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# The Effect of Cervical Spine Isometric Contract-Relax Technique on Hamstring Extensibility

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## Abstract

### Objectives:

To re-investigate the effect of a cervical isometric contract-relax technique on hamstring extensibility and examine the duration of any treatment effect.

### Methods:

Forty asymptomatic participants were randomly assigned equally to either an experimental or control group. Both groups underwent pre and post hamstring extensibility measurements using passive knee extension with the thigh maintained at 90° of hip flexion, with the examiner blinded to treatment allocation of the participants. Torque was measured with a hand held dynamometer to maintain consistent force in pre and post measurements. The experimental group received an upper cervical isometric contract-relax treatment. A digital camera recorded the knee extension angles and the images were computer analysed to determine hamstring extensibility.

### Results:

A split plot ANOVA (SPANOVA) revealed no significant hamstring extensibility differences between or within the groups, immediately or at 30 minutes.

### Conclusion:

The cervical isometric contract-relax treatment produced no significant effect to the extensibility of the hamstring. This study does not support the use of cervical techniques to alter hamstring extensibility.

### Key Words:

Hamstrings, cervical spine, isometric, contract-relax, passive knee extension.

## Introduction

In 1997, Pollard and Ward<sup>1</sup> reported a change in the extensibility of the hamstring muscles following the application of a cervical isometric contract-relax technique (ICR). The reported change was a significant increase in remote hip flexion range of motion (ROM), as measured with the straight leg raise (SLR), with an average increase of 9.05°. They also reported that this finding seemed to be only short term in duration, but did not report how long the altered extensibility remained. This uncertainty about the duration of this reported effect leads to difficulties in assessing this approach for therapeutic merit.

In Pollard and Ward's study<sup>1</sup>, subjects were asked to contract their sub occipital muscles against an operator's manual resistance and then relax. This active component was followed by a passive stretch performed by the operator and the procedure was repeated. Angles of pre and post SLR measurements were obtained by the use of a long armed goniometer. The nominated amount of force to be applied to the subject's leg using a hand-held dynamometer (rather than by the subjective feel of stretch) was 5% of the subjects' body weight. As the use of a repeated SLR test can produce stretch and an increase in ROM itself, a control group receiving a placebo technique (digital pressure to the mastoid processes) was used to monitor the amount of normal increase of hip ROM due to the SLR testing. The treating practitioner was blinded to the pre and post measurements, but it was not specified whether the examiner was blinded to the treatment allocation of the subjects, which raises the possibility of expectation bias. In another study, Pollard and Ward<sup>2</sup> also reported a similar significant increase in hip ROM following upper cervical manipulation treatment (HVLA: high velocity low amplitude thrust), and in this second study both measurer and treating practitioner were blinded to the activities of each other.

Pollard and Ward's<sup>1,2</sup> studies were interesting due to the remoteness of the site of treatment to the region of effect and the lack of any obvious explanation for this effect. These two studies suggested a new approach to the treatment of impaired hamstring extensibility and encouraged further investigation of the remote effect of cervical treatment. The authors concluded that "manual therapy of the neck may have a role to play in the treatment of extra spinal lower limb musculoskeletal conditions<sup>1</sup>".

Although healthy, asymptomatic people commonly present with short hamstrings, Gajdosik<sup>3</sup> suggested that clinical observations often link the presence of short hamstrings with various specific and general dysfunction syndromes of the lumbar spine.

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Hamstring shortening, Gajdosik<sup>3</sup> claimed, may be secondary to lower back pain (LBP) or mechanical disturbances in the lower back.

Various researchers have reported differing results concerning the relationship between hamstring tension and lumbo-pelvic rhythm, depending on the measuring procedures and whether the study was of a static or dynamic nature.<sup>4,5,6</sup> Li et al.<sup>4</sup> examined the relationship between hamstring length and static standing lumbar and pelvic postures and found no significant difference between short and normal length hamstrings on these postures. Subsequent stretching of the hamstrings achieved by forward bending also produced no change in these postures, but did produce a greater degree of forward flexion. Similarly, Gajdosik et al.<sup>5</sup> reported that static standing lumbar, pelvic and thoracic posture angles were not significantly influenced by hamstring length. Hamstring length, however, has been reported to have a significant influence over pelvic, lumbar and thoracic angles and range of trunk flexion during a dynamic toe touch test into flexion. Van Wingerden et al.<sup>6</sup> found that in the first one-third of active seated flexion, lumbar flexion was significantly greater if the knee was flexed to 45° rather than 15° (at 15° of knee flexion, the amount of tension in the hamstrings was three times greater than at 45°). Interestingly, overall maximal flexion was not reduced. Because small to moderate degrees of lumbar flexion is required more often than maximal flexion in daily activities and LBP sufferers may spend more time seated than standing, a possible therapeutic advantage may be achieved by an increase in hamstring length.

