THE EFFECTS OF ACTIVE AND PASSIVE NECK FLEXION ON UNILATERAL STRAIGHT-LEG-RAISING

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SUMMARY

A study was designed to test the effects of passive neck flexion (PNF) as compared with active neck flexion (ANF) on the straight-leg-raise (SLR) test.

Twenty two subjects were measured three times with a goniometer and the difference in range of movement (ROM) was determined by subtracting the SLR recordings obtained by means of PNF from those of ANF. Results demonstrated that neck flexion (NF) performed actively allowed a mean value of 4,13° more SLR than when performed passively. The implications of these findings are discussed.

OPSOMMING

'n Studie is ontwerp om die uitwerking van passiewe nekfleksie (PNF) teenoor aktiewe nekfleksie (ANF) op die reguitbeen-oplig toets (RBO) te ondersoek.

Bogenoemde ondersoeke is op twee-en-twintig persone met behulp van 'n goniometer drie keer gemeet, en die verskil in bewegingsomvang is bereken deur die RBO resultate behaal deur middel van PNF van die van ANF af te trek.

Resultate het gewys dat ANF 4,13° meer RBO toegelaat het as die van PNF. Die implikasies van die bevindinge is bespreek.

INTRODUCTION

The straight-leg-raise (SLR) test has been previously reviewed with respect to standardising the protocol and highlighting relevant aspects of the literature[1]. SLR tests the integrity of the spinal neural structures, namely the spinal cord, nerve roots and dura mater and serves as an objective diagnostic test for lumbar spinal pathology.

One of the qualifying tests associated with SLR is neck flexion (NF). The application of NF is such that increased tension is applied to these neural structures when performed either with SLR [2-8] or independently from it [9], in order to elicit any obstruction to their free movement in the intervertebral canal or foramen.

As the angles that the emergent thoracic and lumbar roots make with the cord are smaller than those made by the cervical nerve roots, there exists greater resistance to cord tension originating cranially rather than caudally[10]. NF provoking sciatic symptoms will therefore imply an increase in tension in the root sheaths and dura mater due to an increase in the bending tensile forces caused at, for example a disc lesion site - known as Hyndman's Sign [10,11] or Brudzinski's Test [3,11,12,13].

The bulk of the literature documents that NF be applied passively when added to the SLR test[3,4,5,12,14,15]. Clinically, it proves quite cumbersome to try and maintain the SLR with one hand while passively flexing the neck with the other.

Documentation of active neck flexion (ANF) is minimal and non-specific. Cailliet[16] and Cyriax[17] note it to be performed by the patient. Cyriax and Cyriax[18] demonstrate it pictorially while Hoppenfeld[19] mentions that in Kernig's Test, the patient forcibly flexes the neck.

None of the authors specify whether NF needs to be applied passively or actively. Surely there can be no difference to the SLR test, as with both methods, tension is applied to the dura and cord and thus transmitted to the lumbosacral roots?

Personal experience and communication with colleagues have brought to light some discrepancy between the amount of SLR available when applying passive neck flexion (PNF) and then ANF on normal subjects (unpublished observations). When ANF was performed, a definite reduction in the resistance of SLR at the end of range (EOR) was observed. The thigh could be flexed a few degrees further on the hip, and the new EOR noted when resistance to the movement was again felt.

No concrete, scientific explanation could be attributed to this phenomenon, and thus it was felt necessary to explore further by formulating an experiment testing the effects of both ANF and PNF on SLR, in order to determine whether there exists any difference in the amount of SLR range when both are individually and successively superimposed.

If ANF does allow significantly more range of SLR movement than PNF, then its implications for the test would be such that, with more range of motion available, more tension could be exerted upon the nerve roots and thus the quality of symptoms produced could be improved.

METHOD

1. SUBJECTS

Twenty two healthy male (12) and female (10) students with a mean age of 20,8 years (SD = 1,65) were tested at the UCT Physiotherapy Department. None of those tested had any known orthopaedic or neurologic dysfunction. Participants were instructed not to begin any new stretching exercises or alter their physical activities during the study period.

