A MEASUREMENT OF HAND FUNCTION IN THE NORMAL CHILD AND THE CEREBRAL PALSYED CHILD

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Although there are reports on hand function in normal children (Weiss and Flatt, 1971; Dickson and Calnan, 1972), there is little or no literature on the assessment of hand function in abnormal children.

Hand function implies the use of the hand in a variety of skilled manipulative movements for precision-handling and power-grasping. In attempts to assess hand function, Weiss and Flatt (op. cit.) used “pinch-strength” to reflect precision-handling. Dickson and Calnan (op. cit.) based a quantitative assessment of hand function on a measurement of “grip-strength”. Extrapolating their work, the present study makes use of power-grip strength, lateral-grip strength and pincer-grip strength as a general measure of hand function. These grips reflect the strength generated by the contraction of the various arm and hand muscles involved in the activity of the hand. The amount of strength generated can then be used as a quantitative measurement of the development of hand function.

The study has been carried out to assess the development of hand function in normal and cerebral palsied children, using the amount of strength generated as a quantitative measurement of hand function.

MATERIALS AND METHODS

The Martin Vigorimeter, a hand dynamometer (Fig. 1) was used to measure the amount of strength generated in the hand.

The scale of the instrument is calibrated from 0-28 lbs/in². The readings obtained were arbitrarily grouped as follows:

(a) power-grip strength: 0-4 lbs/in²
   5-9 "
   10-14 "
   15-19 "
   20-24 "
(b) lateral-grip strength: 0-4 lbs/in²
   5-9 "
   10-14 "
(c) pincer-grip strength: 0-4 lbs/in²
   5-9 "
   10-14 "

Two groups of the Johannesburg population were used:

(i) 210 children (116 boys and 94 girls) of the Kuo Ting Chinese School, aged from 5 to 15 years, representing the normal
(ii) 100 children (56 boys and 44 girls) of the Forest Town School for Cerebral Palsied Children, aged from 5 to 15 years, representing the abnormal.

Both males and females in each group were measured. Only those children able to cooperate were used, to ensure a more accurate result.

A demonstration was first given to each child, to familiarize him/her with the appa-

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ratus and to eliminate the element of fear. Each child stood to be tested, the arm and hand being measured not touching the body.

Motivation, such as verbal encouragement and competition between classmates, was used maximally. No assistance of the hand under test was allowed, but facial grimaces and associated movements of the other hand were not discouraged.

Hand dominance was recorded, and each hand was tested using a suitable bulb size. Children under 10 years used only the small-sized bulb and children over 10 years used the small-sized bulb for the lateral and pincer grips and the medium-sized bulb for the power grip. As muscle fatigue begins with the first concentrated effort, especially in the cerebral palsied (C.P.) children, a single maximum effort only was tested. The strength tests were done as follows:

(a) power grip (Fig. 2) — a stable non-manipulative grasp involving a fisted hand with flexed fingers and opposed thumb;

(b) lateral grip (Fig. 3) — a grasp involving some elements of power and precision handling in the lateral/radial surface of the index finger and the opposing tip of the thumb respectively;

(c) pincer grip (Fig. 4) — a manipulative precision grasp involving the tips of the thumb, index and/or middle fingers (tripod grasp).

RESULTS

(a) Hand Dominance
The table shows the distribution of hand dominance in the normal and cerebral palsied (C.P.) children. In the normal group, 4.8% were left hand dominant, and 95.2% right.
hand dominant. The C.P. children showed a distribution of 36% left hand dominant and 64% right hand dominant, which differed significantly \((p < 0.05)\) from the normal group.

from the age of 7 years for the power grip, 9 years for the lateral grip, and 9 years for the pincer grip.

### Table 1

<table>
<thead>
<tr>
<th>Group Type</th>
<th>Percentage Hand Dominance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Left Hand</td>
</tr>
<tr>
<td>Normal</td>
<td>4.8</td>
</tr>
<tr>
<td>Abnormal (C.P.)</td>
<td>36.0</td>
</tr>
</tbody>
</table>

The Percentage Frequency of Left and Right Hand Dominance.

Note: The distribution of hand dominance in the two groups differs significantly \((p < 0.05)\).

