Clinical Examination Is More Predictive of Ambulation Recovery Than CT Lesion Location Following Subcortical Ischemic Stroke

Charisse D. Litchman, M.D., Mark Dietz, M.D., and Michael J. Reding, M.D.

Stroke outcome predictions based on neuroimaging assessments of lesion size, cortical vs. subcortical location, or lobes involved have not been clinically useful. In order to assess the value of an "arterial distribution" outcome schema for subcortical stroke, we reviewed the CT scans of three hundred patients to find fourteen that were obtained two or more days following ischemic stroke which showed lesions restricted to either the lateral lenticothalamic (LLS) or anterior choroidal (AC) arterial distributions. Films were reviewed by two neurologists blinded to the clinical status. Motor paresis and hemisensory deficits were scored at the time of inpatient rehabilitation hospital admission by the staff neurologist having access to the CTS result but unaware of this study. Functional outcome was assessed by Life Table Analysis of the Barthel Index ambulation subscore recorded up to six months post-stroke by rehabilitation team members unaware of CTS results. Of the fourteen patients, five had LLS lesions and had a 43 percent probability of becoming independent ambulators. The remaining nine had AC lesions and had a 23 percent probability of becoming independent ambulators (P = N.S., Haenszel-Mantel test). Patients with isolated motor deficits had a 70 percent probability of reaching independent ambulation vs. a 0 percent probability of independent ambulation for those with motor plus hemisensory deficits (P < 0.05, Haenszel-Mantel test). These data indicate that ambulation recovery following subcortical stroke is better predicted by clinical evaluation of neurologic impairment than by CT assessment of arterial distribution affected. Key Words: Cerebrovascular disorders—Rehabilitation—Computed transaxial tomography—Ambulation—Functional outcome.

Introduction

The hypothesis underlying correlations between neuroimaging lesion assessment and functional outcome is that a clear definition of brain structural damage should allow one to predict both resultant neurologic impairment and functional disability. Studies categorizing patients according to lobar involvement have not been successful, perhaps because most strokes involve more than one lobe, following vascular distributions rather than anatomic lobar boundaries (1). Several authors have studied the effect of cortical versus subcortical lesion location on functional outcome. Miller et al. found that ten of thirteen patients with "deep infarction" and five of ten patients with cortical lesions required moderate to maximal assistance with transfers and ambulation (2). Chaudhuri et al. found no difference in self-care and ambulation for patients with large superficial strokes ver-
sus those with "deep infarcts" (3). Studies attempting to more precisely define the location of subcortical strokes have used classification schema based on arterial distribution: internal lenticulostriate, lateral lenticulostriate, and anterior choroidal vessels, etc. (4,5). The value of such neuroimaging based classification schema for functional outcome prediction is unproven.

Numerous studies have examined clinical parameters that predict rehabilitation outcomes following stroke. Proposed prognostic factors include age, educational level, functional level at start of rehabilitation, severity of weakness, apraxia, visual neglect, and hemisensory loss, etc. For unilateral hemispheric ischemic strokes, Reding and Potes demonstrated a highly significant difference in the probability of reaching independence in ambulatory and self-care function for patients divided into subgroups based on presence of motor deficit alone, motor plus somatic sensory deficits, and motor plus somatic sensory plus homonymous visual deficits (6).

In this study, we compare the value of CT scan localization versus the bedside neurologic examination in predicting ambulation recovery for patients with subcortical stroke.

Method

All patients were residents on an inpatient stroke rehabilitation unit, thus representing a selected subset of stroke survivors meeting criteria for inpatient rehabilitation admission: need for assistance with basic ADL function, absence of overriding medical problems that would limit rehabilitation efforts, and adequate patient motivation for ADL and mobility training. Inclusion criteria required that CT scans were obtained two or more days after the onset of stroke and that they demonstrated unilateral subcortical ischemic infarction without cortical involvement.

CT scans showing maximum lesion size were reviewed independently by two observers (MD and MR). Lesions were classified as affecting either the lateral lenticulostriate distribution (LLS) involving the caudate, putamen, anterior limb of the internal capsule and variable amounts of the posterior limb of the internal capsule, or the anterior choroidal distribution (AC) restricted to the globus pallidus and posterior limb of the internal capsule (see Figures 1 and 2). In cases of disagreement, reviewers met to reach a consensus reading. Cases in which there was no consensus agreement were dropped from the study. The arterial distribution of the lateral lenticulostriate and anterior choroidal arteries were defined using CT templates published by Weilker et al. (7). Since images were obtained from a variety of scanners at different referring hospitals, it was not possible to measure lesion volume or compare the effect of lesion size on functional outcome.

