·脊柱脊髓疾病·

脊髓末端积水合并脊髓栓系综合征10例临床研究

谢京城 王振宇 陈晓东

【摘要】 **目的** 总结脊髓末端积水合并脊髓栓系综合征的临床表现、影像学特点、诊断与治疗经验。**方法与结果** 10例脊髓末端积水合并脊髓栓系综合征患者(1例为全脊髓积水、8例为骶管内脊膜囊肿、1例合并骶部皮毛窦),临床表现为不同程度双下肢无力,尤以肢体远端显著,5例伴尿道和肛门括约肌功能障碍;5例存在与脊髓空洞平面相关的感觉障碍平面,尤以浅感觉减退为主。术前MRI显示脊髓低位、脊髓末端无圆锥结构、脊髓和终丝内异常信号。于手术显微镜下切断终丝、引流髓内积水、切除骶管内脊膜囊肿、松解脊髓栓系。手术成功率达100%,平均手术时间2.15 h、术中出血量220 ml。无一例发生手术相关并发症。术后视觉模拟评分降低,下肢肌力、尿道和肛门括约肌功能改善。术后平均随访6.10年,McCormick神经功能分级均达到Ⅰ级。末次随访时复查MRI显示,脊髓圆锥结构恢复,脊髓末端上升,髓内积水消失,脊柱生理曲度未发生变化。**结论** 脊髓末端积水合并脊髓栓系综合征临床罕见,主要表现为慢性脊髓功能障碍;MRI特征性表现为脊髓低位,圆锥结构消失,终丝和髓内呈长T_1、长T_2信号,囊壁无强化。于手术显微镜下切断终丝、引流髓内积水、松解脊髓栓系,效果满意。

【关键词】 神经管缺损; 脊髓空洞症; 马尾; 显微外科手术

Diagnosis and surgical treatment of terminal syringomyelia within spinal cord combined with tethered cord syndrome

XIE Jing-cheng, WANG Zhen-yu, CHEN Xiao-dong

Department of Neurosurgery, Peking University Third Hospital, Beijing 100191, China

Corresponding author: XIE Jing-cheng (Email: ab1965@163.com)

【**Abstract**】 **Objective** To summarize the clinical manifestations, imaging characteristics and experience of surgical treatment of spinal cord terminal syringomyelia with tethered cord syndrome (TCS). **Methods and Results** Clinical data of 10 patients with spinal cord syringomyelia combined with TCS surgically treated under microscope from January 1999 to March 2014 in our hospital were retrospectively analyzed. There were 3 males and 7 females with average age of 15.06 years old (ranged from 2 to 35 years old). The course of disease ranged from 3 months to 20 years (average 42.17 months). Among those patients, one patient presented hydromyelia, 8 patients suffered from meningeal cyst within the sacral canal, and one patient were concurrent with sacral dermal sinus. The weakness of lower extremities, especially distal limbs, was the main clinical manifestation. Five patients were accompanied with bowel and bladder dysfunction and 5 patients with sensory disturbance below the level of syringomyelia, especially hypesthesia. Preoperative MRI showed conus medullaris disappeared at the end of spinal cord, and there was fluid signal in the lower spinal cord with hypo-intensity signal in T_1WI and hyper-intensity signal in T_2WI without enhancement. All patients underwent surgical procedures. Under microscope, filum terminale was cut off, drainage was performed, meningeal cyst within the sacral canal was removed, and tethered cord was released. The success rate of operations was 100%. The duration of surgery ranged from 1.52 to 3.07 h (average 2.15 h), with average intraoperative blood loss 220 ml (ranged from 100 to 410 ml). The tethering filum had been totally resected and histological examination showed typical filum tissue in all cases. No operative complication was found. Visual Analogue Scale (VAS) score was decreased, and the lower limbs weakness as well as bowel and bladder dysfunction was gradually relieved after operation. The period of follow-up was ranged from 6 months to 14.50 years (average 6.10 years). All patients presented neurological intactness (McCormick grade Ⅰ), recovery of conus medullaris, rising of the end of spinal cord, no recurrence of syringomyelia with favorable alignment of spine during follow-up period. **Conclusions**

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作者单位:100191 北京大学第三医院神经外科

通讯作者:谢京城(Email:ab1965@163.com)

Terminal syringomyelia in the spinal cord with TCS is rarely occurred and characterized by chronic dysfunction of spinal cord and nerve. The manifestation in MRI imaging is characterized by low level of spinal cord, disappearing of conus medullaris, long T_1 and long T_2 signal of filum terminale and spinal cord, and no enhancement of capsule wall. The surgical treatment includes resection of filum terminale, drainage of the cerebrospinal fluid (CSF) in syringomyelia, and de-tethering of the spinal cord under microscope. The outcome is satisfactory.

