DOI: 10.56452/2021SP-8-047

ISSN: 0974-5823 Vol. 6 (Special Issue 4, November 2021)

International Journal of Mechanical Engineering

Impact of Wrist Posture on Potential CTS Symptoms Using Chi-Square Test and Odds Ratio

Vikas Kaushik[1], Manish Sharma[1], Vinod Kumar[1] and Anurag Malik[2]

Department of Mechanical Engineering, Chandigarh Engineering College, Jhanjeri, Mohali-140307, Punjab, India

[2]Department of Agriculture, Chandigarh School of Business, Jhanjeri, Mohali-140307, Punjab, India

E-mail: vikas.j1611@cgc.ac.in

Abstract: Both wrist position when typing and typing itself have an impact on carpal tunnel pressure. Extreme wrist extension or flexion can put a lot of pressure on the carpal tunnel, damaging the median nerve. The impact of wrist position on probable CTS symptoms is investigated using the chi-square test. The results of the chi-square test showed that employees with non-neutral wrist posture are more likely to experience possible CTS symptoms than employees with neutral wrist posture. Engineering and training initiatives that lessen persistent non-neutral wrist postures should be a part of workplace interventions to avoid CTS. When compared to workers with neutral wrist posture, workers with non-neutral wrist posture are not more likely to experience possible CTS symptoms. The wrist extension angle while using a computer keyboard and the development of CTS are significantly correlated. Engineering and training initiatives that lessen persistent non-neutral wrist postures should be a part of workplace interventions to avoid CTS. As a general rule, keep your wrists in a neutral position as much as possible. Carpal tunnel pressure increases with any departure from neutral wrist posture, which is a sign of CTS. Conclusion An odds ratio test was conducted, and the results showed that employees with non-neutral wrist postures are 2.75 times more likely than employees with neutral wrist postures to experience probable CTS symptoms.

Keywords: CTS (Carpal Tunnel Syndrome), Chi-Square Test, Odds Ratio Test

Introduction

Along with grip strength and hand repetition, wrist posture (repeated or prolonged extension or flexion) may enhance a worker's risk of CTS. Extreme wrist extension or flexion can put a lot of pressure on the carpal tunnel, damaging the median nerve. This physiological data lends support to the idea that persistent uncomfortable wrist postures among employees may result in CTS. When compared to short periods of time, prolonged exposure to non-neutral wrist postures is linked to a two-fold greater risk for CTS. Engineering and training initiatives that lessen persistent non-neutral wrist postures should be a part of workplace interventions to avoid CTS. The wrist extension angle while using a computer keyboard and the development of CTS are significantly correlated. The risk of CTS is higher for computer users who have their wrists extended by more than 20 degrees. Both wrist position when typing and typing itself have an impact on carpal tunnel pressure. The pressure increases with increasing deviation from neutral and is lowest close to the neutral wrist position (0° flexion/extension, 0° ulnar/radial deviation). The small sample size and the restricted wrist posture excursion in the direction of flexion and ulnar deviation may be to blame for the observation of a significant difference in pressure solely in extension and radial deviation.The wrist deviations combined with the hand activities include:

Neutral (no deviation)
Radial deviation
Ulnar deviation
Flexion

DOI: 10.56452/2021SP-8-047

Extension
Extended flexion
Extended extension

Figure 1 displays the human range of motion (ROM), or the maximum values of these angles combined. Wrist flexion, radial deviation, and supination are all given negative values whereas wrist extension, ulnar deviation, and pronation are all given positive values.

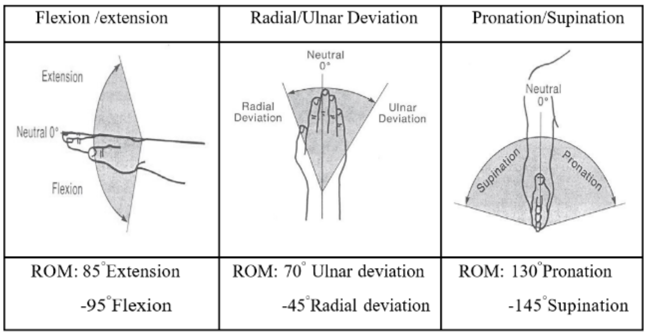

Figure 1 Measurement of wrist posture (American Academy of Orthopedic Surgeons)

The flexion-extension position of the hand was classified as neutral (15 flexion-15 extension), non-neutral (15-45 flexion or extension), or extreme (> 45 flexion or extension) based on the angle between the midline of the forearm (semipronated) and the metacarpal bones. The angle formed by the third metacarpal bone and the midline of the pronated forearm is known as the deviation position of the hand. Neutral (10 ulnar deviation-5 radial deviation), non-neutral (10-20 ulnar deviation or 5-15 radial deviation), or excessive (> 20 ulnar deviation or > 15 radial deviation) are the three categories that deviations fall under. Numbness and tingling are the main symptoms. Pain, a lack of strength, and trouble grasping are examples of secondary symptoms that are typically present in the median nerve distribution area. The onset of symptoms usually happens over the course of several weeks, months, or even years. Even though bilateral CTS is prevalent, it usually affects the dominant hand first and worse than the opposite hand.

