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Pain in the Upper Limb

Two questions to be answered are: (1) What structures may produce this interference and so cause this pain? and (2) Why are these painful conditions relatively common in the upper limb and uncommon or absent altogether in the lower limb?—because we now have definite evidence that sciatica, which of course is common enough, is not due to any lesion at the pelvic outlet but to a radiculitis that is usually the result of an intervertebral disk lesion.

Dealing with the second of these questions first, I suggest that it is man's upright posture combined with the great use of the forelimb when erect which causes the pain in the arm and accounts for its absence in the leg. As the erect position is assumed there is an angulation of the structures leaving the superior aperture of the thorax, so that they are readily stretched across any abnormal or at times even normal structure that may here form the boundary of the opening, whereas in the case of the lower limb the upright position undoes or opens out any such angulation of the neurovascular elements which enter the limb from the pelvis (Figs. 1 and 2).

Character of the Pain

Neural Pain.—This is usually of a tingling or stabbing character and of ulnar distribution. It is due to the lowest trunk of the brachial plexus being stretched over and/or compressed against (a) a cervical rib, (b) a fibrous band corresponding to a rib (Fig. 3), (c) the medial tendinous lower fibres of the scalenus medius (those arising from the seventh cervical transverse process), or (d) occasionally an abnormal scalene muscle (pleuralis of Sibson, intermedius of Testut, minimus of Albinus) lying between the artery and the nerve trunk.

The Scalenus Syndrome.—The part played by the scalenus anticus has been exaggerated, and simple division of this muscle may fail to relieve symptoms. The syndrome should be called the scalenus syndrome and not the scalenus anticus syndrome, as so frequently the scalenus medius (also the scalenus minimus less often) plays a part in its production. At operation it is essential to free the lowest trunk of the plexus from the rib, band, or tendinous scalene fibres over which it may be stretched. A frequent finding in these cases is an abnormal origin of the posterior scapular artery from the third part of the subclavian. The artery passes between the trunks of the plexus and tends to hold down the lowest trunk against the structure over which it is stretched (Fig. 4).

Vascular Pain.—This is usually of a dull aching character, and is due to a relative ischaemia brought about by compression of the subclavian artery (the costoclavicular syndrome).

The Costoclavicular Syndrome.—Interference with the blood flow in the subclavian artery at the

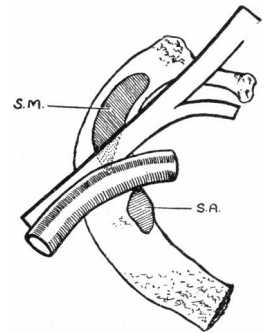


FIG. 3.—Showing the relationship of the lowest trunk of the brachial plexus to the lower medial tendinous fibres of the scalenus medius.

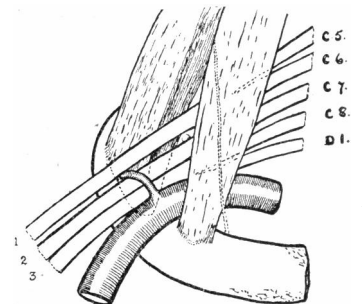


FIG. 4.—The medial tendinous fibres of the scalenus medius are shown and the abnormal posterior scapular artery arising from the third part of the subclavian and passing outwards and backwards between the trunks of the plexus so as to hold the lowest trunk against the subclavian artery.

UPPER-LIMB PAIN DUE TO LESIONS OF THE THORACIC OUTLET*

THE SCALENUS SYNDROME, CERVICAL RIB, AND COSTOCLAVICULAR COMPRESSION

BY

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Cunningham calls the upper opening of the thorax the inlet, the lower opening the outlet. It is assumed that we are referring to the upper opening, for there can be few if any lesions of the lower one which produce pain in the arm.