【**Key words**】 Neural tube defects; Syringomyelia; Cauda equina; Microsurgery

脊髓栓系综合征(TCS)系由于各种先天性或获得性原因牵拉脊髓或脊髓圆锥使其下降而产生的一系列神经功能障碍和脊柱畸形症候群。常见原因为终丝栓系、脊髓脊膜膨出(meningomyelocele)型脊柱裂、脊髓分裂症和腰骶部皮毛窦等[1-4];而脊髓末端和终丝积水引起的脊髓栓系综合征临床较为罕见,特征性影像学改变为脊髓末端空洞形成、脊髓圆锥结构消失、脊髓末端和终丝积水。近10余年来,北京大学第三医院神经外科采用手术显微镜下终丝切断、髓内积水引流、脊髓栓系松解术共治疗10例脊髓末端积水合并脊髓栓系综合征患者,疗效满意,现回顾分析其临床表现、影像学特点、治疗和预后情况,以指导临床实践。

资料与方法

一、临床资料

选择1999年1月–2014年3月北京大学第三医院神经外科诊断与治疗的脊髓末端积水合并脊髓栓系综合征患者10例,男性3例,女性7例;年龄2~35岁,平均15.06岁;病程3个月至20年,平均42.17个月。所有患者均以不同程度下肢无力为首发症状,尤以肢体远端显著,其中5例伴不同程度大小便障碍;双下肢远端肌力减弱,其中3例伴肌萎缩;有5例存在与脊髓空洞平面相关的感觉障碍平面,并以浅感觉减退为主。术前视觉模拟评分(VAS)2~6分,平均3.61分;美国脊髓损伤协会(ASIA)关键肌肉力量评分71~91分,平均81.60分;日本矫形外科学会(JOA)括约肌功能评分1~3分,平均2.40分;McCormick神经功能分级Ⅰ~Ⅲ级,平均Ⅱ级。术前10例患者均行脊柱X线检查,8例存在脊柱裂,6例发生椎管扩大以及椎弓根和椎体压迫性或浸润性破坏;2例患者行脊柱CT检查显示,骶部脊柱裂,同时可见椎管内低密度影;10例患者均行脊柱MRI检查显示,脊髓末端无圆锥结构,脊髓末端和终丝呈长T_1、长T_2信号,增强扫描囊壁无明显强化(图1)。本组患者中1例为全脊髓积水、8例为骶管内脊膜囊肿、1例合并骶部皮毛窦。10例患者的临床资料参见表1。

二、研究方法

1.手术方法 患者俯卧位,腰骶部位于最高点,于静脉麻醉复合吸入麻醉下行脊髓栓系松解术。经X线定位以L_5~S_3为中心作后正中纵行切口,长度为6~8 cm,逐层切开皮肤、皮下组织、筋膜层,骨膜下剥离骶棘肌,显露L_5棘突、椎板下缘和S_{1-3}背侧(自骶正中嵴至骶中间嵴),注意保护小关节囊及其所附肌肉,咬骨钳咬除骶正中嵴,椎板咬骨钳自中线向两侧咬除S_{1-3}节段骶管后壁至骶中间嵴,形成2 cm×4 cm大小骨窗,以显露脊膜囊肿末端、骶管囊肿壁;必要时行L_5椎板切除术,显露内终丝囊肿末端。通常情况下,S_2水平为硬脊膜囊末端,其尾端可见脊膜囊肿。沿中线剪开S_2头端硬脊膜层,向双侧悬吊,再剪开硬脊膜囊尾端脊膜囊肿壁,先剥离并切除囊肿壁,提起其内终丝,向头端逆行分离终丝,直至可见终丝内脑脊液流动,切除终丝,使脊髓空洞内液体流出,脊髓张力下降,脊髓末端上升(http://www.cjcnn.org/index.php/cjcnn/pages/view/v1633)。予大量生理盐水冲洗至颜色清亮,可见马尾神经松弛于椎管腹侧,以5-0血管吻合线连续缝合硬脊膜层,重建完整的硬脊膜囊,逐层缝合骶棘肌、筋膜层、皮下组织,皮内缝合皮肤。本组有1例患者(例10)同时行髓内积水最大层面(L_2水平)椎板切除术和脊髓空洞切开引流术,证实为脊髓空洞症。我科自2011年1月开展术中神经电生理学监测以来,有5例患者行术中神经电生理学监测,主要以探针对内终丝进行甄别,以免术中损伤马尾神经。术后俯卧位,手术切口负重沙袋5~7 d,以防止脑脊液漏。

