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CARPAL TUNNEL SYNDROME IN RELATION TO THE USE OF ELECTRONIC DEVICES

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ABSTRACT

Background: Carpal tunnel syndrome is the most common peripheral nerve compression disorder in adult population. It is often described as an occupational hazard, including occupations involving computer, calculator, sewing machine & mobile phone**. Aim of the study:** To find out the association between carpal tunnel syndrome and the pattern, period and type of the use of electronic devices. **Patient and Methods:** A case-control study was conducted at orthopedic, neurosurgery and nerve study and physiology departments in Erbil Teaching Hospital in Erbil city/ Iraq for the period from 1st of February to the 1st of July 2024. Two hundred patients; 100 cases diagnosed to have carpal tunnel syndrome and 100 controls were included in the study. A structured questionnaire was completed via direct interview with all the participants to collect data related to their sociodemographic characteristics and that of pattern of use of electronic devices**. Results:** Two thirds of the cases were of (30-45 years) age group, large majority (92%) female, 81% housewife's, 93% non-smokers , 66% obese , 8% completed their university education and only 7% had clerical job .Smartphone/Tablet was the most common used device among both studied groups and chatting was the main purpose of use. The duration of use of electronic devices within case group found to be significantly longer than that of control group (p value (0.001).**Conclusions:** The current study revealed a significant association between the duration of the use of electronic devices and carpel tunnel syndrome.

KEYWORDS: Carpel tunnel syndrome, Electronic devices, Pattern of use of electronic devices.

1. INTRODUCTION

1.1 Background

Carpal tunnel syndrome (CTS) is the most prevalent entrapment neuropathy. CTS affects 3.8% of the general population. Its prevalence varies widely in the published literature, and it was reported that it affects females more than males.[1] In addition, CTS was reported more frequently among workers, especially those with occupations that involve exposure to repetitive, high force work using vibrating tools.[2] CTS is a compression neuropathy of the median nerve at the wrist joint, due to the altered wrist biomechanics leading to compression of median nerve in between the carpal bones causing the pain, tingling or numbness present on palm aspect, extending to half lateral side of ring finger, complete middle and index finger with palmer and dorsal aspect of the thumb.[1] The ability of the median nerve's connective tissue layers to elongate, glide, or deform in response to tensile, shear, or compressive pressures is dependent on their extensibility. In addition, the carpal tunnel contains numerous layers of subsynovial connective tissue, which allows the nerve and tendons to glide smoothly. Damage to the tissue may result in permanent diminished nerve compliance during movement. As a result, evaluating the deformability and mobility of the median nerve can provide useful insights into the pathogenesis of CTS.[3] Currently, researchers all over the world observed further advancements in technology and other related industries. Thus, it has been reported that the incidence of work-related musculoskeletal disorders has rapidly increased. Furthermore, workers are becoming more dependent on their smart devices, such as smartphones, which was expected to be used by 6.89 billion people worldwide in 2022. Thus, it is anticipated that various adverse effects of smartphone use will consequently appear.[4] Young adults are more likely to suffer musculoskeletal illnesses because they utilize smart devices such as smart phones, tablets, and computers. Thus, the rapid hand movement associated with prolonged typing should raise concerns about the prevalence of CTS in this cohort. Some

researchers have examined the effect of occupation on the occurrence of CTS.[5] Prolonged use of touch screen devices has been linked to other forms of musculoskeletal disorders. For example, higher musculoskeletal stresses on the neck have been related to tablet usage rather than using a desktop computer. Moreover, smart phone use may cause greater stress on the wrist compared to a keypad phone use.[6]

1.2 Rationale

The use of electronic devices is tremendously increasing all over the world including our community. medically, we concerned about the health hazards of such use including their effect on the oculomotor and nervous system that may interfere with the quality of life of affected persons.

1.3 Aim of the study

To explore the association between carpel tunnel syndrome and the pattern of use of electronic devices.

1.4 Objectives of the study

1. To assess the sociodemographic characteristics and other risk factors of CTS among both studied groups.
2. To explore the mostly used and the purpose of use of electronic devices among cases and control groups.
3. To find out the differences between cases with CTS and controls in regard to the pattern and period of use of electronic devices.

2. Review of literature

Carpal tunnel syndrome (CTS) arises from compression of the median nerve where it passes through the carpal tunnel in the wrist. It is characterized by sensory and, less commonly, motor symptoms and signs in the peripheral distribution of the median nerve. Known causes include trauma, diabetes, rheumatoid arthritis, acromegaly, hypothyroidism and pregnancy.[8]

2.1 Anatomy of carpal tunnel

The carpal tunnel is a narrow channel in the wrist that contains nine flexor tendons and the median nerve and is bounded by eight carpal bones on the dorsal side and the transverse carpal ligament (TCL) which is also known as the flexor retinaculum on the volar side. From radial to ulnar, the proximal carpal row is formed by scaphoid, lunate, triquetrum, and pisiform, and the distal carpal row by trapezium, trapezoid, capitate, and hamate.[9] The TCL is a dense band of fibers that runs between the pisiform and hamate bones medially to the scaphoid and trapezium bones laterally. It forms a fibrous sheath, which binds the carpal tunnel anteriorly and creates a fibro-osseous tunnel. Nine tendons, which control finger movements, including one flexor pollicis longus (FPL), and four each of flexor digitorum superficialis (FDS) and flexor digitorumprofundus (FDP) tendons.[10]

The median nerve, which supplies sensation to the palmer surface of the three radial digits and the radial half of the fourth digit, and it is the only nerve that passes through the carpal tunnel. These structures are surrounded by the subsynovial connective tissue (SSCT), which provides nutrition for the embedded structures, and facilitates sliding movements of the flexor tendons and median nerve (Figure 1).[11]

