Intramedullary mature teratoma of the cervical spinal cord at C1–2 associated with occult spinal dysraphism in an adult

Case report and review of the literature

RAAFAT MAKARY, M.D., Ph.D.,¹ DAVID WOLFSON, M.D.,¹ VICTOR DASILVA, M.D.,² AMIR MOHAMMADI, M.D.,¹ AND SANIA SHUJA, M.D., Ph.D.¹

Departments of ¹Pathology and ²Neurosurgery, University of Florida Health Science Center, Jacksonville, Florida

There is a well-recognized association between dysontogenetic tumors of the spinal cord (including teratomas and enterogenous cysts) and dysraphic congenital spinal malformations. The authors present a case of an adult with an intramedullary mature teratoma (IMMT) at the level of C1–2 of the cord associated with dysraphic congenital spinal malformations. Intramedullary mature teratomas of the cervical region of the spinal cord are very rare in adults; only four such lesions have been reported, two of which involved upper cervical segments. Despite the potentially critical location of the tumor, monitored microsurgery resulted in complete removal of the tumor with an intact surrounding capsule, associated fibrous tract, and ellipse of skin with a central dimple. There was an excellent postoperative neurological outcome. The clinical features, imaging studies, treatment options, postoperative outcome, and plausible pathological correlations of IMMTs are discussed.

KEY WORDS • teratoma • upper cervical spinal cord • occult spinal dysraphism

Intramedullary mature teratomas and enterogenous cysts, frequently coexist with dysraphic congenital spinal malformations. Such associations suggest that dysembryogenetic mechanisms are involved in the pathogenesis of dysontogenetic tumors. Teratomas are tumors of pluripotential cell origin that produce disorganized organogenesis. These lesions display a mixture of tissues derived from the three primitive germ layers (the ectoderm, endoderm, and mesoderm) and are divided into mature, immature, and malignant categories. The degree of tissue maturity, particularly among neural tissues, distinguishes mature from immature teratomas. Intramedullary teratomas in adults are very rare with only approximately 29 such lesions reported, most of which were in the thoracolumbar region. The clinical presentation, like that of patients with other intramedullary cord lesions, is nonspecific and related to the location of the tumor and its mass effect. We present a highly unusual case of spinal cord IMMT at the C1–2 level in an adult with spina bifida. We describe the clinical and MR imaging features of this pathological entity that help in the preoperative differential diagnosis, and we review the treatment strategies and neurological outcomes discussed in the literature. Lastly, we discuss the clinicopathological similarities and differences between teratomas and neuroenteric cysts.

Case Report

History and Examination. This 46-year-old woman had been experiencing neck pain for several years. For the past 3 years, she had also experienced walking difficulties that, after a period of normal walking, would manifest as a sudden hesitation in initiating walking or taking the first step from a stationary position. This had been coupled with progressive shakiness and loss of coordination in the upper and lower extremities, which was worse in the right leg. The patient had also been experiencing a marked limitation in writing and loss of dexterity as a result of the tremors. She

Abbreviations used in this paper: EC = enterogenous cyst; IMMT = intramedullary mature teratoma; MR = magnetic resonance.
denied any bowel or bladder dysfunction. This patient had undergone surgery for thoracolumbar scoliosis at 14 years of age. Four years later, right leg pain and numbness associated with a broken rod and nonunion developed, for which she underwent a repeated operation with insertion of a bone growth stimulator and autologous bone graft material. Postoperatively her right leg pain improved but some numbness persisted.

On physical examination the patient was found to have a skin dimple at the midline of the dorsal upper cervical region. The skin dimple appeared to be connected to an underlying “dermal sinus”, but there was no history of local infection, meningitis, or fluid leakage from the skin dimple. There were no other cutaneous signs of dysraphism such as tufts of hair or lipomatous skin tags. The lesion had been present since birth and the patient had never undergone surgery in this region. The lesion was clinically suspicious for an underlying developmental bone abnormality at the level of the upper cervical spine and foramen magnum. On neurological examination, the patient’s deep tendon reflexes were difficult to elicit and her plantar responses were equivocal. Pinprick perception was decreased in the right L-5 dermatome with impaired proprioception in the right toe. The patient had a negative Romberg sign.

