the carotid artery is free and has a long course between its origin and the skull, so that any tortuosity might be evenly distributed over its whole length. On the right side, however, the innominate artery and its direct continuation upwards as the carotid artery is anchored quite near the aorta by the right subclavian artery, and therefore elevation of the origin of the innominate will tend to cause a relatively acute kink at the site of the origin of the subclavian. The latter vessel passes backwards and to the right, between the scalene muscles, and any redundant length between the innominate and the fixed part of the subclavian will tend to force the bifurcation of the innominate forwards with each systole. The carotid in addition is relatively fixed at its termination, so that the tortuosity and kinking which form the aneurysm-like swelling lie at the bifurcation of the innominate, particularly at the commencement of the carotid artery, and may involve the adjacent part of the subclavian artery in addition.

The possibility of a congenital factor must be considered in view of the somewhat similar tortuosity of the internal carotid, which has been explained on an embryological basis. In this connection it is interesting to find two pairs of sisters in our forty cases.

To sum up, the vascular swelling consists of an arterial bend or loop in the region of the bifurcation of the innominate artery. It may be composite, and the degree which the carotid itself, the innominate, or even the subclavian artery may contribute to the pulsation is often hard to determine. Even necropsy may fail to reveal its exact nature where the dynamic factor has been predominant in its production.

#### DIFFERENTIAL DIAGNOSIS

##### (1) *Carotid Aneurysm*

In a tabulation of 551 published cases of aneurysm involving various arteries by Crisp (1847) the proportion of females to males was less than one to eight; while in the 25 cases of carotid aneurysm there were 13 males to 12 females. Matas (1909) compared the occurrence of aneurysm in the carotid with that in other arteries, and stated that one third of the aneurysms in women occur in the carotid vessels. It is remarked also by Rose and Carless (1937), in reference to carotid aneurysm, that no other external vessel is so frequently the seat of aneurysm in women. Matas also said that the right carotid is more frequently the seat of aneurysm than the left; the points of election are at the origin on the right side, where the carotid is given off from the innominate, and slightly less commonly at its bifurcation. In addition, "carotid aneurysms are usually of small size; they are more often ovoid in form, their long axis lying parallel to that of the vessel."

In a careful search of the clinical records of the London Hospital during the period 1918–38, not a single case of aneurysm of the proximal portion of the right carotid artery was found. There are two specimens of carotid aneurysm in the museum of the Royal College of Surgeons ; one is in the left artery adjoining the aorta, which is also affected by aneurysmal dilatation, and the other is situated at the distal (upper) end of the right carotid where it bifurcates.

A detailed account of 142 cases of aneurysm treated surgically at the Johns Hopkins Hospital has been given by Reid (1926). Included in this number are ten cases (three female) of aneurysm of the common carotid artery, four being situated at the terminal bifurcation of the left vessel. Of the six cases of aneurysm involving the right common carotid artery, three of them lay at the distal (upper) end, whilst of the remaining three, one was continuous with an aneurysm of the innominate artery and the other two were undoubted examples of kinked carotid. One was a female, aged 54, with a history of throbbing in the neck and a systolic blood pressure of 200 mm. At operation no aneurysm was found, the vessel being simply arteriosclerotic. The other case was also a female, aged 46, with no symptoms, but presenting a pulsating swelling in the right side of the neck. The systolic blood pressure was 220 mm., the Wassermann reaction negative, and her arteries were thickened. At operation, no aneurysm was found and it was considered “ a case of tortuous sclerotic vessel forced into an S shape.”

We are unable to discover a single proven case of isolated aneurysm of the right carotid artery near its origin. The condition must be one of great rarity ; when aneurysm does occur, it is only an extension of an innominate aneurysm—the basic lesion. If, then, aneurysm of the right common carotid is so great a rarity, its frequency as reported in text books and in statistics based on clinical data is fallacious and arises from confusion between aneurysm at this site and kinked carotid. Aneurysm of the right common carotid artery near its origin should therefore not be diagnosed as a separate entity. A pulsating tumour in the right side of the neck in a patient over the age of 40, in the absence of congenital anomalies already discussed, should be considered a kinked carotid, unless it is accompanied by signs and symptoms of pressure on adjacent structures and by radiological or other evidence of involvement of the innominate and aorta.

## (2) *Innominate Aneurysm*

Aneurysm of the innominate artery may be present as a small palpable swelling with visible pulsation in the supraclavicular fossa, a fullness above the sternal end of the right clavicle, or a pulsating tumour just above and to the right of the sterno-clavicular joint, spreading characteristically upwards under the sterno-mastoid muscle (Eschenbach, 1923 ; Norris and Landis, 1938 ; Rose and Carless, 1937 ; Parks, 1938).

