

# The Effect of Clavicle Support on Myoelectric Activity of Axioscapular Muscles During Computer Typing<sup>\*</sup>

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## Abstract

In the current office environment, office personnel are using computers for long periods of time on a daily basis. Consequently, there have been increased reports of work-related neck and upper limb musculoskeletal disorders and tension neck syndrome, which affect countless office workers who use computers, which is also the leading cause of occupational illnesses. In rehabilitation treatment, clavicle support that involves the use of elastic material is prescribed to exert corrective pulling forces at the upper back and stabilise the clavicle and shoulder movements. This study therefore aims to evaluate the effect of clavicle support on the myoelectric activity of the axioscapular group of muscles, including the Anterior Deltoid (AD), Upper Trapezius (UT), Middle Trapezius (MT), and Lower Trapezius (LT) in young women who experience chronic neck and shoulder pain during computer use. The results indicate that there is an overall significant difference in the percentage of maximum voluntary electrical activation (MVE%) of the axioscapular group of muscles between the use and absence of clavicle support ( $t = -2.982$ ,  $p = 0.005 < 0.05$ ). Amongst the four types of muscles studied, the use of clavicle support has significant effects on the MT and UT muscles. The results is important to improve our understanding of clavicle support in association with muscle activity, thereby providing the basis for prescribing suitable rehabilitation treatment and intervention devices in the workplace for the reduction of musculoskeletal disorders.

*Keywords:* Clavicle Support; Axioscapular Muscles; Myoelectric Activity

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## 1 Introduction

Today, it is considered normal worldwide for people to use computers for longer periods of time on a daily basis due to increased computer-based tasks at work and as leisure activities. As a negative consequence of computer use, neck and shoulder disorders are now common problems amongst office workers, especially those who are extensive computer users due to constant muscle fatigue. The symptoms include pain, tenderness, fatigue and stiffness in the neck and shoulder

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musculature, and headaches that contribute to demand for medical services as well as the economic cost of absence from work due to the pain [1, 2]. Moreover, the etiology of work related neck and shoulder disorders are multidimensional, associated and influenced by a complex array of individual, physical and psychosocial factors. Prolonged sitting tasks and poor posture or those who sit in a slumped position at a computer may lead to abnormal patterns of trapezius muscle behaviour, fatigue of the lumbar extensor muscles, as well as tightening and shortening of pectoral muscles [3, 4]. In addition, a habitual slouched posture leads to, or is brought on by, a rounded shoulder posture, which over time, fixes the shoulders into a forward position. The rounded shoulder posture is associated with the forward head posture and therefore, results in an increased anterior tilt of the scapula, upward scapular rotation, and retraction during elevation of the arm. Such a change in the axioscapular group of muscles may contribute to more severe neck pain due to mechanical stresses on pain sensitive cervicobrachial structures. During clinical examinations, palpable hardening areas, tender spots and spasms may be found in the trapezius or sternocleidomastoid muscles which are frequently associated with pain on the resistant side of the neck accompanied by a decreased range of flexion, extension, or rotation of the neck [5, 6].

In traditional physical rehabilitation treatment, restoration of a shortened pectoralis minor to its normal length by means of stretching exercises and/or simple therapeutic elastic style of support is generally adopted. Stretching exercises and soft tissue mobilization are very useful in correcting rounded shoulder posture as they assist in relieving pectoralis minor tightness [7, 8]. Therapeutic elastic support such as kinesiology taping is increasingly used to relieve pain, enhance muscle activity, and even offer immediate correction of shoulder misalignments [9]. As compared to other posture correcting devices, the adhesive tape is thin, light in weight, easy-to-use and disposable. However, the application of adhesive tape might cause skin irritation in some patients. For long term user of tape, it may result in large amount of disposable taping. Its effects on correction of rounded shoulder posture are greatly affected by the taping techniques and control of taping stretchability which is subjectively prescribed by the practitioners in each attempt of tape application. Han et al. [9] showed that kinesiology taping with stretch significantly increased the pectoralis minor length, the supine measurement of rounded shoulder posture, and the total scapular distance. Kinesiology taping without stretch, however, has no significant impact on the pectoralis minor, shoulder posture and/or scapular. For shoulder disorders patients with adhesive tapes being aligned on the back, taping might not be a feasible treatment for daily or prolonged use.

