Effects of ankle dorsiflexion on range and reliability of straight leg raising

Robert A Boland and Roger D Adams
The University of Sydney

The effect of dorsiflexion was investigated on range of passive straight leg raising (SLR) and on inter-rater reliability with 35 patients reporting unilateral lumbar pain with or without ipsilateral leg symptoms. Ranges of SLR and SLR with dorsiflexion (SLR/DF) to onset of lumbar or leg symptoms (P1) were independently measured using a gravity goniometer by pairs of different physiotherapists at two clinics. Dorsiflexion significantly reduced SLR range by a mean of 9 degrees across both samples. Similar high inter-rater reliability was found for SLR and SLR/DF in both pairs of physiotherapists. These data show that SLR and SLR/DF are reliable procedures when measured to P1 in the clinical environment and support previous findings that dorsiflexion reduces range of SLR. [Boland RA and Adams RD (2000): Effects of ankle dorsiflexion on range and reliability of straight leg raising. Australian Journal of Physiotherapy 46: 191-200]

Key words: Leg; Low Back Pain; Sciatic Nerve

Introduction

The passive straight leg raise (SLR) procedure is routinely used in the assessment of patients with lumbar pain. Often these symptoms are also associated with symptoms that are in a sciatic distribution. The significance of passive SLR is that it has been shown to move the sciatic nerve adjacent to the sciatic notch, as well as induce movement of, and increase tension within, the lumbosacral spinal nerves, nerve roots and plexus, from which the sciatic nerve arises (Goddard and Reid 1965). These structures can become acutely painful in the presence of disc injury (Smyth and Wright 1958) and other pathologies (Fisk 1975, Lerman and Drasnin 1975, Macnab 1971). Concomitant reflex muscle contraction in the hamstring group or gluteal muscles (Hall et al 1998) might restrict range of SLR as measured by range of hip flexion. Range of passive SLR can therefore be an important clinical indicator of nerve involvement in conditions of the lumbar spine (Alexander et al 1992, Macnab 1983).

Range of passive SLR does not, however, uniquely reflect nerve involvement in lumbar spine conditions. It is also used to measure length of the hamstring muscle group (Bohannon 1982, Hellsing 1988, Salminen et al 1992). Clinicians try to differentiate between short hamstring length and nerve involvement as the cause of pain during the procedure by adding ankle dorsiflexion at the angle of hip flexion at which pain is produced (Breig and Troup 1979, Troup 1981). This is thought to alter sciatic nerve length and tension without affecting hamstring length. Physiotherapists utilise this knowledge of the effect of dorsiflexion on the sciatic neuromeningeal tree by adding it to other assessment and treatment procedures such as “slump”, which are designed to challenge the neuromeningeal system (Maitland 1985). Thus, not only can a clinician assess SLR to determine whether hamstring or neural structures are contributing to symptoms in patients with low back and/or leg symptoms, but the technique can also be used to more specifically target lumbar-sciatic neuromeningeal structures during treatment (Butler 1991, Kornberg and Lew 1989). However, despite the widespread use of dorsiflexion, little data are available that quantify the effect on passive SLR.

Gajdosik et al (1985) examined the effect of dorsiflexion on passive SLR in asymptomatic subjects by positioning the ankle in dorsiflexion before performing the procedure (SLR/DF) to end range of hip flexion. End range was defined as the point at which the therapist felt the onset of firm resistance (R2) during the manoeuvre. Range of hip flexion during this procedure was then compared with range of passive SLR without dorsiflexion to R2 and dorsiflexion was shown to reduce SLR by an average of 10 degrees. Since ankle and knee braces were used...
to maintain limb position, and electromyography was used to ensure that the hamstring group was relaxed during testing, it is unclear whether clinicians could expect a similar magnitude of effect in a group of symptomatic patients. Conversely, it is also possible that the influence of pain during the SLR procedure could magnify the dorsiflexion effect in a symptomatic group. Clinicians would benefit from data that quantifies how consistent these procedures are in the clinical environment.