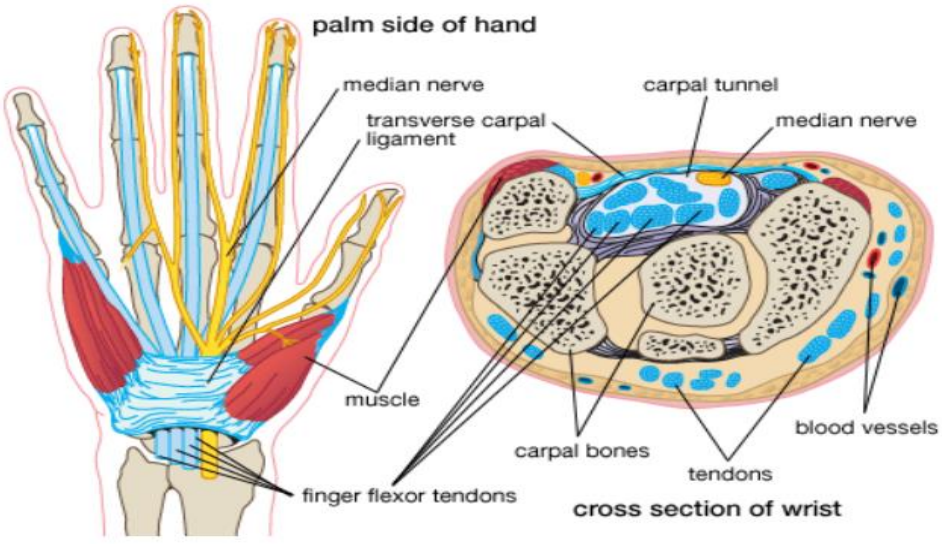

Figure 1: Structure of carpal tunnel.[11]

The mechanical significance of the SSCT relates to its effect on the kinematics and morphology of the different structures within the carpal tunnel.

2.2 Pathophysiology of carpal tunnel syndrome

Carpal tunnel pressure (CTP) plays a role in the pathophysiology of CTS and is an appropriate predictor of CTS. Studies in CTS patients demonstrate elevated CTP when compared with healthy control subjects,

varying between 12–43 mmHg and 5–14 mmHg, respectively. The nerve compression at the carpal tunnel leads to functional change of the median nerve, which can be evaluated by nerve conduction study, i.e. focal slowing of nerve conduction velocity across the carpal tunnel.[12]

It had been found that CTP is influenced by wrist posture, forearm posture, finger posture and fingertip force. Specifically, CTP increases with forearm rotation from 45° of pronation, with finger postures of full finger extension or flexion, and wrist deviation from neutral, especially in wrist extension and ulnar deviation.[13]

For both pressing and pinching tasks, the CTP increased almost linearly with increasing fingertip force, the pressures for pinching being almost 2-fold when compared with those for pressing. Furthermore, the combination of various wrist postures with a gripping task has led to higher CTP than a relaxed hand position, with even higher pressures in CTS patients.[14]

While for the computer work and other smart devices, dynamic activity during typing further increases CTP by approximately 4 mmHg above the pressure associated with just holding hands suspended at the same wrist posture.[15]

The major pathological finding in CTS is non-inflammatory fibrosis and thickening of the synovium, which changes the motion characteristics of the SSCT, tendon excursion and median nerve, under direct vision during open carpal tunnel release. These changes may also cause more strain and pressure in the carpal tunnel, which consequently leads to CTS.[8]

If the hand activity is continued, the initial inflammation within the carpal tunnel may progress to swelling of the structures producing a further increase in CTP which could eventually lead to chronic tenosynovitis and permanent nerve damage.[14]

2.3 Risk factors associated with carpal tunnel syndrome

- Occupational risk factors for CTS include forceful exertion, repetitive motion, awkward posture, localized contact stresses, vibration and cold temperature. These risk factors increase the likelihood of developing CTS through mechanical compression of the median nerve. Activities associated with the development of CTS may arise from ordinary movements that include repetitive gripping, twisting, reaching and moving.[16]

1. Forceful exertion

Forceful exertion is defined as the large amount of physical effort that is required to perform a task, such as heavy lifting, carrying, pushing or pulling, or to maintain control of tools and equipment.[17] Tasks that require forceful exertions place higher loads on the muscles, tendons, ligaments and joints. Greater exerted force means increasing body demands, such as greater muscle exertion along with other physiological changes necessary to sustain an increased effort.[18]

There is strong evidence that the combination of high force and high repetition have a greater risk for CTS and wrist/hand tendinitis than being exposed to force or repetition alone. These risk factors can be further aggravated by awkward body postures, inadequate rest breaks, or lack of job rotation.[19]

2. Repetitive motion

Numerous studies have identified repetitive motion as a risk factor associated with the development of CTS.[20] Highly repetitive work may directly damage tendons through repeated stretching and elongation, as well as increase the likelihood of fatigue and decrease the opportunity for the affected tissues to recover.[21]

3. Awkward posture

Common examples of awkward wrist postures include excessive flexion, extension, radial and ulnar deviation, and pinch grips. There is considerable evidence that awkward posture is the most frequently cited risk factor for the development of CTS.[22]

Awkward postures overload the muscles and tendons, load joints in an uneven or asymmetric manner, or impose a static load on the musculature, thereby inhibiting blood flow. The median nerve may be under considerable risk during awkward hand postures which place extra pressure on the flexor tendons.[23]

- Personal risk factors could be more important than occupational factors including race, age, gender, height and weight. Whites are reported to be more susceptible to the prevalence of CTS when compared with non-white populations.[24] Female gender, body mass index greater than 30, and age of 41–60 years are found significantly more frequently than other factors among CTS patients.[25]

It has been suggested that the explanation for the increased CTS risk among females could be the physiological differences such as lower strength relative to task demands or stature, while the physiological changes due to aging and cumulative workplace exposure with increasing years worked also increase the risk of CTS.[26]

Previous studies suggested that the association between obesity and CTS could be explained either by the accumulation of adipose tissue inside the carpal tunnel or by an increase in hydrostatic pressure through the carpal canal, causing a compression effect on the median nerve.[27]

Besides the demographic risk factors, medical conditions, such as diabetes mellitus, rheumatoid

arthritis, gout and thyroid disease have been linked to CTS.[28] This may be related to anatomic variants (i.e. narrow tunnel, fracture malalignment of the carpal bones, presence of the median artery, abnormal and accessory tendons and muscles), susceptibility of the nerve to pressure (i.e. diabetes, systemic neuropathies), systemic and endocrine disorders (i.e. pregnancy, hypothyroidism, amyloidosis), and space-occupying lesions within the carpal tunnel (i.e. ganglia, osteophytes).[29]

Other aspects of personal lifestyle, such as cigarette smoking, has also been found to significantly increase the risk of CTS. Smoking can impair the vascular supply of the median nerve and thereby may increase the susceptibility of the nerve to physical workloads. Consequently, prolonged tissue ischemia may cause median nerve degeneration and fibrosis.[30]

Pathophysiological mechanisms related to development of CTS are summarized in figure 2.

