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Tightness of Hamstring- and Psoas Major Muscles

A prospective study of back pain in young men during their military service

Anna-Lisa Hellsing

Department of Rehabilitation, University Hospital, Uppsala, Sweden

ABSTRACT

Muscular tightness and the therapeutic effect of stretching has been widely discussed during the last few years in sports training and physiotherapy. Within a prospective study of back function and pain before and after compulsory military service, tightness of hamstring- and psoas muscles was assessed. Around 600 young men were examined three times over a period of four years.

Tight hamstring muscles were found to be very common in this group. Only 43% of the right and 35% of the left legs reached an angle of at least 80 degrees from the couch during the straight-leg-raising test (Lasegue´s test).

The test of muscular tightness showed a significant test-retest reliability over all examinations. Tight hamstring- or psoas muscles could not be shown to correlate to current back pain or to the incidence of back pain during the follow-up period.

INTRODUCTION

What is muscular tightness? There seems to be no clear answer to that question, but a lot of clinical experience. Janda (16) has pointed to the typical pattern of tightness in striated muscles responsible for the postural function. The tight muscle is readily activated in the usual movement pattern, and the tightness is maintained. The tight muscle is kept strong while the phasic antagonist weakens. The result is an imbalance around the joints. As the tightness-pattern can be predicted, even the imbalance shows a regular pattern. This thightness does not show

any characteristical histological or neurological pattern. The muscle is just too short to allow the full range of passive or active mobility. Muscles in the lower extremity which are most liable to tightness are gastro-soleus, tibialis posterior, rectus femoris, iliopsoas, tensor fascia lata, the hamstrings and the short adductors.
Hagbarth (13) found that the muscle fibres show a thixotropic behaviour. The muscular stiffness is reduced after movements that stretches the muscle fibres and is enhanced after movements that shortens them. The aftereffect could last several minutes. In those subjects who had difficulties in relaxing, a passive stretching movement caused disappearance of reflex EMG responses. This character can be part of the explanation, but does not explain the different behaviour between postural and phasic muscles. De Vries (30) also showed a decrease in electrical activity in muscles after stretching. In addition he found that muscle soreness after active muscle work was positively correlated to increased electrical activity. (The tight postural muscles are not normally sore however). Long-term effects of the muscle imbalance because of tightness has not been studied, but several authors point to the short term benefit of stretching exercises.
Regardless of the method used the stretching has been shown to increase the range of motion (8,22,29), better than massage and warming up, separately or combined (31). Soderberg has also pointed to the important implications for physiotherapy (26).
Both hamstring- and psoas muscle tightness could well be responsible for causing or maintaining back pain by diminishing the lumbar- or SI-joint range of motion, and through that even the nutrition of the disc (1,15), the joint cartilage and ligaments (20). The hamstring tightness has also been shown to significantly correlate to back pain in men during compulsory military refresher courses (25). Already at the age of 7-16 years significantly more of tight hamstring muscles were found in the group with postural faults than in the control group (17).
Tightness of the psoas major muscle is not so often mentioned as that of the hamstrings. But even the psoas major belongs to the postural muscles that show a tendency to become tight (16). The psoas muscles, like other postural muscles have function as stabilizers. Deliberate increase of lumbar lordosis in standing was shown to recruite the psoas muscle (3). There is no answer to the question of if the tightness is a result of increased demand of stabilization or just a consequence of a movement pattern that includes more or less constant activation of the muscle, and too little stretching.

As tightness of the hamstrings- and psoas muscles was tested within a prospective study of back pain (14) a further review of the results was carried out.

THE AIMS were to find answers to the questions:

1. What are the observed frequencies of tightness in hamstring- and psoas major muscles in a population of young men?
2. What is the reproducability of a quick screening examination of this tightness when repeated three times by the same examiner over a four year period?
3. What correlations can be found between muscle tightness and other variables in the clincial back examination and correlation to the level of subjective back pain?

METHODS

The sample. At enlistment for compulsory military training 999 men aged 18-19 years old participated in an extra standardized back examination including tests of muscle tightness. They were seen again at the beginning and end of their military service. The second examination was undertaken 1-3 years after the first one, and the third around 1 year after the second; a total span of 4 years. On each occasion every man answered a questionnaire about, among other things his level of back pain. The answers were not seen by the examiner until after each examination. All these men were healthy and fulfilled their basic military training, but 95% at the start stated some degree of back pain (14).

The tests Test of hamstring muscle suppleness was executed by the straight-leg-raising test (SLR) (11,16,19,27). The straight leg was raised by a grip around calcaneus. The subject´s knee was held straight by the examiner´s hand placed over patella. Care was taken not to touch the skin over the hamstring- or gastrocnemius muscles. The leg was raised until either the muscles on the back of the leg stopped further movement or the pelvis could be felt to move or the subject´s pain was too strong for the test to be continued. When pain was apparent it was in all cases felt in the hollow of the knee or halfway down the calf. Three cases with another distribution of pain were not regared as simply hamstring tightness.
The angle between the raised leg and the couch was measured with a normal goniometer and grouped in five groups:

< 30 degrees; 30-59 degrees; 60-79 degrees, 80-89 degrees; 90 degrees or more.

