Effect of Para-Incisional and Zusanli Point Electrical Stimulation on Pain Medication Requirements in Post Inguinal Herniorraphy.

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ABSTRACT

This study was conducted to investigate the proper location of Transcutaneous Electrical Nerve Stimulation (TENS) electrodes to gain the optimum relieve of post-operative pain. Forty patients whom underwent elective inguinal herniorraphy, their ages ranged from 30 to 50 years old, among this number only three patients were females. They were chosen from the surgical ward of Monouf general hospital. They were randomly assigned to four groups. Group A, received electrical stimulation ES on Zusanli (Stomach 36), group B, received ES on paraincisional. Group C, received ES on Zusanli (Stomach 36) and paraincisional at the same time and group D, received sham ES on the same location as group C. All groups were stimulated using adhesive surface electrodes. The consumption of pain medication requirements (opioids and Nonsteroidal Antiinflamatory Drugs) were calculated for each patient. The results showed that the requirements for pain medication were significantly reduced among groups A, and B, (p = 0.025) and it was significant reduced in group C, (p = 0.0001). Conclusion, the findings revealed that the best location of TENS electrodes to reduce pain medication requirements postoperatively was on the paraincisional and Zusanli (Stomach 36) at the same time.

INTRODUCTION

Modern era of electrical stimulation of the skin for the relief of pain has an ancient heritage. In the classical Greece, the electrogenic torpido fish (electric eels) was imported from Egypt after catching it from Nile River and used to treat headaches and joint pains[1].

Since the mid of 1960s decade understanding of the neuropharmacology and neurophysiology of pain has develop rapidly with the discovery of endogenous endorphin and the publication of the gate control theory of pain[2,3].

Several investigators, assimilated existing neurophysological data to offer an explanation of how the intensity of noxious input could be at perceptual level through a gating effect at the spinal segmental level[4].

On the other hand Transcutaneous electrical nerve stimulation TENS is a technique for controlling pain, that is undergoing increased in clinical application of physical therapy. Santiesteban and Sanders have provided further suggestions for establishing a postsurgical TENS program[5].

Furthermore acupuncture and related electrical stimulation techniques are based on traditional Chinese analgesic methods. Acupuncture can activate the bodies pain modulation system and increase the release of

endogenous opioids within the central nervous system, thereby suppressing the transmission and perception of noxious stimuli[6].

Patient controlled analgesia (PCA) using opioid analgesics has become treatment of choice for the management of acute postoperative pain, its wellknown side effects including nausea, vomiting, urinary retention, paralytic ileus, pruritis, constipation and ventillatory depression which might be potentially life threatening complications[7].

On the other hand narcotics have been associated with undesirable side effects such as respiratory depression, sedation, nausea and vomiting. Therefore adjunctive methods of postoperative pain control may limit narcotic side effects. Transcutanous electrical nerve stimulation TENS has been used to control postoperative pain after various surgical procedures[8].

While some investigators have reported that TENS can improve pain relief, decrease narcotic requirements, shorten the recovery room stay, increase postoperative mobility and activity and reduce postoperative side effects and pulmonary complications. Others have failed to confirm any significant beneficial effects7.

The present study is an attempt to detect the best position of TENS to overcome pain in post inguinal herniorraphy which might be of value for physicans, physical therapist to promot on enhance their program of treatment with the sofest and effective modalities. Therefore the aim of the present study was to investigate the proper location of TENS electrodes to gain the optimum relieve of post-operative pain.

SUBJECTS, MATERIAL AND METHODS

Subjects

Forty patients who had underwent elective lower abdominal surgery (inguinal herniorraphy) were participated in the present study. These subjects were selected from the department of general surgery at Menouf General Hospital and the study was conducted in the same hospital. Their ages were ranged from 30 to 50 years old.

