THE ANATOMICAL APPROACH IN STELLATE GANGLION INJECTION

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The sympathetic outflow to the head and neck and the greater part of that to the upper limbs passes on each side through the relatively small confines of the stellate ganglion and is here subject to interruption by stellate ganglion block.

This block will cut off all effferent sympathetic impulses to the head and neck and most, if not all, of those to the upper limb and may be of value for example in estimating the likely improvement in blood supply that would follow a cervical sympathectomy in Raynaud's or other vascular diseases and also as a therapeutic measure temporarily increasing the blood supply in cerebral thrombosis or embolism pending the opening up of collateral circulation.

In addition certain visceral afferent fibres pass through the stellate ganglion, for example, cardiac pain impulses are believed to pass by the middle and inferior cervical cardiac branches of the sympathetic to the cervical sympathetic trunk and so through the stellate ganglion (Peterson, 1938; Mitchell, 1953). Stellate ganglion block, especially if combined with block of the upper thoracic ganglia of the trunk, may relieve the pain (White, 1940).

The fibres turn upward and after synapse in the thoracic, stellate, vertebral or middle cervical ganglia pass through grey rami for distribution through the brachial plexus. Kuntz (1927) has shown that there is a frequent though inconstant intrathoracic connection between the second and first thoracic nerves and Kirgis and Kuntz (1942) have demonstrated a similar connection between the third and second thoracic nerves. These connections would allow sympathetic fibres destined for the brachial plexus to leave the sympathetic trunk at the level of the second and third thoracic ganglia and these fibres would not pass through the stellate ganglion. Therefore to be certain of complete sympathetic denervation of the upper limb stellate ganglion block would be insufficient and it would be necessary to block the sympathetic trunk down to the level of the third thoracic ganglion.

THE ANATOMY OF THE STELLATE GANGLION

The stellate ganglion represents the fusion of the inferior cervical and the first thoracic ganglia with sometimes the second thoracic ganglion in addition and is present in about 80 per cent of subjects (Perlow and Vehe, 1935; Mitchell, 1953). Clinically the term "stellate ganglion" is sometimes used to indicate the inferior cervical and first thoracic ganglia whether or not they be fused. The size and shape of the stellate ganglion are irregular. It varies from 1 to 3 cm in length and from 3 to 10 mm in width (Perlow and Vehe, 1935) but its numerous branches give it a star-shaped appearance. It is often irregularly constricted. It lies in front of the junction of the seventh cervical transverse process with the body of the vertebra, overlapping the longus cervicis to the covering fascia of which it is attached. Around it lie loose areolar and adipose tissue. Traced downwards it lies in front of the eighth cervical nerve,
the neck of the first rib and the first thoracic nerve. Diverticula of the subarachnoid space may emerge with these nerves for a short distance.

Its anterior relations are the vertebral artery and the subclavian artery though this latter is not directly related, while below and in front is the apex of the lung separated by pleura and suprapleural membrane. The apex of the lung rises to the level of the neck of the first rib or ½ inch to 1 inch above the medial third of the clavicle (Cunningham, 1951).

The common carotid artery, internal jugular vein and vagus nerve are indirect anterior relations; the phrenic nerve on the scalenus anterior is anterolateral; the trachea and thyroid gland, the oesophagus and recurrent laryngeal nerve are anteromedial. The blood supply of the ganglion is obtained from the superior intercostal artery
which is an immediate lateral relation in front of the neck of the first rib (Patterson, 1953).

APPROACHES

It will be seen that the sympathetic trunk lies deeply in the neck, that an anterior or lateral approach to the stellate ganglion must pass close to important structures in the root of the neck, while a posterior approach is less direct and longer and must pass through the plane of the brachial plexus (Fig. 2).

When performing stellate ganglion block no attempt is made at injecting the actual ganglion but a quantity of anaesthetic is placed in the plane in which the ganglion or its equivalent lies and the fluid then diffuses to levels as high as the fifth cervical and as low as the fourth thoracic vertebra (Moore, 1954).

