

Evaluating the Mean Cross-Sectional Area (CSA) of Median Nerve by Use of Ultrasound in Thai Population

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Background: The diagnosis of carpal tunnel syndrome (CTS) is usually based on clinical combining with nerve conductive study (NCS). Recently, ultrasound (US) is the choice for investigation of median nerve morphology and size. The advantages of US are non-invasive in nature and no discomfort or pain. Data on median nerve cross sectional area (CSA) in healthy Thai subjects are still limited.

Objective: To know the mean value of normal CSA in healthy Thai population. Is it different from the other countries?

Material and Method: Thai populations, without clinical sign or symptom of CTS, were included in the present study. A linear array transducer was used to scan and measure median nerve cross-sectional area and the maximum transverse and antero-posterior diameter were recorded.

Results: Eighty-eight wrists of 44 asymptomatic of CTS and healthy Thai volunteer were examined with US. The mean CSA measurement were found as $6.83 \pm 0.98 \text{ mm}^2$ by tracing method (TM) and $6.81 \pm 1.12 \text{ mm}^2$ by ellipsoid formula (EF) method. No significant differentiation was observed between CSA calculated using TM and EF of median nerve. There was no significant difference in CSA between right and left hand or dominate and non-dominant hand. CSA calculated by the TM and EF method were found to be significantly larger in male than in female. There was no correlation between CSA and age or BMI.

Conclusion: Although body habitus of people was different among countries, the mean CSA of median nerve in healthy people are not significantly difference.

Keywords: Ultrasound, Mean cross-sectional area (CSA), Median nerve

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Carpal tunnel syndrome (CTS) is one of the most common upper limb compression neuropathies^(1,2). It is due to an entrapment of the median nerve within the carpal tunnel. The prevalence of CTS in the population is about 3% in women and 2% in men, with a peak prevalence in women older than 55 years of age⁽³⁾. The usual age range of CTS is 40-60 years. In daily clinical practice, the diagnosis of CTS is usually based on clinical symptom combining with nerve conductive study (NCS)^(4,5). Recently, ultrasound (US) is the additional choice for investigation of median nerve morphology and size⁽⁶⁾. Compared with NCS, the advantages of the ultrasound are non-invasive in nature and it does not cause any discomfort or pain. US has potential advantages as it widely available, relatively lower cost and shorter examination time.

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Only a few studies in literature used US for evaluating cross sectional area (CSA) of median nerve in healthy subjects. Data on median nerve CSA in healthy Thai subjects are still limited. The objective of the present study is to measure the mean value of normal CSA in healthy Thai population. Is it different from the other countries?

Material and Method

During September, 2009 to March 2010, Thai healthy volunteer with no clinical, sign or symptom of CTS were included in the present study. All subjects were screened to exclude systemic disorder; diabetes mellitus, connective tissue disorder and kidney or thyroid abnormality. Occupational health conditions, particularly in industries where work involves high force and repetitive use of vibrating tools, were excluded. Other exclusion criteria were previous wrist surgery, existing anatomical variation of median nerve, neurological disease, space occupying lesion in nervous system and pregnancy.

Demographic data was collected in patient

data record form for gender, age, weight, height, occupation and dominant hand.

Ultrasound protocol

High-resolution ultrasound using 12 MHZ linear transducer was used to scan all wrists in neutral position with palm up and fingers in semi-extended position. The course of median nerve was assessed in transverse plane.

The CSA of median nerve was measured by two different methods as suggested by Duncan et al⁽⁷⁾. The first method was direct measurement by using tracing method (TM), in which the margin of median nerve was measured with electronic caliper. This measurement was performed from the inner border of perineural echogenic rim surrounding hypoechoic median nerve as shown in Fig. 1A. The second method was indirect measurement, using the ellipsoid formula (EF), calculating the transverse and anteroposterior dimensions. In this measurement, the formula of ellipsoid area was used $D1 \times D2 \times 3.14/4$ as shown in Fig. 1B. For each wrist, the measurement was repeated three times and the average number of these three values was taken.