Another consideration, besides the effect of dorsiflexion on range of SLR, is the effect that ankle movement could have on reliability of SLR. Any interaction between dorsiflexion and the condition causing the pain, or indeed the pain itself, might affect the repeatability of SLR/DF in a different way from any effects on SLR. This would be reflected in reliability measures such as the intraclass correlation coefficient (2,1) (Shrout and Fleiss 1979), which are sensitive to differences in bias between raters or occasions. It is possible that superimposing dorsiflexion on SLR might reduce reliability if the torque applied to achieve dorsiflexion varied between repeat performances of the procedure, either within or between examiners, because this would affect the amount of pre-tension applied before hip flexion was commenced. Not all of these issues can be answered from the literature, since no studies were found that measured the effect of dorsiflexion on SLR in a patient sample. Thus clinicians do not know what the effects of ankle dorsiflexion are on repeated measurements of SLR.

The purpose of this study was to investigate the effect of ankle position on range of hip flexion during SLR in a sample of patients with low back pain. It would also evaluate the inter-rater reliability and error associated with repeat performances of SLR in two different ankle positions with a patient group. Since clinicians use SLR/DF as a treatment technique, reliability and error data would reveal whether the technique itself could be used as a measurement procedure in the presence of pain. It would be more valid for clinicians to estimate treatment effects via change in range of SLR/DF if this was the movement of interest instead of indirectly estimating effects from change in range of SLR. Consequently, clinicians would then only need to consider whether the change in range of SLR/DF following treatment was of a magnitude greater than that associated with measurement error and the issue of how closely range of SLR/DF correlated with SLR would not need to be established.

**Methods**

**Subjects** Patients from two physiotherapy clinics were involved in the study. Group A consisted of 10 male and 10 female volunteers aged between 20 and 70 years with a mean (SD) of 50 (18) years, who participated whilst attending for treatment at the physiotherapy department of the Repatriation General Hospital at Concord, New South Wales. Group B consisted of 12 male and three female volunteers from the Royal Australian Navy aged between 21 and 51 years with a mean (SD) of 33 (9) years, who participated whilst attending for treatment at the physiotherapy department at HMAS Kuttabul in Sydney. Subjects were eligible to participate if they had unilateral lumbar spine pain, with or without ipsilateral leg symptoms. The presence of lumbar symptoms was considered justification for testing of SLR during the physical examination. Exclusion criteria were the presence of any of the following: inflammatory joint disease, cardiac failure, malignancy, recent spinal or lower limb fracture, hip pathology and resting pain in the low back or leg prior to, or during, testing. Ethical approval had been granted from the Ethics Committee of the Repatriation General Hospital, Concord and the Australian Defence Medical Ethics Committee, for the respective groups.

**Examiners** Four physiotherapists acted as examiners for the study. One pair of physiotherapists collected data from Group A (Examiners 1 and 2) and a different pair collected data from Group B (Examiners 3 and 4). One examiner from Group A was a physiotherapist with four years of graduate experience and the other was a manipulative physiotherapist with one year of postgraduate experience. Both examiners from Group B were manipulative physiotherapists, one with seven years and the other with four years of postgraduate experience. Within each pair, one physiotherapist was the treating physiotherapist who took the patient history and continued treatment upon completion of testing.

**Experimental design** Any patient who presented for treatment of low back pain was provided with information about the study. After the treating physiotherapist had finished taking the patient’s
history and confirmed that all inclusion and exclusion criteria had been met, the patient was invited to participate in the study. When written informed consent had been gained, the subject was introduced to the other physiotherapist, who was not present during the history taking. Both physiotherapists then left the room and the subject undressed to bra and underpants for females, and underpants for males, and put on a hospital gown. The treating physiotherapist then performed the physical examination to the point when testing of SLR was usually performed. According to a random order determined by lots, one physiotherapist measured the ranges of SLR and SLR/DF. These were taken in the absence of the other therapist and upon completion, the first physiotherapist left the room and the other entered to repeat the measurements. Randomising the order of examiners was undertaken to counter any effects from testing order on measurements because an examiner who always tested second might consistently measure lower ranges to P1 if threshold to pain lowered with repeated testing, or conversely measure greater ranges if tissue compliance increased or pain threshold increased.

