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COMPARISON OF LUMBAR RANGE OF MOVEMENT AND LUMBAR LORDOSIS IN BACK PAIN PATIENTS AND MATCHED CONTROLS

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Inconclusive findings have been shown in previous studies comparing lumbar range of movement (LROM) and lumbar lordosis between back pain patients and healthy subjects. In these studies, confounding variables such as age, gender, height, obesity, and pain level were usually not well controlled. The present study aimed to compare LROM and lumbar lordosis between back pain patients and matched controls. Fifteen male back pain patients and 15 age-, height-, obesity-, and physical activity-matched male controls were investigated. To minimize the effect of pain on the measurements, only patients with minimal or no pain at the time of testing were included in the study. Inclinometer technique was used for the evaluation of LROM in flexion, extension and lateral flexion as well as lumbar lordosis. A lumbar rotameter was used for measuring axial rotation. Pelvic motion was limited by a pelvic restraint device during LROM measurements. Results showed that there were no significant differences between the back pain and control groups in flexion, extension, lateral flexion and axial rotation LROM and also in lumbar lordosis. This may indicate that when a back pain patient is not in pain, LROM and lumbar lordosis may not be the measures that distinguish between back pain patients and subjects without back pain.

Key words: low back pain, range of movement, lordosis, spine, inclinometer, impairment.

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INTRODUCTION

In clinical practice, examination of the range of movement (ROM) and lordosis for the lumbar spine are the two common physical examinations used to assess the low back functions of patients with back pain (1–3). This is probably based on the premise that there is a relationship between back pain and changes of ROM as well as posture of the lumbar spine. In addition, clinical observations also show that there are always some changes in spinal ROM and lumbar posture in back pain patients. It is considered that a knowledge of these changes would be useful in establishing the aetiology, prophylaxis and therapy for the back pain patients (4).

Controversies exist in the literature on the association between back pain and the changes of lumbar posture and spinal ROM. Some researches have reported that there is no difference in lumbar lordosis (e.g. 5, 6) and spinal ROM (e.g. 7) between back pain and control groups. In contrast, other studies found that there was an alternation in lumbar lordosis (e.g. 8) or a change in spinal ROM (e.g. 8, 9) in patients with back pain when compared with controls. The studies in the literature commonly include a control group but in some studies this group has not been age- or sex-matched. It has been established that spinal ROM would be affected by age (10–13), gender (11, 12), height (12, 14), and obesity (12). Similarly, lumbar lordosis was also found to be affected by age (13, 15) and gender (15).

Pain levels of back pain patients during ROM measurement are not mentioned in some previous studies. Severity of pain has been demonstrated to affect the degree of spinal ROM (4, 16–20). Magora (21) stated that it was difficult to measure the spinal ROM if the patient was in pain at the time of measurement. This observation is quite valid in the clinical situation. Mayer et al. (1) and Burton et al. (18) asserted that patients with current back pain may be reluctant to move their trunk to the end range because of the fear of increased pain. As such, measurement of spinal mobility without the effects of pain will probably reflect more the real mechanical functions of the spine (4, 16, 18, 19). In addition, occupational and leisure time demands on the back have been suggested as important contributory variables in investigating the relationship between back pain and spinal ROM (18). For this reason, it would be essential to select subjects with similar activity levels to ensure they are motivated to move and that similar demands are put on the spine as in daily activities.

The aim of the present study was to compare the lumbar ROM (LROM) and lumbar lordosis between back pain patients with age-, height-, and obesity-matched healthy subjects. To minimize the effect of acute pain on the measurements, only back pain patients with minimal or no pain at the time of the measurement were investigated.

METHODS

Subjects

Fifteen male back pain patients and 15 age-, height-, and obesity-matched male controls were recruited for this study. The controls were healthy subjects without any history of back pain. The age, height, and

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weight of the subjects were recorded. The body mass index (weight/height^2) which is an index to express the obesity of the subject was calculated. The questionnaire for measuring habitual physical activity (22) was administered to the subject. There were three indices in the questionnaire which represented the physical activity levels at work, sports and other activities during leisure-time.

For inclusion in the back pain group, the subjects were required to have back pain (a) of insidious or non-traumatic onset; (b) of at least 12 months duration; (c) of severity that required either treatment, sick leave or bed rest; and (d) of a nature that is either episodic with at least one episode of back pain each year or semi-continuous with periods of greater or lesser pain. Subjects were excluded if their pain was caused by neoplasm, infection, or neuromuscular disease, or if they had previous spinal surgery. No subjects with workers compensation were included in the present study. Compensation involvement of back pain patients has been shown to affect the pain and disability levels reported by the patients (23).

