The purpose of this paper is to present a clinically feasible method to provide objective, quantitative information regarding the quality of a patient’s gait. The technique used is simple and economical and requires minimal equipment. The four basic temporal and distance factors are 1) stride length, 2) step length, 3) cadence, and 4) velocity. The technique requires the following equipment: 1) grid pattern, 2) stop watch, 3) portable tape recorder, 4) tape measure, 5) marking pen, and 6) masking tape. Case examples are provided to demonstrate the use of the data obtained.

Key Words: Gait, Evaluative studies, Physical therapy.

A considerable portion of many physical therapists’ time is spent improving their patients’ ability to walk. This rather “automatic” mode of moving from point A to point B becomes a complicated act to those patients with lesions in the neuromusculoskeletal systems. In order to improve a patient’s gait, the physical therapist must first ascertain what gait deviations are occurring and what is causing the deviations. Therefore, much attention is given to gait evaluation.

Objective methods such as force plate studies, electrogoniometry, EMG, photography, and energy expenditure studies have been developed to obtain quantitative information about gait. Unfortunately, many of these methods are not easily used in a clinical setting because of equipment cost, space requirements, and time necessary to administer the tests and reduce the data to clinically meaningful information.

Gait evaluation remains based primarily on clinical observations. This observational method of gait evaluation becomes an art with continued practice and application. For this reason, it is still the accepted manner of judging how well a patient is walking. One of the limitations of this method, however, is that this information cannot be quantified. For instance, on evaluation, it can be seen that the patient’s gait has improved. The questions may be posed, “How can you prove that the gait is improved?” or “How much has the gait improved?”

A method is needed to quantify characteristics of gait that can be quantified are velocity, cadence, stride length, and step length. They have been used in studies of normal and abnormal gait. A range of normal data has also been identified as well as deviations from norms. If the physical therapist’s ability to observe can be used to obtain objective, quantitative information in the form of the temporal and distance factors mentioned, then questions such as “How can you prove the patient’s gait is improved?” and “How much better is your patient walking?” can be answered. The purpose of this paper is to present a method for obtaining selected temporal and distance factors in the clinic with a minimum of equipment, space, and time.

METHOD

Equipment and Material

The method requires very little equipment: 1) stopwatch, 2) tape measure, 3) portable tape recorder, and 4) grid pattern. The grid pattern is constructed by laying down masking tape in a straight line about 30 cm (11.8 in) wide and 10 m (32.8 ft) long. The masking tape is ruled off in 3-cm increments for its entire length. These segments are then numbered consecutively, 1, 2, 3… 99. After 99, the segments are numbered consecutively again, beginning with one. The grid pattern can be located in the gait-training area or in a hallway.

Procedure for Data Collection

The procedure is designed so that the physical therapist follows the patient who is walking on the grid pattern and notes where the patient’s heel strike
occurs. By simultaneously making use of the stopwatch and tape recorder, the therapist obtains the four temporal and distance factors in one walking sequence. An outline of the procedure follows:

1. The patient begins at least two strides in front of the grid pattern. The patient is told to look straight ahead and to walk normally.
2. Following closely behind the patient, the therapist calls out heel-strike locations from the grid pattern into the portable tape recorder (Fig. 1).
3. An assistant records the time (using the stopwatch) between the first and last recorded heel strikes, providing the elapsed time of the walking sequence (Fig. 2).

Following the patient, observing the heel strike as it appears on or near one of the numbered segments, and calling out the number to the tape recorder requires some practice. This skill has been mastered by numerous physical therapists and students in one or two sessions. It is practiced with normal subjects walking at moderate velocities and becomes easy when evaluating most patients with gait defects.

**Evaluation of the Data**

With the information obtained in this simple procedure, the four temporal and distance factors can easily be evaluated:

- **Velocity:** The total distance between the first and last heel strikes divided by the elapsed time for the distance.
- **Stride length:** The distance between two consecutive ipsilateral heel strikes as obtained from the tape recorder.
- **Step length:** The distance between two consecutive contralateral heel strikes as obtained from the tape recorder. The side of the more forward heel strike is given credit for the step. For example, the distance between a heel strike location on the right and the next consecutive heel strike on the left is termed a step with the left side.
- **Cadence:** The number of steps taken during the sequence divided by the time elapsed for the sequence.

The technique requires little time—only as long as it takes the patient to walk the distance of the grid pattern. To reduce the data to meaningful information* requires 10 to 15 minutes; however, this can easily be taught and delegated to supportive personnel.

