Visual gait analysis: the development of a clinical assessment and scale

SE Lord, PW Halligan and DT Wade Rivermead Rehabilitation Centre, Oxford, UK

Objectives: To develop and evaluate a four-point scale visual gait assessment form, the Rivermead Visual Gait Assessment (RVGA), for clinical use with patients with neurological deficits.

Design: Preliminary clinical testing of reliability, validity and sensitivity to change.

Setting: Patients were recruited from the Rivermead Rehabilitation Centre (RRC), a centre specializing in rehabilitation for patients with neurological disease.

Patients: Ten inpatients were assessed by up to seven physiotherapists for the main reliability study, and eight different patients were also assessed by two raters one week apart. Twenty outpatients with multiple sclerosis (MS) who were receiving physiotherapy to improve their mobility and 27 inpatients with various neurological conditions were also assessed and the data used to examine validity, reliability and sensitivity to change.

Outcome: The other comparative measures used were walking time, stride length, step length asymmetry, balance and the Rivermead Mobility Index.

Results: Inter-rater reliability between multiple raters was reasonable both for the global scores from the gait assessment form (Kendall’s coefficient of concordance; $p < 0.001$), and for individual items (complete agreement occurred on 63.8% of all observations). There was a significant correlation between the global RVGA score and the various criterion measures ($r = 0.53–0.79; p < 0.001$) and between change in the RVGA score and change in walking time in patients who received treatment ($r = 0.68; p < 0.01$).

Conclusions: The RVGA provides the clinician with a clinical assessment of the quality of gait which may be used in conjunction with other measures to inform and monitor the value of physiotherapy treatment for people with MS and stroke, and possibly other neurological deficits.

Introduction

Physiotherapists use visual gait analysis as the preferred method of gait assessment in their clinical practice.1 The assessment may be used both

---

Address for correspondence: Derick Wade, Consultant in Neurological Disability, Rivermead Rehabilitation Centre, Abingdon Road, Oxford OX1 4XD, UK.

© Arnold 1998
parameters (e.g. gait speed) provide clinicians with a quantitative analysis, but they do not describe the quality of performance (i.e. the ways in which the gait pattern deviates from normal). This is of regular concern to both physiotherapists and patients since treatment is most often directed at this level. The lack of a generally accepted format for the systematic evaluation of gait is reflected in the difficulty seen both in setting goals of gait rehabilitation and in agreeing the variables to be studied.

Several researchers have developed clinical assessments of gait in an attempt to quantify gait analysis and some clinicians have used videotaped recording to increase reliability. Video-recording allows repeated viewing without the necessity for repetition and patient fatigue, and permits the rater to control the pace of the movement analysis, all of which presumably reduces measurement error.

Three studies have examined the inter-rater reliability of videotaped observational gait analysis with more than two raters. Krebs et al. found that there was total agreement in 67.5% of observations when three physiotherapists rated the kinematics of three stance phases in 15 disabled children. Eastlack et al. found slight to moderate reliability (range of kappa 0.11 and 0.52) for 54 physiotherapists observing kinematic and temporospatial variables in three patients with rheumatoid arthritis. Hughes and Bell found significant agreement between three raters for swing phase kinematics in six hemiplegic patients, and poor agreement for both stance phase kinematics and a subsection of the form describing the general characteristics of gait.

All these studies used a three-point ordinal scale to quantify gait deviations, using slightly different descriptor terms. A 'normal' category was included in each scale. Preassessment training and the level of rater clinical experience ranged from extensive rater training for physiotherapists with experience in gait analysis, orientation to the gait assessment form for physiotherapists with diverse clinical skills and a practice session for senior physiotherapists.

The results of these three studies show moderate reliability at best. The possible reasons for this include: variations in equipment, the limitations arising from analysing two-dimensional video representations, the complex and rapid analysis required when gait is divided into sub-phases which may last only a fraction of a second, poor design of the original assessment form, and insufficient rater training.

The current study aims to develop a procedure and assessment form which allows practising therapists to record relevant aspects of the quality of gait observed in patients with neurological disease in a reliable and valid way. The aim of the study was to produce a procedure that could be used on a day-to-day basis without needing special equipment or prolonged training. The study also undertook initial evaluation of validity, reliability and sensitivity to change. The resulting Rivermead Visual Gait Assessment (RVGA) was intended for use with patients with neurological disease who present with impaired walking.