The leg tested for each subject was always on the same side as the subject’s back or leg pain and the order of testing of the two different SLR procedures was randomised for each examiner by drawing lots. Again, order was randomised to counter the effects of pain or changes of tissue compliance during repeated testing. Once both examiners had taken and recorded the total of four measurements, the treating physiotherapist resumed the examination and treatment of the subject. Each examiner within each pair was blind to the results of the other during testing. For one subject, symptoms did not settle immediately on return to the starting position after one of the testing procedures, so testing was ceased. Data for that subject were not included in the analyses.

### Table 1. Hip flexion angles and reliability data for straight leg raising (SLR) and straight leg raising with dorsiflexion (SLR/DF) for Group A.

<table>
<thead>
<tr>
<th></th>
<th>SLR</th>
<th>SLR/DF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Examiners</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Mean *</td>
<td>56°</td>
<td>59.9°</td>
</tr>
<tr>
<td>Standard deviation</td>
<td>20.6°</td>
<td>18.1°</td>
</tr>
<tr>
<td>Mean across examiners</td>
<td>58°</td>
<td>49.2°</td>
</tr>
<tr>
<td>ICC (2,1)</td>
<td>0.86</td>
<td>0.89</td>
</tr>
<tr>
<td>95% Confidence interval for ICC</td>
<td>0.67-0.94</td>
<td>0.59-0.96</td>
</tr>
<tr>
<td>SEM</td>
<td>7.2°</td>
<td>6.7°</td>
</tr>
<tr>
<td>95% Confidence interval</td>
<td>14°</td>
<td>13°</td>
</tr>
</tbody>
</table>

ICC = Intraclass correlation coefficient  
SEM = Standard error of measurement  
* Significant differences for range of SLR/DF subtracted from SLR were found for Examiner 1 and for Examiner 2 ($F_{(1,19)} = 86.76, p_{adj} < 0.001$)

### Testing protocol
Examiners were familiarised with the testing protocol for each technique and were given a week to practise with the measuring instrument which was a pendulum-type goniometer\(^{(a)}\) (pendulometer) before data collection was commenced (Figure 1). The protocol for SLR was according to the recommended standard (Brieg and Troup 1979) that was already familiar to all examiners but the SLR/DF was not, and the examiners familiarised themselves with the technique during the week of practice. The protocol for SLR/DF was based on that used by Gajdosik et al (1985).

Starting position was with the subject supine on a plinth without a pillow for all measurements, with attempts made to align the trunk straight with no lateral flexion or rotation. The subject’s knees were
extended and range of SLR relative to the horizontal was measured by a pendulometer that recorded hip flexion in 2 degree intervals. Thus the accuracy of the instrument was ± 2 degrees. The pendulometer was attached to a Velcro band placed around the lower leg at the level of the fibular head to face laterally (Figure 1) and was set to zero prior to testing. Examiners tried to maintain neutral hip alignment in all planes during testing.

Testing Procedure 1: passive SLR After asking the subject to relax, the examiner placed one hand above the subject’s patella while supporting the lower leg superior to the tendo Achilles with the other hand. The examiner then slowly elevated the leg to the point where the subject reported the onset of any pain in the leg or back, (McCombe et al 1989) or stretch, pins and needles or numbness in the leg or back. This point was defined as P1. Full knee extension was maintained during the manoeuvre to reduce errors associated with variation in knee angle (Callaghan and Williams 1991). The examiner noted the angle of hip flexion at P1 from the pendulometer before lowering the subject’s leg to the starting position and recording the angle.

Testing Procedure 2: passive SLR/DF The subject was asked to relax, then the examiner placed one hand above the subject’s patella while the other hand dorsiflexed the subject’s ankle to end of range (defined as R2) by applying pressure against the plantar aspect of the foot at the metatarsal heads. The examiner then slowly elevated the subject’s leg to P1 while maintaining full knee extension. Range of hip flexion to P1 was noted from the pendulometer before the leg was lowered and the angle recorded. Subjects were instructed to report the point of onset of any lumbar or leg symptoms during testing. This definition of P1, therefore, did not specifically define that symptoms produced replicated a subject’s presenting symptoms. This was justified on the basis that it was unlikely that SLR or SLR/DF would reproduce every subject’s presenting lumbar or leg symptoms. Data as to whether symptoms produced during testing matched subjects’ presenting symptoms were not collected during either procedure. Additionally, the examiner measuring second did not instruct subjects to report the point at which the current procedure reproduced the same symptoms provoked by the first examiner. This aimed to prevent subjects biasing their responses and to prevent

