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Continuous Femoral Nerve Blocks: The Impact of Catheter Tip Location Relative to the Femoral Nerve (Anterior Versus Posterior) on Quadriceps Weakness and Cutaneous Sensory Block

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Abstract

Background—During a continuous femoral nerve block, the influence of catheter tip position relative to the femoral nerve on infusion characteristics remains unknown.

Methods—We inserted bilateral femoral perineural catheters in volunteers (ultrasound-guided, needle in-plane). Subjects' dominant side was randomized to have the catheter tip placed either anterior or posterior to the femoral nerve. The contralateral limb received the alternative position. Ropivacaine 0.1% was administered through both catheters concurrently for 6 hours (4 mL/h). Outcome measures included the maximum voluntary isometric contraction (MVIC) of the quadriceps femoris muscle and tolerance to cutaneous electrical current over to the distal quadriceps tendon. Measurements were performed at Hour 0 (baseline), and on the hour until Hour 9, as well as Hour 22. The primary endpoint was the MVIC of the quadriceps at Hour 6.

Results—As a percentage of the baseline measurement, quadriceps MVIC for limbs with anterior (n=16) and posterior (n=16) catheter tip placement did not differ to a statistically significant degree at Hour 6 (mean [SD] 29% [26] vs. 30% [28], respectively; 95% CI: -22% to 20%; p=0.931), or at any other time point. However, the maximum tolerance to cutaneous electrical current was higher in limbs with anterior compared to posterior catheter tip placement at Hour 6 (20 [23] vs. 6 [4] mA, respectively; 95% CI: 1 mA to 27 mA; p=0.035), as well as at Hours 1, 7, 8, and 9 (p<0.04).

Conclusions—This study documents the significant (70–80%) quadriceps femoris weakness induced by a continuous femoral nerve block infusion at a relatively low dose of ropivacaine (4 mg/h) delivered through a perineural catheter located both anterior and posterior to the femoral nerve. In contrast, an anterior placement increases cutaneous sensory block compared with a posterior insertion, without a concurrent relative increase in motor block.

Introduction

Pain after knee surgery is frequently treated with a continuous femoral nerve block (cFNB).¹ Because available local anesthetics inhibit both afferent (sensory and proprioception) and efferent (motor) neural impulses,² cFNB induces quadriceps femoris muscle weakness.³ Minimizing motor effects during cFNB is imperative since quadriceps weakness is associated with both functional disability⁴ limiting ambulation/rehabilitation,⁵ and an increased risk of falling in elderly patients.⁶ Unfortunately, all previously proposed cFNB infusion strategies designed to decrease muscle weakness while retaining commensurate analgesia have failed in this goal.^{7–9}

The anatomy of the femoral nerve may permit affecting the various terminal nerves to different degrees since “distal branches of the femoral nerve are represented as individual fascicles or colocalized groups of fascicles in the compound femoral nerve.”¹⁰ Although there is individual variability as well as somewhat conflicting published data,^{10,11} fascicles leading to the major knee extensor muscle, the quadriceps femoris, are generally centrally and dorsally located at the level of the inguinal crease,^{10,12} while fascicles leading to the sensory branches are usually located on the nerve periphery.¹⁰ Theoretically, varying the exact location of local anesthetic deposition relative to the femoral nerve during cFNB

(anterior vs. posterior) may alter the sensory-to-motor block ratio. A favorable change in this ratio (concurrent increased sensory and decreased motor blocks) may provide an increased margin of safety for patients with cFNB without compromising, and possibly even improving, postoperative analgesia.

We therefore tested the hypothesis that differing the location of the perineural catheter tip relative to the femoral nerve (anterior vs. posterior) during cFNB impacts quadriceps muscle strength.

Materials and Methods

Enrollment

Our local IRB (University of California San Diego, San Diego, CA) approved all study procedures. The trial was prospectively registered at clinicaltrials.gov (NCT01263249). Enrollment included a convenience sample of relatively healthy adult (> 18 years) volunteers of both sexes. Exclusion criteria included current daily analgesic use; any opioid use within the previous 4 weeks; any neuromuscular deficit of either femoral nerves and/or thigh musculature; body mass index > 30 kg/m²; pregnancy; and incarceration. Of note, any individual (e.g., medical trainees, study coordinators, etc.) whose non-study performance was potentially evaluated by the Principal Investigator (B.I.) was considered part of a “vulnerable population” and excluded from volunteering as a study subject as mandated by current United States ethical guidelines.¹³ All participants provided written, informed consent before any study procedures. This study was undertaken in a Clinical and Translational Research Institute (University of California, San Diego, California, United States).