2.疗效评价 分别采用VAS量表、ASIA关键肌肉力量评分、JOA量表括约肌功能评分和McCormick神经功能分级评价手术疗效。(1)VAS量表:评价术后疼痛情况。0分,无疼痛;1~3分,轻微

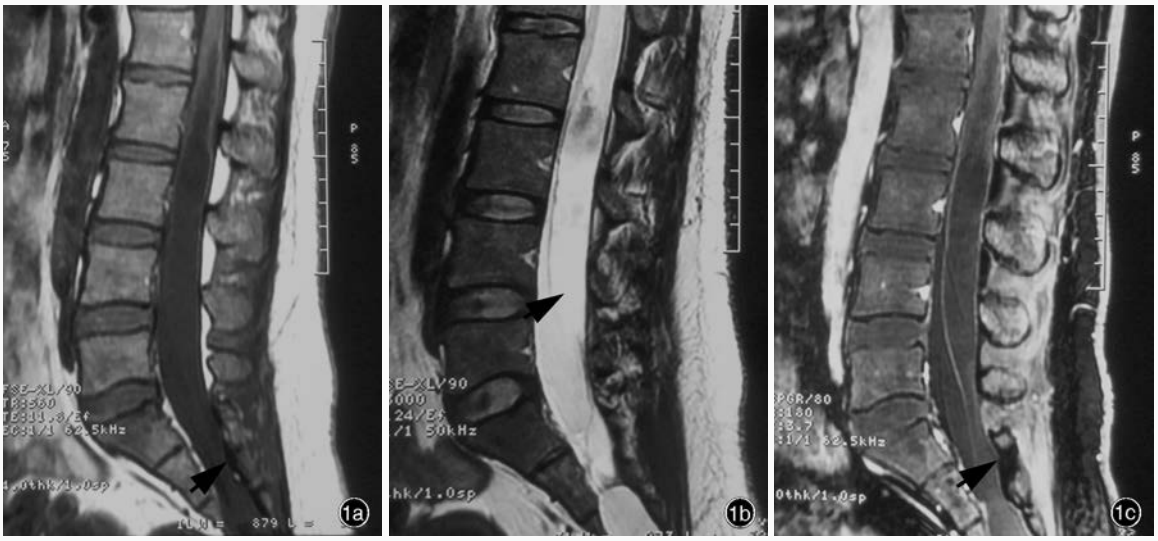

图1 女性患者(例10),33岁,临床诊断为脊髓末端积水合并S_{2-4}节段终丝脊膜囊肿。术前腰骶椎MRI检查所见 1a 矢状位T_1WI显示,脊髓末端无圆锥结构,代之以空洞,脊髓末端和内终丝呈低信号,直达S_2水平硬脊膜囊末端,硬脊膜囊末端可见脊膜囊肿(箭头所示) 1b 矢状位T_2WI显示,脊髓末端和内终丝高信号(箭头所示) 1c 矢状位增强T_1WI显示,脊髓末端和内终丝积水(箭头所示),腔内未见异常强化信号

Figure 1 Preoperative MRI findings of a 33-year-old female patient (Case 10) diagnosed as terminal syringomyelia within lower spinal cord combined with meningeal cyst at S_{2-4} sacral spine Sagittal T_1WI showed conus medullaris disappeared at the end of spinal cord, while there was fluid signal at the end of spinal cord and internal terminal filum with hypo-intensity signal along with the terminal of dural sac (S_2 level), and the meningeal cyst was shown at sacral level (arrow indicates, Panel 1a). Sagittal T_2WI showed hyper-intensity signal at the end of spinal cord and internal terminal filum (arrow indicates, Panel 1b). Sagittal fat-suppressed enhanced T_1WI showed fluid siganl at the end of spinal cord and internal terminal filum without enhancement (arrow indicates, Panel 1c).