Treating the hamstrings in patients with acute lower back pain is often difficult because commonly used techniques for increasing hamstring length, such as ballistic, static and contract-relax techniques<sup>7</sup>, may cause aggravation by compressing or stretching irritable pain producing tissues. Such interventions risk the aggravation of the local inflammatory response and may cause further muscle spasm and guarding<sup>8</sup>. Pollard and Ward's studies<sup>1,2</sup> suggested a different approach (cervical spine treatment) that might avoid compressing or stretching irritable structures, but still produce an increase in hip flexion and hamstring extensibility.

In an effort to address the presently sparse amount of information on the remote effects of cervical techniques and to attempt to verify Pollard and Ward's<sup>1</sup> intriguing findings, this study re-examined the effect of cervical isometric contract-relax technique on hamstring extensibility. It investigated both immediate and medium term effects (5 and 30 minutes post-treatment) and used torque controlled passive knee extension (PKE), which may be a better indicator of

hamstring length as it is likely to be less sensitive than the SLR to neural stretching.

## Methods

This study sought and received approval from the Victoria University Ethics Committee. All data collection in this study was conducted in tandem with a separate cervical high velocity low amplitude (HVLA) manipulation PKE study<sup>9</sup>, numbering 40 participants in all. Twenty participants from a reliability and validity comparison study between PKE and SLR methods of hamstring measurements<sup>10</sup>, having undergone the same PKE test protocol but no therapeutic intervention, were used as a comparable control group for this study.

## Participants

Forty volunteer participants, ranging in age from 19-40 years (mean age 23.3) were drawn from the Victoria University Osteopathic Medicine student body. The forty subjects were randomly divided into two groups of 20 via order of their volunteering. Participants were briefed on the theory and procedures of the study and signed an informed written consent form.

## Withdrawals and Exclusions

Participants were informed that if they did not wish to continue with the study they could withdraw at any time without prejudice. All participants eligible for the experiment had to have received and passed a vertebral basilar insufficiency test as well as a cervical ligamentous stability screen<sup>11</sup> within 6 months of the study. Any potential participants who reported an incidence of acute spinal pain, lower limb pain or muscle injury within two weeks of the test were excluded. Also excluded from the experiment were any potential participants who were currently being treated for neurological or systemic disorders.

## Materials

All PKE measurements took place on an electrical operating treatment table (Athlegon, Aust.A002716). Across the width of the table was an adjustable metal cross bar (Figure 1.) for bracing the thigh at 90° of hip flexion. To this cross bar was also attached a smaller padded cross bar for control of abduction and adduction of the flexed thigh and for greater participant comfort. Pelvic movement was impeded by a broad Velcro® strap placed across the upper thigh of the non-test leg, securing it to the table. Torque (force of passive stretch) was measured by the use of a hand held Pressure Dynamometer (Nicholas, Lafayette USA). The leg under study (the choice of right over left hamstring was purely



**Figure 1**

arbitrary) was marked with 4x 2cm squares of coloured sticking tape. To measure the angles of the PKE testing, a remotely controlled tripod mounted digital camera was used (Canon MV 430i, Japan) at a distance of 3 meters. The collected digital images were later analysed by computer (Swinger 1.29 Pro version analysis package) to obtain the angles of knee extension. Participants were weighed on a standard weighing scale and their height was measured by a metric wall mounted tape measure.

### PKE Test Protocol

The PKE method of hamstring muscle extensibility measurement was chosen for several reasons. Firstly, the SLR involves a considerable amount of pelvic rotation and PKE is less associated with this movement<sup>12,13</sup>. Other structures involved with SLR, such as the deep fascia of the leg, soft tissues of the pelvis and neural structures may limit hamstring extensibility<sup>14</sup>. PKE also affords greater control of abduction and adduction of the leg via the adjustable metal cross bar used for thigh support. PKE has previously been shown to be a reliable method of hamstring measurement<sup>13</sup>.

Participants were initially measured for height and weight and had their age and sex recorded. Their right leg was then marked with coloured sticking tape on the lateral malleolus, greater trochanter, proximal fibula head and the lateral femoral condyle.

The participants were then asked to attempt 10 toe touches to give the hamstrings a pre- measurement warm up. Once lying supine comfortably on the treatment table, their left leg was secured to the table by a broad Velcro® belt across the upper thigh. The right thigh was then passively flexed 90° until it made contact with the padded horizontal bar. In this

position, the hand held dynamometer was placed just proximal (50mm) to the achilles insertion at the calcaneus and the lower leg was then extended until the participant felt the hamstrings resist stretch. At this point of extension the amount of pressure, reading on the dynamometer was noted and a digital picture was taken by remote control. All further PKE measurements for that particular participant were again recorded at this same torque.

