A COMPARATIVE STUDY OF LUMBAR RANGE OF MOVEMENT IN HEALTHY ATHLETES AND NON-ATHLETES

Carla Chertman[1], Humberto Maldonado Campoy dos Santos[2], Leonardo Pires[3], Marcelo Wajchenberg[4], Delio Eulálio Martins[5], Eduardo Barros Puertas[6]

ABSTRACT

Objective: To compare the amplitude of trunk flexion and extension through goniometry among athletes and non-athletes and to correlate these data with the popliteal angle and hamstring muscle tests. Methods: The amplitude of trunk flexion and extension was evaluated in 50 individuals who practiced sports on a regular basis and 50 non-athletes who did not present any painful lumber symptoms or any symptoms that could affect test performance. The measurements were made consecutively by two independent examiners by means of goniometry. The trunk flexion and extension values from the goniometry evaluation were correlated with the popliteal angle and hamstring flexibility tests, and the statistical correlation between them was analyzed. Results: The mean values obtained were 130.7 (101.9) for flexion and 40.2 (36.4) for extension. Statistically significant differences between the athletes and non-athletes were found in relation to the following parameters: goniometer in flexion with examiner 1, goniometer in flexion with examiner 2 and hamstring test. No statistically significant differences were found between the two groups in relation to the following parameters: goniometer in extension with examiner 1, goniometer in extension with examiner 2 and popliteal angle test. Conclusion: Individuals who practiced sports presented higher trunk flexion values. The use of goniometry to measure trunk amplitude showed variations in measurements between the examiners.

Keywords – *Spine; Arthrometry, articular; Athletes*

INTRODUCTION

Over recent decades, there have been great efforts towards improvements in the performance and results attained by athletes, within sports. Coaches have been accompanied by physical trainers and the demands on athletes have increased. Within this new reality, it has been seen that athletes have been consulting physicians because of a variety of ailments relating to sports practice. Thus, a need for better understanding of diseases relating to this specific public has been created.

With regard to the lumbar spine, measuring its range of motion has always been important for physicians and physiotherapists. This evaluation forms part of orthopedic physical examination, since limitations on movement have a variety of clinical correlations. For example, disc fractures or hernias leading to changes in flexion and to spondylosis, spondylolisthesis or canal stenosis may occur, thus giving rise to changes in extension movements[1]. Although range-of-motion examinations are nonspecific, they identify spinal diseases at different levels and thus also serve as an instrument for assessing the therapeutic response.

Thomas *et al*[2] measured lumbar range of motion and concluded that there was an association between measures that restricted the range of motion and occurrences of lumbar pain. Mayer *et al*[3] measured the

We declare that there is no conflict of interests in this article

range of motion in individuals with and without lumbar pain. Fitzgerald *et al*[4] demonstrated the relationship between the range of motion and age. Ensink *et al*[5] described how range-of-motion measurements changed according to the time of day because of loss of height of the intervertebral discs.

A variety of instruments have been used in practice for assessing lumber range of motion, and also in studies in the literature. Simple radiography is considered by many authors to be the standard method for such measurements[6,7], but new methods have been proposed with the aim of establishing therapeutic follow-up parameters without excessive exposure of patients to radiation. Clinical methods have gained space in the literature, such as proposals for economically viable, reproducible and harmless alternatives that are reproducible and harmless, as is the case with long goniometry.

Two factors of importance in studying lumbar range of motion can also be added: measurements on the popliteal angle and the hamstrings. Gajdosik *et al*[8] concluded that flexion measurements on the lumbar range of motion between groups of individuals with short and long hamstring muscles differed significantly.

The present study aimed to compare normal range-of-motion values for trunk flexion and extension between athletes and non-athletes, determine the mean interval of the value for athletes using the goniometer method, and correlate these data with the popliteal angle and hamstring tests.

METHODS

Subjects

This study was conducted between July 2002 and August 2003 and included the participation of a total of 100 individuals, who were divided equally into two groups: athletes and non-athletes. Individuals were considered to be athletes if they practiced a sports activity in a non-sporadic manner, consisting of a minimum of six hours of training a week with specialized monitoring, along with regular participation in competitions. Individuals were considered to be non-athletes if they did not regularly practice any physical activity. Individuals of both sexes aged between 14 and 45 years, without any painful lumbar symptoms, were included in both groups. The exclusion criteria for both groups were: previous lumbar surgery, painful symptoms in regions adjacent to the spine that would interfere with carrying out the

test, difficulty in adapting to the measurement instruments and non-consent to the study objectives among the participants.

