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Paraplegia after epidural-general anesthesia in a Morquio patient with moderate thoracic spinal stenosis

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Abstract

Purpose—We describe an instance in which complete paraplegia was evident immediately postoperatively after apparently uneventful lumbar epidural-general anesthesia in a patient with Morquio Type A syndrome (Morquio A) with moderate thoracic spinal stenosis.

Clinical features—A 16-yr-old male with Morquio A received lumbar epidural-general anesthesia for bilateral distal femoral osteotomies. Preoperative imaging had revealed a stable cervical spine and moderate thoracic spinal stenosis with a mild degree of spinal cord compression. Systolic blood pressure (BP) was maintained within 20% of the pre-anesthetic baseline value. The patient sustained a severe thoracic spinal cord infarction. The epidural anesthetic contributed to considerable delay in the recognition of the diagnosis of paraplegia.

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Conflicts of interest None declared.

Conclusion—This experience leads us to suggest that, in patients with Morquio A, it may be prudent to avoid the use of epidural anesthesia without very firm indication, to support BP at or near baseline levels in the presence of even moderate spinal stenosis, and to avoid flexion or extension of the spinal column in intraoperative positioning. If the spinal cord/column status is unknown or if the patient is known to have any degree of spinal stenosis, we suggest that the same rigorous BP support practices that are typically applied in other patients with severe spinal stenosis, especially stenosis with myelomalacia, should apply to patients with Morquio A and that spinal cord neurophysiological monitoring should be employed. In the event that cord imaging is not available, e.g., emergency procedures, it would be prudent to assume the presence of spinal stenosis.

Morquio Type A syndrome (Morquio A), also known as mucopolysaccharidosis Type IVA (MPS IVA) is an autosomal recessive lysosomal storage disorder. Deficiency of the N-acetylgalactosamine-6-sulfate sulfatase (GALNS) enzyme results in accumulation of the glycosaminoglycans (GAGs), keratan sulphate, and chondroitin-6-sulfate principally in cartilage and the extracellular matrix of connective tissue.¹ The resultant abnormalities of chondrogenesis and subsequent osteogenesis (dysostosis multiplex)² are largely responsible for the typical phenotype with conspicuous elements such as short stature, kyphoscoliosis, prominent bell/barrel-shaped chest, frontal bossing, genu valgum (“knock knees”), and joint laxity.^{3,4} The latter two abnormalities frequently necessitate orthopedic interventions to achieve limb realignment.^{2,4}

Morquio A has numerous anesthetic implications. Chief among them are: restriction of chest excursion and thereby limited pulmonary function, abnormalities of the aortic and mitral valves,^{1,3} and the frequent occurrence of atlantoaxial instability (caused by odontoid hypoplasia) accompanied by cervical spinal stenosis.⁵ The last two of these frequently create difficulty and mandate extreme caution with airway management.⁶ Nevertheless, while the dominant spinal concern has principally related to pathology at the cervical level, spinal stenosis also commonly occurs at lower levels.^{5,7} We encountered an instance in which complete paraplegia was evident immediately postoperatively after apparently uneventful combined general-epidural anesthesia in a Morquio A patient with moderate thoracic spinal stenosis.

Case description

The patient, a 16-yr-old male (height, 119 cm; weight, 44 kg) with Morquio A granted consent for this report. He was scheduled for bilateral distal femoral osteotomies to ameliorate genu valgum deformities. Nine months previously, he had undergone a neurosurgical evaluation because of several episodes of fecal incontinence. That examination revealed normal lower extremity strength and normal reflexes, including a plantar flexor response, i.e., no long tract signs. His gait was slow and ataxic but in a manner consistent with his musculoskeletal abnormalities (bilateral hip dysplasia, genu valgum, marked ligamentous laxity). Magnetic resonance imaging (MRI) of the entire spine was performed and revealed cervical (C) findings of a hypoplastic odontoid process, moderate stenosis at the craniocervical junction, mild or moderate stenosis from C2–C6 with “subtle ventral contour deformities of the cervical spinal cord”, thoracic (T) findings of moderate

stenosis from T1–2 to T3–4 (with no mention of contour abnormalities of the cord) with milder stenosis at lower levels, slight kyphosis at the thoracolumbar junction, lumbar (L) findings of no obvious central canal stenosis, but minimal cerebrospinal fluid (CSF) around the cord T11–L1. The absence of cord signals suggestive of myelomalacia was noted. The radiologist did not report kyphosis at the C-T junction, but in retrospect, there was exaggeration of the normal thoracic kyphosis at T2–4 (Fig 1A). Flexion-extension *x-rays* revealed no atlantoaxial instability. Based on all of these radiologic findings, neurosurgical intervention was deemed unnecessary. The patient also had moderately severe obstructive sleep apnea requiring CPAP at home. Pulmonary function testing showed a mild restrictive defect. He was not taking any medication.

