Transcutaneous electrical nerve stimulation for pain management in patients with uncomplicated minor rib fractures

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Abstract

Objective: Few non-surgical conditions are more painful than rib fractures. There are a few methods for pain relief in patients with minor rib fractures.

Methods: We used a non-steroidal anti-inflammatory drug (NSAID, Naproxen sodium) and transcutaneous electrical nerve stimulator (TENS) to control pain of the patients with uncomplicated minor rib fractures. One hundred consecutive patients admitted to Kartal Education and Research Hospital Emergency Service, were randomized into four groups. The patients were assigned to one of the following pain treatments: NSAID, TENS, NSAID plus inactive TENS or placebo. The patients used NSAIDs and placebo four times a day and TENS twice a day for 3 days. All patients were asked to assess their pain level with a scoring system on days 0, 1 and 3.

Results: The most effective treatment was TENS on days 1 and 3 ($P < 0.05$). Although NSAID and NSAID plus inactive TENS controlled pain better than placebo on day 1 ($P < 0.05$), this superiority did not continue to day 3 ($P > 0.05$). There was no difference between NSAID and NSAID plus inactive TENS in controlling pain on either days 1 or 3.

Conclusion: We conclude that TENS was more effective than NSAID or placebo in patients with uncomplicated minor rib fractures, because of its prominent and admirable efficacy in reduction of pain. © 2002 Elsevier Science B.V. All rights reserved.

Keywords: Transcutaneous electrical nerve stimulator; Non-steroidal anti-inflammatory drug; Rib fracture; Pain; Pain relief; Naproxen sodium

1. Introduction

Rib fractures are the most common form of the chest wall injuries with a rate of 35–40% of all thoracic trauma [1–3]. Patients with multiple rib fractures face high rates of complications such as atelectasis, alveolar collapse or supervening infection, because pain prevents coughing, deep breathing and bronchial toilette [4,5]. Effective pain relief can prevent complications, and decrease mortality and morbidity in these patients [6]. Minor rib fractures (less than four fractured ribs) do not include flail chest or fractures of the first rib or second rib [1,6]. This type of injury comprises over half of all rib injuries and rarely causes complications [2]. But patients with minor rib fractures can also suffer severe pain. Non-steroidal anti-inflammatory drugs (NSAIDs) and narcotics are the preferred drugs for pain control of these patients [3,6].

Transcutaneous electrical nerve stimulator (TENS) has been effectively used in acute and chronic pain for a few decades. TENS creates a feeling of light touch and pressure on the skin and has been used for minimizing chronic pain (such as osteoarthritis, phantom limb pain, neuropathic pain syndromes) or acute pain (such as lacerations, fractures, hematomas, contusions, postoperative pain) [7]. In this study, we examined the efficacy of TENS therapy and compared it with a standard NSAID (Naproxen sodium) in reduction of pain for patients with uncomplicated minor rib fractures.

2. Methods

One hundred consecutive patients with minor rib fractures, admitted to Kartal Education and Research Hospital Emergency Service beginning in February 1998, were randomized into four groups. The patients in group 1 ($n = 25$) used 275 mg of oral Naproxen sodium (Aprol tablets 275 mg, Bilim Pharmaceutical Inc., Istanbul, Turkey) four times a day for 3 days. The patients in group 2 ($n = 25$) were treated with TENS twice a day for 3 days. Group 3 patients ($n = 25$) were treated with both Naproxen sodium and TENS, but the TENS units were inactive. Inactive TENS machines were out of battery and there were no
signs on the machines that showed they were ‘on’. Group 4 (n = 25) used placebo tablets, which were similar in appearance to the Aprol tablets. The hospital ethics committee approved the study.

The exclusion criteria were: (1) having first or second rib fractures, more than three rib fractures or flail chest; (2) requiring hospitalization for cranial or abdominal trauma; (3) patient refusal; (4) undergoing any kind of surgery (including tube thoracostomy); (5) having a cardiac or psychiatric illness; (6) being under the age of 10; (7) having history of gastrointestinal bleeding or ulcer or other contraindications for NSAIDs; or (8) being pregnant.

All patients suffered from blunt thoracic trauma. Chest pain, increasing with breathing in, was the most common symptom. The numbers of the fractured ribs were determined with X-ray examinations of chest. All patients were hospitalized; if surgery was required they were excluded from further study. Remaining patients were discharged from the hospital on the next day and had outpatient chest radiographies on the second and third days. If any complication that required surgery was observed during this period, the patient was re-hospitalized, treated and excluded from further study. The patients were encouraged to cough and breathe deeply. Antibiotics were not routinely used. Written informed consent was obtained from all patients or from parents if the case was under 18. Those who refused to participate to the study were excluded, and the patients also had an opinion of leaving the study at any time.