As it was important to avoid pain during the testing, only patients with minimal or no pain at the time of testing were recruited. The level of pain at the time of testing was recorded using a visual analogue scale (VAS) (24). The disability of the back pain patients was measured by the Roland-Morris Disability Questionnaire (25). The mean duration of back pain of the patient group was 6.1 ± 3.9 years (range 1.1–15.5), VAS score (maximum score 10) was 1.1 ± 0.7 (range 0–2.4), Roland-Morris Disability Questionnaire score (maximum score 24) was 2.4 ± 2.0 (range 0–7). The study was approved by the Medical Research Ethics Committee of The University of Queensland, and all subjects gave their written informed consent to participate.

Experimental procedure

The LROM in three planes and lumbar lordosis were measured in both back pain and control groups. Back pain patients were encouraged to move to their end range as far as the pain allowed. Reliability of the LROM and lumbar lordosis measurements adopted in the present study was found to be good (26). Before the measurement, all subjects were asked to do a warm-up procedure which involved movement of trunk flexion, extension, lateral flexion and axial rotation to both sides.

To limit the pelvic motion during LROM measurement, a custom-built pelvic restraint device was used in the present study. A metal frame was built with four poles around a wooden base on which the subject stood. The movement of the pelvis was restrained by two bars placing in front and behind. The bar in front was placed just below the anterior superior iliac spines and the bar behind was placed below the posterior superior iliac spines. The force of the fixation was adjusted without undue discomfort.

Flexion and extension. The inclinometer technique described by Mayer et al. (1) was adopted for measurements of the flexion and extension ROM of the lumbar spine. The advantage of the inclinometer technique is that both lumbar and pelvic movement during flexion and extension would be taken into consideration. The angle of the tangent at a particular point with regards to the vertical was recorded from the inclinometer. The subtraction of the measurement at the L5-S1 level (reflecting the pelvic movement) from the measurement of the T12-L1 level (reflecting the lumbar in addition to pelvic movement) gives the regional lumbar motion.

The subject stood inside the pelvic restraint device with the feet about shoulder width apart. The pelvis was restrained by the bars in front and behind. An inclinometer (BASELINE Gravity Inclinometer, Fabrication Enterprises, New York, USA) with two-point contact at its base was used in the present study. Subjects were first asked to stand in their usual, relaxed posture. The baseline inclinometer values were recorded at the T12-L1 and L5-S1 levels. Subjects were asked to bend forward and then backward to the end of their active range with maximal effort. The readings at the T12-L1 and L5-S1 levels were measured in the maximum flexed and extended positions.

Lateral flexion. A modified inclinometer apparatus, similar with that developed by Mellin (27) was designed in the present study to measure the lateral flexion of the lumbar spine. The apparatus included a base with two-point contact and a protractor on a joint. The inclinometer, which was positioned in coronal plane, was attached to the protractor. The hinged device was to accommodate the posterior incline of the T12-L1 level so that the inclinometer could be maintained in a vertical position. The vertical position was maintained by checking the spirit-level that attached at right angles to the inclinometer. The subject was then placed in the pelvic restraint device which controlled the pelvic movement as described in the previous section. The baseline measure of the inclinometer reading at the T12-L1 level was recorded. The subject was then requested to do the side bending of the trunk to both sides as far as possible without any noticeable flexion/extension and axial rotation. The reading at the T12-L1 level was again recorded from the inclinometer at the end range of lateral flexion.

Axial rotation. A lumbar rotameter devised by Twomey & Taylor (28) was used to measure regional lumbar axial rotation in the present study. A belt was attached around the trunk with the pointer at the level of T12-L1. The protractor was placed under the pointer with the base of the protractor aligned in parallel with the coronal plane. As in the flexion/extension and lateral flexion measurements described in previous sections, the subjects were positioned in standing with the pelvic restraint device which limited the pelvic rotation. With their arms positioned across their chest, subjects were asked to turn to the right and to the left sides to the end of their active range using a maximal effort. The axial rotation ROM was read from the deflection of the pointer on the protractor. The subject was corrected if there was observable flexion, extension or lateral flexion accompanied with the axial rotation movement.

Lumbar lordosis. Without the pelvic restraint device, the subject was asked to stand in a relaxed posture with the heels about shoulder width apart, hands hanging freely by the side and eyes looking forward. The lumbar lordosis was measured with inclinometer recordings recorded at T12-L1 and L5-S1 levels.