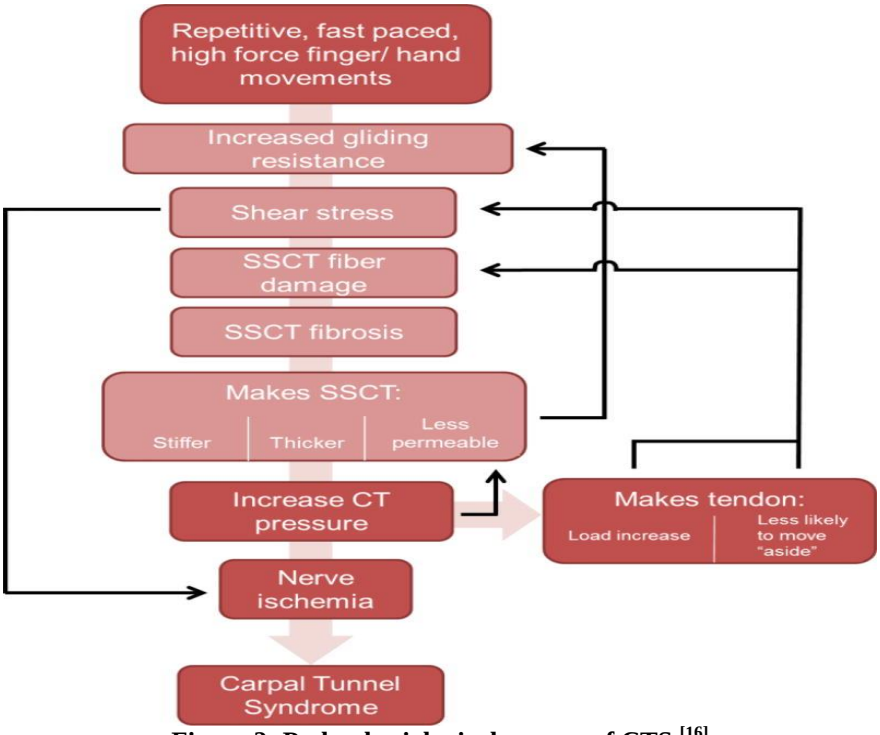

Figure 2: Pathophysiological aspects of CTS.[16]

2.4 Clinical presentation of carpal tunnel syndrome

❖ **Symptoms**

Early symptoms often include tingling and numbness in the hand and fingers. Typically, the thumb, index finger, middle finger, and the radial half (Thumb side) of the ring finger are affected. The little finger is usually spared. Patients with CTS may experience pain, which can be localized to the wrist or involve the entire hand. In more severe cases, pain may radiate proximally into the forearm or even above the elbow to the shoulder, although the neck is not affected.[31]

Moreover, weakness in the hand can occur due to numbness or weakness of the thumb's pinching muscles, which are controlled by the median nerve. This weakness may lead to dropping objects or difficulty with fine motor tasks like buttoning clothing or turning keys.[31]

❖ **Signs**

Clinical signs may include weakness in thumb abduction and opposition (The ability to move the thumb away from the palm and touch it to the other fingers). The thenar eminence (The fleshy part at the base of the thumb) may show atrophy in more advanced cases. Bilateral CTS is common, affecting up to 65% of patients, although unilateral initial presentation is encountered more frequently.[32,33]

2.5 Diagnosis of carpal tunnel syndrome

The diagnosis of CTS is usually based on history, physical examinations, electrodiagnostic testing and diagnostic imaging. Although electrodiagnostic testing, including electromyography and nerve conduction studies, is generally regarded as the gold standard for the diagnosis of CTS, the sensitivity has been reported to be in the range of 49–86% and false negatives in the range of 16–34%.[34]

Even though electrodiagnostic studies show the level of the lesion, they are still not capable of providing anatomical information about variations of the median nerve and surrounding tissues in the carpal tunnel that could help in determining etiology.[35]

Compared with other diagnostic modalities, electrodiagnostic testing remains an expensive and time-consuming procedure not readily accessible to many physicians who are encountering the disease, and it may

even cause mild discomfort relating to electric shock during the procedure.[36]

In recent years, diagnostic imaging, such as ultrasonography, has been of value in the diagnosis of CTS, as it is able to directly show the morphological changes of the median nerve and surrounding tissues in the carpal tunnel, as well as causes of median nerve compression.[37]

2.6 Relation between smart devices Use and Carpal tunnel syndrome

A study conducted in Hong Kong involving university students found that intensive users of electronic devices reported more wrist/hand pain than non-intensive users. These intensive users also showed signs of effects on the median nerve within the carpal tunnel, resulting in symptoms similar to CTS. While this study did not directly prove a causal link between small electronics use and CTS, the symptoms observed after using these devices are similar to those seen in CTS.[38] Prolonged use without recovery time or in awkward postures may increase the risk of injury.[39] It was reported that 27.2% of university students in different gulf countries as Saudi Arabia and United Arab Emirates spent more than 8 hours/day using their smart phones. This finding must raise the concerns about the development of musculoskeletal disorders especially in university students.[7]

Another study investigated the link between electronic devices and CTS. Researchers found that young adults who spent an average of 9 hours a day using mobile phones, tablets, gaming consoles, and computers reported more pain in their wrists and hands than peers who used electronic devices less frequently. While this study didn't directly prove causality, the symptoms observed after using these devices were similar to those seen in CTS, suggesting an increased risk.[40]

Moreover, a study conducted in Ethiopia found that among computer user bankers, the annual prevalence of CTS was 11.7%. Several factors were associated with CTS and included smoking as smokers had a 4.2 times higher risk of developing CTS. Individuals with more than 5 years of work experience were at a 7.98 times higher risk. In addition, repetitive movements increased the risk (3.9 times higher). Moreover, bankers who hadn't received regular physical training were at a 5.2 times higher risk.[41]

3. PATIENT AND METHODS

3.1 Study design

A case-control study.

