Comparative Study between the Effect of Desktop and Laptop Computers over Neck and Back Muscles. For Protracted Users. A prospective Study on 30 Volunteers.

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ABSTRACT

Background: *Computer work is becoming an integral part of office activities. The computer type and user sitting style may affect differently the craniocervical angle and the load over specific muscles in the back and neck. No enough available data exploring this issue.* ***Subjects:*** *From November, 2008 through April, 2009, thirty non-professional computer workers (15 males and 15 females) were enrolled in the study. Their mean age was (24.36±3.27) years, mean weight (71.3±5.7) kg, and mean height (167.33±5.92) cm. They were assigned in one group. For each sitting style the following recordings were taken: electromyography for semispinalis cervicis, capitis and upper trapezius muscles and subject's posture was captured by an infrared camera. Primarily they assumed the desktop sitting style for twenty minutes before taking the first recording. Following rest for ten minutes, they assumed the laptop sitting style for twenty minutes and second recording was made.* ***Results:*** *There was a statistically significant increase in the craniocervical angle in the style of sitting in front of desktop computer (157.82±1.14) than in that of a laptop (152.22±0.99) at P = 0.0001. There was significant decrease in semispinalis cervicis and capitis muscular activities for desktop than for laptop on both sides at P = 0.0002. There was no such significant difference in the muscular activities of upper trapezius between two the 2 styles (at P = 0.22 for the right and P = 0.66 for the left).* ***Conclusion:*** *Contrary to laptop sitting style, sitting in front of desktop computer increases the craniocervical angle and lessens the muscular load on the semispinalis cervicis and capitis of both arms. The always involved upper trapezius muscles are not affected.*

Key words: *Craniocervical angle, ergonometry, electromyography, EMG, MCU.*

INTRODUCTION

At present, the need to use desktop and laptop computers on a daily basis for office work or to access information technology armamentarium made their presence in many workplaces, banks and schools mandatory. Laptops have the advantages over desktop of being portable, light weight and space saving, enabling the users to work anywhere and at anytime[1]. Most laptops are designed with the screen joined to the keyboard, making difficult - or even impossible - to be adjusted separately in terms of screen height and distance, and keyboard height and distance[2]. This leads to prolonged flexion at cervical spine with consequent higher activity in the cervical erector spinae and upper trapezius muscles, with a posture in which the trunk is slightly inclined backward[3]. This leads to a consequent forward head and trunk flexion adopted as a fixed postural habit. Recently concerned health professionals have begun to see the physical effects of these malpostures particularly in those spending long hours day after day using their computer[4]. The aforementioned forward head posture (FHP) involves a combination of lower cervical flexion and upper cervical extension and has been linked to some musculoskeletal dysfunctions such as upper crossed syndrome[5]. A FHP reduces the average length of muscle fibers, which contributes to extensor torque at the atlanto-occipital joint, and it is possible that this shortening reduces the tension-generating capabilities of muscles. In clinical practice it is widely believed that a FHP and other ergonomic disadvantages linked to conventional laptop PC contributes to the development of chronic neck and shoulder pain[1,6]. It is possible to evaluate and analyze the muscular work pattern at workstation by electromyography (EMG)[7], and this helps to either prevent a problem or correct it, if included in a successful ergonomic program aiming to improve health users and enhance their productivity. Selecting ergonomically designed tools and making sure that they are used correctly can help operators to reduce the incidence and severity of these impairments[8], and sometime encouraging workers to adopt more flexed neck to lessen unnecessary mechanical load on it[9].