2. GONIOMETRIC VALIDATION

The reliability and repeatability for the intratester goniometric measuring was evaluated prior to the SLR testing procedure. Firstly, a female's right leg was immobilised in hip flexion (same surface markings described in procedure), and

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seven measurements were taken by the tester with the same goniometer. The same leg was then immobilised at a fixed angle in the SLR position using the pulley system to be described, and a further seven measurements were taken as before. These measurements were then analysed for variability (coefficient of variation) to determine intratester reliability and repeatability and are reported in the results section.

3 . INSTRUMENTATION

An overhead pulley system was used to maintain the passive SLR on each subject's right leg. The range of movement (ROM) was measured with a plastic long arm goniometer, which was found to be of high reliability when compared with the tape measure and flexometer for recording SLR[20]. A pressure transducer (calibrated in millimetres mercury [mmHG]) was used to indicate the EOR by measuring the resistance of the hamstrings and posterior thigh structures. This method was employed as subjective estimates of EOR would have varied considerably due to different pain threshold levels between subjects.

A plasterzote knee backslab was applied to each right leg with a crepe bandage in order to prevent knee flexion. A sling was placed beneath each subjects' right heel, and provided the point of attachment for the pulley's rope, as well as keeping the pressure transducer in place. The rope was then passed through a hook above the subject's right hip so that its force was exerted at about 90° to the leg when SLR was performed.

4 . PROCEDURE

In order to measure the angles of SLR, the following anatomical landmarks were delineated:-

a) the greater trochanter

b) a point on the line connecting the greater trochanter and the lateral femoral condyle

c) a point on the horizontal line from the greater trochanter to the mid axilla.

After being marked, each subject was then positioned on the plinth in supine and the backslab applied. The pressure transducer was preset for each measurement at 40 mmHg, and placed under the heel within the sling. The rope was connected to the sling and passed through the hook, and the free end given to the subject. They were then instructed to relax their hamstring muscles, and not to resist or assist the SLR in any way.

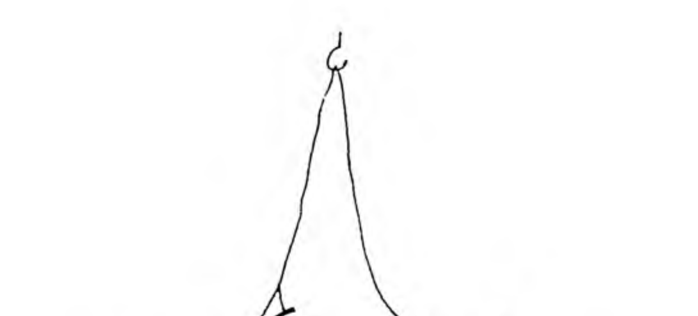

Figure 1: SLR starting position showing the knee backslab, the pulley and the sling

Each subject's right leg was then raised by the tester, (with attention to the SLR biomechanical detail as described before[1]) until the pressure gauge value read 120 mmHg. At this stage each subject was asked to hold the opposite end of the rope with both hands while keeping their elbows on the plinth. This maintained the SLR position and enabled the tester to read the pressure values and measure the SLR range with the goniometer.

