·神经影像学·

颈髓脱髓鞘病变与髓内胶质瘤的鉴别诊断

贺桂女 韩雄 王恩锋 王莉梅 袁丽品 李艳伟 晏僖

【摘要】 **目的** 对颈髓炎性脱髓鞘病变和髓内胶质瘤的影像学特征进行分析，以提高对二者的鉴别诊断能力。**方法与结果** 对22例颈髓炎性脱髓鞘病变、16例颈髓髓内胶质瘤患者的临床资料和MRI表现进行回顾分析。结果显示，两组患者临床均表现为感觉异常[77.27%(17/22)和12/16]、肢体无力[72.73%(16/22)和10/16]和自主神经功能紊乱[45.45%(10/22)和4/16]。颈髓MRI检查病灶≥3个椎体节段者分别占63.64%(14/22)和15/16，病灶平均长度为(3.41±1.74)和(3.59±1.28)个椎体节段；呈长T_1[68.18%(15/22)和7/16]、等T_1[31.82%(7/22)和6/16]或长T_2信号[100.00%(22/22)和8/15]，胶质瘤组尚可见混杂T_1和混杂T_2信号(3/16和6/15)；脱髓鞘病变组患者病灶边界模糊常见[90.91%(20/22)]，并以条片状和点状强化为主(13/16)，而胶质瘤组则以局限性脊髓增粗(15/16)、脊膜增厚(14/16)更常见，呈块状或环形强化(12/16)，且可见中央管周围脊髓组织受累(14/15)，易发生颈髓囊性变或中央管扩张、出血坏死和"帽征"(7/16、5/16和4/16)。**结论** 虽然任何单一临床和MRI特征均不足以鉴别颈髓炎性脱髓鞘病变和髓内胶质瘤，但不同特征综合分析有助于提高鉴别诊断水平。

【关键词】 脱髓鞘疾病； 神经胶质瘤； 脊髓； 磁共振成像； 诊断，鉴别

Differential diagnosis of cervical spinal cord demyelinating diseases and cervical intramedullary gliomas

HE Gui-nü[1], HAN Xiong[1], WANG En-feng[2], WANG Li-mei[3], YUAN Li-pin[1], LI Yan-wei[1], YAN Xi[1]

[1]Department of Neurology, [2]Department of Radioloy, People's Hospital of Zhengzhou University, Zhengzhou 450003, Henan, China

[3]Department of Neurology, the First Affiliated Hospital of Zhengzhou University, Zhengzhou 450052, Henan, China

Corresponding author: HAN Xiong (Email: hanxiong7589@126.com)

【**Abstract**】 **Objective** To analyze the imaging characteristics of cervical spinal cord demyelinating diseases and cervical intramedullary gliomas, so as to improve the differential diagnosis between them. **Methods** A retrospective analysis was conducted using clinical and MRI data from 22 cases of cervical spinal cord demyelinating diseases and 16 cases of cervical intramedullary gliomas. **Results** Clinical features in both groups included paresthesia [77.27% (17/22), 12/16], weakness of limbs [72.73% (16/22), 10/16], and dysfunction of autonomic nerve [45.45% (10/22), 4/16]. In cervical MRI, the lesions involving more than 3 vertebras were 63.64% (14/22) in demyelinating group and 15/16 in glioma group, and the average lengths of lesions were (3.41 ± 1.74) and (3.59 ± 1.28) vertebras in 2 groups. The lesions showed long T_1 signal [68.18% (15/22), 7/16], equisignal T_1 [31.82% (7/22), 6/16] and long T_2 signal [100% (22/22), 8/15] in 2 groups. Mixed T_1 and T_2 signals (3/16, 6/15) could be seen in glioma group. Demyelinating lesions had unclear boundary [90.91% (20/22)] with patchy and ribbon-like enhancement (13/16). Limited enlargement of spinal cord (15/16) and thickening spinal meninges (14/16) were more common in glioma group, usually with block and circular enhancement (12/16). Spinal cord involvement around central canal could be seen (14/15), and the cysts or central canal enlargement, hemorrhage and "cap sign" were showed frequently (7/16, 5/16 and 4/16). **Conclusions** Although none of one single clinical or MRI feature was sufficient enough to identify cervical spinal demyelinating diseases from cervical glioma, the comprehensive analysis of multiple features could help to make differential diagnosis of these diseases.