SUBJECTS AND METHODS

Thirty right handed non athletic non professional computer user volunteer subjects (15 males and 15 females) were enrolled in this study. The work was completed at the Basic Sciences Department, Faculty of Physiotherapy at Cairo University in Egypt from November, 2008 through April, 2009. Volunteers' age ranged from 18 to 30 years and all signed a written consent after taking the approval of the Ethical Committee. Exclusion criteria included a pre-existing neck or upper limb disorders, any existing neurological or systemic illness, and also those having impaired performance for any reason. Diabetics and pregnant females were also kept out. Volunteers were assigned as a single group. At the beginning they assumed the first sitting style for twenty minutes, and after ten minutes rest they assumed the second sitting style for an equal time. The first sitting style was a desktop user’s position where the chair and table height were adjusted to allow 90^o elbow flexion with vertical upper arm and a horizontal forearm[10]. The screen inclined backwards by 20^o and away from the user by approximately 80 cm. The top of screen was adjusted 20^o below eye level. Second sitting style was a laptop user's position, the operator is away from the computer by the same distance as the first sitting style (80 cm.) and his knees are at 90^o flexion and calves hanging vertically and the screen (with minimum glare). It was difficult to precisely adjust the craniocervical angle to be equal in both sitting styles, as minor alterations were mandatory to adjust the user for his best performance (Fig. 3) The angle for desktop sitting style ranged between 156.2 and 159.7, while for laptop sitting style it was between 150.2 and 153.9 degrees. (Table 3 – Fig. 1). Subjects were instructed to work continuously in a non-stop manner, avoiding moving their chair or computer table and also avoiding looking to the recording camera.

Equipment:

The study equipments included a camera system and an EMG unit. The desktop computers had a 14" wide screen monitor while laptops were provided with 15.6" ones. The Myomonitor is a dual mode portable EMG and physiological signal data acquisition system. The apparatus surface sensors were used for recording activities of semispinalis cervices and capitis and upper trapezius (UT) on both sides. For UT the sensor is placed at a lateral distance 25 mm from midpoint between acromion and C7, while for the other 2 muscles the sensors were placed at the posterior aspect of neck on the occipital bone on the area between the superior and inferior nuchal lines. The ground electrode was placed on the lateral epicondyle of the elbow (Fig. 3). At the end of fifteen minutes in each position the EMG triggered the motion capturing system to begin recording simultaneously for 5 seconds aiming at relating the muscular load to the postural change[11]. Angles' calculation are 3D angle: It was the real angle of the joint in all planes X, Y, and Z dimensions without neglecting the rotations of the joint as in 2D angles. The craniocervical angle is the angle between the line from the tragus to the outer canthus of the eye and the line from the tragus to the C7 spinous process. The data were collected in three sheets: personal data sheet, motion analysis sheet, and EMG sheet and stored on a removable SD memory card. Paired samples t-test was used to evaluate the statistical difference between the two styles at P = 0.05. For the camera, the QUALISYS ProReflex analysis system was used, where a Prorefex Motion Capture Unit (MCU) utilising infrared light reflection by 3 silver- colored reflective markers by 3 cameras supported by an A wand –kit for calibration, and an ABC-530 serial interface adaptor (Fig. 4). Markers were fixed over the outer canthus of the eye, the ear tragus and the 7^{th} cervical spinous process. The cameras capture capability was 120 frames / second.

RESULTS

Half of the volunteers were females. Mean age in the full series was (24.36±3.27) years, mean weight (71.3±5.7) kg, mean height (167.33±5.92) cm (Table 1). The style of sitting in front of desktop had significantly increased the craniocervical 3D angle appreciably (157.82º±1.14). While for laptop sitting style, the craniocervical 3D angle had significantly decreased (152.22º±0.99) at P-value (0.0001). The muscular activities of the right semispinalis cervicis and capitis had been significantly decreased in the desktop sitting style (12.34±0.74) mv. compared to (14.51±0.81) mv for laptop sitting style (P = 0.0002). In the left side it was (13.99±0.93) mv. and for the right side (12.09±0.87) mv. For the upper trapezius the results were nonsignificant at P = 0.22 and 0.66 for the right and left sides respectively. (Table 2 and Fig. 1&2). There was no differences between males and females regarding these data.

Table (1): Personal Data.