The examiners contacted the coaches of athletes who were being monitored at the sports traumatology center of our institution, and requested these athletes' presence prior to their regular training sessions. The group of non-athletes was composed of school and university students in the city of São Paulo who fulfilled the criteria.

All the participants in this study read and signed the free and informed consent statement, and for those who were under the age of 18 years, consent and signatures were obtained from the adults legally responsible for them.

PROCEDURES

The measurements were always made in the afternoons by two examiners who had previously been instructed about how to carry out the tests. The flexion and extension measurements on the lumbar spine were obtained consecutively by the two examiners, using a simple goniometer, such that all the volunteers performed each movement twice. To avoid the variations described by Ensink *apud* Thomas *et al*[2], consecutive measurements were made during the same period of the day.

The evaluations on the flexion and extension range of motion of the lumbar spine were made using a simple goniometer after instructing the volunteer regarding positioning and the correct way of doing the test.

The individuals began the test in an upright standing position, with the knees completely extended and arms in front of the body (Figure 1). Then, upon a verbal command from the examiner, they made slow and gradual movements for flexion (Figure 2) and extension (Figure 3) as far as the maximum amplitude, at which point the goniometer measurement was made. To evaluate lumbar flexion, the arms had to be flexed at 90 degrees, and to evaluate lumbar extension, the arms had to be kept fixed behind the neck. For these measurements, the iliac crest was taken as the fixed reference point, while the mobile point used was the axillary line collateral to the iliac crest anteriorly, such that the fixed arm of the goniometer remained central in the lateral region of the trunk.

To evaluate the flexibility of the hamstring muscles, two tests were used: popliteal angle and arm reach. The volunteers began in a lying down position, with the leg under evaluation flexed at 90 degrees at the hip and
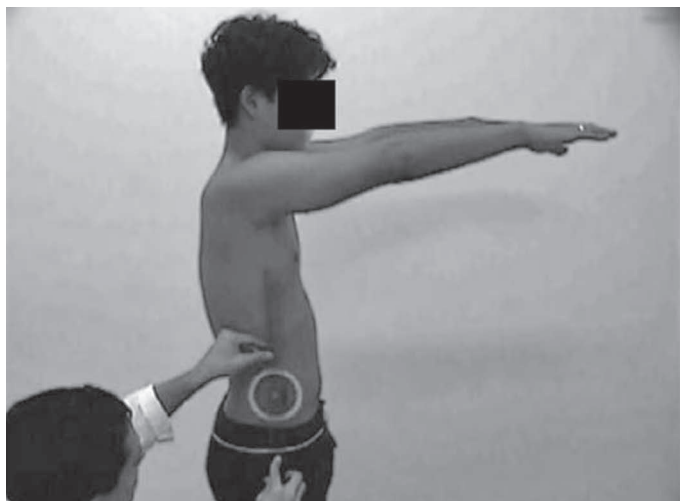
Figure 1 – Individual's initial position and emplacement of goniometer

Figure 2 – Maximum flexion and measurement with goniometer
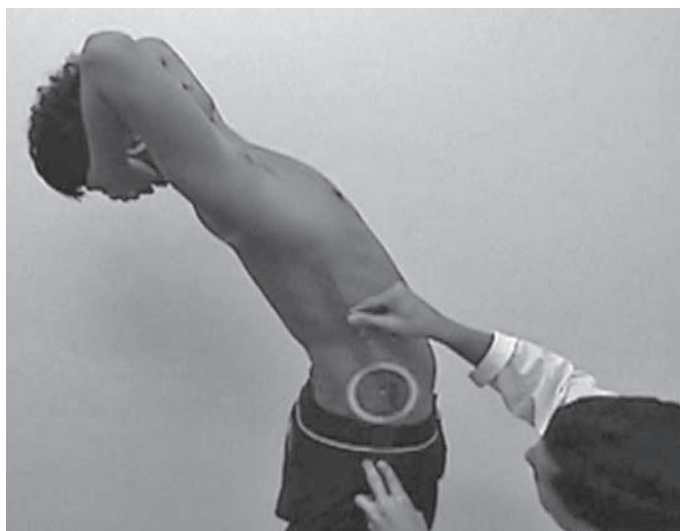

Figure 3 – Maximum extension and measurement with goniometer

knee, and the other leg extended on the bed. Upon a verbal command from the examiner, they actively extended the knee until encountering natural resistance.

The popliteal angle was also evaluated using the simple goniometer, and for this measurement, the lateral joint interline of the knee was taken as the fixed reference point, the lateral malleolus was taken as the reference point for the mobile arm of the goniometer and the central lateral region of the thigh was taken as the reference point for the fixed arm of the goniometer.

