Blood Supply of Cervical Spinal Cord in Man

A Microangiographic Cadaver Study

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ADAMKIEWICZ* and Kady' described the blood supply of the spinal cord in the 19th century. Kady's monograph is detailed, highly accurate, and illustrated with full-paged colored plates. His studies have been repeated many times both to confirm them and to bring the knowledge into the English and French languages. All investigators have relied upon conventional techniques with the result that Kady's few mistakes have escaped detection. Those who used radiography did not employ methods refined enough to demonstrate small vessels clearly.

We have thought it worthwhile to restudy the blood supply of the cervical cord using both microdissection and microangiography, and can now provide the surgeon with a more accurate description of the arteries in this region.

Material and Methods

Cervical spinal cord specimens were obtained from 43 unselected cadavers prior to autopsy at the South Stockholm Hospital, Stockholm, Sweden. The mean age was 70 (range: 30 to 80); there were 26 males and 17 females. An air myelogram was done as part of an associated investigation, then both common carotid and vertebral arteries were ligated in the neck. Two liters of a 12 per cent suspension of barium sulphate (Micropaque® or Mixobar®) in normal saline or water were infused for about 2 hours, into the larger of the vertebral arteries. When both of the vertebral arteries were found occluded by atheroma, one of the carotid arteries was used. An initial pressure of 50 to 80 cm. of suspension was increased at the end of 1 hour to 150 to 200 cm. Shortly after the infusion was started, contrast material flowed from one of the other major arteries of the neck, which had been temporarily opened for this purpose. A common carotid was usually used and drainage was permitted until pure contrast solution issued, thus allowing some blood trapped in the arteries to escape. When the earlier specimens were removed from the body, some of the contrast material drained from the vertebral and larger radicular arteries. To keep these parts of the arterial tree filled in the later specimens, the suspension was warmed during the infusion and 150 ml. of 10 per cent gelatin was added to the last 300 ml.

The subarachnoid space was then filled with 10 per cent formalin solution by lumbar puncture and the cadaver returned to the cold room overnight. The next morning the cervical and upper thoracic cord was removed, along with its roots and dural covering. The vertebral arteries were removed in some of the specimens. Until studied, the cords were kept in 10 per cent formalin.

Postero-anterior roentgenograms were made of all the specimens, by laying them on the film in thin polyethylene bags. We used Kodalith Ortho Type 3 film, which has a power of resolution about 10 times that of ordinary x-ray film, and a Philips tube no. 25633/62 with a fine focus (0.4 × 0.4 mm.). The radiation was generated at 30 kV. and 25 mA. The focus-film distance was 110 cm.; the exposure time 30 min.

The dura mater was then removed from each specimen and the roentgenograms repeated. The roots on some of the cords were cut short and lateral roentgenograms made. The length of branches of the central arteries was measured directly from the microangiograms. There was no enlargement to consider for the specimens were in contact with the films during the exposures and the distance from the focal spot to the film was relatively great.

The cords were examined under a dissecting microscope, and the diameters of the radicular arteries were measured with the eye-piece scale of the microscope and tabulated. No corrections were made for changes in size due to fixation. When an artery was partially empty and lay flat, its true diameter was estimated by subtracting 0.1 or 0.2 mm. from the measured value. The veins of the roots and cord were noted. After the arteries on the surface of the specimens were examined, frozen sections from 1 to 4 mm. in thickness were cut in the sagittal, coronal and transverse planes. The sections were put into thin polyethylene bags and x-rayed on Kodak.

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Maximum Resolution Plates. These plates are less sensitive but have a power of resolution 3 or 4 times greater than the Kodalith emulsion used to study the whole specimens. The radiation was generated at 35 kV. and 22 mA. The exposure times ranged from 25 to 75 min. The sections were returned to formalin and some were later examined under the dissecting microscope.

The microangiograms were studied and photographed with a microscope.

Nomenclature

A short description of the vessels to be discussed in detail will indicate the terms used.

Most of the blood to the cervical spinal cord comes by way of the vertebral arteries. Radicular arteries on the C7, C8 and T1 roots are fed by other branches of the subclavian arteries. The radicular arteries reach the cord by travelling on some, but not all, of the anterior and posterior roots. Those on the posterior roots join the 2 posterior spinal arteries which originate above, usually from the vertebral or posterior inferior cerebellar arteries. In the midline on the front of the cord runs the anterior spinal artery which arises superiorly from the vertebral arteries and is supplied along its length by the anterior radicular arteries. A plexus of small arteries communicate with the anterior and posterior spinal arteries while surrounding the cord in the pia mater. Central arteries leave the anterior spinal artery and pass posteriorly in the anterior median fissure to convey blood to the central part of the cord. The central arteries and their ramifications make up the central circulation. Branches from the pial plexus penetrate the outer part of the spinal cord and this is called the peripheral circulation. Venous pathways run parallel to the corresponding arteries.

Dissecting Microscope Findings

Radicular Arteries. When the specimens were examined with a dissecting microscope, it was noted that the arteries carrying blood to the spinal cord were on the anterior surface of the adjacent neural tissue. The vertebral arteries lay anterior to the spinal nerve roots at the level of the ganglia or immediately lateral to them (Fig. 1). Radicular arteries left the vertebrales 0.1 to 1 cm. inferior to the roots. When they reached the roots, they were enclosed by perineurium which was continuous with the connective tissue surrounding the vertebral arteries. Passing medially, the radicular arteries entered the dural root pouches on the anterior surfaces of their respective roots. For this reason, the posterior radicular arteries were

Fig. 1. Transverse sections showing relationship of vertebral arteries (arrows) to roots at 4th cervical level. ×3.