【**Key words**】 Demyelinating diseases; Glioma; Spinal cord; Magnetic resonance imaging; Diagnosis, differential

doi:10.3969/j.issn.1672-6731.2014.09.008

作者单位：450003 郑州大学人民医院神经内科(贺桂女、韩雄、袁丽品、李艳伟、晏僖)，影像科(王恩锋)；450052 郑州大学第一附属医院神经内科(王莉梅)

通讯作者：韩雄(Email:hanxiong7589@126.com)

颈髓是多发性硬化(MS)[1]、视神经脊髓炎(NMO)[2]、临床孤立综合征(CIS)、急性横贯性脊髓炎(ATM)等炎性脱髓鞘疾病(demyelinative diseases)之好发部位,也是颈髓髓内胶质瘤的常见部位[3],临床鉴别比较困难,极易误诊[4]。由于这两类疾病治疗原则和临床转归的巨大差异,早期鉴别至关重要。鉴于病例数较少和颈髓MRI技术的限制[5],这两类患者的颈髓组织活检和外科手术风险较大且十分困难,相关文献报道亦较少[6-7]。在本研究中,我们对郑州大学人民医院神经内科近年诊断与治疗的22例颈髓炎性脱髓鞘病变和16例颈髓髓内胶质瘤患者的临床资料进行回顾分析,对比二者之间的差异,希望能够提高早期诊断水平并改善患者预后。

资料与方法

一、诊断标准

1. 多发性硬化　符合2010年McDonald诊断标准[8]:(1)≥2次临床发作,≥2个病灶的客观临床证据或有1个病灶的客观临床证据并有1次既往发作的合理证据。(2)≥2次临床发作,有1个病灶的客观临床证据并满足空间多发性。(3)有1次临床发作,≥2个病灶的客观临床证据并满足时间多发性。(4)临床孤立综合征并满足时间和空间多发性。

2. 视神经脊髓炎　均符合2006年Wingerchuk等[9]修订的诊断标准,脊髓和视神经均受累,并满足以下3项支持标准中至少2项:(1)脊髓MRI显示病灶长度≥3个椎体节段。(2)头部MRI不符合多发性硬化诊断标准。(3)血清NMO-IgG阳性。

3. 临床孤立综合征　首次发作,且有1项临床客观证据[8]。

4. 急性横贯性脊髓炎　符合2002年横贯性脊髓炎协作组(Transverse Myelitis Consortium Working Group)推荐的标准[10]:(1)感觉障碍、运动障碍和自主神经功能紊乱归因于脊髓。(2)有明确的感觉减退平面。(3)影像学检查排除脊髓外压迫性病因。(4)脑脊液检查呈炎症性改变。(5)症状出现后4小时至21天病情进展至低谷。

5. 胶质瘤　经郑州大学人民医院影像学或病理检查明确诊断。

二、纳入与排除标准

1. 纳入标准　入组病例均须满足上述相应诊断标准并颈髓受累。

2. 排除标准　经MRI检查和临床表现排除脊髓性颈椎病、创伤、畸形或其他肿瘤引起的脊髓损伤。

3. 一般资料　选择2012年1月–2014年7月就诊于我院的颈髓炎性脱髓鞘病变患者22例及同期在我院经影像学或术后病理检查诊断的颈髓髓内胶质瘤患者16例。(1)颈髓炎性脱髓鞘病变组(脱髓鞘病变组):男性10例,女性12例;年龄13~76岁,平均(43.55±18.60)岁;病程4小时至24个月,中位病程4周;急性期18例、慢性期4例。其中临床孤立综合征3例占13.64%、多发性硬化9例占40.91%、视神经脊髓炎4例占18.18%和急性横贯性脊髓炎6例占27.27%。(2)颈髓髓内胶质瘤组(胶质瘤组):男性8例,女性8例;年龄31~74岁,平均为(51.31±11.72)岁;病程1~36个月,中位病程10个月。其中影像学诊断9例,术后经病理检查证实7例(室管膜瘤6例、星形细胞瘤1例)。

三、观察方法

1. MRI检查　两组患者均于入院后行颈椎MRI检查。脱髓鞘病变组均行颈髓常规T_1WI、T_2WI扫描,其中21例行增强扫描;胶质瘤组均行颈髓T_1WI平扫和增强扫描、15例行常规T_2WI扫描。(1)设备与药品:检查设备为德国Siemens公司生产的Trio Tim 3.0T超导型MRI扫描仪,两通道常规颈部线圈由德国Siemens公司提供。增强扫描对比剂为钆-二乙三五醋酸(Gd-DTPA,469.01 mg/ml)10 ml,注射剂量0.10 mmol/kg。(2)检查方法:两组患者颈髓扫描序列为自旋回波序列(SE),即SE-T_1WI和SE-T_2WI。矢状位T_1WI重复时间(TR)500 ms、回波时间(TE)9.70 ms,视野(FOV)250 mm×250 mm,矩阵320×320,层厚3 mm,行无间隔扫描,平均采集次数2次;矢状位T_2WI重复时间4500 ms、回波时间91 ms,视野250 mm×250 mm,矩阵320×320,层厚3 mm,无间隔扫描,平均采集2次。横断面T_1WI重复时间542 ms、回波时间13.49 ms,视野200 mm×200 mm,矩阵256×192,层厚3 mm、无间隔,平均采集2次;横断面T_2WI重复时间5240 ms、回波时间87 ms,视野200 mm×200 mm,矩阵256×192,层厚3 mm、无间隔,平均采集2次。矢状位增强T_1WI重复时间845 ms、回波时间14 ms,视野250 mm×250 mm,矩阵320×320,扫描层厚3 mm、无间隔,平均采集次数2次;横断面增强T_1WI重复时间319 ms、回波时间13.49 ms,视野200 mm×200 mm,矩阵256×192,层厚3 mm、无间隔,平均采集2次。