Tightness of the psoas major muscle was tested with the subject lying supine. He was asked to move to the side until one leg was hanging freely over the side of the couch and to hold the other leg maximally flexed to flatten and stabilize the back. This position meant an abduction of the leg of around 20 degrees. This modification of the test (19.page 153) was carried out due to the time saved by simpler instruction to the subject. The normal result was that, with the knee flexed the lower leg hung along the gravity line with the thigh resting just under the horizontal through a slight extension in the hip joint. If the thigh did not reach the horizontal even if the knee was allowed to extend, it was judged as psoas tightness (hip joint without remark). The angle of the defect of the thigh to horizontal (the couch) was measured and the result grouped into four groups:

none or < 5 degrees defect; 5-10 degrees defect; 11-20 degrees defect more than 20 degrees defect

Drop outs: The second examination was performed completely on 613 subjects and the third on 547. Apart from 262 exempted or not yet drafted (14) the abscense was mainly due to difficulties for the subjects of leaving their military training.

Statistical methods

Contingency coefficient, c, has been used as a measure of the strength of correlation. Neither the usual correlation coefficient, r, or Spearman´s rank correlation can be used if one of the variables is expressed in a nominal scale. Like the usual correlation coefficients the value of c is zero when there is no correlation, but c never reaches the value 1.0 even if the correlation is perfect. The upper limit for c depends on the number of categories for the studied variables. For 2x2 and 3x3 tables the upper limit value is 0.707 and 0.816. The chi square test has been used to judge if the correlations are statistically significant or not. The level of significance is shown as p (probability), i.e. the probability for a random sample to show at least the observed value, even if there is no correlation.

RESULTS

Frequencies. From table 1 can be seen that the average number of right legs that reached 80 degrees or more was 43.5% while the corresponding figure for the left leg was 35.4%. The left hamstring muscles were at each occasion more tight than the right ones.

Table 1.
Frequencies of hamstring muscle tightness as result of straight-leg-raising test (SLR) on three different occasions. Per cent of each examination within brackets.

EXAMINATION	1. n=999	%	2. n=613	%	3. n=547	%
Right leg						
Value of SLR						
< 30°	-		1	(0.2)	-	
30-59°	45	(4)	74	(12.1)	64	(12)
60-79°	426	(43)	277	(45.2)	289	(53)
80-89°	247	(25)	137	(22.3)	115	(21)
≥ 90°	281	(28)	124	(20.2)	79	(14)
Left leg						
Value of SLR						
< 30°	-		-		-	
30-59°	76	(7.6)	92	(15)	76	(14)
60-79°	490	(49)	314	(51)	312	(57)
80-89°	217	(21.7)	110	(18)	87	(16)
≥ 90°	216	(21.6)	97	(16)	72	(13)

Table 2 shows the corresponding values for psoas major tightness. The average without tightness was, for the right leg 76.9 % and for the left 79.9%.

Table 2.
Frequencies of psoas muscle tightness on three different occasions. Per cent of each examination.

EXAMINATION EXTENSION DEFECT	1. n=999	%	2. n=612	%	3. n=347	%
Right leg						
None or < 5°	688	68.9	472	77.1	463	84.6
5-10°	217	21.7	99	16.2	66	12.1
11-20°	88	8.8	40	6.5	17	3.1
> 20°	6	0.6	1	0.2	1	0.2
Left leg						
None or < 5°	711	71.2	503	82.1	472	86.3
5-10°	220	22	78	12.7	62	11.3
11-20°	63	6.3	31	5	13	2.4
>20°	5	0.5	1	0.2	-	

In both cases of hamstring- and psoas muscles tightness, the right and left sides were significantly positively correlated ($p<0.00$; c=0,726-0.760 for hamstrings; c=0.588-0.648 for psoas major). The correlation between the tightness for psoas and for hamstrings was sometimes, but not always significant ($p=0.0002-0.4903$; c=0.092-0.175 for the first examination).

Reproducability. Comparisons between the different examinations of SLR showed significant correlations between the results, with an average total agreement of 51% and 52% for the right and left leg respectively (see table 3). The best correlation was obtained between the second and third examination concerning the right leg.

From table 4 it can be seen that most of those who were judged different on different occasions changed one class, but 25 legs changed two classes, 20 of those were more tight at the end of military service than at the beginning. These 25 however dit not show homogeneity in any of the other variables.

Table 3.
Reproducability of the straight-leg-raising test for hamstring tightness, at three examinations.
Number and per cent of total agreement.

