Stereotactic rostral mesencephalotomy in cancer pain and deafferentation pain

A series of 40 cases with follow-up results

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Recent evidence from pain research suggests that only cancer pain should be treated by surgery, as it is morphine-sensitive and because neuropathic sequelae are more acceptable when life expectancy is short. Among various ablative surgical procedures, stereotactic rostral mesencephalotomy remains one of the few that have stood the test of time. The indications, however, are very specific: only pain caused by cancers of the head and neck, or lateralized pain in the extremities are susceptible to this approach. According to the literature, pain relief can be obtained in 80% to 90% of patients without persistent untoward sequelae. Resulting vertical gaze paralysis and pupillary abnormalities may be a transient phenomenon.

Compared with cervical cordotomy, stereotactic mesencephalotomy has the advantage of relieving pain also at the facial-cervical level; furthermore, it lacks side effects referable to the motor system and can be performed bilaterally.

In this study of stereotactic rostral mesencephalotomy, we investigated the long-term pain relief in 33 patients who fulfilled this specific indication and compared these results with long-term effects in seven patients with deafferentation pain. Although the literature mentions less significant pain relief achieved by ablative surgery in patients with deafferentation syndromes, there remain many advocates for stereotactic mesencephalotomy.

Clinical Material and Methods

Patient Population

Group A consisted of 33 patients with cancer pain located predominantly on one side of the body. These included 20 men and 13 women; mesencephalotomy was carried out in 15 patients on the right, in 16 on the left, and in two bilaterally. Life expectancy was restricted due to the underlying disease, and pain had been treated with central analgesics (morphines) at doses up to levels that interfered with normal psychological functioning. The primary tumors involved were: lung (12 cases), kidney (three), breast (three), sarcoma (five), chondrosarcoma (two), colon (two), maxilla (two), bladder (one), ovary (one), lung and colon (one), and lung and breast (one). Locations of nociceptive pain in these 33 patients were: cervical plexus (three cases), brachial plexus (12), lumbosacral plexus (13), thoracic wall (three), abdominal wall (one), and skull base (one).

Group B consisted of seven patients with otherwise intractable deafferentation pain syndromes. These included four men and three women with a mean age of...
FIG. 1. Diagrams, sagittal (a) and frontal (b) views, showing the position of the lesion in stereotactic mesencephalotomy performed for pain relief in 40 patients. Abbreviations: sph.tr. = tractus spinothalamicus; pyr.tr. = tractus pyramidalis; LM = lemniscus medialis; Q = tractus quintothalamicus; PAG = periaqueductal gray matter; sth = corpus subthalamicum; Ru = nucleus ruber; Ni = substantia nigra; coll.sup./inf. = colliculi superior/inferior. (Reproduced with permission from Bosch DA: Stereotactic Techniques in Clinical Neurosurgery. New York: Springer-Verlag, 1986, pp 167-175.)

72 years. Mesencephalotomy was carried out in five patients on the right and in two on the left. All had undergone various surgical or medical treatments for thalamic pain (two cases), trigeminal neuralgia (two), post-herpetic neuralgia (two), and phantom-limb pain of the arm (one).

Surgical Technique

The stereotactic technique used (Leksell system) was standardized with a single introduction of the electrode toward the calculated target in the rostral mesencephalon, followed by radiofrequency heating* (thermistor electrode diameter 2.1 mm, length of exposed tip 2.5 mm) to 75°C for 60 seconds. The surgical procedure was deliberately carried out under general anesthesia to exclude any information as to the effectiveness of or side effects from mesencephalotomy during surgery. The target for treatment was derived from the stereotactic brain atlases of Schaltenbrand and Wahren and Afshar, et al. The position of the spinothalamic tract was defined by the following coordinates: 5 mm behind the posterior commissure on the intercommissural line, 5 mm below this line, and 8 mm lateral to the midsagittal plane (Fig. 1). The target was identified based on intraoperative ventriculography with water-soluble contrast medium using a frontal burr-hole route (Fig. 2). Computerized tomography (CT) or magnetic resonance imaging stereotactic guidance was avoided because of their questionable accuracy at the time this study was performed (1982 to 1987). Brain protection included 5-mg doses of dexamethasone administered three times daily and tapered off to zero in 5 days. Bilateral mesencephalotomy was carried out in two cases, in one with a 3-month interval between procedures and in the other at a single procedure (which led to a major

* Radiofrequency heating manufactured by Radionics, Burlington, Massachusetts.

FIG. 2. Plain films, frontal (upper) and lateral (lower) views, showing the route for stereotactic ventriculography via a frontal burr hole and the position of the electrode at the target. (Reproduced with permission from Bosch DA: Stereotactic Techniques in Clinical Neurosurgery. New York: Springer-Verlag, 1986, pp 167-175.)
Stereotactic mesencephalotomy for pain relief

**Fig. 3.** Autopsy section of the rostral mesencephalon, cut through a bilateral lesion. The right-sided lesion is 4 months old (diameter 4 mm) and the left-sided lesion is only 1 month old (diameter 8 mm). Active tissue repair is seen. (Reproduced with permission from Bosch DA: Stereotactic Techniques in Clinical Neurosurgery. New York: Springer-Verlag, 1986, pp 167–175.)

complication). Long-term follow-up monitoring included questionnaires to local physicians with information collected up to the time of patient death in Group A and for 1 year or more in Group B. Assessment of pain relief (both immediate and long term) was based on the medication required and was measured on a four-point scale: excellent = no medication; good = nonsteroidal anti-inflammatory drugs; moderate = morphine; poor = no relief.

**Results**

Immediate pain relief in Group A was excellent to good in all except four patients (87.9%). Two of the failures suffered from facial pain due to cancer. Four of the seven Group B patients had good pain relief, but it lasted for only a few weeks. Testing after surgery revealed only patchy loss of pinprick sensation with a consistent decrease in temperature perception on the affected side.