2. 治疗方案 (1)脱髓鞘病变组：22例中19例行糖皮质激素或免疫抑制剂治疗，余3例因拒绝上述治疗仅予对症治疗。19例中18例在急性期以大剂量甲泼尼龙1000 mg/d或500 mg/d静脉滴注，连续冲击治疗3～5 d，病情改善者改为泼尼松60 mg/d清晨顿服，每3天剂量减半，直至2～3周后停药；1例在缓解期予小剂量泼尼松5～15 mg/d口服，共治疗3个月。上述18例急性期患者中2例联合免疫球蛋白0.40 g/(kg·d)静脉滴注，连续治疗5 d；1例辅助应用环磷酰胺200 mg/d静脉滴注，连续治疗5 d，同时充分水化治疗。治疗1个月后，18例临床症状明显缓解，4例效果不明显。(2)胶质瘤组：16例中7例行手术切除病灶，术后症状完全缓解4例，未缓解、原有症状加重和出现新发症状者各1例；其余9例均选择保守治疗。

结 果

一、一般情况及临床表现

脱髓鞘病变组22例患者中13例为首次发作、余9例为复发。脱髓鞘病变组和胶质瘤组患者临床症状与体征相似，均表现为感觉异常[77.27%(17/22)和12/16]，如麻木、疼痛、束带感、Lhermitte征，肢体无力[72.73%(16/22)和10/16]，以及自主神经功能紊乱[45.45%(10/22)和4/16]；其中脱髓鞘病变组有3例(13.64%)伴视物异常。

二、MRI表现

脱髓鞘病变组和胶质瘤组患者病灶长度分别为0.50～7和2～7个椎体节段，平均(3.41±1.74)和(3.59±1.28)个；病灶≥3个椎体节段者分别占63.64%(14/22，余8例病灶<3个椎体节段者中多发性硬化6例)和15/16；有强化病灶者分别占76.19%(16/21)和16/16。

脱髓鞘病变组和胶质瘤组患者MRI检查显示(图1，2)，病灶呈长T_1[68.18%(15/22)和7/16]、等T_1[31.82%(7/22)和6/16]或长T_2信号[100%(22/22)和8/15]，胶质瘤组部分患者还可见混杂T_1(3/16)和混杂T_2信号(6/15)。脱髓鞘病变组患者病灶边界模糊[90.91%(20/22)]，伴脊髓增粗[59.09%(13/22)]或脊膜增厚[45.45%(10/22)]，而胶质瘤组患者病灶边界清晰(11/16)、脊髓增粗(15/16)和脊膜增厚(14/16)征象更常见；脱髓鞘病变组患者病灶多呈条片状或点状强化(13/16)，其中块状和环形强化分别占2/16和1/16，而胶质瘤组病灶主要呈块状或环形强化(12/16)，其中条片状强化仅占4/16，无点状强化。胶质瘤组出现髓内囊性变或中央管扩张、出血坏死、病灶头和(或)尾端“帽征”的比例分别为7/16、5/16和4/16，而脱髓鞘病变组未见上述表现。

横断面T_2WI显示，两组患者病灶累及白质前索[68.18%(15/22和13/15]、侧索[81.82%(18/22)和12/15]、后索[63.64%(14/22)和13/15]，以及灰质前角[59.09%(13/22)和13/15]、侧角[54.55%(12/22)和12/15]、后角[45.45%(10/22)和10/15]的概率相近，但胶质瘤组病例病灶累及中央管周围者多见，占14/15，而脱髓鞘组为11/22。

讨 论

本研究所纳入的颈髓脱髓鞘病变患者平均年龄为(43.55±18.60)岁，临床症状以感觉异常居首位(77.27%)，其次分别为肢体无力(72.73%)、自主神经功能紊乱(45.45%)或视物异常(13.64%)，与文献报道相似[11-12]。Lowe[13]研究发现，室管膜瘤多发生于40～50岁患者，以男性多见，而本组胶质瘤组患者平均年龄为(51.31±11.72)岁，男女比例1∶1，可能与病例数较少有关。