Blood pressure (BP) was 110/83 (mean arterial pressure [MAP] 92) at admission on the morning of surgery. In the operating room, with the patient in a sitting position, a catheter was inserted uneventfully 5 cm into the epidural space via the L2–3 interspace. A test dose of 1.5% lidocaine 3 mL with epinephrine 1:200,000 was administered. The patient moved himself to the supine position. General anesthesia was induced with propofol, fentanyl, and rocuronium, with laryngoscopy revealing a Cormack-Lehane Grade 1 view and allowing uncomplicated placement of an endotracheal tube. Anesthesia was maintained with sevoflurane and propofol by infusion. Shortly after induction, an epidural bolus of 0.2% ropivacaine 8 mL was administered, and an infusion at 8 mL·hr⁻¹ was dispensed for the duration of the procedure (four hours, 50 min). The patient remained in the supine position. Blood pressure was recorded at five-minute intervals. After transient hypertension (143/88) with intubation, over the ensuing 58 intervals, the mean (SD) systolic BP was 96 (7) mmHg, diastolic BP was 53 (6) mmHg, and MAP was 67 (5) mmHg. The lowest MAP was 59 mmHg (which occurred at two consecutive intervals). Forty-six of the 58 systolic BP recordings were > 90 mmHg. No vasopressors were administered.

Upon arrival to the postanesthesia care unit (PACU) approximately five hours after the case began, the absence of lower extremity movement was recorded. The epidural infusion was discontinued 30 min later. One hour thereafter, examination revealed the absence of motor function and sensation below T4. Approximately five hours after PACU admission, a physician noted a T6 sensory level. For a period of approximately six hours, beginning at the time of PACU arrival, systolic BP ranged from 84–89 mmHg. The epidural catheter was removed nine hours after PACU arrival. Five hours thereafter (13.5 hr after cessation of the epidural infusion) motor and sensory levels were noted to be at T5. Epidural hematoma was suspected and an MRI was ordered. The MRI, performed 21 hr after PACU arrival, revealed abnormal T2/short T1 inversion recovery (STIR) cord signal extending from T1 through T7, with restricted diffusion of essentially the full diameter of the spinal cord. The lesion was interpreted as representing spinal cord infarction, “T2–3 through T5 with adjacent cord edema T1–2 through T7”. The patient remained paraplegic at the T4 level.

Discussion

Abnormalities of the spinal column occur in all Morquio A patients and are characterized by odontoid hypoplasia, platyspondyly (vertebral flattening), and relatively larger intervertebral discs. The latter two traits contribute to the frequent occurrence of spinal stenosis, and that

propensity is probably aggravated by accumulation of GAGs in the posterior longitudinal ligament (PLL), the anterior extradural space, and the ligamentum flavum. The occurrence of atlantoaxial instability and cervical spine stenosis in Morquio A syndrome has been given substantial and appropriate emphasis.^{5,6} Stenoses occurring at other loci have been given less emphasis because these sites are particularly infrequent causes of disability or the necessity for intervention. Nevertheless, stenoses in the thoracic⁷ and lumbar regions most certainly occur, and some have asserted that complete spine imaging should be part of the comprehensive care of Morquio A patients.^{5,7} Anesthesiologists should consider subclinical spinal stenosis in the management of Morquio A patients, particularly when imaging has not and cannot be obtained.

Our patient sustained a spinal cord infarction. While an embolic event in the anterior spinal artery distribution is a remote possibility, the present event appears most likely to have been the result of spinal cord compression with critical reduction of transmural pressure (i.e., mean arterial pressure – local tissue pressure). Subsequent to the events described herein, another occurrence of intraoperative spinal cord ischemia in an Morquio A patient has been described.⁸ That report entailed spinal cord ischemia at almost the exact location as that suffered by our patient. Those authors were performing a decompression at the craniocervical junction, i.e., remote from the area of spinal cord infarction. Transient hypertension occurred as that patient was turned to the prone position, but BP was otherwise apparently well maintained during the remainder of the procedure.

