Chronic proximal spinal muscular atrophy of childhood and adolescence: problems of classification and genetic counselling

IRENA HAUSMANOWA-PETRUSEWICZ*, JACEK ZAREMBA†, AND JANINA BORKOWSKA*

From the *Department of Neurology, Medical School, and †Department of Genetics, Psychoneurological Institute, Warsaw, Poland.

SUMMARY Results obtained from a study of 354 cases of chronic proximal spinal muscular atrophy of childhood and adolescence suggest that the condition is not as homogeneous as it was previously thought. A tentative classification based on our results is proposed. Estimates of genetic risks are provided, taking into account the sex and age at clinical onset. In our opinion these factors are more reliable than the data hitherto available because they are based on a considerably larger series.

The problem of the influence of sex in the chronic proximal form of spinal muscular atrophy (CPSMA) of childhood and adolescence based upon a study of 354 cases was discussed in our previous article published in this Journal.1 The information gathered during the study mentioned above allows us to comment on two other aspects, the classification of CPSMA and genetic counselling. The material and methods were described earlier.1

Classification

Until recently CPSMA of childhood and adolescence was considered to be a single condition, because there were no grounds for dividing it into different entities.2 3 We were even doubtful about the intermediate form of Fried and Emery4 being a separate entity (see No 25 355 in McKusick5). This problem was discussed in one of our earlier publications.6 However, our recent results1 7 suggest some heterogeneity of CPSMA. In this respect the subgroup with onset at 10 to 36 months of age was of particular interest because of a sharp and significant fall of the p value of the segregation ratio (table 1, figure). It is possible that a large proportion of cases in this age range are phenocopies or new dominant mutations or both. They are distributed throughout the whole age spectrum of our material, but in the age range 10 to 36 months, in which there

<table>
<thead>
<tr>
<th>TABLE 1 Segregation ratios and empirical risk values according to sex in different age at onset subgroups of CPSMA of childhood and adolescence.†</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
</tr>
<tr>
<td>-----</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>M</td>
</tr>
<tr>
<td>F</td>
</tr>
<tr>
<td>All</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>M</td>
</tr>
<tr>
<td>F</td>
</tr>
<tr>
<td>All</td>
</tr>
</tbody>
</table>

†More detailed data are given in tables 2 and 3 of our previous publication.1 p=segregation ratio. r=empirical risk.

![Diagram of segregation ratios on four different age at onset subgroups (compare with table 1).](http://jmg.bmj.com/)

Received for publication 27 September 1984.
Accepted for publication 12 October 1984.
may be only a few autosomal recessive cases, they
become more evident. In one of our previous
publications² we considered the problem of domi-
nant mutations and tried to explain their very
infrequent occurrence (0.75% in a large combined
series of an international study on SMA³). How-
ever, we are now reconsidering our previous opinion
because there is a possibility that most cases of the
dominant form of juvenile SMA (No 15 860 in
McKusick⁵) are new mutations, and that mild cases
compatible with familial occurrence of this form of
the disease are very rare, hence the apparent paucity
of dominant cases of SMA. Most of them may never
produce evidence of their dominance because of
their greatly reduced fitness. Such cases may form
an important part of the subgroup of SMA with
onset at 10 to 36 months.

The basic defect of CPSMA and of other forms of
SMA is not known and its clinical picture does not
provide a sufficient basis for genetic classification.
Therefore, we cannot be sure whether the condition
we are dealing with constitutes a single entity or
whether it is composed of several genetic entities. In
view of the above data it is reasonable to assume
that there may be three entities (table 2) as follows.

(1) The infantile chronic form characterised by
age at onset usually between three and nine months
with classic features of autosomal recessive inheri-
tance with complete penetrance and the course of
the disease tending to be milder in females. These
cases constitute 51% of our material (see table 2 of
our previous publication¹). It should be stressed
that the group of patients included here may overlap
to some extent with the classic acute form of Werndig-
Hoffmann disease as defined by Pearn et al¹⁰ and
Feingold et al.¹¹ The subjects described by Pearn
et al.¹² ¹³ under the term ‘subacute and chronic
SMA’ correspond to our infantile chronic form, but
includes also (2) and (3) below.

(2) The childhood isolated form (32% of our
cases) is characterised by onset usually between 10
to 36 months with a predominance of isolated cases.
Most cases described as the intermediate form or
type II of the disease⁴ ¹⁴ appear to fit well with this
form, both by the range of age at onset and by the
very infrequent occurrence of familial cases. The
segregation ratios in this form are not compatible
with autosomal recessive transmission. The assump-
tion that this subgroup contains many dominant
mutations or some phenocopies or both is more
plausible.

It should be noted that Fried and Emery⁴ assumed
that this form is recessive and deliberately excluded
from their material one family in which the condi-
tion was inherited as an autosomal dominant trait.
Incidentally, in their study of 14 cases there was only
one other family showing features of autosomal
recessive transmission. By the criteria presented
here, however, this family would be included in the
first form because of the age at onset under nine
months.

(3) The mild childhood and adolescent form (17%
of our cases) is characterised by age of clinical onset
usually after the third year of life and autosomal
recessive transmission with marked sex influence,
expressed by a smaller proportion of affected
females and consequently by a significant reduction
of penetrance.

The classification and terminology of different
forms of SMA are controversial. In McKusick⁵ the
following three forms of proximal SMA appear to be
relevant to our series. (Numbers in brackets are
McKusick Catalog numbers.⁵) (1) Muscular atrophy,
juvenile (Kugelberg-Welander syndrome) (25 340*).
(2) Muscular atrophy, spinal, intermediate type
(25 355). (3) Muscular atrophy, juvenile (Kugelberg-
Welander syndrome) (15 860*).

