Original Article :

Movement sequence analysis of cephalocaudal and hip regions during various phases of selected daily activities

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Abstract

Background:

The previous studies conducted that the contribution of lumbar spine segment and hip motion during functional activities of daily livings, however, it is still unknown whether different spinal segment and hip motion occur in a specific sequence during functional tasks. The current study aimed to identify the movement sequence of cephalocaudal and hip regions while performing several dominant daily activities.

Methods:

Twelve male participants (mean age = 29.6 ± 4.2 years; weight = 73.4 ± 8.4 kg; height = 1.76 ± 0.08 meters) recruited in this study. Five Tri-axial accelerometer sensors used to collect data of a novel approach to understand the multi-cephalocaudal regions and hip movement sequences when performing several dominant daily activities.

Results:

Regional sequences during flexion and extension tasks at starting phase of movement illustrated (92%) of participants move their head cervical region first as well as object lifting (80%). first. Regional sequences during standing-to-sitting task at starting phase of movement found (70%) of participants move their lumbar region first, while (78%) of participants during sitting-to-standing task moved their hip first

Conclusion:

This study indicates variations of movement sequence of cephalocaudal and hip regions at different phase. While the head-cervical region moved first in starting phase of flexion, extension, and lifting task, hip region moved first in the end phase of flexion, extension, and standing-to-sitting task.

Keywords:

Words, Spine, Hip, Sequence, Movement, Cephalocaudal, Regions, Daily activities

الملخص

الخلفية:

أجريت الدراسات السابقة على مساهمة الجزء السفلي من العمود الفقري وحركة الورك أثناء الأنشطة الوظيفية للحياة اليومية، ومع ذلك، لا يزال من غير المعروف ما إذا كانت حركة العمود الفقري والورك مختلفة من جانب التسلسل في الحركة أثناء المهام الوظيفية. تهدف الدراسة الحالية إلى تحديد تسلسل حركة مناطق الرأس والعمود الفقري والورك أثناء أداء عدد من الأنشطة اليومية المعتادة.

طريقة البحث:

أجريت الدراسة على اثني عشر مشاركًا (متوسط العمر = ٢٩,٦ ± ٤,٢ سنة ؛ الوزن = ٧٣,٤ ± ٨,٤ كجم ؛ الطول = ١,٧٦ ± ٠,٠٨ متر)، وفي هذه الدراسة استخدمت تقنية جديدة وهي عبارة عن حساسات تقيس الحركة مع الوقت وهي ثلاثية المحاور التي جمع من خلالها بيانات عدد من مناطق الجسم حددت وعددها خمسة وبنهج جديد يقيس حركة المناطق وايها تحرك قبل الآخر عند أداء العديد من الأنشطة اليومية.

النتائج:

تم توضيح التسلسلات الإقليمية أثناء مهام الانثناء للأمام والثني للخلف في مرحلة بدء الحركة وكان (٩٢٪) من المشاركين يحركون منطقة الرأس والرقبة أولاً وكذلك رفع الأشياء، (٨٠٪) من المشاركين تحرك الرأس والعنق اولا. أثناء مهمة الجلوس في مرحلة بدء الحركة (٧٠٪) من المشاركين قاموا بتحريك منطقة أسفل الظهر أولاً، بينما قام (٧٨٪) من المشاركين أثناء مهمة الوقوف بتحريك الورك أولا.

الخلاصة:

تشير هذه الدراسة إلى اختلافات في تسلسل الحركة لمناطق الرأس والورك في مراحل مختلفة. بينما تحركت منطقة الرأس - والرقبة أولاً في مرحلة البدء لمهمة الانثناء للأمام، وثني الظهر للخلف، والرفع، وتحركت منطقة الورك أولاً في المرحلة النهائية من الثني للأمام، ثني الظهر للخلف ، ومهمة الوقوف إلى الجلوس.

Introduction:

Evaluations of hip and spine mobility is vital for the assessment of low back pain (LBP)[1]. There are various available methods used for the assessment of spinal and hip mobility. For instance, Modified-Schober Test has been validated to assess lumbar mobility during forward bending of spine[2]. Although this test is simple and easy to use, it is unable to detect different motions occurring at multiple spinal segments and hip. Previous studies identified a specific movement patterns at various spinal segments while performing functional and clinical movement [1,3–6]. Additionally, a relationship between specific movement patterns at different spinal segments and functional activities of daily living (ADLs) is not well established[7]. For example, sit-to-stand is a common functional activity that involve a specific movement patterns at hip and spine. Therefore, accurate knowledge of physiological movement of each spinal segment and hip region and the behavior of each regional movement is important.