| Table 2. Hip flexion angles and reliability data for straight leg raising (SLR) and straight leg raising with dorsiflexion (SLR/DF) for Group B. |
|---|---|---|---|
| | SLR | SLR/DF |
| Examiner | 3 | 4 | 3 | 4 |
| Mean * | 53.2° | 49.6° | 42.1° | 41.9° |
| Standard deviation | 16.4° | 15.8° | 15.6° | 16.1° |
| Mean across examiners | 51.4° | 42.0° |
| ICC (2,1) | 0.91 | 0.91 |
| 95% Confidence interval for ICC | 0.72-0.97 | 0.75-0.97 |
| SEM | 4.8° | 4.8° |
| 95% Confidence interval | 9° | 9° |

ICC = Intraclass correlation coefficient
SEM = Standard error of measurement
*Significant differences for range of SLR/DF subtracted from SLR were found for Examiner 3 and for Examiner 4 ($F_{1,14} = 72.03, \ p_{adj} < 0.001$)

| Table 3. Pooled hip flexion angles and reliability data for straight leg raising (SLR) and straight leg raising with dorsiflexion (SLR/DF) from both groups. |
|---|---|---|---|
| | SLR | SLR/DF |
| Examiner | 1 or 3 | 2 or 4 | 1 or 3 | 2 or 4 |
| Mean | 54.8° | 55.5° | 44.5° | 47.7° |
| Standard deviation | 18.7° | 17.7° | 18.9° | 18.6° |
| ICC (1,1) | 0.88 | 0.89 |
| 95% Confidence interval for ICC | 0.80-0.94 | 0.80-0.94 |
| SEM | 6.4° | 6.1° |
| 95% Confidence interval | 13° | 12° |

ICC = Intraclass correlation coefficient
SEM = Standard error of measurement
Boland and Adams: Effects of ankle dorsiflexion on range and reliability of straight leg raising

Data analysis Data from Gajdosik et al (1985) showed a mean difference between passive SLR and SLR/DF ranges of 10 degrees with a standard deviation of 5 degrees. It was determined from these that, for the current study, a sample size of 20 in Group A would have 80 per cent power to detect an effect size of 3 degrees. After data from Group A had been collected, a sample size of 15 was chosen for Group B, since this number would have 80 per cent power to find an effect size of 4 degrees (Welkowitz et al 1972). Data were analysed using Quattro Pro for Windows Version 5.0(b), and special-purpose software written to calculate the various forms of intraclass correlation coefficient (ICC) (Shrout and Fleiss 1979) and repeated measures ANOVA (Winer 1971).

To determine inter-rater reliability of the SLR and SLR/DF procedures for each pair of examiners, ICCs were calculated from the 20 pairs of data for Group A and the 15 pairs for Group B. The ICC (2,1) form (Shrout and Fleiss 1979) was employed for these analyses. Repeated measures ANOVA were performed on data from Group A and then Group B to evaluate effects due to i) ankle position during testing (dorsiflexed or not), ii) examiner (1 or 2) and iii) any interaction between these factors. As multiple tests of significance were performed, observed $p$ values were adjusted ($p_{adj}$) using the Bonferroni method (Bland and Altman 1995) according to the number of comparisons made for each ANOVA. The standard error of the measurement (SEM) was also calculated, a statistic that can be expressed in the original units of measurement and which represents the standard deviation of the distribution of test-retest errors (Domholdt 1993). As an approximation, doubling the SEM then adding and subtracting the resulting amount from any first measure gives a 95 per cent confidence range (Domholdt 1993). This is a valuable calculation for clinicians, since a therapist who performs a repeated measurement that varies from the first but lies within this range can attribute the difference to chance. Conversely, a second measurement falling outside this range is more likely to be due to systematic factors, such as treatment...
effect or differences between examiners. Finally, to obtain better estimates of reliability and stability, data for both groups were pooled. The ICC (1,1) formula was calculated (Shrout and Fleiss 1979) since the examiners who performed the measurements were no longer the same throughout.

