Lumbosacral neurenteric cyst in an infant

Case report

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The case of a combined intra- and extraspinal neurenteric cyst in an infant is reported. This case is unique because an intraspinal cyst was not suspected clinically until large numbers of squamous epithelial cells were obtained at lumbar puncture performed as part of a workup for a septic entity. The cyst extended from an intradural location ventral to the conus medullaris at L-1 through a ventrolateral defect in the S-4 vertebral body to communicate with a large presacral component. The entire cystic cavity was lined by stratified squamous epithelium. The possible pathogenesis of this lesion is discussed.

KEY WORDS: neurenteric cyst • lumbar puncture • magnetic resonance imaging • laminectomy

Neurenteric cysts are rare anomalies that follow disturbances in the complex series of interactions resulting in the formation of the primitive neurenteric canal, notochord, neural tube, and the adjacent endoderm and mesenchyme during the 3rd week of embryogenesis. Persistent or abnormal communications between neuroectoderm, notochord, and endoderm may occur and cysts, fistulae, and spinal dysraphism result with or without extraspinal components.

The case of a combined intra- and extraspinal lumbosacral neurenteric cyst is described. Several features of this case are unusual. First, a neurenteric cyst lined solely by stratified squamous epithelium has not been reported previously. Second, the presence of an intraspinal cystic mass lesion was initially suspected after sheets of squamous epithelial cells were obtained at lumbar puncture; this is the first report of cytological findings of desquamated squamous epithelial cells associated with a neurenteric cyst. Third, a lumbosacral location for a neurenteric cyst is uncommon in infants.

Case Report

This 3-month-old male infant presented with a 2-day history of fever, coughing, vomiting, diarrhea, and upper-airway congestion. This baby was the product of a full-term pregnancy and his postnatal life had been uncomplicated by illness. However, the mother was aware that her child had displayed progressive arching of the back and neck since birth.

Examination. Neurological examination demonstrated an alert but irritable infant with an initial temperature of 39.2°C. His neck was retroflexed and resisted ventral flexion. The thoracolumbar spine was arched, dorsally concave. The infant moved all extremities vigorously, was normoreflexic, and had no objective sensory dysfunction. The anterior fontanel was full but soft. There were no cutaneous abnormalities.

A lumbar puncture was performed as part of a workup for a septic entity. Sheets of squamous epithelial cells admixed with neutrophils were noted on Gram and Wright's staining (Fig. 1). Because the presence of squamous cells at lumbar puncture suggested the presence of an intraspinal cyst, a series of radiographic studies were obtained. Plain films of the lumbar spine revealed increased interpedicular distances at the L-3, L-4, and L-5 vertebrae. A myelogram with iohexol contrast medium followed by computerized tomography was performed by CI-2 puncture and revealed a partial block beginning at the L-1 level, extending caudally with thinning of the subarachnoid space by a mass lesion (Fig. 2). Magnetic resonance imaging demonstrated lumbosacral intraspinal and presacral cystic mass lesions that appeared to communicate in the lower
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Fig. 1. Photomicrograph of fluid obtained at lumbar puncture demonstrating sheets of squamous epithelial cells. Wright's, × 200.

Fig. 2. Myelogram via C1–2 puncture showing an intrathecal mass filling the lumbar subarachnoid space; the interpedicular distances are increased at the L-3, L-4, and L-5 vertebrae.

Fig. 3. Magnetic resonance T₁-weighted image with gadolinium contrast enhancement demonstrating an intraspinal cystic lesion (single arrow) that appears to communicate with a presacral cystic lesion (double arrows) through a ventral defect at S-4.

sacral region (Fig. 3). Results of a barium enema and vesicourethrogram were normal and helped to exclude the presence of fistulous association with the urinary system or digestive tract.

Operation. The patient was placed prone on laminectomy rolls and the rectum was packed with povidone-iodine (Betadine)-soaked gauze. A thoracolumbosacral laminectomy was performed and, upon the dura being opened, a tubular mass surrounded by thickened arachnoid was noted. The mass was attached to the ventral conus at L-1 and extended caudally through the end of the thecal sac, exiting through a right ventrolateral defect in the S-4 body. The intraspinal cystic mass lesion was dissected free from normal neural tissue, doubly ligated at its point of exit from the spinal canal, then sectioned between the ligatures. The distal sacrum and the coccyx were split in the midline and continuation of the cystic mass was dissected off the rectum; adhesions were present, but no discrete fibrous cord or fistulous tract connecting the neurenteric cyst to the rectum was found.