N	Sex	Age	Wt.	Ht.
1	M	28	75	160
2	M	21	69	173
3	F	23	74	158
4	M	23	60	165
5	F	24	69	166
6	F	19	70	167
7	M	28	80	175
8	F	18	63	158
9	F	20	65	167
10	M	21	83	179
11	F	28	75	170
12	M	29	80	170
13	F	26	67	165
14	M	27	70	169
15	F	28	65	163
16	M	20	78	162
17	M	22	67	159
18	F	23	79	167
19	M	20	72	169
20	F	21	70	175
21	F	25	68	160
22	M	29	75	158
23	F	28	79	173
24	F	25	75	173
25	M	26	66	165
26	M	26	70	172
27	M	27	69	172
28	F	27	72	177
29	M	25	70	168
30	F	24	64	165

Table (2): Results of Ergonometric Study.

SN	C.C.A D. top	C.C.A L. top	EMG Activities Desktop				EMG Activities Laptop			
			Rt. Semi	Lt. Semi	Rt. U Trap	Lt. U Trap	Rt. Semi	Lt. Semi	Rt. U Trap	Lt. U Trap
1	158.4	151.8	12.2	11.5	10.1	9.5	13.5	12.9	10.1	9.5
2	157.5	152.7	12.5	11.8	10.2	9.3	13.9	12.8	10.4	9.2
3	159.4	150.9	12.9	12.1	9.9	9.8	14.2	13.5	10.5	10
4	158.1	151.8	13.1	12.2	9.5	8.3	14.5	13.9	9.5	8.9
5	158.6	151.9	12.6	12.1	9.4	9.1	14.8	13.6	9.9	8.9
6	157.4	152.9	13.2	12.8	9.8	9.2	15.5	14.1	9.7	8.5
7	156.9	151.8	12.5	11.9	9	8.2	13.7	13.1	10.3	9.6
8	156.6	153	11.1	11.5	10.2	9.7	13.9	13.1	10.1	9.2
9	156.2	151.5	12.9	11.8	10	9.5	13.3	13	9.8	9.1
10	157.5	152.5	12.8	12.1	9.2	8.5	13.9	12.9	9.9	9.2
11	158.3	152.6	12.2	11.5	9.5	8.9	13.5	12.9	9.6	8.9
12	156.5	151.6	11.5	10.5	10.1	9.8	14.9	13.5	10.5	9.7
13	158.6	152.6	13.2	12.4	10.2	9.9	14.7	13.1	10.4	9.9
14	157.3	151.9	13	12.5	9.7	9.5	14.6	13	9.3	8.9
15	157.9	152.7	11.9	10.9	9.6	9.1	15.1	14.2	9.5	8.4
16	159.7	150.6	12.7	13.6	10.4	10.6	15.6	13.7	10.3	10.6
17	156.2	153.9	10.9	11.6	10.5	9.8	14.3	14.8	10.6	9.5
18	158.4	154.2	13.3	12.4	9.8	8.2	14.7	15.8	10.4	9.2
19	158.8	152.7	12.7	11.7	10.4	10.5	13.7	15.3	9.4	8.4
20	157.2	152.6	12.1	12.2	10.3	8.9	13.2	14.7	9.6	8.2
21	159.5	151.3	11.8	11.5	9.3	9.3	14.7	14.3	9.1	9.5
22	155.8	154.3	12.9	12.8	9.7	10.5	15.8	14.8	10.3	10.7
23	159.6	152.7	12.5	11.9	9.2	9.5	14.7	13.2	10.2	9.2
24	159.2	152.3	11.7	10.2	9.1	8.6	15.8	15.9	9.8	8.6
25	156.4	150.2	13.2	13.2	10.3	9.1	13.6	14.8	9.9	8.1
26	158.8	151.6	11.4	13.9	9.5	8.3	13.8	14.7	10.2	9.8
27	157.2	151.2	12.7	12.5	10.2	9.7	15.8	15.1	10.5	9.2
28	157.9	153.7	12.6	11.2	10.7	8.4	15.4	14.8	10.2	10.6
29	158.7	151.8	11.9	12.7	9.2	9.6	14.6	13.6	9.3	9.6
30	156.2	151.4	10.4	13.8	9.8	10.2	15.8	14.8	9.1	8.3

Abbreviations: C.C.A.: cranio cervical angle, Rt. Semi = right semispinalis cervicis and capitis muscle, Lt. Semi = left semispinalis cervicis and capitis muscle, Rt. U.Trap = right upper trapezius muscle, Lt. U.Trap = left upper trapezius muscle.