The following approach routes have been employed:

(1) Anterior or paratracheal (Orkin, Papper and Rovenstine, 1950; Aymes and Perry, 1950; Adriani, Parmley and Oschner, 1952; Davis, 1952; White, Smithwick and Simeone, 1952; Moore, 1954; Smith, 1951).

This route passes lateral to the trachea and thyroid gland and medial to the great vessels. It is the shortest and most direct approach. Although it passes close to important structures it appears to be relatively free from serious complications (Orkin et al., 1950). In Moore's series of over
2,000 injections using this approach complications were limited to nausea and vomiting from intravascular injections, occasional hoarseness from overflow on to the recurrent laryngeal nerve and partial paralysis of the upper extremity from overflow on to the brachial plexus, complications which are not serious when short-acting drugs are employed.

The technique (Moore, 1954) is as follows: the patient lies in the dorsal recumbent position without a pillow and with the neck in maximum extension in order to straighten the oesophagus. The site of skin puncture is marked at two fingers' breadth lateral to the jugular notch of the sternum and two fingers' breadth above the clavicle. This point should be at the level of the seventh cervical transverse process and is checked by feeling for Chassaignac's tubercle after turning the head to the opposite side, and by marking the lower border of the cricoid cartilage. The point should be about $\frac{1}{4}$ inch below these landmarks. The sternomastoid and the carotid sheath are displaced laterally out of the way, the pulsations of the common carotid being felt on the lateral side of the depressing fingers. The needle is inserted and pushed posteriorly until it impinges on the seventh cervical transverse process at a depth usually not greater than $\frac{1}{4}$ inch. If bone is not met and paraesthesia of the brachial plexus are elicited the needle must be withdrawn and directed more medially or slightly upwards or downwards, but this is seldom necessary. After meeting the transverse process the needle is withdrawn $\frac{1}{4}$ inch to free it from muscle.

The needle is aspirated to exclude the possibility that its tip might be in a vessel and as a double precaution a pause of 15 to 30 seconds is made after the injection of the first 2 ml of anaesthetic. Injection into the vertebral artery is dangerous since it directly vascularizes the hind brain and cerebellum. Although it is likely that the needle sometimes passes through the thyroid gland, no sequelae from this cause have been noted.

(2) Antero-lateral and Lateral (Leriche and Fontaine, 1934; Goinard, 1936; Arnulf, 1938, 1947; Oschner and De Bakey, 1939; Murphy, 1944; Volpittio and Risteen, 1944; De Souza Pereira, 1945; Fitzpatrick and Higdon, 1946; Clark and Wolfson, 1948; Gilbert and de Takats, 1948; Swan and McGowan, 1951; Bryce-Smith, 1952).

This route begins more laterally at a variable height above the clavicle and passes posterolaterally to the carotid sheath and above the subclavian artery and apex of the lung. Accidental spinal anaesthesia has occurred more frequently with this route than with others (Orkin et al., 1950) and this would be expected as the needle is directed towards the intervertebral foramina. Pneumothorax has also occurred when using this route. De Souza Pereira (1945) in an attempt to avoid these accidents, and to block the middle cervical and vertebral ganglia at the same time as the stellate ganglion, used descending infiltration anaesthesia. He adopts a bony reference point which is easy to find, the anterior tubercle of the sixth cervical transverse process. The soft structures are displaced as far as possible to the opposite side of the neck so that the needle can be introduced in an anteroposterior direction towards the base of this process. This direction prevents the entry into an intervertebral foramen. When pressure on the structures is released the needle assumes a lateral position. Anaesthetic is injected into the prevertebral muscles and into the loose fascia in front of them.

(3) Posterior or Paravertebral (Labat, 1930; Wertheimer and Trillat, 1936; Paraf and Le Foyer, 1937; White, 1940; Mandl, 1947).

This route passes through the mass of postvertebral muscles, then between the vertebral transverse processes and close to the emerging spinal nerve and perhaps a diverticulum of the subarachnoid space. The direction of the needle is then changed and it follows the side of the body of the vertebra to the region of the head of the rib. Needles as they advance alongside the bodies of upper thoracic vertebrae are very close to the mediastinal pleura. The route is about $3\frac{1}{2}$ inches (8.8 cm) long, rather more than twice the length of the anterior approach, and it cannot be easy for the beginner to judge the position of the tip of the needle.

