Effects of Smartphone Usage Duration on Neck Dysfunction in Young Versus Middle-Aged Patients with Chronic Mechanical Neck Pain

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ABSTRACT

Background: Neck pain is a common musculoskeletal disorder. It has many risk factors such as the prolonged use of smartphones. However, it is unclear whether the deleterious effect of prolonged smartphone use is age dependent or not. Therefore, the purpose of this study was to compare the effects of smartphone usage duration on pain, deep cervical flexor (DCF) muscles endurance and neck proprioception in young and middle-age adults with mechanical neck pain.

Methods: Eighty females with mechanical neck pain were recruited for this study. Patients were divided into two equal groups based on age (young and middle-aged adult groups). Patients browsed the internet continuously for 10- and 30-minutes, at two different sessions. All variables were assessed before (baseline) and immediately after net browsing (post-task).

Results: Patients in the two groups showed significant pain accentuation after smartphone usage, regardless to the duration. However, changes in pain severity with device use were not different between the two groups ($P>0.05$). For DCF endurance, there were no significant differences within and between the two groups ($P>0.05$). For proprioception acuity, the middle-aged group showed increased neck extension error after the 10 min task and neck flexion error after the 30 min task ($P<0.05$). Comparing changes in proprioception acuity between the two groups showed significant defect only in neck flexion after 10 min of smartphone use in young adults ($p<0.05$).

Conclusion: Continuous use of smartphone for net browsing up to 30 minutes increase pain and proprioception deficit in selected directions with no evidence of change in DCF endurance within the same session. Age did not affect the pain severity، DCF endurance and proprioception acuity after smartphone usage.

Keywords: Neck pain, Smartphone, Neck endurance, Age.

INTRODUCTION

Neck pain is a common musculoskeletal dysfunction in women with an overall prevalence of 0.4% to 86.8% (1). It may cause disability that negatively impact working capability and activities of daily living (ADL). Neck pain has been associated with altered and/or impaired musculoskeletal function such as reduced deep cervical flexors (DCF) endurance (2), limited active range of motion (AROM) (3), and reduced proprioception acuity (4,5).

There are many risk factors for neck pain including sociodemographic factors, work-related disorders and prolonged use of hand-held devices (7,8). The increased smartphone popularity among adults has been claimed to aggravate neck dysfunction. For example, neck pain increased after texting for 3 minutes (9). Further, smartphone use has been associated with increased activation of neck extensor muscles (10–12), decreased cervical lordosis (13) and proprioception defect even in healthy subjects (14). Moreover, smartphone users showed increased forward head posture (8,15). Yet, the relationship between neck dysfunction and smartphone usage is still unclear (16–19), particularly in vulnerable groups such as patients with neck pain.

A few studies were conducted to elucidate this relationship. However, these studies were done on young adults below the age of 35 years old (12,20–23). As aging negatively affect cervical proprioception acuity (24,25) and muscle endurance (26), it could be assumed that prolonged smartphone use would affect middle-aged patients with neck pain more than younger adults. Therefore, this study aimed at comparing the immediate effects of smartphone continuous use for net browsing, for10- or 30 minutes, on neck pain, DCF endurance and proprioception acuity in young and middle-aged patients with chronic mechanical neck pain.

MATERIALS AND METHODS

This is cross-sectional two-time observational study that was carried out in the outpatient clinic of the Faculty of Physical Therapy, Cairo University, between September and December 2018. The study was approved by the Ethics Committee of the Faculty of Physical Therapy, Cairo University.

Eighty female patients with mechanical neck pain were enrolled in this study. Patients were divided equally based on age into two groups: Group I (G1): young adult patients with an age ranging between 18 and 29 years old, and group II (G2): middle-aged patients aging between 30 - 60 years.

All patients were referred with the diagnosis of chronic mechanical neck pain for more than 3 months. Patients were included in the study if they scored >8% on the neck disability index (NDI), were free from any red flags such as malignancy, infection, inflammation, or myelopathy (27), and had at least one year of experience with touch-screen smartphone (28). Patients were excluded from the study if they had a history of upper quadrant deformity, injury or surgery within the past year (12), low back pain, visual or vestibular dysfunction, neurological or systemic disorders that interfere with balance and sensation (29,30), or any physical impairment that may interfere with smartphone use while sitting and standing (28).