One of four previously educated nurses, who did not know if the TENS machine was inactive, informed the groups 2 and 3 patients about TENS therapy (Fig. 1). These patients were told that they might or might not feel a sensation of tingling, and this instruction was carefully standardized. The same blinded nurses performed two phases of TENS therapy during the hospitalization period and instructed the patients how to use the machine at home. These nurses were told that every patient would be treated with active TENS units and they were not let to know about the content of the study. The first phase of TENS therapy (either active or inactive) was performed in groups 2 and 3 within 2 h after admission to the hospital and the second phase was 12 h after the initial one. The patients used the machine as they were instructed at home twice a day for 2 more days. The stimulators (Dual-channel TENS, Biotens Inc. Istanbul, Turkey) had a frequency capacity of 2–120 Hz, an output of 12 ma, and a pulse width of 0–80 ms. They were used in 80 Hz, 12 ma, and 50 μs. The electrodes of TENS were placed with adhesive gel on the either both sides of the fractures, along the lines of intercostals nerves. The treatment was conventional TENS therapy and each phase lasted for 30 min. The patients in the groups 1, 2 and 4 used the drugs either Naproxen sodium or placebo, four times a day for 3 days. These treatments also began within 2 h after the admission to the hospital.

All patients were asked to assess their pain level with a scoring system from 0 to 10 (0 – no pain, 10 – the worst pain they had ever had in their lives). Some pictures of facial expressions were also used for clarifying this system and determining the correct level of pain. The patients answered the scoring system three times: First, when they were hosp-
talized (before the treatment); second, on the next day before they were discharged from the hospital (after two phases of TENS therapy and/or four tablets of drugs); and third day (after the therapy had ended).

2.1. Statistical analysis

Data were presented as means and standard deviations. An analysis of variance $F$-test was used for showing the difference between the groups. Mann–Whitney $U$-test was used for pair wise comparisons and overall comparison was confirmed with non-parametric Kruskal–Wallis test. The significant $P$ value was considered as 0.05.

3. Results

The study included 100 (41 female, and 59 male) patients with rib fractures. The ages were between 11 and 81 (40 ± 16). Age and sex differences between the groups were not statistically significant. Thirty-one patients had one rib fracture, 43 had two fractures, and 18 had three fractures (1.8 ± 0.8) (Table 1). The numbers of fractures of each group were similar ($P > 0.05$).

Eight patients were excluded because of complications, and they were replaced. Seven had respiratory distress during the hospitalization period; three had hemothorax, and four had pneumothorax. All were treated with tube thoracostomy. Right hemothorax was diagnosed on the eighth patient the day after he had been discharged. He was re-hospitalized and underwent a tube thoracostomy procedure. No other patients required surgery, nor was there any mortality.

The patients were asked to assess the severity of pain three times in days 0, 1 and 3 (Table 2). Each group was analyzed statistically for the pain levels on days 0, 1 and 3. The pain levels of each group were not statistically different on day 0 ($P > 0.05$). On day 1, the pain levels in placebo group were higher than other groups ($P < 0.05$), and the pain levels group 2 were lesser than groups 1 and 3 ($P < 0.05$). On day 3, group 2 patients had lesser pain than groups 1, 3 and 4 ($P < 0.05$), and there was not a statistical difference between these three groups ($P > 0.05$).

On each group, the pain levels of days 0, 1 and 3 were also compared. All patients, except placebo group, had significantly lesser pain on days 1 and 3 than day 0 ($P < 0.05$). In placebo group, the pain levels were lesser on day 3 than on day 0 ($P < 0.05$), but there was no difference between the pain levels on days 0 and 1 ($P > 0.05$).

No complications due to TENS therapy or Naproxen sodium were seen during the study.

4. Discussion

Mild rib injuries contain less than four fractures and are very common after blunt chest traumas [1,6]. They rarely cause life threatening conditions [1], but the pain can cause restriction of coughing, deep breathing and bronchial toilette [8–10]. The primary goal of treatment of mild fractures should be the reduction of local pain [1]. Adequate analgesia improves pulmonary function by reducing pain and intercostals muscle spasm [9]. Invasive pain relief methods of intercostals catheter, intrapleural catheter or epidural catheter are not convenient for these patients, because these procedures have high rates of side effects such as pruritus, pneumonia, bladder distension, hypotension, delayed respiratory depression, headache, ileus and catheter complications (such as pneumothorax, infection and bleeding).

