Active Finger Extension
A Simple Movement Predicting Recovery of Arm Function in Patients With Acute Stroke

Nicola Smania, MD; Stefano Paolucci, MD; Michele Tinazzi, MD; Anna Borghero, MD; Paolo Manganotti, MD; Antonio Fiaschi, MD; Giuseppe Moretto, MD; Paolo Bovi, MD; Mattia Gambarin, MD

Background and Purpose—Early prognosis of arm recovery is a major clinical issue in stroke. The aim of this study was to assess the prognostic value of 4 simple bedside tests.

Methods—Forty-eight patients with arm paresis/plegia were evaluated on days 7, 14, 30, 90 and 180 after stroke. Assessment included 4 potential predictors of arm recovery (active finger extension, shoulder abduction, shoulder shrug and hand movement scales) and 3 outcome measures evaluating arm function (Nine Hole Peg Test, Fugl-Meyer arm subtest, Motricity Index arm subtest).

Results—The active finger extension scale was the most powerful prognostic factor. Patients with active finger extension scores >3 had a high probability of achieving good performance as assessed by the Motricity Index.

Conclusions—Active finger extension is a reliable early predictor of recovery of arm function in stroke patients. (Stroke. 2007;38:1088-1090.)

Key Words: prognosis ■ rehabilitation ■ stroke

Recovery of function of the paretic arm is one of the main concerns of patients after stroke. To date only a few studies have focused on simple clinical bedside tests predicting functional recovery in stroke. Katrak et al1 showed that preservation of proximal (shoulder) movements after stroke is an early predictor of arm recovery. Studies on neurophysiological control of distal movements in stroke support the hypothesis that active finger extension (AFE) could be a predictor of paretic arm recovery.2

The aim of this study was to clarify the role of 4 clinical indexes—AFE, shoulder abduction (SA), shoulder shrug (SS) and the hand movement scale (HMS)—as early predictors of recovery of arm function in stroke patients.

Materials and Methods

We prospectively studied 48 patients (mean age: 74.39±9.33; males 45.83%, 50% with left brain stroke) out of 137 patients consecutively admitted from October 2003 to August 2004 to the Neurology Division of the Azienda Ospedaliero-Universitaria of Verona, Italy, for their first ischemic stroke. Eighty-nine were excluded according to the following criteria: hemorrhagic stroke; unilateral neglect; limb apraxia; impaired verbal comprehension; other neurological or psychiatric conditions; orthopaedic diseases and/or pain limiting movements of the affected arm. During the study, we observed 11 drop-outs, including 2 deaths.

Patients were evaluated on days 7, 14, 90 and 180 after stroke. The evaluation protocol included 4 potential predictors of arm recovery (independent variables). AFE: the patient was asked to actively extend all affected fingers except the first simultaneously, with scores ranging from 0 (absence of muscle contraction) to 5 (normal muscle power).3 SS: the patient was required to shrug the affected shoulder (score: 0 if unable, 1 if able).1 SA: the score was 0 if the active range was <30° and 1 if >30°.1 HMS: this is a 6-point scale evaluating the ability to perform hand movements of different degrees of difficulty.4

We used only 3 validated tests as outcome measures (dependent variables): the Nine Hole Peg Test (NHPT) (score: time used to pick up and insert 9 pegs in 9 holes in a wooden board; maximum time allowed: 2 minutes),5 the Fugl-Meyer arm subtest (FugM) (score: 0 to 66),4 and the Motricity Index arm subtest (MI) (score: 0 to 99).6 Data were analyzed according to an intention-to-treat model. Forward stepwise multiple linear regression was done to clarify the prognostic role of the AFE, SS, SA and HMS (all performed 7 days after stroke) on NHPT, FugM and MI at different times poststroke (14, 30, 90 and 180 days). To quantify the probability of a good outcome, we performed logistic regression (forward stepwise, Wald test) using the top MI score (99) as a dependent variable at each step. Independent variables—all dichotomous—were: high basal AFE score (coded as 1=3 and 0=≤3), SS score, SA score, high basal HMS score (coded as 1=3 and 0=≤3).1 In order to take into account multiple inquiries we set the significance level at P<0.01. Data were analyzed using the SPSS statistical package, 11.0 version.
Results

As shown in Table 1, in the multiple regression analysis the AFE test was the only predictor that was associated with all 3 types of dependent variable (NHPT, FugM and MI), and was the only variable associated with performance in the NHPT (at 14 and 30 days). SS was mainly associated with MI, and SA with FugM.