临床观察表明，常规MRI技术对脊髓病变的检出率可高达90%[14]，对脊髓脱髓鞘病变与胶质瘤的鉴别诊断具有重要作用。在本研究中，脱髓鞘病变组9例多发性硬化患者中6例颈髓病灶<3个椎体节段，但约63.64%(14/22)的患者颈髓病灶≥3个椎体节段，其中1例多发性硬化患者病灶累及6个椎体节段，支持沈雪莉等[15]关于我国部分多发性硬化患者脊髓病灶可累及>2个椎体节段的观点。本研究所显示的两组患者颈髓受累长度和病灶平均长度，以及脱髓鞘病变组患者病灶边界模糊，胶质瘤组边界清晰，均与文献报道相似[15-18]；而MRI显示脊髓增粗更多见于髓内胶质瘤[18]，可能与脱髓鞘病变系炎症或自身免疫反应导致的组织间隙水肿、白细胞浸润，周围血管通透性增加等，使病灶和周围脊髓肿胀、增粗有关，而颈髓髓内胶质瘤组患者因病灶主要位于脊髓中央且周围组织水肿明显，因此局部增粗影像更常见且十分显著。

颈髓脱髓鞘病变在MRI上主要表现为低或等T_1、长T_2信号，病灶单发或多发不连续[11-12,15-16]，而髓内胶质瘤则表现为低或等T_1信号和高或混杂T_2信