**Method**

The items used in the assessment form were derived from current texts and papers describing normal and pathological gait, descriptions of gait in physiotherapy records, clinical observation, previous research and current gait assessment forms. As the assessment was intended for practical clinical use, it had to be reasonably short and easy to use.

The RVGA (see Appendix) comprises two observations of the arms covering both swing and stance of gait, and 18 observations of the trunk and lower limb: 11 observations during the stance phase and seven during the swing phase of gait. The observations apply only to one side at a time. A four-point scale was used to quantify the degree of abnormality for each of the component items: 0 = normal, 1 = mild, 2 = moderate and 3 = severe. A global score can be calculated by summing the total numbers of deviation scores, range from 0 (normal gait) to 59 (grossly abnormal gait).

Patients from the Rivermead Rehabilitation Centre (RRC), a regional rehabilitation and research centre that provides interdisciplinary rehabilitation for adults with neurological disease, participated in the reliability study provided they met the following criteria:
1) Impaired walking pattern due to neurological disease (for which they were receiving ongoing physiotherapy).
2) Ability to walk for a period of 10 min (interspersed with rest).
3) No other pathology that affected their ability to walk.
4) Willingness to participate in the study.

Reliability

Three independent studies were conducted to establish the inter-rater and intra-rater reliability of the RVGA. In each case the patients were asked to walk at their normal walking speed, with the aids and orthoses they normally used. Each assessment took between 10 and 15 min, and the patient rested if necessary. All observations referred to the affected leg, or to each leg separately if bilateral abnormalities were present. Each rater made independent observations using the form provided. Patients were also assessed for walking time, stride length and step-length asymmetry (see below). Therapists could move around to obtain the view(s) they needed.

1) The first study (intra-rater) involved one research therapist (SL) assessing six patients on two occasions seven days apart; patients were not expected to change over this time. This included three with a diagnosis of multiple sclerosis (MS) with bilateral involvement, one with head injury and two with unilateral stroke.

2) The second study (multiple inter-rater) involved physiotherapists at RRC. The study took place over five months and staff changes meant that there was a variation in the total number of raters and in the specific individual raters present at each assessment. The raters had a wide level of clinical experience (one year post qualification to at least 15 years in neurology); most had no specific knowledge or experience of detailed gait analysis. Raters were trained on the RVGA over 5-10 min prior to its use, but were not given specific gait analysis training. Reliability was assessed using 10 patients: one with head injury, two with MS, and seven with unilateral stroke. Nine of the patients presented with predominantly unilateral gait deviations and one with bilateral deviations, as determined by clinical assessment. One patient was assessed by five raters, four patients were assessed by seven raters, and five patients were assessed by six raters.

3) The third study (two inter-rater) involved the research physiotherapist (SL) who designed the RVGA, and a senior physiotherapist not working at RRC who received training and practice in the use of the form on at least three separate occasions. The form was tested using seven patients with MS with bilateral gait abnormalities and one patient with a stroke who presented with a predominantly unilateral deficit.

Validity

Several categories of validity were investigated:

Face and content validity

These were investigated by asking physiotherapists to consider all the items included in the form and the observations listed. The frequency with which each gait deviation was scored across different patient groups in the reliability studies was also examined to confirm content validity.

Criterion validity

This was investigated by correlating changes in RVGA gait scores with changes in established ‘criterion’ measures. These included the 10-metre walking time, the Rivermead Mobility Index, functional balance, and the stride length and step length asymmetry. All assessments were carried out in the physiotherapy gymnasium at RRC, where a 10-metre grid divided into 3-cm sections was placed directly on to the floor. To measure stride length and step-length asymmetry, the physiotherapist walked behind the patient and noted (using a tape-recorder) the point on the grid where each heel strike occurred. Patients were asked to walk at their normal speed on both occasions.

Sensitivity to change

This was investigated by using the RVGA as one of the outcome measures in a pilot randomized control study comparing two physiotherapy treatment approaches designed to improve
mobility in 20 people with MS. Patients were treated three times a week for a six-week period and were assessed following intervention by a blinded, independent assessor.

