# Meta-analysis

## A Meta analysis of characteristics of median nerve and sural nerve injury in patients with diabetic peripheral neuropathy
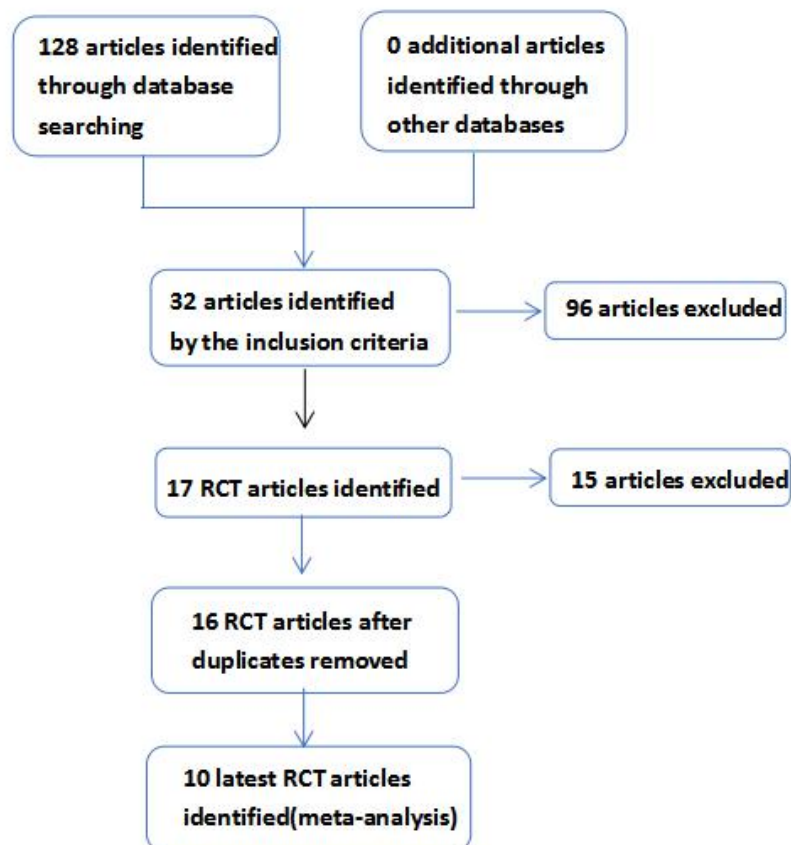
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**Highlights：**
To assess the injured degree of median nerve and sural nerve in patients with diabetic peripheral neuropathy, a meta-analysis was performed. Meta analysis showed that The CPT values of median nerve and sural nerve at 2000 Hz, 250 Hz and 5 Hz of patients group were higher than those of normal control group ($P$ <0.05 for all). Sensory nerve quantitative detector could detect nerve damage early, accurately and monitor the effect treatment in patients with DPN.

**Abstract**

**Objective:** A meta-analysis of randomized trials was performed to assess the injured degree of median nerve and sural nerve in patients with diabetic peripheral neuropathy (DPN). **Methods:** we searched Pubmed Database, China Biomedical Literature Database, VIP Database, ChinaNet for studies. Then evaluated these studies in order to find the researches in line with the requirements of the study; Each relevant research was carefully read to extract relevant data; The current perception threshold (CPT) value of median nerve and sural nerve were compared at 2000Hz, 250Hz and 5Hz between patients with DPN and the normal control group. **Results:** Finally 10 articles that meet the standards were included, with 1054 cases in the patient group and 719 cases in the normal group. The CPT values of median nerve and sural nerve at 2000 Hz, 250 Hz and 5 Hz of patients group were higher than those of normal control group ($P <0.05$ for all). **Conclusion:** Systematic reviews showed that the sensitivity of the median nerve and sural nerve in DPN patients was generally reduced. Sensory nerve quantitative detector could detect nerve damage early, accurately and monitor the effect treatment in patients with DPN.

**Keywords:** Diabetes, Peripheral Neuropathy, The Sensitivity of the Median Nerve and Sural Nerve

摘要

**目的**：对国内外公开发表的通过感觉神经定量检测仪测量糖尿病周围神经病变(Diabetic peripheral neuropathy, DPN)患者正中神经和腓肠神经损伤程度的临床随机对照研究进行荟萃分析，观察 DPN 患者周围神经损伤的特点。

**方法**：在 Pubmed 数据库、中国生物医学文献库、维普数据库、中国知网中检索有关感觉神经定量检测与 DPN 的文献，并评价所有相关的文献；经过仔细阅读文献并提取相关数据；对每个纳入研究中的糖尿病患者在 2000Hz、250Hz、5Hz 的电流感觉阈值(Current perception threshold, CPT)值与正常对照组 CPT 值进行对比，各组数据均以均数±标准差(m±s)表示分析的统计量，并进行异质性检验。

**结果**：最终纳入 10 篇符合标准的文献，患者组 1054 例，正常组 719 例。患者组左、右正中神经和左、右腓肠神经在 2000Hz、250Hz、5Hz 时的 CPT 值均大于正常对照组(*P*<0.05)。

**结论**：纳入荟萃分析的 DPN 患者左、右正中神经和腓肠神经的敏感性均普遍降低

**关键词**：糖尿病；周围神经病变；正中神经和腓肠神经的敏感性

## Introduction

Diabetic peripheral neuropathy (DPN), one of the most common chronic complications of diabetes mellitus, is a group of peripheral neuropathy characterized by sensory and autonomic symptoms, which seriously affects the quality of life of people with diabetes [1]. In this study, a meta-analysis of the published data on the degree of median nerve and sural nerve injury in patients with DPN was conducted in order to observe the characteristics of peripheral nerve injury in patients with DPN. The sensory nerve quantitative detector could objectively and quantitatively evaluate the degree of nerve injury in patients with DPN, which provides a strong support for the diagnosis and evaluation of the degree of nerve damage in diabetic patients [2]. The degree of median nerve and sural nerve damage of all the patients with DPN were evaluated by sensory nerve quantitative detector to make the diagnosis objective [3].