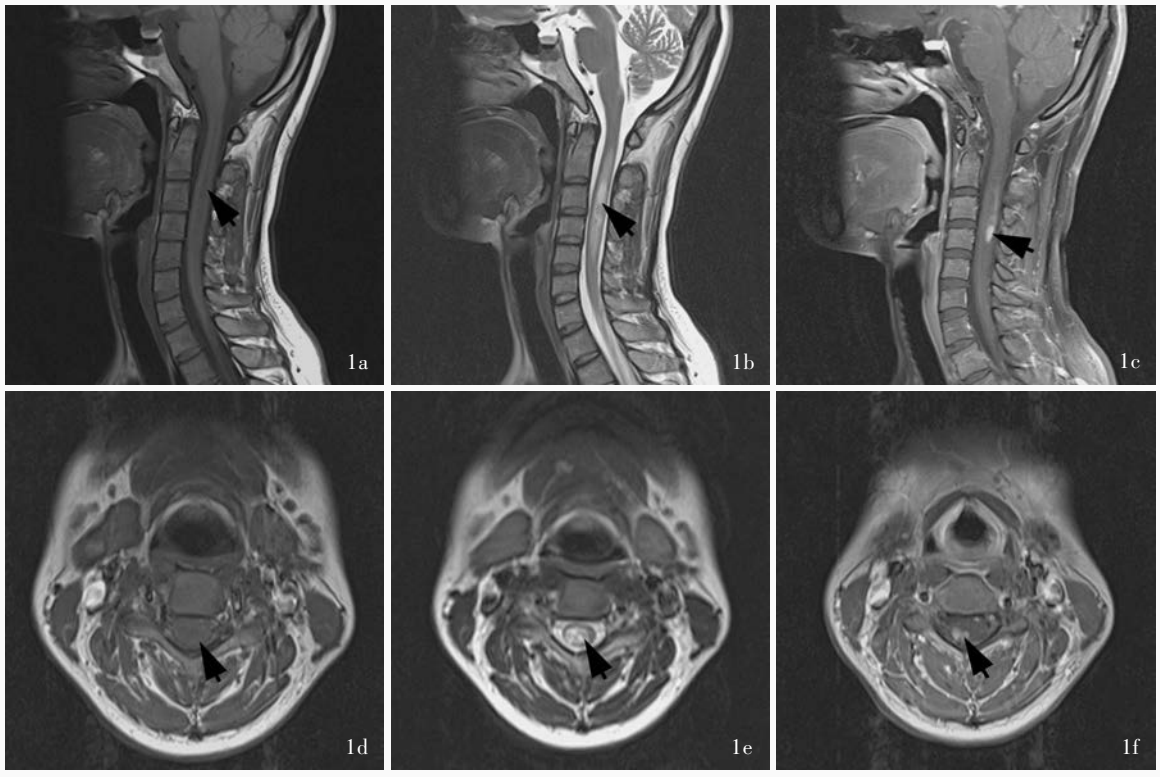

图1 女性患者，25岁。主因右眼视物模糊18个月、右侧肢体麻木无力2 d就诊。体格检查：右眼视力减退，右上肢和T_5水平以下浅感觉显著减退。实验室检查：血清NMO-IgG阳性。临床诊断：视神经脊髓炎。MRI检查所见 1a 矢状位T_1WI显示，C_{2-5}水平不均匀低信号（箭头所示） 1b 矢状位T_2WI显示病灶呈高信号（箭头所示），共累及4个颈髓节段，局部颈髓明显肿胀，蛛网膜下隙狭窄 1c 矢状位增强T_1WI显示，C_{2-4}水平呈条片状不均匀强化（箭头所示），边界欠清晰但脊膜无增厚 1d 横断面T_1WI显示病灶呈低信号（箭头所示） 1e 横断面T_2WI显示，病变弥漫性累及颈髓周围白质和中央灰质，信号不均匀（箭头所示） 1f 横断面增强T_1WI显示，病变呈局灶性强化（箭头所示），位于右侧后索和侧索

Figure 1 A 25-year-old female patient presented with right eye blurred vision for 18 months and right limb numbness for 2 d. Physical examination: right eye hypopsia, right upper limb and below T_5 superficial sensibility hypoesthesia. Laboratory test: NMO-IgG was positive. Clinical diagnosis: NMO. MRI findings. Sagittal T_1WI showed heterogeneous low-intensity signal of C_{2-5} (arrow indicates, Panel 1a). Sagittal T_2WI showed high-intensity signal of the lesion (arrow indicates), which involved C_{2-5} level, with obvious swelling of partly cervical cord and stenosis of subarachnoid (Panel 1b). Sagittal enhanced T_1WI showed the lesion with uneven patchy and ribbon-like enhancement of C_{2-4} level (arrow indicates), with vague border and without spinal meninges thickening (Panel 1c). Axial T_1WI showed low-intenisty signal of lesion (arrow indicates, Panel 1d). Axial T_2WI showed the lesion involved surrounding white matter and central gray matter in cervical cord, and with uneven signal (arrow indicates, Panel 1e). Axial enhanced T_1WI showed the lesion of cervical cord with focal enhancement (arrow indicates), and located in the right side of posterior and lateral funiculus of spinal cord (Panel 1f).

号[3,18-19]，与本组病例的观察结果相似。本研究结果显示，髓内胶质瘤组患者出现混杂T_1和混杂T_2信号的比例分别为4/16和6/15，但颈髓脱髓鞘病变组病例无相似发现，因此，可能有助于二者的鉴别。从横断面MRI观察，脱髓鞘病变主要累及脊髓白质但灰质亦可受累[20]，而髓内胶质瘤则以脊髓中央受累多见[3]，本研究亦是如此；可能的原因为室管膜瘤等胶质瘤多起源于脊髓中央管周围室管膜细胞，且呈膨胀性生长；脱髓鞘病变则为小静脉周围炎症而形成偏心性分布[15]。颈髓脱髓鞘病变因病程和局部病损程度不同，增强扫描可表现为强化或不强化，本研究颈髓脱髓鞘病变组病灶强化者占76.19%（16/21），明显高于Bot等[1]报告的17.20%，可能与MRI场强有关（3.0T对1.0T）。本研究与同类研究结果相类似，颈髓脱髓鞘病变强化特征呈条片状或点状[11,15]，而髓内胶质瘤则因病灶血供丰富，故强化明显且多呈块状或环形[3,17]。

既往研究较少涉及脊膜改变，本研究颈髓脱髓鞘病变组患者局部脊膜增厚者（45.45%）明显少于髓内胶质瘤组（15/16），但其机制尚不十分清楚。汤化民等[21]发现，约有36.60%的视神经脊髓炎患者最终可出现脊髓囊性变或中央管扩张，而本研究颈髓脱髓鞘病变组无一例发生囊性变或中央管扩张、出血坏死，这种差异性可能与病程长短有关；髓内胶

