ON A CASE
OF
FUSIFORM AND TUBULAR ANEURISM OF
THE SUBCLAVIAN ARTERY,
AND ITS SUCCESSFUL
TREATMENT BY INDIRECT DIGITAL COMPRESSION.

BY
ALFRED POLAND, F.R.C.S.,
SURGEON TO GUY'S HOSPITAL.

TO WHICH IS APPENDED
A CASE OF SUBCLAVIAN ANEURISM SUCCESSFULLY
TREATED BY DIRECT COMPRESSION.

By F. M. CORNER, ESQ., OF POPLAR.

AND FOLLOWED BY THE NOTES OF
A SUCCESSFUL CASE OF AMPUTATION AT THE SHOULDER-
JOINT FOR SUBCLAVIAN ANEURISM.
By PROFESSOR SPENCE, OF EDINBURGH.

Received March 30th.—Read June 8th, 1869.

SUBCLAVIAN aneurisms, at all times, attract the serious consideration of the surgeon.

The following case is an example of one form of aneurism of this artery, of great rarity and interest, involving many points of obscurity, which we shall briefly attempt to elucidate. The main features, to which our attention will have to be drawn, are:

1. The remarkable deviation from the normal course of the subclavian artery on the right side, and in its external third

2. The peculiar character of the aneurism,—it being of the fusiform or tubular variety of aneurism by dilatation, where all the coats are uniformly involved.

3. The treatment adopted, viz., indirect compression through digital pressure on the proximate or cardiac side of the tumour, leading to a successful issue.

Patrick G—, æt. 44, was admitted into Guy's Hospital on October 7th, 1867, under the care of Mr. Poland. He was a bricklayer's labourer, but for several years previously, had been employed at the gas works, where he had done much heavy work and been exposed to great heat. Latterly, he had been in the habit of carrying a load of bricks over the right shoulder, until he was obliged to desist, from the severe pain in that region. With the exception of an attack of rheumatism, ten years ago, chiefly affecting the left shoulder, he had always enjoyed good health until about two years back, when he suffered from occasional pains in the right arm and the limb itself became weaker. He attributed this to an injury of the right index finger received about that time, which was attended with inflammation, but this subsided, and the wound healed in three weeks. During the last month, the pain in the arm became more severe and continuous; it was of a gnawing character, chiefly confined to the fore-arm but extending occasionally upwards to the shoulder, and was more especially worse at night. He was thus compelled to give up work, and seek medical advice, when he was treated for rheumatism. The pain continuing unabated, he applied to Dr. David Johnson, of the Old Kent Road, who at once discovered a pulsating tumour above the clavicle, of an aneurismal nature, and advised the man to seek admission into a hospital immediately, that he might undergo the treatment necessary for it. The patient was quite unaware of the presence of a tumour, and was not at all disposed to attribute his sufferings to it.

On admission, the man's expression was somewhat anxious, but he appeared to be fairly nourished, and his general health was good. The right arm was weak, but he could perform easy motion with it: its circumference was three quarters of an

inch less than that of the left arm, both over the biceps and in the fore-arm. He complained of pain down the radial border of the fore-arm and in the index finger, occasionally extending upwards to the acromion process. There was numbness in the fingers and in the hand generally, but there did not seem to be any impairment of actual sensation. The arm was always cold, and had to be wrapped in flannel. There was evidence of deficient nutrition in the nails of the fingers of the right hand, which were ill-developed and desquamating. There was very little superficial fat about him, so that the relations of the tumour in the neck could be readily made out. In the right supra-clavicular triangle was a pulsating tumour of the size of a large filbert, fusiform in shape, passing downwards and outwards so as to meet the clavicle at an angle of forty-five degrees; it was more than an inch in length, and nearly half an inch in breadth at its widest calibre; above, it diminished gradually to the size of a large goose quill, and, after remaining for about a quarter of an inch of that size, it curved downwards and inwards and was lost under the muscles; below, the tumour did not seem to diminish so rapidly, but the pulsation of the artery could be felt between it and the clavicle, as well as very distinctly below that bone. The tumour was almost subcutaneous, and the pulsations in it very strong; the expansion, which was uniform, being very considerable during each beat. There was no doubt as to its aneurismal nature, and, on careful examination of the neck, the subclavian artery was found to have taken an unusually high course, and to be supported, moreover, by a bony structure, which was too high for the first rib. When pressure was applied to the unaffected portion of the artery above the tumour, the pulsation was readily stopped and the tumour became quite soft and could be emptied. The pulse could be felt in the right radial artery or, in fact, in any artery of the right arm, up to within a short distance below the clavicle; there was no tumour or swelling along the course of these vessels, and the axilla was quite free from induration or glandular enlargement.

After a few days' rest, it was decided to try the effect of continuous digital pressure on the cardiac side of the tumour; and the whole of the arrangements for carrying out this plan were entrusted to the dresser, Mr. W. D. Lovell. The compression was managed by placing the thumb upon the artery leading to the tumour, and by gentle pressure against the bony support to the artery behind, with a very slight amount of force, the pulsation was completely arrested. The pressure could be kept up by the same person for twenty minutes or longer without any inconvenience; it was continuously carried out for ninety-six hours, with the exception of a few minutes' interruption. The patient, soon after the commencement, complained of pain in the right shoulder and arm with numbness in the fingers, and the temperature of the arm also became less; as he was disposed to be irritable, and as he suffered much pain, a grain of opium was ordered every six hours, which had the desired effect. After the first twenty-four hours he became very faint, and a little brandy and water was given; he was kept on low diet with beef-tea. About the forty-eighth hour the tumour appeared to be rather smaller and harder, but it still received impulse from the heart's action. At the sixtieth hour he became very restless and excited, and notwithstanding the opium this condition lasted over two hours, but it was probably attributable to the manner in which the pressure had been applied by those in charge; when this was remedied, he became more comfortable, and soon had an hour's continuous rest. At the seventy-second hour, it did not appear that much progress had been made; he had another severe attack of faintness, and as he was under the influence of opium the quantity was ordered to be decreased; subsequently he again became very restless, and had profuse perspirations; he said he could not bear the pressure any longer, but by persuasion, however, it was still persevered with, precautions being taken to guard the integuments which were now becoming very red and tender. There was some difficulty in maintaining an uniform compression, in consequence of his irritability and tossing about; he also complained of violent headache, and

had an anxious expression of countenance; the left pulse was feeble and about sixty. Under these circumstances, at the ninety-sixth hour, pressure was left off, much to the patient's relief, and he then slept heavily for several hours. The tumour at the time of discontinuing the pressure was undoubtedly much smaller and harder, and although pulsation in it could still be felt, yet this was more readily controlled by very slight means. After recovering from the immediate effects of the treatment, he left the hospital at the end of the month.

