Influence of Age, Gender, and Sidedness on Ulnar Nerve Conduction

Mahinda Kommalage and Sampath Gunawardena

Summary: Anatomic variation and susceptibility for injuries depending on gender were described for the ulnar nerve. The aim of this study was to investigate the association between gender and ulnar never motor conductance and the influence of sidedness for this association. Study was conducted as a retrospective study using nerve conduction study data of ulnar nerve of 2,526 patients. Influences of age, gender, and sidedness on ulnar never motor conduction velocity (UMV) were investigated. Regression analysis was conducted to compare the relationship between UMV and age. Regression was significantly higher in males (−0.253 vs. −0.113), suggesting higher influence of age on UMV in males than in females. When analyzing right and left sides separately, influence of age on UMV is higher in males (−0.286 vs. −0.109) only in right side. Multiple regression analysis was done comparing the influence of age, gender, and sidedness on UMV, and it found that the order of influence is gender, age, and sidedness (Beta values 0.153, −0.140, and 0.029). Ulnar nerve motor conductance depends on gender, age, and sidedness. Males are having lower UMV than females. Age-dependant change of UMV is more prominent in males than in females and is more prominent in right hand than in left hand in males.

Key Words: Ulnar never motor conduction velocity, Age and ulnar nerve, Gender and ulnar nerve, Sidedness and ulnar nerve, Ulnar never motor conduction velocity in males.

(*J Clin Neurophysiol* 2013;30: 98–101)

Ulnar neuropathy represented one third of all nerve injuries and was the most frequent nerve injury (Kroll et al., 1990). Therefore, the ulnar nerve is often subjected to nerve conduction study, which is the main investigation for a nerve injury. Understanding the influences of physical and biologic factors on ulnar nerve conduction is important in interpreting the results of conduction studies of the nerve.

Conduction velocity of a nerve depends on many well-known factors such as temperature, the diameter, and the type of the nerve fibers contained in the nerve. Influence of age (Rivner et al., 2001; Stetson et al., 1992), body mass index (Buschbacher, 1998; Landau et al., 2005), and height (Robinson et al., 1993; Stetson et al., 1992) on conductance of ulnar nerve were described in previous studies.

Many gender-related variations were described related to the ulnar nerve. Previous studies on cadavers described gender-related anatomic differences in the elbow related to the ulnar nerve. Two main differences were larger fat content on the medial aspect of the elbow in females compared with males and the tubercle of the coronoid process was larger in males (Contreras et al., 1998). Males are more predispose to ulnar nerve injury (Cheney et al., 1999) and susceptible to direct pressure on unmyelinated ulnar nerve fibers (Morell et al., 2003).

Because of these gender differences in the anatomy and susceptibility of the ulnar nerve for external forces, we hypothesized that motor conduction property of the ulnar nerve is different in males than females. In this study, we investigated the influence of gender on ulnar never motor conduction velocity (UMV) and disparity of this association in left and right hands.

METHODS

Selection of Subjects

Study was conducted as a retrospective study using data of the patients who were referred for nerve conduction studies to the neurophysiology laboratory in the Department of Physiology, Faculty of Medicine, University of Ruhuna (Galle, Sri Lanka). The majority of the patients were referred with symptoms suggestive of carpal tunnel syndrome. Data were collected from records of those patients who had undergone nerve conduction studies from 2003 to 2009. Data on age, sex, ulnar nerve conduction velocity, sides of the hand, and temperature of the hands (from limited number of hands) were used for analysis. Hands with UMV below 50 m/s were excluded from the analysis because of possible neuropathy in the ulnar nerve (Campbell, 1999; Practice Parameter for Electrodiagnostic Studies in Ulnar Neuropathy at the Elbow, 1999). Hands with complaints related to the ulnar nerve, suspected ulnar nerve diseases/conditions, were excluded considering information available in the records. The study was approved by the Ethical Review Committee, Faculty of Medicine, University of Ruhuna.