In the supine position, subjects had an IV line placed in the upper extremity, standard American Society of Anesthesiologists-recommended external monitors applied, and oxygen administered by nasal cannula (3 L/min). Intravenous midazolam (1 mg) and fentanyl (50 µg) were administered, while ensuring that study subjects remained responsive to verbal cues. Any hair in the area that would be subsequently covered by the catheter dressings was removed with a surgical hair clipper. After skin disinfection (chlorhexidine gluconate and isopropyl alcohol) and draping, bilateral femoral perineural catheters were inserted.

Randomization

Subjects acted as their own controls: The dominant side (right or left) was randomized to one of two treatment groups: perineural catheter tip placement immediately anterior or posterior to the femoral nerve. On the nondominant contralateral side, the catheter tip was placed in the other possible position relative to the femoral nerve. Randomization was based on computer-generated codes in blocks of two, stratified by sex. The Investigational Drug Service prepared the randomization list and provided the investigator inserting each catheter with the treatment assignment immediately preceding catheter insertion. For each subject, all clinical personnel and the subject him/herself were masked to treatment group, other than the investigator(s) inserting the catheters.

Catheter insertion

The dominant side (right vs. left) catheter was always inserted first. With a 13-6 MHz 38 mm linear array transducer (HFL 38×, SonoSite M-Turbo, Bothell, WA) in a sterile sleeve, the femoral nerve was identified in a transverse cross-sectional (short axis) view at the inguinal crease. A local anesthetic skin wheal was raised lateral to the ultrasound transducer. An uninsulated, 8.9 cm, 17 gauge, Tuohy-tip needle (FlexTip, Arrow International, Reading, PA) was inserted through the skin wheal and directed medially in-plane beneath the

ultrasound transducer to either immediately anterior or posterior to the femoral nerve with an anterior bevel direction. Normal saline (5–10 mL) was injected as the needle tip approached the lateral edge of the femoral nerve to open the space between the nerve and overlying fascia (anterior) or underlying muscle (posterior) to avoid needle-nerve contact. The needle was advanced until the tip was at the midpoint of the visualized femoral nerve, at which time a 19 g flexible epidural-type open-tip catheter (FlexTip, Arrow International, Reading, PA) was inserted through the length of the needle and advanced 1 cm beyond the needle tip (Fig. 1). With the catheter tip remaining visualized by ultrasound to ensure that its position remained fixed, the needle was withdrawn over the catheter until the needle tip was superficial to the iliac fascia. The needle was then held in place and 2 cm of catheter inserted above the iliac fascia while ensuring that the catheter tip remained stationary. The needle was then withdrawn over the remaining catheter. The injection port was attached to the catheter and the catheter secured with sterile liquid adhesive, an occlusive dressing, and an anchoring device.

This procedure was repeated in the nondominant leg and the catheter inserted in the alternative position relative to the femoral nerve. The same volume of normal saline used in the first insertion was injected *via* the needle for hydro-dissection. If this second catheter insertion required a higher volume of normal saline than the initial insertion, the difference in volume was subsequently injected *via* the initial catheter. This protocol resulted in equal volumes of normal saline bilaterally.

Perineural infusion

The Investigational Drug Service prepared and delivered to the investigators two identical infusion pumps (CADD®-Solis Ambulatory Infusion Pump, Smiths Medical, St. Paul, Minnesota, United States) with 100 mL of 0.1% ropivacaine programmed to administer a continuous infusion of 4 mL/h (4 mg/h) for 6 hours. At Hour 0, each infusion pump administered a 2 mL bolus to fill the “dead space” of the catheter hubs and lengths, and subsequently initiated the basal infusions. The infusion pumps were turned off at Hour 6, and the perineural catheters removed.

Subjects remained in the Clinical and Translational Research Institute for 23 hours, or until their quadriceps femoris strength had returned to baseline levels, whichever was longer.

Outcome measurements

We selected measures that have established reliability and validity,^{3,6,14–16} and minimal inter-rater discordance.¹⁵ Measurements were performed at Hour 0 (baseline), and on the hour until Hour 9, as well as the following morning at approximately Hour 22. In all cases, measurements were taken in the seated position with the dominant side measured first, followed by the nondominant side. Initially, quadriceps femoris strength was evaluated with a single measurement, followed by tolerance of transcutaneous electrical stimulation 0–1 cm medial to the distal quadriceps tendon with a single measurement. The primary endpoint was the difference in maximum voluntary isometric contraction (MVIC) of the quadriceps femoris expressed as a percentage of the baseline measurement six hours after initiation of local anesthetic administration. Secondary endpoints included quadriceps femoris MVIC at other time points and cutaneous sensation 0–1 cm medial to the distal quadriceps tendon in the 22 hours after initiation of local anesthetic administration.