The technique (White, 1940) is as follows:

The patient lies on his side with legs drawn up, head flexed and supported so that there is no
lateral curvature of the spine. 10 cm needles are inserted 4 cm lateral to the tip of the seventh cervical spine and upper three thoracic spines. These sites should be at the levels of the upper four thoracic transverse processes. The needles are pushed inward perpendicularly to the skin until the transverse process or the articulating portion of rib is touched at a depth of 2 to 5 cm. It is important to visualize the depth of the ribs in order not to penetrate pleura and puncture the lung. Once contact has been made with the bone the needle is manipulated caudad until it touches the lower border of the transverse process. The depth marker is set at 3 cm from the skin and each needle is now inclined at an angle of approximately 20° with the median sagittal plane. Contact should be made with the side of the body at the further depth of 3 cm and the angle may need to be adjusted to allow this. The needle may be worked forward in contact with the vertebral body. The farther forward the tips of the needles can be inserted and still maintain their contact with bone the less alcohol will come in contact with the intercostal nerves. The needles should not be attached to the syringe during their insertion. The operator must be satisfied that the tips are not within the pleura, within a blood vessel or in an outward prolongation of the subarachnoid space. The latter is more likely to occur if the needle passes above the transverse process in a cephalad direction. Aspiration must always be carried out before injection. It is advisable to inject 2 ml of 2 per cent procaine initially and wait for 5 to 10 minutes. One should be satisfied before injecting alcohol that the needles are placed correctly and that there is no ulnar block.

COMPlications

Complications may be due to the drug employed or to the approach adopted. No approach is free from complications and those which have been recorded include:

(1) **Puncture of blood vessel.** This is unimportant in itself, but intravascular injection is a danger despite preliminary aspiration. It may occur with any approach and the vessel concerned may be the vertebral, subclavian, inferior thyroid or, especially in the posterior approach to the upper two thoracic ganglia, the costocervical trunk (White, 1940).

(2) **Pneumothorax.** The frequency of occurrence is approximately 2 to 4 per cent when all approaches are considered (Moore, 1954) but pneumothorax rarely occurs when the paratracheal approach is used. The air enters the pleural space from the puncture wound of the lung and may accumulate over some hours. Pleural irritation occurs if alcohol is injected into the pleural cavity.

(3) **Subarachnoid tap.** Cerebrospinal fluid may be aspirated, and this is more likely to occur with the anterolateral and posterior approaches. Accidental spinal anaesthesia is the main danger leading to hypotension and bilateral paralysis. Molitch and Wilson (1931) report a case of Brown-Séquard syndrome following alcohol injection by the paravertebral route.

(4) **Block of the recurrent laryngeal nerve** occurs in 5 to 8 per cent of cases and is more likely in the anterior and anterolateral approaches. Moore (1954) prefers the posterior to the paratracheal route if more than 5 ml of alcohol are to be injected.

(5) **Brachial plexus block,** usually shown initially by tingling or numbness of the hand, is due to overflow of the anaesthetic on to the brachial plexus. If alcohol is to be used radiological control of the position of the needle may be advisable.

(6) **Block of the phrenic nerve** is infrequent.

(7) **Puncture of the oesophagus** was reported by Adriani et al. (1952).

**SUMMARY**

The anatomy of the stellate ganglion is described.

The main hazards of anaesthetic block of the ganglion are intravascular injection, spread to the brachial plexus, injection into the subarachnoid space and pneumothorax.

The route chosen will depend on individual preference but the paratracheal route is the shortest and the most free of serious complications. Its disadvantages, if alcohol injection is contemplated, are the not infrequent spread to the recurrent laryngeal nerve and the brachial plexus. The posterior route may be preferable in certain cases as when much alcohol is to be injected and when thoracic ganglia lower than the stellate are also to be blocked.
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REFERENCES

Ranson, S. W., and Billingsley, P. R. (1918). *J. Comp. Neur.*, 29, 313.

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