He again became the patient of Dr. Johnson, who kindly looked after the man, and occasionally sent him on to the hospital to report himself. Soon after his discharge, the pulsation began gradually to diminish and the tumour to become more solid, so that at the end of a month there was no pulsation whatever in it; the pain in the shoulder and arm had considerably decreased, but was not entirely lost.

On December 15th, 1867, the tumour was very carefully examined; its shape and position were not altered, but its size was slightly diminished; it had become quite firm and hard, and there was not a trace of pulsation in it. He had still slight pain in the arm, and although it remained cold and pulseless, the weakness of the limb was the only reason which prevented him from working.¹

Now the first interesting point for consideration is the peculiar anatomical deviation, which, in this instance, was of most essential service for the mode of treatment adopted, and which, in a great measure, led to the successful result. Had the artery run its natural course, the aneurism would have been placed in the axilla, and would probably have re-

¹ This patient has been seen at intervals during the present year, and Dr. Johnson in a note dated July 30th, 1869, reports, "I have seen your patient this day, he declares himself as well as ever he was, and can do as much work without experiencing any discomfort. The temperature of the affected arm is natural, but the limb is still somewhat wasted. There is no return of pulsation in the brachial, ulnar, or radial, arteries. There is no vestige of the subclavian artery in the supraclavicular region, but there is a large artery crossing transversely across the space."

mained unnoticed until it had acquired a large size, or until it had burst; a condition not unfrequent in subclavian and axillary aneurisms.

In the present case, however, the right subclavian artery emerged from between the *scaleni* muscles fully two inches above the clavicle, or rather more; it then took an almost vertical yet oblique course to gain the axilla, and passed behind the clavicle a little to the inner side of the junction of the external third with the internal two-thirds of that bone. The whole course of the artery in this its third portion was three inches and three quarters in extent. The first rib appeared to be higher than usual, and could be readily traced coursing round the inferior part of the neck above the clavicle; and the artery lay upon the rib, passing over and extending some distance beyond it, previous to being lost under the clavicle. The tubercle of the first rib could not be distinguished. The condition gave the idea of the clavicle and shoulder having been let down for some distance, so as to leave the first portion of the axillary artery in the neck. A very similar state of things existed on the left side, but not to so great an extent.

On referring to Quain's *Commentaries on the Arteries*, he alludes to this arching of the subclavian artery in the neck, and gives the measurements of cases coming under his notice; in Plate 20, fig. 3, a drawing is given, which somewhat represents the condition found in the present case. Dupuytren¹ also adverts to the superficial condition of the third portion of the artery in those who are thin and have long slender necks, with lean and pendulous shoulders.

The deviation of the artery is not of unusual occurrence, and may be due either to a natural or to an acquired condition. In the recent volume of the '*Guy's Hospital Reports*' (1869, p. 445) are recorded two specimens observed in the dissecting-room during a very short period; the height to which the vessels rose in the neck, was such as to render the direction of the third portion of the artery almost vertical; it occurred in one instance on the right side, and in the

¹ Dupuytren, '*Leçons Orales*,' t. iv, p. 528.

other on the left, the artery emerging from the scalenus fully an inch and a half above the clavicle.

Mr. Cock has informed me that during a recent examination for the Fellowship of the Royal College of Surgeons, the artery took the above unusual course, and the candidate failed to secure it by the ordinary operation. This failure has occurred to a hospital surgeon in a case recorded by M. Dubrueil,¹ where the axillary artery had to be secured in consequence of not finding the subclavian in its usual position.

The acquired displacement of the artery has generally been due to the pressure of tumours from below upwards, or to an exostosis of the first rib, several cases of which are recorded by Mott,² Gregg,³ and others.

Dr. J. W. Warren of Philadelphia in his recent work, 'Surgical Observations,' narrates a singularly interesting case of acquired deviation of the subclavian artery, which became the subject of aneurism and required operative measures. He was enabled to ligature the artery external to the scalenus muscle, on the cardiac side of the tumour. The case bears a strong analogy to the condition found in my own, as regards the feasibility of successful treatment, but it differs as to the cause of the deviation. The following is an abridged account of the case.

Miss A—, æt. 30, of delicate constitution, had a congenital club-foot of the worst kind, and, in consequence, a double curvature of the spine. For the former of these she was treated eight or nine years since, and the foot, after section of the tendons followed by appropriate treatment, was brought into its natural position, so that she was able to walk without any mechanical support. The curvature of the spine was also submitted to treatment, and with the same successful result. In the early part of December, 1847, she consulted Mr. Warren for an aneurismal tumour, about the

¹ Dubrueil, 'Gaz. Méd. de Paris,' 1837, p. 562.

² Mott's edition of 'Velpeau's Surgery,' vol. ii, p. xxxviii.

³ Gregg, 'Dublin Journal,' vol. xxv, p. 211, 1858.

size of a pigeon's egg, just above the scapular end of the left clavicle, of which she gave the following history. Four months ago, whilst in attendance on a sick brother, she had occasion to draw the cork from a bottle, and felt at the moment a sudden crack at the point where the present tumour is situated. She paid no attention to it at the moment, but a short time afterwards a small swelling, having a decided pulsation, was distinguished at that spot, which has gone on increasing in size up to the present time.

The tumour pulsed strongly and possessed the usual thrill characteristic of an aneurism. On endeavouring to discover the subclavian artery in its natural situation behind the clavicle, at the point where it passes over the first rib, no large vessel, nor any osseous protuberance answering to the tubercle of the first rib, could be found. Different parts of the neck were carefully explored, and a large artery was found passing obliquely upwards, parallel to, and about an inch from, the external border of the trapezius muscle. When compression was made at this point pulsation in the tumour ceased, as well as in the pulse at the wrist. There was no question that this was the subclavian artery, and on seeking for the first rib both this and part of the second rib were felt passing obliquely across the neck above the clavicle. The insertion of the scalenus anticus muscle into the first rib was at length distinguished; the tubercle, however, was not sufficiently developed to be manifest to the touch. The whole osseous system of the chest, in this case, seemed to have undergone a partial displacement. The spine and ribs had been, as it were, moved upwards, while the sternum was carried in an opposite direction. Pressure could not be borne on the vessel above the tumour, in consequence of the pain and numbness produced, and on careful examination the whole of the brachial plexus of nerves could be discriminated in immediate contact with the artery. The anatomical peculiarity in the position of the vessel enabled Mr. Warren to apply a ligature to the third portion of the artery. The case was perfectly successful, but the ligature did not come away until the ninety-sixth day.

