

The Effect of back muscle strengthening on the quality of chest compressions during cardiopulmonary resuscitation

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Abstract

In this paper, the researcher investigated whether strengthening the back muscles affects the quality of chest compressions during cardiopulmonary resuscitation by university students. A total of 50 students majoring in healthcare were included from September 2018 to November. The participants performed chest compressions during cardiopulmonary resuscitation (CPR) for 2 min after back muscle strength was measured. Then, after adequate rest, the participants repeated the back muscle strength measurements and chest compressions after taping the erector spinae muscle. The paired t-test was performed to analyze changes in chest compression quality after taping. As results, taping enhanced back muscle strength and positively affected the depth of chest compressions and the compression to recoil ratio. Taping also increased confidence and lowered fatigability during chest compressions, so the participants preferred being taped while performing chest compressions. Based on these results, taping could help emergency room medical personnel specialized in CPR to enhance the quality of CPR and relieve back pain and fatigability by strengthening the back muscles.

▶ Keyword: Back muscle strength, Cardiac arrest, Cardiopulmonary resuscitation, Chest compression, Taping

1. Introduction

Cardiopulmonary resuscitation (CPR) is a method used to rescue patients who have undergone cardiac arrest [1] and the most important procedure while performing CPR is high-quality chest compressions [2]. The significance of chest compressions has been emphasized, and chest compressions even without breathing during CPR has been announced to the public [3,4]. For the high-quality compression, rescuers should perform chest compressions at a rate of at least 100 compressions/min, compress the sternum at least 50 mm, and change rescuers every 2 min because of rescuer's fatigue [5,6].

A rescuer that is to perform chest compressions kneels next to the person, places the heel of one hand on the compression site, stacks the other hand on top of the one

in parallel, and uses both hands to compress the chest with full extension of the elbows [2,6].

The rescuer does not lift their hands off the compression site, the duration of the compression phase should be equivalent to the duration of the decompression phase [7], and an up-and-down movement of the hip joint carrying the weight of the upper extremities should be applied to maintain appropriate long-term chest compressions [6,8]. Chest compressions consist of isotonic exercises in which the back is flexed and extended and isometric exercises in which the arms, leg, and back muscles are contracted continuously [2,6]. The hip joint is engaged, which may be associated with back muscle strength. Back muscles have significant roles as

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core muscles, maintenance of posture, and protection of the spine [2,6,9]. The most common symptom during chest compressions in CPR is back pain [9]. This study hypothesized that stronger back muscles would reduce back pain, protect the spine, help to keep the appropriate compression posture, and help to maintain longer high-quality compressions. Applying tape to the erector spinae muscle strengthens the back muscles by affecting muscle mobilization [10]. Thus, taping may help protect the spine, reduce pain, and allow the rescuer to maintain long-term high-quality chest compressions during CPR. Previous studies have revealed that subjects with stronger back muscles achieve larger mean compression depth during 2 min of chest compressions [2,6]. Therefore, the present study investigated the effect of taping the erector spinae on the quality of chest compressions.

II. Methodology

1. Participants and data collection

Among freshman majoring in healthcare at N University, 50 participants were included from September to November 2018 after providing informed consent. Their back muscle strength was measured and the quality of chest compressions was analyzed during CPR.

2. Measurements

2.1 General characteristics

Age, height, weight, and education experience with CPR were recorded.

2.2 Back muscle strength

A digital back muscle dynamometer (TKK-5402, Takei, Scientific Instruments Co., Ltd., Nigata, Japan) was applied to measure back muscle strength: the participants adjusted the length of the chain according to their height, bent forward slightly, grasped the center of the bar, and perpendicularly lifted it as high as possible while keeping their legs straight and their feet parallel and flat on the base of the dynamometer [2,6,10]. They were informed about precautions and repeated the test twice. The highest score by each participant was recorded (kg). The quality of chest compressions was assessed to measure back muscle strength. After one day of rest, the back

muscle strength measurements and quality of CPR were repeated after a Professor of physical therapy applied tape to the erector spine.

2.3 Back muscle strength

The tape used in this study (Kinesio, Nitto Denko Corporation, Japan) is shown in Figure 1. Figure 2 shows the taping method used in this study. The tape was applied to the center of the erector spinae after stretching it to the length of ultimate tensile strength.



Fig. 1. Taping used(Kinesio)



Fig. 2. Taping method

2.4 Quality of chest compression during CPR

The A training manikin (Resusci Anne SkillReporter™, Laerdal, Norway) was used to analyze the quality of 2-min chest compressions during CPR, and three measurements (compression depth, compression rate, and the compression to recoil ratio) were collected. The quality of the chest compressions was assessed before and after taping with a 1-day interval.

2.5 Effect of taping on confidence, easiness, and fatigability during chest compressions

A visual analog scale (VAS; scores, 1-10) was administered to evaluate subjective confidence, fatigability, and easiness after 2-min of chest compressions before and after taping. "No confidence" was 1 and "full of confidence" was 10. "Very

Table 3. Effect of taping on compression quality

Characteristics	Before	After	<i>t</i>	<i>p</i>
Chest Compression rate, min	118.10±5.09	110.18±7.20	5.92	<0.001
Mean depth, mm	44.16±4.78	49.98±3.56	-12.01	<0.001
Chest Compression vs. Relaxation Ratio	0.73±0.78	0.81±0.07	-4.58	<0.001

hard” was 1 and “very easy” was 10. “Very fatigued” was 1 and “no fatigue” was 10.