表1 10例脊髓末端积水合并脊髓栓系综合征患者的临床资料

Table 1. Clinical data of 10 patients of terminal syringomyelia within spinal cord combined with TCS

Case	Sex	Age (year)	Duration (month)	VAS (score)	ASIA (score)	JOA (score)	McCormick (grade)	Segment of hydromyelia
1	Male	7	20	5	82	2	Ⅱ	L_2–S_2
2	Male	12	61	3	90	2	Ⅱ	L_{1-5}
3	Female	9	7	2	73	3	Ⅲ	T_{12}–S_2
4	Female	2	10	4	81	3	Ⅱ	T_{11}–S_1
5	Female	35	240	2	80	3	Ⅲ	L_1–S_1
6	Male	11	36	3	71	2	Ⅲ	T_{12}–L_4
7	Female	6	8	2	85	2	Ⅱ	T_5–S_1
8	Female	26	3	4	91	3	Ⅰ	T_7–S_1
9	Female	14	15	6	90	1	Ⅲ	C_1–L_5
10	Female	33	21	5	73	3	Ⅱ	L_1–S_1

VAS, Visual Analogue Scale, 视觉模拟评分; ASIA, American Spinal Injury Association, 美国脊髓损伤协会; JOA, Japanese Orthopedic Association, 日本矫形外科学会

疼痛,可忍受;4~6分,疼痛影响睡眠,但可忍受;7~10分,较强烈疼痛,难以忍受,影响睡眠和食欲。(2)ASIA关键肌肉力量评分:评价肢体运动功能。包括关键肌上肢五组(C_5神经根支配的肱二头肌、C_6神经根支配的桡侧腕伸肌、C_7神经根支配的肱三头肌、C_8神经根支配的中指指深屈肌、T_1神经根支配的小指外展肌)和下肢五组(L_2神经根支配的髂腰肌、L_3神经根支配的股四头肌、L_4神经根支配的胫前肌、L_5神经根支配的跨背伸肌、S_1神经根支配的腓肠肌),每组肌肉分0~5级,总评分100分,0级,肌肉麻痹,无收缩力;1级,有主动收缩力,但不能带动关节活动;2级,可带动关节水平活动,但不能对抗地心引力;3级,能对抗地心引力带动关节活动,但不能对抗阻力;4级,能对抗较大阻力,但肌力仍较正

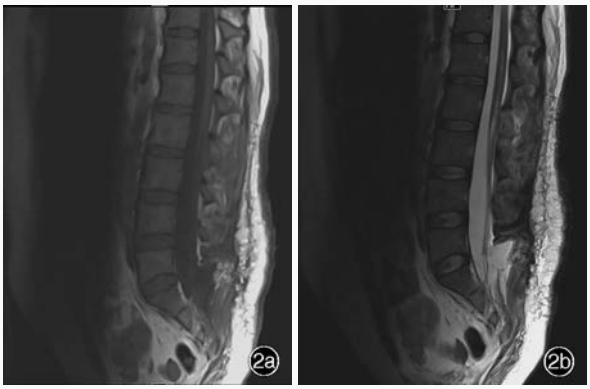

图2　例10患者术后腰骶椎MRI检查显示，脊髓末端圆锥结构位于L_2水平，髓内积水消失，骶管内脊膜囊肿消失，L_2节段和骶管后壁骨性结构阙如，脊柱生理曲度无明显变化　2a　矢状位T_1WI　2b　矢状位T_2WI

Figure 2　Postoperative MRI findings of Case 10　Sagittal T_1WI (Panel 2a) and sagittal T_2WI (Panel 2b) showed the conus medullaris of spinal cord was located at the level of L_2, and the fluid within spinal cord as well as the meningeal cyst disappeared. Bone defect of L_2 segment and posterior sacral canal was noted due to operation process. The physiological curvature of lumbar spine had no obvious change compared with preoperation.

