might be an option for other types of minor surgery within the first months of life in the high-risk population of ex-premature infants.

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Anesthesiology
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The Stellate Ganglion in Magnetic Resonance Imaging: A Quantification of the Anatomic Variability

R. Slappendel, M.D.,* H. O. M. Thijsse, M.D., Ph.D., † B. J. P. Cruil, M.D., Ph.D., † J. L. Merx, M.D. †

STELLATE ganglion blockade is a well established method for the management of certain pain syndromes (e.g., sympathetic reflex dystrophy, facial pain) in the cervicothoracic region and upper extremity. The stellate ganglion resides between the C7 transverse process and the head of the first rib. Local anesthetics are mostly injected at the anterior tubercle of the transverse process of C6 to avoid the pleura, vessels, and nerve roots. It is necessary to know the exact anatomic position of the stellate ganglion when permanent blockade is required by means of a radiofrequency-induced lesion. Unlike during electrical stimulation of somatic nervous tissue no distinct sensory sensation or motor activation is provoked. Magnetic resonance imaging (MRI) provides excellent soft tissue contrast and direct multiplanar views and was used to identify the anatomic position of the stellate ganglion in 8 patients with reflex sympathetic dystrophy. The known anatomic variability of the stellate ganglion was quantified. We report the therapeutic effects of a radiofrequency-induced lesion of the stellate ganglion after MRI-guided localization.

Case Reports

Magnetic Resonance Imaging

The patients were scanned with a 1.5 Tesla Siemens (Erlangen, Germany) magnetic resonance system (type SP). The patient was centered in a cervical coil. Transverse and sagittal images were made at 3-mm intervals with spin echo T1-weighted pulse sequences. number of acquisitions 4, matrix 256 x 256 from C5 to T2 and from the lateral tip of the transverse processes on one side to those on the other side. In the magnetic resonance images, in the transverse plane.
the midline, head of the first rib, and stellate ganglion were located. The distances (mm) from the midline to the head of the first rib and to the stellate ganglion could be calculated. In the sagittal planes, the head of the first rib and the stellate ganglion were chosen to calculate the distance to the dome of the pleura.

**Blockade of the Stellate Ganglion with Local Anesthetics**

Eight patients with reflex sympathetic dystrophy who had responded to stellate ganglion blockade performed using local anesthesia (diagnostic blockade) participated in the study. All patients had pain relief (visual analog scale score 0) or pain reduction (decrease in visual analog scale score of at least 3 points, for at least 4 h) after injection of 4 ml 0.5% bupivacaine. These diagnostic blockades of the stellate ganglion were performed once, using an anterior paratracheal approach with the patient in a supine position. Using fluoroscopy, the groove between the vertebral body and the transverse process of the 6th cervical vertebra was located. After appropriate preparation of the skin, a short beveled needle (27 G, 7 cm) was inserted until the tip of the needle contacted bone. The needle was then withdrawn 1 or 2 mm and the position of the needle tip verified by fluoroscopy followed by injection of contrast dye (0.5 ml Omnipaque 240 (Iohexol 240 mg/ml), Nicomed Imaging AS, Oslo, Norway). After a negative aspiration test (blood and cerebrospinal fluid) and satisfactory spread of contrast prevertebrally, a diagnostic stellate ganglion blockade was performed injecting 4 ml 0.5% bupivacaine. Successful diagnostic blockade was associated with a temporary Horner's syndrome, vasodilatation in the ipsilateral arm, increase in skin temperature (patient's and observer's subjective experience), and decrease of pain within 20 min.

**Radiofrequency-induced Lesion of the Stellate Ganglion**

The anatomic position of the stellate ganglion established by MRI was used for accurate introduction of the electrode. Before inducing the radiofrequency lesion, electrical stimulation via the electrode excluded the presence of somatic nervous tissue (especially the 6th or 7th cervical anterior nerve root) in the vicinity of the electrode. Using a standard insulated stimulation needle (23 G, 6 cm) with a bare tip of 5 mm, a thermal lesion (67°C) was made with a setting of 21 V for 60 s using a lesion generator (Radionics, model RFG, 3B, Radionics, Burlington, MA).

**Results**

**MRI**

In the magnetic resonance image of the stellate ganglion, the head of the first rib and the dome of the pleura were identifiable bilaterally in all eight patients. The distances in both the sagittal and the transverse planes could be measured and are summarized in tables 1 and 2.