On admission to the inpatient stroke rehabilitation unit, a standard neurological examination was performed by a neurologist having access to the CT scan results but unaware of this study. Presence of motor impairment was defined as a Medical Research Council motor score of 4 or less in the affected arm or leg (8). Hemihypesthesia was assessed using the limb placement task asking patients to locate their affected index finger in all four spatial quadrants with their unaffected hand with eyes occluded (9). The greatest consistent error was recorded and scored as abnormal if greater than or equal to six inches. This sensory test was used because it is semiquantitative and can often be understood by even globally aphasic patients. Those unable to comprehend the limb placement task even with maximum gestural cues were scored as abnormal. Hemianopsia was assessed by confrontation visual field testing. Patients were then divided into two groups, one with motor deficit only and the other with motor deficit plus hemihypesthesia and/or hemianopsia. Presence of aphasia did not disqualify patients from being labeled as motor deficit only.

Barthel Index ADL-ambulation scores were determined every two weeks from the time of rehabilitation hospital admission to the time of discharge (10). Actuarial life table analysis was performed on the LLS and AC subgroups at sixty day intervals from date of stroke, scoring the number of patients reaching each of the following outcome goals: Barthel score greater than 60, Barthel score greater than 95, ability to walk greater than or equal to 150 feet with assistance, and the ability to walk greater than or equal to 150 feet independently. The assumption was made that at the time of acute stroke, prior to rehabilitation hospital admission, patient ADL-ambulation function was below each of the outcome goals. Interval scale demographic data were assessed using Students-t test. Categorical demographic features were assessed using Fisher's exact test. Life table curves for the LLS and AC subgroups were compared using the Mantel-Haenszel log-rank method (11). Similar analyses were performed dividing patients into subgroups with motor deficit alone and motor plus sensory deficits.

Results

Of three hundred cases reviewed, ninety-nine showed unilateral supratentorial ischemic infarction on CT studies obtained two or more days post-stroke. Of these, five were LLS and nine were AC distribution strokes. Seven of the fourteen patients had motor deficit and seven had motor plus sensory deficits.
Demographic features for LLS, AC, motor, and motor-sensory strokes are presented in Table 1.

There was no statistically significant difference in the probability of reaching the target ADL or ambulation outcome goals for patients with LLS versus AC lesions.

Those with LLS lesions had a 43 percent probability and those with AC lesions a 23 percent probability of becoming independent ambulators (see Figure 3). The probability statistics for reaching each of the additional ADL-mobility outcome goals are presented in Table 2.

Figure 1. CT images showing the typical lesion seen with infarction in the lateral lenticulostriate vessel distribution.
Patients with isolated motor deficits had a 70 percent probability of reaching independent ambulation versus a 0 percent probability of independent ambulation for those with motor plus hemisensory deficits (p<0.05 Haenszel-Mantel test; see Figure 4). The probability statistics for reaching each of the additional ADL-mobility outcome goals are presented in Table 2.

Discussion

The present study is the first to compare both CT scan and clinical examination results as predictors of functional outcome in subcortical infarction.

The definition of LLS and AC distribution subcortical strokes by CT scan criteria did not predict significantly
Table 1. Demographic features of patient population

<table>
<thead>
<tr>
<th></th>
<th>Arterial distribution</th>
<th>Clinical deficit</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Lateral lenticulostriate</td>
<td>Anterior choroidal</td>
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<tr>
<td>Age</td>
<td>63</td>
<td>74</td>
</tr>
<tr>
<td># Males</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td># Females</td>
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<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Side of infarct L</td>
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</tr>
<tr>
<td>Adm. Barthel Score</td>
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<td>52</td>
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</table>

Patients were divided both by arterial distribution of lesion and by clinical deficit.