常减弱；5级，肌力正常。(3)JOA量表括约肌功能评分[5]：评价膀胱功能。0分，尿闭症或尿失禁；1分，排尿不尽感、排尿费力、排尿时间延长、尿痛；2分，排尿延迟、尿频；3分，排尿正常。(4)McCormick神经功能分级[6]：评价脊髓功能。Ⅰ级，神经系统检查正常，轻度局灶性神经功能缺损但不影响肢体功能，轻度痉挛或反射异常，步态正常；Ⅱ级，存在感觉运动损害并影响肢体功能，轻至中度行走困难，重度疼痛或感觉迟钝且影响生活质量，可站立和独立行走；Ⅲ级，较严重的神经功能缺损，行走拄拐或使用支具，双上肢功能损害，生活能或不能自理；Ⅳ级，严重神经功能缺损症状，需使用支具或轮椅，双上肢功能严重损害，生活完全不能自理。术后3周即开始腰背部肌肉康复训练。所有患者分别于术后3和6个月进行随访，此后隔年随访，复查脊柱MRI以评价脊髓形态和脊柱稳定性。

结　果

本组患者均手术切断终丝、引流髓内积水、松解脊髓与周围蛛网膜粘连，手术成功率达到100%，1例全脊髓积水患者术后效果满意、8例骶管内脊膜囊肿患者完整切除囊肿、1例骶部皮毛窦患者全切除皮毛窦。手术时间1.52～3.07 h，平均2.15 h；术中出血量100～410 ml，平均220 ml。所有患者均于S_2水平缝合硬脊膜囊，重建硬脊膜囊结构。切除的终丝标本经组织病理学检查证实均符合终丝结构；脊膜囊肿壁呈纤维结缔组织结构，部分可见内衬扁平上皮样细胞，大部分未见上皮样结构。本组无一例发生手术相关并发症。

本组患者住院7～12 d，平均8.16 d；出院时VAS评分降至0～3分，平均1.23分；ASIA关键肌肉力量评分增至89～100分，平均93.12分，其中2例患儿(例3和例6)术后24 h踝关节背伸肌力由0级升高至4级，总评分由90分增加至98分；5例括约肌障碍患者JOA量表括约肌功能评分增加至2～3分，平均2.70分。

本组10例患者术后随访6个月至14.50年，平均6.10年。至末次随访时，McCormick神经功能分级均达Ⅰ级；复查脊柱MRI显示，脊髓圆锥结构恢复、脊髓末端上升、髓内积水消失，脊柱序列保持良好(图2)。

典型病例

患儿(例9)　女性，14岁，因双下肢无力、右下肢神经源性间歇性跛行6个月，于2011年6月22日入院。患儿于6个月前无明显诱因出现双下肢无力，尤以右下肢显著且伴间歇性跛行，当地医院行双下肢X线检查未见异常；脊柱MRI检查提示脊髓空洞症，骶管内脊膜囊肿。为求进一步手术治疗至我院就诊。入院后体格检查：神志清楚，语言流利，主动体位，跛行步态，脑神经检查未见异常；左小腿前内侧和右小腿浅感觉减退，双下肢位置觉减退；左侧髂腰肌肌力5级、股四头肌5级、胫前肌4级、跨背伸肌4级、腓肠肌4级，右侧髂腰肌肌力5级、股四头肌4级、胫前肌3级、跨背伸肌3级、腓肠肌3级，双下肢肌张力均正常，无肌萎缩；肛门括约肌松弛；四肢腱反射未见明显异常，病理反射未引出。VAS评分6分，ASIA关键肌肉力量评分90分，JOA量表括约肌功能评分1分，McCormick神经功能分级Ⅲ级。实验室检查各项指标未见明显异常。脊柱MRI检查(2011年6月24日)显示，全脊髓空洞，脊髓圆锥结构消失，骶管内脊膜囊肿(图3)。患儿自发病以来，精神、睡眠、饮食正常，体重无明显下降，大便干燥、小便偶失禁。既往史和家族史均无特殊，否认双侧肢体麻木史、否认上肢无力史。生于河南省南阳市，久居北京市；月经初潮13岁、月经周期30 d、经期3～4 d，末次月经2011年6月6日；未婚。临床