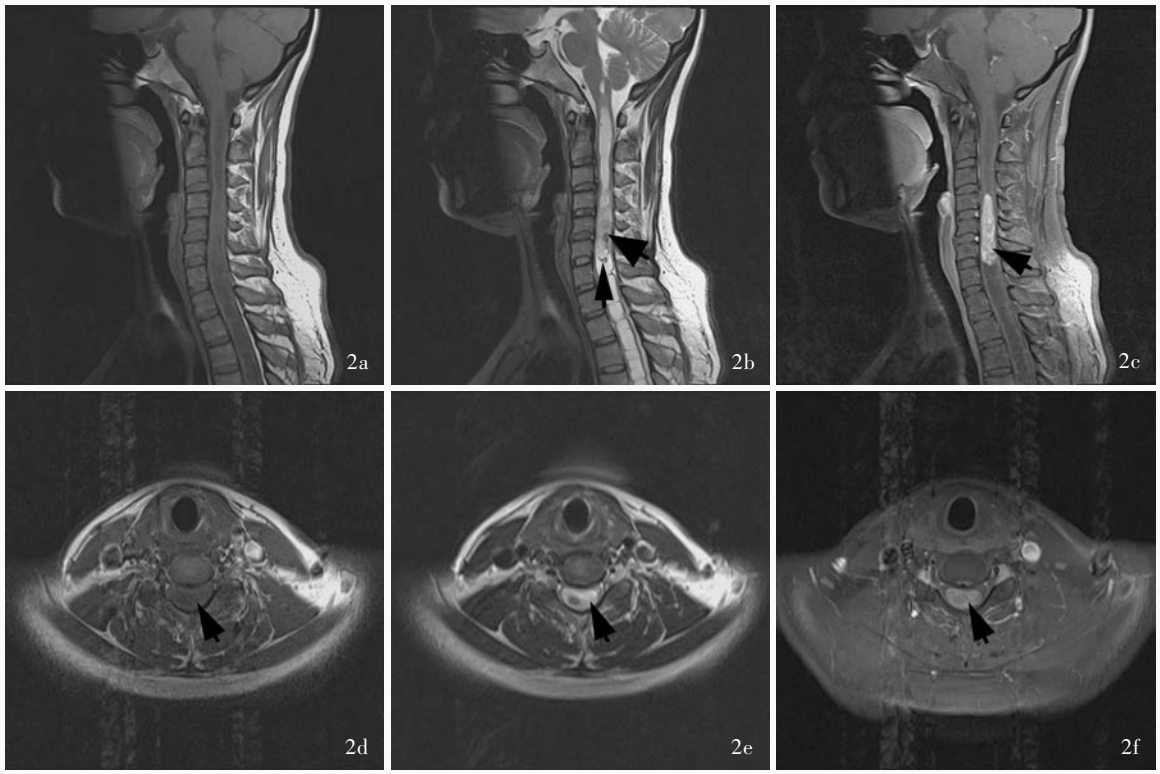

图2 女性患者，36岁。主因肩背部疼痛不适1月余就诊。体格检查：双上肢痛温觉减退。手术切除占位性病变，术后病理检查证实为室管膜瘤（WHOⅡ级）。MRI检查所见 2a 矢状位T_1WI显示，病灶位于C_{4-6}水平，呈等信号，病灶上下可见长节段低信号，为囊性变或中央管扩张，占位效应明显，颈髓增粗 2b 矢状位T_2WI显示，病灶位于C_{4-6}水平，呈混杂信号（粗箭头所示），病灶上下可见长节段高信号，为囊性变或中央管扩张，尾端可见“帽征”（细箭头所示），占位效应明显，颈髓增粗 2c 矢状位增强T_1WI显示，C_{4-6}水平明显强化（箭头所示），病灶边界清晰，其内有点片状低信号，脊膜无明显强化 2d 横断面T_1WI显示，颈髓病灶呈低信号（箭头所示） 2e 横断面T_2WI显示，颈髓病灶呈高低混杂信号（箭头所示），为弥漫性横贯性损害 2f 横断面增强T_1WI显示，颈髓病灶不均匀强化，呈完全横贯性混杂信号（箭头所示）

Figure 2 A 36-year-old female complained of shoulder and back pain for more than one month. Physical examination: pain and temperature sensibility hypoesthesia of both upper limbs. Pathological diagnosis: ependymoma (WHOⅡ). MRI findings. Sagittal T_1WI showed the lesion was located in C_{4-6} with isointense. Upper and lower part of the lesion showed long segment low signal, which was cysts or enlargement of central canal of spinal cord. The lesion had significant mass effect with thickening cervical cord (Panel 2a). Sagittal T_2WI showed mixed intensity (thick arrow indicates), and upper and lower part of the lesion showed long segment high signal, which was enlargement of central canal of spinal cord or cysts. There was "cap sign" in caudal end of the lesion (thin arrow indicates), and the lesion had significant mass effect with thickening cervical cord (Panel 2b). Sagittal enhanced T_1WI showed the lesion with significant enhancement (arrow indicates), with sharp border and low-intensity signal in the lesion. The spinal meninges was not significantly enhanced (Panel 2c). Axial T_1WI showed the lesion with low-intensity signal (arrow indicates, Panel 2d). Axial T_2WI there were mixed signals in the lesion (arrow indicates), with widespread transverse injury of spinal cord (Panel 2e). Axial enhanced T_1WI showed heterogeneous enhancement and complete transverse mixed signals of the lesion in cervical cord (arrow indicates, Panel 2f).