Table (3):

Craniocervical angle	Desktop	Laptop
Mean	157.82º	152.22º
±SD	±1.14	±0.99
Mean difference	5.6	
DF	29	
t-value	18.48	
P-value	0.0001	
S	S	

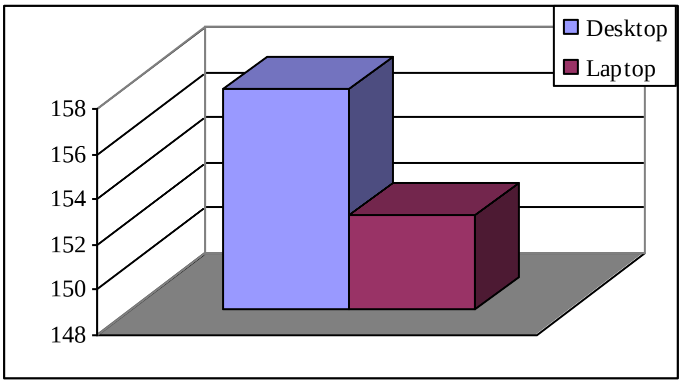
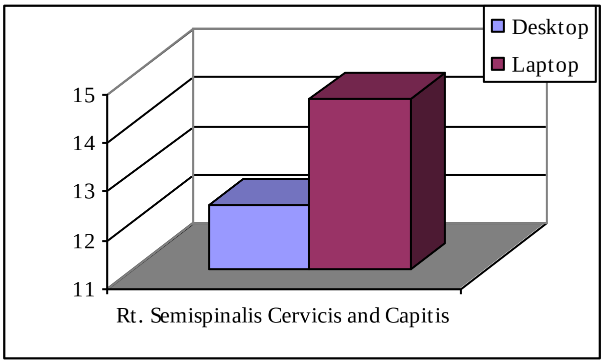
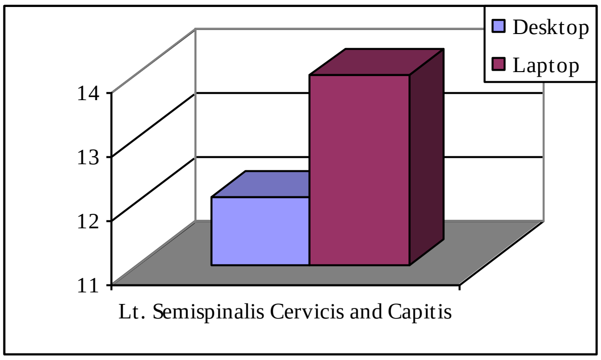


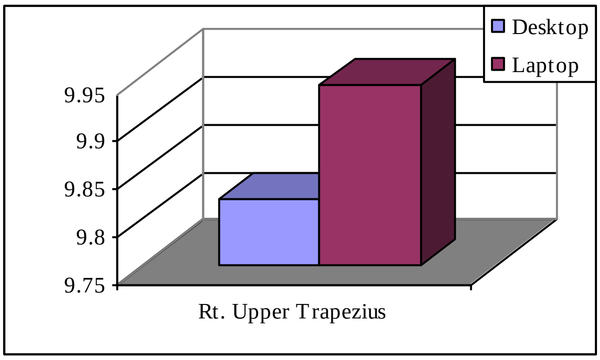
Fig. (1): Mean and ±SD of the craniocervical angle.