**Imaging Studies.** Moderately severe rotatory levoscoliosis of the lower thoracic spine and compensatory dextroscoliosis of the upper lumbar spine were noted on plain radiographs. Expandable Harrington rods had been placed over the thoracolumbar segment, with kyphosis involving mostly the lumbar region but also present in the thoracic and cervical regions. Computed tomography scans of the cervical region with and without contrast agent showed spina bifida at C-2 (Fig. 1 upper), incomplete segmentation of the C-2 and C-3 vertebrae (Fig. 1 lower), and marked scoliosis with mild marginal spondylosis at C-3 and C-4. On MR imaging (with and without administration of contrast agent) the lesion appeared as a complex nonenhancing mass approximately 15-mm long at the level of C1–2. The mass had a cystic portion inferiorly with a signal intensity indicative of protein content and a high signal intensity within the central portion of the mass that was presumably related to internal fat (Fig. 2). The mass originated from the posterior portion of the spinal cord with incomplete cord closure and exposure of the spinal canal at the level of the tumor, suggestive of split cord. No cord tethering or syrinx formation were visible on MR imaging.

**Operation and Histological Studies.** At surgery an ellipsoid incision was made around the “dermal sinus” (Fig. 3A), and the tract was followed to the bifid C-2 lamina. The tract was noted to enter the dura mater and subarachnoid space at that spinal level connecting with a pearly white mass at C1–2 (Fig. 3B). The tract and its connection with the skin dimple and the tumor were preserved intact throughout the surgery (Fig. 3C). The tumor was adherent to the dorsal aspect of the upper cervical spinal cord. Using microsurgical techniques, a tissue plane was identified for most of the ventral aspect of the tumor. Although the inferior portion of the lesion was adherent to the dorsal spinal cord, complete resection was achieved without damaging the spinal cord parenchyma. The tumor was removed en bloc without spilling its contents. Intraoperative somatosensory evoked potentials monitoring did not demonstrate evidence of disruption of the somatosensory pathways from median nerve stimulation bilaterally. The patient tolerated the operation well and suffered no complications.

Grossly, the lesion was a circumscribed 15-mm long, soft, gray and tan tissue mass with a smooth intact outer surface (Fig. 3D). A cross-section of the specimen showed a unilocular smooth wall cyst 10 mm in diameter in its inferior portion with clear fluid contents. A soft yellow strip of tissue 2-mm thick was present across the middle of the specimen. The remaining superior portion of the tumor was formed of solid, soft, gray tissue.
Adult IMMT associated with occult spinal dysraphism

On histological studies, the tumor was found to be a mixture of tissues from all three germ layers. The inferior cystic part was unilocular and lined with focally attenuated ciliated pseudostratified respiratory-type epithelium and contained proteinaceous fluid (Fig. 4A). The middle portion of the lesion, which had a high internal signal on MR imaging, was formed of mature adipose tissue with cartilage, a few seromucinous glands, and blood vessels (Fig. 4B). The superior solid part of the mass was formed of disorganized mature neuroglial tissue (Fig. 4C) with a small cluster of ependymal cells around microlumina (Fig. 4D) and retinal anlage pigment. Dystrophic calcifications were focally scattered in the neural tissue. The tract was in fact a fibrous tract with scattered benign meningothelial tissue and psammomatous calcifications consistent with a rudimentary meningocele.

Postoperative Course. On the 1st postoperative day, the patient did well with no numbness or tingling in her extremities. Muscle strength was 5/5 with intact sensation. The patient was discharged from the hospital on postoperative Day 3 in stable condition. Eleven days after surgery she experienced neck pain and patchy numbness in the right leg and left arm. Physical therapy was started to strengthen her upper and lower extremities and improve her gait.

