

## Effectiveness of transcutaneous electrical nerve stimulation (TENS) on post-laminectomy and dissectomy pain : Preliminary study

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**Objective** : *To determine the effectiveness of TENS on post laminectomy and dissectomy pain and the effectiveness of TENS as patient - controlled analgesia (PCA) on post laminectomy and dissectomy pain.*

**Study design** : *Randomized patient - blinded controlled trial.*

**Setting** : *Department of Orthopedics, King Chulalongkorn Memorial Hospital*

**Materials and Methods** : *Patients post - laminectomy or dissectomy less than 3 level were randomly assigned as patient - blinded into 3 groups; each group had 10 patients: placebo TENS, time - scheduled TENS and PCA TENS. The placebo TENS group received sham TENS with no electrical stimulation but the indicator lights were flashing normally. The time - scheduled TENS group received TENS for 1 hour 3 times/day for 2 days post operatively. The PCA TENS group received TENS for at least 15 minutes whenever they felt pain. If the pain did not subside PCA morphine was used as needed in all groups. Pain scores were recorded before administration of TENS and at 48 - hour post operation. Satisfaction scores and PCA morphine requirement were recorded at 48 - hour post - operation.*

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- Result** : *There was no statistically significant difference in pain scores, satisfaction scores and amount of PCA morphine used among the 3 groups at  $p < 0.05$ . Both the time - scheduled TENS and PCA TENS groups had tendency to receive PCA morphine less than the placebo TENS group. No serious complication was found in all groups.*
- Conclusion** : *There was no statistically significant difference in pain scores, satisfaction scores and amount of PCA morphine used among the 3 groups. Time-scheduled TENS and PCA TENS in post - laminectomy and dissectomy pain had tendency to decrease the amount of morphine used.*
- Keywords** : *TENS, post laminectomy and dissectomy pain, patient - controlled analgesia (PCA).*

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- วัตถุประสงค์** : เพื่อศึกษาถึงประสิทธิผลของ TENS ในการลดปวดผู้ป่วยหลังผ่าตัดกระดูกสันหลัง และประสิทธิผลของการใช้ TENS แบบ *patient - controlled analgesia (PCA)*
- รูปแบบการวิจัย** : การศึกษาเชิงทดลองชนิดมีกลุ่มควบคุมแบบสุ่ม และผู้ป่วยไม่ทราบว่าตนเองอยู่ในกลุ่มใด
- สถานที่ทำการวิจัย** : ฝ่ายศัลยกรรมกระดูก โรงพยาบาลจุฬาลงกรณ์
- วิธีการศึกษา** : ผู้ป่วยหลังผ่าตัดชนิด *laminectomy* และ *dissectomy* ไม่เกิน 3 ระดับ ได้รับการสุ่มเป็น 3 กลุ่ม กลุ่มละ 10 คน ได้แก่ กลุ่มควบคุม *Placebo TENS* คือมีการติดเครื่อง TENS และมีไฟแสดงการทำงานของเครื่อง แต่ไม่มีกระแสไฟกระตุ้นจริง *Time - scheduled TENS* คือ กระตุ้น TENS 1 ชั่วโมง 3 ครั้ง/วัน ห่างกัน 8 ชั่วโมง จนครบ 48 ชั่วโมงหลังผ่าตัด และ *PCA TENS* คือกระตุ้น TENS อย่างน้อย 15 นาที เมื่อผู้ป่วยเริ่มรู้สึกปวดแผล หากยังรู้สึกปวดแผลอยู่จะให้ *PCA morphine* ในทุกกลุ่ม ประเมินระดับความรู้สึกปวด ก่อนกระตุ้นและหลังผ่าตัดครบ 48 ชั่วโมง ประเมินความพึงพอใจต่อการลดปวด และปริมาณ *PCA Morphine* ที่ต้องการใน 48 ชั่วโมงหลังผ่าตัด
- ผลการศึกษา** : ระดับความปวด ความพึงพอใจ และปริมาณการใช้ *Morphine* ในผู้ป่วย ทั้ง 3 กลุ่มไม่มีความแตกต่างอย่างมีนัยสำคัญทางสถิติ ที่  $P < 0.05$  แต่ในกลุ่ม *Time-scheduled TENS* และ *PCA TENS* มีแนวโน้มการใช้ยา *Morphine* น้อยกว่ากลุ่ม *Placebo TENS*
- สรุป** : *Time-scheduled TENS* และ *PCA TENS* ในผู้ป่วยหลังผ่าตัด *laminectomy* และ *dissectomy* มีแนวโน้มที่จะลดปริมาณการใช้ *Morphine* ได้
- คำสำคัญ** : TENS, ปวดหลังผ่าตัด *laminectomy* และ *dissectomy*, *Patient- controlled analgesia (PCA)*

In the management of postoperative pain, opioids and non - steroidal anti -inflammatory drugs (NSAIDs) have remained in the focus in most hospitals. Opioids are effective for pain control but they also have many undesirable side effects, such as nausea and vomiting, sedation, respiratory suppression, constipation and urinary retention.