	EXAMINATION		number	%	p-value	c-value
Right leg	1 x 2	n=613	293	48	0.0001	0.515
	1 x 3	n=547	271	49	0.0001	0.544
	2 x 3	n=489	277	57	0.0001	0.600
Left leg						
	1 x 2	n=613	302	49	0.0001	0.516
	1 x 3	n=547	285	52	0.0001	0.542
	2 x 3	n=489	275	56	0.0001	0.581

Table 4.
Correlation of the results of SLR-test between examination 2 and 3 for right leg. Per cent ot total shown in brackets.

EXAMINATION 2 / EXAMINATION 3									
SLR-value	> 90°		80-89°		60-79°		30-59°		Total
< 30°	-		-		-		1	(0.2)	1
30-59°	1	(0.2)	1	(0.2)	33	(7)	26	(5)	61
60-79°	3	(0.6)	26	(5)	164	(33)	27	(5)	220
80-89°	16	(3)	39	(8)	49	(10)	1	(0.2)	105
> 90°	48	(10)	35	(7)	17	(3)	2	(0.4)	102
Total	68		101		263		57		489

The total agreement for psoas major muscle tightness between examinations 2 and 3 was around 80%.

Correlations to other variables

Tight hamstring muscles showed very weak correlation to the subjective back pain at the first examination and none at all to current back pain on the other occasions. Nor could changes in hamstring muscle tightness between the examinations be shown to correlate to the changes in back pain over the period.

No correlations could be demonstrated between the muscle tightness and i.e. painful hip- or SI-joints.

The unfortunately very small group of 45 who stated no back pain at enlistment showed less hamstring-tightness, but no difference in psoas-tightness compared to the rest.

DISCUSSION

The test, earlier called Lasègue's test is now mostly simplified to straight-leg-raising test (6). A positive test was by Lasègue attributed to be caused by muscle spasm, but was later thought to be caused by tension of an inflamed root. Its value in diagnosing a herniated disc has been much under discussion (23,28). When there is no inflamed root, herniated disc or other pain involved the range of motion is mainly restricted by tight hamstring muscles. Fieldman (10) has shown that the extensibility of the hamstring muscles is one of the main contributing factors to hip joint flexion in standing forward flexion.

A good reliability between testers has been documented concerning the SLR-test (11) even if Bohannon has shown that pelvic stabilization is difficult (5) and suggests that the angle measured should instead be that between the pelvis and horizontal. There are to my knowledge no studies with which to compare the frequencies of muscular tightness found in this study. Most studies contain very few subjects (11,31) or another age group (17,18). Leighton tested flexibility of 400 boys aged between 10 and 18 years old. The value for flexion-extension of the hip joints decreased significantly over the first 6 years of the period. The value of SLR in this study showed a decrease from the age of 18 during the follow-up period. This decrease might reflect a continuation of the natural course, and can not without further evidence be attributed to military service. Ekstrand et al. (8) tested a reference group of 86 non soccer players and

reported a mean of 78.4° +- 5.1° for hip flexion with straight knee. In this study the mean can not be calculated for comparison as the values were only placed in groups.

The total agreement between examinations of 48-57% for the SLR-test shows an acceptible reproducability between occasions even over this period of several years. Systematic errors can of course not be absolutely excluded. The quick screening method used in this study can not really be compared with that used by Ekstrand (9), with two cooperating examinators. The interrassay coefficient of variation was then reduced to 1,9° +- 0,7%. Biering-Sørensen (4) reports a mean of 73,8° and 73,6° for right and left leg respectively in the case of men. He found the test to be well reproducable even at an interval of about six months.

No correlation between muscle tightness and back pain was found in this study, not even current back pain. This coincides with the findings from Biering-Sørensen (4) who found the test of SLR for hamstring tightness to be the least useful of the tests used, in differentiating between the different back pain groups. Alston et al. (2) tested hamstring muscle tightness by straight leg raising and report that only 22% of back pain patients reached 80° compared to 59% in the control group. Seven of the back pain group (21%) showed a range below 60°, but only one (3%) of the controls was that tight in the hamstring muscles. It is worth nothing that 86 men in this study passed their military training with SLR less than 60° at, at least one of the two last examinations.

This points to part of the problem that having tight muscles is the result of both positive and negative factors. Heavy muscular work or strength training, longstanding pain or a poor movement pattern can all result in muscle tightness, probably also depending on genetic factors.

Experience of pain in the tight muscles themselves during the test differed very much between the subjects, but was not systematically recorded. The results in this study can also seem contradictory to clinical experience, i.e. that back pain is diminished by the stretching of tight muscles. It does not actually have to be contradictory however, because more flexible muscles probably alter the load from the painful sites.

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For information and reprints: Anna-Lisa Hellsing, Dept. of Occupational Medicine, Örebro Medical Center Hospital, S-701 85 Örebro.