More recently, a clavicle support (in the form of a postural strap/shoulder brace) that involves the use of elastic material is may also be prescribed to stabilise the clavicle and shoulder movements which may relieve the intense pain and muscle tension of the neck and shoulder regions. As shown in Fig. 1, this is an ergonomic device which typically features two straps that go over the shoulders, thus forming an “x” in the back that prevents muscle strain in the neck, back and shoulders, restores the resting position of the scapula and maintains the proximal shoulder girdle stability necessary to elevate the arms [10-13]. A pair of wide elastic bands may also be placed at the center back so that tension is exerted which can maintain the body in an upright posture. When the clavicle support is worn, it helps to pull the shoulders back, open up the chest, and straighten the thoracic spine by controlling the length (and the corresponding pulling force) of the elastic bands. As indicated by Cole et al. [14], the application of therapeutic scapular bracing helps to reduce the forward shoulder angle and strengthen shoulder instability. Previous study has also shown the effect of kinesiology taping on the immediate correction of rounded shoulder posture [9]. As compared to kinesiology taping, a clavicle support is more durable and ready to

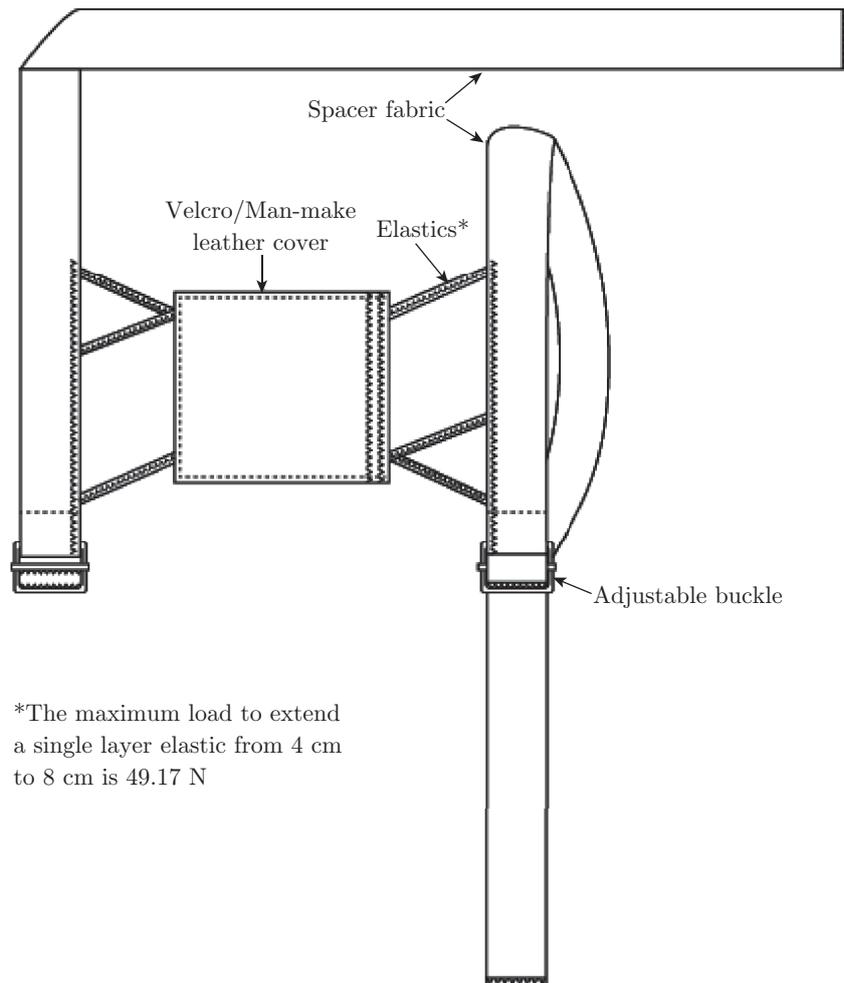


Fig. 1: Schematic diagram of a clavicle support as sourced from a local registered physiotherapist