Muscle strength—We evaluated quadriceps femoris muscle strength with an isometric force electromechanical dynamometer (MicroFET2, Lafayette Instrument Company, Lafayette, IN) to measure the force produced during a MVIC in a seated position with the knees flexed at 90°. ¹⁵ The dynamometer was placed on the ipsilateral anterior tibia

perpendicular to the tibial crest just proximal to the medial malleolus.^{14–16} For all measurements, subjects were asked to take 2 sec to come to maximum effort contracting the quadriceps femoris, maintain this effort for 5 sec, and then relax.^{6,16} The measurements immediately before perineural ropivacaine administration were designated baseline measurements, and all subsequent measurements are expressed as a percentage of the preinfusion baseline.⁶

Tolerance of transcutaneous electrical stimulation—We evaluated tolerance of transcutaneous electrical stimulation with the same quantitative procedure as one described previously.⁸ Electrocardiogram pads were placed 0–1 cm medial to the distal quadriceps tendon and attached to a nerve stimulator (EZstimII, Model ES400; Life-Tech, Stafford, TX). The current was delivered as a tetanic stimulus (50 Hz) increased from 0 mA until subjects detected the electrical current (up to a maximum of 80 mA), at which time the current was recorded and the nerve stimulator turned off.

Statistical Analysis

Sample size calculations were based on our primary aim to determine the effect of ropivacaine administration site (anterior vs. posterior relative to the femoral nerve) but at an equivalent rate/dose when used in cFNB. To this end, the primary endpoint was designated as the quadriceps femoris MVIC expressed as a percentage of the baseline MVIC at Hour 6. A one-sample t-test of the side-to-side difference (equivalent to a paired t-test) was used to determine whether quadriceps MVIC differed significantly by site of administration. A difference of 20 percentage points was considered clinically relevant because a 10% side-to-side strength difference is common, yet functionally unnoticeable in healthy individuals.^{17,18} Based on previously published data,⁹ we assumed the standard deviation of side-to-side difference in percent change from baseline in MVIC to be approximately 27%. Under these assumptions a trial with n=16 subjects has 80% power, with a two-sided alpha=5%, to detect an effect of delta=20% (StatMate, GraphPad Software, San Diego, California, United States). To assess the normality assumption underlying the primary t-test analysis, we examined box and whisker plots, density plots and normal quantile-quantile plots; and submitted the data to Shapiro-Wilks tests of normality. Where the Shapiro-Wilks test indicated deviation from normality, we performed a nonparametric bootstrap sensitivity analysis, resampling with replacement 1,000 times, to generate 95% confidence intervals for the mean.

The same analysis of percent change from baseline at Hour 6 was applied to the secondary MVIC outcome measures, and raw electrical current values at all time points. Profiles of the responses over time were examined with spaghetti and mean plots. Further secondary analyses included mixed-effects modeling of the repeated hourly measures to confirm the analysis of percent change at 6 hours. These models account for the hierarchical correlation of paired measures from each subject over time, and were used to test the effects of subject characteristics, including handedness, sex, height, weight, body mass index, and age. The model also allowed simultaneous analysis of all observations while accounting for within-subject correlation, which can more accurately estimate the standard errors of the estimated differential at each hour. The within-subject correlation was modeled via a subject-specific random intercept. This is similar to a compound symmetric correlation structure without a random effect. The change from baseline, Y , for subject i and time t_j was modeled with the linear mixed-effect model:

$$Y_i(t_j) = Y_i(0)\beta_0 + 1\{t_j=1\}\beta_1 + \dots + 1\{t_j=9\}\beta_9 + b_i + e_{ij}$$

where $1\{t_j=k\}$ is 1 if $t_j=k$ and 0 otherwise. The subject-specific random intercepts b_j and residuals e_{ij} were assumed to follow a Gaussian distribution. We present the estimated difference at each hour with unadjusted p-values, and p-values adjust using the single-step method for simultaneous inference from parametric models. These analyses were executed using R version 2.12 (2010).^a

Because this was a pharmacodynamics study, as opposed to an outcomes trial, we prospectively elected to exclude from the primary analyses subjects in whom catheter tip dislodgement/failure was a probability (as opposed to intention-to-treat analysis optimally used in outcomes trials). Perineural catheter dislodgement/failure was defined as a decrease less than 20% from baseline in motor strength of the ipsilateral quadriceps femoris muscle or sensory perception in the ipsilateral femoral nerve distribution within the first 6 hours after local anesthetic initiation. For unsuccessful perineural catheter insertion or if a perineural catheter was inadvertently dislodged before the measurement of the primary endpoint, the data for that subject (both catheters) would not be included in the analysis.