**Statistical analysis**

For the reliability studies, trunk observations during stance and swing, and the observations during stand of ankle plantar/dorsiflexion and knee flexion/extension were rated on a seven-point scale in order to detect any inter-rater differences in noting the direction of abnormality as well as its extent. This was not done for the validity study, as only one rater was involved. The scores derived from the RVGA were assumed to be ordinal and therefore appropriate for non-parametric statistical analysis.

Within-rater agreement is reported as the least significant difference (LSD), which is an estimate of the difference between a matched pair of readings significant at the 0.05 level.

Inter-rater reliability is reported as the number of ratings for each observation achieving exact agreement and the numbers showing disagreement by 1, 2 and 3 points (out of a maximum possible difference of six). Post-hoc analysis was carried out by combining two categories on the form (mild(1) and moderate(2)) and calculating percentage of agreement on the basis of a three-point scale (i.e. scores 0, 1 & 2, 3). This analysis provided a degree of comparison with the results of previous studies, and was implemented for the first reliability study only. A Kendall’s coefficient of concordance (W) was used to determine inter-rater agreement of RVGA global scores. The kappa, which takes into account chance agreement, is not recommended for polytomous data because the weighting between categories in the scale is nonstandard.

Validity was further investigated by plotting a scatterplot and using a Spearman’s correlation coefficient to measure the relationship between the global gait score and other disability criterion measures. The 20 patients with multiple sclerosis receiving therapy were considered as one group for the purposes of this study, and the gait scores were correlated with walking time, stride length, RMI and the Berg balance score before and after treatment.

The validity of the scale was further established by comparing changes in the global score and changes in other measures for MS patients following treatment. A clinically significant change was determined a priori as: a decrease in 10-metre walking time of 28% or more, an increase in the RMI score by two points or more, an increase in stride length greater than 25%, an increase of six in their Berg balance score and a decrease of at least six points in the global gait score.

**Results**

**Intra-rater reliability (study 1)**

The test-retest results of intra-rater variability on six patients seen twice over seven days are shown in Table 1. An increase of 12 in the RVGA for one patient was accompanied by the highest between-measure difference in walking time of 18.1%, and this patient’s variable gait pattern contributed to the high LSD obtained for the global gait score. The data suggest that a score change of at least 10.5 in the RVGA global score is required before a significant change can be assumed.

**Inter-rater reliability (studies 2 and 3)**

Table 2 shows the modal score (i.e. the most commonly marked score) for each item when 10

| Table 1 Test-retest variability in gait measures for one rater and six patients |
|-----------------------------|-----------------------------|-----------------------------|
|                             | Walking time                | Stride length               | Global RVGA score          |
|                             | Test 1                      | Test 2                      | Test 1                     | Test 2                     |
| Mean score                  | 22.1                        | 22.3                        | 94                         | 93.9                       |
| SD (of difference)          | 2.6                         | 3.9                         | 6.6                        | 10.0                       |
| LSD                         | 6.6                         | 10.0                        | 4.1                        | 10.5                       |

LSD, least significant difference.

\( t = 2.57 \) at 95% confidence level.
patients were rated by multiple observers simultaneously, and it also shows the number of patients scored on the mode and on surrounding scores. The treating therapist was sometimes one of the raters. Some observers did not complete all observations, typically because they considered that there was no abnormality(!). Of the 1322 observations made (from a potential maximum of 1400), exact agreement was achieved on 844 occasions (63.8%), disagreement by 1 point occurred 381 times (28.8%), disagreement by two points occurred 80 times (6%) and disagreement by three points occurred 17 times (1.2%). Least agreement occurred when raters observed trunk and pelvis lateral displacement during stance and the position of the trunk during swing.

Table 3 shows the global scores for the 10 patients. There was significant agreement (Kendall’s coefficient of concordance: $W = 0.84$, $p < 0.001$) between five (arbitrarily selected out of total available on each occasion) raters, which was the minimum number of raters for each test, on the total score for the 10 patients. This suggests good reliability for the global RVGA score.