The arm reach test was carried out with the volunteers initially in a seated position, with extended knees supported on a platform in order to keep the ankles in a neutral position. The individuals then performed trunk flexion with the aim of reaching out as distally as possible with the arms. Using an ordinary measuring tape (marked in centimeters), the distance between the reached-out distal tip of the third finger and the zero point on the platform (heel position) was measured. If the fingers did not reach the zero point, the distance was recorded as a negative value, while if they reached beyond the zero point, the distance was recorded as a positive value.

The quantitative variables were represented by means and standard deviations, and the qualitative variables by absolute and relative frequencies.

The presence of correlations between the parameters studied was evaluated using Pearson's correlation coefficient (r) and its significance was tested.

Student's t test was used for independent samples and for comparing the groups of athletes and non-athletes in relation to all of the parameters of interest. The same method was used for analyzing the goniometry in relation to the parameters, and for comparing the measurements obtained by examiners 1 and 2.

The significance level of 0.05 (5%) was used, and descriptive levels (p) lower than this value were considered significant and represented by *.

RESULTS

Characterization of the samples

The samples were formed by 50 athletes and 50 non-athletes, who were all volunteers. The athletes' group consisted of 31 women (62%) and 19 men (38%), with ages ranging from 14 to 40 years and a mean of 21 years (SD = six years). Among the 50 athletes, 28 (56%) were whites, 13 (26%) were black and nine (18%) were mixed. The distribution of the athletes according to the sport practiced was: 12 athletics participants (24%), two basketball players (4%), one boxer (2%), one cyclist

(2%), three football (soccer) players (6%), one indo-or football (soccer) players (2%), 12 handball players (24%), two judo players (4%), three karate players (6%), one swimmer (2%), one table tennis player (2%), one triathlete (2%) and 10 volleyball players (20%).

The length of time of sports practice ranged from two to 22 years, with a mean of eight years (SD = five years). The length of training time per week ranged from six to 36 hours, with a mean of 16 hours (SD = seven hours).

The right side was the dominant side for 39 of the athletes (78%), while it was the left side for eight athletes (16%) and three athletes (6%) were ambidextrous.

The group of non-athletes was formed by 37 women (74%) and 13 men (26%). Their ages ranged from 17 to 28 years, with a mean of 21 years (SD = two years). All 50 of the non-athletes were white.

Correlation between hamstring and popliteal angle measurements and other parameters among the athletes

The measurements of the right and left popliteal angles did not show any statistically significant correlation with the hamstring measurements and parameters measured using goniometry ($p > 0.05$) in the group of athletes. In other words, increases in the popliteal angle measurements did not signify increases in the measurements obtained using goniometry or the hamstring measurements (Table 1).

Table 1 – Comparison between popliteal angle and other parameters among the athletes

Parameters	Right popliteal angle		Left popliteal angle	
	r	p	r	p
Hamstrings	0.19	0.179	0.07	0.618
Goniometer A1 flexion	0.06	0.707	–0.05	0.737
Goniometer A1 extension	0.11	0.436	–0.02	0.867
Goniometer A2 flexion	–0.08	0.581	–0.12	0.407
Goniometer A2 extension	–0.02	0.919	–0.15	0.300

r = Pearson's correlation coefficient; p = significance

A statistically significant correlation was found between the hamstring measurements and the parameters measured in flexion using goniometry ($p < 0.05$). The correlations were positive, thus indicating that the greater the hamstring measurements were, the greater the measurements obtained in flexion using goniometry also

were. On the other hand, for the parameters measured in extension using goniometry, Table 2 shows that no statistically significant correlation with the hamstring measurements was found ($p > 0.05$).

Table 2 – Comparison between hamstrings and other parameters among the athletes

Parameters	Hamstrings	
	r	p
Goniometer A1 flexion	0.60	< 0.001*
Goniometer A1 extension	–0.06	0.692
Goniometer A2 flexion	0.67	< 0.001*
Goniometer A2 extension	0.11	0.468

r = Pearson's correlation coefficient; p = significance

Correlation between hamstring and popliteal angle measurements and other parameters among the non-athletes

In the group of non-athletes, a statistically significant correlation was found between the right and left popliteal angle measurements and the hamstring measurements and parameters measured by goniometry ($p < 0.05$). The correlations were positive, thus indicating that the greater the angle measurements were, the greater the hamstring measurements and measurements obtained using goniometry in flexion and in extension (Table 3).