All Patients in this study had the following criteria

Inclusive criteria

All patients were operated by open incision (length of surgical line (incisional line) ranges from 10 cm to 15 cm), they were evaluated in same situation and by the same manner, they were continued under their medical and nursing care, and their regular physical therapy regimen.

Exclusive criteria

Patients must not report a history of old upper or lower abdominal surgery or a history of skin abnormalities in the area of treatment. Patients who had diabetes, anemia or any pathological conditions which might affect the result of this study were excluded.

The patients were classified randomly into 4 groups of equal numbers (10 patients for each group).

Group-A

(Zusanli acupoint electrical stimnlation group)this group was composed of 10 patients whom underwent inguinal herniorraphy and repsesented the group who received electrical stimulation at Zusanli acupoint (Zusanli acupoint (ST. 36): is one point among the forty

points of stomach channel. Its location is one finger breadth lateral to the inferior end of the tibial tuberosity).

Group-B

(Para-incisional electrical stimulation group) this group was compsed of 10 patients who had underwent ingiunal herniorraphy and repsesented the group who was received electrical stimulation at dermatomal level corresponding to the abdominal incision.

Group-C

(Para-incisional and Zusanli acupoint electrical stimulation group) this group was composed of 10 patients who had underwent inguinal herniorraphy and represented the group who was received electrical stimulalion at para-incisional and Zusanli acupiont.

Group-D

(Placebo electrical stimulation "Control group") this group was composed of 10 patients who had underwent inguinal herniorraphy and represented the group who was received sham or false stimulation at Zusanli aciopoints. The location of electrodes were fixed as in group A.

Instrumentation

1- Therapeutic equipment

Transcutaneous electrical nerve stimulation (TENS) made by Life Health company- Tywan: (pulse width: 260, frequency: 2 HZ, duration 30 minutes), was used to minimize the post-operative pain.

2- Calculation of the pain analgesic requirements

A- Opioid analgesics consumption.
B- Diclofenac sodium intake.

Procedure of the study

The methods and steps of the procedure of this study were classified into

A- Assessment procedures

At the end of treatment which was three days (72 hours) after surgery the analgesia medications were calculated in each table as there was one table for Opioid consumption and the other for Diclofenac sodium consumption. Therefore the Opioid analgesics consumption and Diclofenac sodium intake were calculated in milligrams (mg) for each patient and recorded in his own sheet for the first 72 hours after surgery and before patient discharged.

B- Treatment procedures

1- A thorough presentation was carried out to the surgeons and nursing staff of surgical ward about the study, its aims, value and procedure.When the surgeon admit a case from outpatient, the nurses used to inform the researcher immediately, to do an interview with patient explaining to him the value of using TENS to reduce the postoperative pain instead of pain medications.The physicians informed that they should prescribe morphine or Diclofenac sodium as (NSAIDs) to all patients whom included in the study. Nurses also informed not to give any pain medications to the patient unless he became unable to tolerate the pain, (i.e) TENS only was failed to reduce the pain. While the patient was still on the operating theater, the researcher fixed adhesive electrodes on the desired location “according to the group which the patient was included in. The treatment time for each patient was 30 minutes every two hours for three days, the apparatus was applied contiously on patient

and just switched on and off till the patient feel tingling sensation.

2- In group A, The stimulating electrodes were placed at the Zusanli acupoints bilaterally. Pair of electrodes were attached to the ipsilateral leg (one finger breath lateral to inferior end of tibial tuberosity). In group B, the four adhesive and sterile electrodes were fixed parallel to the incision line. In group C the one pair of adhesive and sterile electrodes were fixed parallel to the line of incision and other pair was fixed at Zusanli acupoint (ST. 36) as in group A .The group D patients were informed that they might not be able to feel electrical stimulation of transcutaneous electrical nerve stimulation (TENS). Frequency was adjusted from two to four Hz and intensty was set on 0 mA for group D, and for groups A, B and C, was adjusted from 10 to 60 mA according to patient's ability to tolerate the electrical stimulation while the pulse width was adjusted from 100 to 150 µ sec.

