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Original research article

Erector Spinae Muscle Activity during Lifted People with Two Persons in Lifting Phase of Manual Human Handling (MHH)

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ABSTRACT

The objective of this study was to determine the activity of erector spinae muscle in four techniques of lifting phase of manual human handling; two-handed seat carry, four-handed seat carry, fore-and-aft carry and chair carry. Thirty-two (16 couples) healthy young men lifted subjects weighing 60±5 kg from table heights of 50 cm and 100 cm. Surface electromyography was used to evaluate lumbar erector spinae activity during lifting. The four-handed seat carry technique had the highest average of lumbar erector spinae activity both from table height 50 cm and 100 cm. This may be due to more trunk flexion movement than in other techniques. The lowest activity of lumbar erector spinae was found in fore-and-aft carry and chair carry techniques. Moreover, lifting from table height 50 cm had more lumbar erector spinae muscle activity than lifting from table height 100 cm in 3 techniques (two-handed seat carry, four-handed seat carry and fore-and-aft carry). The highest activity of lumbar erector spinae muscle in the four-handed seat carry technique indicated risk of low back pain during lifting, especially lifting people from a table height of 50 cm. Lower lumbar erector spinae muscle activity in fore-and-aft carry and chair carry techniques indicated safer they are safer techniques for lifting.

Keywords: EMG; Erector spinae; Lifting; Manual human handling; Postures

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1. Introduction

Low back pain is one of musculoskeletal disorder problems found in health care professionals, especially nurses or rescuers whose work involves lifting patients [1, 2]. During lifting, exertions require trunk muscle activity; engage the erector spinae muscle, and has influence on spinal loads. High exertions indicate risk of musculoskeletal injury. The prediction of spinal loads in many biomechanics models needs to measure erector spinae muscle activity [3, 4]. The recommendations for lifting technique are to avoid awkward postures, especially in extreme lumbar vertebral flexion (approximately 60^{o}), rotation and lateral flexion during lifting [5]. There are many manual human handling techniques for lifting people. But there is still no study about muscle activity during lifting in each technique and has a low risk of musculoskeletal injury. The objective of this study was to determine the activity of erector spinae muscle in the lifting phase of manual human handling.

2. Materials and Methods

2.1 Subjects

The subjects of this study were thirty-two healthy young men (16 couples), between 18-23 years old, with no musculoskeletal problems. Height differences between participants in each couple was not more than 5 cm. A general health information questionnaire and physical fitness tests: push up, flexibility (sit and reach), grip strength, leg strength and step test, were obtained before starting the experiment. This study was approved by the Thammasat University Human Research Ethics Sub-committee (Second group) and informed consent forms were signed by all subjects.

2.2 Procedure

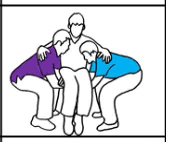
Participants in each couple lifted people weighing 60±5 kg from a table height of 50 cm with four techniques: two-handed seat carry, four-handed seat carry, fore-and-aft carry and chair carry (table 1). They lifted one time for each technique and rested 3-5 minutes between techniques. After that they were asked to lift people from table height 100 cm with three techniques: two-handed seat carry, four-handed seat carry and fore-and-aft carry with back erect posture.

2.3 Instrumentation and data processing

Lumbar erector spinae muscle was monitored bilaterally on both participants while lifting. Skin p was prepared by rubbing with a skin abrasive and using alcohol swabs before attaching electrodes. Working electrodes (Ambu Blue Sensor) were connected to the targeted muscles (3 cm lateral to L3 spinous process area in the lower back) at an inter electrode distance of 2 cm [6]. The bi-polar electrodes were connected parallel to an 8 channelled NORAXON TeleMyo 2400T G2 surface electromyography device. Right iliac crest was used to be a position for reference electrode.

The data was processed by using MyoResearch-XP 1.07 software. The EMG signals were band passed filtered at 1000 Hz. The EMG signal in each participant was normalized by the Maximum Voluntary Contraction (MVC). For MVC preparing, participants were asked to lie prone and exert their maximal voluntary contraction (MVC) trunk extension with counter-resistance applied to the upper thoracic area in the direction of trunk flexion for 5 seconds. Data were computed 3 times and used signal during a middle 3 second period of the hold position [7, 8]. An EMG signal for lifting was collected (from lifting until buttock left from table), calculated mean of muscle activity in v unit, and normalized data to %MVC of each couple in each technique. The Shapiro-Wilk test was used to test data normality. Non-parametric tests (Friedman test and Wilcoxon signed-rank test) were used to determine differences among lifting techniques. The significant level was set at 0.05.

Table 1. The description of participants postures with four manual human lifting techniques

Techniques	Postures	pictures
Two-handed seat carry	One hand support under thigh, for the other one support back of patient so caught with other participant and lifted with back erect.	
Four-handed seat carry	One hand hold with one hand at elbow already caught with other participant and lifted with back erect.	
Fore-and-Aft carry	One participant stood front of and facing the opposite with patient caught knee joints. The other one stood behind and embraced under armpits already lifted with back erect.	
Chair carry	One participant stood front of and face to face with patient caught seat of chair. The other one stood behind and caught backrest of chair already lifted with back erect.	