Results

The present study was a prospective descriptive study including 88 wrists of 44 asymptomatic healthy subjects (24 men, 20 women). US of median nerves of wrist were performed bilaterally in all subjects. The mean age was 37.66 ± 6.38 years (range 30-57). The mean of BMI was 23.63 ± 4.81 kg/m² (range 18.00-45.78). Right hand was dominant hand in 42 subjects and only two subjects were left-handed.

Mean CSA of median nerve as calculated by TM was 6.83 ± 0.98 mm² (range 4.68-9.33). Mean CSA of median nerve as calculated by EF was 6.81 ± 1.12 mm² (range 4.25-10.26) (Table 1). No significant difference was observed between CSA calculation

between both methods ($p = 0.73$).

CSA calculated by TM and EF method were found to be significantly larger in male than in female ($p < 0.05$ and $p < 0.05$, respectively). There was no significant difference in CSA between right and left hand by both TM and EF methods ($p = 0.62$ and $p = 0.95$, respectively). No significant difference in any measurements was found dominant and non-dominant hand ($p = 0.62$ and $p = 0.79$, respectively) (Table 2).

There was no correlation between CSA and age by TM and EF methods as shown in Fig. 2 and 3, respectively. The authors founded the CSA and BMI was also not correlated as shown in Fig. 4 and 5, respectively.

Discussion

The method for diagnosis of CTS is based on clinical symptoms and is confirmed by using NCS. MRI and US are also used to confirm in patient who have clinical suspected the diagnosis of CTS. Among these studies, US has potential advantages of being widely available, comfortable, has a relatively lower cost and shorter examination time.

US is believed to improve a treatment outcome by guiding choice of treatment for orthopedist. US is used to detect space-occupying lesions in carpal tunnel that can cause CTS symptoms such as ganglia,

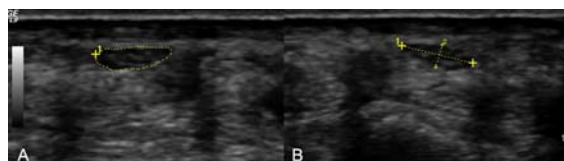


Fig. 1 Sonogram of median nerve in a 39-year-old woman shows a flat and hypoechoic median nerve. (A) The cross-sectional area was 7 mm² using tracing method. (B) The transverse diameter, AP diameter and cross-sectional area were 5.7 mm, 1.8 mm and 8 mm², respectively using ellipsoid formula

Table 1. Ultrasound results of mean CSA

	CSA calculated by TM (mm ²)	CSA calculated by EF (mm ²)
All wrist	6.83 ± 0.98	6.81 ± 1.12
Right wrist	6.77 ± 1.10	6.81 ± 1.27
Left wrist	6.88 ± 0.92	6.80 ± 0.97
Dominate wrist	6.77 ± 1.06	6.84 ± 1.30
Non-dominate wrist	6.88 ± 0.92	6.77 ± 0.95
Female wrist	6.47 ± 0.91	6.41 ± 0.97
Male wrist	7.13 ± 0.95	7.13 ± 1.20

Table 2. P-value of variable comparison

	CSA calculated by TM	CSA calculated by EF
Right vs. Left wrist	0.616	0.950
Dominate vs. Non-dominate wrist	0.618	0.786
Female vs. Male wrist	< 0.05	< 0.05

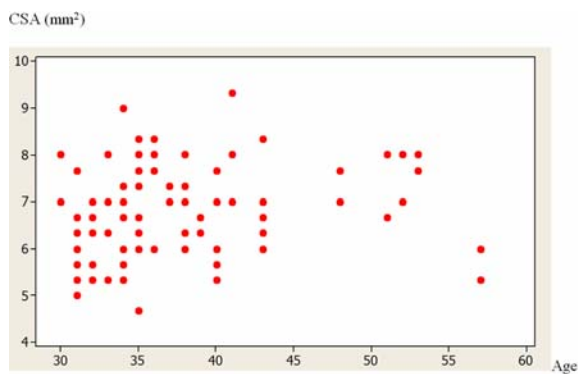


Fig. 2 Scattered plot graph shows correlation between CSA by using TM method and age