In the sagittal planes of the magnetic resonance image, there was one artifact (movement of the patient during the procedure). In two patients, MRI was performed only on the affected side. The distance

![Fig. 2. Magnetic resonance imaging, sagittal planes. Arrow indicates the stellate ganglion.](#)

![Fig. 1. Magnetic resonance imaging, transverse planes. Arrow indicates the stellate ganglion.](#)

**Table 1. Magnetic Resonance Imaging: Transverse Planes**

<table>
<thead>
<tr>
<th>Patient No.</th>
<th>Distance between Midline and Center of the Head of the First Rib (mm)</th>
<th>Distance between Midline and Center of the Stellate Ganglion (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Left</td>
<td>Right</td>
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<tr>
<td>1</td>
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<td>7</td>
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<tr>
<td>8</td>
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</tbody>
</table>
CASE REPORTS

Table 2. Magnetic Resonance Imaging: Sagittal Planes

<table>
<thead>
<tr>
<th>Patient Number</th>
<th>Distance between the Dome of the Pleura and Center of the Head of the First Rib (mm)</th>
<th>Distance between the Dome of the Pleura and Center of the Stellate Gland (mm)</th>
</tr>
</thead>
<tbody>
<tr>
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<td>8</td>
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</table>

NP – not performed.

between the stellate gland and the dome of the pleura varied between 13 and 40 mm (left side) and 10 and 19 mm (right side).

Treatments

A radiofrequency-induced lesion of the stellate ganglion was performed in six patients. Two patients refused treatment after MRI of the stellate ganglion. At 3-month follow-up, five of the six patients experienced pain relief or pain reduction (a decrease in visual analog scale score of at least 5 points) of the upper extremity. These five patients also experienced an increase in skin temperature in the affected extremity. In one patient, a second radiofrequency-induced lesion of the stellate ganglion was induced after 4 weeks, with successful relief of pain. In one patient, there was no response.

Discussion

The sympathetic chain lies anterior to the vertebral bodies in the neck, but as it descends across the 1st thoracic vertebreal body, it lies lateral to the vertebral body. From T1 caudally, the sympathetic chain descends in a subpleural space across the necks of the ribs. 1

An anatomic study of the relationships of the superior pole of the stellate ganglion to the vertebral artery and to the transverse processes of the last cervical and 1st thoracic vertebrae in 440 specimens (220 adult human embalmed cadavers) showed marked variation. 5 The superior pole of the ganglion most commonly was found within an “arterial border” bounded by the subclavian, common carotid, and vertebral arteries (76%), at the level of the inferior third of the vertebral artery (80%), and anterior to the interval between the transverse process of the 7th cervical and 1st thoracic vertebrae (49%). Using fluoroscopy, the head of the first rib is a suitable landmark for a blockade of the stellate ganglion, because its main division is located there. This approach is associated with the risk of a pneumothorax, especially in tall, slender patients. To reduce the risk of a pneumothorax when performing stellate ganglion blocks (local anesthetics), the needle is aimed at the groove between the vertebral body and the transverse process of the 6th or 7th cervical vertebra. Although the spread of local anesthetics is unpredictable, 4 ml of local anesthetic injected at the 6th or 7th vertebra usually reaches the stellate ganglion. However, to obtain a long-lasting blockade using radiofrequency-induced destruction, a precise anatomic position of the stellate ganglion is required. As the procedure is usually performed, ellipsoid lesions form with the usual size varying between 7 and 10 mm long and 4 and 6 mm wide. The lesion size (radiofrequency lesioning) depends on the heat generated, the electrode size (tip, mm), and exposure time. 3 This study in eight patients quantifies a wide spread in the anatomic position of the stellate ganglion. In an earlier study, only one of nine patients with reflex sympathetic dystrophy had pain relief for 2 weeks after using radiofrequency current to destroy the stellate ganglion (C7). 6 In the current study, five of six patients experienced pain relief and increase in skin temperature at the affected side after a 3-month follow-up.

We conclude that there is wide anatomic variation in the position of the stellate ganglion, which has therapeutic implications. When a radiofrequency-induced lesion of the stellate ganglion is performed, more precise localization at the stellate ganglion can be obtained using MRI. 5, 6

References


Anesthesiology, V 83, No 2, Aug 1995

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In Reply.—We did not intend to imply the lack of different lipids in the heart or in adipose tissue. Our studies did not examine lipids. The lack of effects of age, sex, and the long-term effects of surgery on the lipids in the heart or in adipose tissue are not the focus of this study. The authors' comments concerning neurotransmitter effects and the autonomic nervous system are beyond the scope of this paper.

Second, we consider the lack of differences in the lipids in the heart and in adipose tissue to be a limitation of our study. However, the focus of our study was to determine the effects of surgery on the lipids in the heart and in adipose tissue. The lack of differences in the lipids in the heart and in adipose tissue is consistent with our hypothesis that surgery-induced changes in the lipids in the heart and in adipose tissue are not the result of surgery-induced changes in the lipids in the heart and in adipose tissue.

The authors' comments concerning the lack of differences in the lipids in the heart and in adipose tissue are beyond the scope of this paper. The focus of our study was to determine the effects of surgery on the lipids in the heart and in adipose tissue. The lack of differences in the lipids in the heart and in adipose tissue is consistent with our hypothesis that surgery-induced changes in the lipids in the heart and in adipose tissue are not the result of surgery-induced changes in the lipids in the heart and in adipose tissue.