Exploring use of ultrasonography(US) to distinguish symptom dominance for patients with carpal tunnel syndrome(CTS) and implications for different neuroplastic pattern secondary to CTS

Xue Deng, PhD Candidate (HK), M.Sc.OT(US), B.Sc.OT(HK)[1], Lai-Heung Chau, B.Sc.Nursing(HK)[2], Suk-Yee Chiu, B.Sc.Nursing(HK)[2], Kwok-Pui Leung, M.B.Ch.B.(HK)[2], Sheung-Wai Li, M.B.B.S.(NSW)[2], Wing-Yuk Ip, M.B.B.S.(HK)[1]
1.The University of Hong Kong, Pokfulam Road, Hong Kong, 2.Tung Wah Hospital, Sheung Wan, Hong Kong

Background

- Ultrasonography (US) has been cross-validated with Nerve Conduction Studies(NCS) for diagnostic confirmation and severity gradation for carpal tunnel syndrome (CTS)

Research Gap

- NCS's association with CTS symptomatology is limited, correlating more with paresthesia-dominant CTS
- It is unknown if US can be alternatively used to differentiate CTS symptom dominance

Hypothesis

- There are significant difference in US parameters, with cut-off values for symptom differentiation

Objectives

- To examine performance of US parameters between CTS with different symptom dominance
- explore cut-off values of US parameters for CTS symptom differentiation

Methods

- A recent study indicated significant sensory velocity difference (t(46)=1.99, p=0.05) of ipsilateral median-ulnar nerves between pain-dominant (-11.4 ± 5.1m/s) and paresthesia-dominant (-19.3 ± 7.4 m/s) CTS groups; Paresthesia-dominant and pain-dominant area were redefined in our study (figure 1.)

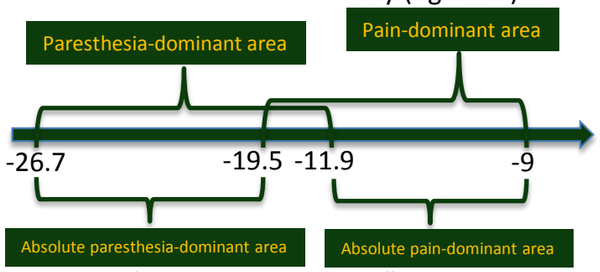


Figure 1. Range of median-ulnar sensory velocity differences between paresthesia-dominant and pain-dominant groups (Unit: m/s). The braces above the arrow displayed group distribution in Maeda et al.'s study (2016) while the braces beneath represented group distribution in our retrospective studies.

Subjects Review

Subjects with both NCS and US recordings admitted from Jan 2014 to Sep 2017 were reviewed in a demographics-matched manner.

Group Assignment

The range of ipsilateral median-ulnar sensory velocity differences were redefined to guarantee the enrolled cases were within absolute range of corresponding symptom dominance, including group 1 (Pain-dominant) and group 2 (Paresthesia-dominant).

Data Analysis

Independent t-tests to examine differences of cross-sectional area (CSA), perimeter (P) at wrist and mid-forearm of median nerve. The ratio of cross-sectional area and perimeter were calculated using standard format. ROC curves were plotted.

Figure 2. NCS Graphs: sensory evoked responses between median and ulnar nerves

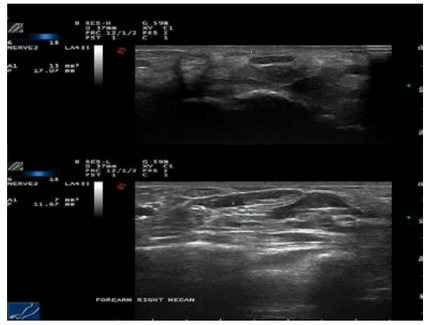


Figure 3. US measurement: CSA and P at wrist (Up) and one third distal forearm (Down)

Results

Demographics/NCS Performance	Group 1 (Pain-dominant Group, N_1=35)	Group 2 (Paresthesia-dominant Group, N_2=44)
Sex	Female Only	
Age (Mean(SD), year)	57.71(7.63)	55.5(8.68)
Wrist Right	18	22
Wrist Left	17	22
Median Motor		
Wrist DML† (ms)	3.8(.4)	4.89(1.18)
Wrist CMAP Amplitude‡(mV)	8.66(2.03)	7.26(2.74)
Conduction Velocity† (m/s)	39.34(8.3)	27.88(5.92)
Median Sensory		
DSL† (ms)	2.54(.19)	3.15(.65)
SNAP Amplitude*(uV)	16.91(7.15)	12.07(5.35)
Conduction Velocity‡(m/s)	47.97(3.88)	37.59(5.54)
Median-Ulnar Velocity Differences	-10.63(1.26)	-22.41(2.66)

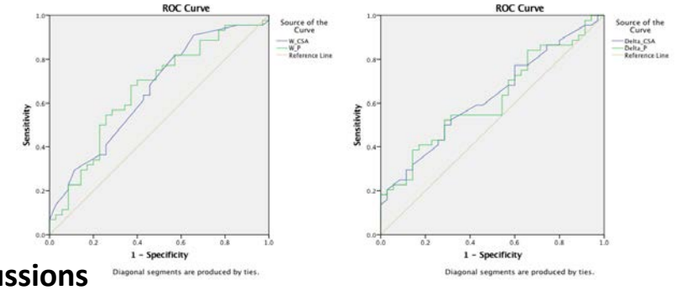
‡ <.05, * p<.001, †p<.0001

DML(ms): distal motor latency; CMAP(mV): compound motor action potential; DSL(ms): distal sensory latency, SNAP(μV): sensory nerve action potential

US Parameter	Group 1	Group 2	Cut-off values	Area Under Curve	Sensitivity(%)	Specificity(%)
DF-CSA(mm^2)	5.87(1.3)	6.04(1.72)	-	-	-	-
DF-P(mm)	10.61(1.56)	10.59(1.82)	-	-	-	-
W-CSA(mm)‡	11.02(2.26)	12.58(3.24)	11.00	.656	82%	43%
W-P(mm)‡	16.14(1.99)	17.23(2.3)	15.64	.660	82%	43%
R-CSA	1.94(.49)	2.17(.82)	-	-	-	-
R-P	1.53(.25)	1.66(.35)	-	-	-	-
ΔCSA(mm^2)‡	5.15(1.93)	6.54(3.3)		.625		
ΔP(mm)‡	5.53(2.01)	6.64(2.63)		.618		

‡ <.05

DF-CSA(mm): cross sectional area of one third distal forearm, DF-P(mm): perimeter of one third distal forearm, W-CSA(mm^2): wrist cross-sectional area, W-P (mm): wrist perimeter, R-CSA: ratio of cross sectional area of wrist over one third distal forearm, R-P: ratio of perimeter of wrist over one third distal forearm, ΔCSA (mm^2): changes of cross-sectional area from wrist to one third distal forearm, ΔP (mm): changes of perimeter from wrist to one third distal forearm



Discussions

- CSA is the most sensitive cut-off value for symptom differentiation, diagnostic confirmation and severity gradation
- Previous studies revealed correlation between pain/numbness severity and cortical thickness, further investigation on correlation between US parameters and cortical thickness should be explored

Limitation of the study

- Retrospective study; Small sample size; Lack of control group

Conclusions

- A potential role of US for CTS symptom differentiation
- A prospective study with a larger sample size can generate more robust result