Initially we grouped them together because, as
already stated, there were insufficient grounds for
making a division. The clinical onset of CPSMA of
childhood and adolescence, as our data show, may
occur between birth and 18 years of life, but in our
opinion there may be cases with onset of clinical
expression in the early twenties. Forms 1 and 2,
together with the acute form (see McKusick No 25
330⁵), constitute the majority of SMA cases.

We have not included the acute form because
most of our cases showed a protracted course.

*Conditions with mode of inheritance believed to be certain.

<table>
<thead>
<tr>
<th>TABLE 2 Proposed tentative classification of CPSMA of childhood and adolescence based upon analysis of 354 cases.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Form of disease entity</strong></td>
</tr>
<tr>
<td>----------------------------</td>
</tr>
<tr>
<td>Infantile, chronic</td>
</tr>
<tr>
<td>Childhood, isolated</td>
</tr>
<tr>
<td>Mild childhood and adolescent</td>
</tr>
</tbody>
</table>

R=autosomal recessive.
D=dominant.
According to Pearn et al\textsuperscript{10} and Feingold et al\textsuperscript{11} this is a distinct condition, although the available data are still ambiguous.

As we have said above, there is a possibility that some of the isolated cases in our material are new dominant mutations corresponding to form 3 (No 15 860\textsuperscript{*} of McKusick\textsuperscript{5}). Such cases in particular may constitute an important component of the subgroup with onset at 10 to 36 months (table 1, figure).

Our data and those of other authors suggest that the following supplementary remarks and alterations in the Catalogs\textsuperscript{5} might be justifiable\textsuperscript{1}.

(1) A better delineation of the acute form (25 330\textsuperscript{*}), not only by the age at clinical onset but also by the age at death according to Pearn et al\textsuperscript{10} and Feingold et al\textsuperscript{11} and naming it ‘infantile acute form of Werndig and Hoffmann’.

(2) Identifying the intermediate type of Fried and Emery\textsuperscript{4} with the ‘infantile chronic’ form described here (table 2) corresponding roughly to the form described by Pearn et al\textsuperscript{12} \& 13 and adding an asterisk to the relevant No 25 355.

(3) Our ‘childhood isolated’ form (table 2) could be considered a possible dominant mutation, identical with that designated No 15 860\textsuperscript{*} in the Catalogs.\textsuperscript{5}

(4) A better delineation of juvenile SMA (25 340\textsuperscript{*}) corresponding to our form of ‘mild childhood and adolescence’ by the range of age at onset and by defining it as a sex influenced condition with reduced penetrance.

**Genetic counselling**

The estimation of genetic risk in CPSMA is apparently a simple matter because, in general, the disease conforms to the autosomal recessive pattern of inheritance. However, our data strongly suggest incomplete penetrance of the gene, because of the assumed ‘female sparing factor’ in higher age ranges, and therefore tentative values of empirical risk based on the \( p \) values can be drawn for all ages of onset subgroups, for males and females separately (table 1).

Although CPSMA of childhood and adolescence is one of the more common genetic conditions, the data on estimates of empirical risk in this disease are scanty and based on small series. The published data available are those of Bundey and Lovelace\textsuperscript{15} and Pearn et al\textsuperscript{12}, the latter being quoted in the book The genetics of neurological disorders.\textsuperscript{16} In table 3 we give their risk figures together with the data from which they were drawn, as compared to our data in the same age ranges. A particularly low risk (1:15) was given by Bundey and Lovelace\textsuperscript{15} for the age at onset over 25 months. Pearn et al\textsuperscript{12} worked out the same value for 36 months onwards. We think that these figures are not reliable enough for genetic counselling in view of the very scanty series from which they were drawn. In the data of these authors, cases with age of onset over 36 months were hardly represented and a considerable proportion of the others could correspond to our subgroup of very low risk, that is, of 10 to 36 months.

Our results, although based on larger series, should also be treated with caution until more data are available. At present, the estimates of genetic risk presented in table 4 could be used for genetic counselling. If two or more sibs are affected the risk value of 1:4 should be given, independent of age at onset and sex, possibly with the exception of females in the subgroup 9 to 18 years if only male sibs were previously affected.

**Table 3** Results of segregation analysis in CPSMA with consideration of the age at onset: comparison of the present results with those of other authors.

<table>
<thead>
<tr>
<th>Age at onset</th>
<th>Bundey and Lovelace\textsuperscript{15}</th>
<th>Pearn et al\textsuperscript{12}</th>
<th>Present series (see also ref 1)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No of probands</td>
<td>No of sibs</td>
<td>( p ) ((r))</td>
</tr>
<tr>
<td>Before 9 mth</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Before 24 mth</td>
<td>19</td>
<td>12</td>
<td>45</td>
</tr>
<tr>
<td>After 24 mth</td>
<td>14</td>
<td>2</td>
<td>27</td>
</tr>
<tr>
<td>36 mth and later</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Overall</td>
<td>33</td>
<td>14</td>
<td>72</td>
</tr>
</tbody>
</table>

\( p \)=segregation ratio.
\( r \)=empirical risk.
Chronic proximal spinal muscular atrophy of childhood and adolescence

The study was supported by a grant from the Polish Academy of Sciences 10.4.05.4.1.

References

7 Zaremba J. Genetics of the chronic, proximal form of the spinal muscular atrophy. Unpublished data, 1983.

Correspondence and requests for reprints to Profesor Irena Hausmanowa-Petrusewicz, Neurological Department, Medical School, ul Lindleya 4, 02005 Warsaw, Poland.