诊断为脊髓空洞症;骶管内脊膜囊肿;脊髓栓系综合征。遂于2011年6月29日行后入路L_5椎板和$S_{1\sim2}$骶管后壁切除、骶管内脊膜囊肿切除、终丝切断、髓内积水引流、脊髓栓系松解术。术中可见脊髓末端位于$L_{4\sim5}$水平,尾端过渡为内终丝,内终丝增粗(约为5 mm)牵拉脊髓,脊髓肿胀,脊髓空洞形成,其内可见脑脊液流动。内终丝于L_5水平突破硬脊膜囊过渡为外终丝,外终丝包膜形成囊肿,大小约5 cm×2 cm×2 cm。先剥离并切除囊肿壁,于L_5水平分离终丝与周围马尾神经的粘连,切断终丝,可见空洞内液体流出,脊髓张力下降,脊髓末端上升,脊髓和马尾神经根搏动良好。手术时间1.50 h,术中出血量50 ml,无手术相关并发症。术后VAS评分3分,ASIA关键肌肉力量评分96分,JOA量表括约肌功能评分2分,McCormick神经功能分级为Ⅱ级。术后第5天(2011年7月4日)双下肢肌力均恢复至5级,ASIA关键肌肉力量评分达100分;复查脊柱MRI显示髓内积水明显减少,脊髓圆锥结构恢复,骶管内脊膜囊肿消失(图4)。患儿共住院8 d,痊愈出院。至末次随访时(2015年12月29日),体格检查未见明显异常,已正常上学。

讨 论

脊髓由外胚层发育而成,胚胎发育早期,脊髓与椎管长度大致相等,随后脊柱生长速度快于脊髓,使脊髓逐渐上升,出生时脊髓末端位于$L_{1\sim2}$水平,至出生后3个月脊髓形态可达成人水平,即圆锥尖位于L_1水平,误差不超过1 cm。脊髓圆锥逐渐变细而移行为终丝,成人终丝直径小于2 mm,内终丝于硬脊膜囊末端(S_2水平)突破硬脊膜囊过渡为外终丝,附着于尾椎。脊髓栓系综合征系由于各种先天性或获得性原因牵拉脊髓或脊髓圆锥使其下降而产生的一系列神经功能障碍和脊柱畸形症候群,临床主要表现为大小便功能障碍、下肢运动和感觉障碍等[7]。该病最早由Garceau[8]于1953年描述,Yamada等[3]于1981年正式命名。脊髓栓系综合征的病因学分型有多种类型[1-4],Lee等[9]根据牵拉原因将其分为5种类型:(1)脊髓脊膜膨出型。(2)终丝紧张。(3)脂肪瘤样畸形。(4)脊髓纵裂畸形。(5)蛛网膜粘连。笔者根据临床经验将其分为6种类型:(1)单纯终丝牵张型。(2)脊髓脊膜膨出型。(3)脊髓脂肪脊膜膨出型。(4)皮下瘘管牵拉型。(5)脊髓纵裂型。(6)继发型。然而在临床实际工作中,笔者仍发现一种特殊类型的脊髓栓系综合征,典型特征为脊髓末端无圆锥结构、脊髓末端和终丝积水致一系列神经功能障碍和脊柱畸形,尤其脊髓末端终丝结构异常,笔者将此种类型命名为脊髓末端积水合并脊髓栓系综合征。

脊髓末端积水合并脊髓栓系综合征临床较罕见[10],由于脊髓末端无圆锥结构,终丝增粗,易与髓内病变混淆,导致误诊或误治。明确诊断主要依靠临床和影像学特点。其临床特点为:(1)运动障碍主要以下肢远端肌肉下运动神经元损害为主,表现为肌力和肌张力下降、肌萎缩、腱反射减退甚至消失,患者常主诉进行性下肢无力和行走困难。(2)膀胱和直肠功能障碍较隐匿,因脊髓圆锥结构消失,加之脊髓受牵拉时最易损伤,故膀胱和直肠功能障碍常同时出现,前者表现为遗尿、尿频、尿急、尿失禁和尿潴留,后者表现为便秘和大便失禁。(3)相对于其他类型脊髓栓系综合征,此种类型患者鞍区和下肢疼痛症状不突出。(4)感觉障碍,表现为脊髓积水相关平面感觉障碍,常合并鞍区皮肤感觉麻木或减退。其影像学特点为:(1)脊髓下降。(2)脊髓末端无圆锥结构而直接过渡为内终丝。(3)脊髓末端和终丝积水。(4)多合并骶管内脊膜囊肿。(5)可导致胸髓甚至全脊髓空洞。(6)多合并骶管脊柱裂。本组10例患者均以不同程度下肢无力为首发症状,5例伴尿道和肛门括约肌功能障碍。MRI是首选检查方法,脊髓末端无圆锥结构、髓内积水呈长条状囊液信号,与脑脊液信号相似,T_1WI低信号,T_2WI高信号,增强扫描囊壁无强化,髓内积水信号向内终丝延伸,多合并骶管内脊膜囊肿,可资与其他髓内病变相鉴别。