### Table 2

**Inter-rater reliability: frequency of response for 10 patients by seven raters (1322 observations; 678 observations missing)**

<table>
<thead>
<tr>
<th>Deviation</th>
<th>n</th>
<th>Modal score</th>
<th>Mode</th>
<th>Mode +/-1</th>
<th>Mode +/-2</th>
<th>Mode +/-3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shoulder depressed/retracted/elevated</td>
<td>44</td>
<td>0</td>
<td>30</td>
<td>14</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Elbow flexed</td>
<td>44</td>
<td>0</td>
<td>38</td>
<td>6</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Stance phase</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trunk flexed</td>
<td>69</td>
<td>5</td>
<td>45</td>
<td>16</td>
<td>8</td>
<td>0</td>
</tr>
<tr>
<td>Trunk: side flexed</td>
<td>69</td>
<td>5</td>
<td>44</td>
<td>19</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Trunk/pelvis laterally displaced</td>
<td>68</td>
<td>2,4,5</td>
<td>30</td>
<td>22</td>
<td>12</td>
<td>4</td>
</tr>
<tr>
<td>Contralateral pelvis drop</td>
<td>69</td>
<td>0</td>
<td>43</td>
<td>19</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>Hip extension decreased</td>
<td>69</td>
<td>1</td>
<td>47</td>
<td>19</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>... with retraction</td>
<td>69</td>
<td>1</td>
<td>49</td>
<td>18</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Knee flexion/extension excessive</td>
<td>69</td>
<td>4</td>
<td>47</td>
<td>18</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>... throughout the range</td>
<td>69</td>
<td>4</td>
<td>40</td>
<td>24</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Ankle in excess plantar/dorsiflexion</td>
<td>69</td>
<td>3</td>
<td>40</td>
<td>22</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>Inversion excessive</td>
<td>69</td>
<td>1</td>
<td>49</td>
<td>19</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Plantar flexion decreased at toe-off</td>
<td>64</td>
<td>2</td>
<td>43</td>
<td>18</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td><strong>Swing phase</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trunk flexed</td>
<td>69</td>
<td>5</td>
<td>33</td>
<td>28</td>
<td>7</td>
<td>1</td>
</tr>
<tr>
<td>Trunk side flexed</td>
<td>67</td>
<td>5</td>
<td>35</td>
<td>23</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>Hike pelvis</td>
<td>69</td>
<td>1</td>
<td>51</td>
<td>18</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Backward rotation pelvis</td>
<td>69</td>
<td>1</td>
<td>45</td>
<td>19</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Decreased hip flexion</td>
<td>69</td>
<td>2</td>
<td>50</td>
<td>18</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Decreased knee flexion</td>
<td>69</td>
<td>2</td>
<td>44</td>
<td>20</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Ankle in excess plantar flexion</td>
<td>69</td>
<td>2</td>
<td>41</td>
<td>22</td>
<td>6</td>
<td>0</td>
</tr>
</tbody>
</table>

### Table 3

**Global scores for 10 patients made by five raters**

<table>
<thead>
<tr>
<th>Patient:</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rater:</td>
<td>1</td>
<td>48</td>
<td>53</td>
<td>50</td>
<td>45</td>
<td>49</td>
<td>55</td>
<td>40</td>
<td>45</td>
<td>39</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>52</td>
<td>44</td>
<td>53</td>
<td>41</td>
<td>54</td>
<td>67</td>
<td>42</td>
<td>47</td>
<td>36</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>46</td>
<td>49</td>
<td>44</td>
<td>44</td>
<td>51</td>
<td>57</td>
<td>44</td>
<td>48</td>
<td>48</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>48</td>
<td>50</td>
<td>49</td>
<td>44</td>
<td>56</td>
<td>62</td>
<td>46</td>
<td>52</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>47</td>
<td>53</td>
<td>51</td>
<td>45</td>
<td>55</td>
<td>56</td>
<td>43</td>
<td>51</td>
<td>47</td>
</tr>
</tbody>
</table>
When the percentage of agreement was based on a three-point scale, total agreement was achieved on 1021 responses (77.2%), one-point disagreement occurred on 254 responses (19.1%), two-point disagreement occurred on 39 responses (2.9%) and three-point disagreement occurred on eight responses (0.6%).

For the inter-rater reliability study between the two raters experienced in neurology who also had a short period of training and discussion, total agreement occurred 122 times out of the 171 observations (71.3%). Disagreement by one point occurred on 47 responses (27.5%) and disagreement by two points occurred on two responses (1.1%). These results suggest that agreement improved after a short (10 min) period of training and discussion on the use of the RVGA.