use once the length of the wide elastic bands is controlled and fixed in the rehabilitation treatment. During the course of treatment, suitable adjustments can also be made on the basis of the treatment efficacy and effectiveness. However, up to now, very few studies exist on the effect of taping and clavicle support on the muscular activity of the axioscapular group of muscles. In this study, we conduct a scientific evaluation of the myoelectric activity of those with neck and shoulder pain during computer use by using surface electromyography (sEMG). Also, the immediate changes in the myoelectric activity of the axisoscapular muscles with the use of a clavicle support are examined so as to evaluate its potential effectiveness in improving work-related neck and shoulder pain.

## 2 Experimental

In this study, a total of 5 females between 20 and 30 years of age (mean: 21.2; SD: 0.8) with more than 3 months of neck and shoulder discomfort due to prolonged use of computer work were recruited. Their Body Mass Index (BMI) ranged from 17.3 to 26.3 kg/m<sup>2</sup> (mean: 20.3; SD: 3.5). The participants are all right-handed who work a minimum of 4 hours daily on the computer and/or a mobile electronic device. The study was approved by the Human Ethics Committee

of the Hong Kong Polytechnic University. All of the subjects signed an informed consent form about the purpose of the study.

A clavicle support strap was prescribed and adjusted based on the instructions of a professional physiotherapist so that the elastic length was adjusted to pull the ear tragus, the seventh cervical vertebra (C7), and acromion to align the same in an imaginary vertical line or to tend to back into the imaginary vertical line (Fig. 2). The subjects were instructed to type a simple fairytale story for 30 minutes with and without the use of the clavicle support strap respectively. The story was presented as a softcopy in Microsoft Word and shown on the left side of the computer screen. The participants were given a 30-minute rest in-between the two conditions (with and without the use of clavicle support) to reduce potential muscle fatigue effects. Another blank Microsoft Word window was opened on the right side of the screen for the participants to type the story. The participants were requested to complete the task at their normal typing speed and keep their pace constant throughout the typing task. They were allowed to correct typing errors as in usual practice. The sEMG data were extracted from three time frames, which were at 2 to 9 minutes (Period 1), 12 to 19 minutes (Period 2) and the 22 to 29 minutes (Period 3). The average of the 3 periods was then used for data analysis. The workstations were arranged to provide ergonomic comfort with height-adjustable seats and computer screens (Fig. 3).



Fig. 2: Imaginary vertical line that passes through the ear tragus, C7, and acromion

The parameters of the sEMG assessment were formulated based on the Surface EMG for Non-invasive Assessment of Muscles (SENIAM) standards [15]. The sEMG activity was acquired with the use of a pre-amplified sensor, MyoScan model T9503M, and a data acquisition system, Flex-comp model T7555M, both from Thought Technology (Montreal, Canada). The sEMG electrodes were placed onto the axioscapular group of muscles; namely, the Anterior Deltoid (AD), Upper Trapezius (UT), Middle Trapezius (MT), and Lower Trapezius (LT) in pairs to determine the muscle activity along the neck and shoulders. The trapezius muscle is often considered a major stabilizing muscle of the scapula, whilst muscle AD assists the pectoral muscles during shoulder transverse flexion. Muscle AD also works with subscapularis in rotation of the humerus. These muscles are consistently associated with neck and shoulder pains with forward head and shoulder postures during typing task. Muscles are stressed during scapula elevation and abduction, medial turning movement of the humerus, pulling the scapula toward the spine, etc. [16, 17].