基于上述临床和影像学特点,手术指征明确,手术目的是防止进一步神经功能缺损,行脊髓栓系松解术,手术要点为:(1)骶管后壁切除范围不宜过大,1.50 cm宽即可显露术野并进行操作。(2)显露和切除骶管后壁,显露正常硬脊膜囊末端、外终丝囊肿。(3)剪开正常硬脊膜,向两侧悬吊以显露硬脊膜下隙,向尾端顺行剪开至内终丝突破硬脊膜囊处,此处即为脑脊液漏口,剪开外终丝囊壁,显露其内的终丝结构。(4)切除外终丝囊壁,逆向剥离终丝,直至内终丝积水处,由于囊壁周围有重要的骶神经根,应轻柔操作。(5)将内终丝于脊髓积水处横断,既解除脊髓牵拉因素,又可将脊髓积水引流。(6)松解牵拉脊髓的其他因素。(7)将终丝向头侧牵引,若

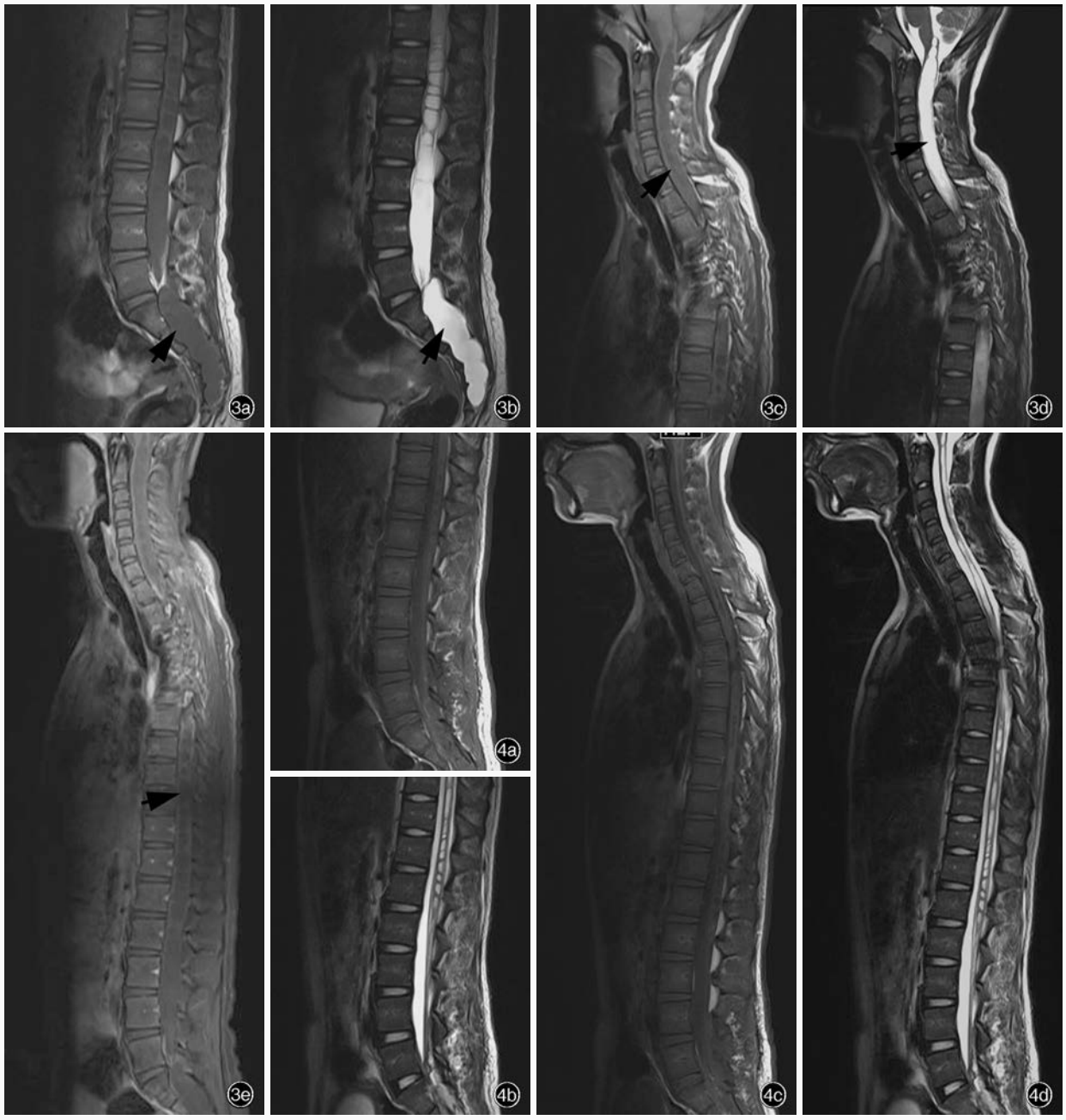

图3　术前脊柱MRI检查所见　3a　下段胸椎和腰骶椎矢状位T_1WI显示，脊髓下段和内终丝积水，骶管内脊膜囊肿（箭头所示）　3b　下段胸椎和腰骶椎矢状位T_2WI显示，脊髓下段和内终丝积水，骶管内脊膜囊肿（箭头所示）　3c　颈胸椎矢状位T_1WI显示脊髓空洞（箭头所示）　3d　颈胸椎矢状位T_2WI显示脊髓空洞（箭头所示）　3e　全脊柱重建矢状位增强T_1WI显示全脊髓空洞（箭头所示）　**图4**　术后脊柱MRI检查所见　4a　矢状位T_1WI显示，脊髓圆锥结构恢复，位于L_2水平，脊髓末端和内终丝积水消失　4b　矢状位T_2WI显示，脊髓圆锥结构恢复，位于L_2水平，脊髓末端和内终丝积水消失　4c　全脊柱重建矢状位增强T_1WI显示全脊髓空洞减少或消失　4d　全脊柱重建矢状位增强T_2WI显示全脊髓空洞减少或消失

Figure 3　Preoperative spinal MRI findings　Sagittal T_1WI (Panel 3a) and T_2WI (Panel 3b) of lower thoracic, and lumbosacral vertebrae showed the fluid signal of lower spinal cord and internal terminal filum, as well as sacral meningeal cyst (arrows indicate). Cervical-thoracic sagittal T_1WI (Panel 3c) and T_2WI (Panel 3d) showed syringomyelia (arrows indicate). Sagittal enhanced