Various functional tasks including lifting, sit-to-stand, flexion, and extension have been associated with LBP and spinal injury [8,9]. Spine and hip motions are connected during many daily tasks [10,11], indicating that any limitation in spine or hip motion will affect the performance of functional ADLs. In particular, sit-to-stand activities are commonest tasks performed daily by working people [12]. Previous studies have reported the quantitative relationship between the lumbar spine and hip motion during daily tasks [13–16]. However, they have considered lumbar spine as a single unit in their measurement. Consequently, other clinicians evaluated the contribution of multisegmented lumbar motion in patient population[17,18] and healthy adults [19,20].

Although previous studies reported the contribution of lumbar spine segment and hip motion during functional ADLS, it is still unknown whether different spinal segment and hip motion occur in a specific sequence during functional tasks. Therefore, the current study aimed to identify the movement sequence of cephalocaudal and hip regions during several dominant daily activities including flexion, extension, lifting, and standing-to-sitting tasks.

Methods:

Participants

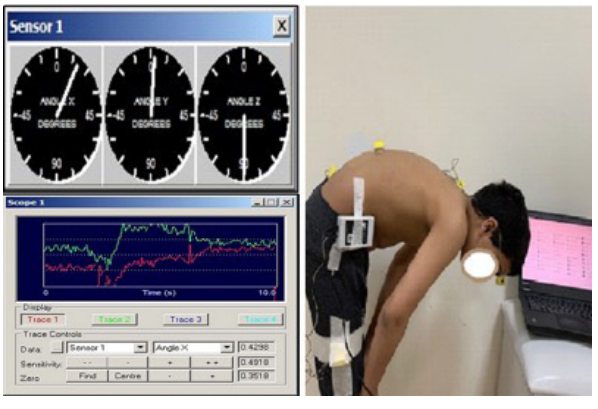
Twelve male participants (mean age = 29.6 ± 4.2 years; weight = 73.4 ± 8.4 kg; height = 1.76 ± 0.08 meters) were recruited. No participant had any history of cervical, thoracic, lumbar pain or not complain of radiated pain to the upper or lower extremities within the last one year. The Ethics

Committee of Najran University approved this study. All participants asked to complete a written informed consent form.

Instrumentation

FiveTri-axial accelerometer sensors used as described in the published study[3] to collect data of a novel approach to understand the multi-cephalocaudal regions and hip movement sequences when performing a number of dominant daily activities.

Figure 1: The dial display for sensor 1 and a "Scope" display showing two data traces on LT and schematic represents the location of three sensors on forehead and spinous processes of T1, T12, and S1 and on the lateral aspect of the thigh midway between the lateral epicondyle and greater trochanter on the iliotibial band (ITB) on RT.



Procedures

When participants attended the laboratory at Physiotherapy Clinic, Applied Medical Science, Collage, Najran University, they returned a signed consent form, which had been provided earlier. The participant should move to a private area to change their clothes and wear shorts. Each participant was instructed to perform forward, backward, rotations, and lateral flexions of head cervical and spine several times before placing the sensors on the body. The participants were asked to lean forward on the table (waist level) to determine the specific spinous processes. Five sensors were attached using double-sided adhesive tape on different parts of the body (e.g., forehead, spinous processes of first thoracic vertebra (T1), twelfth thoracic vertebra (T12), first sacral vertebra (S1), and middle point at lateral aspect of thigh). Four different anatomical regions of interest were created including Head-cervical (HC), Thoracic (T), Lumbar (L), and Hip (H) to quantify regional movement.

Data analysis

The data was analyzed using SPSS. Regional spinal movement time curves were generated and the values of HC, T, L, and Hip at the beginning, peak, and end movement were calculated. Descriptive statistics were reported. The percentage of participants who performed the task in a specific sequence were calculated: Percentage (%) = (number of participants who achieve task's phase/12 (Total number of subjects)) ×100.

RESULTS

Table1: The movement sequence of cephalocaudal and hip regions during various phases of selected daily activities

Regional movements	Subjects' percentage at start of flexion task (%)	Sequences	Subjects' percentage at peak of flexion task (%)	Sequences	Subjects' percentage at end of flexion task (%)	Sequences
Head-cervical region	92	1	60	1	55	3
Thoracic region	70	2	60	1	62	2
Lumbar region	70	2	52	2	72	1
Hip region	62	3	52	2	72	1
	Subjects' percentage at start of extension task (%)	Sequences	Subjects' percentage at peak of extension task (%)	Sequences	Subjects' percentage at end of extension task (%)	Sequences
Head-cervical region	92	1	62	2	45	4
Thoracic region	60	3	62	2	62	2
Lumbar region	72	2	75	1	53	3
Hip region	60	3	75	1	70	1
	Subjects' percentage at start of object lifting task (%)	Sequences	Subjects' percentage at peak of object lifting task (%)	Sequences	Subjects' percentage at end of object lifting task (%)	Sequences
Head-cervical region	80	1	60	2	70	1
Thoracic region	60	2	60	2	70	1
Lumbar region	50	3	70	1	60	2
Hip region	60	2	60	2	60	2
		Sequences		Sequences		Sequences
	Subjects' percentage at start of standing-to sitting task (%)		Subjects' percentage at peak of standing to-sitting task (%)		Subjects' percentage at end of standingto-sitting task (%)	
Head-cervical region	64	2	60	1	50	2
Thoracic region	64	2	60	1	60	1
Lumbar region	70	1	60	1	50	2
Hip region	64	2	60	1	60	1