In 1965, Gate - control theory by Melzack and Wall <sup>(1)</sup> explains the pain mechanism via the spinal cord. The spinal cord is not just a passive conduit for pain transmission, but an active modulator of pain signals. This hypothesis led Wall and Sweet <sup>(2)</sup> to employ electrical current applied to the skin in an effort to activate large -diameter afferents that inhibit small - diameter fibers which results in relief of pain.

Many trials have showed that transcutaneous electrical nerve stimulation (TENS) could reduce the incidence of postoperative complications<sup>(3)</sup> including pain level after operation<sup>(4)</sup> such as post cardiac bypass graft (CABG)<sup>(5)</sup>, spinal fusion<sup>(6)</sup>, lumbar spine surgery<sup>(7)</sup>, thoracic surgery<sup>(8)</sup>, and abdominal surgery.<sup>(9)</sup> Therefore, post - operative TENS should reduce the total requirement for post - operative narcotics and undesirable side effects after abdominal surgery,<sup>(10 - 12)</sup> and hip prosthesis installation.<sup>(13)</sup> In contrast, some studies showed lower incidence of pain reduction and reducing of narcotics used.<sup>(14 - 17)</sup>

In Thailand, Veerawatana et al. studied the effect of TENS in pain reduction with the patients after orthopedic surgery.<sup>(18)</sup> Two groups were comparable for post - operative pain level. Using continuous TENS for 48 hours, the experimental group showed lower pain level than the placebo group. However, this study had different types of surgery that could affect post - operative pain evaluation.

Previously, there have been different types of surgery and different techniques in the use of TENS. The results, therefore, showed controversy in the effectiveness of TENS in postoperative pain reduction. In Thailand, there has been no study of TENS in post - operative spine surgery. This study is aimed to evaluate the effectiveness of time - scheduled and PCA TENS on post - laminectomy and dissectomy pain.

## Materials and Methods

The study has been approved by the Institution Review Board of the Faculty of Medicine, Chulalongkorn University. After signed their informed consent form, patients who were scheduled to receive laminectomy or dissectomy at the Department of Orthopedics, King Chulalongkorn Memorial Hospital were enrolled into the study under the inclusion and exclusion criteria.

### Inclusion criteria:

1. In patient who is undergoing laminectomy or dissectomy that does not extend more than 3 levels (moderate pain)
2. The patient has good consciousness and is well co-operative

### Exclusion criteria:

1. The patient has infection, tumor or malignancy of the spine
2. The patient has spinal cord compression
3. The patient has history of allergy or severe side effect from opioids
4. The patient has history of opioid abuse
5. The patient has previously used TENS
6. The patient is on cardiac pacemaker

Thirty patients were randomly allocated into three groups by block randomization as the followings:

- Group 1: Placebo TENS
- Group 2: Time - scheduled TENS
- Group 3: PCA TENS

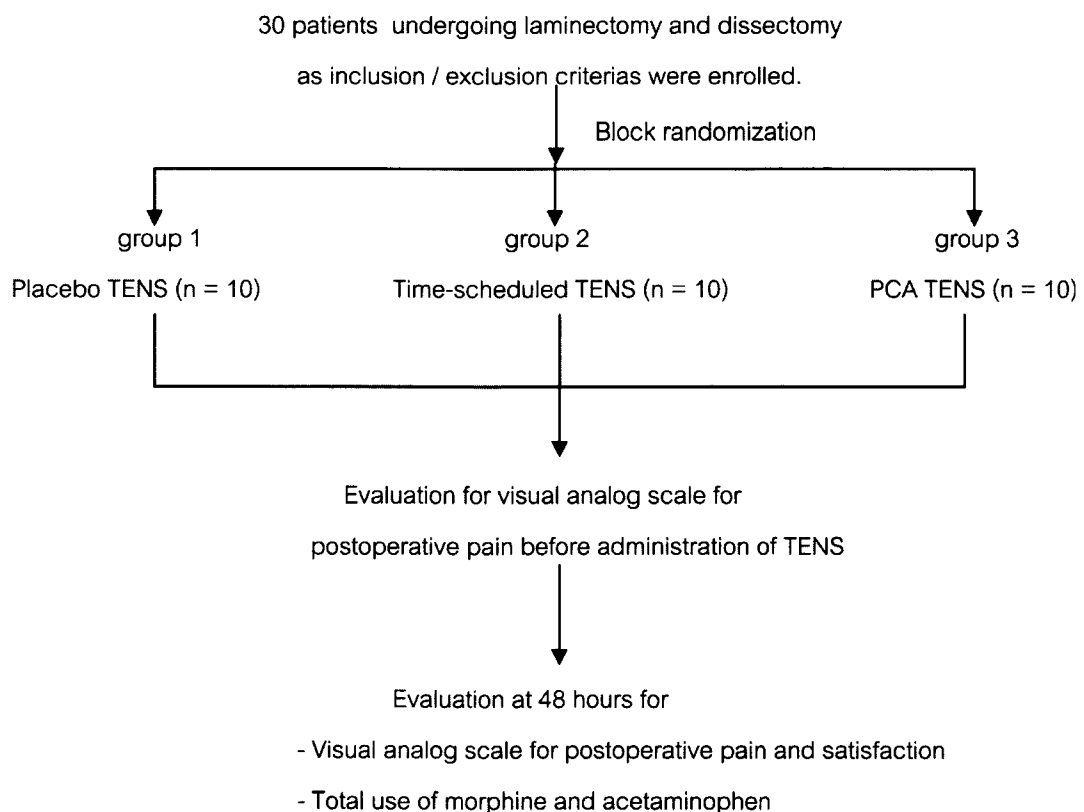
All patients were received the same anesthetic protocol and operation -technique. Standard transcutaneous electrical nerve stimulation (TENS) and PCA morphine machines were used in this study.

After the incision wound was closed, two 4 x 3.5 cm. sterile electrodes were placed longitudinally on either side of the incision. The electrodes were positioned 2 inches away from the suture line.<sup>(19)</sup> Conductive gel was applied under the electrode and fixed on the skin with adhesive tape. Four AA batteries were used to produce the electrical stimulation

for each TENS machine. The batteries were scheduled to be changed every 24 hours. Pain was measured using 100 mm visual analog scale before administration of TENS machine, and at 48 hours post - operation. Satisfaction score was measured at 48 hours post - operation using 100 mm visual analog scale.

In group 1, the placebo TENS, there was no electrical stimulation, but the functional indicator lights were flashing normally. The patients were told that they may not be able to feel the electrical stimulation. The machine was turned on for 1 hour, 3 times per day. In group 2, the time - scheduled TENS, the frequency of the electrical stimulation was set at 100 Hz, the amplitude was set at the highest tolerated amplitude of electrical stimulation. This group received TENS for 1 hour, 3 times per day.<sup>(20)</sup> In

### Protocol Flow Charts



group 3, the PCA TENS, the frequency of the electrical stimulation was set at 100 Hz, the amplitude was set at the highest tolerated amplitude of electrical stimulation. TENS was started and continued for at least 15 minutes whenever the patients felt their pain. If the pain did not subside, the patients in all groups could use PCA morphine when needed. The patients were visited 3 times each day by a trained nurse who evaluated the machine and its function. The patients were received only PCA morphine and acetaminophen as analgesic drugs. The pain score, satisfaction score, total morphine used from PCA machine and acetaminophen used were recorded by a trained nurse during the study period.

### Statistical Analysis

1. The demographic data (age, weight, height), operation time, the amount of analgesic drugs were analyzed using means and standard deviation (mean  $\pm$  SD), and using One - way ANOVA compared between each group.

2. Visual analog scale scores for pain and satisfaction were analyzed:

- using paired t - test comparing between pre- and post - treatment in both the control and experimental groups.

- using One - way ANOVA comparing between the control and experimental groups both pre- and post- treatment.

3. The amount of analgesic drugs were analyzed by One - way ANOVA comparing between the control and experimental groups.

4. The statistical significance was set at  $p < 0.05$

### Results

Thirty patients participated in the study after informed consent had been obtained. There were 28 female and 2 male patients. There was no statistical difference in the mean age, body mass index (BMI), surgical wound length, duration of operation, and postoperative duration before using TENS as shown in table 1.

**Table 1.** Demographic data, surgical wound length, duration of operation, and post operative duration before using TENS.