质瘤组患者病灶呈囊性变或中央管扩张、出血坏死、头和（或）尾端“帽征”发生率分别为7/16、5/16和4/16。因此，我们认为，MRI一旦发现脊髓囊性变或中央管扩张、出血坏死、“帽征”，应考虑髓内胶质瘤占位性改变。

值得强调的是，3.0T场强MRI对病变的阳性检出率优于1.5T MRI[22]，并应按照多发性硬化共识[23]的建议，对所有患者施行矢状位T_1WI、快速自旋回波（FSE）、质子密度加权像（PDWI）和T_1WI增强扫描，必要时选择病灶节段进行横断面FSE/T_2WI、T_1WI增强扫描、3D-T_1WI和短时间反转恢复（STIR），或行脊髓组织活检[6-7]以明确病灶性质。对于临床无法明确诊断的病变，可先以炎性脱髓鞘病变进行试验性治疗，1个月后随访，若病灶缩小，进一步支持炎性脱髓鞘病变的诊断；如病灶扩大或无明显变化则可考虑外科手术治疗。本研究颈髓脱髓鞘病变组22例患者中19例行糖皮质激素或免疫抑制剂治疗，18例临床症状明显缓解，支持Yaghi等[7]关于先进行糖皮质激素试验性治疗的观点。

根据对本组病例的观察并复习相关文献，我们

认为，任何一项单纯临床和MRI特征均不足以鉴别颈髓脱髓鞘病变和胶质瘤，但凡具有以下特征者则支持颈髓脱髓鞘病变：(1)呈急性或亚急性发病，临床反复发作。(2)颈髓内单发或多发不连续病灶，位置偏离中央管、边界模糊，MRI呈长或等T_1信号、长T_2信号。(3)增强扫描呈条片状或点状强化。(4)糖皮质激素治疗后1个月复查MRI显示病灶缩小或完全消失。支持颈髓髓内胶质瘤的特征性改变：(1)表现为慢性病程。(2)脊髓中央可见长节段病灶，呈混杂T_1和混杂T_2信号。(3)病灶内发生囊性变或中央管扩张、出血坏死、头和(或)尾端“帽征”。(4)增强扫描显示脊膜增厚、脊髓增粗。(5)糖皮质激素治疗后1个月复查MRI显示病灶扩大或无明显变化。

本研究对颈髓脱髓鞘病变和胶质瘤之临床和影像学特征进行对比分析，有助于提高临床医师对这两种脊髓病变的鉴别诊断能力。本研究的局限性为样本量较小，不能进行多发性硬化、视神经脊髓炎、临床孤立综合征等亚组分析；存在回顾性研究的局限性；未对两组患者脑脊液NMO-IgG变化进行分析；本研究髓内胶质瘤组患者仅部分获得病理诊断结果，故尚待进一步研究。

参 考 文 献

[1] Bot JC, Barkhof F, Lycklamaà Nijeholt G, van Schaardenburg D, Voskuyl AE, Ader HJ, Pijnenburg JA, Polman CH, Uitdehaag BM, Vermeulen EG, Castelijns JA. Differentiation of multiple sclerosis from other inflammatory disorders and cerebrovascular disease: value of spinal MR imaging. Radiology, 2002, 223:46-56.

[2] Cassinotto C, Deramond H, Olindo S, Aveillan M, Smadja D, Cabre P. MRI of the spinal cord in neuromyelitis optica and recurrent longitudinal extensive myelitis. J Neuroradiol, 2009, 36:199-205.

[3] Kim DH, Kim JH, Choi SH, Sohn CH, Yun TJ, Kim CH, Chang KH. Differentiation between intramedullary spinal ependymoma and astrocytoma: comparative MRI analysis. Clin Radiol, 2014, 69:29-35.

[4] Brinar M, Rados M, Habek M, Poser CM. Enlargement of the spinal cord: inflammation or neoplasm? Clin Neurol Neurosurg, 2006, 108:284-289.

[5] Bot JC, Barkhof F, Polman CH, Lycklama à Nijeholt GJ, De Groot V, Bergers E, Ader HJ, Castelijns JA. Spinal cord abnormalities in recently diagnosed MS patients: added value of spinal MRI examination. Neurology, 2004, 62:226-233.

[6] Cohen - Gadol AA, Zikel OM, Miller GM, Aksamit AJ, Scheithauer BW, Krauss WE. Spinal cord biopsy: a review of 38 cases. Neurosurgery, 2003, 52:806-815.

[7] Yaghi S, Gokdin M, Sethi H. Tumefactive demyelination of the spinal cord. Acta Neurol Belg, 2010, 110:206-208.

[8] Sadaka Y, Verhey LH, Shroff MM, Branson HM, Arnold DL, Narayanan S, Sled JG, Bar-Or A, Sadovnick AD, McGowan M, Marrie RA, Banwell B; Canadian Pediatric Demyelinating Disease Network. 2010 McDonald criteria for diagnosing pediatric multiple sclerosis. Ann Neurol, 2012, 72:211-223.