**Validity studies**

Twenty-seven inpatients with a variety of neurological diseases were assessed. There was a significant correlation between the RVGA global score and walking time \((r = 0.77; p < 0.001)\) and stride length \((r = -0.61; p < 0.005)\), suggesting that the global score is a valid measure of gait impairments. This is also shown in Figure 1. Step-length asymmetry was not associated with the number or nature of deviations observed on the RVGA.

The pre- and post-treatment mean values for the outcome measures used in the MS study are shown in Table 4. There was a significant improvement for all measurements including the RVGA total score after treatment \((p < 0.01)\), suggesting that the RVGA can detect changes in gait impairments.

There was a significant correlation between the global RVGA score and the scores on other outcome measures used in the MS treatment study (Table 5), again supporting its validity as a measure of gait impairment. Table 6 shows the relationship between the changes in the RVGA total score and changes in related measures seen in

![Figure 1](image)

**Figure 1** Total RGVA versus 10-metre walking time for 27 inpatients with a variety of neurological diseases

**Table 4** Mean, standard deviation and range values for five measures: 20 MS patients before and after treatment

<table>
<thead>
<tr>
<th>Measure</th>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walking time (s)</td>
<td>28.5 ± 14.2 (14-59.7)</td>
<td>20.8 ± 11.7 (7-48)</td>
</tr>
<tr>
<td>Stride length (cm)</td>
<td>78.6 ± 13.8 (51-102)</td>
<td>95.3 ± 19.5 (67-145)</td>
</tr>
<tr>
<td>Global score</td>
<td>28.3 ± 9.7 (9-45)</td>
<td>22.7 ± 10.1 (3-41)</td>
</tr>
<tr>
<td>Berg score</td>
<td>37.0 ± 14.2 (13-54)</td>
<td>44.9 ± 9.8 (25-56)</td>
</tr>
<tr>
<td>RMI</td>
<td>10.8 ± 2.1 (6-13)</td>
<td>11.8 ± 2.0 (7-14)</td>
</tr>
</tbody>
</table>

RMI, Rivermead Mobility Index.
treated MS patients. There was also a good correlation between change in RVGA score and change in walking time in patients undergoing physiotherapy for mobility problems ($r = 0.68$, $p < 0.01$) (see Figure 2). Both sets of observations suggest that the RVGA is also a sensitive and valid measure of change.

**Discussion**

Our preliminary studies suggest that the Rivermead Visual Gait Analysis (RVGA) is a valid and reliable way of assessing gait in patients with stroke and multiple sclerosis, and that the RVGA can be used to monitor change in patients even if different therapists are assessing the patient at different times. Our studies were undertaken on a range of patients using a range of therapists, and suggest that the RVGA can be used reliably after relatively short specific training. Further studies are needed to confirm reliability and validity in different settings and with other patient groups. It might also be possible to improve the reliability of the assessment by simplifying or removing some items without losing sensitivity. The utility of the RVGA as a method of assessing gait deviations and directing therapy has yet to be investigated.

**The content of RVGA**

Items were chosen on the basis that they were useful, were capable of being observed simply without equipment, and were likely to be reli-

---

**Table 5** The correlation between RVGA scores and various criterion measures pre and post treatment

<table>
<thead>
<tr>
<th>Criterion measure</th>
<th>Walking time (WT)</th>
<th>Stride length</th>
<th>Berg balance</th>
<th>RMI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before treatment $r$</td>
<td>0.75</td>
<td>-0.24</td>
<td>-0.79</td>
<td>-0.68</td>
</tr>
<tr>
<td>After treatment $r$</td>
<td>0.73</td>
<td>-0.53</td>
<td>-0.79</td>
<td>-0.75</td>
</tr>
</tbody>
</table>

RMI, Rivermead Mobility Index. $r = $ Spearman correlation coefficient; WT, Berg and RMI $p \leq 0.001$; stride length before treatment NS, after treatment $p < 0.05$. 

**Table 6** Score changes in MS patients post treatment

<table>
<thead>
<tr>
<th>Patient</th>
<th>WT ≥28%</th>
<th>Global ≥6</th>
<th>Stride length ≥25%</th>
<th>Berg ≥6</th>
<th>RMI ≥2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>2</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>4</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>5</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>6</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>7</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>8</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>9</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>10</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>11</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>12</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>13</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>14</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>15</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>16</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>17</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>18</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>19</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>20</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

WT, walking time; global, RVGA total score; RMI, Rivermead Mobility Index.
able. Some items that therapists would consider important were not included. For example, only the most affected leg was observed because, after stroke, changes in the unaffected leg are probably secondary to the major impairment in the affected leg. However future research might identify (a) items which can be added to increase utility without compromising simplicity or reliability and (b) items which can be omitted without loss of utility.