Electrophysiological Studies

Electrophysiological studies were performed using a Neuropack MEM 3202 (Nihonkohden, Tokyo, Japan) electromyography machine in the Department of Physiology, Faculty of Medicine (University of Ruhuna, Galle, Sri Lanka). Surface recording and stimulation were carried out for all studies. Recording electrodes were stainless steel disk electrodes with a diameter of 1 cm. Ulnar motor studies were performed by recording the compound muscle action potential from abductor digiti minimi with G1 placed over the muscle belly and G2 placed over the distal tendinous insertion. The ulnar nerves were stimulated at the wrist (8 cm proximal to the G1) and just above the elbow. A ground electrode was placed at the wrist. Compound muscle action potentials with supramaximal stimulation of the nerve were obtained. We measured the latency difference between elbow and wrist stimulation and calculated UMV. Electrophysiological studies were performed in a non–air conditioned room in the daytime in tropical climate with minimum or no temperature change throughout the year.

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ISSN: 0736-0258/13/3001-0098

Influence of Age, Gender, and Sidedness

The following were assessed using the data: (1) mean UMV of males and females in right and left side separately, (2) the influence of age on UMV in males and females, (3) the influence of age on UMV in right and left hands, and (4) comparison of the influences of age, gender, and sidedness on UMV. Regression analysis was conducted to compare the influences of age on UMV separately in right and left hands in males and females. Multiple regression analysis was conducted, and the beat values were calculated to compare the influences of age, gender, and side of the hand on UMV.

Age-Matched Sample

To exclude the influence of age, an age-matched sample with equal number of male and female hands was randomly selected. Mean UMV of males and females as well as mean UMV of right and left sides were compared in this sample.

Statistical Analysis

A *t*-test was used in the comparison of UMV in males and females and right and left hands. Regression analysis was used to compare the influence of age on UMV in male/female and right/left subgroups. Regression coefficients were compared to see the statistical significance between subgroups. To compare regression coefficients of males and females, we first made a dummy variable called female that was coded 1 for female and 0 for male and a variable combining female and age (AgeFemale). We then used female, age, and AgeFemale as predictors with UMV as the dependent variable in the regression analysis. Similar analysis was carried out to compare regressions of right and left sides. SPSS 10.0 software (SPSS Inc., Chicago, IL) was used for the analysis.

RESULTS

A total of 2,526 patients were used for this study, 527 males and 1,999 females. Age range was 11–96 years with mean age of 43.86 (SD 11.49). Mean ages are 44.09 (SD 11.09) years for females and 42.92 (SD 12.98) years for males. Age-matched 1,050 female hands and 1,041 male hands were randomly selected for comparison of UMV.

Influence of Gender

Mean UMV of males and females were 54.04 (SD 5.00) m/s and 56.15 (SD 4.93) m/s, respectively, in the age-matched sample (*t*-test, $P < 0.001$) (Table 1). Because of the possible influence of side of the hand, mean UMV for right and left sides were calculated separately for males and females (Table 1). Mean UMV for males and females were significantly different in both the sides, with lower values in males.

TABLE 1. UMV in Age-Matched Sample

	Males (m/s)	Females (m/s)	Both Genders Together
Right	54.01*	56.36*	55.17
Left	54.06**	55.95**	55.02
Both sides together	54.04***	56.15***	

Male and female UMV were significantly different in right side (*t-test, $P < 0.001$), left side (**t-test, $P < 0.001$), and both sides together (***t-test, $P < 0.001$). Right and left values are not significantly different.

UMV, ulnar never motor conduction velocity.

Influence of Gender for the Relation Between Age and UMV

Regression analysis was conducted to compare the relationship between UMV and age for males and females separately. Both males and females have significant negative beta values suggesting a negative relationship. Beta values were −0.253 ($P < 0.001$) and −0.113 ($P < 0.001$) for males and females, respectively. Regression coefficients of age predicting UMV in males and females were significantly different ($t = 2.69$, $P < 0.01$). Higher beta value for males suggests higher influence in males. When the change of UMV with age was plotted, two clearly separated lines were seen for males and females. The value for females is higher than that for males throughout the age range (Fig. 1).

Influence of Side of the Hand

Mean UMV of right and left side were 55.17 (SD 5.15) m/s and 55.02 (SD 5.01) m/s, respectively, in the age-matched sample. This difference was not significant ($P = 0.50$).

Influence of Side of the Hand for the Relation Between Age and Ulnar Nerve Motor Conduction Velocity

Regression analysis was done to compare the relationship between UMV and age for right and left sides separately. Beta values were −0.136 ($P < 0.001$) and −0.131 ($P < 0.001$) for right and left sides, respectively. Regression coefficients of age predicting UMV in right and left were not significantly different. Regression coefficients of age predicting UMV is calculated separately in right and left hands in males and females. Beat values were shown in Table 2.

