Intramedullary spinal cord tumors in children: localization by intraoperative sonography.

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http://www.ajnr.org/content/5/4/395

This information is current as of October 11, 2023.
Intramedullary Spinal Cord Tumors in Children: Localization by Intraoperative Sonography

Intraoperative sonography was performed in 20 children in order to localize intramedullary spinal cord tumors. It provided excellent visualization of the extent and consistency of the tumor before surgical opening of the dura mater. The sonographic findings were used in selecting the site and extent of myelotomy. Intraoperative sonography proved to be a valuable adjunct to spinal cord surgery.

Intramedullary spinal cord tumors (astrocytoma, ependymoma) are uncommon neoplasms and comprise about 4% of central nervous system tumors in children [1–3]. They are usually benign and may involve only a short segment of the spinal cord or almost its entire length (holocord tumor). They have a propensity to produce intramedullary cysts. These cysts often define the rostral and caudal extent of the solid component of the tumor [4].

The definitive preoperative diagnosis of intramedullary spinal cord tumor usually is accomplished by myelography and computed tomography (CT). Spinal cord expansion often can be detected by these techniques; however, an intramedullary cyst cannot be detected reliably even with delayed metrizamide CT scanning [5, 6]. The use of sonography in the postoperative detection of intramedullary cysts has been described [7, 8]. From the viewpoint of the neurosurgeon, however, it is desirable to determine the location, consistency, and extent of the tumor intraoperatively in order to formulate a surgical plan when radical resection is contemplated.

Intraoperative sonography has gained wide acceptance as a valuable tool in neurosurgical procedures. Its use in spinal surgery has been described [9, 10]. We used intraoperative sonography to localize intramedullary spinal cord tumors in 20 children and young adults.

Materials and Methods

Between October 1982 and September 1983, intraoperative sonography was performed in 20 patients in order to localize intramedullary spinal cord tumors. The patients were 4–18 years of age. The preoperative diagnosis of spinal cord tumor had been established by biopsy and the findings of myelography, CT, and/or sonography. Most of the patients had undergone biopsies of their tumors at outside institutions and were referred to our medical center for definitive surgery.

Intraoperative sonography was performed under sterile conditions on a commercially available real-time unit (Advanced Technology Labs., Bellevue, WA) with a triple-frequency (3, 5, and 7.5 MHz) transducer probe. In this study, the transducer probe operating at a frequency of 7.5 MHz was used in all cases. Sonographic gel was applied to the head of the probe, which was then placed in a sterile sheath along with 2–3 feet (0.6–0.9 m) of transducer cable. After exposure of the dura mater, the surgical wound was filled with saline solution and the sterile transducer probe was gently immersed without touching the dura mater. The spinal cord was surveyed to determine the location of the solid and cystic components of the tumor. This procedure was repeated after surgical opening of the dura mater. The sonographic
findings were used in selecting the site and extent of myelotomy and for decompression of the cysts. When initial scanning indicated more extensive tumor than previously estimated, additional laminectomies were performed to uncover the rostral and caudal intramedullary cysts. Intraoperative sonography was also used to monitor surgical resection. The sonographic scanning procedure was videotaped, and hard copies were obtained from selected frozen images.

**Results**

There were 17 patients with astrocytoma and three with ependymoma. The tumor was confined to the cervical cord in three patients and to the lumbar cord in one; in the others, extensive segments of the spinal cord were involved.

The sonographic features of the cord tumors allowed classification into three categories: (1) **solid neoplasm without cysts** (four tumors), involving short segments of the cord and presenting as a fusiform expansion of the cord without intramedullary cysts (fig. 1); (2) **solid neoplasm with rostral or caudal cyst** (three tumors), presenting as a fusiform expansion of a short segment of the cord with rostral or caudal cyst (fig. 2); and (3) **uniform expansion of the cord with cysts** (13 tumors), involving extensive segments of the cord (holocord) with innumerable cysts of various sizes (fig. 3).

In all cases, the central canal was either partly obliterated or not visualized at all. Normally, the central canal is imaged as an echogenic line within the cord. The sonographic texture of the tumor was variable. In three patients, parts of the tumor were echogenic; (two ependymomas and one astrocytoma). In the other 17 patients, the tumor was sonographically indistinguishable from adjacent normal cord; this group comprised 16 patients with astrocytoma and one with ependymoma. Real-time scanning capability allowed examination of any spinal cord motion during surgery. Generally, the motion was either absent or markedly diminished before decompression of the cysts. After excision of the tumor, the spinal cord demonstrated to-and-fro motion within the spinal canal.

**Discussion**

Bone is an almost impenetrable barrier to the ultrasonic beam. However, when bone is removed, as in laminectomy, and the surgical wound is filled with sterile saline, ideal con-
tions exist for sonographic visualization of the spinal cord. Intraoperative sonography provides excellent visualization of spinal cord widening and intramedullary cysts. It permits the neurosurgeon to formulate a surgical plan before opening the dura mater. If spinal cord widening is seen to extend beyond the confines of the surgical field, additional laminectomies can be performed to determine the total extent of the tumor. By providing a "road map," intraoperative sonography facilitates selection of the site and extent of myelotomy.

Sonographically, intramedullary spinal cord tumors present as localized or diffuse widening of the cord. The tumor may be either solid or cystic. The central canal, which is normally imaged as a linear echogenic line within the cord, is often obliterated. The sonographic texture of the tumor is variable and may be indistinguishable from that of adjacent normal spinal cord. Intramedullary cysts vary in size and location. The centrally placed cysts are generally larger, tend to have smooth margins, and may occupy almost the entire width of the cord. These cystic spaces presumably represent localized dilatation of the central canal (syrinx). Intratumoral cysts, on the other hand, are much smaller, eccentrically located, and more likely to have irregular margins.

Intraoperative sonography can be used also to monitor surgical resection (e.g., in localizing the intramedullary cysts that were overlooked during the initial surgical exploration). In assessing the adequacy of surgical resection of the tumor, however, intraoperative sonography plays only a limited role because the tumor often is sonographically indistinguishable from adjacent normal spinal cord. Perhaps higher-frequency transducers (e.g., 10 MHz), by improving resolution, may permit distinction between tumor and normal cord.

Intraoperative localization of intramedullary cord tumors by sonography can be achieved in less than 10 min. The procedure poses no hazard to the patient or to operating room personnel and can be used as often as deemed necessary during the surgical procedure. We have found it useful for providing information needed for radical resection of intramedullary spinal cord tumors and consider it an important adjunct to spinal cord surgery.

ACKNOWLEDGMENTS

We thank Diana Alderson for editorial assistance and Roseanne El-Ebrashy for manuscript preparation.

REFERENCES