Besides the deviation of the artery from its natural course in my case, there was another anatomical peculiarity to which allusion must be made, viz. the probable existence of a cervical rib which gave support to the artery from behind. These extra cervical ribs are not very common. There are three specimens in the Museum of Guy's Hospital; Sandifort¹ and Quain² give delineations; and there are a few others on record. Dr. Ludwig Stiele³ has ably discussed the subject of cervical ribs; Halbertsma⁴ has endeavoured to ascertain the position of the subclavian artery in cases where there is a cervical rib, but he could not positively determine whether the vessel takes its ordinary course over the first dorsal rib, or whether it passes over the cervical rib. His observations are expressed in the following table:

No.	Reference.	Cervical rib.	Length.	Relation of subclavian artery.
			Centimetres.	
1	Found in body of an aged female	Right side Left side	6.0 6.0	Supports the artery. Ditto.
2	Sandifort Museum	Right side	6.5	Ditto.
3	Found in skeleton about twelve or fourteen years old	Left side	5.6	Ditto.
4	In the Vrolik Museum	Right side Left side	2.5 6.5	Does not support the artery. Supports the artery.
5	Dr. R. Adams, of Dublin (see case appended)	Left side Right side	5.1 5.6	Does not support the artery. Supports the artery.

Paget⁵ has recently alluded to a cervical rib in a female,

¹ Sandifort, plates, vol. ii, tab. 49, figs. 1 and 2.

² Quain's 'Commentaries on the Arteries,' plate xxv, fig. 9, from preparation in Museum at Cambridge.

³ Stiele, Virchow's 'Anatomie u. Physiologie,' 1846, vol. xxxvi, p. 425.

⁴ Halbertsma, 'Archiv für Holland. Beiträgen zur Natur. u. Heilkunde,' 1858, band i, s. 47.

⁵ Paget, in Callender's 'Communication on Ruptured Axillary Artery,' 'St. Bartholomew's Hospital Reports,' vol. ii, p. 104.

aged forty, who had a diffused aneurism of the left axillary artery, and in whom the bony growth projected so that scarcely any room was left behind the clavicle for the finger to be pressed down upon the third part of the course of the artery. It is very probable that this was a short cervical rib, and consequently did not support the artery.

We may then with Henle¹ conclude that, when there is a supernumerary cervical rib extending at least 5·6 centimetres in length, the artery passes over and is supported by it, and this was probably the case with the patient under my care.

This leads us now to the second point of interest, viz., the *character of the aneurismal tumour*. It was one of those peculiar forms of aneurism variously known by the names of fusiform, tubular, or natural, aneurism, or aneurism by dilatation. There was no doubt in my mind, nor in that of my colleagues who examined the case, that the abnormal tumour which presented itself was solely due to a circumscribed dilatation, or expansion, of the entire circumference and calibre of the subclavian artery at a given point. It was remarkably defined at its upper end, and somewhat tapering below towards the clavicle and axilla; it was not a partial, or what is called a *false*, aneurism, *i. e.*, an out-dilatation or tumour from the side of a vessel, and involving only a small portion of its walls, but it was a pure distension of the whole of the arterial coats equally on all sides—a distinct tubular enlargement, increasing the capacity of the artery to a very large extent and allowing fluid blood to pass readily along it, and in so doing modifying, of course, the force of the current of blood through it, but in nowise permitting the chance of any coagulation on its walls. A question naturally suggests itself as to whether this enlargement be, or be not, due to a diseased condition of the vessel at the site of the dilatation—whether the inner tunics from some morbid change had given way and allowed the occurrence of this distension; or whether, all the coats being entire, the

¹ Henle, 'Handbuch der Anatomie,' "Vascular System," p. 249.

muscular one had become weakened or degenerated in its structure, losing therefore its peculiar properties and allowing the expansion of the tube ; or whether it was a pure dilatation without any diseased condition of the vessel, in fact a dilated artery ? These are perplexing questions, and can only be answered by the further examination and more careful investigation of such cases, and this has not hitherto been done satisfactorily.

What is the difference between a dilated artery and an artery the seat of aneurismal dilatation ? Such a question is well worth investigating both anatomically and pathologically, and especially as regards the microscopical examination of the coats. Scarpa¹ evidently had seen or was aware of this peculiar condition of artery in reference to aneurism, and he has endeavoured to elucidate the question of aneurismal dilatation of the arteries ; Hodgson² also has devoted a section to the subject. Breschet³ distinguished four kinds of aneurismal dilatation of all the coats, and among these he placed the spindle-shaped aneurism and the true cylindrical aneurism, which in many respects correspond to the aneurismal tumour under consideration. Broca⁴ seems rather disposed to attribute these enlargements of the vessel to the giving way of the internal coats, and throws doubt as to whether they are always natural dilatations of all the coats ; hence he places them under the denomination "of mixed external fusiform aneurisms." His views are certainly corroborated by the oft-quoted case of fusiform aneurismal dilatations of the femoral artery, recorded by Monro,⁵ where the condition was considered to be simple dilatations of all the coats, but which on more minute dissection proved to be due to atheromatous disease of the internal coats.

There can be no question that an artery may become

¹ Scarpa, Wishart's 'Translation,' p. 57.

² Hodgson 'On Arteries,' p. 45 and 58.

³ Breschet, 'Mém. Chir. sur différentes espèces d'Aneurismes.'

⁴ Broca, 'Sur l'Aneurisme,' p. 22.

⁵ Monro, 'Essays and Obs. Phys. and Lit. Edin.,' vol. iii.

dilated to a greater or less extent, and in more than one place, throughout the whole circumference of its calibre owing to disease of the internal or middle coats; a true ovoid or fusiform aneurism is thus formed, and it is remarkable how often this condition is found in the subclavian and axillary arteries. Yet, on the other hand, may we not have a local dilatation of an artery without any disease of the internal coat?