Pathological Examination. The composite specimen consisted of a bilobed 6.9 × 2.5 × 1.0-cm tubulosaicular cyst with a fibromembranous and fibrofatty covering. An area of focal constriction where the intraspinal and presacral components communicated was 4 mm in diameter and its lumen admitted only a 4–0 lacrimal probe. The cyst contained thick, milky-white fluid. Microscopic examination demonstrated that the cystic structure was lined solely by nonkeratinizing stratified squamous epithelium (Fig. 4). The fibroconnective cyst wall contained smooth-muscle fibers, scattered islands of adipose tissue, nerve twigs, ganglion cells, and rare foci of neuroglial tissue. Subsequent Giemsa staining of the original lumbar puncture fluid smears was undertaken to rule out the presence of Barr chromatin bodies. Due to cell overlap, interpretation was compromised, but no Barr bodies were identified.
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Postoperative Course. The infant developed a transient neurogenic bladder, which resolved completely. More than 1 year after surgery, the infant is developmentally and neurologically within normal limits. The abnormal posturing noted preoperatively has resolved.

Discussion

Neurenteric Cysts

The neurenteric cyst is a form of spina bifida occulta typically consisting of an intradural cyst lined by pseudostratified columnar or cuboidal epithelium which may be ciliated or show a mixture of intestinal, gastric, pancreatic, and/or squamous epithelium.\(^1\,^6\,^11\,^12\,^25\,^31\) The cyst may have a simple connective-tissue capsule, a connective-tissue capsule containing benign elements of mesenchymal origin (that is, adipose or smooth-muscle tissue) and/or neuroectodermal origin (such as nerve twigs and ganglion cells), or a well-formed, multilayered gastric wall.\(^11\,^17\,^26\,^31\) Defects in the vertebral bodies and intra-abdominal and/or intrathoracic cysts are frequently present.\(^2\,^3\,^7\,^11\,^12\,^25\) There may be no detectable connection between the intraspinal and extraspinal components, or the two cysts may be united by a thin fibrous strand coursing through an anterior vertebral defect.\(^7\) Rarely, a single cyst may have both intra- and extraspinal components.\(^11\)

Neurenteric cysts most commonly present during the first decade of life.\(^15\,^31\) Older children and adults typically present with pain or a myelopathy from intraspinal mass effect. Neonates and young children more commonly present with signs and symptoms of cardiorespiratory compromise from intrathoracic mass effect or cervical cord compression. The signs and symptoms of meningitis are also more common in newborns and infants. The most common locations in both pediatric and adult patients are the lower cervical and cervicothoracic regions.\(^11\,^15\,^16\,^19\,^31\) The conus medullaris, another common site in adult patients, is rare in neonates and children.\(^12\,^15\) In addition, intracranial neurenteric cysts have been reported.\(^20\)

Complete resection of neurenteric cysts with subsequent improvement in neurological function is usually possible. These cysts should not be marsupialized as the epithelial secretions may irritate the nervous system. Recurrence has not been reported after complete resection.\(^7\)

Normal Embryology

An evaluation of the various mechanisms proposed for the formation of neurenteric cysts requires an understanding of normal embryology. By the end of the 2nd week of embryonic development, a bilaminar embryonic disc consisting of epiblast and hypoblast has formed, separating a dorsal amniotic cavity from a ventral yolk sac. Gastrulation, the conversion of the bilaminar embryonic disc into a trilaminar embryonic disc, occurs during the 3rd week of embryonic development. On Day 15, the primitive streak forms at the caudal end of the embryo. A primitive groove forms in the primitive streak and is connected to a depression in the rostral primitive streak called the "primitive pit." Epiblast cells migrate through the primitive groove to form the mesoderm and, presumably, also the endoderm. Epiblast that remains dorsally becomes ectoderm. On Day 16, some mesoblastic cells migrate through the primitive pit and extend rostrally between ectoderm and endoderm, forming a midline solid cord of cells called the "notochordal process." The notochordal process continues to grow rostrally to the prochordal plate, a site of fixed attachment of endoderm to ectoderm that defines the future oropharyngeal membrane. In a series of steps, the notochordal process becomes the notochord.

