Case Report

Klippel–Feil Syndrome Associated with Sacral Agenesis, Low Lying Cord, Lipomyelomeningocele and Split Cord Malformation Presenting with Tethered Cord Syndrome: Pentads Neural Tube Defects Spread along Whole Spinal Axis

Guru Dutta Satyarthee, Amandeep Kumar

Neural tube defects are congenital developmental anomaly of the central nervous system and usually have relatively more predilection to affect at anterior and posterior neuropore embryological development sites, so usually one or two defects are commonly encountered. However, occurrence of simultaneous multiple neural tube defects is very rare, presence of constellation of five neural defects is extremely rare, and all defects add up together to produce gross neurological deficit. We present an interesting case of a 23-year-old male who presented with history of lower backache and noticed wasting and weakness of lower limbs associated with difficulty in walking for the last 2 years but had no associated sphincter disturbances. He was operated for lumbosacral lipomeningocele repair at the age of 1 year. He was asymptomatic, following the first surgical intervention. At the current admission, he underwent re-exploration of surgical wound with surgical repair although suffered mild-temporary neurological worsening in the immediate postoperative period. Imaging feature and management of such rare constellation of five embryological anomalies and its significance and brief literature are discussed.

Keywords: Cervical block vertebrae, multiple neural defect, sacral agenesis, split cord malformation

INTRODUCTION

Neural tube defects are congenital developmental anomaly of the central nervous system. It may be of open variety caused by primary neurulation failure, leading to neural tissue getting exposed without skin covering and usually associated with external discharge of cerebrospinal fluid, while another being closed category is caused by faulty secondary neurulation and in resultant defect, the neural tissue being not exposed and usually covered with intact skin. The anterior and posterior neuropore used to close in last, so these sites are most likely to remain vulnerable for occurrence of such congenital defects. However, occurrence of concurrent multiple neural tube defects is extremely rare. Occurrence of lipomyelomeningocele with Type II split cord malformation, low-lying tethered cord with anomaly of cervical vertebrae fusion in the form of block Klippel–Feil syndrome and sacral agenesis plays a challenge to the clinician in the search and early diagnosis for multiple neural tube defects, and further, management of such cases also possesses challenge to the neurosurgical, urologist, orthopedician, and rehabilitatory team.

CASE REPORT

A 23-year-old male presented with low backache for the last 2 years, with a history of surgery for repair of...
lumbosacral lipomeningocele at the age of 1 year. He was asymptomatic after surgery for almost 20-years, and later on, he noticed wasting and weakness of lower limbs associated with difficulty in walking; however, he had no bowel or bladder disturbances. Clinical examination revealed an healthy male, wasting of bilateral calf muscle, and power of grade 4/5 at bilateral hip, knee, and ankle joints and rest of the neurological examination were essentially within normal limits.

X-ray of the lumbosacral spine revealed the presence of spina bifida with agenesis of lower sacral and coccygeal segments [Figure 1]. X-ray of the cervical spine showed fusion of C2 and C3 spinous process [Figure 2], and lumbosacral spine magnetic resonance imaging sagittal section, T1-weighted image showed the presence of the low-lying conus lying at the L4 vertebra level with tethering with lipoma and associated agenesis of the lower sacral and coccygeal segments [Figure 3].

T2-weighted coronal section magnetic resonance image revealed Type II split cord malformation with split extending from D11 vertebrae to L4 vertebrae [Figures 4 and 5]. He underwent surgical repair of lipomyelomeningocele with the resection of residual lipoma; conus was freed and reconstructed, with meticulous dural closure being carried out. In the postoperative period, he had temporary mild worsening in the neurological status, which recovered over next 2 months; however, wasting of calf muscles was still persisting at the last follow-up at 2-years, following the second surgery.