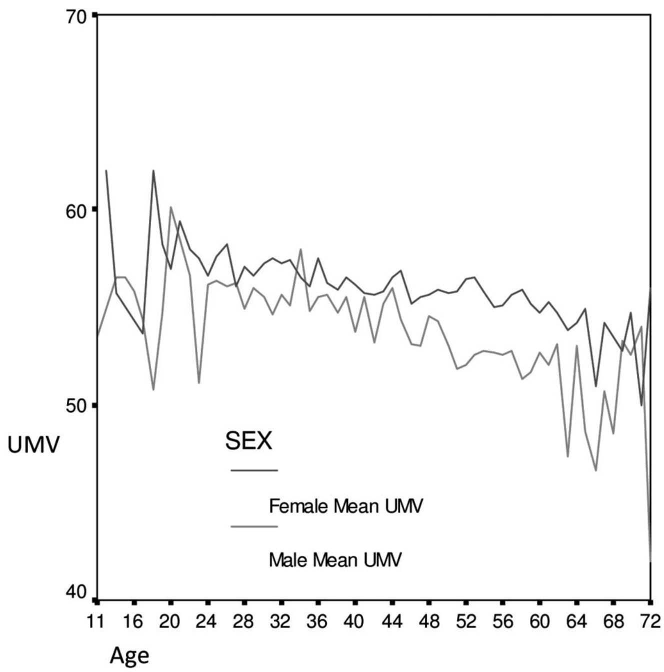

FIG. 1. Change of ulnar never motor conduction velocity (UMV) with age in males and females.

TABLE 2. Beta Values of Regression Analysis of Age and UMV

	Males	Females	Both Genders Together
Right	−0.286*	−0.109*	−0.136
Left	−0.218	−0.118	−0.131
Both sides together	−0.253**	−0.113**	

Male and female regressions were significantly different comparing both sides together (** $t = 2.69$, $P < 0.01$) and in the right side (* $t = 2.59$, $P < 0.05$). All beta values are significant.

UMV, ulnar never motor conduction velocity.

Regression coefficients of age predicting UMV in males and females were significantly different ($t = 2.59$, $P < 0.05$) only in the right side. In the left side, there is no such a difference in males and females. Beat values suggest that the age-dependent changes of UMV have the highest influence on the right hands of males compared with the right hands of females and the left hands of both.

Comparison of Age, Gender, and Side of the Hand

Statistical analysis shows that age, gender, and side of the hand have an influence on UMV. In the next step, influences of these three factors were compared. Regression analysis was done, and beta values were calculated using these three factors as predictors and UMV as the dependent variable. Beta values were −0.140 ($P < 0.001$), 0.153 ($P < 0.001$), and 0.029 ($P < 0.05$) for age, gender, and side of the hand, respectively. Therefore, the order of influence is gender, age, and side of the hand.

DISCUSSION

Agreeing with pervious studies (Rivner et al., 2001; Stetson et al., 1992), clear reduction of UMV with age is shown in this study in both males and females. In addition to that, mean UMV is significantly low in males compared with females. Two lines of UMV for males and females (Fig. 1) are clearly separated throughout the age range, with lower value for males. This separation is prominent in the age range with more subjects: 30 to 60 years. These evidences suggest that UMV is low in males compare with females.

Robinson et al. (1993) showed that influence of gender on UMV and explained that this influence is because of the height and not the gender *per se*. Rivner et al. (2001) showed that UMV changes with age and height in a study using a similar number subjects to this study but did not show the relationship with gender. Pickett (1982) showed an age-independent higher UMV in females using approximately 200 hands. However, this study is the first study to show gender difference in UMV using nerve conduction study data of a larger number of subjects.

Gender differences in the anatomy and susceptibility to external effect of ulnar nerve were described earlier in many studies. It has been shown that males are having differences in anatomic course of ulnar nerve (Contreras et al., 1998), making more susceptible for direct pressure effect (Morell et al., 2003) and susceptible to develop hospitalization-related ulnar neuropathy (Warner et al., 1994) than females. Smaller fat content on the medial aspect of the elbow and the larger coronoid process were described in males compared with females. These anatomic differences can lead to external compression–induced ischemia of the ulnar nerve in males (Contreras et al., 1998). Agreeing with this, it has been shown in previous studies that males are more vulnerable to anesthesia-related ulnar nerve injury compare with females (Warner et al., 1994). Posner (2000) described that the ulnar nerve is subjected to stretch in the anatomic path around the elbow. This results in a cycle of perineural scarring and progressive nerve damage. This type of continuous damage of the ulnar nerve can lead to the changes in never conductivity.