3- Patients were instructed that feeling of only mild tingling sensation is needed. The (TENS) device was recalibrated before the study to insure its accuracy of it's parameters. The electrodes were self adhesive and disposable type which was fixed on the desired placement while the patient still in the operating room until the end of the treatment procedure. Transcutaneous Electrical Nerve Stimalation (TENS) device automatically shuts off at the end of each 30 minutes, which was the desired time for the treatment session.

N.B. The Diclofenac sodium was taken only through intramusclucar route (i.e.) no other analgesic medications were taken orally during this study.

Data analysis

The mean, standard deviation and standard error were calculated for all variables in both groups. Paired "T" test was used also to compare between before and after treatment in the same groups of individuals. Comparison was applied by student t test to compare between two independent means. A value of $p \leq 0.05$ was considered statistically significant.

RESULTS

As regard, the results of this study are shown that many patients had pain relieve from TENS (TENS dependent) and they did not need medication (Opioid or NSAIDs). Table (1) shown the number of TENS dependent cases in Zusanli point stimulated group which was significantly higher than that of sham stimulated group. However, the numbers of Opioid (morphine)and NSAIDs (Diclofenac sodium)treated cases in zusanli point-stimulated group were lower than those of sham-stimulated group, this lowering effect of zusanli point stimulation was numerical rather than statistical.

Table (1): TENS dependant cases and pain medication requirement in group A and D.

Item	Groups		X^2 Value	P value	Level of Significance
	Group B	Group D			
TENS dependent cases	4/10	0/10	5	0.025	S
Opioid treated	4/10	7/10	1.818	0.178	NS
NSAIDs treated	2/10	5/10	1.978	0.16	NS

X^2 value: Chi square value. P value: Probability value. S: Significant. NS: Not significant.
SAIDs: Non steroidal anti-inflammatory drugs (Diclofenac sodium).

It is evident from table (2) that, relative to the sham stimulated group; paraincisional stimulation increased significantly the number of TENS dependent cases. Nonetheless, the numbers of opioid (morphine) and NSAIDs (diclofenac sodium) treated cases in paraincisional stimulated group were lower than those of sham stimulated group, this decreasing effect of paraincisional stimulation was statistically irrelevant.

Table (2): TENS dependant cases and pain medication requirement in group B and D.

Item	Groups		X^2 Value	P value	Level of Significance
	Group B	Group D			
TENS dependent cases	4/10	0/10	5	0.025	S
Opioid treated	3/10	7/10	3.2	0.074	NS
NSAIDs treated	3/10	5/10	0.833	0.361	NS

X^2 value: Chi square value. P value: Probability value. S: Significant. NS: Not significant.
NSAIDs: Non steroidal anti-inflammatory drugs (Diclofenac sodium).

Data presented in table (3) shows that, on comparison with the sham stimulated group, the combined stimulation (Zusanli point & paraincisional stimulation) was highly significant increasing and decreasing effect, respectively on the number of TENS dependent and opioid (morphine) treated cases.

Table (3): Comparison between TENS dependent cases and pain medications requirements in groups C and D.

Item	**Groups**		**X^2 value**	**P value**	**Level of Significance**
	Group C	Group D			
TENS dependent cases	8/10	0/10	13.333	0.0001	S
Opioid treated	0/10	7/10	10.769	0.0001	S
NSAIDs treated	2/10	5/10	1.978	0.16	NS

X^2 value: Chi square value. P value: Probability value. S: Significant. NS: Not significant.
NSAIDs: Non steroidal anti-inflammatory drugs (Diclofenac sodium).

Table (4) shows the differences between Zusanli point- and paraincisional stimulated groups in their TENS dependent, opioid (morphine) and NSAIDs (diclofenac sodium) cases number.

Table (4): Comparison between TENS dependent cases and pain medications requirements in groups A and B.