Reliability

This study involved patients with a range of different impairments, both unilateral and bilateral. However there were insufficient patients to establish reliability in each subgroup and if used in a setting with patients having only one type of gait problem, reliability will need to be established. None the less our data suggest that the RVGA is reasonably robust.

The results suggest that physiotherapists with a range of experience and no specific training in gait analysis are moderately reliable at assessing gait using the RVGA with a four-point scale where each deviation is considered separately. However, visual gait assessment using the RVGA is a more reliable measure when global scores alone are used to evaluate abnormal gait patterns. This suggests that although physiotherapists agree on the overall clinical presentation of abnormal gait, there is less agreement over which deviations contribute to the problem. Agreement occurred between raters on 63.8% of all observations, which suggests that if different clinicians rate the patient’s gait there must be an improvement in over one-third of all observations before a real change in the quality of the gait pattern has occurred. This is not the case when global scores are used, where an improvement of 11 points out of 59 (19%) may possibly be considered significant. Because of the inherent variability in walking in these patient groups, however, clinical levels of significance need to be determined before an improvement in the quality of gait can be considered clinically relevant.

Post-hoc analysis suggests that when the RVGA is used as a three-point scale, agreement improves, and compares favourably with the results of other studies that have used a similar rating system. Although a three-point scale would lead to greater agreement between two raters, a reduction of one category may compromise the sensitivity of the form to change in gait performance, and reduce its validity. It might also reduce its utility as a clinical assessment of an individual patient by an individual clinician.

The RVGA was evaluated in conditions that reflect typical clinical practice: the raters used the form with no preassessment training, assessments were carried out during the course of clinical practice, the raters varied each time as did their level of clinical expertise. Agreement between two raters improved using the RVGA when these conditions were improved upon, which suggests
that a period of training is worthwhile before introducing the RVGA for general clinical use. Particular attention in training may be given to those observations that showed the least agreement amongst the raters. These were trunk and pelvis lateral displacement and flexion and side-flexion of the trunk during swing.

The modal score for the elbow was zero (indicating no abnormality), which suggests that this observation is the least relevant on the form, and may potentially be eliminated. Further analysis is also needed to determine whether some of the deviations covary (e.g. reduced hip extension and retraction), although this may be specific to only one patient group, e.g. stroke. Although patients with a predominantly unilateral deficit often present with bilateral deviations, assessment of the affected side alone appears to be sufficient. The changes seen on the intact side are commonly compensatory.

Validity

Previous studies have not provided evidence of any validation process on the gait forms used. The significant correlations between the global score and other criterion measures, and between changes in the RVGA global score and changes in other measures both suggest that for the RVGA criterion validity has been established. The correlation between global score and stride length in the MS patients before treatment was not significant; the reason for this remains uncertain. The amount of change in the RVGA score that is clinically relevant is unknown, but seven of the 10 patients who improved on three outcome measures following treatment had reduced their global score by at least six points, which shows that the form is sensitive to change when compared with other measures and suggests that a six-point change may be clinically relevant.

Our study did not use any assessments dependent upon video-recording or more complex gait laboratory measures. While these are not necessarily any better at assessing gait deviations, it will be necessary at some point to compare deviations identified with the RVGA against deviations identified by other methods.

In conclusion, this preliminary study suggests that physiotherapists can assess gait clinically with reasonable reliability if they use a formal approach recorded on a structured form such as the Rivermead Visual Gait Assessment (RVGA). The results suggest that the RVGA is both a valid and sensitive measure of gait impairment in patients with neurological disease. The RVGA could be a great advance for practising therapists, allowing them to document gait impairments reasonably quickly in the clinic without expensive equipment, and allowing them to demonstrate clinically relevant changes. However further research is needed to confirm these conclusions and, to consider its utility in directing therapy.