**EXAMPLES**

Table 1 compares temporal and distance factors obtained from a group of 15 people without impairments with a group of 11 people with various impair-

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* Data forms that make the reduction simple and fast are available from the author.
TABLE 1
Comparison of Temporal and Distance Factors Between Two Groups

<table>
<thead>
<tr>
<th>Factor</th>
<th>Nonimpaired Subjects</th>
<th>(n = 15) s</th>
<th>Impaired Patients</th>
<th>(n = 11) s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stride length (cm)</td>
<td>132.0</td>
<td>7.1</td>
<td>91.0</td>
<td>10.1</td>
</tr>
<tr>
<td>Step length (cm)</td>
<td>66.0</td>
<td>3.6</td>
<td>45.5</td>
<td>5.1</td>
</tr>
<tr>
<td>Step length difference (cm)</td>
<td>1.0</td>
<td>0.02</td>
<td>8.6</td>
<td>0.30</td>
</tr>
<tr>
<td>Velocity (cm/sec)</td>
<td>112.0</td>
<td>5.3</td>
<td>57.0</td>
<td>10.7</td>
</tr>
<tr>
<td>Cadence (steps/min)</td>
<td>107.0</td>
<td>2.2</td>
<td>73.0</td>
<td>7.9</td>
</tr>
</tbody>
</table>

ments. The group with impairments walked more slowly, had a much lower cadence and stride length, and had step lengths that were unequal by an average of almost 9 cm (3.5 in).

Table 2 shows the quantitative gait evaluation for a 43-year-old woman with left hemiparesis. Step-length differences are quite large, and velocity compared to the normal subjects presented in Table 1 is very slow.

Table 3 demonstrates the value of a quantitative gait evaluation used to assess progress in patient treatment. The second evaluation was completed 10 days after the first evaluation. Improvement from the first test to the second test is noted. Velocity, cadence, and stride length have increased toward the normal subjects’ values in Table 1. In addition, the average step lengths are equal. Quantitative information about the patient’s gait pattern has been obtained. Answers to the questions “How do you know the patient has improved?” and “How much better is the patient’s gait?” can be objectively and quantitatively documented.

DISCUSSION

In obtaining the temporal and distance factors, the therapist has objective, quantitative measurements of the quality of the patient’s gait. Velocity, cadence, and stride length tend to increase as the gait pattern improves and the patient becomes more stable, becomes stronger, gains range of motion, or improves in coordination. An exception is the parkinsonism gait pattern, in which improvement in gait usually means a decrease in cadence. One of the most often seen gait defects is the “limp,” with unequal step lengths between the left and right sides. As the “limp” is resolved, the step lengths become more equal. Using the quantitative gait evaluation, we can know precisely what the step-length differences are and how much they have improved since the initial or last evaluation. We now have objective, quantitative information pertaining to the effectiveness of the treatment program to improve this patient’s gait, something the health care consumer is becoming increasingly interested in.

TABLE 2
Quantitative Gait Assessment of Hemiparetic Patient

<table>
<thead>
<tr>
<th>Variable</th>
<th>Measurements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stride length</td>
<td>74 cm</td>
</tr>
<tr>
<td>Step length (R)</td>
<td>47 cm</td>
</tr>
<tr>
<td>Step length (L)</td>
<td>27 cm</td>
</tr>
<tr>
<td>Velocity</td>
<td>32 cm/sec</td>
</tr>
<tr>
<td>Cadence</td>
<td>53 steps/min</td>
</tr>
</tbody>
</table>

TABLE 3
Comparison of Two Quantitative Gait Assessments of a Patient

<table>
<thead>
<tr>
<th>Variable</th>
<th>Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step length (R)</td>
<td>40 cm</td>
</tr>
<tr>
<td>Step length (L)</td>
<td>33 cm</td>
</tr>
<tr>
<td>Velocity</td>
<td>35 cm/sec</td>
</tr>
<tr>
<td>Cadence</td>
<td>57 steps/min</td>
</tr>
</tbody>
</table>

SUMMARY

The art and science of evaluating gait patterns by observation and then identifying specific problems remains an integral part of the gait evaluation process. By supplementing the process with a quantitative gait evaluation, the physical therapist can add objectivity to the assessment.

A quantitative gait evaluation requires a minimal amount of equipment, space, and time. It can be used to do part of the initial evaluation and to document treatment program effectiveness. The evaluation is also a feasible clinical research tool.

REFERENCES