Fatal Nemaline Myopathy in Infancy

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ABSTRACT: The clinical and neuropathological findings in two infants with congenital nemaline myopathy are described. One patient presented at birth with severe hypotonia, respiratory failure and contractures and died shortly after the neonatal period. The other presented at age two months with hypotonia and, following a period of clinical stability, died at age seven months from respiratory failure. Pathological findings in the fatal neonatal case revealed numerous rod bodies in lingual, pharyngeal, diaphragm and limb muscles, correlating with clinical findings. Significant, but less rod body involvement was found in the diaphragm and limb muscles of the second patient. Although a neural basis has been suggested for this disorder, no abnormalities were found in the central nervous system or in the peripheral nerves of these two severely affected patients.

CASE REPORTS

Case 1: This male infant was born to a 22 year old healthy primagravida following a normal pregnancy. There was no family history of neuromuscular disease. Labor was spontaneous at term, and because of failure to progress, the infant was delivered by cesarean section. At birth oligohydramnios was noted and the amniotic fluid was darkly stained with meconium. The infant was hypotonic and failed to initiate spontaneous respirations, a neuromuscular disorder was suspected. Serum CK was 91 IU/Litre (N<100) and EMG was normal. A muscle biopsy was taken from the right quadriceps muscle as previously described (McMenamin, Becker and Murphy, 1982). With the modified Gomori trichrome method, masses of red rod deposits were identified in the smaller fibers which on myosine ATPase staining were type 1 fibers (Fig. 1). The type I fibers were small with a sharp, single peak at 10 microns. Electronmicroscopic studies showed numerous electron dense rods measuring up to 5 μm in length and 1.5 μm in diameter (Fig. 2). At the border of the rods, continuity with thin filaments was evident (Fig. 3). Despite continued supportive ventilation, the patient expired at six weeks of age.

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Autopsy examination revealed an abundance of nemaline rods in many skeletal muscles with marked involvement of the diaphragm and intercostal groups. Numerous rods were also present in the pharyngeal muscles and in the tongue. No rods were found in the myocardium or smooth muscles of the gastrointestinal tract on light microscopy or electronmicroscopy. The brain was grossly and microscopically normal. The spinal cord was sectioned horizontally and ten representative levels taken for histological examination. No anterior horn cell loss or astrogliosis was present. The peripheral nervous system was widely sampled: a left vagus nerve, left intercostal nerve, right median nerve, right musculocutaneous nerve, left femoral nerve, right peroneal nerve, and right sural nerve. Conventional histology using myelin (luxol fast blue) and axon (Bielschowsky) stains showed no abnormality. A portion of the sural nerve was also placed in Universal fixative and processed, as previously described (Sachas, Armstrong, Becker and Byran, 1982). The number and size distribution of myelinated fibers was determined (Fig. 4a) using thin plastic sections stained with toluidine blue. The histogram was comparable to a normal age-matched control case (Fig. 4c), and showed a normal maturational fiber distribution (Gutrecht and Dyck, 1970 and Origuchi, 1981). Other autopsy findings were severe atelectasis of the left lung with focal bronchopneumonia. Death was attributed to respiratory failure from atelectasis, consolidation and respiratory muscle failure.

Figure 1 — Biopsy of right quadriceps muscle from Case 1 illustrating mainly small Type I fibers. ATPase (pH 9.4) X 640.

Figure 2 — In the myofibril on the left there is mild thickening and irregularity of Z lines and on the right in the position of the Z lines, there are irregular, large osmiophilic, dense "rods". Case 1. Electron micrograph X 6,667.
Figure 3 — Characteristic lattice structure of rod bodies with suggestive continuity with myofilaments is illustrated. Case 1. Electron micrograph X 28,770.