Statistical analysis

The means and standard deviations of LROM in three planes and lumbar lordosis of both back pain patients and matched controls were computed. Independent *t*-tests were performed to find any significant differences between the back pain and control groups. Statistical significance was set at the 5% level.

RESULTS

No significant differences of the demographic data and habitual physical activity data between the back pain patients and matched controls was found (Table I). The measurements of LROM in three planes and lumbar lordosis for back pain patients and matched controls were presented in Table II. There were no significant differences ($p > 0.05$) of all the measurements between the back pain and control groups.

DISCUSSION

Lumbar range of movement

In examination of the spinal ROM between subjects with back pain and controls, the results in the literature have been conflicting. Some of the previous studies have shown that in back pain patients there is a decrease in the range of flexion (1, 8, 11, 17, 18, 29–31), extension (1, 8, 17, 18, 29–33), lateral flexion (6, 8, 30, 31), and axial rotation (30, 32) when compared with a control group. In contrast, a few studies have shown that there is either no difference or even an increase in the range of flexion (6, 7, 32, 34, 35), extension (7, 9, 34), lateral flexion (7, 32), and axial rotation (9, 36) in subjects with back pain when compared with controls.

It is important to consider that in previous studies a large interindividual variation in LROM was found in both back pain

Table I. *Characteristics of back pain patients* (n = *15*) *and matched controls* (n = *15*). *Values shown are mean* ± *standard deviation with range in parenthesis*

	Back pain patients	Matched controls
Age (years)	27.9 ± 6.7 (20.0–37.0)	27.8 ± 5.9 (20.1–36.9)
Height (m)	1.78 ± 0.08 (1.54–1.87)	1.76 ± 0.07 (1.61–1.87)
Weight (kg)	74.4 ± 9.5 (50.5–85.0)	70.5 ± 9.0 (59.0–86.0)
Body mass index (kg/m^2)	23.4 ± 1.9 (19.1–25.9)	22.7 ± 2.0 (19.5–26.9)
*Habitual physical activity indices**		
Work	2.5 ± 0.5 (1.8–3.3)	2.3 ± 0.5 (1.8–3.4)
Sport	3.4 ± 1.0 (1.5–4.5)	2.8 ± 0.8 (1.5–4.5)
Leisure time	2.7 ± 0.7 (1.5–4.0)	2.9 ± 0.6 (2.0–3.8)

* The score varies between 1 and 5 with 5 representing the highest value.

Table II. *Comparison of lumbar range of movement (LROM) and lumbar lordosis between back pain patients* (n = *15*) *and matched controls* (n = *15*). *Values shown are mean* ± *standard deviation with range in parenthesis*

	Back pain patients	Matched controls	t*	p
Flexion	51° ± 13° (12°–64°)	50° ± 10° (28°–64°)	0.32	0.75
Extension	16° ± 7° (6°–30°)	19° ± 8° (6°–36°)	1.11	0.28
(R) Lateral flexion	29° ± 5° (22°–38°)	31° ± 6° (22°–44°)	1.06	0.30
(L) Lateral flexion	30° ± 6° (20°–44°)	31° ± 5° (22°–38°)	0.45	0.66
(R) Axial rotation	27° ± 7° (17°–40°)	30° ± 10° (17°–52°)	1.05	0.30
(L) Axial rotation	28° ± 6° (19°–38°)	31° ± 10° (17°–52°)	1.00	0.32
Lumbar lordosis	26° ± 9° (10°–44°)	25° ± 8° (12°–46°)	0.12	0.90

* Independent t-test, df = 28.

patients and controls. The use of LROM values to identify subjects with or without back pain may be prone to errors. In addition, a very small difference (e.g. 1° to 2°) in ROM between the subjects with and without back pain may be statistically different if large sample sizes were investigated. Such small changes of ROM values may not have any practical significance in the clinical testing (19).

The varied findings on the association between back pain and spinal ROM may be due to the following confounding variables which have not been fully controlled in previous studies:

(a) Back pain subjects are not age-, sex-, height-, or obesity-matched with controls.

(b) Pain levels of the back pain subjects are not taken into consideration at the time of measurement.