### Table 1

<table>
<thead>
<tr>
<th></th>
<th>Group 1 (n = 25)</th>
<th>Group 2 (n = 25)</th>
<th>Group 3 (n = 25)</th>
<th>Group 4 (n = 25)</th>
<th>$P$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex (f/m)</td>
<td>10/15</td>
<td>11/14</td>
<td>9/16</td>
<td>11/14</td>
<td>0.846</td>
</tr>
<tr>
<td>Age (mean ± SD)</td>
<td>35 ± 19</td>
<td>44 ± 15</td>
<td>41 ± 14</td>
<td>40 ± 16</td>
<td>0.215</td>
</tr>
<tr>
<td>Injury Mechanism</td>
<td>19 (76)</td>
<td>17 (68)</td>
<td>18 (72)</td>
<td>23 (92)</td>
<td>0.352</td>
</tr>
<tr>
<td>Traffic accident</td>
<td>5 (20)</td>
<td>7 (28)</td>
<td>5 (20)</td>
<td>2 (8)</td>
<td></td>
</tr>
<tr>
<td>Fall</td>
<td>1 (4)</td>
<td>1 (4)</td>
<td>2 (8)</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Number of fractures</td>
<td>1 (1%)</td>
<td>8 (32)</td>
<td>10 (40)</td>
<td>10 (40)</td>
<td>0.323</td>
</tr>
<tr>
<td>1 (%)</td>
<td>11 (44)</td>
<td>8 (32)</td>
<td>10 (40)</td>
<td>10 (40)</td>
<td></td>
</tr>
<tr>
<td>2 (%)</td>
<td>10 (40)</td>
<td>12 (48)</td>
<td>10 (40)</td>
<td>11 (44)</td>
<td></td>
</tr>
<tr>
<td>3 (%)</td>
<td>4 (16)</td>
<td>5 (20)</td>
<td>5 (20)</td>
<td>4 (16)</td>
<td></td>
</tr>
</tbody>
</table>

* $P < 0.05$ is significant; and SD: standard deviation.
They also require hospitalization periods and experienced people for placing the catheters. Intercostal nerve blockage is a safe and simple technique, and can be used for both severe and mild injuries [2], but it has a risk of pneumothorax and requires multiple injections that should be done every 6 to 8 h [6,12]. Additionally, multiple fractures require more simultaneous injections that not only increase potential risk of toxicity, but also can be more painful than rib fractures [3,8]. Patient-controlled analgesia with narcotics is also an effective way of reducing pain in these patients. Although this method is frequently recommended, side effects due to narcotics can occur. These include patients compliance, sedation, nausea, vomiting, constipation, respiratory depression and bowel dysmotility [2,6,8,13,14].

TENS has been effectively used in acute and chronic pain for a few decades. TENS controls pain based on gate-control theory [7,15]. According to this theory, there is a gating system in the dorsal horns of spinal cord, where C fibers, transmit pain, and A fibers, transmit sensation of light touch and pressure, meet each other. This system prevents C fibers from transmitting pain when there is a stimulus of light touch and pressure. TENS creates a sensation of light touch and pressure with an electrical energy across the surface of skin, and that effects A fibers. By this path, it prevents the transmission of pain through C fibers [7].

The pain control effect of TENS has been studied for over 25 years. It is not adequate for the relief of severe pain, but has been effectively used for controlling chronic pain conditions of nervous, respiratory or musculoskeletal systems (such as osteoarthritis, phantom limb pain, neuropathic pain syndromes) [2,7,16–19]. It also enhances the tolerance to acute pain due to lacerations, fractures, hematomas, contusions or surgery [4,13,14,19–22]. Sloan et al. studied the effectiveness of TENS on the patients with moderate rib fractures (the number of the fractures were more than three) in not only controlling pain but also improving ventilatory function [4]. TENS reduced the pain, and as a result of this an improvement in PaO2 was also determined in this study.

NSAIDs are frequently used for mild pain due to fractured ribs [2,6,21]. They are safe and reliable, but they can cause some gastrointestinal problems. In our study, the patients, who used NSAIDs (group 1), had an effective pain relief. The pain level in group 1 was statistically lesser than placebo group (group 4) on day 1. But there was not a difference in pain relief between these groups on day 3. In our opinion, NSAIDs are good at controlling pain in early post-traumatic period. There is no need to use NSAIDs for a long duration, because their effects are not more than placebo in late post-traumatic period. It may be because the pain due to mild rib fractures is not severe and stops by the third day. As a conclusion, we recommend using NSAIDs in early post-traumatic period and for a short duration. This will also decrease their well-known potential side effects.

TENS therapy can be an alternative pain control method with high effectiveness and less complications to other techniques. In our study, TENS effectively relieve the pain better than both placebo and Naproxen sodium. The data of group 2 was statistically different from groups 3 and 4, which was very similar to group 1 either on days 1 or 3 ($P < 0.01$). These analyzes reveal that TENS do not have a psychological placebo effect [14,17]. TENS therapy is a practical and beneficial procedure without any serious complications. Patients can easily learn how to apply the electrodes of the machine and also perform the treatment by themselves. In our study, the patients were instructed in the use of the machine during the first and second applications at the hospital and they perfectly completed the treatment by themselves after being discharged. Although some infrequent complications such as skin hypersensibility were published in the literature, no complications due to TENS therapy were seen on our study [23].

As a conclusion, the TENS therapy is an effective, reliable and practical method in controlling pain of the patients with mild rib fractures. It is more beneficial than NSAIDs in early and late post-traumatic period. We recommend using TENS on the patients with uncomplicated minor rib fractures, because of its prominent and admirable efficacy in reduction of pain. NSAIDs can also be effective on controlling pain of these patients in early post-traumatic period.

References