Initially, the examiner screened patients against study eligibility criteria, and explained them the aims and procedures of the study. Eligible patients were invited to participate in the study and if they agreed, an informed consent was signed.

Participants were initially interviewed to answer the smartphone addiction scale (SAS). This is a valid and reliable scale that consists of 10 questions. The possible score of each question ranges from 1 to 6 points, with a total questionnaire score ranging from 10 to 60 points. A score of 34 is considered a cut off for smartphone addiction, with greater scores indicating more addiction (31).

Patients were then asked to use a standardized smartphone (iPhone-6) for web browsing for 10- or 30 minutes. The tested duration order was randomized using the randomizer website (www.randomizer.org). The two testing sessions were done within one week. During testing, all patients were assessed at baseline and immediately post-browsing. All testing were done by a single trained assessor who was kept blind to the results of previous testing session.

Pain severity was quantified using the visual analogue scale (VAS). Proprioception acuity was measured by cervical range of motion (CROM) instrument to quantify the angle of repositioning error (RE) (Performance attainment associates, Roseville, Minnesota; USA). For this purpose, the head reposition accuracy test was done while patients sat on a standard chair with their back straight, hip and knee flexed to 90° and arm rested on their laps (32). Test started with a familiarization trial followed by three actual testing trials in flexion, extension, right and left rotations. During the test, the patient kept the eyes opened and then actively and slowly moved the head from neutral to 30° in each tested direction. Upon reaching the target position, the assessor asked the patient to close her eyes and to memorize the target position. Then, the patient was asked to return the head to neutral position before moving it again to reach the target angle actively. The angle of RE was calculated as the difference between the actually reached and target (30°) angles. A one- minute rest was allowed between testing in each direction (14,23,33).

DCF endurance was assessed using the spinal stabilizer (Chattanooga Group, Chattanooga, USA). Patient assumed the crock lying position with the device's cuff secured under the neck. Patient was asked to chin in slowly while looking at the ceiling in order to press on the cuff without lifting the head. Initially, DCF strength was quantified by asking the patient to hold the chinning in position for three seconds in each tested pressure level (20-30 mmHg, with increments of 2 mmHg). A five-second rest period was allowed between incremental progressions of strength testing. Substitution movements or contraction of superficial muscles terminated the test trail. After determining the strength level, a 5-minutes rest was given before starting the endurance test. During endurance testing, patient was asked to chin in as described earlier at the predetermined strength level and hold the position for 10 seconds. This was repeated 3 times with rest 20 sec with each trial (34).

DATA ANALYSIS

The main outcomes for this study were pain, DCF endurance and proprioception deficit in flexion, extension, right and left rotations. Initially, data were tested of normality using Shapiro-Wilk test. As results were not normally distributed, non-parametric tests were used. For each tested variable, absolute data were compared between baseline and post-task values within each group using Wilcoxon Signed Ranks test. Changes from baseline were compared between groups using the Mann-Whitney test. All statistical tests were performed using the statistical package for social studies (SPSS) version 24 for windows. The level of significance for all statistical tests was set at $p<0.05$.

RESULTS

Three-hundred patients were screened, 80 patients (40 young adult (G1), and 40 middle adults (G2)) were found eligible and were enrolled in this study. The median age, Body mass index (BMI), NDI and SAS are summarized in table 1.

Patient's demographics:

Table 1 Demographic data of patients in both groups.

Demographics	G1	G2	P-value
Age (Years)	25.50 (19 – 29)	36 (30 – 55)	0.00*
BMI (kg/m^2)*	23.51 (17.9 – 24)	26.12 (19.8 – 44.9)	0.001*
NDI (%)*	30 (8 – 58)	28 (8 – 86)	0.278
SAS (points)*	35.50 (17 – 56)	31 (10 – 51)	0.008*

* BMI= Body Mass Index; NDI=Neck Disability Index; SAS= smartphone addiction scale

* indicate significant difference (P < 0.05)

Pain:

Pain were significantly increased after smartphone usage (P < 0.05), regardless to age or duration (P>0.05). Between group comparisons revealed no significant difference in pain in the two tested durations (P > 0.05) (Table 2).