3.2 Study Setting and Duration

The study was conducted at orthopedic, neurosurgery, nerve study and Physiology departments in Erbil Teaching Hospital in Erbil city/ Iraq for the period from 1st of February to the 1st of July 2024.

3.3 Study Sample and Sample size

A convenient sample of 200 adults aged ≥ 18 years of both sexes were recruited for this study and included 2 groups.

3.4 Inclusion criteria

1. The case group: include 100 patients diagnosed by the specialist of orthopedic, or neurosurgeon to have CTS either clinically alone or confirmed by nerve conductive study (NCS).
2. The Control group: include 100 patients presented to Erbil teaching hospital for other health problem rather than CTS.

3.5 Exclusion criteria

Patients with history of trauma, pregnancy, diabatic, RA, gout, hypothyroidism, or other neurological complain or problems that may cause pain, swelling or numbness in wrist or hand rather than CTS also severally ill patients were excluded in the study

3.6 Data collection tools

A structured questionnaire (Appendix1) was prepared by the researcher after a thorough revision of literature and the data were collected through direct interview with all the participants, the researcher used both Arabic and Kurdish languages to communicate with the patients, and after completing the questionnaire their anthropometric measurements (Weight, height) were assessed by the researcher using the same instruments and their BMI was calculated.

3.6.1 Pilot study

It was conducted initially including 5 cases diagnosed with CTS and 6 controls to test the applicability of the questions and whether the participants could answer them completely and precisely and accordingly the questionnaire was depended. All the participants of pilot study were not included in the data analysis of both study groups.

3.6.2 The questionnaire

It is divided into two main domains: the first domine cover the socio-demographic and anthropometric characteristics of the participants and the second domine concerned with the type and pattern of use of electronic devices.

1. Socio-demographic characteristics

1) Age.
2) Gender (Male or female).
3) Educational level (Illiterate, read & write, primary, secondary, university).
4) Occupation: student, employed (Clerical job), employed (Non clerical job), non employed & retired, housewives.
5) Dominant hand (Right, left).
6) Affected hand (Right, left).
7) BMI (Normal, overweight, obese).
8) Smoking (Non-smoker, current smoker).

2. Type and Pattern of use of electronic devices

1) Most used device: smartphone/tablet, computer/laptop, gaming
2) Main purpose for using ED: chatting, web search, games, educational, work.
3) Most common finger used: thumb, index, middle, ring, little.
4) Average time spent/day (Hours).
5) Total time spent / week (Hours).
6) Duration of use of ED (Years).
7) Time (Hours) of each use (Maximum and Minimum).

3.7 Ethical considerations

Formal approval was obtained from scientific committee of Arab Board of Health & Specializations. Then an official permission was obtained from the Directorate of Health of Erbil and from Erbil Teaching hospital. Verbal consent was taken from all participants after explaining the aim of the study and only those who were willing to participate in the study were included.

3.8 Statistical analysis

All data were managed and analyzed using SPSS (Statistical Package for Social Science) version 27 (IBM, Illinois, USA). The data were presented as frequencies, proportion, mean ±SD. Chi- square test and student t-test were used to assess the association between different variables and CTS. A p value of 0.05 considered the level of significancy in this study.

4. RESULTS

The current study included 200 participants; 100 cases of carpal tunnel syndrome and 100 controls. Comparison of sociodemographic and anthropometric characteristics of both study groups (table 1) revealed significant difference between both groups regarding age, educational level, occupation and BMI. Vast majority of both groups (92% cases, 89% controls) were female. Nearly two thirds (63%) of cases were belonged to the age group (≥30-45 years) while only 8% of them had completed their university education compared to 36% of controls. Most of cases (81%) were housewives compared to 56% of controls and only 7% of cases had clerical job. On the other hand two thirds (66 %) of cases and only one third (33%) of controls were obese. The majority of both cases (93%) and controls (90%) were non smokers.

Table 1: Socio Demographic and Anthropometric characteristics of both study groups.

		Cases No (%)	Controls No (%)	P value*
Age	< 30 years	10(10%)	26(26%)	0.004
	≥ 30-45 years	63(63%)	60(60%)	
	> 45 years	27(27%)	14(14%)	
Gender	Male	8(8%)	11(11%)	0.469
	Female	92(92%)	89(89%)	
Educational level	Illiterate	28(28%)	21(21%)	0.001
	Read & write	17(17%)	9(9%)	
	Primary	24(24%)	17(17%)	
	Secondary	23(23%)	17(17%)	
	University	8(8%)	36(36%)	
Occupation	Student	1(1%)	2(2%)	0.001
	Employed (Clerical job)	7(7%)	36(36%)	
	Employed (Non clerical job)	11(11%)	5(5%)	
	Non-employed & retired	0(0%)	1(1%)	
	Housewives	81(81%)	56(56%)	
BMI	Normal	5(5%)	44(44%)	0.001
	Overweight	29(29%)	23(23%)	
	Obese	66(66%)	33(33%)	
Smoking	Non-smoker	93(93%)	90(90%)	0.723
	Ex-smoker	1(1%)	1(1%)	
	Current smoker	6(6%)	9(9%)	

Figure 1 Showed that most of the participants of the case group (91%) and Control group (92%) were right handed dominant

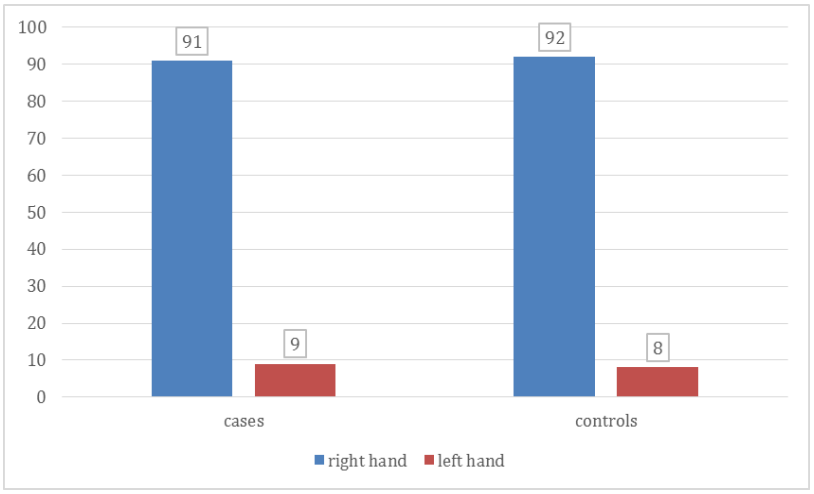

Figure 1: Dominant hand of both study groups.