**Surgical Morbidity**

Two patients in Group A developed persistent and disabling dysesthesias; one had a disturbed position sense when walking, and the other (a long-term survivor with excellent pain relief) developed a rubral myoclonus of his arm which was treated with clonazepam medication. Central diplopia was regularly seen during the first days after surgery, but was persistent in only one case. There was no surgical morbidity in Group B.

**Surgical Mortality**

Except for the one patient who underwent a bilateral mesencephalotomy in a single operative procedure, there was no mortality due to surgery in either group. This one patient suffered from a metastasis to the skull base from a renal carcinoma and had severe pain in his face and neck with only slight lateralization of pain. Autopsy was refused, but it was believed that the simultaneous bilateral mesencephalotomy had caused lethal damage to the ascending reticular activating system, because of instantaneous loss of consciousness and the need for artificial ventilation during the first 24 hours after surgery. Postoperative CT scanning showed no abnormalities and the patient died from pneumonia on the 3rd day. The only other bilateral procedure was performed with a 3-month interoperative interval and caused no side effects; at autopsy 1 month after the second operation, well-delineated lesions were evident (Fig. 3).

**Follow-Up Findings**

In Group A, 27 patients survived longer than 6 weeks postoperatively. Of these, 16 (59.3%) had persistent good or excellent pain relief. All of the good responders had experienced pain in their extremities. Moderate relief (with morphine administered mainly via an indwelling ventricular catheter after some weeks) was obtained in six cases. Little or no relief was experienced by five of the 27 long-term survivors. Four of the seven patients in Group B developed even more severe central dysesthesias as late sequelae from surgery. Measured after a 1-year period, no pain relief could be found in this group of patients. However, the patient with phantom arm pain after plexus avulsion sustained in a car accident had no pain after an ischemic infarction in the parietal lobe 3 years later (an observation also described by others).

**Discussion**

The standardized stereotactic technique used in this series offers a unique opportunity to evaluate the benefits of stereotactic mesencephalotomy in patients with well-lateralized nociceptive pain syndromes (as in cancer) and in patients with well-lateralized neuropathic pain (deafferentation and central syndromes). General anesthesia was used to standardize the procedure as much as possible and because of the poor clinical condition of the patients treated. Moreover, the target was very well defined and the operation itself may be compared with many other surgical procedures for pain relief, such as open anterior cordotomy, midline myelotomy, and dorsal root entry zone lesioning (reviewed by Gybels and Sweet).

**Anatomical Correlates**

Primary nociceptive pain is thought to exist only with a functionally normal nervous system and is therefore sensitive to analgesic drugs such as opioids. Arnér and Meyerson demonstrated the lack of analgesic effect of opioids on neuropathic forms of pain, which may also explain our poor results with stereotactic mesencephalotomy in neuropathic pain. On the other hand, as discussed by Vecht, in cancer a neuropathic com-
ponent to the primary nociceptive pain may also develop due to the progressive nature of the disease. At least this component is deliberately added to the cancer pain syndrome by way of the mesencephalotomy itself.

Analysis of the duration of pain relief after stereotactic mesencephalotomy in cancer patients revealed that the longest relief is achieved for pain in the extremities. Pain in the chest wall and the abdominal wall did not respond as well. This might be explained by evidence from basic neurology that afferents from the body are represented in the spinothalamic tract to a lesser degree than those from the extremities. This tract, being the target of surgery, is known to be neospinal and mainly carries well-lateralized afferent input. The spinoreticular (paleospinal) system, serving the body and its contents, has so many interconnecting and midline-crossing fibers that, even when part of it has been involved in surgery, no pain relief may result from its partial destruction.

The efferent motor system shows a similar discrepancy in the case of pyramidal (neospinal) diseases. These discrepancies might well be representative of the concept of “the thriune brain in evolution,” extensively studied by MacLean.19 As elaborated upon by Cook, et al.2 in their challenging paper on afferents and pain conduction, the spinoreticular short-fiber system is the primary connecting pathway between the body and the brain. Both in afferent and efferent dysfunction of this “primitive” system, clinical signs and symptoms are much less obvious and therefore almost impossible to assess.24 On the other hand, afferents and efferents connecting the extremities and the brain are lesion-prone both in neurological disease and in “experimental” conditions (as with ablative stereotactic surgery).

Nociceptive Pain

Nociceptive pain is sensitive to opioids. Therefore, not only ablative mesencephalonic surgery but also electrical stimulation of the periaqueductal gray matter15 may give good pain relief. Whether it is called destruction of “pain pathways” according to a hodologic phantom or an enhancement of endorphin release (as might be the case in central brain stimulation), the results in terms of pain relief are consistent. Because of the possibility that a neuropathic component is added by the operation, the indications for stereotactic rostral mesencephalotomy should be narrowed for patients with a short life expectancy and a clearly lateralized nociceptive pain syndrome, as is the case in many patients with advanced cancer.

Neuropathic Pain

Neuropathic pain is not responsive to opioids or other analgesic drugs and some sensory deficits are always found on neurological examination. Although Schwartz26 described good relief in central pain syndromes treated with stereotactic ablative surgery, patients with pain such as our Group B cases should in our opinion not be candidates for stereotactic rostral mesencephalotomy. The imbalance between spinothalamic and dorsal column (medial lemniscus) systems that exists in deafferentation pain5 will only be augmented when stereotactic mesencephalotomy is performed.

Conclusions

In summary, stereotactic rostral mesencephalotomy should be performed only in patients with primary nociceptive pain syndromes and, preferentially, in those with clearly lateralized syndromes involving extremities.

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