Both the case reported herein and that of Tong *et al.*⁸ appear to involve a spinal cord injury that was superficially disproportionate to the apparent degree of spinal stenosis, and together, they suggest an exaggerated vulnerability of the spinal cord to compressive insult in patients with Morquio A. We have no certain explanation, but we suspect that the joint laxity that so conspicuously affects the extremities of Morquio A patients also occurs in the spinal column and adds to the risk of cord compression. However, the mobility of the mid-thoracic portion of the spinal column is limited by the stiffness of the thorax in Morquio A patients. Accordingly, in the face of stress from either flexion or extension, the C-T and T-L junctions must assume the major burden of mobility. The implication is that repositioning Morquio A patients after induction of anesthesia with either flexion or extension of the spine may result in a greater degree of angulation and result in more compression at the C-T and T-L junctions than would occur in the typically older patient with degenerative spinal stenosis. While our patient's spinal stenosis was radiologically described as being most severe at the cervical level, one of the contributing factors may have been that the degree of thoracic stenosis, especially at the level of the T3–4 intervertebral disc, was more severe than was appreciated preoperatively (Fig. 2). This may have rendered the patient vulnerable to mechanical compression at that level. We emphasize that this suggestion about vulnerability related to positioning is speculation. Nevertheless, during anesthesia, there should be little hazard attached to an emphasis on maintaining the vertebral column of Morquio A patients in their initial self-chosen position of comfort. We do not know if the same concerns should apply to patients with other MPS syndromes (Hunter, Hurler, Sanfilippo) and are not aware of any similar adverse outcomes. Those conditions are less common, however, and the requirements for orthopedic intervention are less frequent. All

are subject to some degree of spinal stenosis caused by GAG accumulation in the PLL, the ligamentum flavum, and the epidural space; however, joint hypermobility is much less evident with other MPS conditions, and if hypermobility is an important contributing factor, there may be somewhat less hazard.

Our patient received a combined lumbar epidural-general anesthetic. We doubt that epidural anesthesia *per se* is directly injurious to the spinal cord of patients with Morquio A-related spinal stenosis, and two of us (M.C.T., E.J.K.) have employed epidurals to good effect in these patients.⁶ Nonetheless, because of the apparent vulnerability of Morquio A patients to spinal cord ischemia, we now view epidural anesthesia as relatively contraindicated for a number of reasons. First, epidural anesthesia has the potential to make the necessary BP support more difficult. More importantly, it has the potential to delay diagnosis and/or confuse a diagnostic evaluation. There is absolutely no certainty that earlier diagnosis would have altered the outcome in our patient; however, the relative hypotension in the immediate postoperative period might have been managed differently. While systolic BPs of 84–89 mmHg would generally be viewed as entirely adequate for a conversant, supine 16-yr-old patient, had the nature of the lesion been suspected, perfusion pressure support, perhaps augmented by CSF drainage, might have been undertaken in an attempt to mitigate the severity of the injury.

In this connection, we considered the possibility that an epidural infusion might increase neuraxial pressures and thereby decrease local perfusion pressure. We have discarded that possibility because the intervertebral foramina were reported to have been patent in the immediate postoperative MRI.

In the presence of severe spinal stenosis – its hallmarks being gross indentation of the cord with or without increased MR signal representing myelomalacia – many, if not most, anesthesia-surgery teams would seek to support BP near waking-normal levels. The stenosis in the present instance and in that of Tong *et al.*⁸ did not appear to be on that order of severity. While many would view the BP management described above as acceptable for the present patient, the clinical outcome suggests otherwise. In that connection, Kudo describes two noteworthy cases of transient tetraparesis in patients with unsuspected cervical stenosis.⁹ In those patients, the spinal stenosis appeared more severe than that of our patient and the reduction in BP was proportionally greater, yet there was complete recovery after transient postoperative tetraparesis. This is in part the basis of our suggestion that the spinal cord of the Morquio A patient is exceptionally vulnerable to compression during anesthesia. Some institutions, including those in which some of the present authors (M.C.T., S.T.) and others practice (Klane K. White MD, Seattle Children's Hospital, personal communication, July 17, 2014), have taken this concern to the point of instituting the use of spinal cord monitoring in Morquio A patients undergoing all but the briefest of surgical procedures.

