MESENCEPHALIC TRACTOTOMY FOR PAIN
EXPERIENCE WITH SIX CASES
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The convergence of the central trigeminal and spinothalamic tracts in the pons and mesencephalon offers an opportunity for division of the pain pathways from the opposite half of the body. Dogliotti\(^1\) (1938) first carried out this procedure in the upper pons. Walker\(^6\) in 1942 showed that the same result could be obtained in a less hazardous manner by tractotomy at the level of the mesencephalon, and studied the physiological effects of tractotomy at this level in considerable detail.

Walker's\(^6\) patients lost the ability to appreciate painful and thermal stimuli throughout the entire side of the body contralateral to the lesion. Superficial and deep pain were immediately relieved. Touch sensation was not impaired when tested with cotton wool, although a definite increase in the tactile threshold was demonstrable with von Frey hairs. The division of the lateral lemniscus that overlies the pain pathways produced no subjective disturbance of hearing; however, audiometer tests revealed impairment of the appreciation of high tones. There may be temporary minimal weakness of the contralateral lower extremity but there was no disturbance of proprioceptive sensation or coordination.

In view of Walker's\(^6\) findings we operated on 6 patients to satisfy ourselves on the feasibility and results of the procedure. The essential features in the 6 patients selected for operation are shown in Table 1.

Cases 4 and 5 might well have been treated by other surgical procedures but were included in the series in an effort to establish the relief of facial pain

<table>
<thead>
<tr>
<th>Case</th>
<th>Age</th>
<th>Diagnosis</th>
<th>Site of Intractable Pain</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>63</td>
<td>Traumatic disarticulation right arm</td>
<td>Shoulder stump.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>——23 yrs. previously.</td>
<td></td>
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<tr>
<td>2</td>
<td>51</td>
<td>Cutaneous hyperpathia following intercostal neurectomy.</td>
<td>Right paravertebral region from T3–T8.</td>
</tr>
<tr>
<td>3</td>
<td>47</td>
<td>Bronchogenic carcinoma.</td>
<td>Left shoulder, supraclavicular fossa, left arm, and left upper chest.</td>
</tr>
<tr>
<td>4</td>
<td>37</td>
<td>Carcinoma, left maxillary antrum.</td>
<td>Left face.</td>
</tr>
<tr>
<td>5</td>
<td>49</td>
<td>Carcinoma, right nasopharynx.</td>
<td>Right ear, face and neck.</td>
</tr>
<tr>
<td>6</td>
<td>63</td>
<td>Bronchogenic carcinoma, left.</td>
<td>Left shoulder and arm.</td>
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by section of the secondary trigeminal pathways at the level of the mesencephalon. Our experience with these 6 patients will be detailed under the following headings: (1) Operative approach. (2) Physiological results. (3) Relief of pain. (4) Postoperative dysesthesia.

1. **Operative Approach.** All of our patients have been operated upon in the sitting position. This has been satisfactory and in our opinion made the operation easier. A small occipital bone flap is turned down on the side opposite the pain, so as to expose the lateral sinus below and the sagittal sinus medially. The occipital lobe is retracted upwards and laterally. It was necessary in all but one case to coagulate and divide one or two occipital veins as they entered the lateral part of the lateral sinus. No veins enter the mesial portion of the lateral sinus or the posterior part of the sagittal sinus. The tentorium is incised about one inch from and in line with the straight sinus. The posterolateral aspect of the midbrain may then be exposed by tearing the arachnoid overlying the cisterna ambiens. In our experience there have been no undue difficulties in identifying the landmarks on this aspect of the midbrain as shown in Bancroft and Pilcher's book.

As shown by Walker the pain pathways at this level lie just deep to the brachium of the inferior colliculus and are somewhat intermingled with its deep fibres. There is a topographical arrangement, so that the pain fibres from the lower extremity lie dorsolaterally and those from the head and neck ventromedially.

The tractotomy incision is made with a cordotomy knife, and is 5 mm. in depth. It extends from the lateral sulcus, medially and slightly upwards across the brachium of the inferior colliculus to the lower pole of the superior colliculus. Selective partial division of the mesencephalic pain pathways is feasible and has been carried out by Walker. Although no deliberate attempt was made to do this in our series one patient obtained a level of analgesia up to the umbilicus only. In this patient, at a second operation, under local anaesthesia the tractotomy incision was lengthened, ventromedially. There was no corresponding rise in the cutaneous sensory level. It was necessary to make a separate tractotomy incision 3 mm. rostral to the former in order to obtain complete hemianalgiesia. No pain was experienced when the incision was made into the pain pathways at this level.