The Upper Opening of the Thorax.—The superior aperture of the thorax is a narrow opening which is bounded by the first dorsal vertebra, the first pair of costal arches,

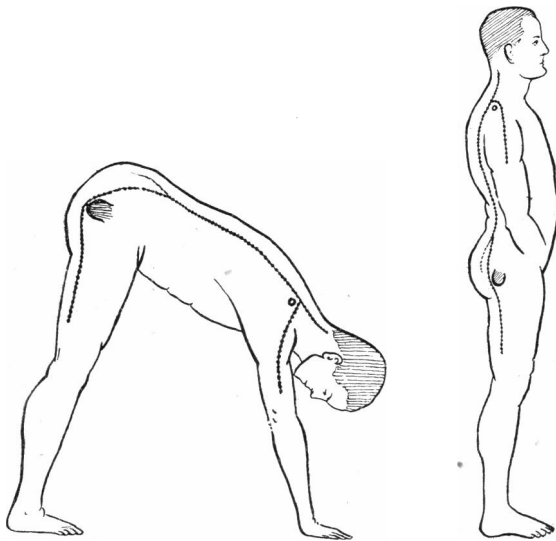


FIG. 1

FIG. 2

FIG. 1.—With the four limbs on the ground the nerve trunks of the limb plexuses enter the limbs approximately perpendicular to their origin and are neither acutely angled nor stretched.

FIG. 2.—With the assumption of the upright position the lowest of the nerve trunks of the forelimb plexus which leaves the thorax is angled acutely. The nerves to the lower limb pass almost vertically downwards and there is no tendency to angulation.

and the manubrium sterni. From it issue the great vessels and nerves to the upper limb, and interference with them at their egress by certain structures may cause pain of two kinds: that of neuralgia or neuritis, or that of ischaemia.

*Read in opening a discussion in the Section of Orthopaedics at the Annual Meeting of the British Medical Association, Harrogate, 1949.

thoracic opening is the consequence of the artery being compressed, when the arm is placed in certain positions, between the clavicle and either the first rib or a cervical rib. Elevation or depression of the shoulder may open out or diminish the space between the bones, according to the shape of the upper thoracic opening as modified by the abnormal rib (cervical or thoracic). While this is probably the explanation in most cases in which the syndrome is well developed, a minor degree of compression may be produced by the scalenus anticus, the artery being compressed between the contracted muscle in front and a rib or band or even the scalenus medius behind (Murphy, 1906; Wingate Todd, 1911).

An alternative hypothesis has been suggested by Wingate Todd (1913), Telford and Stopford (1930), and others, that irritation of the sympathetic fibres accompanying the lowest trunk of the brachial plexus may account for the vascular symptoms by inducing vasospasm, but there is little evidence in favour of this, and recently Sunderland (1948), of Melbourne, who has investigated the question by histological studies of the brachial plexus in some cases in which the syndrome had been present, finds no support for this view.

Other Aetiological Factors.—In addition to abnormalities of the upper thoracic opening, certain other factors may contribute to the appearance or the severity of either the scalene or the costoclavicular syndrome by leading to the depression of the shoulder girdle and thereby increasing the angulation of the issuing nerve trunk and artery. This may come about as the result of: (1) The dropping downwards and backwards of the shoulder girdle which takes place in late adolescence. (2) A downward pull on the shoulder as by a post-bag (Maddox, personal communication, 1946), or, as was seen early in the war when respirators were worn constantly, the respirator strap (Rogers, 1941a, 1941b). Long ago, de Quervain (quoted by Cushing, 1903) noted that rifle drill produced the syndrome in some young recruits, and even the direct pressure of a violin on the root of the neck has been productive of symptoms (Sheen, 1912). (3) Fatigue which may lead to an atonic condition of the supporting muscles of the shoulder girdle.

Diagnosis

Diagnosis is usually evident. A young person who has numbness and tingling in the hand and fingers and along the ulnar border of the forearm, aching around the shoulder girdle, and flattening of the thenar eminence, whose symptoms are relieved by elevating the arm, and whose radial pulse may be obliterated or diminished in volume by stretching the arm well above the head, presents a typical picture, particularly if the symptoms have developed in late adolescence, after losing weight, or after some unusual dragging on the arm or depression of the shoulder as in carrying a respirator. X-ray films may show the presence of cervical ribs or of large costal processes the ends of which are pointed and directed downwards and outwards. They may also indicate abnormalities of the thoracic inlet, and it must be remembered that the first rib may be the cause of symptoms in some cases. Sometimes the subclavian artery can be seen elevated in the supraclavicular triangle so that its pulsations are apparent and may even resemble those of an aneurysm.