3. Results and Discussion

3.1 Result

Fig. 1-3 shows %MVC of lumbar erector spinae muscle activity during lifting in 4 techniques: two-handed seat carry, four-handed seat carry, fore-and-aft carry and chair carry. The significant differences between 4 techniques were observed while lifting people from a table height of 50 cm (Fig. 1.). The four-handed seat carry technique had the highest average %MVC of erector spinae muscle activity, while fore-and-aft carry and chair carry had the lowest muscle activity. For the table height of100 cm, significant differences were found between 3 techniques: two-handed seat carry, four-handed seat carry and fore-and-aft carry (Fig. 2.). Four-handed seat carry still had the highest average %MVC of erector spinae muscle activity. Moreover, %MVC of lumbar erector spinae muscle activity while lifting people from a table height of 50 cm was higher significantly than when lifting people from a table height of 100 cm in all 3 techniques (Fig. 3.).

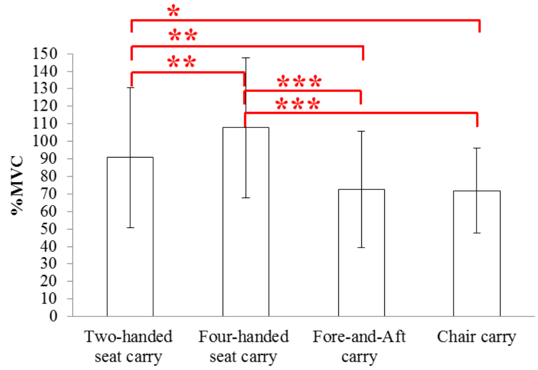


Fig. 1. Average electromyography of erector spinae muscle activity while lifting people from table height 50 cm with 4 techniques.
**p<0.05, **p<0.01, ***p<0.001*

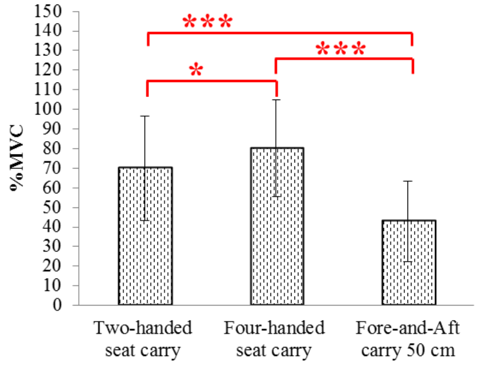


Fig. 2. Average electromyography of erector spinae muscle activity while lifting people from table height 100 cm with 3 techniques.
**p<0.05, **p<0.01, ***p<0.001*

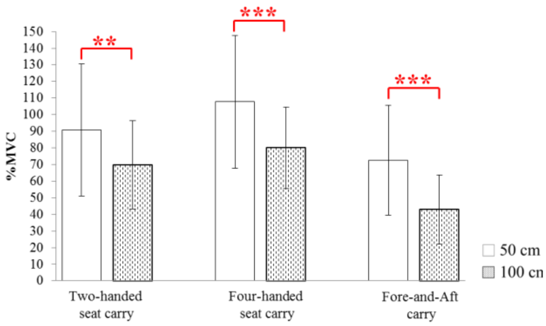


Fig. 3. Compare average electromyography of erector spinae muscle of participants between lifting people from table height 50 cm and 100 cm. *$*p<0.05$, $**p<0.01$, $***p<0.001$*

3.2 Discussion

The erector spinae is the back muscle that protects the spine during manual handling especially in repetitive lifting [9]. The purpose of the current study was to determine the activity of the lumbar erector spinae muscle in the lifting phase of manual human handling with four techniques. The four-handed seat carry technique had the highest lumbar erector spinae muscle activity in the lifting phase when compared to other techniques in both 50 cm and 100 cm. This may be due to the four-handed seat carry requiring more trunk flexion than other techniques (almost full flexion), and needing the highest erector spinae muscle tension [10]. Lifting people from a table height of 50 cm had more lumbar erector spinae muscle activity than lifting from a table height of 100 cm [11] in all techniques. Lifting in lower level required more trunk flexion than in the higher level. Fore-and-aft carry and chair carry techniques had the lowest muscle activity and seem to be safer than other techniques.

In addition, lifting from low level (50 cm) had greater risk of lower back injury than lifting from a table height of 100 cm due to more lumbar erector spinae muscle activity. Increased muscle activity leads to muscle fatigue [12] and pain. Repetitive lifting with trunk flexion may cause injury to the lumbar erector spinae muscle. Increased lumbar muscle strengthening, avoiding posture that require more trunk flexion, and lifting from the low level should be concerns of lifters.

The participants in this study were healthy young men and lifted only one time with an average weight of 30-33 kg. The results cannot be generalized to use for all ages. The repetition of lifting with weak muscle may cause injury to lower back [13]. This study only concerns muscle activity, not other aspects; such as psychophysical responses or comfort during lifting.

4. Conclusion

The study showed that manual human handling especially in lifting phase with four-handed seat carry technique had more lumbar erector spinae muscle activity than other techniques both at 50 cm and 100 cm height, while fore-and-aft carry technique and chair carry had the lowest muscle activity. However, lifting from lower height (50 cm) had a higher risk of causing low back pain.

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