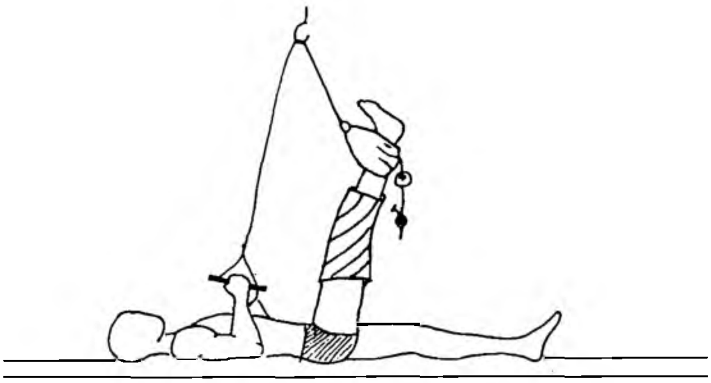

Figure 2: The subject stabilising the leg once passive SLR has been performed

PNF was then applied, and the gauge consulted to see if any changes in pressure had occurred. If so, these were recorded. The head was then lowered, and the gauge rechecked to ensure it read 120 mmHg. The subject was then instructed to actively lift his head himself, approximating his chin to his chest while keeping his shoulders on the plinth. The pressure gauge was again checked and the changes (decreases) in values were then recorded. With the neck still flexed, the leg was then raised further by the tester until the gauge read 120 mmHg again. This new range of SLR was then measured and recorded. Only then was the subject told to lower his head and leg to the plinth.

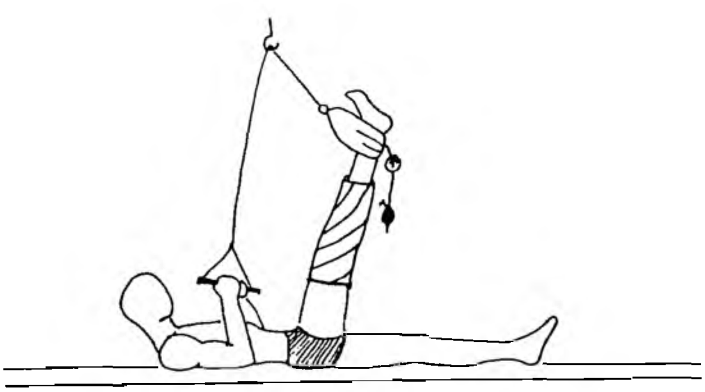

Figure 3: ANF superimposed on passive SLR.

This procedure was performed three times on each subject, with a one minute rest in between.

The data was analysed for statistical significance using the student's t-test.

RESULTS

The coefficients of variation for the goniometric measurements of hip flexion and SLR were 1,5% and 1,3% respectively. Values less than 10% are regarded as acceptable, and thus the above results suggest highly acceptable intratester reliability and repeatability, with the possibility of goniometric error being low.

There were no changes in pressure readings when PNF was applied to SLR, while with ANF, the readings decreased by a mean value of 6,5 mmHg.

SLR Procedure no.	n	mean	s e m	t-value	DF	P
1	22	3.91	0.48	8.07	21	0.001
2	22	3.91	0.46	8.41	21	0.001
3	22	4.59	0.46	9.88	21	0.001
Average	22	4.13	0.47	8.79	21	0.001

TABLE: Mean, standard error mean, t-value, degrees of freedom and probability for the increased range in degrees of SLR with ANF

From the table, it can be seen that the angle of SLR was greater with ANF than with PNF during all three procedures. These values correspond to a significant average mean increase of 4.13° ($p<0.001$). These increases were calculated by subtracting the SLR ranges with PNF from those with ANF.

