ANEURYSM OF THE INNOMINATE ARTERY TREATED BY PROXIMAL LIGATURE

BY

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The surgical treatment of an innominate aneurysm is a sufficiently unusual event to be worthy of record, and the case to be described presented several features of interest.

History of Case

The patient, a Frenchwoman aged 62, was sent to me by Dr. Melsome of Bath, whom she had consulted only seven months before for a pulsating swelling in the right side of the neck just above the clavicle. She was a finely built woman of exceptional muscular development and unusual energy, for which she found an ample outlet in her profession as a masseuse. Apart from the swelling in the neck, she was in excellent health, and of unusual vigour for her age. The pulse was equal on the two sides, regular, and of good volume. Her blood vessels were somewhat thickened and tortuous, and her blood pressure was 160/100, although she had been for some weeks at absolute rest. The Wassermann reaction was negative.

On examination a pulsating swelling could be seen extending about an inch above the right clavicle. The swelling was visible even when she lay at rest in bed, but it became much more prominent on slight exertion, when the expansile character of the pulsation became very obvious. X-ray examination showed slight enlargement of the ascending aorta, with increased prominence of the aortic knuckle and a loss of translucency at the right apex of the lung; it was thought that this might be due to an aneurysm, although no definite outline could be seen. She was kept under observation, at absolute rest, for a fortnight, but as no diminution of the swelling occurred it was decided to operate.

The Operation

On May 24th, 1933, the operation was undertaken under local anaesthesia. After wide infiltration with novocain 1/2 per cent. and adrenaline, an incision four inches in length was made just above the right clavicle, dividing the platysma and the clavicular head of the sternomastoid. The internal jugular vein was divided between ligatures, and a very satisfactory exposure was thus obtained. A large pulsating swelling was seen in the floor of the wound, and this was separated with great care from the surrounding structures, to which it

FIG. 1.—Innominate artery in relation to sternum.

was adherent. A number of large vessels could be detected entering this swelling at various points, but owing to their gross displacement it was impossible at first to discover what they were. The swelling extended across the middle line of the neck, pushing the trachea backwards and to the left, and on freeing it in this region the innominate artery was found to enter it at about the middle line of the neck. The artery was very short, forming little more than a connexion

between the swelling and the aorta, which was itself slightly enlarged. It was obviously due to this enlargement of the aortic arch that the whole of the structures were pushed upwards, and that access from above the clavicle could be obtained.

The carotid and vertebral arteries were next defined, but a large vessel arising from the anterior aspect of the swelling and running almost directly backwards occasioned some difficulty. This ultimately proved to be the subclavian artery, grossly displaced. Of other structures exposed, the vagus was seen passing downwards in front of the aneurysm, while the annulus of Vieussens could very clearly be seen encircling it.

FIG. 2.—Innominate artery in relation to veins.

FIG. 3.—Aneurysm of innominate artery as found at operation.

As digital compression on the common carotid artery did not cause any inconvenience to the patient, a wide ligature of kangaroo tendon was inserted and very gently tied so as just to obstruct the blood flow. A similar ligature was placed on the subclavian, which again caused no inconvenience, although the right pulse, of course, immediately stopped. These ligatures were tightened and loosened several times, and a period of fully half an hour was spent in ascertaining if either alone or together they produced any ill effect. When it had been satisfactorily demonstrated that they produced no symptoms whatever, a wide ligature of kangaroo tendon was placed on the innominate artery itself. The wall of the vessel was obviously fragile, and the ligature was therefore tied with great caution. As there was just room, a second ligature was then placed between it and the aorta, there being just sufficient more or less normal artery to carry the two. The ligature on the subclavian was now finally tied, but that on the carotid was removed, as it was thought that in this way the collateral circulation to the brain would be more easily established, while the complete absence of pulsation in the aneurysmal sac, which had now shrunk to comparatively small dimensions, suggested that this was not likely to prejudice the result of the operation. Finally, the sternomastoid was repaired and the wound closed, a small drainage tube being left in place for twenty-four hours.

The patient made an uninterrupted recovery without incident, and left the hospital four weeks after the operation.