There are many points of difference from kinked carotid. Innominate aneurysm is three times more common in men than in women (Eschenbach,

1923). Throbbing in the neck is usually associated with pain and dyspnoea and local pressure symptoms—arterial, venous, nervous, tracheal, or œsophageal. The lower border of the swelling cannot be defined, for it extends behind the clavicle. The Wassermann reaction is usually positive and syphilitic involvement of the adjoining aorta is invariable (Warfield, 1935). X-ray examination is usually conclusive, showing a tumour of the superior mediastinum rising on the right side at the upper level of the arch of a dilated aorta (syphilitic) and extending above the inner end of the clavicle. In oblique views, a fusiform shadow originating at the arch of the aorta bulges posteriorly and so causes compression of the trachea—a constant feature (Warfield, 1935). The aortic knuckle is sometimes depressed, whereas in kinked carotid it is high.

The differential diagnosis, therefore, rests on the absence on palpation of a lower limit to the swelling in the neck, a positive Wassermann reaction, the association of pressure symptoms and signs, and the X-ray appearance of the aorta and mediastinum.

### (3) *Exaggerated Carotid Pulsation*

Prominent pulsation of the carotid arteries is bilateral in such conditions as neurosis, extreme anæmia, aortic incompetence, and thyrotoxicosis. In hypertension it is frequently right-sided, and of 105 cases of hypertension investigated by Bolotin (1933) 30 per cent. showed pulsation on the right, whereas 24 per cent. had bilateral carotid pulsation, and only 6 per cent. left-sided pulsation alone. This tendency for carotid pulsation to be greater on the right side in hypertension is due in part to those factors that sometimes produce an actual swelling, i.e. kinked carotid.

### (4) *Other Conditions: Venous Pulsation*

A dilated jugular bulb occasionally appears as a pulsating sac above the clavicle, especially in tricuspid incompetence. There is also a varix of the right external jugular vein (Hunter, 1927). Goitre affecting the right lobe, especially if cystic, may resemble the condition superficially, as may a cervical rib displacing vessels in the neck. Tumours or enlarged and adherent cervical glands with transmitted impulse may enter into differential diagnosis. Banks-Davis (1924) and Ballance (1924) have both related errors in the diagnosis of a pulsating abscess, especially where an eroded artery has ruptured and given rise to a pulsating hæmatoma or an infected suppurating aneurysm.

## SUMMARY

An aneurysm-like swelling on the right side of the neck, the so-called kinked carotid, is described on the basis of 47 cases and a review of the cases published previously.

The common form of kinked carotid is generally associated with hypertension—often with hypertension combined with arteriosclerosis—but sometimes with arteriosclerosis alone (25 per cent.). It occurs in middle-aged and older women, especially in those affected by spinal curvature and obesity, and it is

scarcely ever seen in men. The swelling itself produces no symptoms beyond local throbbing; it changes little if at all in the course of years, and it has no bearing on prognosis. X-ray examination shows elevation of the aortic arch due to lengthening and uncoiling of the aorta, aided by a high diaphragm. Attention is drawn to an abnormal shadow sometimes cast by the kinked carotid, which partly obscures the apex of the right lung.

A comparable vascular swelling may be associated with aortic incompetence, coarctation of the aorta, and other congenital vascular anomalies.

The swelling consists of an arterial prominence with tortuosity in the region of the innominate bifurcation, which is often elevated. It may be formed by a loop of the right carotid, though the innominate itself or even the subclavian may contribute. Atheroma of the aorta and these branches is usually present, but not syphilis. The dynamic factor, accentuated by hypertension, is important in the production of the swelling. The necropsy findings in three cases are reported.

Differential diagnosis is discussed chiefly in reference to aneurysm of the right common carotid artery, for which it is frequently mistaken. The occurrence of isolated aneurysm of the proximal portion of the carotid artery, unless traumatic, is doubted; surgical operations performed for such an aneurysm most often discover no more than a kinked carotid.

We wish to thank especially Dr. Donald Hunter for much help with our early observations and for obtaining the post-mortem drawing in Fig. 5. Dr. R. A. Rowlands, Professor Ellis, Dr. William Evans, Dr. Paul Wood, Dr. Doris Baker and Mr. Pearce Gould kindly gave us permission to investigate and record cases under their care; and Sir James Walton kindly advised us on the surgical aspect. We are indebted to Professor Turnbull for the pathological report on Case 37 and to Professor McIntosh for that on Case 40. The Editor of the *Middlesex Hospital Journal* has permitted the reproduction of Fig. 1.