Literature survey

Kong et al. (2011) studied the effect of hand position on maximum grip strength and discomfort. The objective of this study was to measure grip strength and perceived discomfort at different hand positions and to investigate the effects of shoulder angle and reach distance on grip strength. Maximum grip strength and discomfort were measured in 58 male volunteers at 15 different hand positions in standing posture. The hand position was defined by five hand directions (i.e. 0º, 45º, 90º, 130º, and 180º) of the shoulder flexion angle, and three hand-shoulder distances (i.e. 100%, 75%, and 50%) of arm reach. After gripping maximum strength, the subjects rated their perceived discomfort using a visual analog scale (VAS). Analysis of variance on grip strength and discomfort rating showed significant effects of hand-shoulder distance, hand direction and their interaction ($p < 0.05$). No significant interaction effect of grip strength between hand-shoulder distance and hand direction was shown ($p > 0.05$), while there was a significant interaction effect of discomfort and hand direction and hand-shoulder distance ($p < 0.05$). This study showed different effects on grip strength when individuals use different hand positions in order to grip. It is recommended that hand position should be over 75% of arm reach and in the reach direction of between 45º and 135º of the shoulder angle for optimum grip strength and comfort. The risk factors in Carpal tunnel syndrome among automotive glass channel rubber assembly line workers through health surveillance, Phalen‟s and Tinel‟s Tests. Analysis had been made by classifying the workers on the basis of gender and type of work performed i.e. repetitive or non-repetitive work.

Experimental works

A persistent wrist deviation from neutral while working may be linked to carpal tunnel syndrome. Wrist posture is thought to be a risk factor for distal upper extremity musculoskeletal problems. However, there isn't much physiologic support for recommended wrist posture during work. As a general rule, keep your wrists in a neutral position as much as possible. Carpal tunnel pressure increases with any departure from neutral wrist posture, which is a sign of CTS. The wrist extension angle when typing on a computer keyboard and the development of CTS are strongly correlated. The risk of CTS is higher for computer users who have their wrists extended by more than 20 degrees. When compared to short periods of time, prolonged exposure to non-neutral wrist postures is linked to a two-fold greater risk for CTS. Engineering and training initiatives that lessen persistent non-neutral wrist postures should be a part of workplace interventions to avoid CTS. The angle between the metacarpal bones and the midline of the forearm (semipronated) is what is known as the flexion-extension position of the hand. The angle formed by the third metacarpal bone and the midline of the pronated forearm is known as the deviation position of the hand.The various positions of wrist posture are shown in the Table 1.

In the current investigation, 40 employees were discovered to be working with neutral wrist posture, 63 employees were discovered to be working with non-neutral wrist posture, and no employees were discovered to be working with severe posture.

Table 1 Categorization of wrist posture

Wrist posture	Neutral	Non-neutral	Extreme
Flexion	0-15°	15-45°	> 45°
Extension	0-15°	15-45°	> 45°
Radial deviation	0-5°	5-15°	> 15°
Ulnar deviation	0-10°	10-20°	> 20°

In the current investigation, 40 employees were discovered to be working with neutral wrist posture, 63 employees were discovered to be working with non-neutral wrist posture, and no employees were discovered to be working with severe posture..

Analysis of data using chi-square test and odds ratio

The chi-square (χ^2) test is commonly used to determine whether or not data is statistically significant. In the current investigation, it is crucial to assess if the data are statistically significant or not because only in this case can the odds ratio be calculated. According to wrist position, data from health surveillance in the industrial business is divided into two groups. It is presumed that non-neutral wrist posture has no impact on possible CTS symptoms, i.e., non-neutral wrist posture workers are not more susceptible to prospective CTS symptoms than non-neutral wrist posture workers. The two groups of wrist posture are non-neutral group (Group 1) and neutral (Group 2). A 2 × 2 contingency table set-up used for chi-square test is shown in Table 2.