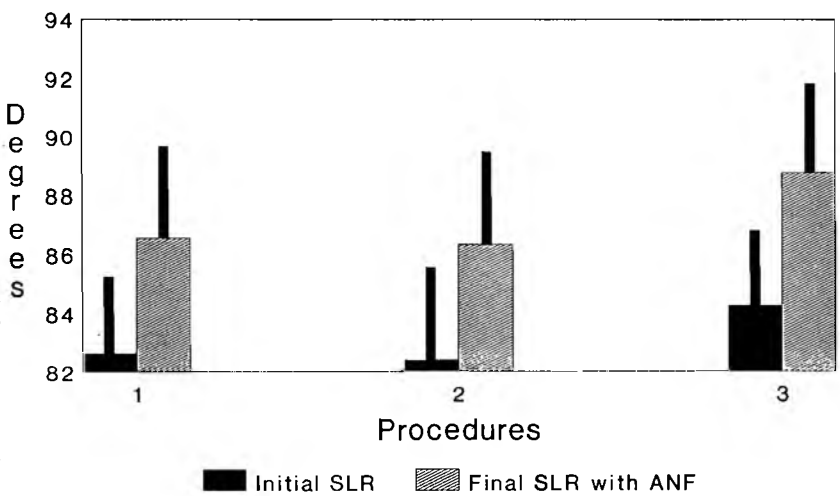

Figure 4: Mean and sem values for initial and final SLR measurements

Figure 4 depicts the relationships between the three procedures' mean initial and final measurements. For procedures one and two, both initial and final readings correlate very closely, varying by only 0,24° and 0,23° respectively. The third procedure's readings were greater than those of the first two, and varied from their combined mean average for the initial and final readings by 1,73° and 2,31°.

These increases can be attributed to the possible stretching and relaxing of the hamstring muscles by the time the third measurements were taken. This might have indicated that some form of stretching exercises should have been performed before measurements were taken, to minimise the hamstrings from stretching further during the three procedures.

DISCUSSION

The results of this study clearly indicate that more SLR was achieved with ANF than with PNF. Analytical comparisons showed a statistically significant difference between the two ($p<0,001$), and it is thus evident that the method of applying NF does affect the range of SLR.

The intratester reliability and repeatability of the goniometric measurements were well supported by the coefficients of variation for hip flexion (1,5%) and for SLR in the sling (1,3%), and compare with reports by Hsieh et al[20] that the goniometer is of high intrasession and intersession reliability and repeatability.

What then are the causes for ANF allowing more SLR then PNF? The most likely answer to this question involves the abdominal muscles. When in supine, flexing the neck is an action against gravity, and is performed by the two sternocleidomastoid muscles working in unison. With this movement being performed, overflow to the abdominal muscles occurs. This can be demonstrated by lying on your back and placing your hands on your abdomen. When you lift your head off the surface, the abdominals are immediately felt to contract tightly. They originate from the sternum and lower ribs and insert into the iliac crests, the superior pubic rami and the symphysis pubis. Thus, when they contract, tension results between the two points of fixation, and if either point is not stabilised, movement can occur[21]. In this case, the chest wall and sternum are rigid, and thus the movement takes place at the pelvis. The abdominal insertions will cause the anterior pelvis to rotate forwards and upwards, and because the back extensors which insert into the posterior pelvis are relaxed, it will rotate backwards and downwards. This pelvic rotation thus relaxes the tension in the hamstring muscles and posterior thigh structures, because of their insertions to the postero-inferior aspect of the pelvis.

Posterior pelvic rotation occurring with SLR begins as early as 10° of hip flexion[23], and can be referred to as the pelvifemoral motion[22-25]. Results have shown that at a maximum SLR of 87,3°, contributing factors were increases of 32,1° in the pelvis/horizontal angle, and 55,2° in the SLR/pelvis angle[23]. Thus, if this much pelvic rotation were occurring just with SLR motion, it would indicate that the pelvis is not completely stabilised during SLR, and applying the force of the abdominals to it during ANF, could result in further rotational movement.

This pelvic rotation thus exerts its effects on the SLR leg through the pelvifemoral motion. The increased posterior pelvic rotation at the end of SLR slightly relieves the tension in the hamstrings, and thus more range of SLR is available, until the hamstrings are once again tight and resisting the movement.

In this study, the increase in pelvic rotation was found to be 4,13°, (from 83,10° to 87,23°) and relates directly to the hypothesis that more SLR can be achieved when ANF rather than PNF is superimposed.

CLINICAL IMPLICATIONS

If this is then the case, how do these findings relate to the clinical environment.

Firstly, applying NF to the SLR test increases the tension in the dura mater and the lumbosacral nerve roots. Whether applied passively or actively, this resultant tension is achieved.

However, ANF applied to SLR adds a few more degrees to the SLR angle. This should then apply further tension to the sciatic nerve and its roots, making the test more specific.