**Results**

The ICC (2,1) data from both groups indicated high reliability, not differing significantly between pairs of examiners or procedures (Tables 1 and 2). While values for ICC above 0.75 have been described as excellent (Fleiss 1986) these data do not inform the clinician about error, nor express information in a form that can be readily compared with the expected improvement in range following a treatment intervention. This information can be calculated from the SEM. For Group A, inter-rater test-retest differences of ≤ 14 degrees for measurements of SLR and ≤ 13 degrees for SLR/DF were consistent with sampling error or chance (Domholdt 1993). In Group B, these respective data were 9 degrees for both SLR and SLR/DF.

Another way of describing agreement between examiners for the two procedures is to compare the effect of dorsiflexion for each subject between therapists. In Group A, the average difference between the two procedures (measurements of SLR/DF subtracted from measurements of SLR) for Examiner 1 was 9.8 degrees compared with 7.8 degrees for Examiner 2. In Group B, the average difference between the two procedures was 11.1 degrees for Examiner 3 and 7.7 degrees for Examiner 4. Figures 2a and 2b illustrate raw data for the difference between the two procedures for each subject plotted against examiners. Figure 2a shows that 95 per cent of the difference measurements between examiners were within 10 degrees. Figure 2b shows that 86 per cent of difference measurements were within 10 degrees. These data support the ICC and error data that imply consistency and stability of measurements between examiners for the effect of dorsiflexion on range of SLR.

The ANOVA for Group A indicated that the difference between the mean ranges of SLR and SLR/DF was significantly different ($F_{(1,19)} = 86.76, p_{adj} < 0.001$) but that neither the main effect of examiner ($F_{(1,19)} = 6.36, p_{adj} = 0.06$) nor the interaction between examiner and ankle position during testing ($F_{(1,19)} = 2.97, p_{adj} = 0.3$) were significant. Similarly, results for Pair B showed a significant effect of dorsiflexion during SLR ($F_{(1,14)} = 72.03, p_{adj} < 0.001$) but no significant effects due to examiner ($F_{(1,14)} = 3.08, p_{adj} = 0.3$) or examiner by ankle position interaction ($F_{(5,14)} = 1.79, p_{adj} = 0.6$). Thus, the observed differences in range between procedures were due to the effects of dorsiflexion on SLR and not from differences in the performance of the procedures between examiners or from cumulative factors related to effects from examiners and dorsiflexion.

To obtain overall estimates of reliability and stability, data for both groups were pooled, yielding 35 repeat measurements of SLR and 35 repeat measurements of SLR/DF. The ICC (1,1) formula was employed (Shrout and Fleiss 1979) since the four examiners were no longer the same throughout testing of all 35 subjects (Table 3). These data were consistent with the individual group data showing comparable ICC (1,1) values and SEMs indicated that changes in range of less than 13 degrees for either procedure after a treatment intervention are likely to be due to error if a confidence level of 95 per cent is used (Table 3).
To obtain a larger sample of measurements for each procedure, the pooled means of the repeat measurements for SLR and SLR/DF procedures were compared. Figure 3 illustrates the effect of dorsiflexion on SLR in the current group of symptomatic subjects by comparing these pooled data of 70 paired comparisons with data from a sample of asymptomatic subjects tested by Gajdosik et al (1985). Dorsiflexion reduced hip flexion range by 9 degrees ($p < 0.001$) in the current sample of asymptomatic subjects taken to P1 compared with an effect size of 10 degrees in the sample of asymptomatic subjects taken to R2 (Gajdosik et al 1985).

**Discussion**

The aims of this study were to evaluate the effect of ankle position on range of SLR and to evaluate the inter-rater reliability of SLR performed with two different ankle positions in a sample of patients, since these data did not exist. Pooled data from both groups indicated that dorsiflexion reduced range of hip flexion during SLR by 9 degrees in a sample of patients with lumbar pain with or without leg symptoms, an amount almost identical to that reported in previous research with subjects who were asymptomatic (Gajdosik et al 1985). The ICC (2,1) values obtained from two pairs of physiotherapists for SLR/DF were as high as those for SLR and error data for SEM were also comparable between tests. These data indicate that the addition of dorsiflexion did not increase the variability associated with SLR and suggest that factors related to subjects (such as pain) and the SLR procedure (such as changes in hand holds) have little effect on the difference in range between the SLR and SLR/DF procedures.