Table 3 – Comparison between hamstrings and other parameters among the athletes

Parameter	Right popliteal angle		Left popliteal angle	
	r	p	r	p
Hamstrings	0.44	0.002*	0.55	< 0.001*
Goniometer A1 flexion	0.39	0.005*	0.43	0.002*
Goniometer A1 extension	0.30	0.026*	0.3	0.006*
Goniometer A2 flexion	0.40	0.004*	0.46	0.001*
Goniometer A2 extension	0.47	0.001*	0.44	0.001*

r = Pearson's correlation coefficient; p = significance

A statistically significant correlation was found between the hamstring measurements and the parameters measured in flexion and extension using goniometry ($p < 0.05$). The correlations were positive, thus indicating that the greater the hamstring measurements were, the greater the measurements in flexion and extension obtained using goniometry also were (Table 4).

Table 4 – Comparison between hamstrings and other parameters among the non-athletes

Parameters	Hamstrings	
	r	p
Goniometer 1 flexion	0.75	< 0.001*
Goniometer 1 extension	0.45	0.001*
Goniometer 2 flexion	0.79	< 0.001*
Goniometer 2 extension	0.44	0.002*

r = Pearson's correlation coefficient; p = significance

Comparison between the groups of athletes and non-athletes

No statistically significant differences were found between the groups of athletes and non-athletes in relation to the parameters of popliteal angle and goniometer in extension ($p > 0.05$).

In relation to the parameters of hamstrings and goniometer in flexion, a statistically significant difference was found between the groups of athletes and non-athletes ($p < 0.05$). For all the parameters, the group of athletes presented a significantly greater mean than that of the group of non-athletes (Table 5).

Table 5 – Comparison between the parameters in all the groups

Parameter	Athletes	Non-athletes	Student's t test
	Mean ± SD	Mean ± SD	
Right popliteal angle	145.2 ± 17.2	147.6 ± 14.3	p = 0.465
Left popliteal angle	146.4 ± 16.7	145.7 ± 14.4	p = 0.813
Hamstrings	8.4 ± 8.6	-1.2 ± 8.3	p < 0.001*
Goniometer A1 flexion	121.9 ± 13.2	111.9 ± 13.0	p < 0.001*
Goniometer A1 extension	40.2 ± 9.4	39.8 ± 8.4	p = 0.814
Goniometer A2 flexion	130.7 ± 14.5	113.8 ± 14.5	p < 0.001*
Goniometer A2 extension	36.4 ± 7.4	34.0 ± 7.6	p = 0.122

r = Pearson's correlation coefficient; p = significance

Comparison between the examiners A1 and A2 in the group of athletes

A statistically significant difference was found between the examiners A1 and A2 in relation to the parameters of goniometer in flexion and goniometer in extension ($p < 0.05$). For the parameters of goniometer in flexion, the means obtained from the measurements of examiner A1 were shown to be significantly lower than those of examiner A2. For the parameter of goniometer in extension, the means obtained from the measurements

of examiner A1 were shown to be significantly greater than those of examiner A2 (Table 6).

Table 6 – Comparison between examiners in the goniometry evaluation on the athletes

Parameter	A1	A2	Student's t test
	Mean ± SD	Mean ± SD	
Goniometer in flexion	121.9 ± 13.2	130.7 ± 14.5	p < 0.001*
Goniometer in extension	40.2 ± 9.4	36.4 ± 7.4	p < 0.001*

r = Pearson's correlation coefficient; p = significance

Comparison of flexion between examiners A1 and A2 in the group of non-athletes

A statistically significant difference was found between the examiners A1 and A2, in relation to the parameter of goniometer in extension ($p < 0.05$).

For the parameter of goniometer in extension, the mean obtained from the measurements made by examiner A1 were found to be significantly greater than those of examiner A2. No statistically significant difference was found between examiners A1 and A2 in relation to the parameter of goniometer in flexion ($p > 0.05$) (Table 7).

Table 7 – Comparison between examiners in the goniometry evaluation on the non-athletes

Parameter	A1	A2	Student's t test
	Mean ± SD	Mean ± SD	
Goniometer in flexion	111.9 ± 13.0	113.8 ± 14.5	p = 0.149
Goniometer in extension	39.8 ± 8.4	34.0 ± 7.6	p < 0.001*

r = Pearson's correlation coefficient; p = significance

DISCUSSION

In this study, it was observed that trunk flexion presented higher values among individuals who practiced sports. This has importance in detecting spinal diseases, and in the response among individuals undergoing treatment.