## Data and Methods

### Included researches

Randomized controlled trial (RCT) with the CPT values of left and right median nerve and sural nerve in patients with DPN was measured by sensory nerve quantitative detector.

### Inclusion criteria and exclusion criteria:

DPN patients were included in the patient group, regardless of the type of diabetes; Normal people without diabetes were included in the control group. Exclusion criteria [4]: 1. Repeated published articles. 2. Does not meet the RCT standards. 4. Observations do not contain credible CPT values.

### Observation Indicators

CPT values of the left and right median nerve and sural nerve measured by the sensory nerve quantitative detector.

### Search Strategy

Retrieval in the Pubmed Database: Search (((((Diabetic peripheral neuropathy[Abstract]) AND Diabetic peripheral neuropathy[Title])) OR ((diabetes[Title]) OR diabetes[Abstract]))) AND ((((current perception threshold[Title]) OR current perception threshold[Abstract])) OR ((CPT[Abstract]) OR CPT[Title])). Retrieval of a literature on the association of sensory nerve quantitative detection with diabetes using a search-based approach in the Chinese Biomedical Literature Database: (("Sensory Nerve Quantification" OR "Current Sensory Threshold") AND ("Diabetes" OR "Type 2 Diabetes "OR" Diabetic Peripheral Neuropathy ")). Searching VIP database retrieval formula: (U = quantitative sensory nerve OR U = detector current perception threshold) AND (U = diabetes OR U = type 2 diabetes OR U = diabetic peripheral neuropathy). In China National Knowledge Internet search term retrieval: "Sensory nerve quantitative detector", "Current sense threshold", "diabetes", "Type 2 diabetes", "Diabetic peripheral neuropathy."

### Literature screening and data extraction

We carefully read each relevant research to extract the relevant data. When the relevant data is not available or not provided in the study, we try to contact with the investigators to obtain the most detailed data. After the original data were obtained, we used this data to evaluate the combined effect of the sensory nerve quantitative detector in the diagnosis of DPN [5]. We included the following data from the included studies: first author, year of publication, sample age, sample nationality, ethnicity, CPT values of the left and right median nerves of the patients at about 2000 Hz, 250 Hz, 5 Hz, and normal controls with left and right median nerve, sural nerve at 2000Hz, 250Hz, 5Hz CPT value.

### Bias risk assessment of the studies included

The risk of bias in inclusion of RCT was evaluated by two investigators based on the Cochrane Handbook 5.1.0 Risk Assessment Tool for Biased RCT [6]. The evaluation includes: random sequence generation, distribution hiding, blindness of participants and investigators, blindness of outcome measurers, completeness of outcome indicators, selective reporting and other sources of bias. Each item was evaluated with "low risk of bias", "not clear" "high risk of bias", and the original study fully met the above criteria, suggesting that the lowest possible probability of any bias was Grade A. Partial satisfaction of the above quality criteria prompted a bias, suggesting the probability is moderate, Grade B. The original study does not meet the above quality standards at all, indicating that there is a high possibility of bias for the Grade C.

### Statistical Analysis

Statistical analysis using SPSS Statistic 17.0 and Review Manger 5.3 statistical software package [7].

## Results

### Results of literature search

We found 88 possible related researches, of which 32 met the original inclusion criteria. 15 reports were excluded as they were not case-control studies. If the same author published several papers about one subject, we eliminated sample duplication between different studies and used the latest and most comprehensive research for data extraction [8-9]. In 17 researches, a

team of researchers did multiple analyzes of the same study sample, so we extracted a study with the latest publishing time. In the end, 10 studies were included for our meta-analysis (Figure 1).

**Figure 1 Literature screening process**
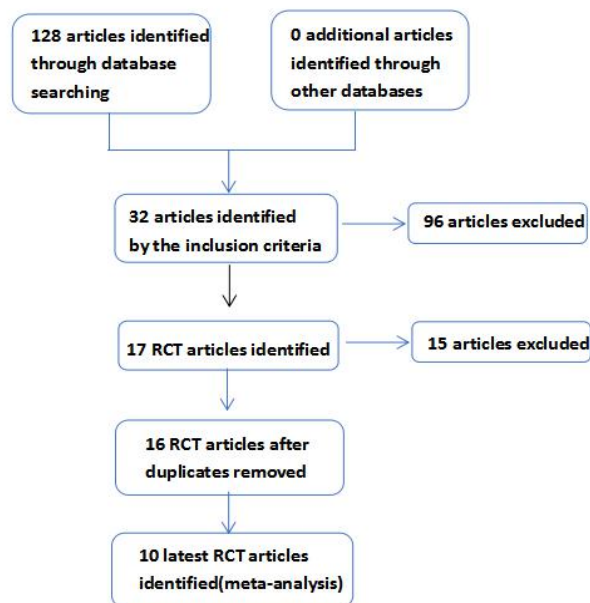


**Meta-analysis results**

***Characteristics of left median nerve injury*** As shown in Figure 2, Figure 3 and Figure 4, all the 10 articles reported CPT values of 2000Hz, 250Hz and 5Hz in the left median nerve of DPN patients. The heterogeneity test was done by random effects model, results were $I^2$ = 97%, $I^2$ = 88 % and $I^2$ = 94%, respectively. The results showed that the CPT values of the left median nerve at 2000 Hz, 250 Hz and 5 Hz were higher in the patients than those in the normal group (WMD = 108.34, 95% CI: 104.88-111.81, *P* <0.05) (WMD = 86.61, 95% CI: 84.10 ~ 89.11, *P* <0.05), (WMD = 82.30, 95% CI: 79.07 ~ 85.53, *P* <0.05).