2. **Physiological Results.** In an effort to corroborate the physiological effects of the procedure as described by Walker, careful pre-operative studies were carried out, including perimetry and tests of vestibular and cochlear function. Special attention was paid to the examination of the sensory system. No attempt was made to determine accurately the thresholds of touch and pain with von Frey thorns and hairs. Each patient was carefully examined with respect to the subjective equality of the response evoked on each side of the body in regard to cutaneous, deep and discriminative sensation.

All 6 patients showed a loss of pain and temperature sensation throughout the opposite side of the body and head. The sensory disturbances extended to the midline.
Deep pain was abolished on the involved side with the exception of the
testicle. Deep pressure in that half of the abdomen, on the muscle bellies,
Achilles tendon, subcutaneous bones, brachial plexus, ulnar and supra-
orbital nerves, was without response from the patients. The same was true of
deep pressure on the lateral wall of the rectum and vagina. One patient con-
sented to have ureteral sensation investigated. Dermakin bags were
threaded up each ureter through a cystoscope and inflated at regular inter-
vals throughout the course of the ureter. On the analgesic side, the ureter was
insensitive in its upper two-thirds only. The lower one-third and the other
ureter had normal sensation. Distension of the bladder produced a normal
response.
This situation persisted for days or a few weeks, then a change occurred;
stimulation now provoked an unusual abnormal pain response which will be
detailed in Section 4.
Subjectively, touch sensation was consistently diminished on the anal-
gesic side, although to a minimal degree, for with the eyes closed the patient
was always able to recognize at once the lightest stimulus with cotton wool.
This was at variance with Walker's\textsuperscript{6} observations in which the lowered
touch threshold could be demonstrated only with von Frey hairs. The cen-
tral pathways for touch are widely dispersed and it was to be expected that
a small incision in the midbrain would not affect this sensation to any marked
degree.
By standard clinical tests vibration and position sense were not altered
by the operation with one exception, in which there was evidence of damage
to the cerebral peduncle as well as to the medial lemniscus. As Walker\textsuperscript{6}
stated, there was no evidence in our cases to suggest that discriminative sen-
sation was impaired in any way.
The vestibular responses were not impaired when tested postoperatively.
Walker\textsuperscript{6} described this in his cases and in a personal communication to one
of us (McKenzie) has stated that bilateral mesencephalic tractotomy results
in total loss of hearing. None of the patients complained of disturbance of
hearing. In 2 of the 3 patients tested postoperative audiograms showed per-
sistent decrease in the perception of high tones.
Taste sensation was not affected either subjectively or objectively in the
2 patients examined.
Five of the patients showed a temporary complete homonymous hemi-
anopsia in the contralateral field of vision. The production of the field defect
seemed to be related as much to the retraction of the occipital lobe as to the
division of the occipital veins. In one patient the hemianopsia was not pres-
ent until the third postoperative day. Another had no field defect although
a large vein was divided. The last patient, who was operated upon twice, had
no field defect following the first procedure in which two veins were divided.
Following the second operation, during which no further veins were divided,
he had a complete homonymous hemianopsia for 5 days. Each patient had
full visual fields to perimetric examination from 5 to 7 days after operation.
The hemianopsia probably was derived from a combination of pressure on
the optic radiation caused by the retraction and temporary impairment of the cortical circulation, the result of venous interruption. Two patients complained of difficulty in reading anything but large print for 3 or 4 weeks, but this was not permanent.

3. Relief of Pain. In the early postoperative period all 6 patients were free of their intractable pain with the exception of one, who after completion of tractotomy at a second operation obtained complete relief. Headache was restricted to the side of the head, with no sensory disturbance. Walker found that even the headache produced by the intravenous injection of histamine was chiefly confined to one side. Some days later, a spontaneous burning dysesthesia developed on the analgesic side in 3 of the 6 patients. This dysesthesia was considered to be more intolerable than the original pain. In addition an unusual abnormal pain response to sensory stimulation developed in all 6 patients. This will now be discussed in more detail, because we feel that it is a very serious postoperative complication.