Fig. 3: Workstation with adjustable seat and computer screen

The back of the subjects was shaved and cleaned with alcohol as suggested by the SENIAM standards. The electrodes were also placed in accordance with the SENIAM instructions and the sEMG signals were verified through an impedance test available in the BioGraph Infiniti software (Thought Technology Ltd.) The sEMG signals were sampled at a rate of 2048 Hz. Since the levels of muscle changes were measured between different muscles of the same subject or same muscles of different subjects, the Maximum Voluntary Contraction (MVC) normalisation was measured. The MVC trials included flexion of arm, abduction of arm, horizontal adduction of arm, shrug, adduction of arm and retraction of the shoulder and press down [18]. Subjects were asked to do the above motion and hold for 3 seconds in half range of  $90^\circ$  and full range of  $180^\circ$ . The motions were repeated for 3 times and assigned randomly to avoid inertial fatigue.

For sEMG signal processing, all the EMG signals were high-pass filtered at 20 Hz by using a fourth order Butterworth IIR filter to remove artefacts and a 60 Hz notch filter to remove power-line noise. Then the Root Mean Square (RMS) amplitude of the sEMG signal ( $sEMG_{RMS\mu V}$ ) was computed. The resultant amplitudes which were expressed as a percentage were normalized to the MVCs of each subject in accordance with the following equation:  $MVE\% = (sEMG_{RMS\mu V}/MVE_{RMS\mu V}) \times 100$  [19]. The maximum 1000 ms RMS value across all the MVC trials for each muscle was regarded as the MVE ( $MVE_{RMS\mu V}$ ) and used as the reference value to normalize the signals.

In statistical analysis, all of the data were reported as a mean. The data were analyzed by using the Statistical Package for the Social Sciences (SPSS) Version 17.0 (SPSS Inc., Chicago, IL). Pairwise comparison between the use and absence of clavicle support (t-test) was used to determine the differences in the muscular activities in each condition. The alpha level was set at the conventional level of 0.05.

### 3 Results and Discussion

The results of the normalised MVE% of the four types of muscles in the axioscapular group of muscles during computer use in the wear trial are presented in Table 1 and Figs. 4 and 5 respectively. The results indicate that the muscle activity considerably varies amongst the 5

subjects. For example, the left AD and LT, as well as UT muscles of Subject 1 have very high muscle activity. The use of clavicle support tends to reduce the activity of the AD muscle, but increases the activity of the UT muscle. In the case of Subject 5, high activity level is observed on muscle UT, whilst the use of clavicle support fails to reduce the activity of the 4 muscles studied.

Table 1: Normalised MVE% of axioscapular group of muscles between use and absence of clavicle support

Subject	Without Strap				With Strap			
	AD	LT	MT	UT	AD	LT	MT	UT
	Left/right				Left/right			
1	20.1/4.7	24.4/6.9	5.8/13.0	16.6/22.1	0.7/1.9	24.8/6.2	6.1/14.6	20.3/50.3*
2	3.6/8.2	4.8/8.5	2.2/6.7	11.2/2.3	5.8/12.3	6.7/9.8	13.2*/13.1	7.2/17.0*
3	18.6/23.9	10.3/8.7	7.5/6.4	11.7/10.1	16.8/27.2	7.7/13.5	5.7/7.3	22.0/13.8
4	1.7/7.1	3.8/9.3	5.0/7.5	8.6/18.5	2.1/7.1	4.5/6.3	6.5/11.1	9.6/19.1
5	3.9/0.3	3.1/2.8	9.7/2.9	25.4/16.0	11.2/8.2	8.5/8.4	20.5*/7.0	46.7/45.1*

Note: \* Significant at  $p < 0.05$  in reviewing MVE% on the individual muscles

In the pairwise comparison between the use and absence of clavicle support (t-test), there is an overall significant difference in the MVE% ( $t = -2.982$ ,  $p = 0.005 < 0.05$ ). In reviewing the MVE% on the individual muscles in the axioscapular group, some significant differences between the use and absence of clavicle support were found on the MT ( $t = -2.791$ ,  $p = 0.021$ ) and UT ( $t = -3.011$ ,  $p = 0.05$ ) muscles. However, the use of clavicle support has no significant effects on the AD ( $t = -0.117$ ,  $p = 0.909$ ) and LT ( $t = -1.457$ ,  $p = 0.179$ ) muscles.