DCF endurance:

Endurance was no significantly different after smartphone usage (P>0.05), regardless to age or duration. This was also true for between group comparisons as no significant differences were found between G1 and G2 in the two tested durations (P > 0.05) (Table 2).

Table 2 Between group comparisons in pain and DCF endurance results.

			G1	G2	Between group comparison (P-value)
Pain	10 min	Pre	2.75 (0 – 9.60)	3.16 (0 – 9.25)	0.22

		Post	4.97 (0 – 9.90)	4.90 (0 – 9.90)	0.23
		Change	1.10 (-3.75 – 5)	1.10 (-2 – 6.80)	0.73
		Within group comparison (P-value)	0.00*	0.00*	
	30 min	Pre	2.67 (0 – 9.40)	3.20 (0 – 9.80)	0.59
		Post	4.80 (0 – 9.90)	5.50 (0.54 – 10)	0.81
		Change	1.45 (-5.50 – 7.85)	1 (-4.10 – 5.40)	0.37
		Within group comparison (P-value)	0.00*	0.00*	
DCF endurance	10 min	Pre	30 (22 – 30)	28 (22 – 30)	0.00*
		Post	30 (26 – 30)	30 (22 – 30)	0.00*
		Change	0 (-4 – 8)	0 (-4 – 6)	0.23
		Within group comparison (P-value)	0.72	0.09	
	30 min	Pre	30 (22 – 30)	30 (22 – 30)	0.29
		Post	30 (22 – 30)	30 (22 – 30)	0.00*
		Change	0 (-4 – 4)	0 (-6 – 8)	0.47
		Within group comparison (P-value)	0.49	0.96	

* indicate significant difference (P < 0.05)

Proprioception acuity:

For the 10 min usage, within group comparisons showed significant increase in extension RE in middle-aged adults (G2) (P < 0.05). For the 30 min task, within group comparisons showed significantly slight reduction in flexion RE in middle-aged adults (P < 0.05).

Comparing the magnitude of RE changes between baseline and post-task values between the two groups showed significantly less changes in RE in the middle-aged compared to young adult group in the 30 minutes task only (P < 0.05). (Table 3).

Table 3 RE significant results in both group.

			G1 Young adults	G2 Middle-aged adults	Between group comparison (P-value)
Flexion	10 min	Pre	2.50 (0 – 10.60)	1.7 (0 – 7)	
		Post	3.30 (0.30 –10.30)	2.3 (0.30 – 10)	
		Change	1.01 (0 – 9.33)	0.40 (0 – 4.70)	0.00*
		Within group comparison (P-value)	0.15	0.26	
	30 min	Pre	2 (0.60 – 12.00)	2.1 (0 – 7.66)	

		Post	2.8 (0 – 11.30)	1.9 (0 – 11.30)	
		Change	0.183 (0 – 7.97)	2.4 (0 – 5.70)	0.96
		Within group comparison (P-value)	0.09	0.00*	
Extension	10 min	Pre	2.63 (0.60 – 11.00)	2 (0.30 – 11.60)	
		Post	3.15 (0.66 – 10.60)	3.3 (0.33 – 14.66)	
		Change	0.55 (0 – 9.60)	1.3 (0 – 10)	0.84
		Within group comparison (P-value)	0.29	0.00*	
	30 min	Pre	2.63 (0.33 – 10)	1.5 (0.30 – 17)	
		Post	3.66 (0.66 – 11.33)	1.4 (0 – 10.30)	
		Change	1 (0 – 7.97)	3.1 (0 – 15.70)	0.844
		Within group comparison (P-value)	0.05	0.80	
Right rotation	10 min	Pre	2 (0 – 7.60)	2.5 (0 – 12.00)	
		Post	2.33 (0 – 10.60)	2.8 (0 – 9.00)	
		Change	0.835 (0 – 8)	0.5 (0 – 6.97)	0.554
		Within group comparison (P-value)	0.07	0.52	
	30 min	Pre	1.83 (0 – 7.33)	3 (0.30 – 10.33)	
		Post	2.48 (0 – 12.00)	3 (0.30 – 8.00)	
		Change	0.68 (0 – 12.00)	2.2 (0.27 – 9.33)	0.441
		Within group comparison (P-value)	0.10	0.11	
Left rotation	10 min	Pre	2.6 (0.66 – 17.60)	2.5 (0.30 – 9.00)	
		Post	2.6 (0.60 – 9.30)	2.3 (0.66 – 8.00)	
		Change	0.15 (0 – 10)	0 (0 – 6.70)	0.300
		Within group comparison (P-value)	0.96	0.96	
	30 min	Pre	1.6 (0 – 10.66)	1.6 (0.33 – 10.33)	
		Post	2.3 (0 – 10.00)	1.1 (0.30 – 14.60)	
		Change	1.85 (0 – 7.40)	2 (0 – 9)	0.817
		Within group comparison (P-value)	0.61	0.95	