Various analyses of consistency for SLR using fluid-filled and pendulum goniometers on patient groups have been used in the literature and consequently comparison between data is compromised. Without the presentation of reliability data in the units of measurement, many data can be difficult to interpret. Previous percent agreement data showed that 71 percent (82 of 116) paired comparisons between three raters were within a difference range of 10 degrees in 55 patients with unilateral sciatica (Kosteljanetz et al 1988). An ICC of 0.80 was reported between raters measuring SLR in a group of patients with ankylosing spondylitis (Viitanen et al 1995) while ICCs of 0.96 for left SLR and 0.94 for right SLR were found with two pairs of raters investigating a group of patients with low back pain (Waddell et al 1992). Inter-rater Pearson’s correlations of 0.68 and 0.86 were described in another sample of patients with low back pain (McCombe et al 1989) and a Pearson’s correlation of 0.97 was quoted by another group using an hydrogoniometer to measure SLR to estimate hamstring group tightness in 30 adolescents with and without low back pain (Salminen et al 1992). High intra-rater data for SLR have also been reported in studies of patients with low back pain (Chow et al 1994, Million et al 1982, Porter and Trailescu 1990) and asymptomatic subjects (Hsieh et al 1983, Rose 1991).

While the procedure for SLR/DF in this study differed from the SLR procedure commonly used in clinical practice, inter-rater reliability for SLR/DF and SLR were similar in both groups. The usual procedure for a clinician using SLR on a patient with low back pain is to perform SLR to P1 or R2. If the addition of dorsiflexion is indicated, the leg position is held (Macnab 1983) or lowered a few degrees until symptoms have disappeared and dorsiflexion is added in an attempt to reproduce low back or leg symptoms (Breig and Troup 1979, Haldeman et al 1988). In this study, as is the case during certain manual assessment and treatment techniques, dorsiflexion was taken to R2 before SLR was performed to P1 (Butler 1991). Despite these procedural differences, and despite current testing protocols not requiring patients to report that the same symptoms had been reproduced by each examiner, there was comparable reliability and error data between procedures. Thus, poor inter-therapist reliability of defining R2 that has been previously reported (Matyas and Bach 1985) does not seem to have adversely affected the SLR/DF procedure. Clinicians can therefore use SLR/DF and be confident of its reliability and error in patients with lumbar pain syndromes.

The inter-therapist reliability for both procedures was high, even though an inter-examiner difference of 6 degrees was found between SLR/DF procedures in Group A (Table 1). In large part, high reliability was observed because the inter-rater differences were proportionately small compared with the (up to) 90 degree range of SLR expected across the population (Gajdosik et al 1992) and also observed in the current sample. In fact, the small inter-rater variability compared with the large within group variability in SLR ranges is a feature that gives robustness to the procedures during repeated measures analyses and is
one basis for the observed high ICCs (Shrout and Fleiss 1979).

The small but consistent inter-rater differences could be due to the automated nature of the testing sequence, that is, the role of habit with respect to speed and torque of the leg raise within therapists. It could be argued that a clinician who is familiar with the SLR procedure would probably be consistent between occasions of testing with respect to instructions, starting position, speed and torque applied. Since instructions and starting position were standardised in this study, the highly repeatable and consistent differences in ranges of hip flexion between therapists could be indicators of consistent differences in applied speed and torque between examiners during the procedures, although no data were collected to verify this. The similarity between reliability data for both procedures, however, emphasises that the unfamiliar SLR/DF procedure was easily learned by each examiner and was probably performed in a repeatable or habitual manner (Magill 1989).

While intra-rater reliability data were not collected, current data provide clinicians with important information about the effect of interventions designed to increase range of SLR or SLR/DF. By pooling data from both groups, the SEMs and 95 per cent confidence intervals were able to be determined for both SLR procedures (Table 3). These data suggest that a therapist who takes a repeat SLR measurement that is within 13 degrees of a first reading taken by another therapist is within the region of sampling error. Similarly, a difference between therapists in SLR/DF range of less than 12 degrees could also be attributed to error. Since inter-rater reliability is generally lower than intra-rater data, these data provide clinicians with important information about the effect of interventions designed to increase range of SLR or SLR/DF. Test-retest differences observed by a single therapist of greater than these ranges can be considered conservative estimates of effects likely to be due to treatment interventions or change in the condition causing the symptoms. Thus, a therapist who measures a post-treatment change in SLR within the error range should reserve judgment about whether a treatment effect has occurred, since it has been shown that repeated applications of SLR do not significantly increase the range of SLR (Chow et al 1994).