Results

Seventeen subjects enrolled during a 3-month period beginning January 2011 (Table 1). All had bilateral femoral perineural catheters successfully inserted per protocol. There were no catheter failures or adverse events. The 4th subject was excluded from analysis the day after the infusion when it was determined that her measurements were faulty due to an imprecise data-capture technique. We enrolled a 17th subject to replace the 4th so a total of 16 subjects could be included in the analysis in order to adhere to the *a priori* sample size estimation. No additional protocol deviations occurred. The mean difference between anterior and posterior quadriceps MVIC at baseline was 1.09 (95% CI −0.83 to 3.01, one-sample t-test $p=0.243$).

Quadriceps MVIC for limbs with anterior ($n=16$) and posterior ($n=16$) catheter tip placement did not differ to a statistically significant degree at Hour 6 (mean [SD] 29% [26] versus 30% [28], respectively; 95% CI: −22% to 20%; $p=0.931$), or any other time point (Fig. 2). However, the maximum tolerance to cutaneous electrical current was higher in limbs with anterior versus posterior catheter tip placement at Hour 6 (20 [23] vs. 6 [4] mA, respectively; 95% CI: 1 mA to 27 mA; $p=0.035$), as well as Hours 1, 7, 8, and 9 ($p<0.04$; Fig. 3). The Shapiro-Wilks test indicated that the tolerance data was not normal at all hours ($p<0.003$), so we estimated 95% CIs for the means using the nonparametric bootstrap. The bootstrap results were consistent with the prespecified t-test analysis at Hour 6 (95% CI: 4.3 mA to 26.6 mA), and found significant differences at all hours except Hour 22 (Figure 4).

The mixed-effects models were largely consistent with the simple one-sample t-test analysis performed at each hour (Tables 2 and 3). However, reduced unexplained variance resulted in smaller p-values (<0.001 for sensory at Hours 6–8), including a statistically significant sensory effect at Hour 5 ($p=0.009$). Summary statistics are provided (Table 4).

Discussion

This randomized, subject/observer-masked, split-body, controlled investigation documents the significant (70–80%) quadriceps femoris weakness induced by a cFNB infusion at a relatively low dose of ropivacaine delivered through perineural catheters located both anterior and posterior to the femoral nerve. In contrast, an anterior placement increases tolerance of transcutaneous electrical stimulation (350%) compared with a posterior

^aR Software Environment for Statistical Computing, R Foundation for Statistical Computing (version 2.12), Vienna, Austria. Available at: <http://www.r-project.org>. Accessed May 25, 2011.

insertion (50%), without a concurrent relative increase in motor block. To our knowledge, this is the first report of a successful approach to influence the motor-sensory ratio during cFNB, with possible implications for postoperative ambulating patients as well as perineural local anesthetic infusion research, in general.

Clinical significance

Although falls certainly occur in patients without a regional anesthetic/analgesic after orthopedic procedures of the lower extremity,¹⁹ there is growing evidence that lower extremity continuous peripheral nerve blocks may increase the risk of these adverse events.^{20–23} The primary mechanism is currently unknown, and may be induced motor weakness, sensory block, a proprioception deficit, or another factor yet unidentified. Nonetheless, weakness of the knee extensor muscles during cFNB severely limits postoperative rehabilitation,⁵ itself a critical component in optimizing joint function after total knee arthroplasty.²⁴ Though the current study did not find a motor-sparing benefit in altering perineural catheter location relative to the femoral nerve, the possibility of improved analgesia with an infusion anterior to this nerve may permit a lower local anesthetic dose than would be required with a posteriorly inserted catheter.