As shown in Table 2, in the logistic regression analysis, patients with a basal AFE score $\geq 3$ had a 12- to 18-fold greater probability than the other patients of reaching the maximum MI score. An HMS score $\geq 3$ was associated with a high probability of full recovery on MI, but only in a chronic phase (evaluation on day 180). SA and SS did not enter any of the models.

Discussion

The present study shows that it is possible to predict recovery of function of the affected arm after stroke by means of a simple bedside clinical evaluation. In particular, AFE proved to be a strong early predictor of short-, medium- and long-term poststroke recovery, being significantly associated with all the dependent measures studied. Patients with a basal AFE score $\geq 3$ had a high probability of reaching the top score on MI. SA, SS and HMS exhibited inferior predictive power. It is important to note that the 3 measures used as dependent variables (NHPT, FugM and MI) evaluate different functional aspects, thus providing a very comprehensive picture of arm function. One possible explanation of these results may be that preservation of AFE might possibly be related to the degree of sparing of cortico-motoneuronal pathways after stroke. Given that cortico-motoneuronal representation of distal movement is mostly unilateral (whereas proximal movement is represented bilaterally in the brain), the only way to test sparing of neurons governing distal function is by requiring the patient to perform distal movements. Among the most commonly used clinical tests of distal movement the AFE scale presents a number of clinical advantages. The finger extension task is very easily understood by most stroke patients, whereas other selective finger movements (eg, sequences of opposition between the thumb and other fingers) are sometimes too difficult to understand and execute and may be influenced by the patient’s cognitive status. A commonly used test of distal movement is finger flexion. This movement (not tested in the present study), however, may be part of synergistic movements emerging after lesions involving corticospinal

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**TABLE 1. Multiple Regression Analysis to Test the Value of AFE, SS, SA and HMS as Predictors of Recovery of Arm Function**