**DISCUSSION**

Neural tube defects are congenital development anomaly and commonly observed at these potential sites, which includes posterior and anterior neuropore, as these sites used to close in the last during the embryonic life and remain most vulnerable for congenital defect.[2] Divergent views are existing regarding etiogenesis of multiple neural tube defects, and two most important theories are postulated. The first is orderly closure theory, which is widely accepted. Another theory is multiple neural tube defect closure theory, which was postulated by Van Allen et al. in 1993, described, and advocated five sites of initiation for the neural tube closure process and the multiple tube defect commonly used to occur at the these collision sites of neural tube closure and as such can produce a spectrum of combinations of associated developmental anomaly, which are developing simultaneously in an individual. The occurrence of two or more meningomyelocele, or meningocele in combination with encephaloceles or even triple meningoceles, can be lying dispersed along the entire neuraxis; however, such occurrence of two or three defects combinations occurring along the entire
Satyarthee and Kumar: Pentad defect in association with spinal dysraphism

The vertebrae axis is extremely rare although reported in the form of isolated case reports. Yamada et al. reported simultaneous occurrence of pentad of congenital defects, spread along the whole spinal axis, not reported previously, who presented with tethered cord in the literature, the current case report represents the first case of its kind.

Exact mechanism of dichotomy about the age of onset clinical presentation is still debated being symptomatic either in the infancy age or later life. As majority may get symptomatic in infancy or early childhood, a few cases only get symptomatic in adult age. Various postulates are put forward to explain such different ages of getting symptomatic. The spectrum of amount of the traction applied on the conus is incriminated to be related to the age of onset of clinical manifestation. In those cases, who have thick filum terminale or very firm causing tethering and severely stretched conus, it leads to early onset of neurological disturbances even appearing in infancy or toddler age. While lesser degree of tethering may cause only minimal or nonprogressive neurological deficits in childhood, making subclinical in childhood until aggravated factors precipitates traction as concluded by Pang and Wilberger.

However, other postulates hypothesized that the mechanism of late onset of tethered cord syndrome is due to progression of tightening of conus; as a child grows older, the cumulative effect of repeated cord traction over many years, during natural movement of spine, could ultimately leads to the development of the conus injury. Dubowitz et al. reported direct trauma to the back can precipitate the neurological deficit manifestations by causing deformation of the remaining merely functioning neuronal elements of the involved stretched cord. Yamada et al. reported neurological dysfunction in patient with tethered cord correlating well with the anoxia of mitochondria, which is energy powerhouse within the conus. Developmental stenosis of lower spinal cord and disc prolapse are also other known precipitate factors.

The closed spinal dysraphism with lipoma called as lipomyeloschisis and it can be of lipomyelomeningocele or lipomyelocele when associated with meningomyelocele or myelocele. Lipomyelocele is one of the more common than lipomyelomeningocele, usually presents as a fatty subcutaneous mass and commonly located in the thoracolumbar spinal region.

With the growth of spinal canal, lipomas cause distortion of nerve roots attached to the lipoma, leading to neurological deficits. Posterior spinal defect is commonly observed in these patients, which is covered with skin and shows interspersed lipomatous tissue. The interface of neural placode-lipoma junction lies inside or just at dural edge within the spinal canal in the lipomyelocele, while in the lipomyelomeningocele, it lies outside the spinal canal with resultant enlargement of anterior subarachnoid space.

MRI remains the investigation of choice for such cases. It can clearly delineate posterior spinal elements defect with the presence of intact skin cover and interspersed lipomatous tissue. In lipomyelocele, the lipoma-neural placed interface lies within the spinal canal or at its edge while in lipomyelomeningocele it lies outside the spinal canal due to enlargement of subarachnoid space and commonly associated with low lying conus. Clinically important differential diagnosis of such lesions includes meningocoele, lipomeningomyelocele and terminal myelocele.
Clinically, it may present with low backache, weakness of both lower limbs, foot deformity, spinal deformity, or failure of sphincter control of bowel and urinary bladder; these can lead to significant progressive disability and psychological trauma to the patients as well as family and associated economic loss to the society.