As shown in Figure 5, Figure 6 and Figure 7, all the 10 articles reported CPT values of the right median nerve of DPN patients under 2000Hz, 250Hz and 5Hz. The heterogeneity test results were $I^2$ = 95%, $I^2$ = 81 % and $I^2$ = 52%, respectively. The results showed that the CPT values of the right median nerve of the patients at 2000 Hz, 250 Hz and 5 Hz were higher than those in the normal group (WMD = 106.54, 95% CI: 103.83-109.25, *P* < 0.05) 90.06 ~ 94.34, *P* < 0.05), (WMD = 86.90, 95% CI: 84.08 ~ 89.72, *P* < 0.05).

***Characteristics of left sural nerve injury*** As shown in Figure 8, Figure 9 and Figure 10, all 10 articles reported CPT values of the left sural nerve of DPN patients under 2000 Hz, 250 Hz and 5 Hz. The heterogeneity test results were $I^2$ = 92%, $I^2$ = 83% and $I^2$ = 85%, respectively. The results showed that the CPT of the left sural group under 2000 Hz, 250 Hz and 5 Hz were higher than those of the normal group (WMD = 107.77, 95% CI: 104.69-110.86, *P* < 0.05) (WMD = 100.26, 95% CI : 97.53 ~ 102.99, *P* < 0.05), (WMD = 90.71, 95% CI: 87.87 ~ 93.55, *P* < 0.05).

***Characteristics of right sural nerve injury*** As shown in Figure 11, Figure 12 and Figure 13, all 10 articles reported CPT values of the left sural nerve of DPN patients under 2000 Hz, 250 Hz and 5 Hz. The heterogeneity test results were $I^2$ = 85%, $I^2$ = 95% and $I^2$ = 95%, respectively. The results showed that the CPT of left sural nerve of patients under 2000 Hz, 250 Hz and 5 Hz were higher than that of the normal group (WMD = 106.47, 95% CI: 103.48-109.47, *P* < 0.05) (WMD = 87.22, 95% CI : 84.86 ~ 89.58, *P* < 0.05) (WMD = 92.89, 95% CI: 90.80-94.99, *P* < 0.05).

## Discussion

Sensory nerve quantitative detection is a noninvasive, noninvasive and painless test [19]. Compared with commonly used neurological diagnostic tests, such as sensory nerve conduction velocity (SNVC), somatosensory evoked potential

| Study or Subgroup | DPN Mean | SD | Total | Normal Control Mean | SD | Total | Weight | Mean Difference IV, Fixed, 95% CI |
|---|---|---|---|---|---|---|---|---|
| Fukashi Ishibashi 2015 | 105.35 | 55.87 | 200 | 17.11 | 5.09 | 40 | 19.2% | 88.24 [80.34, 96.14] |
| Fukashi Ishibashi 2016 | 132.54 | 41.89 | 198 | 11.71 | 3.53 | 29 | 33.6% | 120.83 [114.86, 126.80] |
| G Ponirakis 2016 | 546.39 | 34.05 | 74 | 298.44 | 88.43 | 70 | 2.5% | 247.95 [225.83, 270.07] |
| KK Bo 2014 | 412.65 | 146.76 | 46 | 353.61 | 182.16 | 46 | 0.3% | 59.04 [-8.56, 126.64] |
| Qing Gao 2014 | 110.2 | 47.3 | 66 | 13.8 | 4.7 | 66 | 9.1% | 96.40 [84.93, 107.87] |
| Ren-Hua Zhao 2015 | 468.35 | 160.88 | 109 | 371.47 | 117.22 | 109 | 0.9% | 96.88 [59.51, 134.25] |
| Rui-Qin Du 2012 | 332.2 | 167.3 | 48 | 282.1 | 82.5 | 48 | 0.4% | 50.10 [-2.67, 102.87] |
| TH Schindler 2017 | 324.57 | 132.54 | 20 | 247.23 | 71.36 | 18 | 0.3% | 77.34 [10.55, 144.13] |
| Xiao-Pin Pu 2014 | 109.9 | 47.1 | 225 | 13.6 | 4.5 | 225 | 31.4% | 96.30 [90.12, 102.48] |
| Ya-Lin Wang 2013 | 398.72 | 82.13 | 68 | 220.82 | 45.6 | 68 | 2.4% | 177.90 [155.57, 200.23] |
| | | | | | | | | |
| Total (95% CI) | | | 1054 | | | 719 | 100.0% | 108.34 [104.88, 111.81] |