Differential Diagnosis

The syndrome must be differentiated from ulnar neuritis, herniated cervical nucleus pulposus producing a radiculitis, and writers' cramp.

Ulnar Neuritis.—In ulnar neuritis (for example, a lesion at the elbow) there is no flattening of the thenar eminence except in a few rare cases of ulnar innervation of the thenar muscles (Hight, 1943), there is no shoulder pain, the lesion is strictly confined to ulnar territory, and relief does not follow abduction of the limb.

Cervical Disk Lesions.—In cervical disk lesions the disk involved is usually that between C5 and C6 or that between C6 or C7, so that the root affected is either C6 or C7. Pain is more intense in the shoulder region; ulnar-sided pain or tingling is not present in the forearm or in the hand, and symptoms usually appear at a later age. Radiology may show a narrowed disk space between the vertebrae. Elevating the head—pressing upwards below the mastoids—may relieve the pain during an attack, and further differentiation may be provided by the abduction test.

Writers' Cramp.—This has a hysterical background which is often elicited on cross-examination—e.g., it occurs only when writing Service or business letters and not when writing for pleasure, and there is an absence of the precise mechanical picture presented by the patient with a scalene syndrome.

The Abduction Test.—If the signs and symptoms are due to the scalene syndrome or a cervical rib they are produced by a chafing action of the lowest trunk of the brachial plexus over the rib or the band representing it. If the nerve trunk is therefore lifted off the rib or band and kept thus elevated, the condition is alleviated. This may be achieved by placing the arm at rest in abduction on an aeroplane splint and so maintaining it for a few days.

Treatment

Non-operative.—In early and mild cases relief may be obtained by splinting and rest followed by exercises designed to develop the elevating musculature of the shoulder girdle. In more persistent cases, in which the abduction test has confirmed the presence of a chafing structure below the lowest trunk of the brachial plexus, operation is indicated.

Operative.—This consists of exploration of the region of the lowest components of the brachial plexus and also the subclavian artery in its three parts. A straight incision running upwards and outwards across the root of the neck in a crease-line just above the clavicle gives adequate access. If care is taken to free completely the artery from compression and the lower side of the nerve trunk from chafing or other irritation, the results of operation are excellent.

Comment

The views here expressed are derived from my experience of 33 operations which in the past twelve years I have performed for the scalene syndrome or costoclavicular compression. Eight operations were performed for cervical rib, 25 for the scalene syndrome. These 33 operations represent 30 patients. Bilateral operations were performed in two—in the one case separated by an interval of four months, in the other by one of 11 years. These were both cases of scalene syndrome in which a second operation on the other side was requested because of the benefit obtained from the first operation. In another case I performed two operations on the same side because of a return of symptoms due to adhesions. Three other patients had been operated upon previously by other surgeons. In one a cervical rib had been removed on the left side, and as similar symptoms occurred on the opposite side she requested removal of the rib on that side also; the other two cases were recurrences due to the lower side of the lowest trunk of the plexus not having been freed from its source of irritation. Of my 30 patients, 17 were women, 13 men; their ages varied between 17 and 55. One patient, a man of 45, was in jeopardy with gangrene of his fingertips and a subclavian aneurysm due to the artery being damaged by costoclavicular compression. I resected the aneurysm and left the rib. He has been well and doing hard work in a motor garage for nine years since the operation.

Conclusion

The scalene syndrome is of commoner occurrence than cervical rib in producing pain in the upper limb, and when symptoms are persistent it is not enough merely to divide the scalenus anticus, because the lowest trunk of the brachial plexus may still be stretched over and from time to time chafed by an underlying rib or band, or by the medial and tendinous lower fibres of the scalenus medius or an abnormal scalene muscle. It is necessary to divide any such structure so as to free completely the lowest trunk of the plexus, exploration of which is therefore the indication and not merely anterior scalenotomy. Similarly, where the subclavian artery is elevated over and compressed between an abnormal rib behind and the scalenus anticus in front, the part of the abnormal rib lying below and behind the artery must be removed so that the vessel is free to sink down on to Sibson's fascia. Only if these principles are applied in operating on cases of pain in the upper limb due to lesions of the thoracic operculum may we expect results that are wholly satisfactory.