Study Limitations

Central to this issue, the current study measured cutaneous sensation just medial to the distal quadriceps tendon in healthy volunteers. By including only nonsurgical subjects, we were able to exclude postoperative pain as a confounding variable, allowing isolation of the variable catheter location effects on muscle strength and cutaneous sensation. Of course, the inclusion of nonsurgical volunteers also makes extrapolation to clinical practice problematic. Whether cutaneous sensation correlates well with postoperative pain after various knee procedures remains unknown. Answering this question will require studying patients after numerous types of surgical procedures, and the results of the current study should be viewed as a reference point to help design future clinical trials.

Similarly, the approximately 70% decrease in quadriceps femoris MVIC with a relatively low dose of ropivacaine suggests that additional decreases in local anesthetic dose may be desirable to further limit infusion-induced quadriceps weakness; but, it remains unknown whether such a low dose of ropivacaine would provide adequate postoperative analgesia. Further study is required to investigate why an anterior catheter location resulted in more cutaneous anesthesia than a catheter in the posterior position. Furthermore, all subjects remained supine during the period of perineural infusion (except during hourly measurements), unlike ambulating postoperative patients; and, to what degree this difference may have on our results remains unclear. Lastly, visualizing the perineural catheter tip using a needle in-plane (short axis) approach of the femoral nerve is relatively easy in comparatively thin, healthy volunteers. However, this maneuver is far more challenging (often impossible) using alternative ultrasound approaches; in patients with larger body mass indexes; and for deeper nerves requiring a steeper needle trajectory.²⁵

Finally, the results of the current study may not be applicable to other local anesthetics,²⁶ infusion durations, or ropivacaine dosages, the latter being important as the degree of postoperative analgesia provided by ropivacaine at 4 mL/h remains undetermined.²⁷

Summary

This study documents the significant (70–80%) quadriceps femoris weakness induced by a cFNB infusion at a relatively low dose of ropivacaine (4 mg/h) delivered through a perineural catheter located both anterior and posterior to the femoral nerve. In contrast, an anterior placement increases cutaneous sensory block compared with a posterior insertion,

without a concurrent relative increase in motor block. These findings both demonstrate a beneficial aspect of ultrasound-guided catheter insertion, and suggest that important clinical benefits may be attainable for postoperative ambulating patients. Additional study within a surgical population is warranted due to limitations of the volunteer subject model of the present investigation.

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Figure 1.

Examples of posterior (Panel A) and anterior (Panel B) perineural catheter tip insertion. The yellow horizontal line indicates the approximate anterior surface of the femoral nerve.

Figure 2.

Effects of perineural catheter tip position relative to the femoral nerve (anterior vs. posterior) on *quadriceps femoris* strength. Ropivacaine, 0.1%, was infused for 6 hours at 4 mL/h bilaterally. Mean (standard error) values are illustrated. There were no statistically significant differences at 95% confidence between treatments at any time point.

Figure 3.

Effects of perineural catheter tip position relative to the femoral nerve (anterior vs. posterior) on *tolerance of transcutaneous electrical current* in the femoral nerve distribution. Ropivacaine, 0.1%, was infused for 6 hours at 4 mL/h bilaterally. Mean (standard error) values are illustrated. Statistically significant differences between treatments at 95% confidence are designated with an asterisk (§ denotes a statistically significant difference between treatments at 95% confidence exclusively with the mixed effects models).

Figure 4.

Box plots of differences in *quadriceps femoris strength* and *tolerance of transcutaneous electrical current* between perineural catheter tip positions relative to the femoral nerve (anterior minus posterior). Ropivacaine, 0.1%, was infused for 6 hours at 4 mL/h bilaterally. The boxes, which depict quartiles, are superimposed over spaghetti plots of each subject's trajectory.

Table 1

Subject characteristics

Dominant Side Randomized to:	Anterior (n=8)	Posterior (n=8)
Age (yr)	24.4 (4.2)	25.6 (4.8)
Sex (female / male)	4 / 4	4 / 4
Height (cm)	174.6 (9.0)	171.1 (10.7)
Weight (kg)	67.7 (13.6)	67.0 (12.1)
Body mass index (kg/m ²)	22.0 (2.6)	22.7 (1.6)
Dominant side (left)	0	0

Values are reported as mean (SD) or number of subjects

Table 2

Mixed effects model estimates of change from baseline in maximum voluntary isometric contraction of the quadriceps femoris muscle adjusting for the baseline values. The model included a subject-specific random intercept (standard deviation = 8.19) and the residual standard deviation was 6.57. The table includes p-values adjusted for multiple comparisons using the single-step method for simultaneous inference from parametric models, as well as unadjusted p-values.