The distinction is one of paramount importance in our prognosis and treatment; for in the one instance there is liability to extension and sudden rupture, if the aneurism be not attended to; whilst in the other the disease may remain quiescent for a long period of years.

I cannot but think that in my case the internal coats were atheromatous, and that if treatment of some kind had not been adopted a false aneurism, or more likely rupture of the vessel, would have occurred.

Vacca Berlinghieri¹ has described the case of a man, æt. 60, who had, for a period of twenty-four years, been the subject of aneurismal dilatations of both his subclavian arteries; that on the left side seemed to be purely a dilatation of all the coats, whilst that on the right had latterly assumed a really aneurismal character.

But the most unique case of a dilated subclavian artery assuming an aneurismal character, was laid before the Dublin Pathological Society in March 1839, by Dr. Robert Adams of the Richmond Hospital; there were but few notes accompanying the preparation, so that, on communicating with Dr. Adams on the subject, he has transcribed the report of the case (which has never been published) from the hospital books, and has kindly permitted me to make use of the same.

“J. N—, æt. 55, a labourer in a brass-foundry, was admitted under the care of Dr. Robert Adams into the Richmond Hospital in May 1836, on account of an attack of

¹ Quoted in the ‘*Sammlung eisiger Abhandlungen von Scarpa, Vacca Berlinghieri, und Ucelli über die Pulsadergeschwülste, von Dr. Seiler.*’ Zurich, 1822, p. 140.

inflammation which had involved all the structures of his left eye. The eye had been lost three years previously and was totally disorganized, and he was now suffering from recurrent inflammatory action. While the patient was undergoing palliative treatment, it was observed that he had a pulsating swelling in the supra-clavicular region of the left side, of which he never complained or even made mention until he was interrogated on the subject by the resident pupil of the hospital. His aspect was that of one who had lived too freely, his complexion being of an unhealthy sallow cast; his occupation was a most unwholesome one, and he was the subject of an habitual chronic cough. When asked about the swelling he stated that a few weeks before his admission he, for the first time, noticed a 'beating' above the centre of the left collar-bone, but as there was no swelling and no pain he quite disregarded it.

"In the left supra-clavicular space there projected a pulsating tumour; it was not very prominent, and was of an ovoid shape and transverse in direction; it became more manifest when the shoulder was depressed. The integuments over it were natural in appearance. Pressure on the artery at the outer margin of the scalenus muscle stopped all pulsation in the swelling, as well as in the radial artery. When the naked ear was applied closely to the supra-clavicular region and to the tumefaction, there was no 'bruit de souffle' audible; when the patient coughed the pulsation at the moment ceased in the tumour. Behind and to the inner side of this swelling a hard prominence could be felt, either arising from a malformation of the first rib, or perhaps from some prolongation of the transverse process of a cervical vertebra. On lifting up the tumour and drawing it somewhat forwards, which could partially be effected by pressing the fingers behind it, the swelling (that is to say, the arterial part of it) was shown to be much smaller in reality than might have been imagined. Upon this examination and this manipulation of the tumour, the idea occurred to my very intelligent clinical clerk, Mr. Bradshaw, and myself, that the lesion in this case was a fusiform dilatation of the left subclavian artery as it passed

through its third stage, and which fusiform swelling had not yet attained any considerable size. This was the diagnosis arrived at and entered in the hospital case book soon after the admission of the patient in 1836.

"The prognosis formed at that time as to the course the disease seemed likely to take was favorable, and I expressed my opinion to my clinical class that I knew of no treatment necessary so far as the arterial lesion was concerned.

"On examining the supra-clavicular region on the right side, some abnormal condition of the first rib could also be made out, but no aneurismal swelling could be either seen or felt; there was observed only an inordinate activity of pulsation marking the course of the artery. I may add that there was nothing abnormal observed in the sounds of the heart, the action of it was regular and moderate; the pulse was of equal strength in both radial arteries, and it averaged about 78 per minute.

"The patient having been relieved of the inflammation and agonising pain in the left eye was discharged. Subsequently such was the general delicacy of his health that he was unable to support himself and was obliged to take refuge in the poor-house of that day—within the walls of the House of Industry Hospital establishment; and it became my duty, as junior surgeon, to visit N— occasionally, and I had to remark that the fusiform swelling of the left subclavian never seemed to undergo any change; the man suffered no pain, there was neither decrease nor increase of pulsation nor of swelling up to the period of his death, which was the immediate consequence of an attack of typhoid pneumonia in March, 1839.

"*Post-mortem.*—The principal part of the swelling which occupied the supra-clavicular region of the left side was seen to have been constituted, as diagnosed in May 1836, by a fusiform dilatation of the left subclavian artery. This dilatation occupied the vessel for the length of three inches of its course; the increase in the calibre of the vessel commenced at a point about half an inch external to the outer

margin of the scalenus anticus, and gradually the dilatation became greater for two inches and a half. The tube became somewhat diminished in size as it entered within the boundaries of the axillary region, but it was not reduced to its normal dimensions until the artery became brachial. The fusiform swelling of the artery, when all the surrounding structures were removed, appeared to be much better defined, and smaller, than might have been imagined from a mere superficial inspection of the supra-clavicular region; but a careful examination and manipulation of the swelling during the lifetime of the patient had prepared us for seeing the condition of the vessel which has just been adverted to. The ovoid swelling was about the size of a pigeon's egg and occupied the third stage of the artery. The lining membrane, as well as the middle and external coats of that portion of the artery affected by the swelling were perfectly healthy. These tunics did not appear to be atrophied or hypertrophied; neither did the dilated portion of the vessel in any part of its course contain coagula.

“The bony prominence which had been felt behind the subclavian artery, and which contributed to constitute part of the projection on the surface of the supra-clavicular region of the left side, was now considered to be due to a congenital deformity and abrupt termination of the first rib. The right first rib was also shortened and malformed; it could be felt, but it was not seen projecting in the neck. That on the left side was very straight, only two inches in length, of a phalangiiform appearance, and terminated anteriorly in a hard flattened extremity; this was connected inferiorly by a diarthrodial joint with a process of bone which grew up from the second rib just at its angle, the articular surfaces being covered with cartilage. The rib on the right side was larger, more curved, and measured two and a quarter inches in length; this had a ligamentous connection with the second rib, and from the upper edge of its anterior extremity there projected a long, sharp, spiculous growth. The left subclavian artery ran in front of the distal extremity of the malformed rib, and was

supported by the bony elevation of the second rib; the right artery was supported on the shortened first rib."