Anatomic location makes the ulnar nerve vulnerable to injury because of compression and stretch, which is common in many occupations (Descatha et al., 2004; Pellieux et al., 2001). Repeated external compression as a result of the routing activity may have induced ischemia of the ulnar nerve. External compression can be more prominent in manual workers. In the Sri Lankan society, males are employed and engaged in more manual works than females. Even though we did not study the occupation of the participants, comparative reduction of UMV in males can be attributed to occupational factors.

This study provides additional evidence for the existing knowledge on gender difference in ulnar nerve pathophysiology. Although the difference is numerically small, when interpreted together with other compounding factors, it can be of considerable value in making a clinical decision.

Another explanation for gender difference of UMV is the influence of height. It is an accepted fact that males are taller than females. The gender dependence of conduction quality of other nerves also is explained with height (Stetson et al., 1992). But the arm length which is related to height was shown not related to ulnar nerve conduction (Hennessey et al., 1994). Therefore, effect of gender on UMV cannot be completely explained by the height or size of the anatomic structures in upper limbs.

Mean UMV of right and left sides were not different in the age-matched sample. However, only in the right side, males have significantly higher regression coefficients than females, suggesting that the influence of age on UMV is more in the right hand in males. It has been estimated that 85% to 90% of the world's population is right handed (Calvin, 2000). Therefore, the dominant hand should be the right hand for majority of subjects in this study sample, even though we did not study the hand dominance of the subjects. Right hands can undergo more occupational and activity-related trauma. Therefore, the influence on UMV is higher in right hands. Higher influence in males and right side suggests that physical activity and subsequent vulnerability to injury can be related to the reduction of UMV.

This study identified three factors influencing UMV: age, gender, and side of the hand. Regression analysis showed different Beta values suggesting differences in the gravity of these factors. Order of magnitude of these influences is gender, age, and side of the hand. Among them, age was a known factor that influenced UMV. This study identified gender as an influencing factor, which has even higher influence than age. When interpreting the ulnar nerve conduction study findings, gender differences needed to be considered, especially in elderly patients since influence of age can be aggravated by gender.

The following can be considered as limitations of the study. Possible neuropathies were excluded using ulnar motor conduction velocity as a guidance in this study. However, there is a possibility to have patients with early stages of neuropathies, which can be detected only using sensory indices and F-wave. Possible association of ulnar nerve diseases with carpal tunnel syndrome was shown previously (Vahdatpour et al., 2007). Therefore, subjects who participated in this study may not represent a normal healthy population because the majority of them were referred for nerve conduction studies suspecting carpal tunnel syndrome. We did not record hand temperature of all patients. Hand temperature was recorded in 190 patients in this sample, and the value was always above 32°C in those hands. However, this study was conducted in a country with tropical climate with minimum or no temperature change throughout the year during the daytime in a non–air conditioned room. We did not record the height of the subjects. Hence, we cannot exclude the contribution of height to UMV, which was investigated by many previous researchers. There can be other confounding factors, which we did not include in the study. They may have some bearings on the results.

We believe that when interpreting nerve conduction study findings in pathologic conditions affecting the ulnar nerve, three confounding factors—age, gender, and sidedness—need to be considered to some extent, especially when some of them influence together. The results of the study will be important when interpreting nerve conduction study results of patients with complaints related to the hand to diagnose or exclude ulnar nerve pathologic assessment.

CONCLUSIONS

Other than the age of the subject, UMV depends on gender and sidedness of hand. Males are having lower UMV than females. Age-depended change of UMV is more prominent in males than females. Age-dependent change of UMV is more prominent in right hand than in left hand in males. Gender has more influence than age on UMV. When interpreting ulnar nerve conduction study findings, this gender difference needed to be considered.

ACKNOWLEDGMENTS

Authors express their gratitude to Ms Nalani Amarasakara and Ms Bandulatha Keembiyehetty for technical assistance and Mr M.W.S. Sanjeewa Silva for statistical advice.

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