	Subjects' percentage at start of sitting-to standing task (%)	Sequences	Subjects' percentage at peak of sitting-to standing task (%)	Sequences	Subjects' percentage at end of sitting-to standing task (%)	Sequences
Head-cervical region	54	3	70	3	90	1
Thoracic region	54	3	70	3	67	2
Lumbar region	65	2	80	2	67	2
Hip region	78	1	88	1	67	2

%= (number of subjects who achieve task's phase/12 (Total number of subjects)) ×100

1= Segment which move firstly, 2= Segment which move secondly, 3= Segment which move thirdly 4= the last segment which move

Table 1 details the results. During flexion task, while the regional sequences at starting phase showed that the most of the participants moved head cervical region (92%) first followed by thoracic and lumbar (70%) together, and hip (62%) regions, the hip and lumbar regions (70% each) moved at the same time followed by thoracic (62%), and head-cervical (55%) regions at the end phase ((Figure 2, Figure 4). Whereas, the regional sequences at peak phase showed head-cervical and thoracic regions (60%) moved at the same time, followed by lumbar and hip regions (52%), those moved at the same time ((Figure 3).

Figure 2: The movement sequence of cephalocaudal and hip regions by percentage at start of flexion,

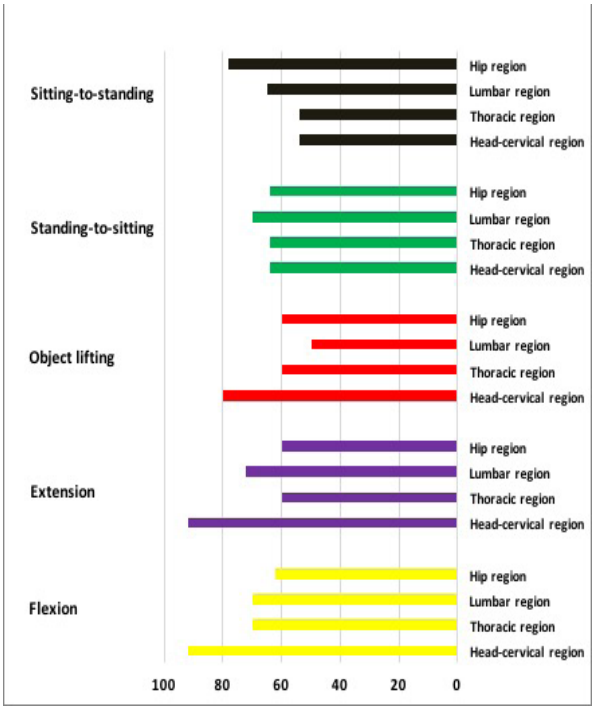


Figure 3: The movement sequence of cephalocaudal and hip regions by percentage at peak of flexion, extension, object lifting, standing to sitting and sitting to standing tasks