Patients	Placebo TENS	Time - schedule TENS	PCA TENS	P - Value
	Mean (SD) n = 10	Mean (SD) n = 10	Mean (SD) n = 10	
Age (years)	57.6 (10.00)	60.50 (10.36)	48.80 (11.99)	0.058
BMI(kg/m <sup>2</sup> )	24.77 (2.64)	26.47 (3.53)	24.66 (2.37)	0.307
Wound length (cm.)	14.65 (4.01)	15.95 (2.80)	12.90 (3.20)	0.412
Duration of operation (min)	254.50 (94.14)	257.00 (42.11)	219.00 (64.36)	0.148
Postoperative duration before using TENS (min)	144.50(43.36)	147.00 (50.89)	130.50 (17.07)	0.412

All patients received the same anesthetic protocol and operation technique. Pain was measured before administration of TENS machine, and at 48 hours post operation by using 100 mm visual analog scale. The mean score of visual analog scale before administration of TENS were between 60 - 70 in all the three groups. After administration of TENS, there was statistically significant reduction of pain score ( $p < 0.05$ ) at 48 hours post - operation in both the control and experimental groups as shown in table 2.

No statistical significance of pain score comparing between each group both before

administration of TENS and at 48 hours postoperative ( $p > 0.05$ ).

All patients also received PCA morphine and acetaminophen as analgesic drugs for postoperative pain control. There was no statistical significance in analgesic requirements in all groups as shown in table 3.

The satisfaction of pain reduction were also evaluated in all patients by using visual analog scale .They were satisfied in postoperative pain control without statistical significance between each group as shown in table 4.

**Table 2.** Postoperative pain evaluation by visual analog scale, VAS (100).

<b>Patients</b>	<b>VAS before administration of TENS Mean (SD)</b>	<b>VAS at 48 hours post operation Mean (SD)</b>	<b>P - Value</b>
Placebo TENS n = 10	68.30 (16.63)	30.70 (24.53)	0.002
Time-schedule TENS n = 10	62.80 (19.78)	28.00 (14.65)	0.001
PCA TENS n = 10	70.00 (22.85)	36.50 (14.47)	0.004

**Table 3.** Postoperative analgesic requirements (morphine and acetaminophen).

<b>Patients</b>	<b>Placebo TENS Mean (SD) n=10</b>	<b>Time-schedule TENS Mean (SD) n=10</b>	<b>PCA TENS Mean (SD) n=10</b>	<b>P-Value</b>
Amount of morphine (mg.)	60.70 (37.62)	38.30 (17.96)	43.30 (25.57)	0.196
Amount of morphine per Body weight (mg./kg.)	1.03 (0.72)	0.49 (0.21)	0.69 (0.43)	0.075
Amount of acetaminophen (tabs)	1.60 (1.83)	3.00 (3.30)	1.60 (2.06)	0.361

**Table 4.** Visual analog scale (100) for satisfaction in postoperative pain control.

Patients	Placebo TENS	Time-schedule TENS	PCA TENS	P-Value
	Mean (SD)	Mean (SD)	Mean (SD)	
	n = 10	n=10	n=10	
VAS for satisfaction	79.70 (17.74)	85.30 (9.75)	71.20 (17.38)	0.139

No serious complication was found in all groups. Two patients (one patient in the placebo and the other in the time-scheduled group) complained of mild discomfort from the hard electrode wire.

### Discussion

There was no significant difference of pain scores and satisfaction scores among the three groups, this indicated a well controlled of postoperative pain level in all groups. The time-scheduled TENS and PCA TENS groups had tendency to use morphine lesser than the placebo group in both total used and amount per body weight, but had no statistically significant difference. In both the time-scheduled and PCA TENS groups, we used TENS machine in a short period that might not be enough for reduce morphine requirement for pain controlled. In other studies, they used continuous TENS and found that there were statistical significant reduction of analgesic requirement.<sup>(6-8,10,11,18)</sup> However, this study only had 30 patients that might not enough to found the statistical significant difference between the control and the experimental groups. We would like to introduce the time-scheduled or PCA TENS for more convenience and less discomfort to the patient. We decided to have PCA TENS to avoid the problem of insufficient time. Nevertheless, future study with sample-size calculation should be done.

### Conclusion

There was no statistically significant difference in pain control between the control and the experimental groups. Time-scheduled and PCA TENS used in patients who received laminectomy and dissection have tendency to reduce the amount of morphine but the difference shows no statistical significance. This might due to small number of the subjects in this study or short period of TENS stimulation.