All PKE measurements were recorded three times and the means of these results were calculated. The first post PKE hamstring length measurements took place after 5 minutes and the second post PKE hamstring length measurements took place after 30 minutes. At all times during the testing process, the results of the knee angle measurements were unknown to the sole measurer, due to the use of a digital camera and the need for subsequent computer analysis.

### Procedure

Forty participants were randomly allotted to either an ICR or a HVLA (the concurrent study) treatment. The measurer was blinded to the treatment allocation of the participants. The control study group was measured on a separate day by the same measurer to avoid inter-examiner measurement error. Following the pre PKE measurements, test group participants left the measurement room and entered a second room to receive either a cervical ICR treatment or a HVLA cervical manipulation treatment.

The ICR technique was performed as described by Pollard and Ward<sup>1</sup>. With the participant lying supine on the treatment table, the operator's hands contacted the occiput and the frontal portion of the skull. The participant's head was then flexed forward to take up the slack in the sub-occipital muscles. In this position, the participant was asked to push back against the operator's resistance with a firm but not painful force for 3-5 seconds and then relax. After relaxation of the muscles, the operator flexed the head further forward and took up any additional slack. This process was performed three times.

### Statistical Analysis

All data collected was recorded on separate test and control pre and post measurements score sheets. This data was entered into the SPSS Version 11 statistical analysis program.

The data was checked for normality assumptions, baseline evenness between groups and for any missing data. A split plot ANOVA or SPANOVA analysis of variance of the data was performed to investigate if any significant differences occurred between the two groups, or within the two groups.

## Results

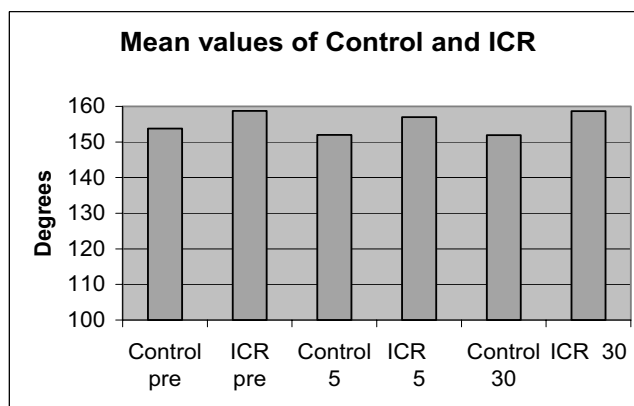
SPANOVA revealed no significant differences in hamstring extensibility between or within the groups, initially, or at 30 minutes. The tests results of the within subjects effects, within subjects contrast, multivariate and between subjects effects, are presented in Table 1. The mean values and standard deviations for the Pre-test, Post-test 5 minutes and Post-test 30 minutes of each group and the totals are presented in Table 2. The assumption of homogeneity of variance-covariance matrices was found to be not violated ( $p > 0.05$ ) as was the assumption of homogeneity of variance ( $p > 0.05$ ). The assumption of sphericity however, was found to be violated ( $p < 0.05$ ). In light of this assumption violation, the significant finding of the multivariate testing ( $p < 0.05$ ), should be viewed with caution.

Groups	Mean	Std. Deviation	N
PRETEST	Control	153.8	20
	ICR	158.8	20
	Total	156.3	40
POST 5	Control	152.0	20
	ICR	156.9	20
	Total	154.5	40
POST 30	Control	151.2	20
	ICR	158.7	20
	Total	154.9	40

**Table 1** - Means and Standard Deviations of PKE Pre-test, Post-test 5 Minutes, Post-test 30 Minutes and Totals.

findings of this study are very similar to the findings of a concurrent study that followed the same test protocol, except that the cervical technique under examination was HVLA<sup>9</sup>.

The present study was modelled on Pollard and Ward's<sup>1</sup> study, but differences exist to allow for some speculation of why their results were different in outcome. Pollard and Ward<sup>1</sup> used the SLR method to measure hip flexion, a test which has been used to assess both hamstring extensibility and sciatic nerve sensitivity<sup>15</sup>, and it is not unreasonable to interpret the results as either a change in hamstring or nerve extensibility. The present study's use of PKE is more likely to be sensitive to hamstring length and less sensitive to neural



**Figure 2** - Mean Values of Control and ICR

		F- value	p - value
Test within –subjects Effects	Time	1.1	0.3
	Time Groups	0.7	0.5
Test within –subjects contrast	Time	0.7	0.4
	Time Groups	0.6	0.4
Multivariate Tests	Time	3.3	0.05
	Time Groups	0.4	0.7
Test between–subjects Effects	Groups	1.5	0.2

**Table 2** - Within-subjects effects, contrast Multivariate, Between-subjects effects

## Discussion

A cervical ICR treatment produced no significant change in hamstring extensibility, in contrast to the results of a previous study<sup>1</sup>. Comparison of the PKE pre and post intervention means for both the ICR and control groups showed little change. Statistical analysis of the test data indicated that no significant difference in variance between and within groups was found to be apparent. It is of interest to note that the

stretch in the initial positioning, although hip flexion at 90° has also been used as a pre sensitising position in nerve extensibility testing<sup>15</sup>.