The further course of the case is of some interest. The patient remained in perfect health until the end of December—that is to say, for seven months—when she had an attack suggesting a small cerebral haemorrhage. Following a very violent fit of sneezing she had a pricking sensation in the left hand, and some uncertainty of movement of the arms and legs. These were accompanied by a slight weakness in the left side of the face, a little difficulty in speaking, and a certain mental vagueness. This cleared up in the course of a few days, although the difficulty in speech persisted for a fortnight. The explanation of these symptoms, suggesting as they do a small haemorrhage on the right side of the brain, is by no means obvious, for one would have imagined that a haemorrhage in this region could scarcely follow ligature. They might have been due, of course, to a small embolus, but they resemble far more the symptoms which follow leakage from a small intracranial aneurysm. Fortunately no recurrence has taken place, and at the present time, nearly a year after the operation, the patient appears to be in perfect health.

Literature on the Subject

The literature on the subject is not extensive, and it has been admirably collated on two occasions, by Sheen in 1905 and by Thompson in 1915. Ballance has described five personal cases, thus achieving a position which is unique, while Reid has recorded three cases in his review on all the aneurysms admitted to Johns Hopkins Hospital. I think it will be of interest to give a brief account of these articles, since each presents some important aspect of the subject.

Sheen's Case

Sheen¹ describes a case of aneurysm of the right subclavian, in which the innominate and right common carotid were tied at the primary operation, and two months later the subclavian was tied close to the aneurysm.

The patient was an old soldier, aged 46, who for six months had suffered from numbness and tingling of the right hand and arm, accompanied latterly by severe pain. Six days before admission he noticed a swelling above the right clavicle. He was a well-built man in good general health, with a typical pulsating swelling reaching 5 cm. above the right clavicle. The right radial pulse was only just perceptible, and the fingers of the right hand were bluish white. The heart and the other arteries appeared normal. At the end of two months' observation, during which the aneurysm increased in size, the operation was undertaken through a median incision extending from the cricoid cartilage to a point one inch below the sternal notch. The innominate was exposed after some dissection, and ligatured with stout floss silk to form a stay-knot of two ligatures. The carotid, which was now flaccid, was tied by a single silk ligature. Recovery was uneventful, but pulsation soon returned in the aneurysm. Two months later the subclavian was tied close to the aneurysm through an incision above the clavicle. There was no return of pulsation, and pain and tingling of the arm disappeared.

Sheen found thirty-six cases, including his own, of ligature of the innominate artery, of which, however, only eight recovered. As the cases dated back to 1818 it is evident that this very high mortality was largely due to sepsis and resulting haemorrhage. Only one patient, indeed (operated upon by Smyth of New Orleans), recovered in what may be termed the "pre-antiseptic" period of surgery. After the year 1871 sixteen cases were operated upon with nine deaths. Sheen concludes that the operation is reasonably safe in those cases in which the aneurysm is of a circumscribed character and in which the condition of the other arteries is good; that the carotid should be tied as well as the innominate, if possible at a previous operation; and that some cerebral lesion is the complication most to be feared.

Thompson's Case

Thompson² describes one case, and has collected fifty-two cases of ligature of the innominate artery from the literature.

His patient was a negro male, aged 46. Six weeks before admission a swelling appeared in the right armpit. Four days before admission the arm began to swell, and he had intense pain in the hand and wrist. The right axilla was occupied by a huge swelling, which extended upwards above the clavicle. The right arm and forearm were greatly swollen and oedematous with distended veins, and the radial pulse was imperceptible. Under local anaesthesia a transverse incision was made above the clavicle, dividing the sternomastoid, sternohyoid, and sternothyroid. The aneurysm was exposed, its sac blending with the scalenus anticus. On following the carotid downwards the innominate was exposed with ease, but the situation of the subclavian was such that ligature of this artery appeared to be too dangerous. The innominate itself was therefore tied with narrow linen tape, a stay-knot being formed. Pulsation in the aneurysm disappeared, and no cerebral symptoms followed. Pain and swelling in the arm remained, and a month after the opera-

tion a large axillary abscess was opened. A week later there was severe haemorrhage from the abscess cavity, which was stopped by packing. The patient died a month later without cerebral complications, and it was shown that the aneurysm was completely consolidated.