[9] Wingerchuk DM, Lennon VA, Pittock SJ, Lucchinetti CF, Weinshenker BG. Revised diagnostic criteria for neuromyelitis optica. Neurology, 2006, 66:1485-1489.

[10] Transverse Myelitis Consortium Working Group. Proposed diagnostic criteria and nosology of acute transverse myelitis. Neurology, 2002, 59:499-505.

[11] Zhu X, Mo YF. MRI diagnosis of multiple sclerosis in spinal cord and its clinical analysis. Zhongguo CT He MRI Za Zhi, 2010, 8:6-8.[朱熙, 莫友发. 脊髓多发性硬化的MRI诊断及临床分析. 中国CT和MRI杂志, 2010, 8:6-8.]

[12] Pericot I, Tintoré M, Grivé E, Briev L, Rovira A, Montalbán X. Conversion to clinically definite multiple sclerosis after isolated spinal cord syndrome: value of brain and spinal MRI. Med Clin (Barc), 2001, 116:214-216.

[13] Lowe GM. Magnetic resonance imaging of intramedullary spinal cord tumors. J Neurooncol, 2000, 47:195-210.

[14] Ashburner J, Friston K. Multimodal image coregistration and partitioning: a unified framework. Neuroimage, 1997, 6:209-217.

[15] Shen XL, Lu X, Zhang SM, Cui MY. Analysis of clinical manifestations and MRI features in multiple sclerosis involved with spinal cord. Zhongguo Xian Dai Shen Jing Ji Bing Za Zhi, 2011, 11:96-98.[沈雪莉, 卢希, 张斯萌, 崔梦遥. 多发性硬化脊髓受累临床与MRI对照研究. 中国现代神经疾病杂志, 2011, 11:96-98.]

[16] Huang J, Liu YO, Li KC. Progress of spinal cord MRI study in multiple sclerosis. Zhongguo Yi Xue Ying Xiang Ji Shu, 2011, 27:1926-1929.[黄靖, 刘亚欧, 李坤成. 多发性硬化脊髓MRI研究进展. 中国医学影像技术, 2011, 27:1926-1929.]

[17] Pan H, Liu B, Qian YF, Wang HB. Comparative observation on MRI features of intramedullary ependymoma and astrocytoma. Zhongguo Yi Xue Ying Xiang Ji Shu, 2011, 27:1993-1996.[潘豪, 刘斌, 钱银锋, 王海宝. 对比观察髓内室管膜瘤及星形细胞瘤的MRI特征. 中国医学影像技术, 2011, 27:1993-1996.]

[18] Wang AF, Zhang Y, Hu Y, Li JL, Jing YP, Wang XY. MRI features of 22 cases with intramedullary spinal cord ganglioglioma. Zhengzhou Da Xue Xue Bao (Yi Xue Ban), 2010, 45:1032-1034.[王岸飞, 张焱, 胡瑛, 李建灵, 荆彦平, 王晓艳. 脊髓胶质肿瘤22例MRI表现. 郑州大学学报(医学版), 2010, 45:1032-1034.]

[19] Lotfinia I, Vahedi P. Intramedullary cervical spinal cord ganglioglioma, review of the literature and therapeutic controversies. Spinal Cord, 2009, 47:87-90.

[20] Nakamura M, Miyazawa I, Fujihara K, Nakashima I, Misu T, Watanabe S, Takahashi T, Itoyama Y. Preferential spinal central gray matter involvement in neuromyelitis optica: an MRI study. J Neurol, 2008, 255:163-170.

[21] Tang HM, Luo TY, Li YM, Lü FJ, Zeng C. Magnetic resonance imaging of spinal cord in acute transverse myelitis, neuromyelitis optica and multiple sclerosis. Chongqing Yi Ke Da Xue Xue Bao, 2010, 35:1258-1261.[汤化民, 罗天友, 李咏梅, 吕发金, 曾春. 视神经脊髓炎、多发性硬化患者脊髓改变的磁共振表现及鉴别诊断. 重庆医科大学学报, 2010, 35:1258-1261.]

[22] Philpott C, Brotchie P. Comparison of MRI sequences for evaluation of multiple sclerosis of the cervical spinal cord at 3 T. Eur J Radiol, 2011, 80:780-785.

[23] Simon JH, Li D, Traboulsee A, Coyle PK, Arnold DL, Barkhof F, Frank JA, Grossman R, Paty DW, Radue EW, Wolinsky JS. Standardized MR imaging protocol for multiple sclerosis: consortium of MS centers consensus guidelines. AJNR Am J Neuroradiol, 2006, 27:455-461.

(收稿日期：2014-09-03)