In this study, we evaluated the immediate effects in the myoelectric activity of muscles AD, UT, MT and LT when a clavicle support is worn. To the best of our knowledge, this is the first study to make this evaluation. The record of sEMG in axioscapular muscles allows quantified information of the change in muscle reaction with the application of clavicle support. Results revealed that wearing clavicle support leads to immediate change of muscular activity in the axioscapular group of muscles. There is a significant increase of activity on muscles UT and MT. As no previous study has examined the change of axioscapular muscle in computer users with neck and shoulder pain syndrome in relation to the use of clavicle support used in the current study, it is not possible to compare these results directly with those of any other previous study. There were considerably differences of the application methods and materials of the scapular tapes and/or shoulder braces. Nevertheless, it is noted that the increased activity the UT muscle is different from previous reports that the scapular taping and stretching exercises were prescribed to reduce the activation of muscle UT since muscular imbalance from scapulothoracic dysfunction is often assumed to be the result of overactivity of the UT and decreased activity of the LT. The use of scapular taping resulted in significant reduction of muscle activity in the UT and an increase in muscular activity in the MT [20, 21]. Even though no statistical difference is found in the muscle activity of LT ( $p > 0.05$ ), the current study shows that the wearing of clavicle support tends to produce a small increase in the muscle activity of the LT during computing typing. This result is somewhat consistent with the use of scapular taping that no significant change was recorded in muscular activity in the LT. No significant differences were found in the muscle activity in the AD with clavicle support ( $p > 0.05$ ). Our results suggest that the clavicle support enhances muscle

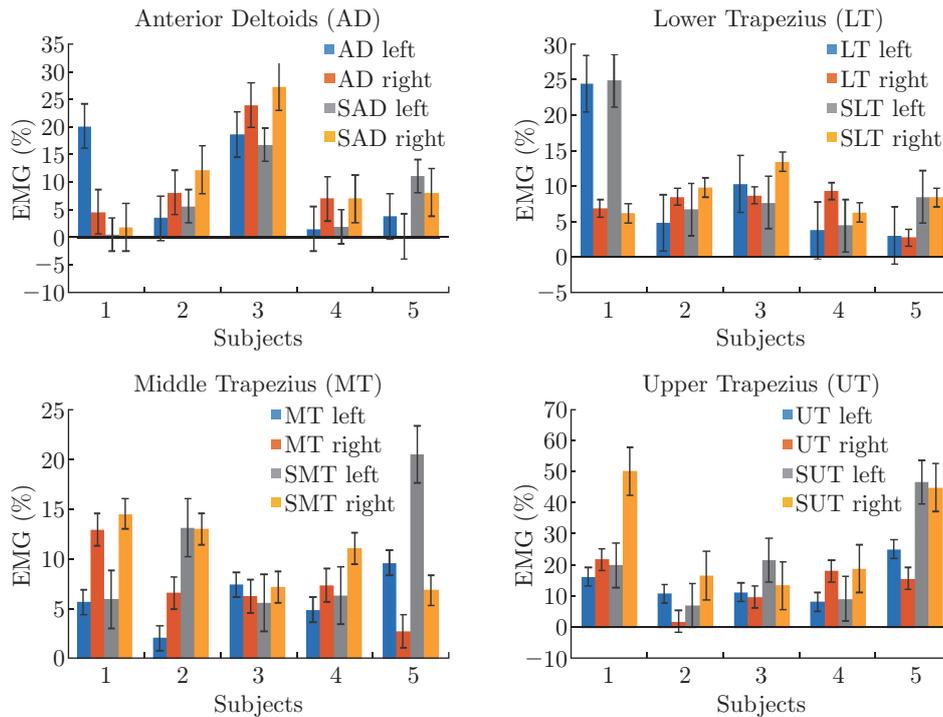


Fig. 4: MVE% of the left and right axioscapular group of muscles during computer typing without clavicle support (AD, UT, MT and LT) and with the use of clavicle support (SAD, SUT, SMT and SLT)