Figure 4 — Distribution of diameters of the myelinated nerve fibers in the sural nerves in a) Case 1, b) Case 2 and c) normal control infant.
Case 2: A two month old female infant presented with hypotonia from birth. She had a female sibling who died at six months of age who was also hypotonic from birth. A neuromuscular disorder was clinically suspected in this patient but unfortunately no investigative or pathological studies were performed. The patient had one healthy male sibling, both of her parents were clinically normal, and there was no other history suggestive of neuromuscular disease in the family. She was born at term without complication and her birthweight was 3.9 kg. Although hypotonic, her neonatal course was otherwise normal. Examination at age two months revealed a well nourished child without dysmorphic features. Her cranial nerves were normal. She had moderate generalized wasting, hypertrophy, or fasciculations and her deep tendon reflexes were absent in the smooth muscle of the gastrointestinal tract. Gross and microscopic examination of the brain revealed no abnormalities. The autopsy findings in infants with CNM have been reported by Eeg-Olofsson et al., 1983; Gillies et al., 1979; Kolin, 1967; Matsuo et al., 1982; Neustein, 1973; Norton et al., 1983 and Shafiq et al., 1967). Pertinent information on findings in the nervous system has been lacking, and no studies of peripheral nerves have been described. Nemaline rods have been found in variable amounts in most skeletal muscles including the tongue, pharynx, diaphragm and intercostal groups. It has been stated that the number of rods does not always correlate with the degree of weakness in a given muscle (Bender, 1980). However, the early severe diaphragmatic involvement with rod bodies in Case 1 was associated with profound respiratory failure, and this has been noted in at least one other fatal neonatal case (McComb et al., 1979). The equally striking tongue and pharyngeal involvement correlated with the feeding difficulties in this patient. This clinicopathological correlation may be more prominent in the severe neonatal form of the disease. The absence of smooth muscle and cardiac involvement has been noted in some of the other autopsied cases (McComb et al., 1979 and Shafiq et al., 1967).

Case 2 presented with the less severe form of the disease. This variety is not typically associated with a rapidly progressive clinical course (Bender, 1980 and Volpe, 1981). Despite a period of clinical stability, she deteriorated dramatically and subsequently died from her primary disease. This type of clinical course has been described in one other fatal case in infancy (Shafiq, Dubowitz, Peterson and Milhorat, 1967). Thus, a favorable prognosis cannot reliably be given if the patient presents in a relatively asymptomatic manner in early infancy having survived the neonatal period. Neustein (1973) stated that the disease was fatal in approximately one out of five reported cases in infancy and this is consistent with our experience.

Although the inheritance of CNM in most cases is considered to be autosomal dominant with reduced penetrance (Kondo and Yuasa, 1980), as in central core myopathy, a disorder with an equally distinctive histological pattern, the clinical course has been described as either non-progressive or slowly progressive (Bender, 1980; Brooke, 1977 and Dubowitz, 1978). However, two syndromes presenting in infancy are now recognized (Volpe, 1981). A non-progressive or slowly progressive form presenting with mild hypotonia at birth, conforming to the more common variety, and a more severe, less common form with marked hypotonia, muscle weakness and pulmonary failure from respiratory muscle weakness.

The clinical presentation of our two patients sharply contrasted with each other. The case presented with the severe, less common form of the disease. He was initially managed as an infant with hypoxic-ischemic encephalopathy. Intrauterine hypotonia may predispose the infant with a congenital neuromuscular disorder to hypoxic-ischemic injury at birth, and this may mask the primary underlying disease. This patient was similar to the cases reported by Gillies et al. and McComb et al. (1979). In addition to other congenital abnormalities, the case of McComb et al. had bilateral talipes equinovarus. This abnormality which is likely due to muscle contracture resulting from decreased intrauterine motor activity, is found in other neuromuscular disorders presenting at birth including congenital myotonic dystrophy (Harper, 1975) and congenital muscular dystrophy (McMenamin, Becker and Murphy, 1982). The presence of this finding in the newborn infant, particularly when associated with persistent feeding difficulties, failure to initiate spontaneous respirations, muscle weakness and absent or depressed deep tendon reflexes should alert the physician to the possibility of an underlying congenital neuromuscular disorder.

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Although the inheritance of CNM in most cases is considered to be autosomal dominant with reduced penetrance (Kondo and Yuasa, 1980), an autosomal recessive mode of inheritance could also be implicated in our second case. Muscle biopsies were not obtained from the parents who were both clinically asymptomatic.

The rod body is thought to be a lateral expansion of the Z band which is normally found at either end of the sarcomere in which the thick contractile filaments are embedded (Price et al., 1965). Recent evidence suggests that the rod body may in fact represent actin (Jennekens et al., 1983 and Yamaguchi et
Another histological feature of CNM, also clearly evident in our patients, was the predominance of small type-I fibers. This finding is considered by some to represent a paucity of type II fibers and, therefore, a selective loss of type II motor neurons (Engel, 1970 and Karpati et al., 1971). Neurogenic findings at EMG have been described in infants with CNM (McComb et al., 1979, Neustein, 1973 and Norton et al., 1983) and a reduced number of anterior horn cells in the spinal cord has been described in an older patient (Dahl and Klatzow, 1974), thus suggesting a neural basis for this disorder. However, no neurogenic findings were evident at EMG in our patients. Although a functional defect cannot be excluded, we found no abnormality in the central nervous system or of peripheral nerves in these two severely affected infants.

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REFERENCES