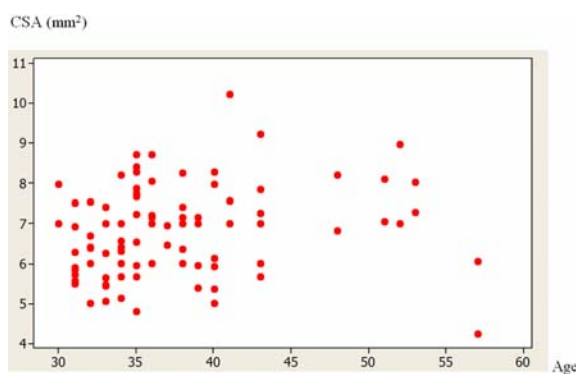


Fig. 3 Scattered plot graph shows correlation between CSA by using EF method and age

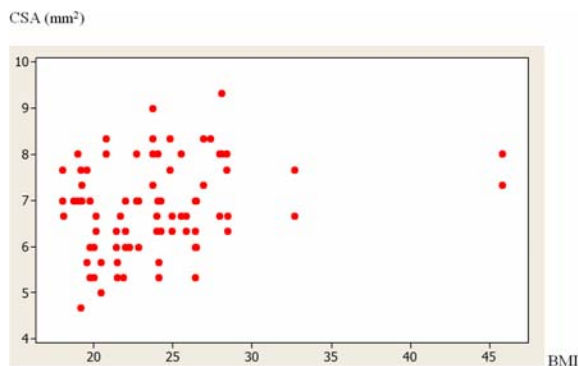


Fig. 4 Scattered plot graph shows correlation between CSA by using TM method and BMI

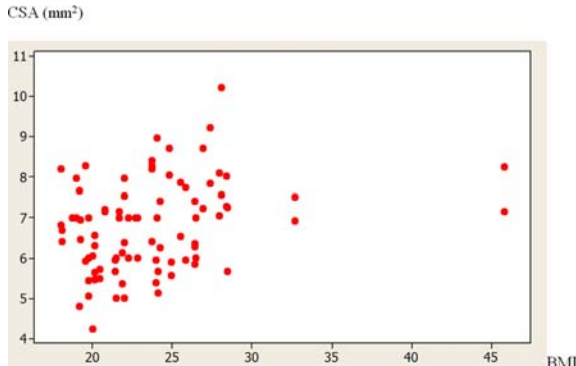


Fig. 5 Scattered plot graph shows correlation between CSA by using EF method and BMI

fibromatosis, neural tumor and tenosynovitis.

Recently, several studies showed that measurement of CSA of median nerve by US may help to diagnosis CTS. One of these studies showed that the US measurement has high sensitivity (89%) and specificity (94.7%) in diagnosis of CTS in patients with clinical symptoms and abnormal electrophysiological findings⁽⁸⁾. The US criteria for diagnosis of CTS is CSA cut-off value of median nerve larger than 9-10 mm²⁽⁹⁻¹¹⁾. Therefore, mean CSA of median nerve in healthy subject is important to make an accurate diagnosis.

The authors postulate that mean CSA of Asian people is smaller than in Caucasian because Asian

people have smaller body habitus. The mean CSA which was used in the previous study may not be used in Asian country.

In majority of the previous publications, the mean CSA of median nerve in the control groups or normal population ranging from 7-8 mm^{2(7,8,12,13)}. The mean of CSA in our study was 6.83 and 6.81 mm² by TM and EF method, respectively. This result shows no significant difference of mean normal CSA of medial nerve between healthy Thai population and other countries. It implied that US criteria for diagnosis of CTS with CSA cut-off value of 9-10 mm² may also be used in Thai population.

The authors also found that there was no difference of CSA between right handed and left handed subjects. Similarly, there was no significant difference of CSA between dominate and non-dominate hand. These results showed that the CSA of median nerve was not depended on activity.