While the 9 degrees decrease in SLR due to the addition of dorsiflexion in this study of low back pain patients closely approximates the 10 degrees effect observed in an asymptomatic sample (Gajdosik et al 1985), the difference in procedures between studies complicates comparison of data. Examiners in the present study took SLR to P1 in both procedures, whereas the examiners in Gajdosik et al raised the leg to R2 in both procedures. Nevertheless, a larger difference than 1 degree between asymptomatic and symptomatic samples might have been expected because nerve involvement is more likely in a sample of patients with lumbar pain compared with a sample of asymptomatic subjects. In patients with lumbar pain, this would be expected to reduce the threshold to pain provocation of movements such as ankle dorsiflexion which affect lumbosacral and sciatic tissues (Breig and Troup 1979, Goddard and Reid 1965). The effect of this decrease in threshold would be to reduce the difference between ranges of SLR and SLR/DF to P1 in a symptomatic group compared with an asymptomatic group. Comparatively higher thresholds might be expected if movements were taken to R2 in an asymptomatic group resulting in greater differences between ranges of SLR and SLR/DF. Further research would need to be undertaken to explore this hypothesis.

The observation that dorsiflexion to P1 reduced SLR by the same amount in both patient groups suggests that SLR/DF stresses different structures to SLR in a consistent and reproducible manner. In fact, in only two of 35 subjects tested did dorsiflexion not reduce range of SLR. In these two patients (each from different groups), only one physiotherapist from each pairing found SLR range was greater than range of SLR/DF. A logical conclusion is that ankle dorsiflexion can be added prior to performing SLR to stress other tissues before the hamstring muscle group. A large body of evidence suggests that these tissues are continuous with the sciatic nerve (Breig and Marions 1963, Breig and Troup 1979, O’Connell 1951, Smith et al 1993, Woodhall and Hayes 1950) and the results of this study are consistent with that argument.

Conclusion

This study was conducted in the clinical environment on a sample of patients in whom SLR would routinely be assessed during the physical examination. The findings of high reliability and comparable error
ranges in such a patient group should, therefore, have good external validity to the clinic if the same protocol is performed. Thus, data indicate that SLR/DF can also be used as a measurement procedure in addition to the SLR procedure and that any difference in ranges between procedures is due to the effect of dorsiflexion rather than subject or procedural factors. A therapist who measures a change in range of more than 13 degrees for either SLR or SLR/DF can be confident that the change is not due to error. Changes in range of less than this amount could still be due to factors such as treatment effects but a therapist cannot be as confident about such a conclusion.

**Authors** Robert Boland, School of Physiotherapy, The University of Sydney, Post Office Box 170, Lidcombe, New South Wales 1825. E-mail: r.boland@cchs.usyd.edu.au (for correspondence). Roger Adams, School of Physiotherapy, The University of Sydney, Post Office Box 170, Lidcombe, New South Wales 1825.

**Footnotes** (a)Myrin Pendulometer, LIC Rehab Vardrum, Svetasv 4, 17183 Solna, Sweden. (b)Borland International, 1800 Green Hills Road, Scotts Valley, Ca 95067-0001, USA.

**Acknowledgements** The authors acknowledge the assistance of the Physiotherapy Departments of the Repatriation General Hospital Concord, NSW, and HMAS Kuttabul, NSW, in recruiting subjects; the Australian Defence Medical Ethics Committee; and Jill Allen, Christine Davis, Con Traiforis and Chi Yui Tsang, who acted as examiners or assisted with data collection during this study. Data from Group A were presented at the 9th Biennial Conference of the Manipulative Physiotherapists Association of Australia in November 1995, and were published as an extended abstract in the Conference Proceedings.

**References**


Boland and Adams: Effects of ankle dorsiflexion on range and reliability of straight leg raising