Hour	Estimated Change from Baseline	95% Confidence Interval		p-value	Adjusted p-value
		Lower	Upper		
1	1.98	-3.37	7.34	0.466	0.98
2	2.13	-3.23	7.48	0.434	0.97
3	2.01	-3.34	7.37	0.459	0.98
4	1.01	-4.35	6.36	0.711	> 0.99
5	1.09	-4.26	6.45	0.687	> 0.99
6	-1.05	-6.4	4.3	0.699	> 0.99
7	1.40	-3.95	6.75	0.606	> 0.99
8	1.99	-3.36	7.35	0.463	0.98
9	-0.46	-5.82	4.89	0.865	> 0.99
22	-0.74	-6.09	4.62	0.786	> 0.99

Table 3

Mixed effects model estimates of change from baseline in tolerance to cutaneous electrical current (mA) adjusting for baseline tolerance. The model included a subject-specific random intercept (standard deviation = 11.3) and the residual standard deviation was 11.8. The table includes p-values adjusted for multiple comparisons using the single-step method for simultaneous inference from parametric models, as well as unadjusted p-values.

Hour	Estimated change from baseline	95% Confidence Interval		p-value	Adjusted p-value
		Lower	Upper		
1	2.18	-6.00	10.36	0.599	> 0.99
2	2.62	-5.57	10.80	0.528	> 0.99
3	3.37	-4.82	11.55	0.417	0.98
4	5.24	-2.94	13.42	0.207	0.78
5	9.80	1.62	17.99	0.019	0.12
6	13.62	5.43	21.80	0.001	0.01
7	13.74	5.56	21.92	0.001	0.01
8	13.24	5.06	21.42	0.002	0.01
9	8.12	-0.07	16.30	0.052	0.29
22	-0.70	-8.88	7.49	0.867	> 0.99

Table 4

Summary statistics

End Point	Hour	N	Minimum	First Quartile	Median	Mean	Third Quartile	Maximum	SD
Quadriceps Femoris Maximum Voluntary Isometric Contraction	1	16	-27	-6	3.5	3.75	11.5	43	18.2
	2	16	-43	-8.75	-1.5	4.25	13.5	56	26.2
	3	16	-82	-2.5	7.5	6	16.8	86	41.6
	4	16	-64	-18.5	4.5	3.19	18.5	64	33.4
	5	16	-59	-22.2	-0.5	3.62	34	63	36.1
	6	16	-76	-14.8	1.5	-0.875	19	69	39.8
	7	16	-51	-13.2	0.5	6.44	19.8	84	38.5
	8	16	-56	-21.8	2.5	8.56	29.5	103	44.9
	9	16	-53	-24.5	-3	2.06	11.2	99	43
	22	16	-33	-15.2	-1	-2.94	3.25	32	15.5
	1	16	-5	-1.23	0.5	1.92	2.3	16.4	5.7
	2	16	-11.1	-1.92	0.05	2.07	5.75	16.3	7.43
	3	16	-18.9	-2.57	3.05	1.96	6.2	20.2	10.2
	4	16	-14.6	-6.6	-0.05	0.95	8.45	16.1	9.42
	5	16	-18.3	-5.58	0.2	1.04	9.7	16.6	10.8
	6	16	-37.6	-6.75	-0.3	-1.11	8.95	19.9	13.6
	7	16	-25.8	-3.28	0.5	1.34	8.5	20.3	11.7
	8	16	-28.3	-5.6	0.5	1.94	11.9	24.9	13.7
	9	16	-27	-7.12	-0.85	-0.519	5.02	23.3	12
	22	16	-4.4	-2.25	-0.3	-0.794	0.55	3.4	2.24
	1	16	-1	0	1	2.56	2.25	12	4.05
	2	16	-7	0	1	3	3	23	7.68
	3	16	-6	-0.5	1.5	3.75	4.25	22	8.07
Sensory (mA)	4	16	-5	-0.25	1	5.62	5.5	36	11.9
	5	16	-8	-1.25	1.5	10.2	8.25	77	22
	6	16	-8	-1	4.5	14	16.2	77	24.1
	7	16	-8	-1.25	4.5	14.1	25.5	74	23.8

End Point	Hour	N	Minimum	First Quartile	Median	Mean	Third Quartile	Maximum	SD
	8	16	-3	-1	3	13.6	20.5	77	21.9
	9	16	-7	-1.25	0.5	8.5	22.5	41	15.3
	22	16	-3	-1	0	-0.312	0.25	1	1.14