Magnetic resonance images of the cervical spine obtained 1 month postoperatively demonstrated the absence of residual tumor. At the 2-month follow-up examination, improvement in her bilateral hand tremors was noted but minimal numbness and some gait instability persisted, for which she continued physical therapy. At the most recent follow-up visit, 6 months after the operation, the patient had no residual hand tremors and her gait had markedly improved. Radiographic and clinical follow up did not reveal any instability at the level of C1–2 after surgery.

Discussion

A very small proportion of teratomas of the central nervous system occur in the spinal cord; these lesions constitute only 0.2 to 0.5% of all spinal cord tumors. Intramedullary spinal cord teratomas in adults are rare, and to the best of our knowledge only 29 cases have been reported. The thoracolumbar region of the spinal cord is the most commonly affected site in adults. In only four of the reported cases of spinal teratomas in adults was the lesion located in the cervical cord. The authors of one of these reports documented multiple lesions extending from the medulla oblongata to the L-2 level. Ak et al. reported a lesion in the upper cervical cord at the C2–3 level, and in the other two cases the lesions were located in the lower cervical segments at the levels of C5–T2 and C6–T1. To the best of our knowledge we present the third case published in the literature of an IMMT in an adult in which the lesion occurred in the upper segment of the cervical cord (C1–2) and the fifth case in which an IMMT was located in the cervical spinal cord.

Several hypotheses have been proposed for the origin of spinal cord teratomas. The most widely accepted theory is misplacement of pluripotential embryonic cells into the dorsal midline during their normal migration from the primitive yolk sac to the gonadal ridges. The typical location of most central nervous system teratomas in midline structures supports the theory that they originate from pluripotential cell rests at the sites of early neural tube closure. In addition, there is a well-known association of spinal cord teratomas with dysraphic congenital spinal malformations such as spina bifida, dermal sinus, split cord, meningocele, lipomeningomyelocele, syrinx, and thickened terminal filum. This association suggests that a developmental fault arose during embryogenesis related to dysfunction of several factors that probably involve genetic and cellular inductive interactions. There may be a cause-and-effect relationship between spinal cord malformation and the migration of pluripotential cells that get entrapped in an abnormal environment and lead to teratoma formation.

The role of plain radiography is limited to detecting changes in the vertebral bodies such as erosion and widening of the interpedicular space with or without vertebral abnormalities at the level of the lesion. Vertebral abnormalities include spina bifida, vertebral body fusion, asymmetry of the vertebral bodies and diastematomyelia. In the present case, plain radiographs revealed dysraphic features in the form of bifid C-2 vertebral lamina, fusion of the C-2 and C-3 vertebral bodies, and scoliosis.

Computed tomography scanning may show variable tumor density or calcification. Magnetic resonance imaging usually shows mixed high and low signal intensity corresponding to cystic and solid composition of the tumor. Calcification within the tumor, although not detected on imaging studies, was present at the microscopic level in the lesion in our patient.

The distinction between ECs and mature teratomas of the spinal cord is a histopathological and clinical dilemma, in the presence of a coexisting occult neural tube dysraphism. Enterogenous cysts are subdivided into three groups: Group I is characterized histologically by the presence of only endodermally derived tissues; Group II by

Fig. 2. Preoperative MR image of the brain and cervical spine. A complex mass (15-mm long) located in the posterior portion of the spinal cord at the level of C1–2 with some extension toward the central canal. The mass has a mixed signal intensity with a signal intensity indicative of the presence of protein content in the inferior and posterior cystic portion. There is a high signal intensity in the central part of the lesion that is presumably related to fat content.