The most affected hand of patients with CTS as shown in (Figure 2) is the right hand (47%) followed by the left hand (23%) while (30%) of them have their both hands affected

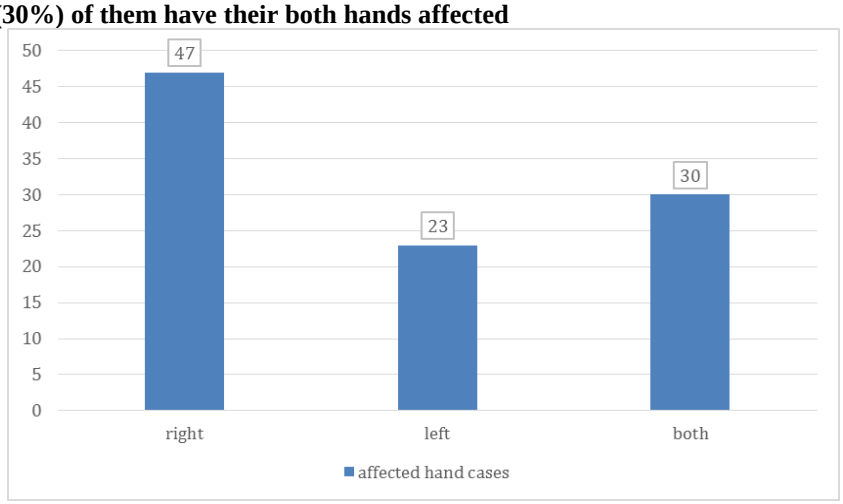

Figure 2: Affected hand of cases with carpal tunnel syndrome.

Figure 3 revealed that out of 47 patients with CTS whose right hands were affected were right-handed and only one was left handed. While out of 23 patients whose left hand were affected 19 of them were right-handed. meanwhile out of 30 patients whose both hands were affected 26 of them were right-handed and only 4 were left handed.

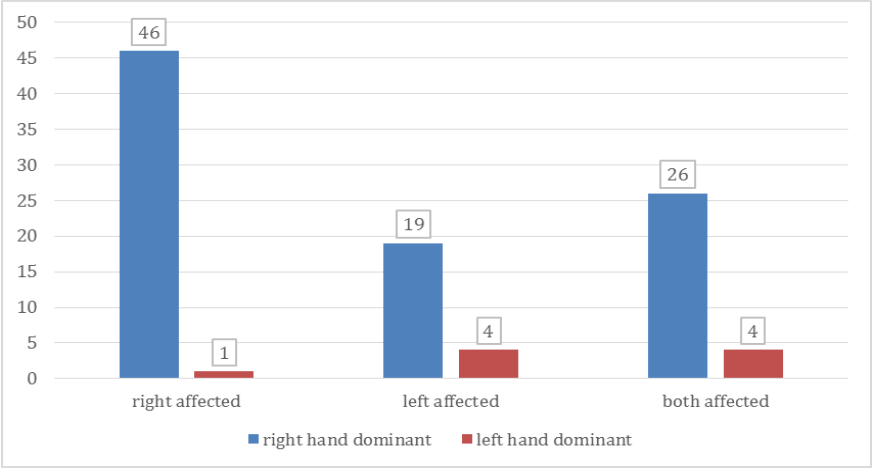

Figure 3: Distribution of cases by their dominant hand.

4.1 Patterns of electronic devices use of both study groups

Comparison of patterns of use of electronic devices among both study groups (table 2) revealed significant difference between both groups regarding most used ED where most of both groups use smartphone/ tablet and only 4% of cases used computer/laptop (p value 0.043). On the other hand, 75% of cases reported chatting as the main purpose for using ED versus 50% of the control group, while only 19% of cases reported web search compared to 37% of controls (p value 0.001). No statistical difference was found between cases and control groups regarding the most common finger used in ED (p value 0.064).

Table 2: Patterns of electronic devices use of both study groups.

		Cases No (%)	Controls No (%)	P value
Most used	Smartphone/Tablet	96(96%)	100(100%)	0.043
	Computer/laptop	4(4%)	0(0%)	
	Gaming device	0(0%)	0(0%)	
Main purpose for using ED	Chatting	75(75%)	50(50%)	0.001
	Web search	19(19%)	37(37%)	
	Games	0(0%)	0(0%)	
	Educational	1(1%)	11(11%)	
	Work	5(5%)	2(2%)	
Most common finger used	Thumb	50(50%)	63(63%)	0.064
	Index	50(50%)	37(37%)	
	Middle	0(0%)	0(0%)	
	Ring	0(0%)	0(0%)	
	Little	0(0%)	0(0%)	

4.2 Duration of use of electronic devices of both study groups

As shown in table 3 the duration of use of ED by case group was significantly longer than that of control group where the mean ±SD of average time spent/day by case group was (3.28±2.29) hours compared to (2.01±2.07) hours of control group (p value0.001) and that of total time spent / week (22.84±16.02) hours of case group in comparison to (14.41±14.48) hours of control group(p value0.001).

Table 3: Duration of use of electronic devices of both study groups.