Acknowledgements

We thank the Lewis Family Trust for funding Sue Lord for a one-year research fellowship; the physiotherapists at Rivermead for their help in developing the assessment and in reliability studies; Ms Femke Maselkowski for helping in one reliability study; Dr Anne Ashburn and Dr Val Pomeroy for their detailed and constructive criticisms of an earlier draft; and the patients for participating.

References


Appendix 1 - The Rivermead Visual Gait Assessment form

Patient:____________________

Scoring: 0 = normal       Deviations: 1 = mild   2 = moderate   3 = severe (please circle)

Upper Limb Position

1 Shoulder Depressed/Retracted/Elevated 0 1 2 3
2 Elbow flexed  ≤45° (=0)  45° to 90° (=1) >90° (=2) 0 1 2

Stance Phase

3 Trunk flexed/extended
   Inclined:  backward  forward
   3 2 1 0 1 2 3
   Direction:  left  right
   3 2 1 0 1 2 3
   Amount:  excessive  reduced
   3 2 1 0 1 2 3

4 Trunk side flexed

5 Trunk and pelvis: lateral displacement
   Contralateral drop pelvis 0 1 2 3
   Hip extension decreased 0 1 2 3
   with backward rotation 0 1 2 3
   Knee flexion excessive: at initial contact 0 1 2 3
   Throughout range 0 1 2 3
   or
   Knee extension excessive: at initial contact 0 1 2 3
   Throughout range 0 1 2 3
11A Ankle in excess **plantar** flexion

or

11B Ankle in excess **dorsi** flexion

12 Inversion excessive

13 Plantar flexion decreased at toe-off

**Swing Phase**

14 Trunk flexed

**Direction:**

- backward
- forward

15 Trunk side flexed

**Direction:**

- left
- right

16 Hike pelvis (elevation)

17 Backward rotation pelvis

18 Decreased hip flexion

19 Decreased knee flexion

20 Ankle in excess plantar flexion

**Any other deviations noted**

Reference limb

Walking aid

AFO

**Total score** _/59_  

**Date**
Rivermead Visual Gait Assessment: guidelines

Because the descriptor terms ‘mild, moderate and severe’ cannot be strictly quantified, interpretation of their meaning will depend in part upon the clinician’s own process of gait analysis. The notes overleaf refer to the components of normal gait, and may be useful as a guide when considering the deviations.

Shoulder depressed/retracted/elevated
   The posterior border of the scapular lies approximately 25 mm from, and almost parallel with, the thoracic vertebrae between the levels of T1-T8.

Elbow flexed
   The elbow flexes to approximately 8° during stance.

Trunk flexed and side flexed
   During both stance and swing phases the trunk is erect and rotates about the vertical axis.

Trunk and pelvis lateral displacement
   The trunk and pelvis displace laterally approximately 25 mm during stance, towards the stance leg.

Contralateral pelvis drop
   During midstance the pelvis dips only a few degrees on the opposite side, its position maintained by contraction of the hip abductors on the stance side.

Hip extension
   During midstance and terminal stance the hip moves from 30° flexion to 0° (20° apparent hyperextension if the angle from hip to ankle is considered).

Backward hip rotation
   The pelvis moves from 5° forward rotation at initial stance to 5° backward rotation at terminal stance.

Knee flexion/extension at initial contact
   The knee is in a neutral position at initial contact and during mid and terminal stance. The yield of the knee is 15°, and occurs during the loading response just after initial contact.

Ankle plantar/dorsiflexion
   The ankle moves from neutral to 10° plantar flexion before midstance when the position changes to 10° dorsiflexion, as the leg moves forward over the foot.

Inversion
   The foot moves from slight inversion/supination on initial stance to eversion/pronation which is maintained until heel-off when the foot is again supinated.

Plantar flexion decreased at toe-off
   The ankle provides the push-off required at preswing by moving from dorsiflexion to 10° plantar flexion.

Hike pelvis
   The pelvis is slightly lower on the leg during the swing phase, thus lowering the height of the hip joint.
Backward rotation pelvis
   By terminal swing the pelvis is in 5° forward rotation.

Hip flexion
   The hip flexes throughout the range from 0° at initial swing to reach a peak at 60–70°, before dropping to 25° at terminal swing.

Knee flexion
   The knee flexes from 40° at preswing to 60° during midswing.

Plantar flexion
   The ankle moves from plantar flexion to neutral by midswing to clear the ground by approximately 14 mm, and stays in neutral until the loading response during stance.