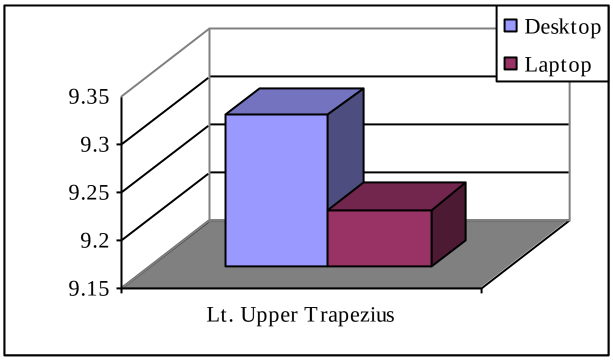
Rr. Semispinalis cervicis & capitis



Lt. Semispinalis cervicis & capitis



Rt. Upper Trapezius



Lt. Upper Trapezius

Fig. (2): Mean and ±SD of the EMG activities of tested muscles.

Fig. (3): Laptop and desktop sitting styles with marker placement sites: on craniocervical angle, the outer canthus of the eye, ear tragus and on C7 spinous processes.

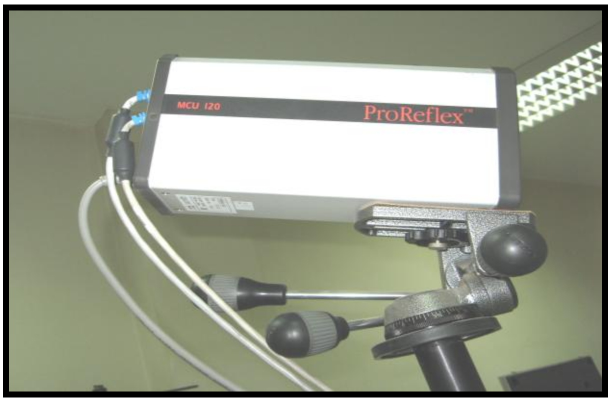


Fig. (4): Pro-Reflex camera and its handel.

DISCUSSION

For computer workers display height and screen type are crucial factors for minimizing musculoskeletal strains in the neck and upper limb[12]. Analysis of earlier statistical studies in this respect point to a decrease in the percentage of EMG activity of right compared to left semispinalis cervicis and capitis muscles with desktop than with laptop use. This decrease may be a feature of the usually adopted more erect position of the head and trunk which is more evident on the desktop position. This erect posture places the center of gravity of the head and neck close to their axes of rotation at cervical spine, thus decreasing the flexion impetus and reducing the demand on the neck extensor muscles to maintain the head and neck in equilibrium[13]. In addition to this reason, it has been reported 12 earlier[14] that the momentum arms of most of the neck extensors vary by <1 cm on changing head and neck posture. For the semispinalis capitis and trapezius muscles this may increase by up to 2-3 cm from flexed to extended postures. This results in a less demand on the extensor muscles due to the inverse relationship between the momentum arm and the force exerted (momentum arm = momentum /force). On the other hand the myoelectric activity over the right upper trapezius showed a less difference between desktop and laptop sitting postures. It may be attributed to the need to increase the flexion angle between the head and neck in laptop than desktop workers. This accentuation moves the center of gravity further forward in front of the cervical spine increasing the momentum arm of the gravitational force. This had to be compensated by an increased activity in the upper trapezius muscle to keep the head in a balanced position. The results of this work go with those of Straker and his colleagues 4 years ago[10] who reached to the same conclusion by studying the muscle activity of the spine and upper limb of 36 young adults at different display heights. Surprisingly this was against the older viewpoint of Seghers and his team[15] who reported an appreciable difference in muscle activity between the right and left trapezius, and that the right trapezius was consistently more activated than the left at all screen heights. This odd result is probably related to the dominant hand control over the cursor keys during the experimental part of their study.