	Cases Mean ± SD	Controls Mean ± SD	P value*
Average time spent/day (Hours)	3.28±2.29	2.01±2.07	0.001
Total time spent / week (Hours)	22.84±16.02	14.41±14.48	0.001
Duration of use of ED (Years)	14.22±5.78	13.73±5.26	0.531
Time of each use (Hours)			
Maximum time of each use	0.711±0.65	0.698±0.91	0.908
Minimum time of each use	0.218±0.83	0.188±0.61	0.771

*Using Independent

5. DISCUSSION

Carpal tunnel syndrome (CTS) is a prevalent condition characterized by the compression of a nerve in the wrist, which occurs in around 3-6% of the overall population.[10] CTS, is frequently referred to as an occupational danger, particularly in professions that include the use of computers, calculators, sewing machines, and mobile phones. CTS can be caused by frequent and repeated wrist movements, working with a bent wrist, powerful hand motions, and inadequate hand rests.[11] The current study included 200 participants: 100 cases and 100 controls. The most frequent age group(63%) among cases was ≥ 30-45 years which was significantly different from what was reported by Al Shahrani et al.,[42] in Saudi Arabia as the most frequent age was < 30 years old (68.1%). Larger number of included participants and different patients' characteristics could explain this discrepancy. Cases were significantly older in age >45year (73.7%) which was agreed by Al Shahrani E et al., 2021[43] in Saudi Arabia. This was also agreed by Mohammad,[44] in Pakistan and by Ulbrichtová et al.,[45] in Slovakia. Older age is commonly associated with more common musculoskeletal disorders due to loss of tendon elasticity, cumulative neuronal damage across years and burden of specific occupations. In the current study vast majority (92%) of the cases diagnosed to have CTS were females which was agreed with a study of Al Shahrani E et al.,2021[43] in Saudi Arabia as 84.2% of the cases were also females. Females are more prone to musculoskeletal disorders compared to males explaining this finding. Cases in this study were of lower educational level compared to controls, similar results were found in two studies conducted in Saudi Arabia one by Al Shahrani E

et al., 2021[43] and other by Al Shahrani & Al Shehri,[47] Lower educational level is associated with more abuse of electronic devices and lack of knowledge about its risks. Cases were significantly housewives 81% compared to controls 56%, in the same context, Shahrani & Al Shehri,[47] in Saudi Arabia reported significant association between employment status and the development of CTS. This could be explained by more vacant time in housewives which is associated with more use of smart phones. Different results were reported by Al Shahrani E et al., 2021[43] in Saudi Arabia as no significant difference was detected between cases and controls regarding employment status. This could be explained by the participants distribution in their study as they were categorized only into employed and unemployed.

Meanwhile two thirds of cases in this study were obese compared to one third of controls, which agreed with Al Shahrani E et al., 2021[43] in Saudi Arabia as 63.2% of the cases were obese. This was also agreed by Mohammad,[44] in Pakistan and by Ulbrichtová et al.,[45] in Slovakia. The significant association between obesity and musculoskeletal disorders is well-documented. It has been found that a recent gain in weight is a risk factor for CTS because of increased fluid accumulation in the tissue spaces in the carpal tunnel[46] Dominant hand was the right hand in the vast majority of cases and controls (91%&92% respectively). This was agreed by Al Shahrani E et al 2021,[43] in Saudi Arabia as dominant hand in cases was right hand (92.6%) and also in controls (93.7%). On the other hand, Mohammad,[44] in Pakistan reported that dominant hand of cases was the right hand (89.5%) and control (94.5%). Majid et al.,[48] in Malaysia reported that the dominant hand was the right hand (83.1%). The difference in these two studies can be attributed to smaller number of included patients and different patients' personal characteristics. Affected hand of cases was the right hand (47%), left hand (23%) and both hands (30%) which is explained by the previous finding as most of the participants had right dominant hand. Contradicting results were reported by Gonçalves et al.,[49] in Brazil as the affected hand in cases was the right hand (51%), both hands (45%) and left hand (4%). This study focuses only on smartphone users which affected the pattern of handling the device and subsequently yielded different pattern of hand affection. Comparison of patterns of electronic devices use of both study groups revealed a significant difference between both groups. Use of computer/laptop was significantly found in cases (4%) compared to none in controls. Use of computer/laptop is more associated with strain of fingers' ligaments and tendons compared to smart phones. Al Shahrani et al.,[42] in Saudi Arabia reported that use of smart phones was the most prevalent among CTS cases followed by computer (47.8% and 41.5% respectively) which is different from our results (96%, and 4% respectively). Main reason for using ED was for chatting (75%) and web search (19%) which was significantly different in cases compared to controls. Chatting is associated with more effort on the hand wrist, carpal tunnel thus increases the risk of CTS. Similar findings were reported by Al Shahrani et al.,[42] in Saudi Arabia as the main purpose for using ED was for chatting (65.7%) followed by web search (57.4%). In addition, Al Shahrani & Al Shehri,[48] in Saudi Arabia reported that the main reason for using smartphones was for chatting (91.6%) followed by web search (73.7%). Gonçalves et al.,[49] in Brazil reported that the main reason for using smart phones was for chatting (84%). In the present study, the most common finger used among cases was thumb in half of the participants and index in the other half with no significant difference compared to controls. In line with our results, Al Shahrani et al.,[42] in Saudi Arabia reported that the most common finger used among cases was thumb (74.7%) followed by index (46.7%). Mohammad,[44] in Pakistan reported that the most common finger used among cases was thumb (81.6%) followed by index (18.4%). In the current study, average time spent/day among cases had a mean of 3.28 ± 2.29 hours which was less than data reported by Anand et al.,[1] in India (5.8 ± 2.4 hours), In addition in this study, total time spent/week had a mean of 22.84 ± 16.02 hours which was also less than data reported by Anand et al.,[1] in India (4.8 ± 1.38 days). Comparison of duration of use of electronic devices of both study groups revealed significantly longer average time spent/day and total time spent / week in cases compared to controls. Longer time spent on electronic devices is associated with more effort on the hand wrist and carpal tunnel. In agreement with current results, Shahrani & Al Shehri,[47] in Saudi Arabia reported that cases had significantly longer average time spent/day and total time spent / week compared to controls. Mohammad,[44] in Pakistan reported similar findings as carpal tunnel patients had more hours of using touchscreen /day compared to controls. The current study encountered several limitations related to the sample size and duration of the study, beside the nature of the study being a case -control which is like other observational studies that can suggest association between an exposure and the disease but they cannot prove causality.