Thompson, as stated above, found in the literature fifty-two cases of ligature of the innominate artery, including the thirty-six described by Sheen, with a total of sixteen recoveries. He states that ligature of the carotid and the innominate together has a smaller mortality than ligature of the innominate alone. He has analysed a series of thirty-one cases operated upon between 1818 and 1915, with fifteen recoveries and sixteen deaths. It will be noticed that there was only one recovery before 1880: the patient was a man of 33, who was operated upon by Smyth of New Orleans in 1864 for a traumatic aneurysm occurring three months after an injury.

Ballance's Cases

Ballance³ describes five cases in three articles which he has devoted to the subject.

The first case, operated upon in 1902, was that of a soldier, aged 35, who for three months had suffered from loss of voice and swelling in the right side of the neck, with slight dysphagia. There was a large expansile swelling above the right clavicle slightly displacing the trachea. The swelling slowly increased in size. Under chloroform anaesthesia a median incision was made from the lower margin of the thyroid cartilage to the lower border of the manubrium. After a little blunt dissection with the finger the innominate artery was clearly felt. In order to obtain better access the manubrium was sawn through, and the upper portion split vertically. This did not give sufficient access, and a portion of the bone was therefore removed on each side. The innominate artery was then fully exposed and tied by four strands of goldbeater's skin ligature. The patient, however, developed a left hemiplegia and died the next day.

In the second case (1909) the patient, a man aged 35, had a pulsating swelling above the inner end of the clavicle. The wall of the aneurysm appeared to be very thin, but as it was extending rapidly operation was undertaken. The inner end of the left clavicle and the cartilage of the first and second ribs were divided and removed, with the left three-fourths of the manubrium. The exposure was good, but during the manipulation the aneurysm ruptured. The bleeding was immediately stopped by plugging the innominate with the finger. The artery was ligatured with kangaroo tendon, but the man died thirty hours later.

The third case (1912) was that of a man aged 43 with a pulsating swelling above the inner end of the right clavicle. Through a median incision the upper part of the manubrium was removed, giving a good exposure of the innominate, which was tied with a stay-knot. The patient recovered completely, with no complications.

The fourth case, operated upon in 1918, was that of a woman aged 60, who complained of a pulsating tumour above the right clavicle. It was about four inches in diameter, and extended into the superior mediastinum. As the x-ray photograph showed no deformity of the aorta it was determined to attempt ligature of the innominate. A vertical median incision was followed by a transverse one on a level of the upper border of the manubrium. The inner end of the left clavicle, the cartilage of the first left rib, and the left three-quarters of the manubrium were removed. A good exposure of the innominate was obtained, and it was ligatured with kangaroo tendon, forming a stay-knot. Following the operation the right arm was cold and partially paralysed, but it had completely recovered a month later. Pulsation in the aneurysm had ceased. The patient died two and a half years later from other causes, and necropsy revealed the complete success of the operation.

In the fifth case (1925), that of a man aged 55, there was a large pulsating mass extending high up on the right side of the neck and occupying the greater part of both anterior and posterior triangles. In spite of very considerable difficulty from the fixation of the tumour and its dimensions the innominate artery was tied successfully, and this was

followed by ligation of the common carotid and of the axillary arteries at later dates. The patient lived until 1933, and a full account of the case will be found in the *Lancet* for April 14th, 1934.

In his paper of January, 1922, Ballance mentions five other cases from recent literature with three recoveries, and one death from hemiplegia and one from haemorrhage at operation.

Reid⁴ reports that in 124 cases of aneurysm of various arteries admitted to Johns Hopkins Hospital, only three were true cases of innominate aneurysm, and, of these, two were operated upon. One patient died at operation, apparently from traction on the aorta, which would seem to be very dangerous. In one the innominate artery was tied and later the carotid, with improvement. The operation was performed by Halsted, and the patient lived six months, dying of pneumonia.