The diagnosis of based on high degree of clinical suspicion and findings of various neuroimaging modalities includes X-ray and MRI to evaluate the whole spine is must to exclude other associated lesion. However, management includes surgical detethering with careful intradural dissection of lipoma to avoid fresh neurological deficit and meticulous dural and wound closure. However, any case who had associated with sacral agenesis is another indicator for imaging screening of the entire spine. Early diagnosis and prompt surgical management can be helpful in at least halting neurological deterioration, and some cases may get neurological improvement with almost negligible surgical complication rate.[7,9,10]

Authors analyzed 147 cases, having spinal lipomas, out of which 93 had conus lipomas, 26 had filum lipomas, and remaining 28 had only lipomeningomyelocele. Management of such cases was challenging, especially in the groups of the patients with no neurological deficits. The neurological deficits were observed in the older age group patients in comparison to those neurologically intact were relatively younger. Authors concluded prophylactic surgery for congenital spinal lipomas is safe and effective.[10]

Authors also reported a rare occurrence of thoracic myelocystocele associated with multiple neural tube defects including presence of Type-1 split cord malformation with low-lying tethered conus, dorsal syringomyelia in the dorsal region along with the presence of sacral agenesis, who underwent successful surgical repair.[11]

**Conclusion**

In a few cases, spinal dysraphism may have additional presence of two or multiple neural tube defect located at far from conus region along the spinal axis, so screening of the whole spine is highly imperative to look for the search for the presence of additional defect and accordingly surgical planning should be tailor made with aim to improve the neurological outcome and providing proper care in the future as many of additional anomaly currently might be asymptomatic, may get symptomatic later on, warranting neurosurgical therapeutic intervention. Hence, authors advise that MRI screening of the whole spine is highly essential along with screening of craniovertebral junction and scout film of brain to exclude hydrocephalus for holistic management planning of spinal dysraphism cases. Hence, high degree of clinical suspicion of existence of multiple defects, detailed clinical evaluation and appropriate neuroimaging is prerequisite for proper diagnosis of such rare multiple neural tube closure defects.

**Financial support and sponsorship**

Nil.

**Conflicts of interest**

There are no conflicts of interest.

**REFERENCES**

1. Garg K, Tandon V, Gupta DK, Sharma BS. Multiple neural tube defect with split cord malformation – A rare entity. Indian J Pediatr 2014;81:982-3.
2. Srinivvas D, Sharma BS, Mahapatra AK. Triple neural tube defect and the multisite closure theory for neural tube defects: Is there an additional site? Case report. J Neurosurg Pediatr 2008;1:160-3.
3. O’Neill OR, Piatt JH Jr., Mitchell P, Roman-Goldstein S. Agenesis and dysgenesis of the sacrum: Neurosurgical implications. Pediatr Neurosurg 1995;22:20-8.
4. Pang D, Wilberger JE Jr. Tethered cord syndrome in adults. J Neurosurg 1982;57:32-47.
5. Guthkelch AN. Diastematomyelia with median septum. Brain 1974;97:729-42.
6. Dubowitz V, Lorber J, Zachary RB. Lipoma of the cauda equina. Arch Dis Child 1965;40:207-13.
7. Yamada S, Zinke DE, Sanders D. Pathophysiology of “tethered cord syndrome”. J Neurosurg 1981;54:494-503.
8. Freeman LW. Late symptoms from diastematomyelis. J Neurosurg 1961;18:538-41.
9. Gupta SK, Khosla VK, Sharma BS, Mathuriya SN, Pathak A, Tewari MK. Tethered cord syndrome in adults. Surg Neurol 1999;52:362-9.
10. Kumar A, Mahapatra AK, Satyarthee GD. Congenital spinal lipomas: Role of prophylactic surgery. J Pediatr Neurosci 2012;7:85-9.
11. Mankotia DS, Satyarthee GD, Sharma BS. A rare case of thoracic myelocystocele associated with type 1 split cord malformation with low lying tethered cord, dorsal syrinx and sacral agenesis: Pentad finding. J Neurosci Rural Pract 2015;6:87-90.