Item	**Groups**		**X^2 value**	**P value**	**Level of Significance**
	Group A	Group B			
TENS dependent cases	4/10	4/10	0	1	NS
Opioid treated	4/10	3/10	0.22	0.639	NS
NSAIDs treated	2/10	3/10	0.267	0.606	NS

X^2 value: Chi square value. P value: Probability value. S: Significant. NS: Not significant.
NSAIDs: Non steroidal anti-inflammatory drugs (Diclofenac sodium).

From table (5) it is obvious that while the differences between Zusanli point and combined stimulated groups in their TENS dependent, opioid (morphine) and NSAIDs (diclofenac sodium) treated cases number were insignificant; the combined stimulation was of

significant decrement effect on the opioid-treated cases number.

Table (5): Comparison between TENS dependent cases and pain medications requirements in groups A and C

Item	Groups		X^2 value	P value	Level of Significance
	Group A	Group C			
TENS dependent cases	4/10	8/10	3.333	0.068	NS
Opioid treated	4/10	0/10	5	0.025	S
NSAIDs treated	2/10	2/10	0	1	NS

X^2 value: Chi square value. P value: Probability value. S: Significant. NS: Not significant.
NSAIDs: Non steroidal anti-inflammatory drugs (Diclofenac sodium).

On the other hand, table (6) clears that the differences between paraincisional and combined-stimulated groups in their TENS dependent, opioid (morphine) and NSAIDs (diclofenac sodium) treated cases number were insignificant.

Table (6): Comparison between TENS dependent cases and pain medications requirements in groups B and C.

Item	Groups		X^2 value	P value	Level of Significance
	Group B	Group C			
TENS dependent cases	4/10	8/10	3.333	0.068	NS
Opioid treated	3/10	0/10	3.529	0.06	NS
NSAIDs treated	3/10	2/10	0.267	0.606	NS

X^2 value: Chi square value. P value: Probability value. S: Significant. NS: Not significant.
NSAIDs: Non steroidal anti-inflammatory drugs (Diclofenac sodium).

At the end of the study it was clear in table (7) and figure (1), that the number of 20 mg Opioid-treated cases in group A, B, and D was three, three and one, respectively; while, the number of 30 mg Opioid treated cases was one case and two cases in groups A and D, respectively. On the other hand, in group D, the number of 50 and 100 mg Opioid-treated cases was two for each dose level. While the number of 75mg NSAIDs treated cases in groups A, B, C and D was two, three, two and three respectively.

Table (7): Comparison between treatment with Opioid, NSAIDs, compound (Opioid+ NSAIDs) and TENS in four groups.

Item	Mentioned dose	Number of cases/treatment/group			
		Group A	Group B	Group C	Group D
Opioid	20 mg	3/10	3/10	-	1/10
	30 mg	1/10	-	-	1/10
	50 mg	-	-	-	1/10
	100 mg	-	-	-	2/10
NSAIDs	75 mg	2/10	3/10	2/10	3/10
Combined (opioid + NSAIDs)		0/10	0/10	0/10	2/10
TENS		4/10	4/10	8/10	0/10