Heterogeneity: Chi² = 258.59, df = 9 (P < 0.00001); I² = 97%
Test for overall effect: Z = 61.31 (P < 0.00001)
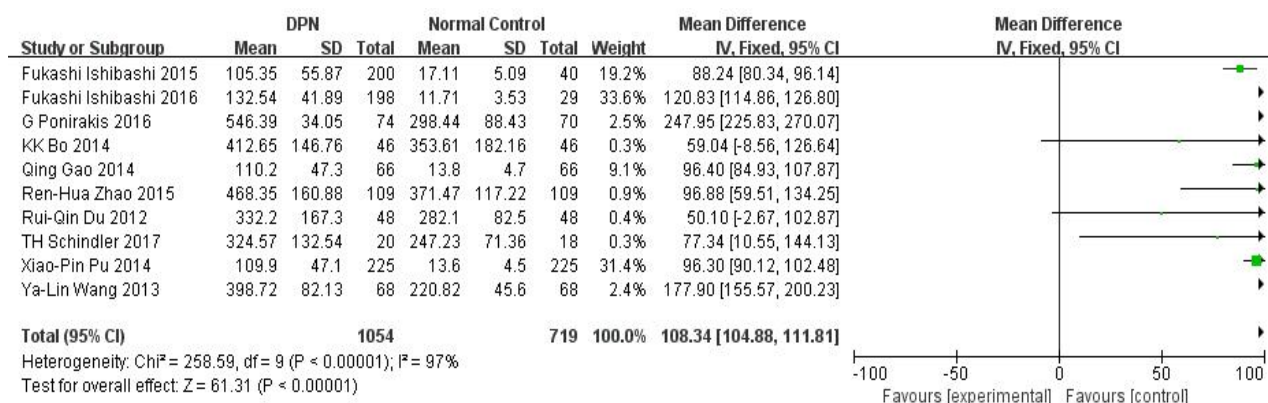
**Figure 2 Comparison of CPT values of the left median nerve at 2000 Hz**
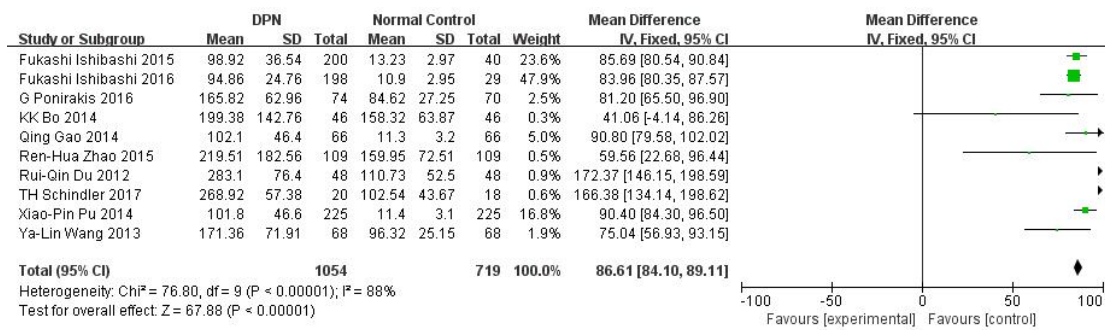
**Figure 3 Comparison of CPT values of the left median nerve at 250 Hz**
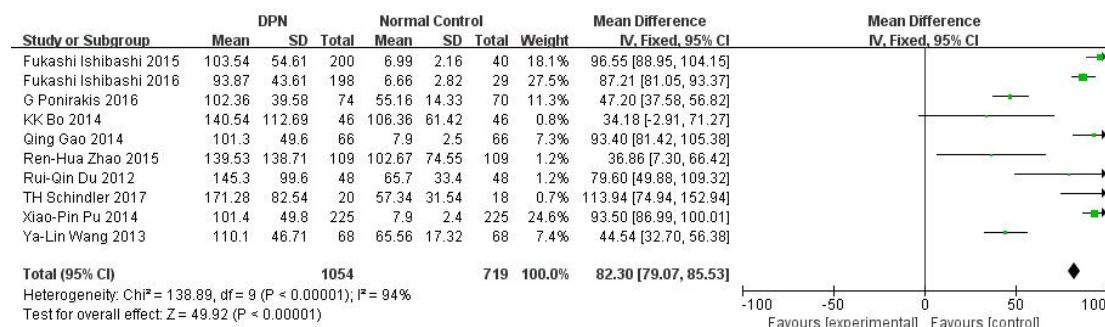


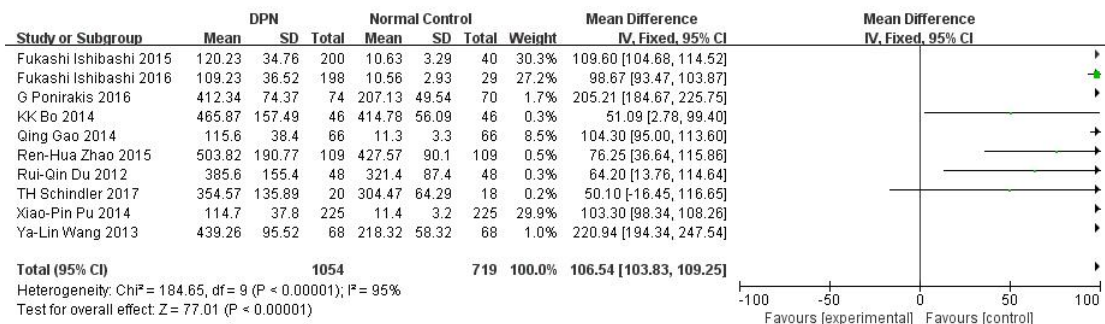**Figure 4 Comparison of CPT values of the left median nerve at 5 Hz**



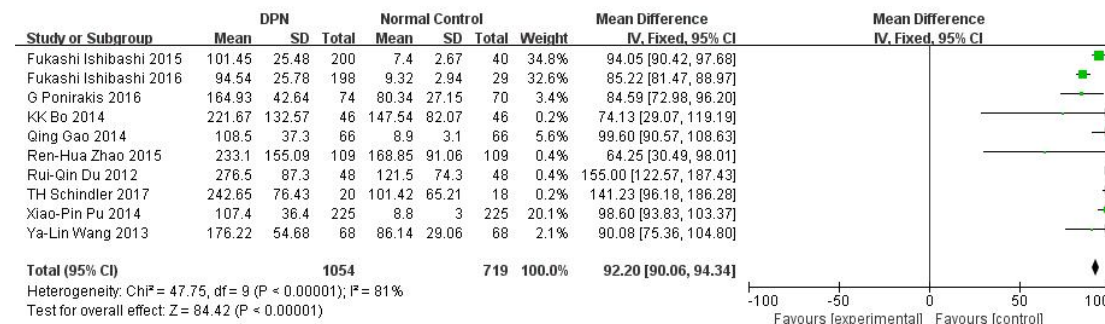**Figure 5 Comparison of CPT values of the right median nerve at 2000 Hz**