Appendix 1

1. Socio demographic data

Age	
Gender	Male
	Female
Educational level	Illiterate
	read & write
	Primary

	Secondary
	University
Occupation	Student
	Employed (Clerical job)
	Employed (Non clerical job)
	Non employed & retired
	Housewives
Dominant hand	Right
	Left
Affected hand	Right
	Left
	Both
BMI	Normal
	Overweight
	Obese
Smoking	Non-smoker
	Ex-smoker
	Current smoker

2. Patterns of electronic devices use

Most used	Smartphone/Tablet
	Computer/laptop
	Gaming device
Main purpose for using ED	Chatting
	Web search
	Games
	Educational
	Work
Most common finger used	Thumb
	Index
	Middle
	Ring
	Little
Average time spent/day	Hours
Total time spent / week	Hours
Duration of use of ED (years)	
Time of each use	Maximum time of each use (hours)
	Minimum time of each use (hours)

6. CONCLUSIONS

- Vast majority cases of CTS were housewives, nonsmokers, about two third of them were obese and of (≥30-45 years) age group
- Only 7% of cases found to have clerical job and just 8% of them had university level of education.
- Nearly half of the cases have their right hand affected, one quarter had their left hand and the others had their both hands affected
- Both the thumb and index were the fingers most frequently used while dealing with electronic devices among both studied groups
- Smartphone/Tablet was the mostly used electronic devices among both studied groups and only 4% of cases used computer/laptop.
- The purpose of use of electronic devices mostly reported by both groups was chatting followed by web search
- Cases reported longer duration of time (average time spent/day and total time spent / week) using electronic devises than control group with statistically significant differences.

REFERENCES

1. Anand B, Kalra R, Chauhan S, Kulshrestha S, Raj S. Association of Portable Electronic Devices With Neck Disability And Carpal Tunnel Syndrome Among Students. J Med Case Rep and Rev, 2021; 4(07): 939-44.
2. LisicaMandek D, Brborović H. Computer use at work and carpal tunnel syndrome: overview of systematic reviews. Sigurnost, 2023; 3, 65(2): 163-77.
3. Warda DG, Nwakibu U, Nourbakhsh A. Neck and upper extremity musculoskeletal symptoms secondary to maladaptive postures caused by cell phones and backpacks in school-aged children and adolescents. In Healthcare, 2023; 10, 11(6): 819.
4. Hassaan MM, Jareebi MA, AlKaabi HA, Hobani AH, Alfuhigi YM, Albahli NK, et al. Prevalence of

thumb and wrist pain among smartphone users in the Saudi Arabian general population: A Cross-sectional study. Cureus, 2024; 25, 16(1): e52922.
5. Abd El Mawgod MM, Alhazmi KM, Alanazi AS, Alenezi SM, Alanazi WA, Alenezi AS, et al. Awareness of carpal tunnel syndrome among the adult population in Northern Saudi Arabia. Cureus, 2024; 11, 16(1): e52100.
6. Vergara Reyes K, Rojas Valdés PI, BesoaínPino F, Saavedra Redlich K. Work-In-Progress: Carpal Tunnel Syndrome rehabilitation: An Approach using a smartphone. In Interactive mobile communication, technologies and learning, 2021; 4: 744-751.
7. Ma'touq J, Alnuman N, Abuzer I, AbdelGader B. The association between mobile phone use and neuromusculoskeletal complaints. Work, 2023; 20: 1-1.
8. Genova A, Dix O, Saefan A, Thakur M, Hassan A. Carpal tunnel syndrome: a review of literature. Cureus, 2020; 19, 12(3): e7333.
9. Padua L, Coraci D, Erra C, Pazzaglia C, Paolasso I, Loreti C, et al. Carpal tunnel syndrome: clinical features, diagnosis, and management. Lancet Neuro, 2016; 1, 15(12): 1273-84.
10. Li ZM, Jordan DB. Carpal tunnel mechanics and its relevance to carpal tunnel syndrome. Hum move sci, 2023; 1, 87: 103044.
11. Omole AE, Awosika A, Khan A, Adabanya U, Anand N, Patel T, et al. An integrated review of carpal tunnel syndrome: new insights to an old problem. Cureus, 2023; 15(6): e40145.
12. Aboonq MS. Pathophysiology of carpal tunnel syndrome. Neurosciences J, 2015; 1, 20(1): 04-9.
13. Duncan SF, Bhate O, Mustaly H. Pathophysiology of carpal tunnel syndrome. Carpal Tunnel Syndrome and related median neuropathies: challenges and complications, Springer, 2017; 13-29.
14. Schmid AB. Pathophysiology of the carpal tunnel syndrome. Physioscience, 2015; 11(01): 2-10.
15. Joshi A, Patel K, Mohamed A, Oak S, Zhang MH, Hsiung H, et al. Carpal tunnel syndrome: pathophysiology and comprehensive guidelines for clinical evaluation and treatment. Cureus, 2022; 20: 14(7).
16. Festen-Schrier VJ, Amadio PC. The biomechanics of subsynovial connective tissue in health and its role in carpal tunnel syndrome. J electro and kin, 2018; 1, 38: 232-9.
17. Karimi N, Tabrizi N, Moosavi M. Prevalence of carpal tunnel syndrome and associated risk factors. J Mazandaran University of Med Sci, 2017; 10, 26(146): 179-84.
18. Pourmemari MH, Heliövaara M, Viikari-Juntura E, Shiri R. Carpal tunnel release: Lifetime prevalence, annual incidence, and risk factors. Muscle & nerve, 2018; 58(4): 497-502.
19. Romana UL, Viera JA, Oto OS, Mária TA, Ján JA, Henrieta HU. Occupational risk factors for carpal tunnel syndrome among working population. Zdravotnickelisty, 2022; 1: 10(1).
20. Feng B, Chen K, Zhu X, Ip WY, Andersen LL, Page P, et al. Prevalence and risk factors of self-reported wrist and hand symptoms and clinically confirmed carpal tunnel syndrome among office workers in China: a cross-sectional study. BMC Public Health, 2021; 21: 1-0.
21. Roquelaure Y, Garlantézec R, Evanoff BA, Descatha A, Fassier JB, Bodin J. Personal, biomechanical, psychosocial, and organizational risk factors for carpal tunnel syndrome: a structural equation modeling approach. Pain, 2020; 1, 161(4): 749-57.
22. Guan W, Lao J, Gu Y, Zhao X, Rui J, Gao K. Case-control study on individual risk factors of carpal tunnel syndrome. Experimental and Therapeutic Medicine, 2018; 1, 15(3): 2761-6.
23. Harris-Adamson C, Eisen EA, Kapellusch J, Garg A, Hegmann KT, Thiese MS, et al. Biomechanical risk factors for carpal tunnel syndrome: a pooled study of 2474 workers. Occupational and environmental medicine, 2015; 1, 72(1): 33-41.
24. Hulkkonen S, Shiri R, Auvinen J, Miettunen J, Karppinen J, Ryhänen J. Risk factors of hospitalization for carpal tunnel syndrome among the general working population. Scandinavian Journal of Work, Environment & Health, 2020; 1, 46(1): 43-9.
25. Ricco M, Cattani S, Signorelli C. Personal risk factors for carpal tunnel syndrome in female visual display unit workers. International Journal of Occupational Medicine and Environmental Health, 2016; 29(6): 927-36.
26. Calandruccio JH, Thompson NB. Carpal tunnel syndrome: making evidence-based treatment decisions. Orthopedic Clinics, 2018; 1, 49(2): 223-9.
27. Ozcakir S, Sigirli DE, Avsaroglu H. High wrist ratio is a risk factor for carpal tunnel syndrome. Clinical anatomy, 2018; 31(5): 698-701.
28. Shiri R. Arthritis as a risk factor for carpal tunnel syndrome: a meta-analysis. Scandinavian journal of rheumatology, 2016; 2, 45(5): 339-46.
29. Al Shahrani E, Al Shahrani A, Al-Maflehi N. Personal factors associated with carpal tunnel syndrome (CTS): a case-control study. BMC Musculoskeletal Disorders, 2021; 22: 1-7.
30. Sharief F, Kanmani J, Kumar S. Risk factors, symptom severity and functional status among patients with carpel tunnel syndrome. Neurology India, 2018; 1, 66(3): 743-6.
31. Eslami S, Fadaei B, Baniasadi M, Yavari P. Clinical presentation of carpal tunnel syndrome with different severity: a cross sectional study. American J Cli and Exp Imm, 2019; 8(4): 32.
32. Alanazy MH. Clinical and electrophysiological evaluation of carpal tunnel syndrome: approach and pitfalls. Neurosci J, 2017; 1, 22(3): 169-80.
33. Mooar PA, Doherty WJ, Murray JN, Pezold R, Sevarino KS. Management of carpal tunnel syndrome. JAAOS-Journal of the American