Conclusion

Contrary to laptop sitting style, sitting in front of desktop computer increases the craniocervical angle and lessens the muscular load on the semispinalis cervicis and capitis of both arms. The always involved upper trapezius muscles were not affected. In general, it is advisable to work with desktop computers for prolonged users (>20 minutes) and also for younger children and school students. Left handed users may need separate study. Individuals suffering from cervical or lumbar spondylosis may need medical consultation before indulging themselves in professional computer activity.

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الملخص العربى

دراسة مقارنة لتأثير الكمبيوتر المكتبي والكمبيوتر المحمول على عضلات الرقبة والظهر

دراسة مستقبلية على30 متطوع

أصبح الكمبيوتر من أساسيات الحياة . وهناك العديد من الأبحاث تتعلق بتأثير الكمبيوتر علي أجزاء الجسم المختلفة . وقد أصبحت شاشات الكمبيوتر بكافة أنواعها وأشكالها كثيرة مما جعلها تأخذ مكانة في أداء الوظائف في أغلب الأعمال المكتبية والهندسية مثل شاشة اللاب . **أهداف البحث :** هو مقارنة الوضع الحركي لزاوية الفقرات العنقية مع الجمجمة ودراسة الرسم الكهربي للعضلتين الرأسية والعنقية والنصف شوكيه اليمنى واليسرى والعضلتين الشبة منحرفة العلوية اليمنى واليسرى في حالة الجلوس أمام نوعين مختلفين من شاشات الكمبيوتر(الشاشة العادية وشاشة اللاب توب) . **التجربة :** أجريت هذه التجربة علي مجموعة من الأشخاص الطبيعيين في معمل التحليل الحركي في كلية العلاج الطبيعي جامعة القاهرة فى الفترة من نوفمبر 2008 إلى ابريل 2009 وكان عددهم ثلاثون شخصاً (15من الذكور و15 من الإناث) تراوحت أعمارهم ما بين 18 إلى 30 سنة . كانت التجربة تتضمن الجلوس أمام نوعين مختلفين من شاشات الكمبيوتر . أحد هذه الأنواع هو الجلوس أمام شاشة الكمبيوتر العادية ، أما النوع الأخر هو الجلوس أمام شاشة اللاب توب يتخذ الشخص في كل نوع مدة 20 دقيقة يتم في هذه المدة استخدام لعبة علي الكمبيوتر مع الأخذ في الاعتبار 10 دقائق من الراحة ما بين استخدام النوعين . وبعدها يتم تسجيل القياسات المطلوبة . **القياسات المطلوبة تتضمن :** 1- تصوير الوضع الجسماني للزاوية ما بين الفقرات العنقية والجمجمة باستخدام 3 كاميرات تحت الحمراء . 2- استخدام جهاز التخطيط الكهربي العضلي لقياس نشاط العضلتين الرأسية والعنقية والنصف شوكيه اليمنى واليسرى والعضلتين الشبة منحرفة العلوية اليمنى واليسرى . تم اخذ النتائج وتحليلها إحصائيا عن طريق استخدام الإحصاء الوصفي في صورة المتوسط الحسابي والانحراف المعياري والإحصاء التحليلية اختبار(ب) t-test . وقد أكدت النتائج وجود فروق ذات دلالات بين استخدام النوعين. فقد زادت الزاوية ما بين الفقرات العنقية والجمجمة في حالة الجلوس أمام شاشة الكمبيوتر العادية وبالنسبة للثقل العضلي فقد قل في العضلتين الرأسية والعنقية والنصف شوكيه اليمنى واليسرى في حالة استخدام الشاشة العادية أيضا بمقدار له دلالة علمية والعكس صحيح عند استخدام اللاب توب . أما بالنسبة لنشاط العضلتين الشبة منحرفة العلوية اليمنى واليسرى فلم يحدث أي اختلاف علي كلا الجانبين أو في كلا الوضعين. ومن هنا يتضح أن الجلوس أمام الشاشة العادية له تأثير إيجابي في تقليل كل من الثقل العضلي والإجهاد الوضعي الجسماني في العضلات الباسطة للرقبة .