The authors found that the mean of CSA in men were larger than the women, significantly. It is probably due to difference in size of neurovascular structure between both genders.

There are three limitations in the present study. The first one is subjects in the present study do not undergo NCS to confirm that all median nerves have normal nerve conduction. The second one is small sample size. The third one is non-normal distribution of age variable.

Conclusion

Although body habitus of people are different between countries, the mean CSA of median nerve in healthy people are not significantly difference.

Potential conflicts of interest

None.

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การประเมินค่าพื้นที่หน้าตัดของ median nerve โดยการใช้อัลตราซาวด์ในประชากรไทย

บุญทรี วานิชวัฒนรำลึก, วิทย์ วราวิทย์

ภูมิหลัง: การวินิจฉัยโรค carpal tunnel syndrome (CTS) มักใช้อาการทางคลินิกและตรวจยืนยันด้วยการตรวจการนำกระแสประสาทด้วยกระแสไฟฟ้า (Nerve conduction study, NCS) ปัจจุบันนี้ มีการนำการตรวจอัลตราซาวด์ (ultrasound, US) มาช่วยตรวจการเปลี่ยนแปลงลักษณะของ median nerve ในโรค CTS อัลตราซาวด์มีข้อได้เปรียบคือ เป็นเครื่องมือที่มีใช้แพร่หลาย ราคาถูก ใช้เวลาน้อย และผู้ป่วยไม่เจ็บตัวจากการตรวจเนื่องจากข้อมูลค่าพื้นที่หน้าตัด (cross-sectional area, CSA) ของ median nerve ในประเทศไทยมีค่อนข้างน้อย ค่าพื้นที่หน้าตัดที่ไซม์มักเป็นค่าที่วัดจากประชากรแถบซีกโลกตะวันตก

วัตถุประสงค์: เพื่อหาค่าเฉลี่ยพื้นที่หน้าตัดของ median nerve ในประชากรไทยที่ไม่มี อาการผิดปกติว่าแตกต่างจากประชากรในประเทศอื่นหรือไม่

วัสดุและวิธีการ: ประชากรไทยปกติที่ไม่มีอาการของ CTS ได้รับการตรวจอัลตราซาวด์โดยใช้หัวตรวจอัลตราซาวด์แบบตรง (linear array transducer) เพื่อวัดพื้นที่หน้าตัดของ median nerve ค่าที่ได้จากการตรวจอัลตราซาวด์ถูกนำมาหาค่าเฉลี่ย

ผลการศึกษา: ประชากรไทยปกติ 44 คน มีทั้งหมด 88 ข้อมือ ได้รับการตรวจอัลตราซาวด์ ค่าเฉลี่ยพื้นที่หน้าตัดคือ 6.83 ± 0.98 ตารางมิลลิเมตร โดยใช้วิธีการวัดเส้นรอบวง (tracing method or TM) และ 6.81 ± 1.12 ตารางมิลลิเมตร โดยใช้วิธีการวัดเส้นผ่านศูนย์กลาง (ellipsoid formula, EF) ไม่มีความแตกต่างอย่างมีนัยสำคัญของค่าเฉลี่ยพื้นที่หน้าตัดระหว่างการวัดทั้ง 2 วิธี, มือขวาและมือซ้าย, มือด้านที่ถนัดและไม่ถนัด แต่มีความแตกต่างอย่างมีนัยสำคัญของค่าเฉลี่ยพื้นที่หน้าตัดระหว่างเพศหญิงและเพศชาย และไม่พบความสัมพันธ์ระหว่างค่าพื้นที่หน้าตัด กับอายุหรือดัชนีมวลกาย

สรุป: แม้ว่ารูปร่างของประชากรไทยจะต่างกับประชากรต่างประเทศ แต่ค่าเฉลี่ยพื้นที่หน้าตัดของประชากรปกติในไทยนั้นไม่แตกต่างจากค่าเฉลี่ยพื้นที่หน้าตัดในต่างประเทศ