** indicate significant difference (P < 0.05)*

DISCUSSION

This study aimed to investigate the immediate effects of using a smartphone for continuous internet browsing, up to 10 and 30 minutes, on pain, DCF endurance and RE of young and middle-aged adults with chronic mechanical neck pain. Pain increased immediately after browsing, regardless to age and duration. There was no differences in changes of pain severity between the two age groups. Endurance was not affected by usage, regardless to the duration and age. Extension and flexion proprioception acuity were decreased in middle-aged adults after 10- and 30 minutes tasks, respectively. The changes in proprioception deficit was less in middle aged adults after 10-minutes compared to that seen in younger adults.

For neck pain, increased severity within the same session of net browsing could be attributed to assuming a static posture for a prolonged period (35). Both age groups responded similarly, implying no effect of age on accentuating perceived pain. The effect of age on pain severity is controversial, a few studies results showed no effect of age on pain (7,35–37), whereas other few studies did (38,39).

The median pain change seen in 10 minutes task was 1.1, whereas that seen in the 30 minutes task ranged between 1.0 (G2) and 1.4 (G1). Changes seen in young adults is slightly greater than that of the 1.2 minimal clinical detectable change reported for chronic musculoskeletal disorders (40). This means young adults showed a more clinically relevant pain increase. This could be attributed to increased neck musculatures flexibility in this group (41), which may have permitted the participates from flexing the neck to a greater range, and hence increasing extensor muscle length for a prolonged period and stimulating pain-sensitive mechanoreceptors. A few other studies showed increased neck pain after smartphone usage. For example, Park and his colleagues (2017) reported increased neck pain in university students who played game on smartphone for 16 min. Pain increased by an average of 1.3, which is close to the values reported in this study. Authors attributed pain with gaming to the sharp increase in neck flexion angle causing fatigue of neck extrinsic extensor muscles (42). Kim also reported a pain increase of 1.2 in normal young adult with forward head posture (FHP) after smartphone use up to 30 minutes. Pain increase was attributed to FHP and its associated pathomechanics (20). As in the current study neck mechanics were not assessed, no explanation could be provided based on muscle activation nor neck kinematics

For DCF endurance, although endurance was consistently less in middle-aged adults, yet the magnitude of changes was similar in the two age groups, implying that no evidence of fatigue occurrence with net browsing for different durations, regardless to age. The lack of interaction between age and the activity tested is in an agreement with Domenech who reported that DCF endurance is independent of age (43), although it may be affected by FHP that increases with age

(26,44). On the other hand, Lee reported reduced DCF endurance in normal young adults who used smartphone more than 2 hours per day (21), however this study was based on self-reporting of smartphone duration by the patients themselves, a design which has inherent recall bias.

For proprioception acuity, only flexion and extension movements showed deficits in middle-aged adults (45). This difference could be attributed to which increases with age. FHP has shown to be associated with increased RE (46).

Comparing patients in the two age groups revealed showed a greater proprioception deficit in young adults in the flexion direction after 10 minutes of smartphone use, however this difference was not evident after 30 minutes. This could be attributed to altered muscle activation early during task execution, before mechanical adaptation such as creeping and stress-relaxation has occurred. Tissue creeping was evident after prolonged sitting with flexed neck. This mechanical behavior was associated with higher cervical flexion ROM, which is greater in young adults (47). Other movements did not show any deficit, which is in agreement with Portelli who showed no differences in the RE of young adult smartphone users (< 35 years) with and without neck pain. Future studies showed consider adding mechanical testing to explain such variation in the response of different age groups.