<table>
<thead>
<tr>
<th>Independent Variables, 7 days</th>
<th>NHPT 14 days</th>
<th>NHPT 30 days</th>
<th>NHPT 90 days</th>
<th>NHPT 180 days</th>
<th>FugM (arm) 14 days</th>
<th>FugM (arm) 30 days</th>
<th>FugM (arm) 90 days</th>
<th>FugM (arm) 180 days</th>
<th>MI (arm) 14 days</th>
<th>MI (arm) 30 days</th>
<th>MI (arm) 90 days</th>
<th>MI (arm) 180 days</th>
</tr>
</thead>
<tbody>
<tr>
<td>AFE $\beta$</td>
<td>-0.623</td>
<td>-0.695</td>
<td>-0.661</td>
<td>-0.428</td>
<td>0.667</td>
<td>0.637</td>
<td>0.590</td>
<td>0.567</td>
<td>0.515</td>
<td>0.394</td>
<td>0.382</td>
<td>0.620</td>
</tr>
<tr>
<td>$P$</td>
<td>$&lt;0.000$</td>
<td>$&lt;0.000$</td>
<td>0.014*</td>
<td>0.012*</td>
<td>$&lt;0.000$</td>
<td>$&lt;0.000$</td>
<td>$&lt;0.000$</td>
<td>$&lt;0.000$</td>
<td>$&lt;0.000$</td>
<td>0.006</td>
<td>0.018*</td>
<td>$&lt;0.000$</td>
</tr>
<tr>
<td>SS $\beta$</td>
<td>- - - -</td>
<td>- - - -</td>
<td>- - - -</td>
<td>- - - -</td>
<td>- - - -</td>
<td>- - - -</td>
<td>- - - -</td>
<td>- - - -</td>
<td>- 0.309</td>
<td>0.308</td>
<td>0.267</td>
<td>- - - -</td>
</tr>
<tr>
<td>$P$</td>
<td>- - - -</td>
<td>- - - -</td>
<td>- - - -</td>
<td>- - - -</td>
<td>- - - -</td>
<td>- - - -</td>
<td>- - - -</td>
<td>- - - -</td>
<td>0.001</td>
<td>0.003</td>
<td>0.018*</td>
<td>- - - -</td>
</tr>
<tr>
<td>SA $\beta$</td>
<td>- - - -</td>
<td>- - - -</td>
<td>- - - -</td>
<td>- - - -</td>
<td>0.341</td>
<td>0.326</td>
<td>0.371</td>
<td>0.376</td>
<td>0.208</td>
<td>- - - -</td>
<td>- - - -</td>
<td>- - - -</td>
</tr>
<tr>
<td>$P$</td>
<td>- - - -</td>
<td>- - - -</td>
<td>- - - -</td>
<td>- - - -</td>
<td>$&lt;0.000$</td>
<td>0.001</td>
<td>$&lt;0.000$</td>
<td>$&lt;0.000$</td>
<td>0.020*</td>
<td>- - - -</td>
<td>- - - -</td>
<td>- - - -</td>
</tr>
<tr>
<td>HMS $\beta$</td>
<td>- - - -</td>
<td>- - - -</td>
<td>- - - -</td>
<td>- - - -</td>
<td>-0.390</td>
<td>- - - -</td>
<td>- - - -</td>
<td>- - - -</td>
<td>0.278</td>
<td>0.319</td>
<td>0.290</td>
<td>- - - -</td>
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<tr>
<td>$P$</td>
<td>- - - -</td>
<td>- - - -</td>
<td>- - - -</td>
<td>- - - -</td>
<td>$&lt;0.000$</td>
<td>- - - -</td>
<td>- - - -</td>
<td>- - - -</td>
<td>0.021*</td>
<td>0.012*</td>
<td>0.044*</td>
<td>- - - -</td>
</tr>
<tr>
<td>Adjusted $r^2$</td>
<td>0.375</td>
<td>0.471</td>
<td>0.424</td>
<td>0.592</td>
<td>0.842</td>
<td>0.766</td>
<td>0.753</td>
<td>0.722</td>
<td>0.796</td>
<td>0.773</td>
<td>0.704</td>
<td>0.635</td>
</tr>
</tbody>
</table>

$-$ indicates not significant; *, tending towards significance.

**TABLE 2. Results of Logistic Regression Analysis With Maximum MI Score as Dependent Variable**

<table>
<thead>
<tr>
<th>Independent variables, 7 days</th>
<th>14 days OR (95% CI)</th>
<th>30 days OR (95% CI)</th>
<th>90 days OR (95% CI)</th>
<th>180 days OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AFE $&gt;3$</td>
<td>19.50 3.58–106.08</td>
<td>15.48 3.42–70.02</td>
<td>14.67 3.55–60.65</td>
<td>10.00 1.49–67.02</td>
</tr>
<tr>
<td>HMS $&gt;3$</td>
<td>NE</td>
<td>NE</td>
<td>NE</td>
<td>6.25 1.14–34.31</td>
</tr>
<tr>
<td>Predictive accuracy</td>
<td>79.2%</td>
<td>79.2%</td>
<td>79.1%</td>
<td>85.4%</td>
</tr>
<tr>
<td>Significance $\chi^2$</td>
<td>16.20</td>
<td>16.14</td>
<td>17.10</td>
<td>26.34</td>
</tr>
<tr>
<td>$P$</td>
<td>$&lt;0.001$</td>
<td>$&lt;0.001$</td>
<td>$&lt;0.001$</td>
<td>$&lt;0.001$</td>
</tr>
</tbody>
</table>

NE indicates not entered.
neurons, and this could be a confounding factor in terms of prognosis of arm recovery.\textsuperscript{2}

Limitations of the study are the small sample size and the limited number of potential prognostic factors examined.

Conclusions
Active finger extension is a reliable early predictor of recovery of arm function in patients with stroke.

Disclosures
None.

References
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