581
endodermal and mesodermally derived tissues; and Group III by endo-, meso-, and ectodermally derived tissue components. In our patient the presence of tridermally derived tissues makes the lesion distinct from Groups I and II. In addition, the features favoring teratoma over Group III ECs were the dorsal location of the tumor and the absence of the ventrally located dysraphic features associated with EC (including cysts of the mediastinum, duplication of the gastrointestinal tract, malformations of the vertebral bodies, or a defect in the vertebral column that communicates with the abdomen or thorax). Also, in our patient the bone defect (spina bifida) was present at the level of the tumor. In contrast, in patients with ECs the associated bone defect is usually several segments caudal to the lesion, as embryologically vertebral bodies move caudally relative to the spinal cord.

Total resection with the capsule intact is the treatment of choice for mature teratomas. This should be attempted if a tissue plane can be identified at surgery between the tumor and spinal cord parenchyma. However, marked tumor adhesions to the adjacent neural tissues are seen in approximately 50% of reported cases and preclude attempts at complete resection due to the risk of injury to functional neural tissue. In such cases, subtotal resection can be performed with removal of as much tumor as possible while preserving the integrity of neural function. Such a procedure would hopefully provide patients with many symptom-free years due to the generally extremely slow growth of the residual teratomatous tissue. Indeed, the difference in recurrence rates for total and subtotal resection is not significant (9% compared with 11%). In the present case, using microsurgical techniques, a tissue plane was identified along most of the tumor interface with the spinal cord parenchyma. An ellipse of skin containing the dimple, the fibrous tract extending from the dimple to the tumor capsule, and the tumor were entirely removed. This en bloc removal was important so that any complications from a retained potential dermal sinus tract would be avoided.
In the literature, complete resection was achieved in 15 of 29 reported cases of IMMT of the spinal cord including two of the four cases involving the cervical cord. Complete clinical recovery without neurological damage was reported in 18 of the 29 cases, including three of the four cases involving the cervical cord. Incomplete resection with incomplete clinical recovery was reported in four cases, and complete excision without complete neurological recovery in one case. In the other cases, the extent of surgery and the clinical outcome were not described.

The role of adjuvant therapy of spinal cord teratoma is not well characterized because of the rarity of these lesions and the limited collective experience in their management. Of note is the fact that no case of malignancy was found in the 29 cases of spinal cord teratomas reported thus far.

Conclusions

Intramedullary mature teratomas located in the upper cervical spinal cord of an adult patient are extremely rare. There are no specific clinical or radiological features for the preoperative diagnosis of these lesions. However, the pres-
ence of spina bifida or other dysraphic congenital spinal cord abnormalities should raise the index of suspicion for the presence of an associated teratoma. In such cases MR images demonstrating heterogeneous signal intensity indicating a solid or cystic composition of the tumor would be helpful. The treatment of choice is complete resection if a cleavage plane is present with preservation of functional neural tissue. Otherwise, incomplete resection is the alternative and may still provide the patient with several symptom-free years because of the slow growth pattern of benign teratomas. Early resection should be attempted before irreversible neurological damage occurs. Whenever possible, complete resection of the tumor with the capsule maintained intact is recommended, as the presence of immature and/or malignant tissue components can only be recognized on postoperative histological examinations. En bloc resection will also reduce the risk of postoperative complications, such as meningitis or myelitis, due to a potentially retained sinus tract. Early resection should be attempted before irreversible neurological damage occurs. Molecular studies of cell-to-cell interactions and their relationship to neurotransmitters and hormones and/or cytokines may be helpful in understanding the pathogenetic mechanisms involved in dysraphic spinal malformations and teratoma tumorigenesis in the spinal cord.

References


Manuscript submitted October 1, 2006. Accepted March 5, 2007. Address reprint requests to: Sania Shuja, M.D., Ph.D., University of Florida Health Science Center/Shands Jacksonville, 655 West 8th Street, Jacksonville, Florida 32209. email: sania.shuja@jax.ufl.edu.