2.6 Taping preference

The participants evaluated their preference for having back muscle tape applied prior to the chest compressions.

3. Data analysis

The data were analyzed by SPSS Statistics 21.0. Age, height, weight, experience with CPR training, and taping preference are presented as mean and standard deviation. The paired t-test was performed to compare the quality of chest compressions, confidence, easiness, and fatigability before and after taping. A p-value < 0.05 was considered significant.

III. Results

1. General characteristics of subjects

Mean age was 20.32 ± 0.86 years, mean height was 172.0 ± 7.14 cm, and mean weight was 62.53 ± 11.44 kg. All participants had undergone CPR training [Table 1].

Table 1. General characteristics of the subjects

Characteristics	N(%) / M±SD
Age(year)	20.32±0.86
Height(cm)	172.58±7.14
Weight(kg)	62.53±11.44
Education CPR	50(100.0)

2. Effect of taping on back muscle strength

Back muscle strength was significantly higher (106.76 ± 22.49) after taping than before taping (96.65 ± 23.12, p<.001)[Table 2].

Table 2. Effect of taping on back muscle strength

	Before	After	<i>t</i>	<i>p</i>
Back muscle strength	96.65 ±23.12	106.76 ±22.49	-23.787	<0.001

3. Effect of taping on compression quality

Mean compression depth without taping was 44.16 ± 4.78 mm, whereas that with taping was significantly deeper (49.98 ± 3.56, p < 0.001). Mean compression rate without taping was 118.10 ± 5.09/min, and that with taping was significantly slower (110.18 ± 7.20, p < 0.001). The compression to recoil ratio before taping was 0.73 ± 0.78, and that after taping was 0.81 ± 0.07 (p < 0.001)[Table 3].

4. Effect of taping on confidence, easiness and fatigability from chest compressions

Confidence without taping was 5.50 ± 1.31 out of 10 on the VAS, and that with taping was significantly higher (7.28 ± 1.40, p < 0.001). Ease of performing the procedure without taping was 5.80 ± 1.24, whereas and that with taping was 5.60 ± 1.41 (p > 0.05). Fatigability without taping was 7.46 ± 1.43 and that without taping was significantly lower (5.12 ± 1.40, p < 0.001)[Table 4].

Table 4. Effect of taping on confidence, easiness and fatigability from chest compressions

Characteristics	Before	After	<i>t</i>	<i>p</i>
Confidence	5.50 ±1.31	7.28 ±1.40	-7.958	<0.001
Easiness	5.80 ±1.24	5.60 ±1.41	1.257	0.215
Fatigability	7.46 ±1.43	5.12 ±1.40	9.482	<0.001

5. Taping preference

Confidence Nineteen participants preferred performing chest compressions without taping (38.0%) and the other 31 participants preferred chest compressions with taping (62.0%)[Table 5].

Table 5. Taping preference

Characteristics	Before	After
Preference	19(38.0%)	31(62.0%)

IV. Discussion

CPR is the most important procedure used to rescue patients who have suffered cardiac arrest, and chest compressions are the most important aspect of CPR [1,2]. Proper chest compressions require physical power and effort [2,6]. This study tried to enhance back muscle strength by taping and analyzed the effect

of taping on chest compressions. Back muscle strength was significantly higher with taping than that without taping, suggesting that the skin stimulation of taping increased muscular activity, regulated electromagnetic flow [10], or stimulated muscle tissue under the skin and visceral organs to affect muscular strength. Therefore, taping the erector spinae may mobilize the muscle [11]

and strengthen it. This study revealed that taping affected chest compression quality, as mean compression depth was significantly deeper with than that without taping. Taping the erector spinae may have strengthened the back muscles used in isotonic exercise during chest compressions and enhanced muscle endurance [6,11], which allowed long-term high-quality chest compressions. Taping could also reduce back pain during compressions and help the subject maintain a stable posture [2,6,9], which could increase the depth of compressions. Although mean compression rate was higher with taping than that without taping participants achieved rates of 100–120/min, under both conditions, which is the recommended rate according to the K of Cardiopulmonary Resuscitation [12]. The compression to recoil ratio was significantly higher with taping than that without taping, which contrasted with previous studies [2,6]. Taping may have enhanced recovery to the first position after deep compression. The VAS score for confidence in performing chest compressions during CPR was significantly higher with taping than that without taping, whereas the fatigability score was significantly lower with taping than that without taping. Taping the back muscles can reduce back pain during chest compressions [9,10] and help maintain a stable position for a longer time [2,6,13], which may have increased confidence and lowered fatigability. Overall, the majority of the participants preferred performing chest compressions (31 participants, 62%) after being taped than without. Some limitations of this study should be mentioned. First, the results were difficult to generalize because the participant pool was too restricted(only one university). Second, this study did

not evaluate basic physical strength affecting back muscle strength, which would change the compression to recoil ratio. Third, other factors affecting chest compression quality (such as rescuer position, posture, and distance from the patient) were not investigated, which could restrict the effect of strengthening the back muscles. However, this study was significant because it investigated the effect of back muscle strength, which has not been considered during CPR and revealed an association with chest compression quality.

V. Conclusions

Strengthening the back muscles with taping significantly affected compression depth and the compression to recoil ratio. Furthermore, taping elevated confidence and lowered fatigability during chest compressions. Overall, the majority of participants preferred taping while performing chest compressions. Further studies are needed to resolve the limitations of this and other previous studies and reveal the relationship between back muscle strength and other factors affecting chest compression quality in CPR rescuers.

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