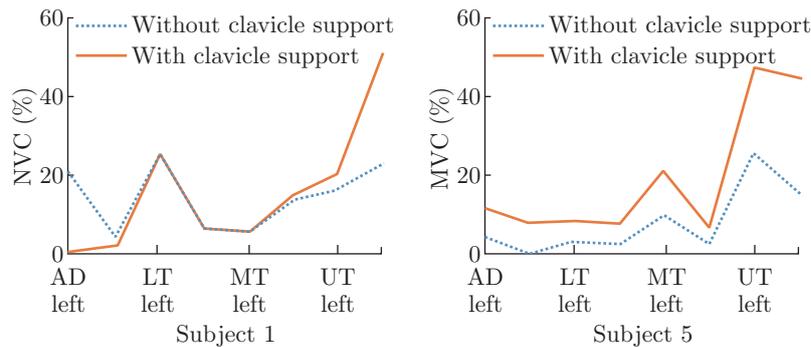


Fig. 5: MVE% of the left axioscapular group of muscles during computer typing of Subjects 1 and 5, with the use and absence of clavicle support

activity in the MT, but fails to inhibit muscle activity in the UT. It also appeared to produce beneficial changes in muscular activity in the LT in subjects with tension neck and shoulder pain. Since muscle LT seems best suited for postural and stabilizing functions in the shoulder and arm movements, whereas UT seems best suited for phasic activities [22], some modifications may be required on the clavicle support of reducing muscular activity in UT and increasing muscular activity in LT should be further investigated.

In this study, the EMG differences and changes in response to the wearing of clavicle support are highly variable amongst the subjects studied. As no previous study has considered the influence of clavicle support on muscular activity changes and thus we cannot directly compare our results to any other studies. There are several possible explanations for the considerably EMG differences. First, clavicle support strap was prescribed the physiotherapist that the elastic

length was adjusted with the alignment of the ear tragus, C7, and acromion in an imaginary vertical line. The dimension differences of elastic length and pulling force induced by the clavicle support therefore lead to substantial muscular activity differences of the axioscapular group of muscle. The large differences of muscle activities amongst subjects could also be attributed to their posture changes that they spontaneously slouched their back or habitually moved their head forward during the typing task which has not been taken into consideration in this study. It was observed that rather than restoring the scapula to a resting position and/or preventing shoulders and head from forward movement, the wearing clavicle support has resulted in compensatory head and shoulder postures so as to balance out the induced pulling forces in the back. Hence, posture changes should be taken into account when evaluating the impact of clavicle support and/or interventions on mechanical correction of the rounded shoulder posture and the corresponding muscle activity. On the other hand, the effects of therapeutic support on other scapular muscles such as serratus anterior (SA) that contributing to the stability and movement of the scapula should also be investigated. As indicated by Cool [22], impaired control of the scapula by the SA muscle is common in patients with shoulder problems. Strengthening of the SA methods are routinely included in rehabilitation to actively counteract the strength and movement loss in rounded shoulder posture [23, 24]. It is anticipated that the effective therapeutic elastic support should enhance activity in the SA.

The current study helps to enhance the understanding of the immediate effect of clavicle support on axioscapular muscles. As prescribed as a rehabilitation treatment of muscle training, it is crucial to determine the long-term effectiveness of a clavicle support in relieving work-related neck and upper limb musculoskeletal disorders. To optimize its design and fabrication, it is also imperative to evaluate the wear comfort and the rate of patient compliance during the continuous use of clavicle support.

## 4 Conclusion

As the trend for work carried on computers is likely to increase, an increase in the prevalence of disorders in the neck and shoulder regions is foreseeable. There is therefore a substantial need to design and prescribe suitable treatment to relieve neck and shoulder pain and the associated problems. When a clavicle support strap is used, there is overall significant change in the MVE% of the axioscapular group of muscles, particularly in the MT and UT muscles. In general, considerable differences have been observed amongst the 5 study subjects when clavicle support is prescribed. It is recognised that the experimental conditions may not be able to fully replicate the computer use environment and the number of subjects is small, however, the findings can serve at the very least to improve our understanding of clavicle support in association with axioscapular muscle activity in young women. This provides the basis for the design and development of suitable intervention devices in the workplace for the reduction of musculoskeletal disorders and enhances the quality of rehabilitation treatment.

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