Table 2. Probability of reaching functional outcome goals

<table>
<thead>
<tr>
<th>Functional goal</th>
<th>Arterial distribution</th>
<th>Clinical deficit</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Lateral lenticulostriate</td>
<td>Anterior choroidal</td>
</tr>
<tr>
<td>Ambulation independent 150 ft</td>
<td>43</td>
<td>23</td>
</tr>
<tr>
<td>Ambulating 150 ft with assistance</td>
<td>80</td>
<td>89</td>
</tr>
<tr>
<td>Barthel score ≥95</td>
<td>43</td>
<td>11</td>
</tr>
<tr>
<td>Barthel score ≥60</td>
<td>80</td>
<td>89</td>
</tr>
</tbody>
</table>

*Patients were divided both by arterial distribution of lesion on CT scan and by clinical deficit. Probabilities are presented as percentages.

different ADL or ambulation outcome results. Our findings are comparable to those obtained by Levine et al., who used an arterial distribution schema similar to ours and showed that half of the patients in both subcortical locations had "significant residual deficits" (5). They did not use a standardized ADL-ambulation scale, nor did they present any statistical analysis of their data.

Rascol published a CT scan localization study of patients presenting with isolated motor weakness (4). Within this clinically defined patient group, he found subcortical strokes affecting any one of three different arterial distributions: internal lenticulostriate and anterior choroidal artery. Of twenty-five patients with lesions confined to one of these arterial distributions, those with internal lenticulostriate and anterior choroidal distribution lesions "recovered fully." Two of five patients with partial lenticulostriate distribution strokes had residual hemiparesis, and three of four patients with complete lateral lenticulostriate distribution strokes had major residual deficits. No statistical analysis was performed and outcome results were not scored on a standardized scale. Rascol was able to show that patients with pure motor strokes do well except when they are due to lateral lenticulostriate vessel involvement. The more extensive the lateral lenticulostriate involvement, the worse the outcome. This is contrary to some of our data. Of our five patients with pure motor hemiparesis from anterior choroidal distribution lesions, only two became independent ambulators. The disparity between his results and ours might be partially attributed to the fact that all of our anterior choroidal infarcts extended rostrally into the corona radiata. His conclusion, that the CT scan predicts functional outcome, can be applied only to those patients with pure motor hemiparesis, a syndrome which itself carries a good prognosis. By including only those patients with isolated motor deficit, his method of prognostication employs clinical findings before utilizing those of the CT scan.

The fact that clinical parameters were better predictors of outcome than the CT scan estimation of arterial distribution affected is noteworthy. The linkage between sensory-motor impairments and ambulation outcome is simpler than the more remote task of estimating the probability that these neurologic impairments exist based on the size and location of the CT lesion. An area of altered brain structure does not mean that the area involved is functionally impaired. Even knowing that a motor path-
Figure 3. This life-table analysis shows the probability of recovering the ability to walk 150 feet independently for patients with lateral lenticulostriate (LLS) versus anterior choroidal (AC) lesions as defined by CT scan.

Figure 4. This life-table analysis shows the probability of recovering the ability to walk 150 feet independently for patients with different neurologic impairments. See the text for a definition of motor and motor-sensory deficits.
way is interrupted does not translate directly into a given severity of arm or leg weakness. With technological advances allowing better neuroimaging, there is still a gap between the area of apparent damage and neurologic impairment. Magnetic resonance technology has only compounded the problems of predicting neurologic impairment from lesion location and size by revealing areas of leukoaryosis of questionable clinical significance. SPECT and PET technology reflect both areas of primary ischemic dysfunction and distant areas of diaschisis. SPECT and PET techniques may seriously overestimate the area of actual brain infarction, making outcome prediction even more problematic than predictions made on the basis of older CT technology.

The timing of CT scans is important in assessing lesion size and location. Studies done within the first 24 to 48 hours post-stroke may show no lesion. Lesion size is maximal at seven to ten days and may overestimate the area of infarction due to edema within and around infarcted brain (12). Serial CT studies by Skriver and Olsen showed a “fogging” effect in 54 percent of ischemic strokes occurring at two to three weeks post-onset (13). The “fogging” effect is thought due to luxury perfusion and neurolytic changes in the infarcted tissue giving an X-ray appearance isodense with that of surrounding normal tissue. While the ideal time for CT assessment of lesion size and location is four weeks or longer post-onset, such delayed studies do not seem to be a cost-effective measure of outcome prediction. We chose to include films done two or more days post-stroke because these films were expected to show the lesion and were readily available for most patients referred to our facility.

In our study, characterizing patients as having motor deficit alone or motor plus sensory deficit provided a statistically significant prognostic indicator. While the CT scan has revolutionized the acute care of stroke vic-

tims, division into prognostic groups based on clinical criteria is superior to CT appearance in predicting functional outcome for patients with subcortical infarction.

References