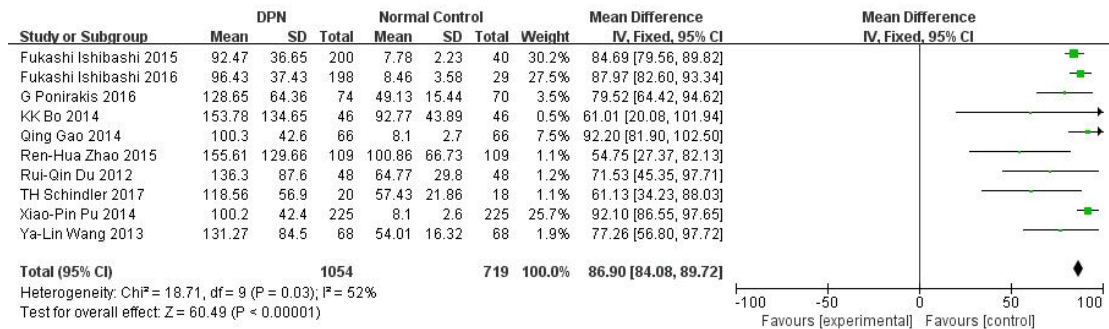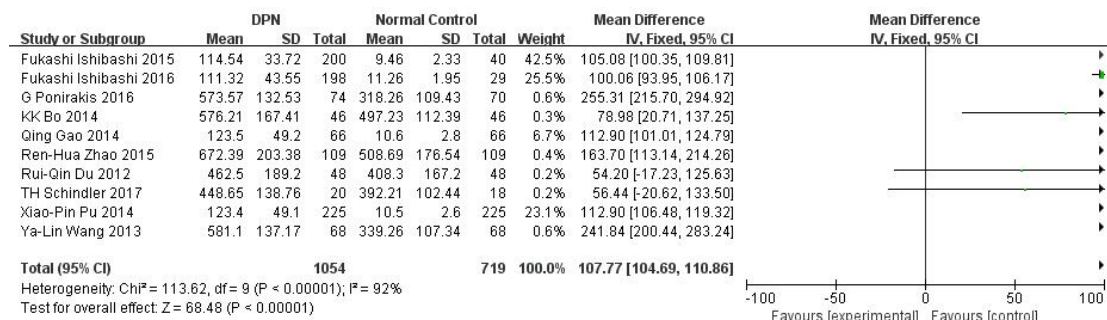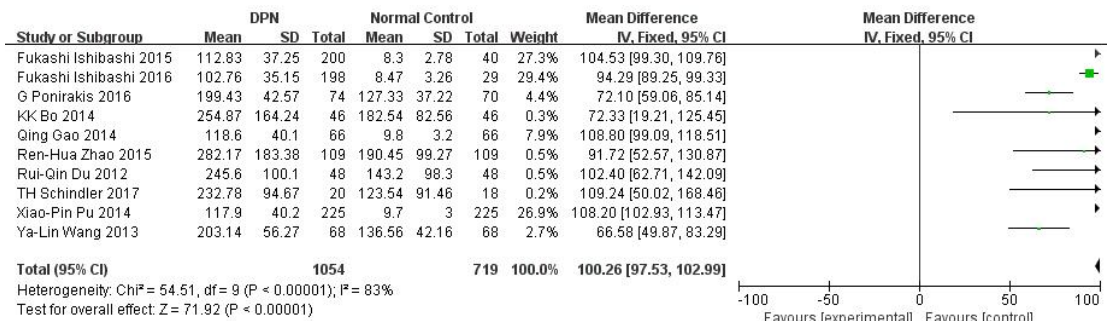**Figure 6 Comparison of CPT values of the right median nerve at 250 Hz**

| Study or Subgroup | DPN Mean | SD | Total | Normal Control Mean | SD | Total | Weight | Mean Difference IV, Fixed, 95% CI |
|---|---|---|---|---|---|---|---|---|
| Fukashi Ishibashi 2015 | 92.47 | 36.65 | 200 | 7.78 | 2.23 | 40 | 30.2% | 84.69 [79.56, 89.82] |
| Fukashi Ishibashi 2016 | 96.43 | 37.43 | 198 | 8.46 | 3.58 | 29 | 27.5% | 87.97 [82.60, 93.34] |
| G Ponirakis 2016 | 128.65 | 64.36 | 74 | 49.13 | 15.44 | 70 | 3.5% | 79.52 [64.42, 94.62] |
| KK Bo 2014 | 153.78 | 134.65 | 46 | 92.77 | 43.89 | 46 | 0.5% | 61.01 [20.08, 101.94] |
| Qing Gao 2014 | 100.3 | 42.6 | 66 | 8.1 | 2.7 | 66 | 7.5% | 92.20 [81.90, 102.50] |
| Ren-Hua Zhao 2015 | 155.61 | 129.66 | 109 | 100.86 | 66.73 | 109 | 1.1% | 54.75 [27.37, 82.13] |
| Rui-Qin Du 2012 | 136.3 | 87.6 | 48 | 64.77 | 29.8 | 48 | 1.2% | 71.53 [45.35, 97.71] |
| TH Schindler 2017 | 118.56 | 56.9 | 20 | 57.43 | 21.86 | 18 | 1.1% | 61.13 [34.23, 88.03] |
| Xiao-Pin Pu 2014 | 100.2 | 42.4 | 225 | 8.1 | 2.6 | 225 | 25.7% | 92.10 [86.55, 97.65] |
| Ya-Lin Wang 2013 | 131.27 | 84.5 | 68 | 54.01 | 16.32 | 68 | 1.9% | 77.26 [56.80, 97.72] |
| **Total (95% CI)** | | | **1054** | | | **719** | **100.0%** | **86.90 [84.08, 89.72]** |

Heterogeneity: Chi² = 18.71, df = 9 (P = 0.03); I² = 52%
Test for overall effect: Z = 60.49 (P < 0.00001)