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### References

1. Melzack R, Wall PD. Pain mechanisms: a new theory. *Science* 1965 Nov; 150(699): 971-9
2. Wall PD, Sweet WH. Temporary abolition of pain in man. *Science* 1967 Jan;155(758): 108-9



3. Hymes AC, Raab DE, Yonehiro EG, Nelson GD, Printy AL. Electrical surface stimulation for control of acute postoperative pain and prevention of ileus. *Surg Forum* 1973; 24: 447 - 9
4. VanderArk GD, McGrath KA. Transcutaneous electrical stimulation in treatment of postoperative Pain. *Am J Surg* 1975 Sep; 130(3): 338 - 40
5. Forster EL, Kramer JF, Lucy SD, Scudds RA, Novick RJ. Effect of TENS on pain, medications, and pulmonary function following coronary artery bypass graft surgery. *Chest* 1994 Nov; 106 (5): 1343 - 8
6. Issenman J, Nolan MF, Rowley J, Hobby R. Transcutaneous electrical nerve stimulation for pain control after spinal fusion with Harrington rods: A clinical Report. *Phys Ther* 1985 Oct; 65(10): 1517 - 20
7. Schuster GD, Infante MC. Pain relief after low back surgery: the efficacy of transcutaneous electrical nerve stimulation. *Pain* 1980 Jun; 8(3): 299 - 302
8. Erdogan M, Erdogan A, Erbil N, Karakaya HK, Demircan A. Prospective, Randomized, Placebo-controlled Study of the Effect of TENS on postthoracotomy pain and pulmonary function. *World J Surg* 2005 Dec; 29(12): 1563 - 70
9. Cooperman AM, Hall B, Mikalacki K, Hardy R, Sardar E. Use of transcutaneous electrical nerve stimulation in the control of postoperative pain. *Am J Surg* 1977 Feb; 133 (2): 185 - 7
10. Hamza MA, White PF, Ahmed HE, Ghoname EA. Effect of the frequency of transcutaneous electrical nerve stimulation on the postoperative opioid analgesic requirement and recovery profile. *Anesthesiology* 1999 Nov; 91(5):1232-8
11. Wang B, Tang J, White PF, Naruse R, Sloninsky A, Kariger R, Gold J, Wender RH. Effect of the intensity of transcutaneous acupoint electrical stimulation on the postoperative analgesic requirement. *Anesth Analg* 1997 Aug; 85(2):406 -13
12. Ali J, Yaffe CS, Serrette C. The effect of transcutaneous electric nerve stimulation on postoperative pain and pulmonary function. *Surgery* 1981 Apr; 89(4): 507-12
13. Pike MP. Transcutaneous electrical stimulation. Its use in the management of postoperative pain. *Anaesthesia* 1978 Feb; 33(2): 165 - 71
14. Breit R, Van der Wall H. Transcutaneous electrical nerve stimulation for post operative pain relief after total knee arthroplasty. *J Arthroplasty* 2004 Jan; 19(1):45 - 8
15. Gilbert JM, Gledhill T, Law N, George C. Controlled trial of transcutaneous electrical nerve stimulation (TENS) for postoperative pain relief following inguinal herniorrhaphy. *Br J Surg* 1986 Sep; 73(9): 749 - 51
16. Cuschieri RJ, Morran CG, McArdle CS. Transcutaneous electrical stimulation for postoperative pain. *Ann R Coll Surg Engl* 1985 Mar; 67(2):127 - 9
17. McCallum MI, Glynn CJ, Moore RA, Lammer P, Phillips AM. Transcutaneous electrical nerve stimulation in the management of acute postoperative pain. *Br J Anaest* 1988 Sep;

- 61(3): 308-12
18. Harntavichai V, Somboonvit N, Ukritsana B, Naovaratanophas P, Hanpanitkitkan S. Transcutaneous nerve electric stimulation (TENS) for relief of postoperative pain. *Vajira Med J* 1987 Sep; 31(3): 145-50
19. Rakel B, Frantz R. Effectiveness of transcutaneous electrical nerve stimulation on postoperative pain with movement. *J Pain* 2003 Oct; 4(8): 455-64
20. Woolf CJ, Thompson JW. Stimulation-induced analgesia: transcutaneous electrical nerve stimulation and vibration. In: Wall PD, Melzack R, eds. *Textbook of pain*. 3<sup>rd</sup> ed. New York: Churchill Livingstone;1994. P.1191-208