In a study using goniometers, Boone et al[9] concluded that this was a dependent evaluative method, although their study was limited to arm and leg joint, and the lumbar spine was not tested. In fact, the movement of the lumbar spine is a challenge for the equipment, given that the spine has multiple joint axes with positions that change during the movement[10]. The long goniometer is a piece of apparatus composed of two transparent

jointed flat arms measuring 50 cm that measure the range of motion in degrees. Although this equipment is mechanically precise and specific goniometers for different joints exist, studies on the validity and reliability of this equipment for measuring human movement are scarce. Moreover, there are theoretical limits relating to its use for the lumbar spine, given that this is an instrument with a simple folding action that keeps its axis fixed during the movement. As mentioned earlier, the axis of the lumbar spine changes its position during the movement[10].

Mayerson and Milano[11] found fluctuation of 4º between measurements, thus placing doubt on the reliability of the method, but suggesting that it might be reliable under well-defined circumstances. Fitzgerald et al[4] used a goniometer to measure spinal range of motion, but with a technique that combined it with the technique of spinal traction. They found inter-observer reliability, but this result was based on data from 17 young adults, such that the authors themselves considered that there were limitations in generalizing the result to a broader age range.

Based on our results and on a review of the literature, we consider that goniometry is a reliable method. However, we believe that its use should be limited to analysis of the response to treatment, and we reaffirm that in such cases, all the measurements should be made by the same professional. With regard to detection of spinal diseases, we believe that new studies with other methods or with a greater number of volunteers should be carried out in order to elucidate this issue.

Regarding trunk extension values, we did not find any difference between the groups or athletes and non-athletes. Perhaps other studies might better define the behavior of this measurement among athletes, or perhaps there is a better method for measuring it. In an analysis on range of motion using an inclinometer, Saur et al[6] did not find any correlation with extension measurements made by means of radiology.

CONCLUSION

With regard to hamstring measurements, we agree with the literature in that we observed that there was a positive correlation between these measurements and those obtained using a goniometer in flexion. Furthermore, through noting that there is a difference between the groups of athletes and non-athletes regarding this measurement, our study suggests that hamstring measurements should be taken into consideration when considering athletes' range of motion in investigations on disorders. On the other hand, the popliteal angle measurements showed a correlation pattern differing from the other measurements between the groups of athletes and non-athletes, such that we suggest that new studies should try to elucidate this matter.

REFERÊNCIAS

1. Delfino A. Coluna lombar. In: Barros Filho TEP, Lech O. Exame físico em ortopedia. 2a ed. São Paulo: Sarvier; 2001. p. 50.

2. Thomas E, Silman AJ, Papageorgiou AC, Macfarlane GJ, Croft PR. Association between measures of spinal mobility and low back pain. An analysis of new attenders in primary care. Spine (Phila Pa 1976). 1998;23(3):343-7.

3. Mayer TG, Tencer AF, Kristoferson S, Mooney V. Use of noninvasive techniques for quantification of spinal range-of-motion in normal subjects and chronic low-back dysfunction patients. Spine (Phila Pa 1976). 1984;9(6):588-95.

4. Fitzgerald GK, Wynveen KJ, Rheault W, Rothschild B. Objective assessment with establishment of normal values for lumbar spinal range of motion. Phys Ther. 1983;63(11):1776-81.

5. Ensink FB, Saur PM, Frese K, Seeger D, Hildebrandt J. Lumbar range of motion: influence of time of day and individual factors on measurements. Spine (Phila Pa 1976). 1996;21(11):1339-43.

6. Saur PM, Ensink FB, Frese K, Seeger D, Hildebrandt J. Lumbar range of motion: reliability and validity of the inclinometer technique in the clinical measurement of trunk flexibility. Spine (Phila Pa 1976). 1996;21(11):1332-8.

7. Dvořák J, Panjabi MM, Chang DG, Theiler R, Grob D. Functional radiographic diagnosis of the lumbar spine. Flexion-extension and lateral bending. Spine (Phila Pa 1976). 1991;16(5):562-71.

8. Gajdosik RL, Albert CR, Mitman JJ. Influence of hamstring length on the standing position and flexion range of motion of the pelvic angle, lumbar angle, and thoracic angle. J Orthop Sports Phys Ther. 1994;20(4):213-9.

9. Boone DC, Azen SP, Lin CM, Spence C, Baron C, Lee L. Reliability of goniometric measurements. Phys Ther. 1978;58(11):1355-60.

10. Vieira ER. Análise da confiabilidade de equipamentos e métodos para medir o movimento de flexão anterior da coluna lombar[tese].São Carlos: Universidade Federal de São Carlos; 2002.

11. Mayerson NH, Milano RA. Goniometric measurement reliability in physical medicine. Arch Phys Med Rehabil. 1984;65(2):92-4.