**Figure 7 Comparison of CPT values of the right median nerve at 5 Hz**

| Study or Subgroup | DPN Mean | SD | Total | Normal Control Mean | SD | Total | Weight | Mean Difference IV, Fixed, 95% CI |
|---|---|---|---|---|---|---|---|---|
| Fukashi Ishibashi 2015 | 114.54 | 33.72 | 200 | 9.46 | 2.33 | 40 | 42.5% | 105.08 [100.35, 109.81] |
| Fukashi Ishibashi 2016 | 111.32 | 43.55 | 198 | 11.26 | 1.95 | 29 | 25.5% | 100.06 [93.95, 106.17] |
| G Ponirakis 2016 | 573.57 | 132.53 | 74 | 318.26 | 109.43 | 70 | 0.6% | 255.31 [215.70, 294.92] |
| KK Bo 2014 | 576.21 | 167.41 | 46 | 497.23 | 112.39 | 46 | 0.3% | 78.98 [20.71, 137.25] |
| Qing Gao 2014 | 123.5 | 49.2 | 66 | 10.6 | 2.8 | 66 | 6.7% | 112.90 [101.01, 124.79] |
| Ren-Hua Zhao 2015 | 672.39 | 203.38 | 109 | 508.69 | 176.54 | 109 | 0.4% | 163.70 [113.14, 214.26] |
| Rui-Qin Du 2012 | 462.5 | 189.2 | 48 | 408.3 | 167.2 | 48 | 0.2% | 54.20 [-17.23, 125.63] |
| TH Schindler 2017 | 448.65 | 138.76 | 20 | 392.21 | 102.44 | 18 | 0.2% | 56.44 [-20.62, 133.50] |
| Xiao-Pin Pu 2014 | 123.4 | 49.1 | 225 | 10.5 | 2.6 | 225 | 23.1% | 112.90 [106.48, 119.32] |
| Ya-Lin Wang 2013 | 581.1 | 137.17 | 68 | 339.26 | 107.34 | 68 | 0.6% | 241.84 [200.44, 283.24] |
| **Total (95% CI)** | | | **1054** | | | **719** | **100.0%** | **107.77 [104.69, 110.86]** |

Heterogeneity: Chi² = 113.62, df = 9 (P < 0.00001); I² = 92%
Test for overall effect: Z = 68.48 (P < 0.00001)

**Figure 8 Comparison of CPT values of the left sural nerve at 2000 Hz**

| Study or Subgroup | DPN Mean | SD | Total | Normal Control Mean | SD | Total | Weight | Mean Difference IV, Fixed, 95% CI |
|---|---|---|---|---|---|---|---|---|
| Fukashi Ishibashi 2015 | 112.83 | 37.25 | 200 | 8.3 | 2.78 | 40 | 27.3% | 104.53 [99.30, 109.76] |
| Fukashi Ishibashi 2016 | 102.76 | 35.15 | 198 | 8.47 | 3.26 | 29 | 29.4% | 94.29 [89.25, 99.33] |
| G Ponirakis 2016 | 199.43 | 42.57 | 74 | 127.33 | 37.22 | 70 | 4.4% | 72.10 [59.06, 85.14] |
| KK Bo 2014 | 254.87 | 164.24 | 46 | 182.54 | 82.56 | 46 | 0.3% | 72.33 [19.21, 125.45] |
| Qing Gao 2014 | 118.6 | 40.1 | 66 | 9.8 | 3.2 | 66 | 7.9% | 108.80 [99.09, 118.51] |
| Ren-Hua Zhao 2015 | 282.17 | 183.38 | 109 | 190.45 | 99.27 | 109 | 0.5% | 91.72 [52.57, 130.87] |
| Rui-Qin Du 2012 | 245.6 | 100.1 | 48 | 143.2 | 98.3 | 48 | 0.5% | 102.40 [62.71, 142.09] |
| TH Schindler 2017 | 232.78 | 94.67 | 20 | 123.54 | 91.46 | 18 | 0.2% | 109.24 [50.02, 168.46] |
| Xiao-Pin Pu 2014 | 117.9 | 40.2 | 225 | 9.7 | 3 | 225 | 26.9% | 108.20 [102.93, 113.47] |
| Ya-Lin Wang 2013 | 203.14 | 56.27 | 68 | 136.56 | 42.16 | 68 | 2.7% | 66.58 [49.87, 83.29] |
| **Total (95% CI)** | | | **1054** | | | **719** | **100.0%** | **100.26 [97.53, 102.99]** |

Heterogeneity: Chi² = 54.51, df = 9 (P < 0.00001); I² = 83%
Test for overall effect: Z = 71.92 (P < 0.00001)

**Figure 9 Comparison of CPT values of the left sural nerve at 250 Hz**

| Study or Subgroup | DPN Mean | SD | Total | Normal Control Mean | SD | Total | Weight | Mean Difference IV, Fixed, 95% CI |
|---|---|---|---|---|---|---|---|---|
| Fukashi Ishibashi 2015 | 100.73 | 54.61 | 200 | 7.37 | 3.81 | 40 | 13.7% | 93.36 [85.70, 101.02] |
| Fukashi Ishibashi 2016 | 94.43 | 38.89 | 198 | 7.47 | 2.19 | 29 | 26.9% | 86.96 [81.48, 92.44] |
| G Ponirakis 2016 | 139.27 | 35.42 | 74 | 65.78 | 22.53 | 70 | 8.7% | 73.49 [63.85, 83.13] |
| KK Bo 2014 | 187.47 | 139.35 | 46 | 108.34 | 85.27 | 46 | 0.4% | 79.13 [31.92, 126.34] |
| Qing Gao 2014 | 109.6 | 37.9 | 66 | 8.7 | 2.8 | 66 | 9.6% | 100.90 [91.73, 110.07] |
| Ren-Hua Zhao 2015 | 191.33 | 181.13 | 109 | 115.51 | 97.95 | 109 | 0.5% | 75.82 [37.16, 114.48] |
| Rui-Qin Du 2012 | 134.6 | 87.9 | 48 | 98.6 | 78.5 | 48 | 0.7% | 36.00 [2.66, 69.34] |
| TH Schindler 2017 | 124.84 | 75.83 | 20 | 84.27 | 54.65 | 18 | 0.5% | 40.57 [-1.17, 82.31] |
| Xiao-Pin Pu 2014 | 108.6 | 37.6 | 225 | 8.5 | 2.6 | 225 | 33.3% | 100.10 [95.18, 105.02] |
| Ya-Lin Wang 2013 | 145.91 | 40.72 | 68 | 76.18 | 28.71 | 68 | 5.8% | 69.73 [57.89, 81.57] |
| **Total (95% CI)** | | | **1054** | | | **719** | **100.0%** | **90.71 [87.87, 93.55]** |