#### ILLUSTRATIVE CASES

##### *Group I. With Hypertension or Arteriosclerosis.*

*Case 1.*—Female, aged 52. Sought advice for a lump on the right side of the neck, thought to be gradually increasing in size and noticed for two years.

*Examination* (1923). A thin and bent patient with a prominent pulsating swelling, the size of a walnut, rounded, beneath right sterno-mastoid muscle, near the sternum, in the position of the right carotid artery. Aneurysm suspected and operation considered.

*Course.*—In 1927, swelling as in 1923 or larger. Slight left carotid pulsation without any swelling. B.P., 175/75. W.R., negative. X-ray: left ventricle moderately enlarged, aorta unfolded and summit reaches clavicle. Blood pressure: 1928, 140/70; 1929, 135/80; 1930, 155/85. In 1935 death, with hemiplegia.

*Case 2.*—Female, aged 79. A swelling on the right side of the neck was noted first at hospital in 1913 and again in 1920.

*Examination* (1938).—Average weight, not stout. Visible pulsation of the right carotid artery at the level of the thyroid cartilage; a little lower down there was a pulsating swelling the size of a pigeon's egg. It extended from the left of the middle of the episternal notch to behind the right sterno-mastoid muscle and then slightly external to it. Its course was upwards and to the right; there was a forward and then a lateral kink before it turned somewhat posteriorly and then upwards to the normal position of the common carotid artery. The swelling was more noticeable on lying

down. Slight general kyphosis ; moderate scoliosis to the right. B.P., 260/105. Radial and brachial arteries consistent with age ; no abnormal tortuosity. W.R., negative. X-ray : left ventricle enlarged ; aorta unfolded and elongated, the summit reaching the lower border of the clavicle. A pulsating, faint shadow continuous with the denser aortic shadow extended upwards from below the right clavicle to the apex of the right lung, which it obscured (Fig. 3). When the patient was turned slightly to the right, it filled the centre of the clear space of the right apex. Palpation confirmed that this was due to the pulsating swelling noted in the neck. The diaphragm was not raised.

*Case 3.*—Female, aged 64. Referred by her own doctor on account of “ pulsating swelling in the right side of the neck ; I think, an aneurysm.”

*Examination* (1936).—Expansile swelling, round, size of a walnut, above the right sterno-clavicular joint, in the position of the proximal part of the right common carotid artery. It was visible and palpable both internal and external to the sterno-mastoid muscle, equally prominent lying or standing. High dorsal scoliosis to the right, and considerable kyphosis. B.P., 165/80. Brachial and radial arteries were not unduly thickened nor tortuous. X-ray : left ventricle enlarged ; aorta elongated, the summit reaching the upper border of the left clavicle.

*Course.*—In 1938, no increase in size of swelling. B.P., 195/100. X-ray : left ventricle enlarged ; elongation of aorta, with summit reaching above the left clavicle.

*Case 4.*—Female, aged 65. Swelling in the right side of the neck, of five years' duration.

*Examination* (1932).—Round pulsating swelling above the inner end of the right clavicle, extending from the middle of the suprasternal notch to a point external to the right sterno-mastoid muscle and projecting this muscle. B.P., 280/140. X-ray : left ventricle considerably enlarged ; wide vascular pedicle with elongation of the aorta so that the summit of the aortic knuckle appeared well above the upper border of the left clavicle, obscuring the inner portion of the apex of the left lung. The apex of the right lung was also obscured in its inner half by a shadow with an outward convexity which was shown during radioscopy to be subjacent to the pulsatile vascular swelling in the neck (Fig. 4). The diaphragm was high.

*Course.*—She died suddenly at home the same year (1932).

#### *Group II. With Aortic Incompetence.*

*Case 5.*—Female, aged 59. History of swelling of the right side of the neck.

*Examination* (1938).—Pulsating swelling, as large as a hen's egg, above the inner end of the right clavicle ; it projected medially, and its upper and outer portion curved laterally and then medially to attain the normal position of the right common carotid artery. Aortic diastolic murmur ; pulse collapsing ; radial and brachial arteries thickened and moderately tortuous. B.P., 220/60. W.R., positive. X-ray : heart enlarged to the left, aorta elevated and slightly widened.

#### *Group III. With Coarctation of Aorta.*

*Case 6.*—Male, aged 25. Pulsating swelling noticed in the neck for many years.