4. Postoperative Dysesthesia. After a period varying from 3 or 4 days to 2 weeks after the operation a new response developed to pin prick, deep pressure or thermal stimuli in all 6 patients. In 1 patient even the lightest touch provoked a violent response. Upon stimulation the patients complained of a deep, diffuse, poorly localized pain associated with strong withdrawal and grimacing. They described it as agonizing and miserable—an entirely new experience for them. In addition to this, spontaneous burning pain on the side with disturbed sensibility developed in 3 patients. In 2 this dysesthesia, although generalized over that half of the body, was worse in the region of their previous pain. One man who had had a unilateral prefrontal lobotomy prior to the tractotomy stated that he was nearly driven insane by this dysesthesia. In another patient unilateral prefrontal lobotomy failed to relieve the dysesthesia although her reaction to it was dulled somewhat. Both these patients stated that this spontaneous pain was much more intolerable than the pain for which they were operated upon. In the third patient, who had been operated upon for intractable pain in the face, burning pain developed in the same region. Intramedullary tractotomy 3 months later gave him complete relief.

The nature of this intolerable pain similar to pain in the thalamic syndrome has been the subject of some thought by several authors.

Head and Holmes suggested that the pain associated with a thalamic lesion is the result of interruption of corticothalamic fibres, the function of which is to inhibit the reaction of the thalamus to afferent impulses arriving at the thalamus.

Kendall based his theory on the assumption that painful sensations are of two distinct types, each conducted centrally by separate sets of fibres—one fast, the other slow. Normally the delayed disagreeable sensation conducted by the slow fibres is blocked by a thalamic inhibitory mechanism set up by the arrival at the thalamus of impulses conducted by the fast fibres. If however, the fast fibres are destroyed, the inhibitory process fails and the
poorly localized, diffuse, disagreeable pain is felt. Kendall also felt that the
total amount of damage to the pathways conducting these afferent impulses
must not be very extensive. In his case in which there was complete loss of
temperature appreciation there was no over-reaction to hot or cold objects.
Each of our patients had complete loss of pain and temperature sensation on
the side of the dysesthesia.

The dysesthesia in our patients following discrete lesions of the central
pain pathways just prior to their entry into the thalamus cannot, of course,
be explained by the theory of Head and Holmes, who postulated inter-
ruption of corticothalamic fibres.

The recent work of Magoun et al. suggests that the great afferent systems
give off collaterals into the reticular formation as they pass up the brain-
stem. There is as yet no anatomical verification of Magoun's work. One of
us (Drake) suggests that lesions of the pain tracts low in the brainstem or in
the spinal cord would interrupt the central pathway provided by these
collaterals. If, however, the lesion is above the origin of the collaterals—
even though it may be complete—a secondary route via the reticular forma-
tion would provide a means by which the slower impulses might reach con-
sciousness. Such a pathway would account for the delay in perception and
diffuseness of the pain.

We have seen this same abnormal response to stimulation but to a minor
degree in at least 3 patients who had the spinothalamic tract divided high in
the first cervical segment. We cannot recall seeing this response following
section of the tract in the upper thoracic region.

CONCLUSIONS

From our experience with 6 cases of mesencephalic tractotomy the fol-
lowing conclusions are drawn:

1. The operation is technically quite feasible and the landmarks are
definite. A good physiological result with loss of appreciation of pain and
temperature over the whole of the opposite half of the body is obtained.
There are no severe neurological sequelae, such as profound disturbance of
balance or paralysis. However this excellent temporary result was nullified
in our cases by the development of intolerable, spontaneous dysesthesia in
3 out of 6 patients, coupled with a new disagreeable response to stimuli in
all 6 patients. This postoperative dysesthesia has profoundly influenced
our thoughts about the operation; so much so that we are unlikely to carry
out the procedure again. An anatomical explanation is suggested to explain
this postoperative dysesthesia in Section 4 of this report.

2. We feel that the technique and knowledge of spinothalamic tractotomy
in the upper cervical and lower medullary region will gradually develop and
replace mesencephalic tractotomy for the relief of shoulder and arm pain.

3. Pain in the face and upper neck secondary to carcinoma is best re-
lieved by section of the descending tract of the 5th nerve, the glossopharyn-
geal and upper filament of the vagus and the upper cervical dorsal roots.
This calls for a smaller exposure than that necessary for section of the 5th root at the pons. In addition the patient is spared the additional misery of complete anaesthesia in the tongue and mouth area.

The authors wish to thank Doctor E. H. Botterell for permission to include Case 6.

REFERENCES