This study has a few limitations: first, only female gender was tested. Although women are more likely to develop neck pain than men, yet studying gender parity should be considered, especially with men using smartphone for prolonged period during gaming. Second, this study was open labeled and no blinding of assessor was done. Third, patients were allowed to choose their preferred sitting posture, which may have contributed to variation of neck posture. Fourth, no kinematic or kinetic analysis was done to explain the current results, Future studies are recommended to consider these limitations.

Conclusion:

Based on this study, smartphone usage does not change pain, DCF endurance and proprioception in rotation between young and middle-aged adults after smartphone use for neck browsing up to 30 minutes. Yet, it has a minimal effect on flexion and extension proprioception acuity after 30 and 10 minutes, respectively. On the other hand, pain increased in each group within the same session, regardless to duration.

تأثيراستخدام الهواتف المحموله على اعتلال الرقبه فى صغار و متوسطى العمرمن مرضي آلام الرقبه المكانيكيه المزمن

خلفيه: آلام الرقبه هى اضطرابات شديده الانتشار فى الجهاز العضلى الحركى.هناك عوامل كثيره متعلقه بحده آلام منها استخدام الاجهزه مثل الهواتف المحموله. و لكن لم يتم التاكد بعد هل تاثيرالهواتف المحموله يختلف باختلاف عمر الشخص الذى يستخدمه ام لا. لذلك’ هدفت هذه الدراسه الى المقارنه بين تاثير مده استخدام الهواتف المحموله على الآم الرقبه، قوه احتمال عضلات ثنى الرقبه العميقه وحساسيه مستقبلات الرقبه الحسيه العميقه في صغار و متوسطى العمر من مرضي الآم الرقبه المكانيكيه المزمن.

الطريقه: ثمانين سيده من مرضي الآم الرقبه المكانيكيه المزمن خضعوا لهذه الرساله. تم تقسيم المرضى الى مجموعتين على حسب اعمارهم. طلب من المرضي التصفح على شبكه الاتصالات لمده ١٠ أو ٣٠ دقيقه متواصلين فى جلستين مختلفتين.فى كل جلسه تم قياس المتغيرات البحثيه قبل و بعد انتهاء التصفح مباشره.

النتائج: وجد ان المرضى فى كلا المجموعتين اظهروا زياده طفيفه فى حده الآم ذات دلاله احصائيه بعد استخدام الهواتف المحموله بغض النظر عن مده الاستخدام. ولكن لا يوجد اى فروق فى تغيرات شده الآم بين المجموعتي الدراسه فى شده الآم . بالنسبه لقوه احتمال عضلات ثنى الرقبه العميقه، لا يوجد دليل احصائي على اختلاف فى قوه احتمال العضلات فى نفس الشخص او بين المجموعتين. بالنسبه لدقه المستقبلات الحسيه العميقه،اظهر متوسطى العمر اخطاء ذات دلاله احصائيه فى حركه الثنى و الفرد للرقبه بعد ١٠و٣٠ دقيقه من الاستعمال. وعند المقارنه بين المجموعتين ظهر اختلال زائد فى ثنى الرقبه ذات دلاله احصائيه فى مجموعه الصغار مقارنه بمتوسطى العمر.

الاستنتاج: استخدام الهاتف المحمول المستمر بغرض تصفح شبكه الاتصالات لمده تصل الى ٣٠ دقيقه تؤدى الى زياده الآم طقيقه و خلل اكثر فى المستقبلات الحسيه العميقه فى بعض الاتجاهات مع عدم دليل للتغير فى قوة احتمال عضلات ثنى الرقبه العميقه فى نفس الجلسه. التقدم فى العمر لا يؤثر على شده الآم و لا قوه احتمال عضلات ثنى الرقبه ولكن يوثر بطريقه طفيفه على دقه المستقبلات الحسيه العميقه بعد استخدام الهواتف المحموله.

الكلمات الداله: الآم الرقبه، الهواتف المحموله، قوة احتمال الرقبه، العمر.

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