Heterogeneity: Chi² = 61.97, df = 9 (P < 0.00001); I² = 85%
Test for overall effect: Z = 62.61 (P < 0.00001)

**Figure 10 Comparison of CPT values of the left sural nerve at 5 Hz**

| Study or Subgroup | DPN Mean | SD | Total | Normal Control Mean | SD | Total | Weight | Mean Difference IV, Fixed, 95% CI |
|---|---|---|---|---|---|---|---|---|
| Fukashi Ishibashi 2015 | 109.23 | 34.45 | 200 | 10.89 | 3.16 | 40 | 37.8% | 98.34 [93.47, 103.21] |
| Fukashi Ishibashi 2016 | 121.45 | 46.67 | 198 | 9.46 | 3.55 | 29 | 20.4% | 111.99 [105.36, 118.62] |
| G Ponirakis 2016 | 499.72 | 110.56 | 74 | 327.24 | 60.22 | 70 | 1.1% | 172.48 [143.61, 201.35] |
| KK Bo 2014 | 647.76 | 228.45 | 46 | 505.17 | 143.27 | 46 | 0.1% | 142.59 [64.66, 220.52] |
| Qing Gao 2014 | 118.4 | 41.2 | 66 | 10.5 | 4 | 66 | 9.0% | 107.90 [97.91, 117.89] |
| Ren-Hua Zhao 2015 | 705.62 | 205.22 | 109 | 521.04 | 190.16 | 109 | 0.3% | 184.58 [132.06, 237.10] |
| Rui-Qin Du 2012 | 488.4 | 190.2 | 48 | 422.1 | 256.4 | 48 | 0.1% | 66.30 [-24.01, 156.61] |
| TH Schindler 2017 | 468.4 | 154.34 | 20 | 412.65 | 73.4 | 18 | 0.2% | 55.75 [-19.91, 131.41] |
| Xiao-Pin Pu 2014 | 118.5 | 41.3 | 225 | 10.4 | 4.1 | 225 | 30.5% | 108.10 [102.68, 113.52] |
| Ya-Lin Wang 2013 | 511.18 | 167.26 | 68 | 316.76 | 69.52 | 68 | 0.5% | 194.42 [151.37, 237.47] |
| **Total (95% CI)** | | | 1054 | | | 719 | 100.0% | 106.47 [103.48, 109.47] |

Heterogeneity: Chi² = 61.70, df = 9 (P < 0.00001); I² = 85%
Test for overall effect: Z = 69.67 (P < 0.00001)

**Figure 11 Comparison of CPT values of the right sural nerve at 2000 Hz**

| Study or Subgroup | DPN Mean | SD | Total | Normal Control Mean | SD | Total | Weight | Mean Difference IV, Fixed, 95% CI |
|---|---|---|---|---|---|---|---|---|
| Fukashi Ishibashi 2015 | 98.56 | 29.58 | 200 | 8.92 | 2.64 | 40 | 31.9% | 89.64 [85.46, 93.82] |
| Fukashi Ishibashi 2016 | 92.42 | 29.76 | 198 | 8.22 | 2.48 | 29 | 31.0% | 84.20 [79.96, 88.44] |
| G Ponirakis 2016 | 134.92 | 56.21 | 74 | 106.53 | 29.33 | 70 | 2.6% | 28.39 [13.86, 42.92] |
| KK Bo 2014 | 298.57 | 169.35 | 46 | 192.04 | 115.33 | 46 | 0.2% | 106.53 [47.32, 165.74] |
| Qing Gao 2014 | 104.7 | 36.3 | 66 | 9.3 | 3.6 | 66 | 7.2% | 95.40 [86.60, 104.20] |
| Ren-Hua Zhao 2015 | 306.43 | 211.72 | 109 | 206.8 | 126.36 | 109 | 0.3% | 99.63 [53.34, 145.92] |
| Rui-Qin Du 2012 | 284.7 | 96.3 | 48 | 153.7 | 100.5 | 48 | 0.4% | 131.00 [91.62, 170.38] |
| TH Schindler 2017 | 253.57 | 48.91 | 20 | 123.45 | 67.21 | 18 | 0.4% | 130.12 [92.39, 167.85] |
| Xiao-Pin Pu 2014 | 104.6 | 36.2 | 225 | 9.2 | 3.1 | 225 | 24.7% | 95.40 [90.65, 100.15] |
| Ya-Lin Wang 2013 | 140.91 | 73.85 | 68 | 142.63 | 37.26 | 68 | 1.4% | -1.72 [-21.38, 17.94] |
| **Total (95% CI)** | | | 1054 | | | 719 | 100.0% | 87.22 [84.86, 89.58] |

Heterogeneity: Chi² = 169.92, df = 9 (P < 0.00001); I² = 95%
Test for overall effect: Z = 72.43 (P < 0.00001)