(b) **Hand Strength**

Diagram 1 shows the distribution of mean hand strength for both normal and C.P. children. It was noted that no C.P. child scored in the ranges above 10-14 lbs/in², while 10% and 1% of the normal children scored in the 15-19 lbs/in² and 20-24 lbs/in² ranges respectively, using the power grip.

**Age Dependence of Hand Strength**

Diagram 2 shows the changes in mean hand strength with age for both normal and C.P. groups. A significant difference \((p < 0.05)\) in these changes in the two groups was noted.

**Sex Dependence of Hand Strength**

Diagram 3 shows the distribution of mean hand strength with sex for both the normal and C.P. groups. No significant difference between the sexes, in either group, was noted.

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Discussion

There is little or no literature to date to suggest comprehensive methods of assessing abnormal hand function, particularly in cases of cerebral palsy. Therefore, in this study measures of changes in hand strength with power and precision grips, age and sex, and of hand dominance were investigated in the abnormal child and compared with that in the normal child, in an effort to assess hand function.

(a) Hand Strength

The distribution of mean strength for the normal and C.P. groups showed a close similarity for all grip types. However, it must be noted here that the Martin Vigorimeter was found to be insensitive in the lower range (0-4 lbs/in²), which may have led to inaccurate results, for the precision grips particularly, in this range.

No significant difference was found in the strength generated by males and females in either test group.

Burke et al. (1952-1953) suggested an increase in grip strength with age in normal individuals. In this study, changes in mean strength with age were observed from the ages of 7, 8 and 9 years, when a significant difference \( (p < 0.05) \) between the normal and abnormal test groups was calculated. This observation was made for all grip types, but more particularly for the power than for the lateral or pincer grips. This difference between the two groups showed a gradual increase with an increase in age. This study, therefore, supported the work of Burke et al., and further showed a similar increase in strength with age in the normal child and a similar but slower increase in the C.P. child.

The difference in mean strength between the normal and the C.P. children may be due to a combination of factors, such as deficient coordination and muscle imbalance and a slower rate of physical maturation often shown in the C.P. child.

It seems, therefore, that the generation of strength in the hand, being greater for the power than the lateral or pincer grips, depends not only on the bulk of hand intrinsic musculature, but also on all the muscles in the arm and hand functioning as a coordinating unit. Therefore, a certain level of physical and neurological maturation must be obtained before the finer, skilled manifestations of hand function, requiring a high level of coordination, can be achieved.

(b) Hand Dominance

The significance, if any, of hand dominance in hand function in the abnormal child does not appear to have been studied in any detail. Kellor et al. (1971) compared dexterity and hand strength in the normal individual, but do not consider any role of hand dominance in hand function.

It was found in this study that in both normal and C.P. groups of children, the dominant hand was not markedly stronger than the non-dominant hand.

In this study, the C.P. group as a whole showed a percentage left hand and a percentage right hand dominance which was significantly different \( (p < 0.05) \) from that in the normal group. None of the different types of C.P. children tested showed the same percentage range of left and right hand dominance as the normal group. However, the M.C.D. type of C.P. (following the classification of Ingram, 1966), again showed a higher percentage right hand than left hand dominance \( (78.1\% \text{ and } 21.9\% \text{ respectively}) \), and this was significantly different \( (p < 0.05) \) from the normal group. This group of C.P. children most closely approximated the normal group, and it is of interest to note that it was the only type of C.P. studied in which the major disability was not physical.
From this work it can be suggested that the Martin Vigorimeter, despite its insensitivity in the lower ranges, may be used to assess hand function by measuring hand strength. This measurement may then be used to assess the degree of hand function in the abnormal (for example, cerebral palsied) child.

**Summary**

An attempt at assessing abnormal hand function as seen in the cerebral palsied child, as compared with the normal child, is made by a measurement of hand strength.

The Martin Vigorimeter, a hand dynamometer, was used to measure power-grip strength and lateral- and pincer-grip strengths in 210 normal and 100 cerebral palsied children, aged from 5 to 15 years.

The distribution of mean hand strength was found to be similar in the two groups. No significant difference in mean strength existed between the sexes. However, from the age of 7 years the changes in mean hand strength with age differed significantly \((p < 0.05)\) between the two groups. A significant difference \((p < 0.05)\) was also found in both the distribution of left hand dominance and right hand dominance in the normal and abnormal groups.

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**Bibliography**