*Examination* (1927).—Pulsating swelling in the right side of the neck, situated in the suprasternal notch and also under the right sterno-mastoid muscle. The bifurcation of the innominate artery was palpable above the clavicle, and the right common carotid seemed dilated and tortuous. The pulsating swelling appeared to be caused by the tortuosity of the common carotid. The temporal and external carotid arteries were dilated and tortuous, and pulsated excessively. Loud systolic murmur at the base ; aortic second sound loud and ringing, followed by a short soft aortic diastolic murmur. B.P., 195/85, right arm. Femoral pulse almost absent. X-ray : considerable enlargement of left ventricle ; aortic arch high, ascending aorta much dilated and the pulsation exaggerated.



## REFERENCES

- Abbott, M. E. (1927). Osler and McCrae, *Modern Medicine*, 3rd ed., London, 4, 794.
- Balfour, G. W. (1898). *Clinical Lectures on Diseases of the Heart and Aorta*, 3rd ed., London.
- Ballance, C. (1924). *Proc. roy. Soc. Med.*, Sect. of Laryngol., 17, 55.
- Banks-Davis, H. J. (1924). *Ibid.*
- Barié, E. (1912). *Traité pratique des maladies du cœur et de l'aorte*, 3rd ed., Paris.
- Beardwood, J. T. (1931). *Med. Clin. N. Amer.*, 19, 989.
- Bolotin, M. T. (1933). *Med. J. & Rec.*, 137, 419.
- Brown, G. E., and Rowntree, L. G. (1925). *J. Amer. med. Assoc.*, 84, 1016.
- Burns, A. (1809). *Observations on Some of the Most Frequent and Important Diseases of the Heart*, Edinburgh.
- Corrigan, D. J. (1832). *Edinb. Med. & Surg. J.*, 37, 225.
- Coulson, W. (1851). *Trans. Path. Soc. London*, 3, 302.
- Crisp, E. (1847). *A treatise on the Structure, Diseases and Injuries of the Blood Vessels*, London.
- Eastwood, S. R. (1927). *Proc. roy. Soc. Med.*, 20, 339.
- Eschenbach, E. (1923). *Zentralbl. f. Herz u. Gefäss.*, 15, 1.
- Faure, A. (1874). *Arch. gen. de Méd.*, 23, 22.
- Freyberger, L. (1898). *Trans. Path. Soc. Lond.*, 49, 44.
- Guyon (1909) quoted by Matas, R. *Keen's Surgery*, vol. 5.
- Hamilton, W. F., and Abbott, M. (1928). *Amer. Heart J.*, 3, 381, 574.
- Hare, H. A. (1886). *New York med. Record*, 29, 558.
- Hirschfelder, A. D. (1918). *Diseases of the Heart and Aorta*, Philadelphia and London, 2nd ed., p. 656.
- Holst, J. E. (1934). *Hospitalstidende*, 77, 79.
- Hulke (1893). *Lancet*, 1, 1385.
- Hunter, D. (1927). *Proc. roy. Soc. Med.*, 20, 336.
- Keen, W. W., and Da Costa, J. C. (1909). *Keen's Surgery*, vol. 5.
- Kelly, A. B. (1924). *Proc. roy. Soc. Med.*, Sect. of Laryngol., 17, 1.
- Krause, W. (1868). "Varietäten des Aortensystems," in Henle's *Anatomie des Menschen*, vol. 3.
- Matas, R. (1909). *Keen's Surgery*, vol. 5.
- (1931). *New Orleans med. surg. J.*, 84, 448.
- Norris, G. W., and Landis, H. R. M. (1938). *Diseases of the Chest*, 6th ed., Philadelphia, p. 978.
- O'Malley, J. F. (1924). *Proc. roy. Soc. Med.*, Sect. Laryngol., 17, 55.
- Osler, W., and McCrae, T. (1908). *A System of Medicine*, London, 4, 492.
- Parks, H. (1938). *Arch. intern. Med.*, 61, 898.
- Powell, R. Douglas (1909). *Middlesex Hosp. J.*, 13, 1.
- Reid, M. R. (1926). *Arch. Surg.*, Chicago, 12, 1.
- Rose and Carless (1937). *Manual of Surgery*, 15th ed., London, 1, 344.
- Stadler, E., and Albracht, K. (1911). *Dtsch. Arch. klin. Med.*, 103, 313.
- Stolkind, E. (1909). *Proc. roy. Soc. Med.*, 27, 641.
- Torrens, R. A., and Horton, B. T. (1938). *Ann. intern. Med.*, 12, 688.
- Warfield, C. H. (1935). *Amer. J. Roentgen.*, 33, 350.
- Weber, F. Parkes, and Price, F. W. (1912). *Lancet*, 2, 692.
- White, P. D. (1937). *Heart Disease*, 2nd ed., New York, p. 321.