**Figure 12 Comparison of the CPT values of the right sural nerve at 250 Hz**

| Study or Subgroup | DPN Mean | SD | Total | Normal Control Mean | SD | Total | Weight | Mean Difference IV, Fixed, 95% CI |
|---|---|---|---|---|---|---|---|---|
| Fukashi Ishibashi 2015 | 102.35 | 31.64 | 200 | 8.47 | 2.59 | 40 | 22.1% | 93.88 [89.42, 98.34] |
| Fukashi Ishibashi 2016 | 107.88 | 25.43 | 198 | 6.53 | 2.57 | 29 | 32.8% | 101.35 [97.69, 105.01] |
| G Ponirakis 2016 | 94.78 | 54.38 | 74 | 71.55 | 22.1 | 70 | 2.4% | 23.23 [9.80, 36.66] |
| KK Bo 2014 | 193.64 | 136.68 | 46 | 103.41 | 89.23 | 46 | 0.2% | 90.23 [43.06, 137.40] |
| Qing Gao 2014 | 100.6 | 28.9 | 66 | 7.6 | 3.2 | 66 | 8.9% | 93.00 [85.99, 100.01] |
| Ren-Hua Zhao 2015 | 202.5 | 193.49 | 109 | 122.03 | 118.51 | 109 | 0.2% | 80.47 [37.87, 123.07] |
| Rui-Qin Du 2012 | 155.6 | 88.9 | 48 | 110.3 | 81.4 | 48 | 0.4% | 45.30 [11.20, 79.40] |
| TH Schindler 2017 | 135.54 | 56.68 | 20 | 108.43 | 65.21 | 18 | 0.3% | 27.11 [-11.94, 66.16] |
| Xiao-Pin Pu 2014 | 100.4 | 28.5 | 225 | 7.5 | 3.1 | 225 | 31.4% | 92.90 [89.15, 96.65] |
| Ya-Lin Wang 2013 | 100.82 | 75.06 | 68 | 79.68 | 24.37 | 68 | 1.3% | 21.14 [2.38, 39.90] |
| **Total (95% CI)** | | | 1054 | | | 719 | 100.0% | 92.89 [90.80, 94.99] |

Heterogeneity: Chi² = 198.99, df = 9 (P < 0.00001); I² = 95%
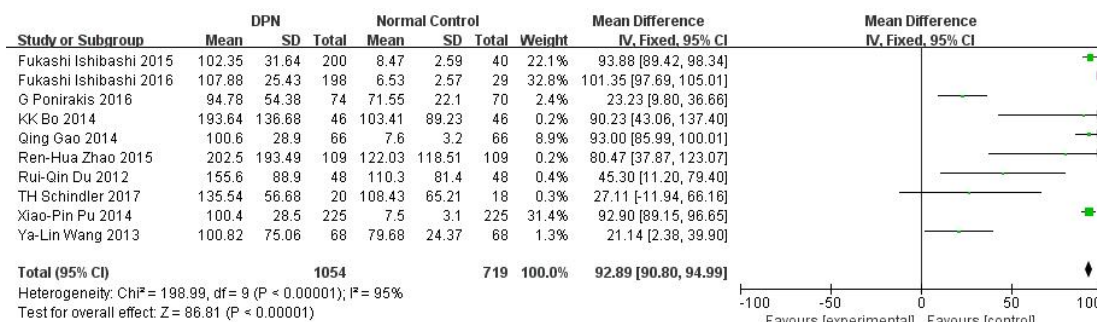Test for overall effect: Z = 86.81 (P < 0.00001)

**Figure 13 Comparison of the CPT values of the right sural nerve at 5 Hz**

(SSEP), and electromyography (EMG), sensory nerve quantitative detection is relatively insensitive in the detection of skin temperature, thickness changes, scar tissue or edema,which often interfere with the aforementioned neurological test [20]. The early, often-specific selection of many types of diseases involves a single neurofibrillar subtype, whereas other neurofibrillar subtypes are not implicated and are limited to evaluating the function of the crude myelinated sensory nerve fibers [21]. DPN is often manifested as demyelinating degeneration of the nerve fibers (Wallerian degeneration) in the early stages, therefore, there is no abnormalities to detect it before 3 to 6 weeks using acupuncture EMG tests [22].

Sensory nerve quantitative detector can assess Aβ, Aδ, C nerve fiber function separately through three kinds of neural sinusoidal waveform (2000Hz, 250Hz, 5Hz). The CPT value at 2000 Hz reflects the function of the great myelinated nerve fibers, the CPT value of 250 Hz is the function of small myelinated nerve fibers, and the CPT value of 5 Hz shows the function of the unmyelinated nerve fibers. These three kinds of nerve fibers are the main sensory nerve fibers, which conducts skin feel and pressure sensation, temperature sensation, pressure sensation and fast pain sensation [23]. With the development of DPN, the sensory nerve quantitative detector can quantitatively describe the change of nerve conduction velocity: If the nerve

conduction velocity decreases, the nerve sensitivity decreases and the CPT value increases [24]. So in order to detect nerve damage early, accurately and monitor the effect treatment in patients with DPN, sensory nerve quantitative detector is a good choice. In the Masson's study, 33 diabetics and 54 controls were included, and found the sensitivity and specificity of Neurometer was 94%, 100%, respectively [25]. In the Ziccardi's study, with 73 diabetics and 47 controls, the sensitivity and specificity of Neurometer was 60% and 95% [26]. In this study, systematic evaluation showed that: CPN values of left and right median nerve and sural nerve in DPN patients were significantly higher than those in normal control group, that is, peripheral nerve sensitivity of DPN patients were generally decreased, suggesting that all patients included in the study were in the mid-late DPN course.

## Conclusion

The sensitivity of the left and right median and sural nerve in DPN patients enrolled in the meta-analysis were generally lower. Sensory nerve quantitative detector could detect nerve damage early, accurately and monitor the effect treatment in patients with DPN.

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