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Original research article

Surgical management of 142 cases of split cord malformations associated with osseous divide

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ABSTRACT

Objectives: To investigate the key surgical points in treating split cord malformations associated with osseous divide and scoliosis (SCM-OD-S).

Materials and methods: The surgical options and methods of a total of 142 SCM-OD-S cases were retrospectively analyzed, and the surgical precautions and imaging diagnosis were also discussed.

Results: The 142 patients were performed osseous divide resection plus dural sac molding, which achieved good results and no serious complication such as spinal cord and nerve injury occurred; certain symptoms such as urination-defecation disorders, muscle strength subsidence, Pes Cavus, and toe movement disorder in partial patients achieved various degrees of relief, and it also created good conditions for next-step treatment against scoliosis.

Conclusions: The diagnosis of SCM-OD mainly depended on imaging inspection, routine magnetic resonance imaging (MRI) combined with computed tomography (CT) 3D reconstruction, which can comprehensively evaluate the types and features of diastematomyelia as well as other concomitant diseases. SCM alone needed no treatment, but surgery will be the only means of treating SCM-OD. Intraoperatively removing osseous divide step-by-step, as well as carefully freeing the spinal cord and remodeling the dural sac, can lay good foundations for relieving tethered cord, improving neurological symptoms, and further scoliosis orthomorphia, thus particularly exhibiting importance for the growth and development of adolescents.

1. Introduction

Split cord malformations (SCM) is a congenital spinal cord malformation characterized by segmental osseous divide of spinal cord tissue in the sagittal plane, is more common in children and adolescents, and mainly occurs in the thoracolumbar segment, as well as often being accompanied by such deformities as back skin abnormalities, spina bifida, myelocele (meningocele), Tethered cord, or scoliosis, among which scoliosis is the most common [1,2]. The biggest threat of

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SCM comes from osseous divide caused rigid segmentation of spinal cord, which makes the patients suffer from sustained spinal cord traction and oppression after birth, followed by spinal cord growth restriction and gradual aggravation of clinical symptoms. Surgery is still the only treatment method, especially for the patients with split cord malformations associated with scoliosis (SCM-S). Initial-stage surgery can remove osseous divide and artificially remodel the dural sac, which not only clears the way for late-stage orthomorphia but also can avoid post-orthopedic traction injury of spinal cord tissue, so it is particularly important for adolescents in their growing period [3].

In recent years, with the development of imaging inspection methods, the understanding of this disease has achieved great progresses. Meanwhile, the application of micro-surgery and the further development of the concept of minimally invasive treatment provide important guarantees for improving surgical outcomes and reducing postoperative complications. However, due to lacking the orientation signs of the nervous system in early stages, as well as lacking comprehensive and systemic laboratory inspections, clinical misdiagnosis and missed-diagnosis are common. At the same time, the causes and nerve damage mechanisms of SCM still lack detailed understanding, and the current treatment opinions about whether SCM should be treated earlier than scoliosis orthomorphia are still controversial [4,5]. Furthermore, surgical methods toward split cord malformations associated with osseous divide (SCM-OD) are diverse and difficult. Therefore, clinical classification, diagnosis, clinical pathological features of SCM, as well as diagnosis, treatment, and prognosis of SCM-OD, still need further standardization and improvements.

Our department has treated a total of 3850 patients with congenital scoliosis from April 2000 to May 2014, including 189 SCM cases, among who 142 cases are formed by SCM combined with intra-spinal OD. Therefore, we performed this retrospective clinical study, hoping to provide theoretical basis and practical experience for the surgical purposes, indications, strategies, postoperative complication prevention, and long-term surgical efficacy evaluation of such disease based on our advantages of having sufficient cases, as well as complete clinical data and follow-up information.

2. Materials and methods

2.1. *Clinical data*

Patient selection: This study had collected a total of 142 patients underwent SCM-OD resection in the department of neurosurgery in our hospital between April 2000 and May 2014. All the patients had complete imaging and clinical follow-up data, including 28 males and 114 females (M:F = 1:4), aging 3–36 years, with the median age as 13.4 years. The intraspinal crests in all the patients were in the thoracolumbar segment, mainly 1–2 cm in length; furthermore, 5 patients had two simultaneous discontinuous crest. At the same time, such data as the nerve function improvement and long-term scoliosis improvement degree after OD resection were completely recorded (Table 1).

Clinical symptoms: Among the 142 patients, 97 patients were combined with low spinal cord and filum terminale thickening, 62 patients were combined with segmental syringomyelia and congenital intraspinal tumor (including bronchogenic cysts, intestinal cysts, or lipoma), 70 patients were combined with unilateral lower limb muscle atrophy, muscle weakness, or foot deformity, partial patients were combined with mild urination or defecation disorder, and 42 patients were combined with thoracic deformity and moderate – severe pulmonary dysfunction.

Table 1 – Clinic pathologic features of 142 patients with split cord malformations.

Clinical case characteristics	Cases (%)
Age	
<14	108 (76.1)
≥14	34 (23.9)
Gender	
Male	28 (19.7)
Female	114 (80.3)
Longitudinal interval number	
≤1	137 (96.5)
>1	5 (3.5)
Longitudinal interval position	
Cervical vertebra	0 (0)
Thoracic vertebra	90 (63.4)
Lumbar vertebra	52 (36.6)
Sacral vertebrae	0 (0)
Longitudinal interval length	
≤1 section	136 (95.8)
>2 sections	6 (4.2)
Combined lesion	
None	7 (4.9)
Thickening of low spinal cord	97 (68.3)
Spinal fracture/Meningocele	62 (43.7)
Syringomyelia	56 (39.4)
Sacral cyst	41 (28.9)
Intraspinal tumor	14 (9.9)
Nerve injury symptoms	
No	35 (24.6)
Yes	107 (75.4)

2.2. *Surgical indications*

OD can cause the Tethered cord syndrome, such as urination or defecation disorder, bi-lower extremity weakness, or talipes equinus. Because the patients are in the growth and development period, so compression of OD toward the spinal cord will limit the activity of the spinal cord, thus producing the Tethered cord syndrome toward the children in their growth and development period. Although no symptom may appear, scoliosis dose exist and needs orthopedic surgery, which may longitudinally extend the spinal column and cord.

2.3. *Surgical methods*

Preoperative localization: CT-guided positioning was mainly used; each patient was placed in the prone or lateral side on the CT bed (with the convex side of scoliosis downwards when in the lateral position). According to the cursor position, the needle was guided to stab the spinous process or the spinal lamina if the spinous process was absent, certain amount of methylthioninium chloride was injected onto the surface of the positioned spinous process to complete the preoperative localization.

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