Our case allows us to offer only suggestions rather than firm mandates. In patients with Morquio A syndrome, it seems prudent to avoid epidural anesthesia without very firm indication, to provide careful support of BP, and to position the patient in baseline posture with avoidance of flexion or extension after induction of anesthesia and the subsequent loss of muscle tone. If the spinal cord/column status is unknown or if the patient is known to

have any degree of spinal stenosis, we suggest that the same very rigorous BP support practices that are typically brought to bear in other patients with severe spinal stenosis, especially stenosis with myelomalacia, should be applied to Morquio A patients. In the event that cord imaging is not available, e.g., emergency procedures, it would be prudent to assume the presence of spinal stenosis (as well as atlantoaxial instability). In addition, intraoperative electronic monitoring of the spinal cord should be considered, especially if the status of the spinal cord cannot be confirmed prior to surgery.

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References

1. Yasuda E, Fushimi K, Suzuki Y, et al. Pathogenesis of Morquio A syndrome: an autopsied case reveals systemic storage disorder. *Mol Genet Metab*. 2013; 109:301–11. [PubMed: 23683769]
2. White KK, Jester A, Bache CE, et al. Orthopedic management of the extremities in patients with Morquio A syndrome. *J Child Orthop*. 2014; 8:295–304. [PubMed: 25001525]
3. Tomatsu S, Montano AM, Oikawa H, et al. Mucopolysaccharidosis type IVA (Morquio A disease): clinical review and current treatment. *Curr Pharm Biotechnol*. 2011; 12:931–45. [PubMed: 21506915]
4. Tomatsu S, Mackenzie WG, Theroux MC, et al. Current and emerging treatments and surgical interventions for Morquio A syndrome: a review. *Res Rep Endocr Disord*. 2012; 2012:65–77. [PubMed: 24839594]
5. Solanki GA, Martin KW, Theroux MC, et al. Spinal involvement in mucopolysaccharidosis IVA (Morquio-Brailsford or Morquio A syndrome): presentation, diagnosis and management. *J Inherit Metab Dis*. 2013; 36:339–55. [PubMed: 23385297]
6. Theroux MC, Nerker T, Ditro C, Mackenzie WG. Anesthetic care and perioperative complications of children with Morquio syndrome. *Paediatr Anaesth*. 2012; 22:901–7. [PubMed: 22738181]
7. Baratela WA, Bober MB, Thacker MM, et al. Cervicothoracic myelopathy in children with Morquio syndrome A: a report of 4 cases. *J Pediatr Orthop*. 2014; 34:223–8. [PubMed: 24096444]
8. Tong CK, Chen JC, Cochrane DD. Spinal cord infarction remote from maximal compression in a patient with Morquio syndrome. *J Neurosurg Pediatr*. 2012; 9:608–12. [PubMed: 22656250]
9. Kudo T, Sato Y, Kowatari K, Nitobe T, Hirota K. Postoperative transient tetraplegia in two patients caused by cervical spondylotic myelopathy. *Anaesthesia*. 2011; 66:213–6. [PubMed: 21265817]

Fig. 1.

A Sagittal T2/STIR-weighted image of the thoracic and lumbar spine obtained seven months preoperatively. Characteristic Morquio A syndrome features are evident, including platyspondyly and relatively large intervertebral disks. Obliteration of the CSF space anterior to the spinal column caused by disk protrusion is evident at T3–4 and T4–5 (white arrows). There was similar protrusion at T2–3 (see Fig. 1B), which is not well seen in this image because mild thoracic dextroconvex scoliosis results in variation of the sagittal plane within the image. Increased cord signal indicative of myelomalacia was not evident. The white dot identifies the body of T3. STIR = short T1 inversion recovery; CSF = cerebrospinal fluid. B Sagittal T2/STIR-weighted image of the thoracic spine obtained 21 hours after emergence from anesthesia. The spinal stenosis observed in Fig. 1A is again evident. The bracket identifies the extent of the abnormal T2/STIR “bright signal” consistent with spinal cord infarction and edema. The white dot identifies the body of T3

Fig. 2.

Axial T2-weighted image at the level of the T3–4 intervertebral disk obtained seven months preoperatively. There is cerebrospinal fluid (CSF) (white) around the posterior portion of the spinal cord but not the anterior. The anterior surface of the cord has a “tenting” rather than a smooth convex configuration, reflecting bilateral ventrolateral pressure on the anterior surface of the cord (solid white arrows). The trachea and the esophagus are identified for orientation