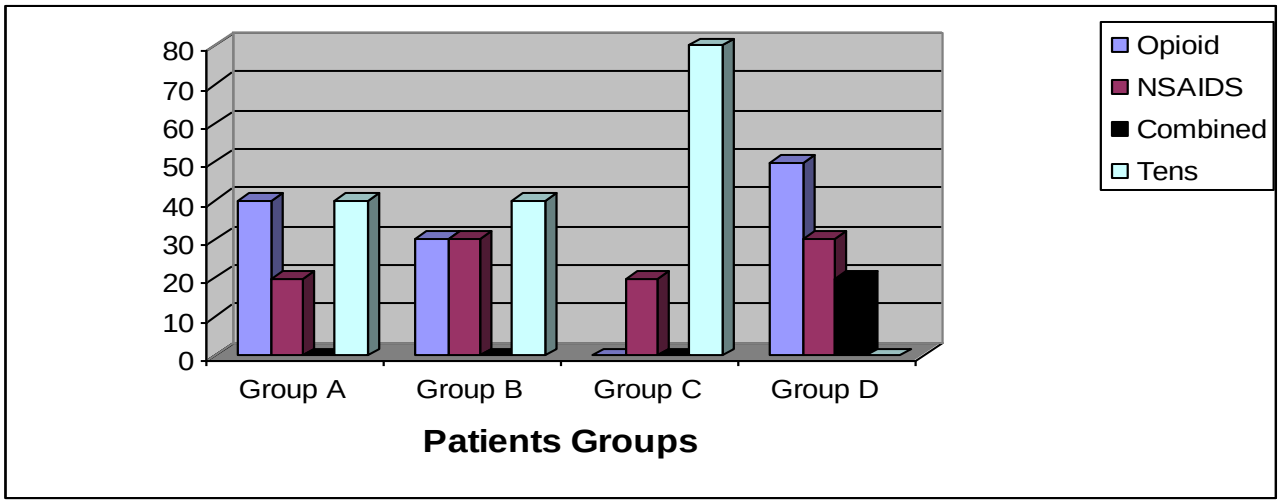

Fig. (1): Shows the TENS dependent cases, Opioid (morphine) and NSAIDs (Diclofenac sodium) treated cases percentages in different groups.

DISCUSSION

This study was conducted to investigate the influence of TENS application on postoperative pain in patient who had been operated upon for inguinal herniorraphy. Also to compare between the location of electrodes on acupoint (Zusanli- ST.36 point) nonacupoint (paraincisional) and combination of both simultaneously. The pain relieve was determined and measured in this study by the reduction of pain medication requirements.

The results of this current study revealed that TENS application reduces the postoperative pain. It showed decrease in the pain medication requirements on comparison with the control group. The severity of pain in the examined three groups (A,B and C) was reduced as the number cases; whom does not require pain medication was significantly increased in comparison with control group.

On comparison between the different locations of the TENS electrodes, it was found that application of TENS electrodes at the paraincisional and at the Acupuncture point (Zusanli, ST. 36) simultaneously had superior influence when compared with the location of electrodes at, either paraincisonal or Acupoint (Zusanli, ST. 36) only. While there was no difference between the location of TENS electrodes at paraincisional and at acupuncture point (Zusanli, ST. 36).

These data demonstrate that the site of electrical stimulation (location of electrodes) is an important for pain relieving efficacy after surgery[7].

Furthermore it was reported that the central neuron sensitization is reduced by TENS and may underlie the reduction in hyperalgesia observed after treatment with TENS[9].

On the other hand it was observed that TENS is an ineffective tool in reducing pain postoperatively in the cases of inguinal herniorraphy, as there was no difference in the pain scores and pain medication requiments between the treatment group the control group over the first three postoperative days[10].

Also, TENS application only without any analgesics is ineffective in relieving post

median sternotomy pain when applied in the first 12 hours postoperatively [8].

As regards some researchers used TENS for treatment of acute postoperative pain for twenty patients undergoing decompressive lumbar Laminectomy in a double blind study and it was concluded that TENS offered no advantage over placebo in the management of those cases[11].

Low frequency TENS releases Met-enkephalin, which is antagonist by naloxone as it is mediated by μ-receptors. Whereas hypoalgesia induced by high frequency TENS.

Required much higher doses of naloxone for reversal but was easily reversed by a kappa-receptors antagonist, indicating that the effect were mediated via kappa-receptors[11]. While the peptides mediating the response to the low frequency TENS can not be acting on delta-receptors which are at least as insensitive to naloxone as kappa-receptors and preferred by enkephalin[12].

