# Comparison of Pain Tolerance Thresholds of Upper Limb to Identify the Most Appropriate Venipuncture Site

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**Purpose:** Venipuncture is often accompanied by pain, which can compromise dental care and foment distrust toward dental care providers. The aim of the present study was to identify sites on the forearm and hand that have the greatest pain tolerance threshold (PTT) during venipuncture.

**Materials and Methods:** The PTT was estimated in 20 healthy volunteers using a noninvasive nerve conduction threshold device. The subjects self-stimulated 5 sites (median cubital vein, cephalic vein at the cubitus, basilic vein, cephalic vein at the carpus, and superficial dorsal vein) at 2 kHz, 250 Hz, and 5 Hz. We measured the stimulation intensity before the subject deactivated the device. Differences in the average PTT values at each site were compared using the Kruskal-Wallis and Scheffé tests. $P < .05$ was considered to indicate statistical significance.

**Results:** The PTT was significantly greater at the superficial dorsal vein than at the basilic vein for all 3 noninvasive nerve conduction threshold frequencies ($P < .05$). The estimated PTT was significantly greater at the superficial dorsal vein than at the median cubital vein and cephalic vein at the carpus in response to 250-Hz stimulation ($P < .05$).

**Conclusions:** The greater PTT of the superficial dorsal vein suggests that venipuncture at this site should result in the lowest pain intensity among all upper limb sites.



*J Oral Maxillofac Surg 73:850.e1-850.e5, 2015*

Venipuncture is a ubiquitous technique for the administration of general anesthesia and intravenous sedation. However, the pain associated with venipuncture and the accompanying connective tissue and blood vessel injuries can compromise patient care by leading to noncompliance or avoidance of dental procedures and create general fear toward dental care providers.[1,2] Many methods have been proposed and used for reducing venipuncture pain.[3-5] Therefore, decreasing the pain associated with venipuncture might facilitate treatment compliance and improve dental health.

Although a standard text of intravenous sedation[6] has recommended the dorsum of the hand, dorsum of the wrist, ventral forearm, and antecubital fossa, as well as other sites for venipuncture, no study has identified the most suitable venipuncture site on the basis of the greatest pain threshold.

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Received October 17 2014

Accepted January 23 2015



0278-2391/15/00099-3

http://dx.doi.org/10.1016/j.joms.2015.01.027

The aim of the present study was to identify the sites on the dorsal forearm and hand that have the greatest pain tolerance thresholds (PTTs) for venipuncture.

## Materials and Methods

The research ethics committee of Kyushu Dental University approved the present study, which was conducted in accordance with the guidelines of the Declaration of Helsinki. All 20 volunteers provided written informed consent and all 20 healthy volunteers were male (mean age 23 ± 1.5 years).

The PTT was measured using a constant current device (Neurometer CPT/C, Neurotron Inc, Baltimore, MD). The 5 sites tested in the present study were those often recommended for venipuncture[6]: median cubital vein, cephalic vein at the cubitus and carpus, basilic vein more than 10 cm distal to the radial styloid process, and superficial dorsal vein (Fig 1).

Each subject lay in a supine position on a bed in a quiet room while the PTT was measured. The same operator measured the PTT for all subjects. Using the textbook procedure,[6] a tourniquet (soft rubber tubing) was placed around the arm to distend these veins. We then confirmed that a radial pulse was still palpable before PTT measurement. Next, 2 electrodes to deliver electrical stimulation were placed on each distended vein. We explained the procedure to the subjects as follows: "press and hold down the button until you start feeling pain, cannot endure the unpleasant sensation, or the stimulus automatically shuts off. The stimulus is under your control and will turn off as soon as you release the button."

The Neurometer CPT/C delivers sine wave stimulation at 2 kHz, 250 Hz, and 5 Hz when the subject pushes the switch. The sine wave is delivered at regular intervals (2 kHz, 0.5 second; 250 Hz, 1.5 seconds; and 5 Hz, 1.75 seconds) with a progressively increasing current amplitude in 0.01-mA increments. The stimulation output was increased from 0 mA to a maximum of 9.99 mA until the subject was unable to tolerate the stimulus. The measuring sites and frequencies were selected randomly by us, and the stimulation with the sine wave was delivered continuously until the subject turned the switch off or when the maximum output intensity (9.99 mA) had been reached and the stimulation was stopped. We measured the PTT values when the subject turned the Neurometer switch off. The measurement was performed 3 times, and the PTT values were averaged. These PTT values were measured on the left upper limb.

The mean PTT values at the 5 sites were compared using the Kruskal-Wallis test and Scheffé test for pairwise comparisons. $P < .05$ was considered to indicate statistical significance.

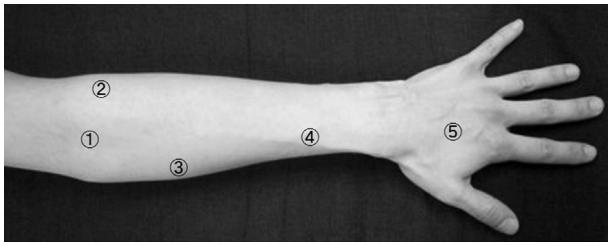


**FIGURE 1.** Measurement sites of pain tolerance threshold (PTT). PTTs were measured 3 times per subject at the 5 sites shown. All 5 sites have been recommended for venipuncture: 1, median cubital vein; 2, cephalic vein at cubitus; 3, basilic vein; 4, cephalic vein at carpus; and 5, superficial dorsal vein.

*Yoshida et al. PTTs of Upper Limb Identify Most Appropriate Venipuncture Site. J Oral Maxillofac Surg 2015.*

## Results

The PTT at the superficial dorsal vein was significantly greater than that at the basilic vein for the 2-kHz, 250-Hz, and 5-Hz stimulations ($P < .05$ for all; Figs 2 to 4). The PTT was also significantly greater at the superficial dorsal vein than at the median cubital vein and cephalic vein at the carpus for the 250-Hz stimulation (Fig 3). Moreover, among the 5 sites, the PTT at the superficial dorsal vein was the greatest for all 3 frequencies.

## Discussion

We used the Neurometer CPT/C to measure the PTT. The device can measure the current perception threshold (CPT), which is the threshold for sensing stimulation, and the PTT, which is the threshold for sensing pain. According to previous studies,[7,8] the PTT can be detected with greater reliability than the CPT. Therefore, we measured the PTT in the present study.

The Neurometer CPT/C delivers biphasic sine wave stimuli at 5 Hz, 250 Hz, and 2 kHz, which are the stimulation frequencies thought to activate all sensory fiber classes.[9] Nerve conduction and pharmacologic studies in animals and humans have shown that C-fiber activation is predominant at 5 Hz, Aδ-fiber activation is predominant at 250 Hz, and Aβ-fiber activation is predominant at 2 kHz.[10-15] Aδ and C fibers both transmit nociceptive signals; Aδ fibers respond specifically to intense mechanical stimulation and are thus activated when the needle pierces the skin. Additionally, a previous study has also reported that Aδ fibers, which are excited by 250-Hz electrical stimulation, responded to pinprick sensations.[13] The stimulation caused by a pinprick is similar to that caused by venipuncture. Therefore, it is logical to conclude that the site showing the greatest PTT at 250 Hz would minimize the venipuncture pain experienced.

In the present study, the PTT was significantly greater at the superficial dorsal vein than at the median