Pain at the time of the measurement in back pain patients has been shown to affect the degree of spinal ROM. Troup et al. (17), Burton et al. (18) and Battié et al. (19) found that spinal mobility of patients with current back pain was lesser than that of the back pain patients without pain at the time of measurement. Significant association between severity of back pain and degree of spinal ROM was also found (4, 16, 20). To avoid the effects of pain on joint movement, back pain patients without pain at the time of measurement were recruited in a previous study on spinal movement analysis (35). It is interesting to note that LROM in these back pain patients were not different with that found in subjects without back pain (35). Similar findings were also demonstrated in a roentgenographic study which compared the LROM of pain-free subjects with and without a history of back pain (7).

(c) Measurement techniques of the LROM are not standardized and in some studies the measurement are quite gross.

It is difficult to compare the results between different studies as different techniques have been used for measurement, for example, tape measure, flexible ruler, inclinometer etc. Low correlation in ROM findings between different techniques has been demonstrated and this may indicate that different component of ROM is measured by each technique (12). Some studies have adopted measurement technique which reflect movement of the whole spine and may not reflect the regional lumbar spine movement. For example, flexion of the lumbar spine has been measured by recording the fingertip to floor distance (8). This measurement may not totally reflect the ROM of the lumbar spine since it has not taken into account the ROM of other joints such as the hip joint and thoracic spine (37). It would be more reflective of lumbar problems if the ROM of lumbar spine was measured rather than the whole spine.

Our study found that there was no difference in LROM in three planes between back pain patients with the matched controls. There are difficulties in comparing our LROM findings with previous studies since there are differences in the degree of control for the above-mentioned confounding variables between the present study and previous studies. To have a valid measurement of the lumbar ROM, the confounding variables should be taken into consideration. The present study attempted to match the age, gender, height, and obesity between the back pain and control groups. Back pain was minimal during the measurement in our patients so as to minimize its effects on LROM. The ROM values measured during pain-free period would be a useful index of the impairment (joint stiffness) of the spine (16, 18). In addition, the method of measuring ROM in the present study is adapted from those studies which have shown that regional lumbar ROM could be measured. To further improve the measurement method, a pelvic restraint device was also used during the measurement.

The non-significant difference of spinal mobility between back pain patients and matched controls may also be due to the relatively similar active lifestyle adopted by back pain patients (as reflected by the habitual physical activity indices) which was comparable with the matched subjects in the present study. This may indicate that the motivation of the back pain patients in the present study may have been good. Poor motivation and non-optimal effort have been suggested as variables which can affect patient performance in ROM measurement (38).

The present investigation is a cross-sectional case–control study and could not reflect the ROM changes during the course of back pain. The ROM measurement during the pain episode would be useful in monitoring the progress of back pain. Serial measurements may reflect either recovery or progression of the back disorders. Usually, spinal ROM improves as the pain subsides (4, 39). It should be noted that the inclinometer and rotameter measurement are mainly static measures and may not demonstrate the changes in velocity and acceleration (40), in hip and spine movement pattern (35) that had been shown in back pain patients. In addition, there may be changes in mobility at the involved lumbar segments in back pain patients but these could not be detected by the measurement method in the present study. Norlander et al. (41) devised a non-invasive technique for measuring segmental flexion of cervico-thoracic spines and this may be applied to the lumbar spine.

Lumbar lordosis. We have found that there was no difference in degree of lordosis between the back pain patients and the matched controls. In the literature, some studies have demonstrated either an increase (3, 8, 21, 42) or a decrease (21, 29, 33, 42, 43) of lumbar lordosis in patients with back pain when compared with controls. However, a number of studies have found that no difference exists between back pain and control groups in lumbar lordosis for male subjects (5, 32, 44–46), female subjects (5) or in a group with male and female subjects included (6, 47). In an investigation of more than 3000 subjects in an aircraft company, Battié et al. (48) found that there was no association between changes in lordosis and previous history of back pain. It appears that the angle of lumbar lordosis may not be related to back pain.

Pain at the time of measurement of the posture may be a confounding variable. Magora (21) claimed that the decrease in lordosis is of more importance for it may indicate severe pain. More recent studies (20, 32) refute this assertion as their studies demonstrated that there was no association between degree of lordosis and severity of back pain.

Conclusion

To perform a valid study for comparison of LROM and lumbar lordosis between back pain patients and controls, variables such as age, gender, height, obesity, and pain level should be controlled. This study made an attempt to control most of the confounding variables in evaluating the spinal ROM predominantly at the lumbar spine. When a back pain patient is not in pain, LROM and lumbar lordosis may not be the measures that distinguish between back pain patients and subjects without back pain.

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