It was noticed that low frequency TENS applied on Zusanli ST. 36 resulted in a marked increase of ir-Meap but not ir-Dyn A, whereas high frequency TENS produced a 49% increase in ir-Dyn A, but not ir-MEAP, in the CSF samples which it was examined by radio immunoassay[12].

It was suggest that low frequency (2-4Hz TENS) had greater analgesic effect than high frequency (100Hz TENS) using an experimental acute pain models. In contrast, it was reported that the use of high frequency TENS produced greater analgesic effects[13,14].

It was found that no difference between low frequency (2Hz TENS) and high frequency (100Hz TENS). However, the alternating pattern low and high frequency (TENS) may offer an advantage over either frequency alone[16].

Transcutaneous electrical nerve stimulation (TENS) application at both Chinese acupoints and dermatomal levels corresponding to the surgical incision have been reported to be significantly decrease postoperative opioid requirements and the opioid related side effects. The effectiveness of TENS in reducing the need for opioid analgesics has recently been shown to be influenced by both location of TENS electrodes and intensity of electrical stimulus[6,7,8,17].

It was mentioned that, while the precise mechanism of action of TENS is not understood, it appears to exert its beneficial effects through several different modes of action. The classical gate control theory of pain suggests that stimulation of large diameter, mylinated A-β nerve fibers, which have a low threshold for stimulation by electrical current, can alter pain recognition in the substantia gelatinosa, thus closing the transinission of painful stimuli through the smaller diameter A-δ and C fibers.

There is also evidence that TENS can directly decrease the conduction and amplitude of painful stumuli through the A-δ fibers. Finally, an endogenous opioid dependent mechanism involving the release of endorphins, enkephalins, in CNS has been proposed[6].

In a preliminary study the result of stimulation at both classical Chinese acupoint (Hegu LI. 4) on the nondominant hand and the paraincisional dermatomes with a high intensity (9-12 mA) of TENS produced 50% decrease in the postoperative opioid analgesics requirement. In the current study, the application of TENS at the (Zusanli ST. 36) and paraincisional dermatoms at the same time, the ratio of reduction in the requirement of opioid analgesia was 70%. This indicating that stimulation at Zusanli ST 36 and paraincisional at the same time produced more endogenous analgesia [6,16].

In the present study the consumption of nonsteroidal antiinflammatory drugs (NSAIDs) was only Diclofenac sodium which was introduced by the intramuscular route only. Comparing the three groups to the controlled; it was found that in acupoint stimulation and the combind acupoint and paraincisional group the NSAIDs requirement reduced by 30% but the NSAIDs requirement reduced by 20% in the paraincisional group, the underlying cause for this is unclear.

It was noticed that the controlled group of the present study has a very obvious effect on reduction of pain medication requirements which might 30% in opioids and 70% in NSAIDs.

On the other hand it has been reported that both active TENS and sham TENS are significantly reduced analgesic requirements and subjective reports of pain and no significant difference were found between true active TENS and sham TENS[18].

The researcher noticed that the postoperative pain medications requirement was high on the first 18 hours after surgery, in a few cases who required one shut of diclofenac sodium (75mg) intramuscular (IM) after that time. It was noticed also that the paraincisional and paraincisional and Zusali (ST 36) groups, were started ambulation very early compared to the controlled group, also the period of paralytic ilieus was shorter in the postoperative period among those groups compared to the controlled groups, but there was no objective parameters to record these findings and follow it up. This results has an agreement with the work of wang et al[6].

On the other hand TENS decreased postoperative pain, hence decrease the requirement of opioids also decreased the opioid related side effects after lower abdominal surgery[16].

Finally in this study there was a benefit to establish the optimum location of TENS electrodes to achieve the maximum possible postoperative analgesia by TENS and to reduce the requirements for pain medications after lower abdominal surgeries. As it is very clear from the significant reduction of opioid (mophine) and NSAIDs

requirements in the group of paraincisional and Zusali (ST. 36 TENS) and this was the most effective location for TENS electrodes for stimulation[7].