Academy of Orthopaedic Surgeons, 2018; 15, 26(6): e128-30.
34. Wipperman J, Goerl K. Carpal tunnel syndrome: diagnosis and management. American family physician, 2016; 15, 94(12): 993-9.
35. Durham CO, VanRavenstein K. It's all in the wrist: diagnosis and management of carpal tunnel syndrome. Orthopaedic Nursing, 2017; 1, 36(5): 323-7.
36. Wang WL, Buterbaugh K, Kadow TR, Goitz RJ, Fowler JR. A prospective comparison of diagnostic tools for the diagnosis of carpal tunnel syndrome. J hand sur, 2018; 1, 43(9): 833-6.
37. Yoshii Y, Zhao C, Amadio PC. Recent advances in ultrasound diagnosis of carpal tunnel syndrome. Diagnostics, 2020; 15, 10(8): 596.
38. Hassan A, Beumer A, Kuijer PP, van der Molen HF. Work-relatedness of carpal tunnel syndrome: Systematic review including meta-analysis and GRADE. Health Science Reports, 2022; 5(6): e888.
39. Trillos-Chacón MC, Castillo-M JA, Tolosa-Guzman I, Medina AF, Ballesteros SM. Strategies for the prevention of carpal tunnel syndrome in the workplace: A systematic review. Applied ergonomics, 2021; 1, 93: 103353.
40. Gautam N, Shrivastava A. A Review on Risk Factors and Diagnosis of Carpal Tunnel Syndrome. ECS Transactions, 2022; 24, 107(1): 6921.
41. Demissie B, Yenew C, Alemu A, Bantie B, Sume BW, Deml YA, et al. Carpal tunnel syndrome and its associated factors among computer user bankers in South Gondar Zone, Northwest Ethiopia, 2021: a cross sectional study. BMC Musculoskeletal Disorders, 2023; 19, 24(1): 828.
42. Al Shahrani AS, Albogami SS, Alabdali AF, Alohali SK, Almedbal HS, Aldossary GF. Does the use of electronic devices provoke the carpal tunnel syndrome (CTS) symptoms and functional impairment? A cross-sectional study. The Egyptian Rheumatologist, 2019; 1, 41(4): 313-7.
43. Al Shahrani E, Al Shahrani A, Al-Maflehi N. Personal factors associated with carpal tunnel syndrome (CTS): a case-control study. BMC Musculoskeletal Disorders, 2021; 22: 1-7.
44. Mohammad WS. Work-related risk factors for Carpal Tunnel Syndrome among Majmaah University female touchscreen users. Pakistan journal of medical sciences, 2019; 35(5): 1221.
45. Ulbrichtová R, Jakušová V, Osina O, Zibolenová J, Kuka S, Hudečková H. Association of the role of personal variables and nonoccupational risk factors for work-related carpal tunnel syndrome. Cent Eur J Public Health, 2020; 1, 28(4): 274-8.
46. Mansoor S, Siddiqui M, Mateen F, Saadat S, Khan Z. H, Zahid, etal. Prevalence of Obesity in Carpal Tunnel Syndrome Patients: A Cross-Sectional Survey. Cureus, 2017; 9: e1519.
47. Al Shahrani ES, Al Shehri NA. Association between smartphone use and carpal tunnel syndrome: A case-control study. J Fam Med and Primary Care, 2021; 27, 10(8): 2816-21.
48. Majid N, Ismail MA, Masar ML, Syabariyah S. Mobile Games Among University Students: A symptom and functional severity for Carpal Tunnel Syndrome. Env-Beh Pro J, 2022; 30, 7(20): 255-60.
49. Gonçalves AM, Carmo VJ, Araújo LM, Pereira TM. Use of smartphones as a risk factor for the development of morbidities in the wrist and fingers. RevistaBrasileira de Ortopedia, 2023; 24, 58: 457-62.