Dr. Adams remarks, "What these costal malformations had to do with the dilatation of the left subclavian artery, or with the abnormal irritability of the right subclavian, I feel quite at a loss to conjecture."

"Strict examination was made as to the condition of all the other parts of the circulatory system, and all these structures were found sound. The lungs presented the usual morbid phenomena of typhoid pneumonia."

Dr. Adams adds, "The great point of interest in the case, and what alone made me bring it before the meeting of the Pathological Society, was the singularity of it, controverting by a fact Scarpa's views that in all cases the internal coat of the artery had given way. Certainly there was no atheromatous degeneration of the internal coat, nor any thickening of either the middle or external coat, and the circumstance of the dilatation not having undergone any increase while under observation for three years would seem to imply, that the peculiar lesion consisted in a fusiform dilatation unaccompanied with any special weakening of any of the three tunics, or with any rupture whatsoever."

Dr. Adams, in reply to further inquiry respecting the possibility of the costal malformations being cervical ribs, states, "I do not at all just now dispute the possibility of there having been a cervical rib; when the patient was examined in the hospital the bony growth or prominence was conjectured to be either an arrest of development of the first rib, or an extension of the transverse process of the last cervical vertebra."

It seems a very remarkable circumstance that the right subclavian artery, which was supported on the malformed rib, should be natural; whereas the left artery, which was placed at the distal extremity of the rib and rested upon a bony process from the rib below, should have undergone the condition in which it was found.¹

¹ A duplicate plaster cast of the external aspect of the patient during life is

There is another curious feature in my case, viz., the absence of all pulsation in the radial, ulnar, brachial, and axillary, arteries to within an inch of the distal side of the arterial tumour. There was an imperfect supply of blood to the limb, as evidenced by the deficient nutrition, by the sensation of cold, and by the diminished natural heat of the limb which necessitated artificial warmth by the application of flannel envelopes; the muscles likewise were weak and partially wasted, so that the patient was rendered unfit for work. These conditions were due entirely to the want of a proper arterial supply, and yet there was no apparent cause to account for this deficiency; certainly nothing in regard to the aneurismal swelling, as the blood flowed freely through it; there was no exostosis of the first rib pressing upon the artery as met with by Mayo;¹ there was no tumour or glandular swelling to be found anywhere in the course of the artery, as observed by Hodgson,² although repeatedly and carefully looked for, and yet there was a total arrest of all pulsation in the vessels of the limb.

If we peruse the recorded cases of subclavian aneurism, we find several instances in which no radial or even brachial pulse existed. Now, although in the majority of aneurisms we find that they more or less interfere with the circulation in the part below, they generally render it more feeble; and when the pulsation in the vessels below ceases, it is because the aneurism has caused pressure on the trunk, or the canal has been blocked up by coagulum. In the present instance, however, there was no obstruction whatever; the aneurism, as is the case with nearly all fusiform aneurisms, was free from coagulum, and contained nothing but fluid blood, which readily passed through it without any obstruction, and the artery some short distance below the

placed in Guy's Hospital museum, as also a copy of the artery drawn after its removal from the body.

¹ Mayo, "Case where the Subclavian was pushed forward by an Exostosis on the first Rib, causing it to simulate an Aneurism, and where the Circulation through the artery was arrested," *London Med. Journ.*, 1831, vol. ii, p. 40.

² Hodgson 'On the Arteries,' p. 262, case 38.

dilatation pulsated as strongly as the portion above it, though this pulsation ceased after the artery had entered the axilla. Thus the presence of the aneurism does not explain the absence of pulsation in the vessels below. We must, therefore, look for some other cause, and this brings us to the second question, viz. the condition of the vessels themselves. This, of course, must be conjectural; is it possible for the arterial vessels to have lost their peculiar property of elasticity, their pulsating and beating, and yet to allow a diminished current of blood to pass through them; thus becoming like veins through whose tubes blood flows without appreciation by the finger? It is possible for such a condition of things to exist, viz. absence of pulsation in, and yet a free although diminished flow of blood through, an arterial vessel altered and deprived of its natural property?

Another view of the cause of the absence of pulsation in the arm is the probable existence of an actual disease in the vessels themselves, viz. a form of chronic arteritis leading to complete obliteration of their tubes. Here we find many circumstances in corroboration, for, on careful perusal of the case, there are evidences of slow and gradual changes having taken place in the limb after an injury to the right index finger about two years ago; the finger became inflamed, and, although it healed in three weeks, to this alone does the man attribute his present state, for after that time he began to suffer occasional pains in the right arm, which gradually became weaker so as to force him to give up work; there was also defective nutrition of the fingers, as evidenced by the condition of the nails, the loss of temperature commencing at the extremities, and at times the almost entire absence of blood in the fingers (especially in the index, which was often perfectly white and blanched), so as to require friction and wrapping in cotton wool to enable blood to re-flow into them—all these symptoms, although present in aneurism, yet go far to establish the suggestion of a chronic arteritis and subsequent obliteration of the main trunks. If we turn to page 576 of Mr. Hodgson's work, we find there, recorded in the appendix, a case of obliteration of the

brachial, ulnar, femoral, popliteal, and tibial, arteries, occurring in a gentleman of thirty-six years of age, who after an attack of fever and pleurisy became the subject of this affection, and of which he died very shortly, so that the absence of pulsation in all these vessels was proved to have been caused by obliteration from chronic arteritis.

Mr. Savory¹ has also related the case of a young woman, æt. 22, in whom the main vessels of both upper extremities, and of the left side of the neck, were obliterated throughout by arterial disease, and had degenerated into a fibrous cord.

Might not such be the condition in the present case?

Supposing that this state of things did exist in the man's arteries, was this assumed morbid condition, this blocking up of the vessels as high as the axilla, the cause of the aneurismal dilatation of the third portion of the subclavian artery? Was the force of the heart's impulse, thrown upon this portion of the tube, the cause of its bowing out under the pressure by a kind of *vis a fronte*? This may seem to be a very rational view of the matter, but it is very unusual and not borne out by facts; it did not occur in the two instances just alluded to; and, again, pressure on, or ligature of, an artery does not lead to aneurismal dilatation on the cardiac side of the vessel, even if it have some morbid condition of its coats; if it were so there would be an end to such curative measures as are adopted, for we should be doing no good in thus treating an aneurism, as by getting rid of one aneurism, we should be laying the foundation for another, which in its turn would require a similar treatment and be followed by the same results. Hence, then, I cannot but regard the aneurismal dilatation in the present instance as a purely local disease caused by an atheromatous condition of the vessel, and it would in all probability have increased in size, become diffused, and led to the death of the patient.