Conclusion

The findings of this study revealed that the best location of TENS electrodes to reduce pain medication requirements postoperatively was on the paraincisional and Zusanli (Stomach 36) simultaneously.

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الملخص العربى

تأثير التنبيه الكهربي لجانبي الجرح ونقطة زوسانلي على احتياجات الأدوية المثبطة للآلام فيما بعد إصلاح الفتق الإربي.

تم اجراء هذا البحث للتوصل إلى الوضع الأمثل لأقطاب التنبيه العصبي الكهربي عبر الجلد للحصول على افضل مستوى لتقليل الالم مابعد الجراحة . أربعون مريضا ممن تم إصلاح للفتق الإربي لهم وتتراوح أعمارهم بين الثلاثين والخمسين عاماً و بينهم ثلاث سيدات . وقد تم اختيارهم من قسم الجراحة العامة بمستشفى منوف العام حيث تم توزيع هؤلاء المرضى عشوائيا في أربع مجموعات متساوية (أ، ب، ج، د). مجموعة (أ) تم تثبيت أقطاب جهاز التنبيه العصبي الكهربي عبر الجلد على نقطة زوسانلي وهى نقطة تابعة لنقاط الإبر الصينية (قناة المعدة نقطة رقم 36) . مجموعة (ب) تم تثبيت أقطاب جهاز التنبيه العصبي الكهربي عبر الجلد على جانبي الجرح (الشق الجراحي). مجموعة (ج) تم تثبيت أقطاب جهاز التنبيه العصبي الكهربي عبر الجلد على نقطة زوسانلي وكذلك على جانبي الجرح (الشق الجراحي) في آن واحد. مجموعة (د) وهى المجموعة الضابطة في البحث وقد تم تثبيت أقطاب جهاز التنبيه العصبي الكهربي عبر الجلد بنفس الطريقة التي تم التثبيت بها في مجموعة (ج) وتم اختيار تردد تيار التنبيه الكهربي عبر الجلد (من 2 : 4 هرتز). تم ضبط قوة التيار الكهربي تدريجيا حتى وصل إلى درجة يمكن أن المريض بتنميل قليل فى مجموعات (أ، ب، ج) . ولكن فى المجموعة (د) وهى المجموعة الضابطة تم إخبار المرضى بأنهم لن يشعروا بشدة التنبيه الكهربي رغم أنهم سوف يرون ضوء لمبة المبين الدال على خروج التيار الكهربي من الجهاز وتم ضبط زر قوة التيار على صفر. وقد أظهرت الدراسة النتائج الآتية: أن جهاز التنبيه العصبي الكهربي عبر الجلد له تأثير إيجابي في تقليل كمية الأدوية المثبطة للآلام سواء المخدرة (المورفين) وكذلك المسكنة (ديكلو فيناك صوديوم) فيما بعد جراحة أسفل البطن (الفتق الإربي) في المجموعات الثلاث (أ، ب، ج) عموماً مقارنة بالمجموعة الضابطة (د). وقد اظهرت النتائج :أن جهاز التنبيه العصبي الكهربائي عبر الجلد يقلل أو يزيل الآلام الحادة تماماً فيما بعد جراحة إصلاح الفتق الإربي.وكذلك يقلل احتياج المريض إلى الأدوية المثبطة لآلام فيما بعد جراحة أسفل البطن (إصلاح الفتق الإربي) . **الخلاصة :** أن وضع أقطاب جهاز التنبيه العصبي الكهربي عبر الجلد على جانبي الجرح (الشق الجراحي) وكذلك على نقطة زوسانلي في آن واحد هو الوضع الأمثل للحصول على أعلى درجة من تسكين الألم أو إزالته نهائيا وذلك في حالات الألم الحاد فيما بعد العمليات الجراحية لأسفل البطن ومثال على ذلك (إصلاح الفتق الإربى).