As previously documented[1], the root tension and movement with SLR is considered to increase only up to 70°, after which it becomes sluggish and ceases at 90°[15,30,37]. It would then seem that ANF used with SLR might only be effective if the end of the SLR angle is anywhere less than or equal to roughly 70°.

If SLR is limited by back and/or leg pain comparable to sciatic nerve involvement, then the purpose of the NF qualifying test is only to reproduce or enhance this pain. No further range of SLR is required (as this would only exacerbate the patient's pain and make it quite unbearable) and thus ANF or PNF can be used.

Because we know that SLR also causes lumbo-pelvic movement, irritable facet or sacroiliac joints can also produce comparable back pain[1]. Therefore, NF could be used as a differentiating test for neural or articular structure involvement[1]. Pain on further SLR reproduced with ANF can either be due to stretching of the dura mater or movement of the irritable lumbosacral joints, due to pelvic rotation caused by the abdominals. If PNF is then applied and the pain enhanced, then this can only be attributed to the fact that the dura and nerve roots' mobility are being painfully impaired, for there does not exist any anatomical means by which PNF can exert any effect on the sacroiliac or facet joints, or even be thought of to be a cause for pelvic movement.

If PNF does not cause an increase in painful symptoms, then the cause can most likely be attributed to the irritable lumbo-pelvic joints which are being mobilised with SLR and ANF, or neural structures unaffected by NF (e.g. disc prolapse situated inferomedially to the nerve root and dura mater[28]).

If ANF exerts an effect on the pelvis and indirectly on the hamstrings, are there any other structures which might also be affected?

The isometric contraction of the abdominal musculature with ANF helps to decrease intradiscal pressures[29] by increasing intra-abdominal pressure. The increase in intra-abdominal pressure together with the splinting effect of the abdominal muscles, reduces the pressure on the discs. Further studies would be needed to determine if there exists any abating of discal symptoms with the decrease in intradiscal pressure when ANF is applied.

Fisk[30,31], referring to hamstring tightness and SLR, notes that "limited SLR by the hamstring muscles can be improved with manipulation of the lumbar spine, resulting in either alteration of the gamma inflow to the muscle spindles allowing lengthening of the hamstrings, or sacro-iliac joint mobilisation". That ANF might exert an effect on the hamstrings by also altering the gamma inflow to the muscle spindles or any other neurological pathway can only be seen as speculation, and further insight and experimentation would be needed to determine if any relationship does exist.

RECOMMENDATIONS

Having analysed and tabulated the results for the twenty-two normal subjects who took part in this experiment, it can be seen that it can only be regarded as a pilot study. The study itself needs to include a larger number of candidates, spanning a wider age group; 12-16 years and 35-55 years.

More care also needs to be taken to attempt to control the interfering variables which might have affected the results. These were;

1. movement of the skin where the bodymarkings were delineated, such that they were no longer over the bony landmarks being represented, when SLR measurements were taken
2. leg weight differences between subjects, exerting varied forces on the pressure transducer
3. the position of the hook of the pulley above the right hip. Visual estimates of the point above the right hip were used, and varied positions could have caused different angles of pull of the rope on the SLR leg.

Further research involving ANF, pelvic rotation and SLR would be beneficial in helping to understand this phenomenon.

1. Tests performed in the clinical environment involving subjects with back symptoms, to determine whether ANF and PNF can actually be used in a differentiating role, for patients who exhibit articular and neural symptoms.
2. A study to determine how much more pelvic rotation actually does occur when ANF is added to full SLR.
3. ANF tested on passive and active SLR.
4. Lastly, experimentation to determine the neurological effects of ANF on hamstring muscle spindle control.

CONCLUSION

The angle of SLR with ANF was definitely more than the angle with PNF. This bears important clinical relevance with regard to how NF is performed, as well as qualifying the signs produced with SLR.

Emphasis is not placed on demanding the sole use of ANF, but with the clinician's discretion, it can be useful in:-

i) applying more tension to the nerve roots, and
ii) differentiating between neural and articular low back pain causes.

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CLASSIFIED ADVERTISEMENTS