On the other hand, there is still the fact that this condition might be a purely dilated artery, like Dr. Robert Adams's case, and have remained *in statu quo* for years without the

¹ 'Med.-Chir. Trans.,' 1856, vol. xxxix, p. 205.

necessity for any interference whatever, but time and observation of the progress of the case could alone have proved this.

There is still one other peculiarity about this case, viz. the condition of the fingers on the affected side; the finger ends were ill-developed and somewhat clubbed in shape, the nails were desquamating and of a darkish colour, whilst the fingers generally were cold and numb. Such a condition occurred in a case of enormous subclavio-axillary aneurism recorded by Dr. J. Ogle in the 'Pathol. Trans.,' vol. x, p. 103.

In this case the report states, "the pulse at the right wrist eventually entirely failed, and the nails of the fingers became exceedingly hypertrophied, becoming much broader and thicker, as well as longer; and the ends of the fingers clubbed in shape, and quite darkly *cyanotic* in colour."

Dr. Ogle remarks, "the peculiar cyanotic character of the fingers of the affected hand along with the increased growth of the nails . . . I attribute to exalted nutrition induced by the presence of an increased amount of blood in the veins of the part, detained there by the pressure upon and interference with the circulation in the neighbourhood of the axilla. The œdema and want of pulse at the radial artery, in addition to other symptoms, palpably indicate this obstruction."

In these two instances only has this condition been found, and it is probably but an accidental circumstance, for there are numerous cases in which the main channels of the subclavian, axillary, and brachial, vessels have been obstructed without causing any marked changes in the fingers. On the other hand, a clubbed condition of the fingers and a weak circulation are met with in phthisis, and are by some physicians considered to be a sign of the disease. In Dr. Ogle's case the man had hæmoptysis three years before death.

In a case of subclavian aneurism recorded by Langenbeck,¹ he makes mention of a peculiar condition of the finger ends as occurring at the time when a recurrent increase of

¹ Langenbeck, 'Berliner Wochenschrift,' March, 1859, No. 12.

the aneurism took place, after having been quiescent for a period of three years and apparently disposed to subside spontaneously.

We now arrive at the treatment which was carried out in the present case, and this will entail some interesting points for observation and inquiry.

Whatever explanation we might choose to adopt respecting the nature of the aneurism, our attention was mainly directed to relieve the patient's sufferings which were due chiefly to the pressure of the pulsating tumour upon the brachial plexus and its branches. The tumour was quite elastic, contained fluid blood, and was readily emptied by direct pressure as well as by compression of the artery on its cardiac side; there was no coagulum and no prospect of this forming whilst the current of blood passed freely through the vessel. The idea therefore of gaining a deposition of solid material by indirect compression was considered by myself and others as quite unreasonable, not only on account of the difficulty in making pressure and keeping it up for a sufficient length of time, but also by the absence of a sac or any other hindrance whereby a coagulum or a clot could be retained for the filling-up process. It was a question, therefore, whether to leave it alone or to tie the subclavian on the cardiac side of the dilatation close to the external border of the scalenus anticus muscle. After several consultations it was agreed not to subject the man to any risk, but to watch the case, and if the tumour increased in size and threatened rupture, then to adopt such means as might be necessary. However, it was suggested that digital pressure on the cardiac side of the tumour should be tried, inasmuch as there was plenty of space to compress the artery, and there was moreover a capital background in the abnormally placed rib; besides, compression of the artery against the bone could readily be maintained with very little force and without interfering with any nerve.

The plan was agreed to, and the report of the case gives the result. Although the digital compression did not actually obliterate the dilatation, yet it was the means of setting up

the process by which it became eventually blocked up and consolidated into a fibrous cord.

This result fully corroborates the principles laid down by Bellingham¹ many years ago, and demonstrates most fully the justness of the following remark by him, viz., "that the partial current through an aneurismal sac will lead to the deposition of fibrine in its interior, and cause it, within a few hours, to be filled and obstructed, so as no longer to permit of the passage of blood through it."

Such is the result in cases of ordinary aneurism and it can be easily comprehended, but when we consider the fusiform or tubular variety of aneurism, where there is a dilatation of the whole calibre of the artery, we cannot quite so readily bring our minds to regard the process of filling up to be the same.

Mr. Luke² has recorded a case of tubular aneurism of the femoral artery in a man, æt. 38, and in this instance the tumour was of an oblong form, extending from Poupart's ligament three or four inches down the thigh. This was treated by direct compression, of sufficient force only to retard the flow of blood through it, and a cure was effected.

Mr. Luke enters into a long dissertation as to the mode in which this was carried out; he believes that the process is not always one of deposition of coagula from the blood, but that the sac itself, or more properly its vessels, are the efficient agents in the fibrinous formation; that instead of growing by deposits on its inner or central surface, the increase must take place upon the exterior surface, which lies in contact with the sac; and he concludes that the action itself by which the vessels deposit the fibrinous secretion is probably of the plastic kind, bearing a certain analogy to the adhesive process in other parts.

Broca³ has given special attention to the mode in which fusiform aneurisms undergo cure, and premises the subject by elaborately considering the mechanism of the flow of

¹ Bellingham 'On Compression in Aneurism,' p. 127.

² Luke, 'Medical Times and Gazette,' 1845, p. 78.

³ Broca 'On Aneurism,' p. 142.

blood through these dilatations, and the condition of the blood itself; he thus sums up the process of coagulation. "In all this, from the commencement of the diastole to the end of the systole, the blood is completely renewed in the centre of the aneurism, much less in the neighbouring layers, and almost none at all in the peripheral layers; the latter thus becoming in a condition favorable to the coagulation of the fibrin, permits the deposition of active clots (fibrin) in the parietes of the sac, forming the first fibrinous layer in the fusiform aneurisms; similar layers of deposit ensue, and each new deposition narrows the cavity of the sac by degrees until the obliteration is completed."