Differences between the degree of force applied to produce hamstring extensibility may also be a major reason for the different findings. Pollard and Ward's<sup>1</sup> choice of 5% of body weight pressure measured by the dynamometer, compared to

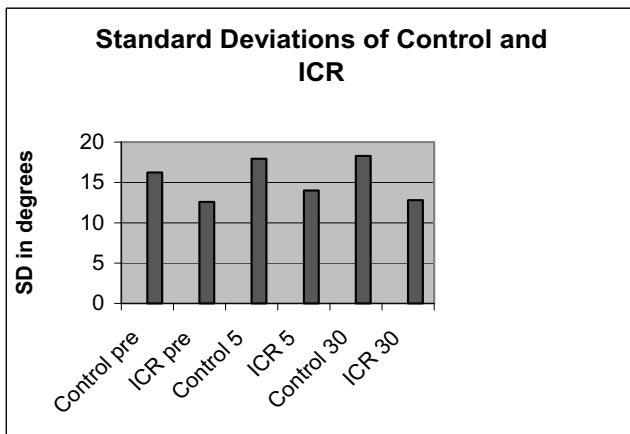


Figure 3 - Standard deviations of Control and ICR

this present study's average of 9.5% (where the hamstrings were extended to a point of discomfort), indicates that almost twice the pressure was used in this present study. Pollard and Ward's<sup>1</sup> post measurement ROM gains using 5% of body weight force were likely not have been sufficient to reach subjective awareness of a sense of hamstring stretch by the subject, as used in this present study. This is supported by the findings of Fredriksen et al.<sup>13</sup> who reported that at least 8kg was required to produce a subjective sense of stretch for measuring hamstring length in both males and females. At 5% of body weight, subjects would need to weigh 160kg to fit the 8kg category. Another study found that an average of 7.9 % of body weight was required to register a subjective response to hamstring stretch using the SLR<sup>10</sup>.

It has been suggested that cervical ICR may produce remote effects following stretch of the dura<sup>1</sup>. The present study used nearly twice the pre-intervention torque to elongate the hamstring muscles than the study by Pollard and Ward. It may be argued that the stronger PKE pre-stretched the dura, thus negating or masking any further effect of dural stretch by the ICR. If this was the case, it suggests the effect of cervical ICR was no greater than the effect of direct hamstring stretching, contrary to Pollard and Ward's study<sup>1</sup>.

Post intervention measurements in Pollard and Ward's<sup>1</sup> study took place after a 30 second interval. Within this brief period of time, it is assumed that the subjects never left the treatment table or actively contracted their hamstrings. In the present study by comparison, the subjects stood up and walked into a separate treatment room, then returned for their post treatment measurement, a period of approximately five minutes. If "only short term"<sup>1</sup> increases of hip ROM equate to a period of less than five minutes, then this could be another explanation of the conflicting findings.

As the reported effect<sup>1</sup> was brief in nature, it might also be weak and the small amount of gentle ambulation between rooms involving multiple contractions and relaxations of the hamstrings, might also have negated any effect if present. Pollard and Ward's<sup>1</sup> less forceful measurement protocol could mean that any increase in hamstring extensibility might only operate within a less forceful range of stretch, operate for less than five minutes and be abolished by gentle ambulation. If this is the case, the clinical significance of such findings is tenuous.

## Recommendations

This present study did not confirm the presence of an increase in hamstring extensibility following a remote cervical treatment intervention. A repeat of this present study with a larger number of participants would reduce the chance of a type I error, as the power of study was low. The possibility of a pre dural stretch mechanism might be addressed by a study examining the effects of cervical spine ICR on hamstring extensibility, when comparing the forces of both subjective hamstring stretch and 5% of body weight, using PKE. Researchers should also re-examine Pollard and Ward's studies using the SLR measurement, as this may be more sensitive to dural and neural stretch.

## Conclusion

This study demonstrated no significant change to hamstring extensibility, as measured by torque-controlled PKE, following the application of a cervical isometric contract-relax treatment. The therapeutic usefulness of a cervical technique to achieve a change in hamstring length was not supported.

## Acknowledgments

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