reconstructed whole spine T_1WI revealed syringomyelia within the spinal cord from cervical down to lumbar spine (arrow indicates, Panel 3e). **Figure 4**　Postoperative spinal MRI findings　Sagittal fat-suppressed T_1WI (Panel 4a) and T_2WI (Panel 4b) showed the conus medullaris of spinal cord was restored and located at the level of L_2, furthermore, the fluid signal at the end of spinal cord along with the internal terminal filum disappeared. Sagittal enhanced reconstructed whole spine T_1WI (Panel 4c) and T_2WI (Panel 4d) demonstrated that syringomyelia within the spinal cord from cervical down to lumbar spine was reduced or vanished.

反向牵引极易造成圆锥的附加损害。(8)为避免手术对脊髓的损伤,有效的术中神经电生理学监测尤为重要[11]。(9)以5-0血管吻合线缝合硬脊膜末端漏口,重建完整硬脊膜囊。(10)术后嘱患者俯卧位5~7天,以保证漏口愈合。本组10例患者均采用后路腰骶部入路手术行终丝切断、髓内积水引流、脊髓栓系松解术,其中1例(例10)术中在脊髓积水最显著的腰椎部位探查,行空洞穿刺术,均获得满意疗效。术后平均随访6.10年,所有患者神经功能完好,尤其是尿道和肛门括约肌功能恢复满意,复查MRI显示脊髓圆锥结构恢复、髓内积水消失、脊髓末端上升,由于术中对脊柱稳定性的保护,脊柱生理曲度保持良好。

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Epigenetic Methods in Neuroscience Research published

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