Table 2 2×2 contingency set-up used for chi-square test

Description	Group 1	Group 2	Total
Symptom Present (Test positive)	a	b	a + b
Symptom not Present (Test negative)	c	d	c + d
Total	a + c	b + d	a+b+c+d = n

Table 3 Survey based observed frequency data for non-neutral and neutral wrist posture group

	Non-neutral wrist posture	Neutral wrist posture	Total
Symptom present	28	9	37
Symptom not present	35	31	66
Total	63	40	103

	F_o	F_t	$(F_o-F_t)^2$	$(F_o-F_t)^2/F_t$
Non-neutral wrist posture group	28	22.631	28.826	1.7273
	35	40.369	28.826	0.7140
Neutral wrist posture group	9	14.369	28.826	2.0061
	31	25.631	28.826	1.1246
				$\chi^2 = (F_o-F_t)^2/F_t = 5.572$

Calculated χ^2 for non-neutral and neutral wrist posture group = $(F_o-F_t)^2/F_t = 5.572$

The number of degrees of freedom is required in order to apply the chi-square test. In the 2 x 2 contingency Table 1, the degrees of freedom v = (2-1) (2-1) = 1 is required in order to apply chi-square test. In general, for r rows and c columns, the number of degrees of freedom is (r-1) (c-1). In the present 2 x 2 contingency table, the standard value for degree of freedom 1 at 5% level is 3.84. Since the calculated value of χ^2 is 5.572 which is greater than standard value, the hypothesis is rejected. Hence, there is a significant difference amongst the non-neutral and group workers. So odds ratio can be calculated for non-neutral and neutral wrist posture group. Odds ratio is calculated using formula

$$OR = \frac{a/c}{b/d} = \frac{ad}{bc}$$

Where

a = CTS sufferers of non-neutral wrist posture group

b = CTS sufferers of neutral wrist posture group

c = non CTS sufferers of non-neutral wrist posture group

d = non CTS sufferers of neutral wrist posture group

$$OR = \frac{28x31}{9x35}$$

$$OR = 2.75$$

DOI: 10.56452/2021SP-8-047

The odds ratio value indicates that non-neutral wrist posture workers have a 2.75 times higher risk of developing CTS symptoms than non-neutral wrist posture workers.

Results and Discussion

The impact of wrist position on probable CTS symptoms was investigated using the chi-square test. The results of the chi-square test showed that employees with non-neutral wrist posture are more likely to experience possible CTS symptoms than employees with neutral wrist posture.

Conclusion

An odds ratio test was conducted, and the results showed that employees with non-neutral wrist position have a 2.75 times higher risk of developing possible CTS symptoms than employees with neutral wrist posture.

Future scope

An instrument called electrogoniometer can be used for measuring wrist angle which can measure wrist angle more accurately as compared to manual goniometer.

References

1. Fagarasanu M., Kumar S. “Carpal tunnel syndrome due to keyboarding and mouse tasks” International Journal of Industrial Ergonomics, 2003, 31, 119-136.
2. Fung B. K. K., Chan K. Y., Lam L. Y., Cheung S. Y., Choy N. K., Chu K. W., Chung L. Y., Liu W. W., Tai K. C., Yung S. Y. and Yip S. L. “Study of wrist posture, loading and repetitive motion as risk factors for developing carpal tunnel syndrome” World Scientific Publishing Company, Hand Surgery, 2007, Vol. 12, No. 1 (13–18).
3. Gagne R. “Repetitive Strain Injury (RSI) Review of proactive measures to reduce costs and future injury rates” Fit2WRK Clinical Educational Series Volume 1.11, 2010.
4. Gerdle B, Karlsson S, Day S, Djupsjöbacka M “Acquisition, Processing and Analysis of the Surface Electromyogram” Modern Techniques in Neuroscience. Eds: Windhorst U and Johansson H. Springer Verlag, Berlin, 1999, Chapter 26: 705-755.
5. Ghasemi Mohammad, Rezaee Maryam, Chavoshi Farzaneh, Mojtahed Mohammad, Koushki Shams Ehsan “Carpal Tunnel Syndrome: The Role of Occupational Factors Among 906 Workers” Trauma Mon.2012; 17(2):296-300.
6. Gorsche G. Ron, Wiley Preston J, Renger F Ralph, Brant F Rollin, Gemer Y Tara, Sasyniuk M Treny “Prevalence and incidence of carpal tunnel syndrome in a meat packing plant” Occup Environ Med 1999;56:417–422.
7. Gupta S.P., “Statistical Methods” 2001.
8. Harris-Adamson Carisa, Eisen A Ellen, Dale Marie Ann, Evanoff Bradley, HegmannT Kurt , Thiese S Matthew, Kapellusch M Jay, Garg Arun, Burt Susan, Bao Stephen, Silverstein Barbara, Gerr Fred, Merlino Linda, Rempel David, “Personal and workplace psychosocial risk factors for carpal tunnel syndrome: a pooled study cohort” Occup Environ Med 2013;70:529–537.
9. Jagga V., Lehri A., Verma S.K. “Occupation and its association with Carpal Tunnel syndrome- A Review” Journal of Exercise Science and Physiotherapy, 2011, Vol. 7, No. 2: 68-78.
10. Jantree C., Bunterngchit Y., Tapechum S., Vijitpornk V. “An Experimental Investigation on Occupation Factors Affecting Carpal Tunnel Syndrome in Manufacturing Industry Works” AIJSTPME 2010, 3(1): 47-53.