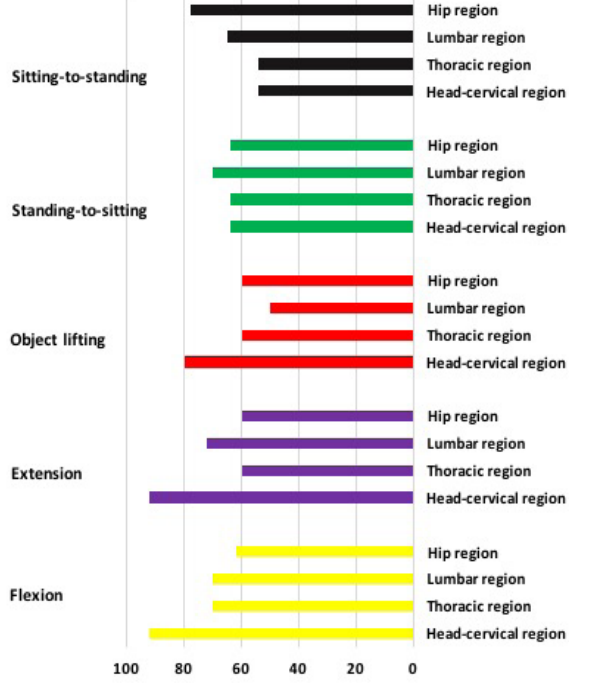
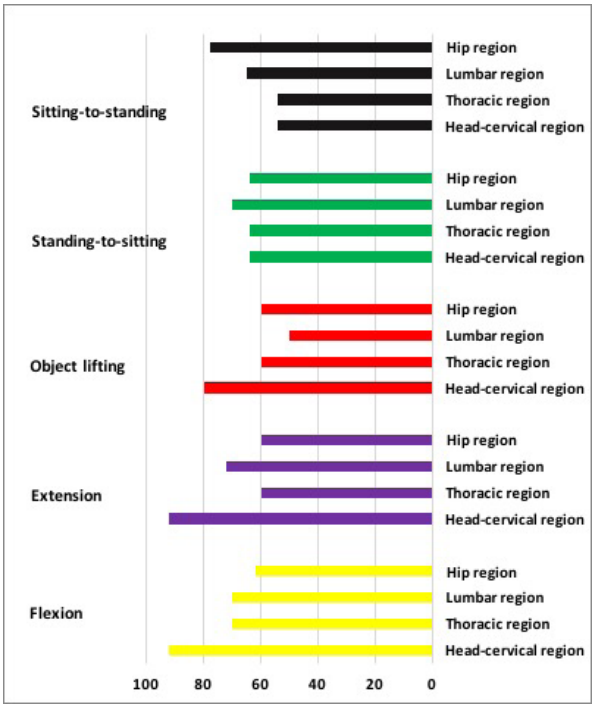


Figure 4: The movement sequence of cephalocaudal and hip regions by percentage at end of flexion, extension, object lifting, standing to sitting and sitting to standing tasks



Discussion

This study aimed to identify the movement sequence of cephalocaudal and hip regions during several dominant daily activities including flexion, extension, lifting, standing-to-sitting and sitting-to-standing tasks. The results of the current study identify distinguished temporal changes in the movement sequence of cephalocaudal and hip regions during several dominant daily activities. For instance, head-cervical region moved first at the starting phase of flexion, extension, and lifting task. Whereas, the lumbar and hip regions moved first at the starting phase of standing-to-sitting and sitting-to-standing task, respectively. However, in the peak phase, head-cervical and thoracic regions moved first during flexion task, while lumbar and hip regions moved first during extension task. While lumbar and hip regions moved first at the peak phase of lifting task and sitting-to-standing task, respectively, all the regions moved together at the peak phase of standing-to-sitting- task. In contrast, in the end phase of flexion and extension, hip and lumbar regions and hip region moved first, respectively. Whereas, head-cervical and thoracic regions and hip and thoracic regions moved first in the end phase of lifting and standing-to-sitting task, respectively. The head-cervical region moved first in the end phase of sitting-to-standing task.

Although previous studies were more focused on the assessment of range of motion, LBP may be associated with impaired movement sequence at cephalocaudal and hip regions[21,22].There were conflicting studies indicating the pattern and contribution of spine and hip motion between healthy adults and LBP patients. For instance, in healthy adults, lumbar spine dominates the movement in initial phase while hip motion dominates peak and terminal phase during spinal flexion motion[13,23,24]. Similarly, in the current study, the head-cervical region dominates the starting phase, while head-cervical and thoracic regions equally dominate the peak phase and hip and lum-

bar region dominates the end phase of spinal flexion. Previous studies also reported greater contribution of spine in the early phase of flexion task while hip region contributed more than spine at the terminal phase of flexion task [13,14].

However, there are some methodological differences exist in the previous studies in the measurement of movement sequence. While previous studies limited to lumbar and hip motions, the current study included movement sequence of cervical, thoracic, lumbar, and hip regions. In addition, the current study used several dominant daily activities such as flexion, extension, lifting, and standing-to-sitting and sitting-to-standing tasks to measure movement sequence of cephalocaudal and hip regions. No previous studies have investigated the movement sequence of cephalocaudal and hip regions during these tasks.

Limitation

The current study has potential limitations. First, the sample size was small, including only 12 subjects. Second, since all participants were male, the results cannot be generalized to female population. Third, other factors such as spine length, leg length, and pelvic angulation might affect the pattern of movement sequence during these tasks. Furthermore, the study participants were all healthy university staffs and students, therefore, the sample population may not be truly representative of all groups of young males.

Conclusion

This study indicates variations of movement sequence of cephalocaudal and hip regions at different phases of dominant daily activities. While the head-cervical region moved first in the starting phase of flexion, extension, and lifting task; the hip region moved first in the end phase of flexion, extension, and standing-to-sitting task. Such findings will add new information for clinicians and physiotherapist during spinal assessment.

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