Le Fort¹ differs in some respects from the views of Broca on the state of the blood and the circulation in the fusiform aneurisms. He refers the formation of a clot to a more or less complete stagnation of the blood, and to the contact of the blood with a structure which is not the internal membrane of the vessel, as must always take place in aneurismal sacs, since in these, rigorously speaking, there is no internal coat. In arterial dilatation, therefore, where the internal membrane exists, the blood has no tendency to coagulate, and at the same time it does not stagnate, but if the internal membrane has disappeared at any point, then clots may be formed in the parietes of the vessel, and these clots are firm and fibrinous. He also adds that inflammation plays a great part in the formation of a clot.

We cannot enter further into this interesting subject; suffice it to say that there are two theories respecting the obliteration of tubular or fusiform aneurisms—the one that it is due to the successive depositions of laminæ or layers of coagulum from within to without, from the blood current to the walls of the sac; and the other that the deposition commences from the external wall, by plastic effusion from the coats of the dilated artery, and probably from their *vasa vasorum*, and that this effusion by extending inwards ultimately blocks up the vessel.

The main point seems to be, how are we to favour the

¹ Le Fort, 'Dict. Encyclop. des Sciences Médicales,' article "Aneurisme."

obliterating process in fusiform aneurisms? It appears that a very essential condition is a change in the internal lining membrane of the artery. A dilated artery, with a healthy condition of all its coats, is not in a condition favorable to coagulation; in fact, it does not differ from an ordinary arterial tube and may remain in the same state for years, and this is well exemplified by Dr. Adams's case; but should inflammation be set up in the dilatation, or should the internal coat undergo morbid changes, then there may be a prospect of effecting its obliteration, as occurred in the present case.

The discrimination between these two conditions in a vessel is highly important, for in the one instance we should be disposed to leave it alone; but in the other instance, where the dilatation is due to disease of the internal coats, we must endeavour to bring about the obliteration of the vessel, otherwise a regular aneurism may form or the artery may burst, as has happened in many of the examples of subclavian aneurism.

The length of this communication prevents my entering upon the various modes of treatment adopted in subclavian aneurism, and therefore in conclusion I shall only add a few words on the subject of compression of this artery.

Three methods offer themselves, viz.—1st. Pressure on the artery on the cardiac side of the tumour; 2nd. Pressure on the distal side; and 3rd. Pressure directly upon the sac itself; recollecting at the same time that subclavian aneurisms are very frequently of the fusiform variety, and consist in a general dilatation of the whole of the coats; that the contents are fluid, with a want of tendency to clot formation; that they generally retain a small size, and very slowly enlarge; that they most frequently give way either into the neck, or on to the thorax, or into the axilla. Hence, then, caution must be used in adopting compression as a means of cure.

My case is a good example of the 1st method, viz., *pressure on the cardiac side of the aneurism*; but it is very doubtful whether such an extraordinary anatomical disposition of parts will again favour a patient afflicted with

aneurism in this region. Pressure also on the subclavian artery just as it emerges from the scalenus is exceedingly painful and cannot be borne for any length of time.

2nd. *Distal pressure* can only be performed below the clavicle, but so much force is required that it is altogether impracticable, although we have a very interesting example of nature performing this operation herself in a case of subclavian aneurism mentioned by Hodgson. It suggests the idea of the distal operation.

3rd. *Direct pressure* upon the tumour itself; this mode of treatment has been most successfully employed by Mr. F. M. Corner, of Poplar, who has kindly permitted me to present his case to the Fellows of the Society as an appendix. The compression did not require any amount of force, but was made in such a manner as to retard the flow of blood through the aneurism.

The following is an epitome of the examples of the varied methods of compression :

1. Compression on the cardiac side of a subclavian aneurism.

a. Case related by Beauchène in 'Corvisart, Le Roux, and Boyer's Journal,' quoted by Hodgson at p. 113. In this instance the pressure was produced naturally by the scalenus anticus.

b. Case related in this communication.

2. Compression on the distal side of the aneurism.

a. Case related by Hodgson at p. 110, where an aortic aneurism was the cause of compression.

b. Case related by Auchinloss,¹ where, in a case of aneurism involving the subclavian, carotid, and innominate, arteries, natural pressure on the artery was effected as it passed between the scaleni, which acted like a ligature and obliterated the vessel at this part to the extent of the breadth of the muscles.

¹ Auchinloss, 'Edinb. Med. and Surg. Journ.,' 1836, vol. xlv, p. 338.

3. Compression directly applied on the aneurism itself.

a. Corner's case, as related in the appendix.

b and *c.* Two cases related by Dr. J. M. Warren in his 'Surgical Observations,' where direct compression, with ice and rest, seemed to have given an impetus to the tumour; in the one case producing obliteration of the sac, in the other causing suppurative and destructive inflammation, but ultimately leading to a successful issue.

d. The well-known case recorded by Dr. Yeatman,¹ who invented and used a kind of horse-hair cushion buckled over the tumour by means of straps passed under either axilla; in his case, however, it was a large diffused aneurism which occupied the axilla as well, but the compression was of material service in the process of cure.

I have been permitted to append the notes of an unpublished case which came under the care of Professor Spence, of Edinburgh, and although it does not bear upon the subject of compression, yet it possesses many interesting points for consideration. It is the only case on record in which amputation on the distal side of a large subclavian aneurism has been performed.

¹ Yeatman, 'Med. and Phys. Journ.,' vol. xxxiii, p. 377.

APPENDIX No. 1.

Aneurism of the Right Subclavian Artery, cured by direct Compression, in a man who had undergone a spontaneous cure of a left popliteal aneurism, and in whom also a right popliteal aneurism had been successfully treated by compression on the proximate side.

By F. M. CORNER, Esq.,

SURGEON TO THE POPLAR HOSPITAL.

B. C—, æt. 46, was working as a shipwright in June, 1866, when he noticed a pulsating tumour about the size of a walnut above the right clavicle, for which he could not attribute any cause. The swelling was immediately outside the scalenus muscle and appeared partly overlapped by it; its impulse could not be arrested by pressure on the proximal side of the tumour. It gradually enlarged to the size of a hen's egg, and he complained of pain, coldness, and weakness, of the right arm. These feelings were similar to those experienced by him in his feet and legs when suffering from popliteal aneurisms in 1859 and 1861.

His early history is as follows:—In December, 1859, he applied to me, complaining of swelling and coldness in the left leg and foot, which had existed more than a month. He was a thin, spare man, had never been at sea, had never had syphilis, and had worked steadily as a shipwright. On careful examination no pulsation could be felt in either tibial artery, or in the popliteal, or in the femoral below the giving off of the profunda. He had experienced a pain and stiffness in the *left* popliteal space, where now existed a firm swelling about the size of a nut. He was recommended gentle exercise and friction, which effected but a slow amendment, although the swelling quickly disappeared.