Other Records

Juckelson⁵ records a case in a man aged 30, following a punctured wound in the neck; he was treated by ligation of the innominate and extirpation of a portion of the sac, and was well five and a half years after the operation. Buchser⁶ gives a pathological report with a clinical history of an innominate aneurysm which perforated the trachea. His article includes a full bibliography of the German literature. Baldwin⁷ describes a case (1910) in which he ligatured the subclavian and the common carotid arteries in a woman aged 52, with an aneurysm of the innominate. She recovered completely and lived for eighteen years. The case is remarkable, since it has been generally held that in the case of innominate aneurysm distal ligation is not successful.

Lessnoi⁸ records a case of traumatic aneurysm of the right common carotid artery in a man of 35, treated by ligation of the innominate, with recovery. In the same article he describes eight other cases of traumatic aneurysm, so that the incidence in this region is obviously rare. Flint⁹ gives details of a case (1927) of a traumatic aneurysm of the innominate artery in a man of 37, following on a bullet wound received in 1918. Rapid growth of the aneurysm began in December, 1926, eight years after the injury, accompanied by severe dyspnoea and dysphagia. Proximal ligation of the innominate artery was carried out a month after the onset of symptoms, and this was followed by the opening up of a leaking aneurysmal sac, the turning out of the clot, and the suture of the open mouth of the subclavian artery. The patient made a good recovery. Cabot¹⁰ reports a case in which he ligatured the common carotid artery for an innominate aneurysm, but death occurred from pneumonia. McCarthy¹¹ discusses, at considerable length, the treatment of aneurysms by distal arterio-venous anastomosis, describing one successful case in which an aneurysm of the innominate was cured by anastomosis to the internal jugular vein.

Conclusions

It will be seen that ligation of the innominate artery for aneurysm is a well-established surgical procedure, in which the risks of the operation are entirely justifiable in view of the gravity of the condition. Technically the operation may be easy of achievement, or the difficulties from adhesions may render it impossible. Apart from the risk of haemorrhage at the time of operation, the two chief dangers to be feared are interference with the cerebral circulation and interference with the circulation in the arm. The latter does not appear to be as serious as might be imagined, probably because during the existence of the aneurysm a wide collateral circulation has opened up. The danger to the brain, however, must always remain a serious one, and there would seem to be

no means of discovering the extent of the risk in any particular case.

I am convinced that the method adopted, of operating under local anaesthesia and of applying tentative ligatures to the arteries, is a sound one. General anaesthesia involves a disturbance to the circulation, which cannot be anything but inimical to the interests of the patient, while it precludes entirely the very important information, which a conscious patient can give, as to the effects of occluding the circulation of a large vessel.

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HYPERTONIC RECTAL SALINE FOR INTRACRANIAL INJURY IN THE NEWBORN

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J. N. Cruickshank, in his study¹ of 800 cases of death in the newborn, wrote: "The present writer believes that increased intracranial pressure is a factor of first importance in the production of a large proportion of cases of neo-natal death." Modern investigations have shown how intracranial pressure can be reduced by the introduction of hypertonic salt solutions intravenously or into the alimentary canal. The present communication is an account of the practical application of these experimental findings in an effort to save a certain number of newborn babies who would otherwise die.

It is generally agreed that, as a result of the birth process, the contents of the baby's skull may exhibit haemorrhage (gross or microscopical), oedema and congestion, or contusion. Cruickshank's studies throw doubt upon the supposed frequency of small areas of haemorrhage, and, in his view, haemorrhage into the substance of the brain does not occur, except in unusual circumstances. He believes that the clinical effects often attributed to haemorrhage are due really to congestion and oedema, leading to anoxaemia of the medullary centres. In the post-mortem records of Cruickshank's monograph, oedema of the brain and meninges was a very constant finding, especially in those cases marked in life by respiratory failure. It is not maintained that hypertonic rectal saline can do anything for those cases in which meningeal or cerebral haemorrhage has occurred, but in view of Cruickshank's findings as regards the latter alternative I believe it should always be used, even if the clinical diagnosis between oedema and haemorrhage cannot be made.

Pathology of Increased Intracranial Pressure

The clinical features of this condition in the newborn may be briefly sketched against the pathogenic background referred to above.

The labour has usually been somewhat difficult, with a prolonged second stage. Occipito-posterior presentations,