Summary

Pain in the upper limb due to lesions of the upper thoracic opening may be the result of compression of the subclavian artery (the costoclavicular syndrome), or irritation by a band, rib, the scalenus medius, or an abnormal scalene muscle of the lowest trunk of the brachial plexus stretched over it and compressed from in front by the scalenus anticus (the scalene syndrome).

Similar pain does not occur in the lower limb, because acute angulation of the nerve trunks leaving the pelvis does not occur as in the case of the neurovascular bundle leaving the thorax. This angulation in the case of the upper limb and its absence in the case of the lower limb is due to the upright posture.

Elevation of the limb to a right-angle will usually relieve symptoms, indicating that similar relief can be obtained from operation.

Operation is best performed through an incision above the clavicle crossing the posterior triangle of the neck.

Anterior scalenotomy is not enough. The under surface of the lowest trunk of the plexus must be cleared so that no further chafing action of this nerve trunk can occur.

I am indebted to my friend and colleague Mr. Cecil Lewis, F.R.C.S., for the accompanying drawings.

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The Scottish Society of the History of Medicine, which was founded in April, 1948, has just issued its first annual report. There are already 75 members of the Society, and it is hoped that this number will increase. The sixth meeting, and the first annual meeting of the society, was held in the council room of the University of Edinburgh on October 1, 1949. It took the form of a discussion on "The Teaching of the History of Medicine." The subject was introduced by the president, Dr. Douglas Guthrie, followed by Dr. W. D. D. Small, P.R.C.P.Ed., and Mr. Denys Hay, lecturer on history and director of studies in the Faculty of Arts. A large number of members took part in the discussion, and the honorary secretary, Dr. H. P. Tait, brought the meeting to an end with a brief review of the opinions which had been expressed.

THE COMPARATIVE MERITS OF SODIUM AND PROCAINE PENICILLIN GIVEN INFREQUENTLY

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Penicillin is widely used in general practice and in the out-patient departments of hospitals for the treatment of acute staphylococcal infections of the skin and subcutaneous tissues, but as yet the dosage employed in different hospitals varies widely.

One school, of which the chief protagonist has been Eagle, believes that the aim should be to maintain a bactericidal level of penicillin in the blood, and hence in the tissues, continuously throughout treatment. This belief is based (Eagle, 1948) on the principle that the frequency of penicillin administration should depend on the generation-time of the micro-organism concerned. If too long a period after administration is allowed the blood will become free from penicillin and surviving organisms will be able to multiply. If this is permitted for only a brief period the effect of treatment will merely be counteracted in part; if, however, too long an interval is allowed the effect of treatment may be counteracted by the supervening multiplication of organisms. This view receives tacit support from the fairly general practice of treating out-patients with large doses of penicillin once or twice a day, and admitting to the wards serious cases, or those which do not improve, for treatment with three-hourly injections.

On the other hand, clinical reports in ever-increasing numbers suggest that penicillin given in large doses daily or twice daily is effective for staphylococcal infections.

For instance, Wheatley (1947) treated seven cases successfully, in six of which single daily doses of not more than 200,000 units of penicillin were employed. D'Abreu, Flood, and Hewitt (1947) and Barclay (1949) report some benefit from the use of spaced doses in the treatment of septic hands, although in the last group systemic penicillin was combined with local penicillin.

The object of this paper is to describe a clinical investigation in which acute septic infections of the skin and subcutaneous tissues, mainly staphylococcal, have been treated by one of two methods, the first designed to keep a low penicillin concentration in the blood throughout most of the 24 hours, the second to produce two high concentrations of penicillin in the 24 hours, allowing the blood to become free from penicillin during an appreciable part of that period. The opportunity has also been taken to make some general observations on the treatment of infections of this type.

Methods of Treatment

The first group of patients was given a single daily intramuscular injection of 300,000 units of procaine penicillin in arachis oil, an amount which has been shown to produce low concentrations throughout most of a 24-hour period