In February, 1861, he again consulted me on account of a swelling in the *right* popliteal space, which he had only noticed a week before. The tumour measured four inches in

length and three inches in breadth. Compression of the femoral artery completely stopped the pulsation in it, and steady pressure removed the swelling.

On March the 5th the following treatment was put into practice. An elastic cotton bandage was lightly applied from the toes to the thigh, and Carte's instrument used alternately at the groin and thigh. His pulse was quiet and very compressible. He was ordered morphia and digitalis three times a day; fish diet and meat were given on alternate days, but no stimulants. The glands in the groin became swollen and tender, so that he could not bear pressure for more than two hours at a time.

On March the 15th there was no deposition in the aneurismal sac. I therefore made use of a common sash-bolt weighing 7 lbs., which, when laid upon the upper end of the artery, so far arrested the current of blood that only occasional and slight pulsation was felt in the swelling. This weight was removed at night and readjusted in the morning, continuing it until 7 p.m.

On March the 18th the foot and leg became suddenly cold and numb; half the aneurism below had become solid, and the tibials had ceased to beat. The pressure by the bolt was now continued for one or two hours only during the day.

On March the 21st the whole of the sac seemed to have become filled, and on April 6th all hardness in the ham had disappeared, but the patient could not walk many miles without feeling his foot cold.

The man followed his usual employment and continued in tolerable health until June, 1866, when he began to suffer much pain about the shoulder-joint, and accidentally discovered a swelling above the clavicle.

In August, 1866, he became an in-patient at St. Thomas's Hospital, and the swelling was pronounced to be one of subclavian aneurism; it was proposed by some that the subclavian artery should be ligatured, but on consultation the operation was negatived.

In January, 1867, he placed himself under my care. The tumour was of the size and shape of a hen's egg, but more

flattened; the contents appeared to be perfectly fluid, and the aneurism seemed to be one of dilatation of all the coats; the long axis of the tumour passed in the direction of the artery. He experienced a sensation of coldness in the arm, which was weak and painful; the pulse was small, soft, and readily compressible. The tumour was close to the scalenus, so that there was no room for pressure on the artery on its cardiac side. The case was seen by Mr. Hutchinson, of the London Hospital, who agreed with me that operative measures should be abandoned, in consequence of the fatality attending ligature of the first portion of the subclavian, and of the innominate artery.

In January, 1867, he was kept in bed and ice was applied over the tumour; it was kept on continuously nearly all day. His diet consisted of animal food and bread, vegetables being withheld. No benefit resulted from this treatment.

In August, 1867, a leather cup was accurately moulded to the swelling above the clavicle and fixed on by straps which passed under each axilla. From this he derived great comfort, experiencing less uneasiness in the part, and feeling much safer when making exertion. He then acted as ship-keeper, avoiding only laborious jobs, and lived as an ordinary working man.

In August, 1868, he felt himself suddenly bad, experiencing sickness and vertigo, so that he was obliged to hold on to something to prevent his falling; and on feeling the swelling afterwards he found no pulsation in it.

On the 15th of this month he was seen by me; there was some slight pulsation to be felt, but the bulk of the swelling was hard.

When again examined on October 26th, neither swelling nor pulsation could be found. A slight impulse existed in the radial and brachial arteries; the temperature of this limb was somewhat lower than that of the opposite. Sensation was perfect, and he had resumed work as a shipwright.

APPENDIX No. 2.

Notes of a case of Subclavian Aneurism, in which Amputation at the Shoulder-joint was performed; recovery. Death four years after, probably from internal aneurism.

By PROFESSOR SPENCE, F.R.S. ED.,

SURGEON TO THE EDINBURGH ROYAL INFIRMARY.

A man, æt. 33, who was an engineer on board ship and had been long in warm climates, came under the care of Professor Spence suffering from an aneurism of the right subclavian artery. He attributed it to exertions in repairing machinery, but his history was not very distinct. He complained of rheumatismal pains in the right arm which had been of fully two years' duration. The aneurism was detected by a surgeon only shortly before his admission into the hospital.

The tumour occupied the whole of the subclavian triangle, and extended inwards beneath the sterno-mastoid muscle. The innominate artery and the aorta appeared to be healthy. The aneurism was fusiform, its contents completely fluid, and there seemed to be no tendency to coagulate. There was rather more pulsation than usual under the pectoral muscles below the clavicles.

Condition of the limb.—Circulation much impaired, the radial pulse almost imperceptible; the hand and part of the forearm were purple and mottled, and the arm œdematous—in fact, threatening gangrene.

Sensation.—Excruciating pains in the arm, but the hand was numbed, and there was scarcely any sensation in the little or ring fingers. The muscles were not wasted, but the agonizing pain and the swelling of the arm prevented voluntary motion, although there were cramps and spasms at night.

Treatment.—The choice lay between ligature of the innominate artery and amputation at the shoulder-joint. Taking into

consideration the hitherto fatal results of the former operation and the state of the arm, I preferred amputation, as combining the effect of Brasdor's method with the removal of the *vis a fronte*, the attractive power of tissues to be supplied by the circulation; and I hoped that when the parts which the vessel supplied with blood were removed, it would gradually contract and the blood be directed into other channels.

Another method was suggested, viz., opening the sac after having controlled the circulation through the innominate, on the principle advocated and carried out by Mr. Syme in axillary aneurism, but I rejected it as quite unsuitable here, since the vertebral circulation into the sac could not be commanded by compressing the innominate, and moreover the ligature on the cardiac side of the sac would have been close upon the vertebral, thyroid axis, and internal mammary, arteries, even supposing that the coats of the vessel were healthy.

Amputation was performed on the 6th of April, 1864.

The immediate results promised a complete success; for the first ten days the tumour was scarcely to be felt, but no coagulation occurred. When he left the hospital the aneurism was feeble in its pulsation, and it had diminished to about one third of its original size; there was little coagulation, however, and to favour this he was directed to use the iodide of potassium.

He died in the course of the summer of 1868, but I have not been able to ascertain the exact cause of death. I suspect there was no post-mortem examination. I had heard incidentally, some time before his death, that the aneurism had increased towards the chest; probably the innominate and aorta had also become involved.