On Day 18, the primitive pit invaginates into the notochordal process, forming a canal that extends the entire length of the notochordal process. The notochordal process then fuses with the ventral endoderm. This area of fusion deteriorates such that the notochordal process becomes intercalated within the embryonic endoderm. During the period of notochordal intercalation, a temporary transembryonic communication called the "neurenteric canal" exists between the amniotic cavity and the yolk sac at the site of the primitive pit. The notochordal plate then folds along its ventral aspect forming a central lumen and becomes the notochord. The endoderm then forms a continuous ventral layer once again. While it is forming, the notochord induces the overlying ectoderm to form the neural plate. In a process called "neurulation," a central groove in the neural plate forms and its lateral ridges fuse dorsally to form the neural tube. The central nervous system ultimately develops by the processes of folding and differential thickening of the neural tube.
The notochordal lumen and the neurenteric canal normally become obliterated and the notochord largely degenerates except in the intervertebral spaces where it becomes the nucleus pulposus. Caudal to the posterior neuropore at S-2,24 the neural tube forms by medullary cord canalization (secondary neurulation).8

Pathogenesis

Theories proposed for the formation of neurenteric cysts10,25 can be separated into five groups: 1) abnormal endodermal-ectodermal adhesion, with subsequent splitting of the notochord;22,25 2) splitting of the notochord as the primary event;4 3) persistence of the neurenteric canal or formation of an accessory neurenteric canal; 4) overdistention of the neural tube;10 and 5) a teratomatous origin from primordial germ cells.14,25,27 In addition, the possibility of abnormal secondary neurulation must be considered as an explanation for congenital sacrococcygeal spinal lesions.18 An abnormal adhesion between the endoderm and endoderm in the midline could result in interference with rostral migration of mesoblast and cause a split in the notochord to develop.4 Subsequent mesodermal maturation around this adhesion along with differential growth of the neural and endodermal tubes could potentially explain the presence of intra- and extraspinal cysts associated with anterior vertebral body defects.3,22,23 Bentley and Smith proposed that the initial defect is a split notochord. Because the neural plate requires induction from the notochord, there would be an associated deficiency in the neural plate and split in the spinal cord, thereby allowing an endodermal diverticulum to herniate through the defect and make contact with the endoderm. Bremer believed that neurenteric cysts and diastematomyelia could be explained by the presence of a persistent or accessory neurenteric canal. Because many cases of neurenteric cysts are located rostrally and because the primitive pit is ultimately located at the caudal end of the spine, Bremer suggested that more rostral “accessory” neurenteric canals are responsible. Gardner extended his hydrodynamic theory to explain neurenteric cysts and anomalies of non-neural organs. According to Gardner, “if neural tube overdistention splits the underlying notochord and damages primitive gut, anomalies of endodermal organs may result.” Lastly, intraspinal lesions called “neurenteric cysts” by some authors have been called “teratomatous cysts” by others, based on the theory that these lesions develop from primordial germ cells.14,25,27

Teratomatous Cysts

Primordial germ cells originate from the caudal midline wall of the yolk sac and migrate along the dorsal mesentery of the hindgut to the gonadal ridges, the site for development of the ovaries and testes. The predilection of teratomas for the ovaries, testes, and midline locations within the nervous system along with the frequent presence of Barr bodies in teratomas in male patients have been the basis for believing that these tumors are of germ-cell origin. Based on similar reasoning, several authors have used the controversial term “teratomatous cyst” to describe intraspinal cysts lined by ciliated columnar or cuboidal epithelium and containing immature tissue from two or three germ layers in their walls. However, use of the term is problematic; as a descriptive term, it poses difficulties when attempts are made to separate this entity from a cystic teratoma and it is unclear whether previous authors have always made this distinction. Only the epithelial lining of teratomatous cysts has been shown to have a different nuclear sex from its bearer; the teratomatous cyst capsule, which may include smooth or striated muscle, cartilage, fat, lymphoid tissue, glial tissue, and pacinian corpuscles, has been negative for Barr bodies in male patients.25 In addition, it may be misleading to assume karyotype from nuclear sex.29 Theoretically, primordial germ cells along the dorsal midline could be included within a cyst of developmental origin and give rise to an epithelial lining with a nuclear sex different from that of the capsule, but distinguishing such a lesion from a teratoma would remain difficult.

As described, however, our case does not conform to previous reports of teratomatous cysts. Teratomatous cysts have not been reported to have both intra- and extraspinal components and the squamous epithelial cells of the lesion in our case did not demonstrate Barr bodies. The diagnosis of a benign cystic teratoma was unlikely because of the rarity of teratomas showing both intra- and extraspinal components, the absence of solid components in our case, and the more plausible explanation that it was developmental in origin.25 The path taken by the neurenteric cyst in our patient strongly suggested a developmental origin, but an explanation of its exact pathogenesis based on the development theories described remains unclear.

Conclusions

Although development theories provide a useful framework for investigation, knowledge of the embryological errors and molecular events underlying the formation of neurenteric cysts and other congenital spinal lesions remains fragmentary.8,28 Only continued experimental work, especially with animal models like the homozygous curly-tailed mouse,8 will provide insight into the pathogenesis of human neural tube defects and congenital lesions like the neurenteric cyst.

References

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